SOMMARIO

Questo studio è stato realizzato nel contesto delle attuali tendenze green, considerando come la presenza del Tartufo calabrese sia importante, sebbene ancora non sufficientemente valorizzata. Sono state esaminate le potenzialità del prodotto nel promuovere il collegamento tra foreste e sistemi agroforestali. Ci si è inizialmente focalizzati sul mercato del tartufo, a partire dai consumatori e dalle loro preferenze e abitudini, per la comprensione necessaria a studiare tutti i fattori per potere puntare ad azioni di marketing adeguate. Nell'area indagata, in provincia di Reggio Calabria, dove sono state impiantate le prime tartufaie artificiali, e dove le tartufaie naturali sono in difficoltà, la filiera inizia a compiere i primi passi. I risultati di questo studio sono utili anche per sostenere gli attori della catena del valore. Nell'area indagata sono state individuate le aree potenzialmente utili per la produzione di tartufo nella provincia di Reggio Calabria. I risultati della ricerca forniscono nuovi spunti per comprendere gli aspetti e le problematiche che ruotano attorno al tartufo fresco e trasformato, e possono rappresentare una linea guida per sviluppare tecnologie ed innovazioni che corrispondano alle specifiche richieste dei consumatori e fornire strumenti di marketing e strategie appropriati per farne crescere il business.

ABSTRACT

This study was carried out in the context of current green trends, considering how the presence of the Calabrian Truffle is important, although still not sufficiently valued. The potential of the product in promoting the connection between forests and agroforestry systems was examined. The initial focus was on the truffle market, starting from consumers and their preferences and habits, for the understanding necessary to study all the factors to be able to aim for adequate marketing actions. In the investigated area, in the province of Reggio Calabria, where the first artificial truffle grounds were planted, and where natural truffle grounds are in difficulty, the supply chain is starting to take its first steps. The results of this study are useful for supporting the actors in the value chain. In the investigated area, the potentially useful areas for truffle production in the province of Reggio Calabria were identified. The research results provide new insights into understanding the aspects and issues surrounding fresh and processed truffles, and can represent a guideline for developing technologies and innovations that match specific consumer demands and provide appropriate marketing tools and strategies to grow business.

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TRUFFLE CHAIN IN CALABRIA: PRODUCTION AND MARKETING ASPECTS

Dottorato di Ricerca in Scienze Agrarie, Alimentari e Forestali

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# TRUFFLE CHAIN IN CALABRIA: PRODUCTION AND MARKETING ASPECTS

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In copertina
*Foto: Tartufaia naturale in area pre-aspromontana su Pino d'Aleppo*

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# TRUFFLE CHAIN IN CALABRIA: PRODUCTION AND MARKETING ASPECTS

## Ph.D. THESIS

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# Contents

# Abstract

Truffles are an excellence of “Made in Italy” and their extraction and research became UNESCO heritage in 2021. This doctoral thesis aims to investigate the potential and possibilities of valorization of the truffle supply chain in the Calabria Region and, more specifically, in the geographical context of the Ionian area in the province of Reggio Calabria.

Truffles, a niche ecological product, are found in Calabria in semi-natural areas where the soil and climate characteristics are favorable; furthermore, truffles are also starting to be cultivated through truffle farming (not yet in production).

In the post-2020 CAP, the promotion and sharing of knowledge and innovation must be addressed through complementary and transversal knowledge with an “interactive model”, Open Innovation, which brings together public and private operators such as farmers, researchers, intermediate operators and consumers to trigger sustainable development processes.

This study was carried out in the context of current green trends, considering how the presence of the Calabrian Truffle is important, although still not sufficiently valued. More specifically, here the potential of the product in promoting the connection between forests, protected areas and agroforestry systems was examined. Furthermore, the truffle was studied as a gastronomic and tourist attraction of a potential Calabrian Truffle supply chain.

The investigated area was also examined with the support of Geographic Information Systems, identifying the best areas potentially useful for truffle production in the province of Reggio Calabria. This approach was useful to produce a geographic database useful to identify the best areas to produce and promote truffle production. Furthermore, Focus Groups, case studies and interviews with diggers and operators allowed to carry out a SWOT analysis.

The thesis work initially focused on the truffle market, starting from consumers and their preferences and habits, in order to identify the demand for fresh and/or processed product. In particular, the consumer figure plays an important key role and the analyses on consumption preferences represent the heart, the starting point for the understanding needed to study all the factors that - in the context of the thesis work - are necessary to be able to aim at adequate marketing actions and push towards a Calabrian Truffle supply chain.

The analyses of consumption preferences empirically explore the factors that influence truffle consumption. Therefore, a PLS-SEM model was implemented and validated using an extended version of the theory of planned behavior. The results showed how truffle consumption intentions involve several factors.

The multicriteria approach also allowed the identification of consumer profiles that are attracted by a particular product such as fresh and processed truffles and that complain about the poor availability and the difficulties in purchasing.

In the investigated area, in the province of Reggio Calabria, where the first artificial truffle grounds were planted, and where natural truffle grounds are in difficulty (climate reasons, fires and others), the supply chain is starting to take its

first steps and the connection between the different actors involved is having difficulty taking off, especially in the transformation and marketing phase. A renewed, recent interest is evident in the actions of regional politics (CREA Calabria and Calabria Region) and in particular by the catering industry. The results of the research have provided new insights into understanding the aspects and problems that revolve around fresh and processed truffles, which can represent a guideline for developing appropriate marketing strategies to grow the business.

**Keywords:** Truffle, marketing, Calabria, supply chain, consumers, multivariate analysis

# Riassunto

Il tartufo è un'eccellenza del "Made in Italy" e la sua estrazione e ricerca sono diventate patrimonio UNESCO nel 2021. Questa tesi di dottorato ha lo scopo di indagare le potenzialità e le possibilità di valorizzazione della filiera del tartufo nella Regione Calabria e, più in dettaglio, nel contesto geografico dell'area ionica in provincia di Reggio Calabria.

Il tartufo, prodotto ecologico di nicchia, in Calabria si trova in aree semi-naturali dove le caratteristiche pedoclimatiche sono favorevoli; inoltre, il tartufo sta iniziando a essere coltivato anche attraverso la tartuficoltura (non ancora in produzione).

Nella PAC post-2020, la promozione e la condivisione di conoscenze e innovazione devono essere affrontate attraverso conoscenze complementari e trasversali con un "modello interattivo", Open Innovation, che metta in contatto operatori pubblici e privati quali agricoltori, ricercatori, operatori intermedi e consumatori per innescare processi di sviluppo sostenibile.

Questo studio è stato realizzato nel contesto delle attuali tendenze green, considerando come la presenza del Tartufo calabrese sia importante, sebbene ancora non sufficientemente valorizzata. Più specificatamente, qui sono state esaminate le potenzialità del prodotto nel promuovere il collegamento tra foreste, aree protette e sistemi agroforestali. Inoltre, il tartufo è stato studiato come attrattiva gastronomica e turistica di una potenziale filiera del Tartufo calabrese.

L'area indagata è stata esaminata anche con il supporto dei Sistemi Informativi Geografici, individuando le migliori aree potenzialmente utili per la produzione di tartufo nella provincia di Reggio Calabria. Questo approccio è stato utile per produrre un database geografico utile per identificare le migliori aree per produrre e promuovere la produzione di tartufo. Inoltre, Focus Group, casi di studio e interviste a cavatori e operatori hanno permesso di effettuare un'analisi SWOT.

Il lavoro di tesi si è inizialmente focalizzato sul mercato del tartufo, a partire dai consumatori e dalle loro preferenze e abitudini, al fine di identificare la domanda di prodotto fresco e/o trasformato. In particolare, la figura del consumatore gioca un ruolo chiave importante e le analisi sulle preferenze di consumo rappresentano il cuore, il punto di partenza per la comprensione necessaria a studiare tutti i fattori che - nell'ambito del lavoro di tesi- si rendono necessarie per potere puntare ad azioni di marketing adeguate e spingere verso una filiera del Tartufo Calabrese.

Le analisi delle preferenze di consumo esplorano empiricamente i fattori che influenzano il consumo di tartufo. Quindi, è stato implementato e validato un modello PLS-SEM utilizzando una versione estesa della teoria del comportamento pianificato. I risultati hanno mostrato come le intenzioni di consumo di tartufo coinvolgano diversi fattori.

L'approccio multicriteriale ha consentito altresì l'identificazione di profili di consumatori che sono attratti da un prodotto particolare come i tartufi freschi e lavorati e che lamentano la scarsa reperibilità e le difficoltà nell'acquisto.

Nell'area indagata, in provincia di Reggio Calabria, dove sono state impiantate le prime tartufaie artificiali, e dove le tartufaie naturali sono in difficoltà, (motivi climatici, incendi e altro) la filiera inizia a compiere i primi passi e il collegamento fra i diversi attori coinvolti ha difficoltà a decollare, specialmente nella fase di trasformazione e commercializzazione. Un rinnovato, recente interesse si evidenzia nelle azioni della politica regionale (CREA Calabria e Regione Calabria) ed in particolare da parte della ristorazione.

I risultati della ricerca hanno fornito nuovi spunti per comprendere gli aspetti e le problematiche che ruotano attorno al tartufo fresco e trasformato, che possono rappresentare una linea guida per sviluppare strategie di marketing appropriate per farne crescere il business.

**Parole chiave:** Tartufo, marketing, Calabria, filiera, consumatori, analisi multivariata

# GENERAL INTRODUCTION

In recent years, interest in truffles has increased, both for the wild ones and for those grown in artificial truffle grounds. In the latter case, new income opportunities are promoted for the various operators in the supply chain (Huber et al., 2023), supporting the recovery and enhancement of marginal and inner areas (Ferraro et al., 2022), which can also be realized through the promotion of potential links with food and wine tourism.

The truffle represents an interesting economic resource in the areas where these special forest products occur. In recent years, there has been an increase in interest on these prized mushrooms, both by those who have identified a profitable activity in the production and marketing of truffle plants and by farmers who intend to enhance their land (Brun & Mosso, 2013; Laganà et al., 2024; Oliach et al., 2021; Pampanini et al., 2012. ). In this context, the truffle sector can attract new economic flows generated by territorial marketing and by the promotion of fresh and/or processed products.

Another aspect not to be underestimated concerns the green and environmental role of truffles. Green aspects is becoming central in the new paradigms and analysis models and, also, in the relationship with environmental, social and economic sustainability.

In awareness of this growing importance of truffle cultivation and its use in the gastronomic sector in marginal and inner Italian areas, our study examines the importance of study of truffle value chain in Calabria and in particular in the the province di Reggio Calabria

The research objective of the PhD project is to investigate which factors that contribute to the creation and valorization of a Calabrian truffle supply chain, and, more in detail, the potentiality and possibility in the geographical context of the Ionian area, located in the Reggio Calabria province.

The starting point for this study is the market demand for truffles and truffle-based products, to highlight consumer requests. The second aspect to take into consideration concerns the supply of truffles: agro-forestry companies with natural and/or controlled truffle grounds (present and potential in Calabria) and artificial truffle grounds. Finally, the third aspect regards what challenges and opportunities arise for Calabrian truffle farming operators (diggers, traders, processors and restaurateurs ecc).

In artificial truffle grounds, it represents a productive and reforestation innovation (National Strategy for Intelligent Specialization, SNSI 2014-2020; Agenda 2030; Strategies for Internal Areas).

In light of the aforementioned observations, the following research questions were formulated:

- Are consumers interested in truffles and truffle-based products?
- Reputation and range of choice of truffle-based products encourage consumer attractiveness?

- Does the protection of natural truffle grounds and the introduction of artificial truffle grounds allow for the combination of productivity and sustainability in Calabria?
- Can the truffle supply chain in Calabria bring new opportunities for operators?
- Does focusing on the truffle supply chain in Calabria represent a challenge capable of enabling the transfer of innovation and knowledge?

Our thesis to answer these research questions is that activities that revolve around truffles represent a promising and constantly growing commercial driver. The following research hypotheses have therefore been formulated:

*H1:Knowing the attitude of truffle consumers positively influences the development of the truffle supply chain in Calabria*

*H2:Knowing the attitude of truffle consumers positively influences the economy of the Calabrian territory.*

*H3: Knowing the attitude of truffle consumers positively influences intangible forest services, cultural aspects and the well-being of the population.*

It is assumed that consumers' intentions in using truffles involve several factors, such as personal experiences, organoleptic characteristics (aroma and taste), food safety, trust in the seller/brand, traceability information and consumers sensitivity to the protection of the environment and forests.

Truffle are known throughout the world and considered a delicacy of high commercial value, characterized by a unique taste and a characteristic aroma deriving from a mixture of hundreds of volatile compounds (Mello et al., 2006). For these particular characteristics, truffles are appreciated in the international food markets (Ciani et al., 1992) for their belonging to a niche of excellence and particular "appeal".

However, the truffle supply chain has raised controversial opinions: considered positive for rural economies and for the sustainable use of natural resources. It can generate confusion and concern for the evident information asymmetries and the reduced availability of clear information for consumers, also due to the use of synthetic flavorings, the risk of product counterfeiting etc. These aspects and concerns can represent a weakness point in the overall system, despite the popularity of the product worldwide (Marone, 2011; Tsitsipati & Athanasios, 2014).

Weiss et al. (2020), highlighted that NWFPs contribute to different types of ecosystem services, such as the provision of social services (human nutrients and renewable materials) and cultural services (maintenance of traditions and experiences), as well as the creation of jobs and income opportunities in the agro-forestry areas. Therefore, these products play a fundamental role in forestry and rural development. It may be able to promote growing strategies for Calabria as indicated among the objectives of the 2030 Agenda and in the Strategies for Internal Areas, which are aimed to the conservation, redevelopment and promotion of

disadvantaged or fragile areas with qualitatively significant cultural and environmental heritage.

Also PNR 2021-27 is aimed to promote the "Multifunctional enhancement of forest production" for a multifunctional and sustainable approach that should enhance the non-woody forest products. These concepts are related to the ongoing attention to the intangible forest and ecosystem services and nature-based solutions (NBS) that forests can dispense for improving the human well-being and give benefits in terms of biodiversity conservation and cultural and recreational services. All these services could be able to improve the local economy, especially in the inner areas.

Truffle farming can also be a tool useful to accelerate and encourage the innovation in agriculture/forestry and rural development. In Calabria, truffle farming can promote sustainability, representing an important tool for the development of the territory as detailed below:

- contributing to food and wine tourism that revolves around the production of truffles and truffle-based gastronomy (fresh and/or processed);
- supporting the economic improvement of companies and farmers to increase the competitiveness of the local business system;
- acting as a driving force for other diversification and multifunctionality activities, such as agritourism, rural and forestry tourism, Forest Bathing (forest bathing as therapy);
- promoting the social use and the return to the local community of forest properties confiscated to the '*ndrangheta* for artificial installations or for the maintenance, recovery and improvement of existing natural truffle grounds.

From this perspective, truffle production could play an important role in Calabria, in line with forest management, allowing, at the same time, local development, land use and forest management, identity building and enabling the activation of multiple skills, as it is already happened in Spain (Büntgen et al., 2017). All the above cited processes can support the local development, in line with the natural and structural characteristics of the territory, where the communities can set up a development strategy based on the system of relationships on cultural, material and immaterial heritage. This is particularly true since the inner areas of our country, despite abandonment, still preserve and have the potentialities for significant innovation (Oteri, 2019), also identifiable in the use and management of forest areas.

*H4:The introduction of artificial truffle grounds and the maintenance of natural ones have a positive and significant impact on increasing truffle production and improving sustainability in Calabria.*

In the context of current green trends, the presence of Truffle in Calabria is important, and capabilities and potential of an excellent product are not yet sufficiently valued.

Traditionally, truffles were collected in semi-natural ecosystems, mainly in Mediterranean forest areas. In the last century, natural truffle production has

drastically decreased, leading to the development of cultivation practices (Hall & Haslam, 2012) that have gained importance throughout the Mediterranean region and are becoming common in other continents, mainly in geographic areas characterized by a climate similar to the Mediterranean.

In PNR 2021-27, particular importance is given to the multifunctional enhancement of forest production for a sustainable approach to non-wood forest products; nature-based solutions (NBS) and green opportunities are more and more considered, safeguarding forest ecosystems and soil through protection actions, sustainable management and restoration of natural forest ecosystems (Moreau et al., 2017). In the dynamic landscape of agriculture and food science, the introduction of artificial truffle ground and manteinance of natural one, appears as a solution to diversify the agro-forestry systems, promote the connection between forests, protected areas and agroforestry systems. The introduction of the artificial truffle ground has the potential to improve the biodiversity, but also the resistence and resilience in the agricultural systems (Matías et al., 2024). As foreseen by the National Strategy for Intelligent Specialization (SNSI) 2014-2020, the productive innovation of artificial truffle grounds represents an opportunity to create productive and reforestation activities, promoting the supply chains linked to the processing and transformation of truffles, in order to reduce the abandonment of the inner areas, create also new employment.

*H5:The introduction of artificial truffle grounds and the maintenance of natural ones have a positive and significant impact on the transfer of innovations and knowledge in Calabria*

Cultivation of edible mushrooms has been an activity of great ecological, social and economic importance for many years. Truffles are hypogeal edible mushrooms with a complex life cycle during which their mycelium establishes a symbiotic interaction with the roots of trees, especially oak, poplar, willow, hazelnut and, sometimes, shrubs.

Among the agro-forestry policy tools useful for the transfer of innovations and knowledge, we recall:

- CAP Strategic Plan 2023-27 aims to strengthen the role of the agricultural, food and forestry sector in international, European and national contexts in line with:European Green Deal;
- EU From Farm To Fork document which strengthen the role of research and innovation through the European Innovation Partnerships (EIP-AGRI) (https://ec.europa.eu/eip/agriculture/en/node.html );

In particular EIP-AGRI is a tool developed to accelerate changes in agricultural productivity and sustainability, by encouraging innovation in agriculture and in the rural communities, supporting a new interactive approach to innovation. At the heart of the EIP-AGRI approach is the "interactive innovation model", defined as: "collaboration between various actors to make the best use of complementary types of knowledge (scientific, practical, organizational, etc.) in view of the co-creation and dissemination of solutions/opportunities ready to be implemented in practice".

As reported by Fieldsend et al. 2021 (2021), the innovation cannot be observed in isolated cases and innovators are not the only agents of change. Innovation is a complex process (Lundvall, 2016) where solutions are created through complementary and transversal knowledge with an “interactive model” that connects farmers, researchers, intermediate actors (input suppliers, experts, processors, distributors) and consumers. This approach, also known as Multi-Actor Approach (MAA), describes how actors, working together in project activities from conceptualization to post-execution, become key elements for a transdisciplinary approach that can have the potential to address future challenges in forestry and agri-food systems. Among these challenges, the one raised by Conway et al 2022 ( 2022) is particularly interesting: it concerns the need to address issues of ageing of the farming population and to be able to provide support to older farmers. This action promotes the social inclusion in agriculture by enabling older farmers to integrate into the social fabric, in consideration of the WHO indications that define an age-friendly community as one in which "policies, services, structures and facilities support and enable people to age actively". Also, Farrel et al. 2021( 2022) underlined the importance of supporting organic farms through EIP-AGRI, pushing for the diversification and the involvement of younger generations in the family farms. Several authors have also highlighted the importance of co-innovation.

For Dogliotti et al. 2014 (Dogliotti et al., 2014) , the co-innovation in family farming systems in Uruguay represents a valid systemic approach in promoting the sustainable agriculture. The participatory process involved different actors who jointly identified problems and solutions through an adaptation in which problem, diagnosis, redesign, implementation and evaluation are planned as a continuous learning process among all participants: farmers, advisors, technicians, researchers.

Madureira et al. (Madureira et al., 2019) reported the case of the implementation and creation of a network suitable for different cultivation systems and provide insights into the study of a network related to small fruits in Portugal.

Oliveira et al. ( 2019) illustrated the example of an Operational Group for the improvement of water management in the irrigation district of Lis Valley, Portugal. In the case of the work of Feo et al. 2022) the multi-actor approach, co-creation and knowledge sharing are useful in the “Thematic Networks” (TN) activated under Horizon 2020 for innovation in agriculture and forestry. Collaboration offers the possibility to share ideas and transform existing knowledge and research results into innovative solutions that can be put into practice more easily.

Cronin et al. ( 2022) argued on the functioning and causes of possible failures of multi-actor projects in agriculture, forestry and related sectors in Projects funded by the Horizon 2020 (H2020) research and innovation (R&I) program. Van Lancker et al. (2016) examined the main components of the Innovation System, the supporting functions and the potential imperfections of the system.

In all these cases, the actors and innovators are not the only agents of change: several additional factors play a key role, such as policy, legislation, infrastructure, financing and market developments (Klerkx et al., 2012).

*H6:Calabrian truffle farming has a positive and significant impact on the operators involved in the supply chain*

Production activities can also contribute both to guarantee additional supplementary income for farmers and for the various operators in the supply chain, but also stimulate the employment potential. In particular, the supply chain systems, on the one hand, can promote territorial synergies and relationships between the actors in the production, harvesting, processing (possible transformation) and final consumption process; on the other hand, it is necessary to encourage comparison between the various actors to encourage innovation in agroforestry and in rural communities to support an interactive approach between the operators in the supply chain and research and innovation in the knowledge system.

Public operators are also involved in these strategic promotional actions of truffle supply chain. In 2017, the Ministry of Agricultural, Food and Forestry Policies (now called MASAF) set up a technical table organized into 3 working groups aimed at drafting a "National Plan for the truffle supply chain 2017/2020" (https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/11100) :

- GROUP 1. Collection and environmental management, qualification of the activity, calendar, environmental management, list of species, issuing of the card;
- GROUP 2. Marketing, management of the fresh product, processing, labeling, traceability, controls and sanctions;
- GROUP 3 - Taxation and Statistics.

The work of each group and its subgroups is aimed, through reflections and insights, to harmonize the positions of the economic and institutional actors of the truffle supply chain in order to outline the shared principles on the collection, cultivation and marketing of truffles. In Calabria CREA ( Council for Agricultural Research and Analysis of the Agricultural Economy) has recently undertaken important initiatives to promote and enhance local truffle cultivation, proposing interesting coordination signals for an effective improvement of the truffle value chain.

*H7:The addition of Calabrian truffle in agri-food products positively influences the local gastronomic heritage*

Various truffles products such as cheeses, pates, pasta, pizzas, sauces or oils, increases the added value of the agri-food sector (industrial and artisanal), giving it luxury and gourmet attributes (Torregiani et al., 2017; Wernig et al., 2018). Typically, when producers proposes truffle products, they refer to the species *Tuber melanosporum* (black truffle) or *Tuber magnatum* (white truffle), due to their unique aroma and high economic value (Campo et al., 2017; Khalifa et al., 2019; Lee et al., 2020; Patel et al., 2017). However, there is a certain tendency within the food industry to add lower-value truffle species with morphological similarities, such as *Tuber indicum and Tuber aestivum* for black truffle products, or Tuber borchii for white truffle products (Oliach et al., 2021).

# ORGANIZATION OF THE WORK

The organization of the thesis is developed according to a holistic approach where all the aspects and the related documents are connected to each other following the research questions and the hypotheses formulated.

The thesis is divided into 4 chapters, as illustrated below:

**Chapter 1**: In the first chapter of this dissertation, the market and marketing and consumer preferences for truffles and truffle-based products are analyzed. After examining the market and international trade, a general review of the truffle market was realized and an analysis of the luxury and niche products market was performed.

Within these dynamics, the figure of the consumer plays an important role and in this regard the thesis continues with two works on consumer preferences that represent the heart and ant the starting point to answer to hypothesis H1,H2 e H3.

Published works represent the scientific approach applied in the study of consumer preferences for truffles and truffle-based products. During the first phase of the doctorate, the research activities focused on the study of the consumer and on the decision-making process that guides their consumption choices through the study of the recent literature and its evolution over time. In the context of the literature on food consumption, have been consulted many research that study and delve deeper consumption intentions, attitudes, preferences, green sensitivity, sustainability awareness, moral attitudes, health consciousness, territorial identity and recently also the impact of COVID-19 on purchase intentions.

In light of methodological approaches observed in this doctoral thesis and in the scientific articles included here we have implemented a methodological approach that involve an exploratory factor analysis (EFA - based on the analysis of principal components - PCA) and the PLS-SEM analysis to test the hypotheses regarding the relationship between the factors/constructs and the behavior and intentions of consumers. These methodologies had growing attention and application o of least squares structural equation modeling (PLS-SEM) in research and in various disciplines (management, marketing, political and environmental sciences, etc.).

- **Article 1**: A scientific article published in the journal Sustainability – MDPI: Laganà, V.R.; Lombardi, F.; Di Gregorio, D.; Nicolosi, A. *Consumption Preferences for Truffles and Truffle-Based Products: An Application of the PLS-SEM Model.* Sustainability 2024, 16, 5002. https://doi.org/10.3390/su16125002
- **Proceedings article 2:** A work presented at the LIX annual conference of Italian agricultural economists (SIDEA) and included online in the book of long-abstracts: Laganà Valentina Rosa, Di Gregorio Donatella, Nicolosi Agata Carmela *"Factors influence the consumption intention towards fresh and processed truffles: an application of the PLS-SEM model*" https://www.sidea.org/wp2/wp-content/uploads/2023/12/BOOK-OF ABSTRACTS_-04.12.2023.pdf.

**Chapter 2**: The second chapter deals with the aspects of territorial analysis in the study area and the open innovation strategies that can be activated in the territory.

Within the same chapter, a description of two case studies is made, giving an overview of artificial truffle grounds in the province of Reggio Calabria, and in particular in the local study area. The aspects examined respond to the research hypotheses H4 and H5. In fact, in order to study the possibilities and potential of truffles in these areas, a cartography created specifically to map the potential areas of truffle production was developed. In fact the Proceedings article 3 is faced on the green role of the Truffle in Aspromonte, in relation to the aspects of conservation and environmental protection. The study was realized in a geographical context to rethink a geography of the mountain in marginal areas. The indexed article n° 4 analyses the tools for promoting and valorizing some typical products, including the Truffle. The data collected were examined through Social network analysis in the context of Southern Italy. This is an interesting connection with the development of the territory with implications on the social and economic sustainability of the Ionian area.

Contributions n°5 and 6 study the adaptation mechanisms of the local food system. In contribution no. 5 we examine in particular, the public space of the market system with the use of Factor Analysis and AGIL Model. The analysis highlights that the resilience of sellers is no longer sufficient and, in many cases, they have equipped themselves with innovative solutions to meet the new customer demands arising from the pandemic. In contribution n°6 territorial approach is explored to study how the Covid-19 pandemic has made the unsustainability and vulnerability of the global food system visible at all levels of society, highlighting its weaknesses and fragility. Adaptation and innovative solutions in weekly food markets can be used to facilitate transition and innovation and be attractive to consumers who are used to going to the supermarket due to opening hours, the diversity of products including food, groceries and others, and the presence of sales or offers. Over 150 vendor stands were interviewed, divided between retailers and farmers and by type of product sold (including mushrooms and truffles). Interviews were carried out in 14 municipal weekly markets in the coastal strip east of Girona in Catalonia and a factor analysis was applied to examine typology, habits and profiles.

- **Proceedings article 3:**"The green role of truffles in Aspromonte: conservation and environmental protection to rethink a geography of the mountain in marginal areas". Valentina Rosa Laganà, Agata Nicolosi, Donatella Di Gregorio curated by V. Bini, V. Capocefalo, S. Rinauro , Geografia e ecologia politica: teorie, pratiche, discorsi Società di Studi Geografici. Memorie geografiche NS 24, 2024, pp. 489-494. ISBN: 978-88-94690149 (journal included in Elsevier's Scopus directory) https://www.societastudigeografici.it/memorie-geografiche/ , presented at the annual national conference of Economic Geography in November 2023.

- **Article 4**: Donatella Di Gregorio, Arturo Guida, Valentina Rosa Laganà, Serafino Cannavò, Agata Nicolosi. "Agri-food and typical products events: promotional tools for a territory in southern Italy", Pirineos. Revista de Ecología de Montaña vol. 177 Jaca, Enero-Diciembre, 2022, e069 ISSN-l: 0373-2568 https://doi.org/10.3989/pirineos.2022.177002
- **Article 5:** The article, entitled "The Impact of COVID-19 on Municipal Food Markets: Resilience or Innovative Attitude?", published Journal of Open Innovation: Technology, Market, and Complexity, Volume 8, Issue 2, June 2022, 87, https://doi.org/10.3390/joitmc8020087
- **Proceedings article 6:** the work entitled "Innovation for weekly food markets after the Covid-19 pandemic" written and presented together with Nadia Fava and Marta Bonet Carrasco of the University of Girona and Agata Nicolosi of the Mediterranean University of Reggio Calabria. It is published online (https://www.aesopsfp2022.com/) in the proceedings of the 10th annual conference of the AESOP Sustainable Food Planning group, in Almere, the Netherlands (from the 19th until the 22nd of October 2022).

**Chapter 3:** In this Chapter, the aspects related to the agri-food sector, within which truffles represent an interesting a niche product and which offers various possibilities of use, were analyzed. To answer the research hypotheses H6 and investigate the possible impact that truffle cultivation can have on operators. For this purpose, a field research was carried out that included a focus group with interviews with opinion leaders and an in-depth analysis of the only two case studies of the territory. In the first case, the focus group allowed to develop a SWOT analysis illustrated in contribution no. 8. Through interviews with opinion leaders, operators, collectors, processors and restaurateurs, the potential present in the territory was identified and the strengths and weaknesses of the sector were highlighted, as well as the opportunities offered by the economic system and the needs raised by the operators who in various capacities deal with truffles in the Calabria Region.

Two agroforestry companies related to the two case studies illustrate the experiences of truffle cultivation and after an initial positive phase they showed some difficulties due to climate changes, the low summer rainfall, not sufficiently compensated by emergency irrigation and other technical-managerial problems.

As for hypothesis H7 regarding the addition of truffles in local gastronomic products A brief overview on nutritional benefits of the truffle was made, following a specific bibliographical research in order to stimulate the interest of operators/processors towards the production of local gastronomic products based on truffles (pasta, cheeses, cured meats, sauces, oils and vinegars and other truffle-base products, etc.). The trends and opportunities for truffles and truffle-based products emerge from contribution no. 7 which highlights the importance of stimulating and expanding the range of products offered to meet the needs of an interesting group of consumers who require greater availability, accessible and traceable prices. As for the structure and functionality of the

supply chain of truffles and truffle-based products with specific reference to the industrial and commercial components, it is still underdeveloped in Calabria compared to other Italian and foreign realities. This is because artificial truffle grounds are not yet in production, while the production from natural truffle grounds is used for self-consumption or marketed by occasional collectors through the short channel directly to private individuals or restaurateurs in small quantities (not subject to regulatory norms) with mainly tacit and/or informal contractual methods. As for the production of truffle-based products from agri-food companies present in the province of Cosenza, they are marketed through various channels, such as large-scale distribution, retail, online, markets, fairs and events, etc.

- **Proceedings article 7**: a Long abstract presented at the CREA National Conference on Truffles in Calabria (Abstract Book, Primo Convegno Nazionale "Il tartufo di Calabria", curated by: Vincenzo Bernardini e Innocenzo Muzzalupo ISBN 9788833853604) Di Gregorio Donatella, Guida Arturo , Cannavò Serafino, Lombardi Fabio, Nicolosi Agata. titled "Consumer preferences for truffles and truffle-based products: trends and opportunities for Calabria" https://tartufodicalabria.crea.gov.it/public/repository/Abstract_definitivo.pdf.
- **Contribution on Volume 8:** the contribution "Truffles in Calabria: precious resource between protection and valorization" on the Volume "Il tartufo nero di Calabria, l'inizio di un nuovo racconto" Donatella Di Gregorio, Serafino Cannavò, Arturo Guida, Valentina Rosa Laganà, Agata Nicolosi curated by Francesco Maria Spanò and Claudio Mattia Serafin edited by Gangemi Editore spa ISBN 978-88-492-5018-3 (pubblished on 23th january 2024)

**Chapter 4:** It reports the main conclusions of this thesis work and further recent developments of the study.

A final appendix also occurs. It reports further articles published during the doctoral period and some documents of a regulatory nature. At the end, a list of references is reported.

In detail, all the documents are linked to each other following the relationships between the product and the factors that motivate its consumption, without neglecting the green and promotional aspects, including the aspects of the recovery of marginal areas and their valorization.

# CHAPTER 1 - MARKET ASPECTS, MARKETING AND CONSUMER PREFERENCES

## *1.1. Truffle Market and International Trade*

The global truffle market size is estimated at USD 583.9 million in 2022 and is expected to grow at a compound annual growth rate (CAGR, https://www.grandviewresearch.com/industry-analysis/truffle-market-report ) of 7.3% from 2023 to 2030. The market is experiencing substantial expansion, driven by a convergence of factors that cater to a wide range of consumer preferences and industry demands. As gourmet cuisine and fine dining lifestyles gain popularity, truffles play a vital role in elevating the flavor and aroma of these dishes, making them even more appealing to consumers. Fine dining restaurants around the world have recognized the allure of truffles. They often feature truffle-based dishes on their menus, ranging from truffle-infused pastas and risottos to truffle garnishes on meats and seafood. The aroma and flavor of truffles offer a sensory indulgence that appeals to the most discerning palates, making them a natural choice for luxury restaurants. First, the truffle market is a market characterized by a generally stable demand, typical of luxury goods (Essiz & Senyuz, 2024; Mishra et al., 2023), and extremely volatile prices, which, for the most valuable species and in years of low production, reach considerable levels. The truffle market has seen a surge in demand in recent years, driven by a growing appreciation for the unique flavor profile and culinary versatility of this elusive delicacy. In the Italian market, two channels of considerable interest coexist. The local one, particularly linked to the food and wine traditions of the territories of origin, and a second one mainly oriented towards exports. The truffle market, in fact, is poorly covered in the panorama of economic-agricultural studies, mainly due to the extreme difficulty in finding reliable data for organizational analyses of the supply chain. The commercial flow of truffles, especially in the European context, has acquired considerable importance in recent years due to the success and appreciation of consumers that the product itself is gaining. Italy plays a leading role in this area (Brun & Mosso, 2015; De Cianni et al., 2023; Kalfagianni & Andreopoulou, 2018; Milanesi et al., 2020). With a decision of the Intergovernmental Committee of December 2021, UNESCO decided to include "the search and collection of truffles in Italy" among the intangible heritage of humanity. (https://ich.unesco.org/en/decisions/16.COM/8.B.18 ). The total economic impact includes not only fresh truffles sold by farmers, but also agritourism, local mycological gastronomy, production of value-added truffle products, truffle fairs and retail markets, the increase in the price of agricultural land in truffle-producing regions, the production of mycorrhizal seedlings in nurseries, dog training, consumption of agricultural products by truffle producers, etc.).

The peculiar characteristics of this market can be summarized according to a schematic review of the literature on the truffle market (Table 1).

**Table 1**. Schematic review of truffle market literature.

| Source | Definition |
|---|---|
| (Pampanini et al., 2012) | *"Italy, together with France, is by far the most important country in the world for the production, processing and marketing of truffles. The supply is very fragmented and the intermediate demand presents strong characteristics of oligo and monopoly in the processing and distribution phases".* |
| (Galluzzo, 2013) | *"Recent results for Italian truffle exports have highlighted its growth over the last 12 years, particularly within the European Union market, both in terms of value and quantity exported."* |
| (Reyna & Garcia-Barreda, 2014) | *"In France, Italy, Spain and Australia, truffles are currently a multi-million dollar industry. The value of T. melanosporum production is estimated at around 20 million euros per year in France, 7.5 million euros in Spain and 4 million euros in Australia in 2012. In Italy, the value of production of all Tuber species together was estimated at 18 million euros".* |
| (Tsitsipati & Athanasios, 2014) | *"The growth of the truffle market could contribute to social welfare through the creation of additional income, cultivation of arid fields and conservation of natural resources thanks to their environmentally friendly way of production."* |
| (Oliach et al., 2021) | *" In France, Italy, Spain and Australia, truffles are an emerging global industry. The economic activity of the truffle sector generates tens of millions of euros per year. ".* |
| (Čejka et al., 2022) | *"The emerging truffle "industry" generates hundreds of millions of euros per year, increases the value of land and properties, promotes mycotourism and stimulates interdisciplinary research".* |

Source: the author

The studies by Charnley et al 2023, Oliach et al 2021, Pampanini 2012 and Pèrez-Moreno 2021 (Charnley et al., 2023; Oliach et al., 2021; Pampanini et al., 2012; Pérez-Moreno et al., 2021) highlight some peculiar characteristics of this market, which:

- quantitative predominance of moderately valuable species (*T. aestivum uncinatum*) but important for the canning industry (75%) and a lower diffusion (20%) of the more valuable species (*T. magnatum* and *T. Melanosporum*) compared to 5% of the other species;

- decline in the production of natural truffle grounds, whose contribution to total production today represents just 5%, due to the combined effect of predation by hunters, wildlife and climate change;
- stagnation or tendency towards productive decline to which improved truffle grounds are exposed, which the law defines as “controlled”, whose contribution to total production can be estimated at around 55%;
- growing contribution of cultivated truffle grounds to production (45%);
- importance of the processing sector as a link between production and distribution, given the high perishability of the product. It receives approximately 70-80% of national production, while 20-30% reaches consumption mainly through the catering channel.

Furthermore, the truffle market has always complained about a structural definition of “property rights” that has led to a loss in the supply chain over the years, preventing the establishment of an organization/structure for the defense and development of the supply chain. The fundamental issue is represented by the property rights on truffles and the limits imposed on them; solutions identified at regional level can lead to the development of entrepreneurial activities on forest land. In this regard, there are also strong differences between neighboring regions. The fundamental question that has always concerned truffles and that gives rise to conflicts of interest is who is the legitimate owner: the owner of the land, the local community in which the truffle-producing territory is located or those who search for and find truffles? The solution given to this problem by Italian law (law December 1985, n. 752) is to consider truffles res nullius unless they are truffles obtained from dedicated cultivations. In this way, truffle hunters/excavators are favoured and the social function of the forest is safeguarded, but the conflicts between the owners of the land and the citizens who use it are far from being resolved.

## *1.2 International Trade*

Interesting is the economic value that truffles are able to generate in limited local contexts and the presence of operators in this chain of actors not structured at a national level, such as diggers or truffle hunters who dedicate themselves to the collection of spontaneous production from the woods without formalizing its quantity and value, means that a significant part of the production escapes official statistics. Even with regard to the production obtained from cultivated truffle grounds, there is no adequate statistical survey in Italy: since they are not considered "agricultural tree crops" but a form of "productive forestry", this type of truffle grounds is not even recorded in agricultural censuses, while forestry statistics no longer provide systematic information on undergrowth products, and in Italy there is also an ongoing review of forestry statistics in an environmental-energy sense, according to an evolution in line with world statistics. The result is that the data on undergrowth production are uncertain and dated and that the same truffle productions still recorded by ISTAT on the basis of information from the

State Forestry Corps are not published, remaining largely unknown to operators in the sector. Ultimately, for this production sector there is a lack of information on production as well as a high level of uncertainty about the ability of official data to provide a faithful representation of the offer. Even at international level, production statistics are completely lacking (neither Faostat nor Eurostat deal with this product), while national statistics are rather dated and no longer systematically collected. However, they constitute an important information base for comparing regions in terms of production despite all the cautions related to the low significance of the results. The only data present in the data source are official data from the United Nations, Department of Economic and Social Affairs, Statistics Division, Trade Statistics Database (https://comtrade.un.org/data)(Table 2). The quantities of fresh or chilled truffles and mushrooms traded as a whole with reference to the years 2019 and 2020 (the 2021 data are incomplete). As can be seen in 2019, world imports between the various countries amounted to 864,684,514 dollars and exports amounted to 845,435,235 dollars with a negative balance since world imports exceeded exports (- 19,249,279 dollars), while in 2020 the balance was in favor of exports (27,419,083). Among the first 11 countries in the world interested in world trade we find Italy which in 2020 ranks third among the exporting countries of truffles and mushrooms.

**Table 2.** Data from the United Nations, Department of Economic and Social Affairs, Statistics Division, Trade Statistics Database. Truffles and mushrooms, fresh or chilled.

| | 2019 Import | 2019 Export | 2019 Saldo Export-Import | 2020 Import | 2020 Export | 2020 Saldo Export-Import |
|---|---|---|---|---|---|---|
| | Trade Value (US $) | Trade Value (US $) | Trade Value (US $) | Trade Value (US $) | Trade Value (US $) | Trade Value (US $) |
| Italy | 86,911,541 | 78,058,745 | - 8,852,796 | 57,983,791 | 55,429,655 | - 2,554,136 |
| Spain | 11,900,946 | 30,712,475 | 18,811,529 | 10,304,155 | 29,816,888 | 19,512,733 |
| France | 90,160,999 | 22,642,657 | - 67,518,342 | 89,857,345 | 18,049,045 | - 71,808,300 |
| Bulgaria | 1,503,087 | 28,760,023 | 27,256,936 | 1,147,867 | 20,884,166 | 19,736,299 |
| Croatia | 4,128,851 | 6,723,128 | 2,594,277 | 1,723,048 | 11,107,025 | 9,383,977 |
| Romania | 7,066,853 | 36,676,265 | 29,609,412 | 5,969,663 | 41,579,888 | 35,610,225 |
| Serbia | 20,797 | 5,053,819 | 5,033,022 | 47,809 | 7,662,029 | 7,614,220 |
| Sweden | 3,737,967 | 1,998,551 | - 1,739,416 | 5,712,403 | 1,724,155 | - 3,988,248 |
| Holland | 36,860,992 | 70,977,200 | 34,116,208 | 32,277,821 | 55,894,847 | 23,617,026 |
| Rep. of Korea | 21,423,903 | 55,088,167 | 33,664,264 | 17,020,957 | 49,220,787 | 32,199,830 |
| China | 155,474 | 214,119,521 | 213,964,047 | 47,158 | 233,327,980 | 233,280,822 |
| altri paesi | 600,813,104 | 294,624,684 | -306,188,420 | 558,567,465 | 283,382,100 | -275,185,365 |
| Mondo | 864,684,514 | 845,435,235 | - 19,249,279 | 780,659,482 | 808,078,565 | 27,419,083 |

Source: https://comtrade.un.org/data/ Codice 070959 Vegetables; truffle and mushrooms n.e.c. in heading 0709, fresh or chilled.

In Europe, the production of cultivated truffles (Chevalier & Sourzat, 2012) is concentrated in Spain (Reyna & Garcia-Barreda, 2014), France (Chevalier & Pargney, 2014) and Italy (Bencivenga & Baciarelli Falini, 2012) (https://comtrade.un.org/data/ )(Fig 1 and Table 3).

In Italy, production is mainly concentrated in two areas: the first concerns the northern part of the country, in an area that includes southern Piedmont and some areas of Lombardy; the second area located in central-northern Italy, includes the regions of Marche, Tuscany, Umbria, Rome, Abruzzo and Molise (Bencivenga & Baciarelli Falini, 2012). Even in southern Italy, Calabria and Sicily are important production areas that are still little studied and valorized (Calvo et al., 2022).

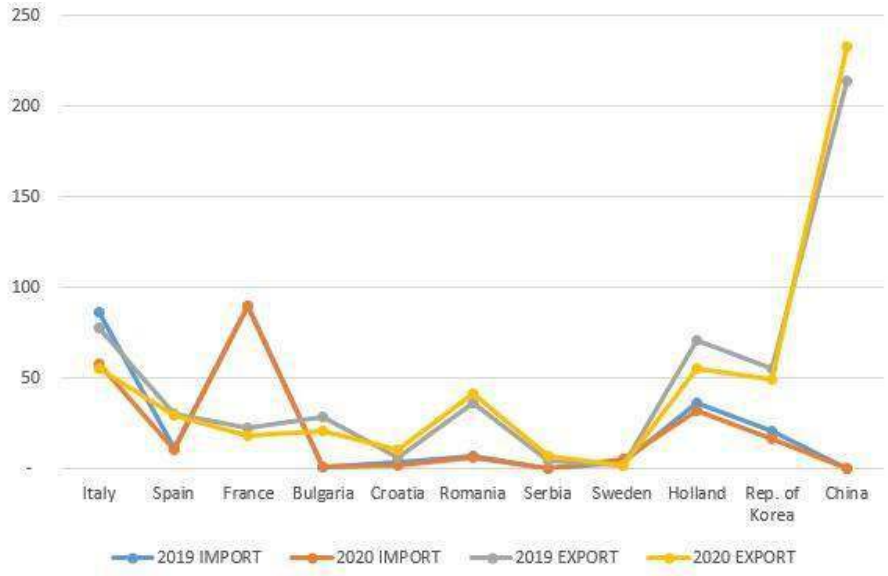


**Figure 1**. Import and export of truffle in the world (2019-2020) Source: https://comtrade.un.org/data/

**Table 3.** Ranking of the main importing and exporting countries and of fresh or chilled truffles and mushrooms

| Incidence of the main importing countries in 2020 | | Incidence of the main exporting countries in 2020 | |
|---|---|---|---|
| France | 40,46 | China | 44,47 |
| Italy | 26,11 | Italy | 10,56 |
| Holland | 14,53 | Holland | 10,65 |
| Rep. of Korea | 7,66 | Rep. of Korea | 9,38 |
| Spain | 4,64 | Romania | 7,92 |
| Romania | 2,69 | Spain | 5,68 |
| Sweden | 2,57 | Bulgaria | 3,98 |
| Croatia | 0,78 | France | 3,44 |
| Bulgaria | 0,52 | Croatia | 2,12 |
| Serbia | 0,02 | Serbia | 1,46 |
| China | 0,02 | Sweden | 0,33 |
| Tot | 100,00 | Tot | 100,00 |

Source: https://comtrade.un.org/data/ Elaboration: The authors

## *1.3 Aspects of Marketing*

The marketing aspect also occupies a large part of researchers' studies for the valorization of food products, with particular reference to territorial marketing and non-wood products of the forest of which the object of study is part. For example, Italian agri-food districts have been a shining example of how to ensure territorial success for niche agricultural products such as truffles, linking them both to tourism and to the gastronomic traditions of rural areas (Star et al., 2020). They have increased the value of organic, traditional and quality food and also the ability of agricultural companies to guarantee, through agritourism and other various activities, the growth of an agricultural production framework capable of ensuring harmonious and integrated development of Italian rural areas, in particular those behind mountain territories, with positive effects on the economy and environment of rural spaces. The development of the forest products and ecosystem services supply chain is also important for sustainable forest management (SFM). A definition of sustainability of food and wine tourism given by Rinaldi 2017 (Rinaldi, 2017) is when "it supports activities, people and institutions in harmony with the other elements of a place, such as natural resources, history and socio-cultural values". All over the world, consumers, producers and public authorities are showing a growing interest in food and agricultural products linked to their place of origin (Sabina del Castillo et al., 2021). Consumers are willing to perceive and evaluate the quality of a product based on its place of origin, transferring opinions about the place and attitudes related to specific goods or services. Regional food culture has therefore become a tool not only to promote economic and rural growth in regions (Florek & Gazda, 2021). It is often seen how a distinctive feature of a territory is used as a brand to create an image that attracts tourists to the region. This is called "territorial marketing" and, together with this brand, related products and services are offered, usually related to recreation, gastronomy and well-being. Non-timber forest products (NFPs), such as mushrooms, truffles, aromatic and medicinal plants, nuts and berries, are natural products linked to local traditions that contribute to rural economies, culture and society. This becomes particularly evident when they are used as identity elements to brand specific geographical areas. Non-timber forest products (NFPs) including truffles can be good examples of products that can be used to define a territorial identity. Lovric et al. (2021) (Lovrić et al., 2021) estimated that harvested NFPs have a total economic value of €23.3 billion/year in Europe, which amounts to €20.5/ha of forest and other woodland. They are natural products and their harvesting and use are linked to rural livelihoods, traditional knowledge, local culture, gastronomy and conservation issues. Sustainable tourism is often present as an activity in the development of a NFP sector and can increase not only economic and environmental benefits but also social and cultural benefits for the local population. Some specific tourism activities related to NWFPs, which are usually offered as ecotourism activities, include mycotourism and truffle tourism (Rovira et al., 2022) (e.g. itineraries, trails or guides to identify mushrooms; guided visits

to truffle plantations or wild collection) (Figure 2). In addition, they can be linked to other products (e.g. itineraries to identify chestnuts, wild plants and berries; aroma parks or botanical gardens with aromatic plants; workshops to develop NWFP-based products). In addition, they can also include agritourism activities (e.g. visits and life experiences in NWFP farms; workshops and tasting of products on the farm) and other types of activities developed for tourists such as show-cooking, fairs and festivals. NWFP-based territorial marketing and related services can be a development tool to diversify agricultural activities (e.g. NWFP-based tourism), maintain rural population incomes and support green jobs, especially in remote areas.

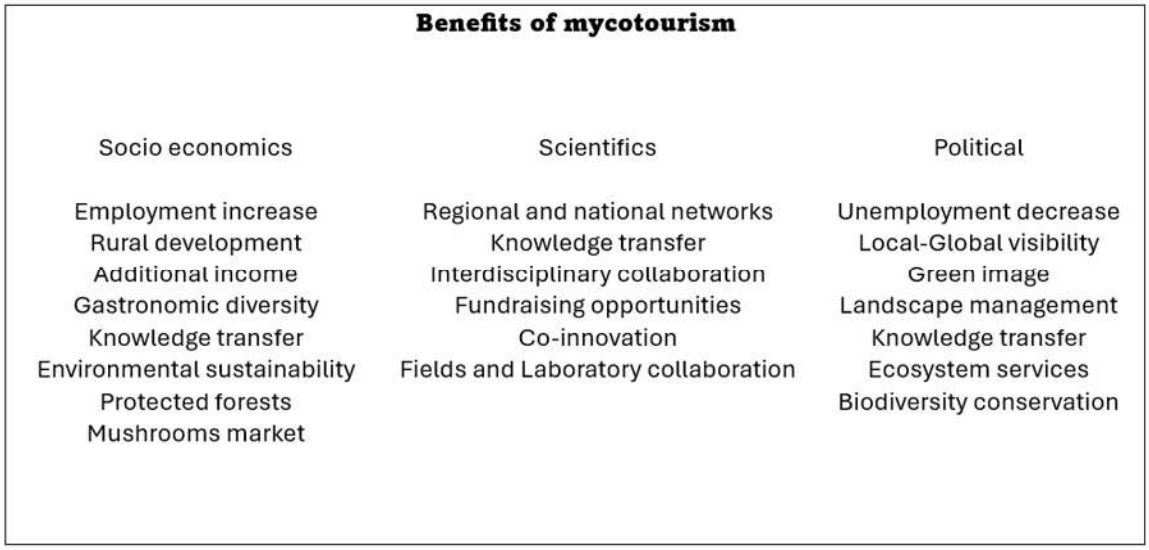


**Figure 2**. Benefits of Mycotourism: Source: Own adaptation from Bűntgen 2017 (Büntgen et al., 2017)

## *1.4. Luxury food market*

Luxury, from a psychological perspective, can be defined as the purchase of goods that the consumer considers to be of high quality, in which a high level of performance is sought, whose aesthetics must positively stimulate all the senses, thus satisfying hedonistic motivations, and which is able not only to tell a story, but is able to transmit it. Poor availability must characterize the distribution of this type of product, or at least it must be perceived as such by the consumer, in order to materialize a feeling of uniqueness and rarity. All these characteristics justify the high cost, which is perceived as a barrier to entry for these types of products. The importance of the intangible symbolic value related to it must, however, be perceived not only by the subject, but also by his or her reference community. After the pandemic, the global luxury industry recorded sales of 1.15 trillion euros in 2021 and continued to grow in 2022 by 19%-21% (Bain & Company, 2023 https://www.bain.com/ ). Recent trends look at luxury food products from the perspective of the consumer's sustainable sensibility (Athwal

et al., 2019). Sustainable luxury represents the ability to consume luxury goods and services that satisfy a person's basic needs and improve their quality of life without negatively impacting the needs of future generations (Batat, 2019). A sustainable consumer should therefore adopt consumption activities that are respectful of the environment, beneficial to the community and the local economy, and support the well-being of individuals. Furthermore, luxury gastronomy not only focuses on the functional aspects of the experience such as food quality, but also reflects experiential and hedonic values that can enhance customers' emotions and increase their sense of enjoyment, pleasure, and joy. (Batat, 2019).

To develop sustainable behaviors, luxury consumers should focus on three main areas:

1. responsible purchasing, such as traceability of luxury products and the materials used to produce them);
2. green consumption and consequently discarding environmentally harmful luxury goods such as animal fur;
3. advanced recycling activities, such as renting or buying second-hand luxury goods).

More and more luxury companies are developing sustainable business practices to meet green luxury consumption trends (such as Truffles) and meet the expectations of engaged and responsible luxury consumers, as well as consumer activists and non-governmental associations (Batat, 2020).

In his study, Batat (Batat, 2020) follows Sheth et al.'s 2011 (Sheth, 1996) "triple bottom line" framework by conducting a comprehensive literature review through a qualitative content analysis of marketing and consumer behavior research that has examined the relationship between luxury and sustainability. Following this perspective, the author highlights the connections between the dimensions of sustainable luxury and the contributions to the three pillars: planet, people and profit. The following table 4 elaborated by Batat, provides a summary of significant studies that have focused on these pillars of sustainable luxury research. According to many researchers, sustainability concerns are very important for luxury companies due to the green luxury consumption trends and the expansion of the luxury market (Athwal et al., 2019; Batat, 2019). In fact, a growing number of consumers are interested in purchasing luxury goods and services, especially consumers from developing countries, who also demand sustainable products. However, some research highlights the incompatibility between luxury and sustainability (Kapferer & Michaut-Denizeau, 2020) as luxury is based on the use of abundance and the use of rare and exotic resources.

As shown in Table 4, most studies that have focused on the relationship between luxury and sustainability address ecological/planetary and social/human issues (Adams et al., 2016; Ryan & Stewart, 2009) as well as the profit-oriented corporate (economic) response to environmental issues.

**Table 4** . Sustainable luxury in marketing and consumer behavior: a review. The pillars of sustainable luxury.

| Authors and year | Focus | Prospective | Pillars |
|---|---|---|---|
| Adams et al. (2018)<br>Bendell e Thomas (2013)<br>Guercini e Ranfagni (2013)<br>Ryan e Stewart (2009)<br>Athwal et al. (2017) | - Sustainable development<br>- Sustainability-oriented innovations as a key strategy<br>- Philanthropic actions by luxury organizations<br>- Luxury brand image and sustainability<br>- Sustainability as an integral part of luxury tourism<br>- Sustainable strategies to increase consumer awareness of companies' CSR activities | Society | Profit, planet, people |
| Henninger et al. (2017)<br>Dekhili e Achabou (2016)<br>Lundblad e Davies (2015)<br>Kapferer e Michaut-Denizeau (2015)<br>Godart e Seong (2014) | - Supply chain transparency<br>- Animal welfare<br>- Worker exploitation<br>- Eco-friendly fashion<br>- Long-lasting products<br>- Consumer motivations for purchasing eco-labels and recycled material<br>- Sustainable luxury and health benefits in fashion and cosmetics<br>- Luxury fashion and sustainable behaviors among Generation Y | Consumers | Planet |

Source: (Batat, 2020)

These studies have highlighted the importance for luxury brands to rethink and transform their production practices into sustainable and green practices, as in the case of truffles and the use of natural resources such as marginal or abandoned areas. The "triple bottom line" supports social justice, economic prosperity and environmental quality. Existing works have mainly examined food sustainability and waste associated with popular restaurants (Sirieix et al., 2017), family restaurants (Jacobs & Klosse, 2016) and the corporate social responsibility of fast food chains. The luxury food market has significant growth opportunities due to several factors:

• Rising Demand for High-Quality Gourmet Food: A trend observed is that consumers are moving towards quality/service food products. These innovative

and high-quality food products have great taste, quality and an innovative dining experience, which is why many customers choose them

• Rise of Culinary and Experiential Tourism: Culinary tourism and experiential gastronomy cater to customers who are looking for luxury foods. People purchase branded luxury products that specialize in meals and related products to complement their dining and class.

• Technological Advancements: Recent changes in food processing technology, such as preservation technology, packaging technology and flavor enhancers, make luxury food products better quality and more attractive. They help attract interested food lovers and of course, high-end retail stores. • Expansion of E-Commerce and Online Gourmet Stores: The increase in e-commerce gourmet food purchases and the emergence of online gourmet stores are contributing to the growth of the global luxury food market. People want quality products and affordable and easily accessible luxury foods are increasing the market for luxury brands.

• Rise of health and wellness trends: The market characteristics of luxury food products are mainly driven by the growing population of health-conscious consumers and the demand for organic/natural and sustainably sourced products. Healthy and gourmet products are of significant interest to today's brand-conscious customers, especially health-conscious customers.

• Rise of at-home dining and entertainment: The increase in people eating, dining and entertaining at home is generating new prospects for luxury foods. People are investing capital in quality ingredients, fine foods and beverages to enhance their at-home meals and entertain guests.

• Rise of food and beverage investment: With the increase in investment by governments and global companies in the food and beverage industry, the luxury food market is also growing. These economic factors are promoting the expansion of the global market and stimulating the emergence of exotic food products

Among luxury products, the niche of fine wines and spirits sales rebounded strongly, reaching €77 billion, up almost 2% from 2019, buoyed by people engaging in post-lockdown socializing in a climate of “revenge conviviality”. Spirits grew the most, driven by rising consumption of Asian spirits (mainly baijiu) and growing interest in high-end spirits. Marketing messages focused on topics such as inclusivity and sustainability to appeal to young adults’ concerns. Sparkling wine, which was disproportionately affected in 2020, recovered better than other segments of the wine market. Fine dining and fine food grew 8-10% at current exchange rates but, at €49 billion, remained 7-9% below 2019 levels. Fine dining, which was hit hard last year, has recovered since lockdowns were eased. Gourmet food grew at a slower pace than last year, despite evidence that greater enthusiasm for home cooking was driving consumers to create high-quality meals with specialist appliances. (Bain and Company 2021, Luxury report, https://www.bain.com/insights/from-surging-recovery-to-elegant-advance-the-evolving-future-of-luxury/ ).

The salient aspects that distinguish a market niche are:

• Specialty: the niche is based on a special product offering, consisting of a specific demand from the target consumer that does not find a direct answer in the panorama of other product offerings present in the reference category. It may also concern a non-pre-existing demand, which emerges from the intersection between multiple product categories and in which the target consumer comes to recognize the satisfaction of a particular need that was unsatisfied until that moment.

• Originality: the offering of niche products tends to immediately stand out in the panorama of the offer for its originality so much so that it is immediately recognizable as such in the eyes of target consumers and therefore has no substitutes.

• Emphasis on value: the focus is on the added value that the consumer recognizes in the offering of special products. Consumer satisfaction is very important, that is, the actual confirmation of the promised specialty characteristics in the performance of the niche product.

• Relativity: the essentially innovative nature of the niche and the specificity of the target naturally limit the size of the business. From a quantitative point of view, it has a smaller size than the reference market.

Luxury consumers are therefore increasingly relying on luxury experiences to build their identity and signal their exclusive status (Bardhi et al. 2020). Given this shift in priorities, authenticity is one of the most significant challenges for the luxury segment of our time. Eating is not just a mechanical action dictated by the need to consume food for one's sustenance, sometimes eating can be an art. Many love to eat well and dedicatedly seek out the most refined flavors, sublime aromas and most inviting textures, to the point of creating a true cult of good food. Driven by the fact that eating is one of life's pleasures, they want to savor ever-new foods and niche local products, transforming their kitchen or their outings into real culinary experiments.

## *1.5 Consumer analysis*

Consumers often consider various factors before purchasing a product, which can be quite diverse. External and internal factors influence consumer behavior, and these factors interact with each other (Hawkins et al., 2019). Externally, current social conditions can influence consumers when they make purchases, for example, when there is a trend or a product has a well-known reputation. Trends can motivate others to try to follow them, which is known as the bandwagon effect, according to Mainolfi 2020 (Mainolfi, 2020). Leibenstein 1950 (Leibenstein, 1950) defines the bandwagon effect as a situation in which someone wants the item precisely because a group of people wants to be a part of it and ignores personal preferences. The bandwagon effect can motivate consumers to purchase because they perceive the product as popular, especially if celebrities and influencers promote it. Sabir et al. 2020 (Sabir et al., 2014) also suggest that

consumers may want to purchase a product because of the bandwagon effect of others, such as family and close friends, or even a large group of strangers, which can create trends. Internally, different consumer attitudes can influence purchase intention, such as materialism and social comparison. These attitudes are internally driven, reflecting consumers' desire to show their social status through specific products (Mainolfi, 2020).

Agri-food products are also perceived by consumers as a set of both tangible and intangible characteristics, which make their choices and the interpretation of their behavior more complex, but at the same time become an opportunity to affirm their values. Intangible characteristics, in fact, go beyond the functional aspects of the product itself, taking into account new elements attributable to numerous categories: the impact of production processes on the environment, the recycling of materials and packaging; the impact on local economic growth; health protection; solidarity towards small producers; justice, etc. (Cembalo et al., 2012). The combination of these characteristics gives products new qualities, which are distinguished by being, obviously, highly subjective. In literature, this consumer is defined as "critical".

As regards local foods, some studies highlight that consumers associate greater freshness, food safety and greater healthiness (Darby et al., 2013; Denver & Jensen, 2014). Through their purchases, consumers contribute to the maintenance of rural communities, in which local farms are strongly integrated, playing a positive role in strengthening and safeguarding the social and economic conditions of local communities (Migliore et al., 2017).

More specifically, when consumers are faced with a product/service, they have a large amount of information available on which to build their opinions and evaluations. These attributes, which can be divided into "intrinsic" (aroma, flavor, shape) and "extrinsic" (brand, price, country of origin), interact with the knowledge already possessed by the consumer (because it derives from consumer experiences, or from other information acquisition processes) thus favoring the creation of expectations on quality. According to the different theories of use of these indicators, when consumers do not have access to intrinsic attributes, to judge and evaluate a product or service, they are forced to rely exclusively on extrinsic attributes (Fandos & Flavián, 2006).

The first group of attributes of a product are all those tangible characteristics (such as flavor, aroma, color), inherent to the product itself, which allow objective measurements and judgments on the quality of the product. These qualities characterize the product with their functionality and reveal its physical aspects and they are specific to each product, expire when the product is consumed and cannot be modified without changing the very nature of the product. These attributes of an agri-food product, such as flavor, color, aroma, freshness, etc., are characterized by the fact that they can be verified and known by the consumer only after the product has been consumed. Before then, the only link between the food product and the future consumer is realized in the concept of "perceived quality".

Organoleptic attributes, especially in agri-food products, play a fundamental role in the evaluation of quality. Taste and smell arise from personal elaborations, therefore they are highly subjective and characterize the identity of each consumer, differentiating them from others. Extrinsic attributes, also known as "image variables", can be defined as characteristics that are linked to the product but are not physically part of it. Quality attributes can be divided into: Indicators (quality management systems, product certification, labelling, minimum standards) and Signals (price, brand, manufacturer's name, packaging, advertising, country of origin, etc.) (Laroche et al., 2013).

Among the most studied extrinsic variables in food choices, price is certainly considered one of the most important. Consumers often and willingly assign price a role as an indicator of quality, since they tend to believe that there is a "natural" ordering on a price scale in which higher quality products are more expensive and lower quality products are cheaper. This connection between price and quality, described in the literature as the "price reliance scheme", reflects the consumers' point of view according to which "you get what you pay for". This is the case, for example, of the luxury goods analyzed in the previous paragraph.

Recently, many authors (Moreau et al., 2017; Privitera & Nicolosi, 2017) have focused on the "rethinking consumption" approach to interpret consumption as a complex practice and as a combination of elements of choice and consumption habits (Mylan, 2014; Warde, 2014) both from the emotional point of view, of rational choices, which influence the consumer towards sustainable consumption practices (Tukker, 2015) and in relation to his know-how.

Already in the 1990s, some authors identified the postmodern consumer (Holt, 1995; Strinati, 1993) as someone who satisfies his own needs within a cultural model independent of the act of consumption, concepts reaffirmed in the 2000s (Arnould & Thompson, 2005; Cicia et al., 2012).

In "postmodern" consumption, products are differentiated, demand is highly segmented, markets are unstable and territory plays a decisive role. In this condition, individual freedom influences consumer choices as well as the environment, the social and cultural context and health aspects are very relevant (Askegaard et al., 2009).

In the academic field, methodological models integrating and enriching the marketing analysis. For example, Rituparna Basu and other authors 2023 (Basu et al., 2023), in their article carry out an in-depth review of postmodern marketing practices and highlight a growing interest among researchers on consumer vulnerability, reiterating a concept examined by Hill & Sharma, 2020 (Hill & Sharma, 2020) and Riedel et al., 2022 (Riedel et al., 2022), and highlighting many of the aspects that revolve around the effects that modern markets have on current culture and societies.

In the context of the literature on food consumption, many studies investigate consumers' intentions regarding healthy behaviors (McEachan et al., 2016; Parashar et al., 2023), healthy eating, environmental protection behavior and

consumption of organic foods. The approach aims to understand the processes that lead individuals to intentional behaviors in their consumption choices.

Ajzen 1975 and 2015 (Ajzen, 2015; Fishbein, 1975) proposes in his fundamental study on the theory of Planned Behavior (TPB) aims to understand the processes that lead individuals to intentions in their consumption choices. This theory is one of the most widespread in behavioral data analysis and socio-psychological analyses as it allows studying the interrelationships between variables that are not directly measurable (latent variables or factors) and has been frequently applied to behavioral studies on food and beverage consumption (McDermott et al., 2015; Pacho, 2020; Steinmetz et al., 2016).

Many scholars who deal with food and beverage consumption, starting from Ajzen's studies have used different constructs in relation to the object of study. For example into delve into the aspects related to organic food (Pang et al., 2021), sustainability (Dragolea et al., 2023; Nekmahmud et al., 2022), food waste (Cassia & Magno, 2024), moral standards (Mulazzani et al., 2023), behavior in choosing local food (Sabina del Castillo et al., 2021), in the study of innovative products including functional food, or even healthy and dietetic nutrition (Lauricella et al., 2017) and curiosity as a factor capable of provoking exploratory behaviours (Chen & Wei, 2017), recently also the impact of Covid on purchase intentions (Qi & Ploeger, 2021).

Gilal et al, in 2019 (Gilal et al., 2019) and Cassia and Magno in 2024 (Cassia & Magno, 2024), address the role and value of self-determination theory (SDT) in marketing studies. They highlight, within the framework of the theory of human motivation (proposed by Deci and Ryan in 1985 (Deci & Ryan, 1980) and resumed by the same authors in 2000 (Vallerand, 2000), a person's commitment to a specific behavior to distinguish, explain and predict intrinsic and extrinsic motivations for purchasing decisions.

Pang et al. 2021 (Pang et al., 2021) propose in their study Roger's 1975 Protection Motivation Theory (PMT) (Rogers & Deckner, 1975) , an extension of the Health Belief Model (HBM). Theory usually used as a theoretical foundation for the study of protective behaviors in terms of attention to an individual's health.

SDT and PMT represent a valid integration of the theory of planned behavior, to empirically explore consumer behaviors.

Below is a schematic review of the literature related to the different theories. (Table 5 )

**Table 5.** Schematic review of consumer approach theory in literature.

| Source | Approach | Definition |
|---|---|---|
| (Ajzen, 2015; Moreau et al., 2017; Mylan, 2014; Tukker, 2015; Warde, 2014) | TPB | *"consumption as a complex practice and as a combination of elements of choice and consumption habits from the emotional point of view, of rational choices, which influence the consumer towards practices of sustainable consumption and in relation to its know-how".* |
| (Cassia & Magno, 2024; Gilal et al., 2019) | SDT | *"a person's commitment to a specific behavior to distinguish, explain and predict intrinsic and extrinsic motivations for purchasing decisions".* |
| (Pang et al., 2021; Rogers & Deckner, 1975) | PMT | *"Theory usually used as a theoretical foundation for the study of protective behaviors in terms of attention to an individual's health". Developed to explain how people respond to fear-provoking health threat communications. Protection motivation refers to the motivation to protect oneself from a health threat; it is usually operationally defined as the intention to take the recommended action* |

Source: the author

Little is known about consumer preferences for truffles and truffle products which represent a niche of valuable products. According to the TPB theory and implemented through the use of PLS-SEM software, a study on consumer preferences for fresh and processed truffles was conducted, which will be presented below.

## Article: Consumption Preferences for Truffles and Truffle-Based Products: An Application of the PLS-SEM Model

Laganà, V.R.; Lombardi, F.; Di Gregorio, D.; Nicolosi, A.

*Sustainability* **2024**, *16*, 5002. https://doi.org/10.3390/su16125002

*Article*

# Consumption Preferences for Truffles and Truffle-Based Products: An Application of the PLS-SEM Model

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**Abstract:** The truffle is a niche, valuable and ecological product exported and consumed all over the world. However, little is known about consumers' preferences for truffles and truffle products. This study empirically explores the factors influencing their consumption in Italy. A PLS-SEM model was implemented and validated using an extended version of the theory of planned behavior, including consumers' food-specific curiosity as an additional construct to basic constructs such as attitude, subjective norms and perceived behavioral control. The analysis allowed us to examine and verify the significance of the relationships between the factors and what impact they have on intentions to consume fresh and truffle-based products. The processing concerns of consumers were reached through face-to-face consultation with a semi-structured questionnaire. The results obtained suggested that consumers' intentions in using truffles involve several factors, such as consumers' personal experiences, organoleptic characteristics (aroma and taste), food safety, trust in the seller/brand, traceability information, the aspect of green products and, more generally, the protection of the environment and forests. The findings provided novel insights for researchers to understand the aspects of truffle consumption, and also represent a guideline for marketers to develop appropriate marketing tactics to grow the truffle business.

**Keywords:** truffles; consumption intentions; semi-structured questionnaire; Italy; PLS-SEM

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## 1. Introduction

Strengthening resilience, halting the loss of biodiversity and building a healthy and sustainable food system are practices which have already been highlighted for some time, and have become essential priorities following the crisis triggered by COVID-19, which has shown the fragility of the food system [1,2]. The pandemic highlighted the value of rural areas for the well-being of the whole society and their specific contribution in tackling the climate crisis. The post-2020 Community Agricultural Policy (CAP) supports farmers and rural communities in facing the difficulties and challenges inherent to innovation in agriculture, forestry and rural development, with the aim of creating synergies between different policy programs at both EU and Member State levels [3].

Moreover, within the main aims of the 2021-27 PNR, particular importance was attributed to the multifunctional role of forests, supporting the valorization of non-timber forest products, but also giving particular care to the value of the intangible forest services through the application of nature-based solutions (NBS) [4,5]. Implementing innovations aimed to improve the conditions of agricultural and rural populations is a task entirely in line with the desired development and growth processes promoted by the CAP.

In recent years, interest in truffles (valuable mushrooms) has increased, for both spontaneously grown truffles and those cultivated in artificial truffle grounds. In the latter case, new income opportunities are promoted for the various operators in the supply chain [6], supporting the recovery and valorization of marginal territories and inner areas [7], which can also happen through the promotion of the potential links with food and wine tourism.

Huber et al. [6] argued that non-timber forest products (NWFP) play a fundamental role in the provision of forest ecosystem services, highlighting how, in the cases observed in Europe, NWFP products offer opportunities to forestry companies willing to manage a combination of woody and non-woody resources. Furthermore, sustainable co-production can support the appropriate management of agro-forest ecosystems across Europe. Truffles and truffle products therefore represent a valuable option for sustainable food supply.

Huber et al. [6] also pointed out that wild mushrooms and truffles strengthen the economic vitality of rural and inner areas, constituting the most widespread opportunity to increase additional income deriving from forest management for non-woody products.

Büntgen et al. [8] focused on the emerging Spanish black truffle industry. After having highlighted the economic crises that many European rural areas are experiencing and which overlap with the long-term negative effects of climate change, they focused on aspects linked to the potential of micro-tourism. They also suggested that micro-tourism, through the use of qualified guides and the promotion of restaurants serving mushrooms, truffles and local products, can compensate for the related economic losses deriving from unemployment and production reductions induced by summer drought, therefore promoting sustainability and the conservation of biological diversity.

In awareness of this growing importance of truffle cultivation and its use in the gastronomic sector in marginal and inner European areas, our study examines the importance of knowing consumers' preferences, attitudes and consumption motivations, and also suggesting appropriate marketing actions.

On the other hand, in 2021 Oliach [9] was already encouraging the promotion of truffle consumption, due to the increase in cultivated truffle plantations; he underlined the importance of the emergence of truffle hunters who collect on behalf of farmers and specialized wholesalers, while the number of collectors who search for truffles to sell them to small itinerant buyers significantly decreased.

Consequentially, the application of the Theory of Planned Behavior (TPB), as described in Ajzen's work [10], can provide a tool for exploring consumption behaviors. The multidimensionality of consumers' eating behaviors has led many authors in the literature to extend the constructs by including others in the applied models [11,12]. At present, however, the objective and subjective knowledge, socio-demographic profiles and lifestyle that influence the consumption of truffles and truffle products are still little explored. As a consequence, this study represents, as far as we know, the first empirical exploration of Italian consumers' preferences on truffles and truffle products. Our findings will improve the understanding of consumer preferences for these niche products, offering valuable information to the supply chain operators in order to develop tailor-made strategies to effectively meet consumer expectations.

In Italy, the truffle market is very fragmented and characterized by a multitude of small operators (pickers, artificial truffle growers, distributors, restaurateurs, etc.). No official data are available on the real amounts of truffles collected each year, especially in relation to the type of sale and negotiation. Many transactions are still carried out at a local scale in the main production regions and, in many cases, occasional sales of small quantities directed to the final consumer are considered. The demand for truffles is mainly linked to the catering, processing and tourism industries; it is highly seasonal, reaching a peak in the months of October–November, when the most truffle harvesting occurs.

Focusing on truffle prices, the economic activity of the truffle sector generates tens of millions of Euros annually. We discuss average retail prices, as reported below, referring to the last decade: *Tuber Magnatum Pico* between 1500.00 and 4000.00 EUR/Kg at retail price and between 800.00 and 2000.00 EUR/Kg wholesale; *Tuber Uncinatum Vitt* truffle between 300.00 and 500.00 EUR/kg at retail and 150.00 and 250.00 EUR/kg at wholesale level; *Tuber Aestivum Vitt* between 100.00 and 300.00 EUR/Kg at retail and 40.00 and 150.00 EUR/Kg wholesale; and finally the *Tuber Melanosporum* truffle, which ranges from 400.00 to 1000.00 EUR/Kg at retail and 200.00 to 600.00 EUR/Kg wholesale. The prices cited above are indicative, since they strongly fluctuate; however, these "random" prices

make the search and purchase of the precious underground mushroom an attractive experience [9]. Oliach et al. [9,13] affirm that, during the last few decades, the European market has undergone changes due to the cultivation of truffles. New producers have appeared in a traditional sector linked to wild production, and new business opportunities have emerged through online sales, giving more visibility to the truffle.

Recently, many authors [14,15] have focused on the "rethinking consumption" approach to interpret consumption as a complex practice and as a combination of elements of choice and consumption habits [16,17] both from the emotional point of view of rational choices, which influence the consumer towards practices of sustainable consumption [18], and in relation to know-how. Truffle farms can allow the valorization of marginal and inner areas, promoting new employment and income opportunities and also supporting gastronomic tourism, which revolves around the production of truffles and truffle-based gastronomy (fresh and/or processed). Thanks to their high cultural and gastronomic prestige, various species of truffles are appreciated all over the world for their high nutritional value, bioactive compounds and prestigious aroma.

The aim of this research work is to explore motivations and preferences for the consumption of truffles and truffle-based products. The study was conducted through a survey of consumers in Italy through face-to-face interviews.

In the context of food consumption literature, many studies have applied the predictive power of the Theory of Planned Behavior (TPB) [10,19] to investigate consumers' intentions regarding healthy behaviors [20,21], healthy eating, environmental protection behavior and the consumption of organic foods. The approach aims to understand the processes that lead individuals to intentional behavior in their consumption choices.

Other studies have added constructs to the TPB by expanding it with additional variables to explain the greater variation in personal conduct and consumption intentions [2,22–24].

TPB provides basic constructs, which are intention (INT) to carry out that specific act of consumption, attitude (ATT), subjective norm (SN) and perceived behavioral control (PBC). All these factors are determined by behavioral, normative and control beliefs, respectively. In the literature, several studies extend these constructs, such as awareness of sustainability, moral attitudes, health consciousness, territorial identity and recently also the impact of COVID-19 on purchasing intentions [2,22,23,25]. Also, our study extended the TPB framework by adding the food-specific curiosity (SGAC) construct in addition to the TPB core theory constructs.

To identify which drivers influence consumers in the process of choosing truffles to be purchased/consumed, an exploratory factorial analysis (EFA) was carried out based on the analysis of the main components (PCA).

To identify the factors that influence the propensity to consume truffles, a structural equation model (PLS-SEM) was implemented using a self-administered questionnaire.

This model represents one of the most widespread methodologies in the analysis of behavioral data, as it allows us to study the interrelationships between variables that are not directly measurable, called latent variables or factors. PLS-SEM was used to test the following research questions:

- Which factors determine the intention to consume truffles and truffle-based products?
- Which are the main personal behaviors and attitudes that guide the choice to consume truffles and truffle-based products?
- Is gastronomic curiosity a relevant factor in the intention to consume truffles and truffle products?
- Is food safety important when planning to consume truffles and truffle-based products?
- Does the approval of family members and acquaintances count in the intention to consume these niche products?

This paper is organized as follows: the introductory section is followed by a literature review on the truffle market and the state of the art. Subsequently, the methodological approach adopted for consumer analyses is illustrated and the results obtained are outlined. The paper concludes with discussions and conclusions.

## 2. Literature Review

### *2.1. Description of the Research Object: Truffle*

The truffles of the *Tuber* genus are the most interesting forest products from an ecological, hydrogeological and economic point of view. Specific growing habitats, unpredictable growth patterns and growing seasons, unique harvesting methods, limited natural resources and a limited shelf life make truffles one of the most expensive foods in the world [26]. The distribution and abundance of the various truffle species are influenced by the climate, soil and vegetation conditions [27]. Because of the great demand for truffles in the market and the shortage of wild resources, cultivation is a possible strategy for truffle production [26].

Due to their high cultural and gastronomic prestige, various truffle species are appreciated worldwide for their high nutritional value, bioactive compounds and prestigious aroma [28–30]. Truffles of the *Tuber* genus have been the focus of cultivation efforts for many years, particularly in southern and central Europe, where regional endemic species such as *Tuber melanosporum*, *T. aestivum* and *T. magnatum* have a long tradition of culinary use [31,32]. Italy is one of the most important countries in Europe for truffles gathering and trade.

The rapidly growing and wide-ranging economic sector includes the production of mycorrhized plants in nurseries, the harvest of wild and cultivated truffles, truffle dog training, the marketing of fresh and processed truffles, the transformation of truffles into secondary products, myco-tourism (i.e., truffle tourism), mycological gastronomy, interdisciplinary research and producer extension services [8].

Broadleaved forests and plantations in the Mediterranean basin in Italy, France, and Spain represent the most productive environments for the production of the Périgord black truffle, *Tuber melanosporum Vittad* [8,33–35]. Due to the organoleptic qualities of its fruitbodies, *T. melanosporum* truffles represent one of the most in-demand Tuber species in the world [36] and one of the most relevant in terms of global consumption and economic importance [37,38]. In the second half of the 20th century, intensive orchard farming started (Murat) due to the introduction of protocols to stimulate *T. melanosporum* ectomycorrhizal production in controlled conditions, among other things. The actual global yield is approximately 120,000 kg per year, generating a yearly revenue of approximately EUR 50 million for truffle farmers [13] with retail prices of ca. EUR 700–1500 per kilogram, depending on seasonal and meteorological variables [33,34,38]. In France, Italy and Spain, productive truffle orchards provide rural landowners with an alternative to agricultural subsidies, encouraging the regeneration of abandoned crop fields because, among other things, this requires little agricultural input [39,40].

The black truffle is cultivated in different countries, mainly in Spain (47 tons/year), France (43 tons/year) and Italy (19 tons/year) [9], as well as in the Southern hemisphere in Australia (11 tons/year) [35], Chile (1.3 tons/year) and Argentina (0.6 tons/year) [41].

Italian truffle hunting and extraction are part of a set of knowledge and practices that has been transmitted orally for centuries. Today, it still characterizes the rural life of entire communities in the Italian peninsula. Truffle hunters usually live in rural areas and small villages. There are two steps to truffle hunting: the hunting and the extraction. The hunting entails the identification of areas where the truffle plant grows, from whose roots grows the underground fungus named 'truffle'. This step is carried out with the help of a trained dog. The hunters then use a special spade that allows them to extract the truffles without disturbing the soil conditions. Truffle hunting involves a wide range of skills and knowledge (about climate, the environment and vegetation) related to the management of natural ecosystems and to the dog–truffle-hunter relationship. This knowledge is passed on through oral traditions, including stories, fables, anecdotes and expressions that reflect the local cultural identity and create a sense of solidarity within the truffle hunting community. Truffle hunting is often associated with popular feasts that mark the beginning and end of the truffle season. Truffle hunting and extraction in Italy are considered traditional knowledge and practices and part of an Intangible Heritage by the Culture Sector of

UNESCO, confirming the great value that the whole world attributes not only to the truffle itself, but to the entire supply chain, rich in history, traditions and culture [42]. Truffle hunting is traditionally practiced with respect for the environment and plant biodiversity, guaranteeing the seasonal regeneration of the truffle. However, the natural production of white truffles in Italy is endangered by several factors including truffle hunting pressure in some Italian regions. The number of truffle hunters is constantly increasing and their official number is now over 70,000 [43].

In 2021, the export of Italian truffles was recorded at +48%, especially to countries like the United States, which have always appreciated them.

Their peculiar sweetness, appreciated by even the most delicate of palates, makes them a very versatile ingredient in the kitchen; they lend themselves not only to classic, elaborate dishes but also to quicker and simpler recipes, such as finger food and appetizers to be offered with aperitifs, or minimal, chic or vegan-friendly recipes, which thanks to the unmistakable flavor of the truffle will have a great impact.

Rich in beneficial nutritional properties, the truffle is recognized as a truly healthy food, and an extremely genuine food; the presence of mineral salts, proteins, magnesium and vitamins also make it an excellent ally for the summer, while the high antioxidant level helps prevent aging.

Thanks to its low calorie content (31 kcal per 100 g) and high water (76%) and fiber (8.4%) content, it is also considered an efficient dietary food. But it is not only the body that benefits from the consumption of truffles: a study has revealed that, thanks to anandamide [44], a neurotransmitter also present in breast milk, all truffles instill in those who taste them a widespread sense of well-being.

### *2.2. Methodological Approach*

In order to carry out this research work, aimed at identifying the factors that determine the propensity to consume truffles and truffle-based products, the TPB was expanded and the PLS-SEM was implemented [2,22–25,45–47].

PLS-SEM has now become the methodology of choice for many researchers studying complex relationships between latent constructs, such as in marketing, consumer choice and other fields. It allows for the evaluation of complex patterns and structural pathways, with many variables considered and used. As highlighted by Lei and Wu [48], PLS-SEM represents an advanced version of general modeling procedures and it is therefore used to evaluate whether the model hypothesized in theory is consistent with the data collected [45,49].

This model represents one of the most widespread methodologies in the analysis of behavioral data, allowing us to study the interrelationships between variables that are not directly measurable (latent variables or factors).

The conceptual framework applied in this study is detailed in Figure 1, which illustrates the research hypotheses and the potential reasons that influence the intentions towards truffle consumption. We considered behavioral intention, defined as the likelihood that a person will engage in a particular behavior [10]. Intention reflects a person's willingness to engage in a goal behavior. In this study, we hypothesize that the intention is connected, on the one hand, to trust in the seller/restaurateur, and to knowledge of the product and environmental sustainability and, on the other hand, to a combination of motivational variables based on attitude, perceived behavioral control, subjective norms and specific gastronomic curiosities (see Appendix A, Table A1).

There is a positive relationship between attitude towards truffle consumption and both intention and actual consumption. In fact, many studies on consumer behavior in the field of food and drink marketing have shown how the attitude towards a product significantly influences intentions and actual consumption [2,50–52]. Attitudes are a person's positive or negative opinions about events or behaviors, and they reflect a series of preferences, and then generate intentions towards purchasing and consuming at home or away from home (restaurants, pizzerias, etc.). Personal attitude is the main decisive factor in the intention to

behave in a certain way and, furthermore, represents the individual's positive or negative evaluation of that behavior.

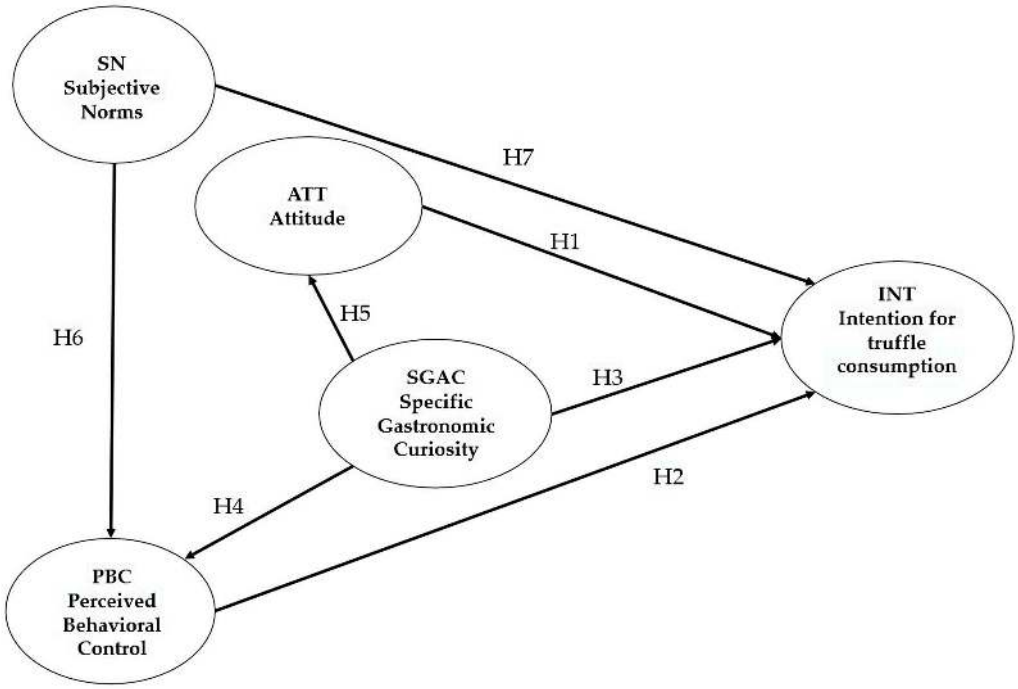


**Figure 1.** Conceptual model hypothesized in the analysis and the related research hypothesis.

The following hypothesis was constructed:

**H.1.** *Attitude has a positive and significant impact on consumption intention.*

In hypotheses H1, it is believed that attitude plays an important role in the intention to consume truffles due to the high cultural and gastronomic prestige and the particular aroma. Furthermore, the consumer, although attracted by a niche product, pays attention to the perceived behavioral control of the product he consumes.

Perceived behavioral control is explained as an individual's perception of their ability or self-judgment in terms of engaging in a certain behavior [1]. Several studies have shown that the greater the behavioral control an individual perceives, the stronger their intention to engage in the behavior in question [53–56]. Shin e Hancer [24] confirmed that, regarding food and drinks, PBC has an influence on intention and actual consumption/purchase. Therefore, the following hypotheses are proposed:

**H.2.** *Perceived behavioral control has a positive and significant impact on consumption intention to consume truffles and truffle-based products.*

In hypothesis H2, perceived behavioral control is believed to be an important element for intentional consumers of truffles, and therefore attention to health, diet and correct nutrition represent key elements and important predictors of purchase intentions.

There is a positive relationship between curiosity and attitude/intention to consume/purchase truffles and truffle-based products. Numerous studies on consumer behavior in the field of food and drink marketing show that specific curiosity towards a product significantly influences consumption attitudes [52,57]. In this regard, the following research hypotheses were formulated:

**H.3.** *Gastronomic curiosity has a positive and significant impact on the intention to consume truffles and truffle-based products.*

**H.4.** *Gastronomic curiosity has a positive and significant impact on perceived behavioral control.*

**H.5.** *Gastronomic curiosity has a positive and significant impact on attitude.*

In the hypotheses H3, H4 and H5, the specific gastronomic curiosity (SGAC) is believed to positively influence the consumption intentions towards truffles and truffle-based product. Gastronomic curiosity moves the consumer towards new cultural experiences, social relationships and an escape from routine. Furthermore, the consumer, although intrigued by a niche product, pays attention to the perceived behavioral control of the product he consumes.

There is a positive relationship between subjective norms and intention to consume/purchase truffles and truffle-based products. In a context linked to the consumption/purchase of food and drinks, many authors [24] underlined how subjective norms are significant predictors of purchase/consumption intention. Subjective norms are understood as the perceived social pressure to engage in or refrain from a particular behavior, representing an individual's perception or opinion of what others believe they should do. Subjective norms concern the perception that particular behavior is approved or disapproved of by the people who are important to him/her (loved ones or close ones, family, friends, partners, etc.) [58]. James, Rickard and Rossman [59] defined them as a powerful internal control factor that can easily shape a person's behavioral intention. Subjective norms are commonly identified as another significant predictor of consumption intention that accentuates the level of importance of another individual's thoughts [16]. Therefore, in this study on truffles, it is believed that there is a relationship between subjective norms and consumption and/or purchase intention at home and away from home. The following hypotheses were therefore proposed:

**H.6.** *Subjective norms have a positive and significant impact on perceived behavioral control.*

**H.7.** *Subjective norms have a positive and significant impact on consumption intention.*

In hypothesis H6, it is believed that consumers' attention, on the one hand regarding possible scams and on the other regarding the information present in product labels, can positively influence greater caution towards perceived behavioral control, in particular with reference to food safety. In hypothesis H7, the aspects related to the importance of information positively influence the intention to consume truffles and truffle-based products.

## 3. Materials and Methods

### *3.1. Data Collection*

The questionnaire was filled out by 145 users residing in Italy and approached in northern regions (the provinces of Lombardia and Piedmont) and in the south–center (the provinces of Lazio, Calabria, Sicily and Campania). Interviews were carried out face to face in the second half of 2022. Respondents were intercepted in particularly crowded places, such as various tourist locations, including some restaurants, hotels and meeting points. Some interviews were conducted during cultural events.

The overall complexity of the structural model has little influence on the sample size requirements for PLS-SEM. Two initial studies [60,61] systematically evaluated the performance of PLS-SEM with small sample sizes, confirming that PLS-SEM performs well.

More recently, a simulation study carried out by Reinartz et al. 2009 [62] indicated PLS Sem as a good choice when the sample size is small.

Researchers can also rely on the rules of thumb provided by Cohen 1992 [63]: regarding statistical power, he analyzed multiple regression models, confirming that that the measurement models had acceptable quality in terms of external saturations, i.e., the saturations should be above the known threshold of 0.70.

The sample size needed for PLS-SEM must be "at least ten times the largest number of structural pathways to a particular latent construct in the model" [45]. As is shown in Figure 1, here we reported seven paths, indicating that the sample size must be greater than 70. Consequently, the sample of 145 valid responses in our survey meets the PLS-SEM minimum size criterion.

The questionnaire required the informed consent of the survey participants, whose anonymity was ensured. Consumers were informed that, according to the Italian pri-

vacy law n. 675/96, data collected were processed in an aggregate manner for research purposes only.

Our study used convenience and snowball sampling methods. It used a qualitative research sampling strategy that involves selecting participants based on their accessibility and availability to the researcher.

The choice of this type of sampling is justified by reasons related to the duration and cost of the investigation; moreover, it aimed to limit the risk of obtaining excessive refusals or missed contacts. Before proceeding with data collection, the questionnaire was pre-tested to assess whether some statements were too difficult to understand due to the language, or for lack of clarity in the wording of the questions. These checks allowed us to improve and establish the construct validity of the questionnaire [64,65].

The survey tool is divided into a grid of choice questions: socio-demographic, occupational and family income characteristics; knowledge, habits, places of consumption (restaurant, home, friends' houses), frequency and prices; any reasons for not purchasing (do not like it, high prices, poor availability, etc.); reasons for consuming truffles (aroma, taste, trust and recommendations of the seller); attention to food safety; curiosity and attitudes; and opinions on truffle groves and sustainability in the territories.

The questions were organized to collect both binary (yes/no) and multiple choice answers (3–4 types of choices), while others were based on a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree).

The current tendency to study increasingly complex relationships makes the application of multivariate analysis methods a useful techniques. Therefore, on the basis of the responses collected, databases were created with the support of the IBM SPSS Statistic v.20 and SmartPLS 4 v. 4.1.0.3 software aimed at detecting the behavior of the consumers [66]. In total, 26 variables were coded, following the order of the questions asked in the questionnaire. The data were processed, analyzed, summarized and interpreted to describe the characteristics of the sample, with the final aim of identifying the main explanatory variables, to highlight the distinctive attributes that most influence consumers' decision-making processes [67].

### *3.2. Research Model's Step*

In the analytical procedure, several steps were performed; firstly, an Exploratory Factor Analysis (EFA), based on principal component analysis (PCA), was applied to identify the latent factors, but also for a preliminary interpretation of the solution obtained. The principal components were extracted with the aim of maximizing the proportion of the variance explained. The reliability of the model was assessed using the Kaiser–Meyer–Olkin (KMO) test and the Bartlett's spherical test (see Supplementary Files) [68,69].

PLS-SEM is a non-parametric statistical method. However, it is recommended to check that the data are not too far from normal to avoid risking standard errors during the bootstrapping procedure. The dataset had no missing values and, considering the principles of the descriptive statistics, the model presents valid absolute values of skewness and kurtosis, as well as with regard to the "Cramer-van Mises *p*-value" equal to 0.000 for all 15 variables considered in the analysis. In particular, the control of the chosen variables allows absolute values of skewness and kurtosis that have to be identified in advance, in order to remove any anomaly values before carrying out the procedure provided by the software. In particular, for skewness and kurtosis, the values must not be greater than +1 or less than −1. In fact, for asymmetry this would mean that the data distribution is unbalanced, while for kurtosis, with a value greater than +1, the distribution is too sharp; if it is less than −1 it is too flattened.

The application of the PLS-SEM procedure allowed us to build the structural model, to examine the final results and the quality criteria of the model [46]. The most important metrics of the model evaluated the reliability, but also the convergent validity and the discriminant validity. The bootstrap procedure was used to estimate the significance of the path parameters and allowed the confidence interval to be reported.

Analysis with the PLS-SEM method is strictly defined and consists of two parts, as described by Hair 2019 [45]. The first step consists of evaluating an external model (reflective and formative measurement models) in which the reliability and validity must be satisfactory. The second step consists of evaluating the internal model to generate loadings and relationships between the structural model (with reference to the latent constructs) and the observed variables [70]. Finally, bootstrapping was carried out to evaluate the statistical significance of the relationships hypothesized in the model. Model estimation provides empirical measures of the relationships between the indicators and the constructs (in the measurement models) and between the constructs themselves (in the structural model). These measures allow us to verify and evaluate the results of the PLS-Sem. In detail:

The most important metrics of the reflective measurement model are

- (1) internal consistency (Cronbach's alpha and CR composite reliability); (2) convergent validity (reliability of indicators and average variance extracted AVE); and (3) discriminant validity (HTMT Heterotrait–Monotrait ratio and Fornell–Larcker criterion);
- With regard to the formative measurement model, the indicators to be verified are the following: (1) convergent validity (reliability and validity of the construct); (2) the collinearity between indicators (VIF); and (3) the significance and relevance of external weights;
- The most important evaluation metrics are the coefficient of determination R2 (explained variance), f2 (effect size), Q2 (predictive relevance) and the size and statistical significance of the model path coefficients (obtained through the procedure PLS predict/CUPAT).

## 4. Results

### *4.1. Socio-Demographic Characteristics*

Table 1 details the socio-demographic information. All interviewees were aged between 20 and 74, with an average age of 42.1 years. Males represented 46.2% of interviewees and females 53.8%. Overall, 34.5% of those interviewed belonged to the millennial generation (respondents were between 26 and 35 years old); the majority of those interviewed had a degree (46.9%) or a post-graduate degree (20.7%), were employed (38.6%) and had a medium–high average annual income (48.3%). They resided in the south–center (74.5%) and north (25.5%) of Italy.

**Table 1.** Socio-demographic characteristics of the sample.

| | | % | | | % |
|---|---|---|---|---|---|
| Gender | Male | 46.2 | Food purchasing responsibility | Interviewed | 69.6 |
| | Female | 53.8 | | Other | 30.4 |
| Age generations | Generation Z | 20.0 | Education level | Middle school | 8.3 |
| | Millennials | 34.5 | | High school | 24.1 |
| | X Generation | 30.3 | | Degree | 46.9 |
| | Baby boomers | 15.2 | | Post-grad degree | 20.7 |
| Annual income | Not answer | 4.1 | Occupation | Employed | 38.6 |
| | ≤15,000 | 5.5 | | Self-employed | 22.8 |
| | 15,001–30,000 | 40.0 | | Retired | 4.8 |
| | 30,001–48,000 | 48.3 | | Student | 20.7 |
| | ≥48,001 | 2.1 | | Other | 13.1 |

The majority of those interviewed declared that they appreciate truffles (72%); 11% had never tasted them but were curious and interested in consuming them, while 17% of those interviewed declared that they do not like truffles and do not consume them (Table 2).

**Table 2.** Consumption, frequency and purchase prices declared by the consumers interviewed.

| | | |
|---|---|---|
| Consumption of truffles and truffle-based products | Appreciate them | 65.5% |
| | Do not like | 15.2% |
| | He/she has never tasted them, but is curious/interested | 19.3% |
| Consumption frequencies | Regularly, at home or in a restaurant | 15.0% |
| | Occasionally, at home or at a restaurant | 57.0% |
| | He/she does not consume them because they do not like them | 17.0% |
| | He/she has never tasted them | 11.0% |
| Purchase prices | <EUR 50.0/100 g | 5.0% |
| | EUR 50.0 and EUR 100.0/100 g | 9.0% |
| | Greater than EUR 100.0/100 g | 1.0% |
| | He/she does not know, does not remember or did not answer | 85.0% |
| Truffles' green role: spontaneous truffles are a resource for protecting forests | Yes, it is true | 68.6% |
| | No, it is not true | 2.6% |
| | I do not know | 28.8% |

As for frequency, only 15% consume them more or less regularly, both at home and in restaurants; 57% consume them occasionally, and finally the remaining 27% do not consume them because they do not like the product (17%) or because they have never tasted it (11%). For purchase prices, the majority (85%) did not respond, did not remember or said they do not purchase. In addition, 9% of those interviewed purchased at a price between 50 EUR and 100 EUR/hectogram; only the 5% of respondents declared having paid a price lower than 50 EUR/hectogram; and finally, the remaining 1% declared having paid a price greater than 100 EUR/hectogram.

Overall, 68.6% of consumers interviewed stated that spontaneous truffles are a resource for protecting forests. Only 2.6% did not agree and 28.8% of consumers did not know or did not answer for this aspect.

### *4.2. Evaluation of PLS-SEM Results of the Structural Model*

From a methodological point of view, the development of the EFA made it possible to reduce the complexity of our database into a smaller number of variables. The analysis, performed on fifteen variables, identified five "latent factors" that explained 74.31% of the total variance. An orthogonal rotation was applied with the Varimax method, allowing a simpler reading of the matrix of the extracted components. The adequacy of the sample was verified with the KMO test (the value obtained, equal to 0.824, was considered adequate) and Bartlett's test of 0.00 (see Supplementary Files). The five components extracted were (1 ATT) "Attitude, preferences and personal experience"; (2 INT) "consumption intentions and motivations"; (3 PBC) "perceived behavioral control"; (4 SGAC) "specific gastronomic curiosity and attitude in the approach to truffle consumption"; and (5 SN) "importance of information on fresh and processed truffles purchased and/or consumed".

The convergent validity was assessed by the factor loadings of the items and the Average Variance Extracted (AVE). The "Standardized factor loadings" of the 15 items considered should be kept in the measurement model only if their standardized loadings

are equal to or greater than 0.6 [71,72]. In fact, as highlighted in Figure 2 and in Table 3, the saturations of the items that make up the measurement model are all valid and between 0.775 and 0.907. The commonly used measure to establish convergent validity is the AVE. It is considered acceptable with values that exceed 0.50, indicating that the variance shared between a construct and its elements exceeds the variance of the measurement error [45]. The results revealed that, for all the constructs, the values of AVE were greater than 0.6 and were between 0.656 and 0.794.

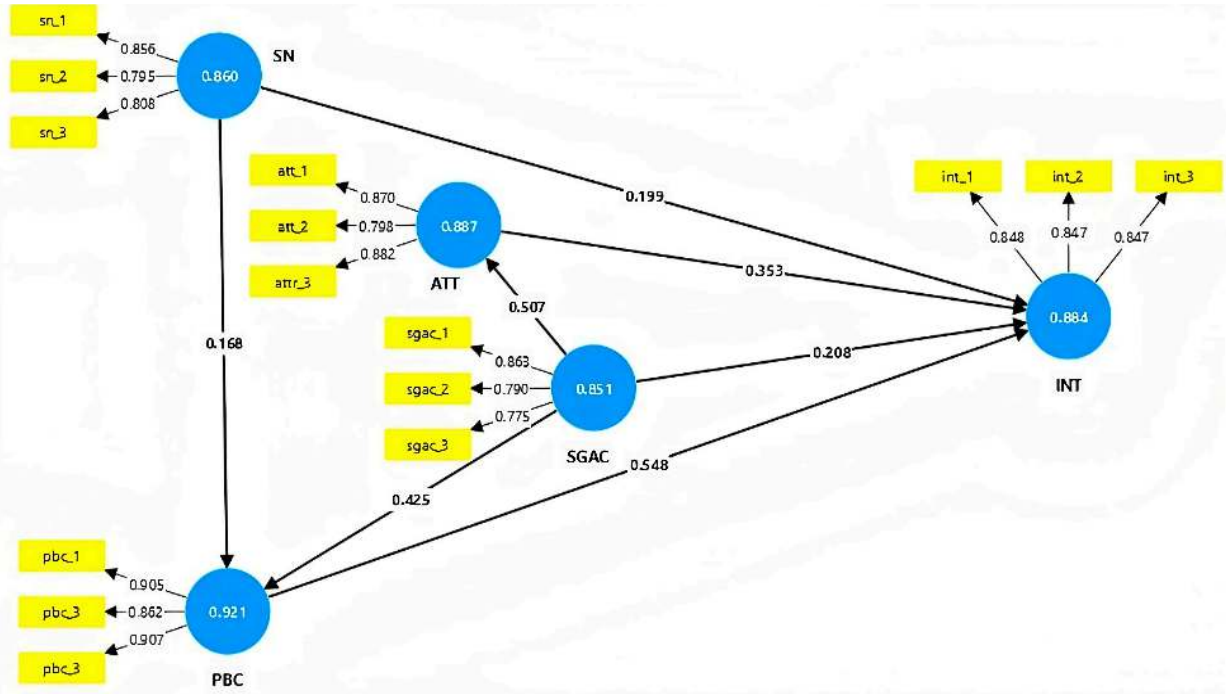


**Figure 2.** Results of PLS-SEM. Own development and adaptation. External model: external saturations; internal model: total effects; constructs: CR composite reliability. ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective.

The internal consistency reliability of the model is represented by the Composite Reliability (CR); it varies from 0 to 1, with higher values indicating higher levels of reliability. This composite reliability in the five latent factors exceeds the recommended value of 0.7 (ATT = 0.887; INT = 0.884; PBC = 0.921; SGAC = 0.851; SN = 0.860).

As for Cronbach's Alpha, it is a conservative measure of reliability, returning relatively lower values than the CR and representing its lower limit. Therefore, it seems appropriate to report on and compare both the parameters. The Cronbach's Alpha values are valid within the range 0.6 to 0.9. Our values are between 0.738 and 0.871, as can be seen from Table 3.

As regards to the discriminant validity, the Heterotrait–Monotrait (HTMT) criterion and Fornell–Larcker criterion were used [45,73].

In order to confirm the validity of the model, as highlighted by Benitez [74], the HTMT can be evaluated in two ways: (1) by comparing it with a threshold value and (2) by building a confidence interval to examine whether the HTMT is significantly lower than a certain threshold value. For the first approach, simulation studies [75,76] suggest a threshold value of 0.90 if the constructs are conceptually very similar or 0.85 if the constructs are conceptually more distinct. For the second approach, previous methodological research has suggested examining whether HTMT is significantly less than 1 or less than other, smaller values, for example 0.85 or 0.90. The HTMT is a reliable tool for assessing discriminant validity [46,77]. As shown in Table 4, following the second approach, the matrix shows that all the HTMT values are lower than 0.85, thus indicating a good discriminating validity.

**Table 3.** Standardized loading of individual items, CR, AVE and Cronbach's Alpha.

| | Factors and Items | Standardization of Individual Items | Cronbach's Alpha | Composite Reliability (rho_a) | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|---|---|---|---|---|---|---|
| | ATT | | 0.809 | 0.814 | 0.887 | 0.724 |
| att_1 | For me and my family it is pleasant to consume truffles and truffle-based products | 0.798 | | | | |
| att_2 | If I want to I can consume truffles and truffle-based products | 0.870 | | | | |
| att_3 | Truffle aroma makes me very keen to consume them | 0.882 | | | | |
| | INT | | 0.805 | 0.814 | 0.884 | 0.718 |
| int_1 | I intend to consume truffles and truffle-based product thanks to the advice of a seller | 0.848 | | | | |
| int_2 | I intend to consume truffles because I consider them a sustainable product | 0.847 | | | | |
| int_3 | I prefer to consume truffles from my area | 0.847 | | | | |
| | PBC | | 0.871 | 0.901 | 0.920 | 0.794 |
| pbc_1 | I consider myself attentive to the quality of the truffles I consume | 0.905 | | | | |
| pbc_2 | I believe I can recognize truffles and truffle products as a healthy and safe food. | 0.862 | | | | |
| pbc_3 | For me, consuming healthy, low-calorie foods like truffles is a good habit | 0.907 | | | | |
| | SGAC | | 0.738 | 0.747 | 0.851 | 0.656 |
| sgac_1 | I am curious about the gastronomic culture that revolves around truffles | 0.863 | | | | |
| sgac_2 | I like trying new foods and new gastronomic experiences | 0.790 | | | | |
| sgac_3 | For me, consuming truffles is important to escape from a routine | 0.775 | | | | |
| | SN | | 0.756 | 0.756 | 0.860 | 0.673 |
| sn_1 | Paying attention to the information on the label when purchasing truffles is a habit acquired in the family | 0.856 | | | | |
| sn_2 | Reading the expiry date is a habit for me | 0.795 | | | | |
| sn_3 | When I buy truffles or truffle-based products I pay attention to possible "scams" | 0.808 | | | | |

Note: ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective norms. Source: own elaboration from the analysis of data from Smart PLS4.

The Fornell–Larcker criterion is valid when the square root of the AVE of each construct is greater than its maximum correlation with any other construct in the model. As shown in the results reported in Table 4, the matrix indicates that each construct shares more variance with the items assigned to it (bold values on the diagonal of the table) than with the remaining constructs in the model, thus confirming that the requirements of the Fornell-Larcker criterion are satisfied.

**Table 4.** HTMT and Fornell–Larcker criterion (discriminating validity).

| | | | **HTMT** | | |
|---|---|---|---|---|---|
| | **ATT** | **INT** | **PBC** | **SGAC** | **SN** |
| ATT | | | | | |
| INT | 0.597 | | | | |
| PBC | 0.510 | 0.738 | | | |
| SGAC | 0.652 | 0.289 | 0.548 | | |
| SN | 0.077 | 0.266 | 0.245 | 0.153 | |
| | | | **Fornell–Larcker Criterion** | | |
| | **ATT** | **INT** | **PBC** | **SGAC** | **SN** |
| ATT | **0.851** | | | | |
| INT | 0.493 | **0.847** | | | |
| PBC | 0.439 | 0.635 | **0.892** | | |
| SGAC | 0.507 | 0.224 | 0.439 | **0.810** | |
| SN | 0.031 | 0.212 | 0.203 | 0.082 | **0.820** |

Note: ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective norms.

The fit of the model is also ascertained by the Standardized Root Mean Square Residual (SRMR) index, which is defined as the difference between the observed correlation and the model-implied correlation matrix. Thus, it can assess the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of model fit criterion.

According to the literature [74,78], a value lower than 0.10 or equal to 0.08 is considered a good fit. Henseler et al. (2015) [77] introduced the SRMR as a goodness of fit measure for PLS-SEM that can be used to avoid model misspecification. In the present study, SRMR has a value of 0.08 and is therefore considered acceptable. The fit is relatively good between the hypothesized model and the observed data.

Figure 2 shows the Composite Reliability (CR) of the constructs, the saturations of the external model and the total effects of the internal model.

The quality criteria R2, f2 and the collinearity statistics were valid (Tables 5 and 6). The first R2 concerns the so-called "coefficient of determination", which is a measure of the share of variance of an endogenous construct that is explained by its predictor constructs (all the constructs connected to it). Furthermore, the coefficient of determination (R2) indicates the degree of explained variance, which is the proportion of the variation in the dependent variable explained by a linear model. Significant, moderate or weak endogenous latent variables have R2 values of 0.75, 0.50 or 0.25, respectively. Based on the R2 value reported in Table 5, in this study, some predictors had weak (ATT = 0.257 and PBC = 0.221) and moderate (INT = 0.498) explanatory power.

**Table 5.** R2 and Q2.

| | **$R^2$** | **$Q^2$ Predict *** |
|---|---|---|
| ATT | 0.257 | 0.239 |
| INT | 0.498 | 0.037 |
| PBC | 0.221 | 0.139 |

* Q2 result of the PLS predicting CVPAT procedure (PLS_SEM ver. 4.1). ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control.

**Table 6.** f2 and VIF collinearity statistics.

| | $f^2$ | VIF |
|---|---|---|
| ATT → INT | 0.169 | 1.466 |
| PBC → INT | 0.428 | 1.399 |
| SGAC → ATT | 0.346 | 1.000 |
| SGAC → INT | 0.057 | 1.461 |
| SGAC → PBC | 0.231 | 1.007 |
| SN → INT | 0.022 | 1.048 |
| SN → PBC | 0.036 | 1.007 |

Note: ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective norms.

The Q2 test is used for a more in-depth investigation of the predictive relevance of the endogenous components [11,45,74]. Q2 greater than zero indicates significant predictive relevance. In the present study, Q2 ATT values = 0.239, INT = 0.037 and PBC = 0.139 were above the threshold value.

Quality criterion f2 is referred to as the "effect size". The guidelines for evaluating f2 are as follows: values of 0.02 represent weak effects, values of 0.15 represent medium effects and values of 0.35 represent substantial effects [79]. As can be observed in Table 6, f2 is also valid, although it varies between the three types, from weak values (SN → INT = 0.022; SN → PBC = 0.036 and SGAC → INT = 0.057) and average values (ATT → INT = 0.169 and SGAC → PBC = 0.231) up to substantial values for PBC → INT = 0.428 and SGAC → ATT = 0.346.

Furthermore, with reference to the collinearity, all the hypothesized paths are valid since the "VIF threshold values" (Variance Inflation Factor) fall within the limits of the range 0.20–5.0, recording values between 1.0 and 1.466 (Table 6).

Table 7 reports the results of the SEM path. The t-values of the seven paths are all supported by the analysis; the hypothesis H2 (PBC → INT) has the highest t-value (8.383), confirming the importance attributed by consumers to food safety, followed by hypothesis H5 SGAC → ATT (7.531), which confirms how the curiosity for a valuable product greatly attracts consumers, even if it is considered a luxury, whether fresh naturally or proposed as a gourmet product.

**Table 7.** Bootstrap procedure—total effects.

| Path Coefficients | Hypothesis | Original Sample (O) | Confidence Interval Bootstrap 97.5% | | t-Values | *p*-Values | Results |
|---|---|---|---|---|---|---|---|
| | | | Lower | Higher | | | |
| ATT → INT | H1 | 0.353 | 0.205 | 0.500 | 4.608 | 0.000 *** | Supported |
| PBC → INT | H2 | 0.548 | 0.414 | 0.672 | 8.383 | 0.000 *** | Supported |
| SGAC → ATT | H5 | 0.507 | 0.365 | 0.633 | 7.531 | 0.000 *** | Supported |
| SGAC → INT | H3 | 0.208 | 0.071 | 0.352 | 2.859 | 0.004 *** | Supported |
| SGAC → PBC | H4 | 0.425 | 0.293 | 0.557 | 6.326 | 0.000 *** | Supported |
| SN → INT | H7 | 0.199 | 0.056 | 0.339 | 2.753 | 0.006 ** | Supported |
| SN → SAF | H6 | 0.168 | 0.020 | 0.325 | 2.147 | 0.032 * | Supported |

* *p*-Value < 0.05; ** *p*-Value < 0.01; *** *p*-Value < 0.001 Source: Authors elaboration from data analysis in Smart-PLS4. Note: ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective norms.

In hypothesis H4, SGAC → PBC (6.326) confirms consumers' interest in food and truffle quality and safety, with additional reference to the curiosity stimulated by new gastronomic experiences.

In hypothesis H1, ATT → INT (4.608) highlights the attitude of the product for its aroma, for the pleasure of tasting it and for sharing it with others (family and/or friends), pushing towards the consumption of fresh and processed truffles.

In hypothesis H3, SGAC → INT (2.859) also confirms how curiosity and gastronomic culture lead to the intention to consume truffles.

Finally, the lowest values of the t-value were recorded for hypotheses H7 and H6, respectively, SN → INT (2.753) and SN → PBC (2.147). This shows that it is necessary to give greater attention to the acquisition of information.

As can be observed in Table 8, the indirect effects represent the mediation effects [80], improving the t-value compared to the direct path (Table 7) only in the following two paths:

- In the first SGAC → PBC → INT mediation path (i.e., from curiosity to consumption intention, mediated by specific attention to subjective norms), the t-value is improved, being equal to 4.920;
- In the second mediation path that we verified, SGAC → ATT → INT (i.e., curiosity towards consumption intention mediated by attitude) improved the t-value to equal to 3.606.

**Table 8.** Specific indirect effects and mediation process.

| | Original Sample (O) | Confidence Interval Bootstrap 97.5% | | t-Values | *p*-Values | Path Hypothesis | Results |
|---|---|---|---|---|---|---|---|
| | | Lower | Higher | | | | |
| SGAC → PBC → INT | 0.233 | 0.151 | 0.336 | 4.920 | 0.000 *** | H4 → H2 | Supported |
| SGAC → ATT → INT | 0.179 | 0.096 | 0.283 | 3.747 | 0.000 *** | H5 → H1 | Supported |
| SN → PBC → INT | 0.092 | 0.010 | 0.189 | 2.005 | 0.045 * | H6 → H2 | Supported |

* *p*-Value < 0.05; *** *p*-Value < 0.001 Source: authors' elaboration. Note: ATT = Attitude; INT = Intention for truffle consumption; PBC = Perceived Behavioral control; SGAC = Specific Gastronomic Curiosity; SN = Subjective norms.

Even in these two cases, the importance attributed to "Perceived behavioral control" and to "Attitude" was underlined; these have the effect of mediating and improving the relationship observed between the two latent variables "Specific gastronomic curiosity" and "Consumption intention", aspects that improve the potential for truffle consumption.

## 5. Discussion

This study used partial least squares structural equation modeling (PLS-SEM) to investigate the factors that determine the desire to consume fresh truffles and truffle products. The work provides information on the demand side of products considered sustainable, contributing to the academic and political debates on green and sustainable production. The results obtained suggested that consumers' intentions to use fresh and processed truffles derive from a complex decision-making process involving several factors, such as consumers' personal experiences, marketing communication, food safety, organoleptic aspects, green appearance products and, more generally, environmental protection. This study represents, as far as we know, the first empirical exploration of Italian consumers' preferences on truffles and truffle products. The findings will improve our understanding of consumer preferences for these valuable niche products. Our results could also offer valuable information to the supply chain operators, in order to develop tailor-made strategies to effectively meet consumer expectations. We can here underline that consumers' intentions to use fresh and processed truffles derive from a complex decision-making process involving several factors, such as consumers' personal experiences, marketing communications, food safety, organoleptic aspects, the green reputation of products and, more generally, environmental protection.

The study examined the relationships and effects of ATT, PBC, SGAC and SN on intentions to consume truffles and foods with truffles. All the relationships were identified

as positive and significant, and all the mediators were reported to have effective mediating impacts on the pathways of the proposed model.

The results were then discussed considering the existing literature, although the works are not very numerous. Firstly, PBC mainly influenced the consumption intentions: hypothesis H2 (PBC → INT) had, in fact, the highest t-value (8.383). This result is consistent with the studies of Qing et al. (2023) [11], Ellinda Patra et al. (2020) [81], Petrescu et al. (2017) [82] and Azlie et al. (2023) [83], who demonstrated that attention to health plays an important role in the decision-making processes. It indicates that people currently give priority to a healthy lifestyle, with increasing attention paid to health and nutrition.

Furthermore, safety focus positively associated with INT is in line with natural resource studies conducted by Qi and Ploeger (2021) [2], van Riper and Kyle (2014; 2020) [84,85] and Goodson et al., 2024 [86]. In fact, INT highlights people's consideration towards the consumption of green products supplied by trusted sellers and deriving from their own territory. Particularly, Büntgen et al. (2017) [8] pointed to the use of qualified micotourism guides: the importance of promoting restaurants serving mushrooms, truffles and local products derived from the sustainable management of forest areas, aiming to support the production of non woody products with particular care on the support of other forest ecosystem services, such as the mitigation of climate change effects and the conservation of the biological diversity, has already emerged.

Research hypothesis H5 highlights the second most significant path (SGAC -> ATT with a t-value equal to 7.531). The attractiveness of truffles and truffle-based products is in line with the study by Chen and Wei 2017 [25], which underlines how consumers often try new foods out of curiosity and interest or to remove ambiguity [87]. As Woo Bin Kim and Ho Jung Choo (2023) [88] already indicated, the curiosity refers to behaviors that explore new stimuli which then translate into greater consumer creativity driven by the desire to acquire new knowledge and new information. Curiosity represents a unique combination of aroma, taste, shape and nutrition. The expansion of a new sensorial experience and the nutritional value of truffles and truffle-based products represents an important reason for their consumption.

Furthermore, other studies in the retail field also treat consumer curiosity as a temporary motivational state or desire evoked by novel or inconsistent stimuli [11,89,90].

Hypothesis H4, (SGAC → PBC, t-value equal to 6.326) also confirms that consumers' interest in food safety, in particular with reference to curiosity, is stimulated by new gastronomic experiences. This means that healthy foods are preferable to less safe foods. Chen and Hua Tsai (2023) [91] used structural equation modeling to explore the behaviors that influence intentions to purchase plant-based meat. In their work, it clearly emerges that exploratory behaviors include risk-taking, a variety of seeking and curiosity, while regulatory-focused values include values focused on promotion and prevention.

Another key result of our work is that hypothesis H1 (ATT → INT, t-value 4.608) had a positive and significant impact on the intention to consume truffles and truffle-based products, thanks to the positive attitude of the whole family and the attractiveness of the truffle aroma, which makes them appetizing. In their article, Chen and Wei 2017 [25] underline the importance of olfactory stimuli capable of activating human cognitive states that can influence individuals' behaviors and moods [92] for attractiveness or, on the contrary, disgust [93]. The aroma of truffles can represent a powerful incentive in purchasing decisions. Smell differs from other senses, triggering emotions and memories [94] that influence individuals' moods.

Finally, according to the research model, all the mediation pathways (i.e., curiosity, healthy eating beliefs, attitudes, intention to consume truffles and truffle products) have indirect and specific mediation effects that are both positive and significant with consumption intentions. In addition, through SGAC, PBC, ATT and SN One interpretations of these results it can be seen that consumers demonstrate an intention to consume truffles and truffle-based products in relation to their sustainability values, product attractiveness and status as a valuable niche product, beliefs and pro-environmental standards and linked to

the product's reputation as being rich in nutritional properties and green. All these aspects play an influential role in consumers' consumption intentions and decisions.

## 6. Implications

### *6.1. Theoretical Implications*

This study provides an overview of the decision-making process of consumers of truffles and truffle-based products, presenting a theoretical framework that contributes to enriching the current literature on consumption behavior regarding truffles and truffle-based products, which has not been explored in depth so far. In fact, to the best of our knowledge, here we present the first study on the constructs that can help in the prediction of the "consumption intention" of truffles and truffle products.

Our study extended the TPB framework by adding the construct of food-specific gastronomic curiosity (SGAC), linking perceived behavioral control (PBC) to the importance attributed to health and food safety. The factors that influence the propensity to consume fresh and processed truffles were empirically examined by evaluating the PLS-SEM model in the context of the consumption of these products in Italy, one of the main European truffle-producing countries.

We can then assert that this is the first empirical exploration of Italian consumers' preferences on truffles and truffle products. The proposed approach facilitated our exploration on the factors influencing the consumption of fresh and processed truffles, also providing information on the extent to which attitudes, the recognition of the green and sustainable role of truffles, subjective and objective knowledge and lifestyles influence consumption.

The empirical investigation demonstrated that all components of the applied model had a strong effect on consumers' consumption of fresh and processed truffles.

This research brings valuable insights into both theoretical and marketing fields. From a theoretical perspective, the study improves the understanding of consumer preferences for these valuable niche products, paving the way for an exploration of the impact of the need for food safety, the emphasis on actual consumption intentions and motivations or potential, the push exerted by curiosity and the highlighting of changes in dietary patterns and the importance that consumers attribute to the sustainability of production systems and the importance of a valuable niche product in purchasing behavior.

### *6.2. Practical and Managerial Implications*

The role that the truffles can have in the correct and sustainable management of forests and mountain ecosystems in the inner areas, in the production of food, in people's control of the territory, in the recovery of wooded areas and in their economic support has been confirmed [95]. Truffle-related activities represent a promising and continuously growing commercial driver. This is a niche segment in a market increasingly oriented towards expanding the consumption base, which is also thanks to countless truffle-based products, which make their purchase more attractive and accessible. The presence of truffles allows and strengthens the socio-economic development possibilities of the territories involved and slows down the processes of depopulation, which is widespread in mountainous and inner areas. Furthermore, the cultivated truffle represents an opportunity to move towards innovative and specialized agriculture which has been experimented on for decades in Italy and in various European countries. In recent decades, the European market has undergone changes due to the cultivation of truffles, and the appearance of new companies and new operators in a traditional sector linked to natural production and new marketing opportunities have emerged, with an expansion of the range of processed products. Furthermore, promotion and online sales have given greater visibility to the truffle.

This research contributes valuable marketing insights with actionable implications for marketing strategies. For example, the study suggests that both subjective and objective knowledge can be effectively improved through well-designed information campaigns that detail truffle characteristics.

The findings could offer valuable information to supply chain operators to develop tailor-made strategies to effectively meet consumer expectations.

Furthermore, it is becoming evident that since consumers are increasingly interested in the naturalness, nutritional aspects and origin of the product, product labels should incorporate such information to stimulate the consumption of truffles and truffle-based products with particular attention. It is important to indicate on labels the presence of the natural aroma of truffles in products that contain it rather than artificial aromas, which are dangerous and banned by the EU.

This work also has implications for policymakers. The European Commission (EC), with its new policies (EU Green Deal with F2F and biodiversity strategies, Horizon Europe, Next Generation EU), is committed to making European food the global standard of sustainability. The only way to make this product attractive is to raise consumer awareness, highlighting the sustainability attributes and dietary recommendations that they appreciate and that lead to the acceptance of greater spending.

## 7. Limitations and Directions for Future Research

The present study investigates consumer preferences for truffles and truffle-based products. The study is certainly not without limitations. The first limitation concerns the very nature of the complexity of consumption choices, conditioned by a variety of factors, including the economic, social and cultural conditions of consumers. This is because the consumption of these products is strongly linked to the economic availability of consumers and also to their education, knowledge of the product and the importance they attribute to truffles and truffle-based products and the ability to appreciate them, aspects linked, therefore, to their socio-cultural sphere. Also, these aspects of the socio-cultural sphere could be the object of future insights. Another limitation concerns the fact that the survey deals with a case study of Italian consumers and the results, therefore, pertain to this investigated universe. To make generalizations it is necessary to further extend the studies to other countries and other populations. Furthermore, the demographic and cultural aspects of consumers could also have a different impact on their consumption choices, with obvious repercussions on the results of the study. Future studies should therefore include the effects of additional consumption factors and their consequences. The survey is therefore a first approach aimed at understanding and investigating the consumption of truffles and truffle-based products in Italy. The study, in our opinion, fills a gap and lays the foundation for future research. As far as possible, this implies the need to consider additional geographical realities, given that the survey carried out only considers the Italian territory. In addition to this, future studies would allow further testing of the methodology developed in the study, in light of greater levels of complexity linked to what has been said.

## 8. Conclusions

This study aims to advance the understanding of attitudes towards the consumption of truffles and truffle products and the underlying mechanisms that influence this propensity. We want to shed light on the decision-making process through which consumers organize and formulate their consumption choices for fresh and processed truffles. The results of this study suggest that intentions to consume fresh and processed truffles derive from a complex decision-making process involving several factors, such as consumers' personal experiences, marketing communication, food safety, organoleptic aspects, products with a green reputation and, more generally, environmental protection. Trying to clarify how these aspects can influence consumption choices is also of great importance for the choices that must be made by stakeholders. The latter in fact require useful and reliable information for the purposes of formulating suitable product promotion and market development strategies. Furthermore, as emerges from the results obtained, it is a market that still has ample opportunity for expansion both in terms of the quantity of truffles marketed and the range of processed products made. This requires the study, coordination and implementation of strategies, with evident positive effects that do not exclusively concern

the food sphere. We are referring to the large scale of the nursery sector, to the marketing of products, to micotourism, to the world of research and dissemination services to producers and also to the selection and training of truffle dogs. It is necessary to improve the labeling of truffle-based products to provide a description of the nutritional content and focus on the natural origin of the aroma attested by reliable certifications to gain consumer trust. The results of this study will be useful to stakeholders to better understand the impact of our insights on consumer purchasing intentions and habits.

Some limitations of the current study point to future research directions. Firstly, the number of interviewees should be increased and the research extended to other Italian or European areas to improve our understanding of the consumption behavior of fresh and processed truffles. Secondly, the study addressed only some factors related to attitudes, behaviors, motivations and subjective norms and may have overlooked further crucial elements (such as the influence of social media, ethical aspects, perception of quality and allowing an enrichment of the results).

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16125002/s1.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. All participants were fully informed of the anonymity of the collected data.

**Data Availability Statement:** https://ich.unesco.org/en/RL/truffle-hunting-and-extraction-in-italy-traditional-knowledge-and-practice-01395 (accessed on 15 July 2022) and https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/11100 (accessed on 15 July 2022) https://www.politicheagricole.it (accessed on 15 July 2022).

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

**Table A1.** Construct, survey question and reference bibliography.

| Construct | Survey Questions | Definition | References |
| --- | --- | --- | --- |
| ATT | 1. For me and my family it is pleasant to consume truffles and truffle-based products<br>2. If I want to I can consume truffles<br>3. Truffle's aroma makes me very keen to consume it | Attitudes are a person's positive or negative opinions. Events and behaviors reflect a series of preferences and generate positive or negative intentions towards purchasing and consuming at home or away from home | [96–99] |
| INT | 1. I intend to consume truffles and truffle-based product thanks to the advice of a seller<br>2. I have an intention to consume truffles because I consider them a sustainable product<br>3. I prefer to consume truffles from my area | Purchasing intent allows people to make informed decisions with the aim of consuming/purchasing both immediately and in the near future | [21,23,72,100,101] |
| PBC | 1. I consider myself attentive to the quality of the truffles I consume<br>2. I believe I can recognize truffles and truffle products as healthy and safe food.<br>3. For me, consuming healthy, low-calorie foods like truffles is a good habit | Personal beliefs and the importance attributed to safety give rise to consumer behavioral control | [21,81–83,102,103] |
| SGAC | 1. I am curious about the gastronomic culture that revolves around truffles<br>2. I like trying new foods and new gastronomic experiences<br>3. For me it is important to escape from routine | Curiosity and gastronomic culture regarding a new food can trigger choice mechanisms that influence the overall eating experience | [103,104] |
| SN | 1. Paying attention to the information on the label when purchasing truffles is a habit acquired in the family<br>2. Reading the expiry date is a habit for me<br>3. When I buy truffles or truffle-based products I pay attention to possible "scams" | Subjective norms relate to beliefs about one's own and others' attitudes with respect to the actions that each person carries out | [12,57,66,105] |

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# Proceedings paper: Factors influence the consumption intention towards fresh and processed truffles: an application of the PLS-SEM model"

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**Keywords:** Truffles; Consumption intentions; Sustainability; Calabria; PLS-SEM

## Introduction

Strengthening resilience, halting biodiversity loss and building a healthy and sustainable food system, already highlighted for some time, have become essential priorities following the crisis triggered by COVID-19 which has shown all the fragility of the food system. The pandemic has highlighted the value of rural areas for the well-being of the entire society and their specific contribution in addressing the climate crisis, the green and digital transition. In the context of the PNR 2021-27, particular importance is given to the multifunctional valorization of forest production for a sustainable approach to non-wood forest products and in relation to intangible forest services and nature-based solutions (NBS) and green opportunities.

Recently, many authors have asked the question according to the approach of "rethinking consumption" (Moreau et al., 2017; Privitera and Nicolosi, 2017), from an emotional point of view, from the point of view of rational choices that move the consumer towards sustainable consumption practices (Tukker, 2015) and in relation to his know-how, thus interpreting consumption as a complex practice and as a combination of elements of choice and consumption habits (Mylan, 2014; Warde, 2014).

The aim of this work is to explore motivations and preferences for truffle and truffle-based products consumption. The study was conducted through a survey of consumers intercepted in Calabria and in Italy remotely with online interviews.

The Truffle in Calabria represents an interesting economic resource both with reference to spontaneous truffles and with reference to artificial truffle grounds and offers income opportunities to different figures who in various capacities enter the supply chain. Truffle grounds allow to recover and enhance territories marginal, to introduce new employment, new income opportunities, to promote the potential linked to gastronomic tourism that revolves around the production of truffles and truffle-based gastronomy (fresh and/or processed). Thanks to their

high cultural and gastronomic prestige, various species of truffles are appreciated throughout the world for their high nutritional value, bioactive compounds and prestigious aroma. Even in Calabria, interest in these prized products is growing. In Italy, the truffle market is very fragmented and consists of a multitude of small operators (collectors, growers of artificial truffle grounds, distributors, restaurateurs, etc.). There are no official data on the real quantity of truffles collected each year, especially in relation to the type of sale and negotiation. Many transactions are still carried out at local fairs in the main production regions and in many cases considered occasional sales directly to the final consumer of small quantities (Truffle Supply Chain Plan 2017-2020).

The demand for truffles is mainly linked to the restaurant, processing and tourism industries and is highly seasonal, reaching a peak in the months of October-November, the period of greatest truffle harvest.

Average retail prices vary greatly depending on the species, ranging from €300.00/kg for Tuber Uncinatum Vitt to around €1000.00/kg for Tuber Melanosporum. The prices indicated are indicative, as it is the very nature of the truffle that makes the prices so fluctuating, but it is precisely these "random" prices that make the search for and purchase of the precious hypogeal mushroom such an attractive experience (Oliach et al., 2021).

## Theoretical-methodological framework

The present work aims to analyze the habits and preferences of consumption of truffles and truffle-based products in order to highlight how the truffle supply chain can contribute to the promotion of growth strategies also for Calabria as has happened in many regions of Italy and abroad.

The research was carried out in the period of January-February 2021 during the Covid-19 pandemic; an online consultation of consumers was chosen by preparing a semi-structured questionnaire, using the Microsoft Forms platform.

The questionnaire was published on the electronic bulletin boards of various "social" groups that were used to share the questionnaire, such as WhatsApp, Instagram and Facebook. The questionnaire was filled out by 121 users, residents of Calabria and other Italian regions.

The survey tool is divided into a grid of choice questions used to detect:

• socio-demographic characteristics, occupational characteristics and family income;

•knowledge, habits, places of consumption (restaurant, home, friends' house), frequency and prices;

•any reasons for not purchasing (dislike, high prices, poor availability, etc.);

•motivations for enjoying truffles: aroma; taste; trust and advice from the seller;

•attention to food safety;

•curiosity and attitudes;

•opinion on truffle grounds and sustainability in the territories;

The questions were organized in such a way as to collect both binary answers (yes/no) and multiple choice (3-4 types of choice) and others are based on a five-point Likert scale, 1 = strongly disagree; 2 = disagree; 3 = neither disagree nor agree; 4 = agree and 5 = strongly agree.

The current trend to study increasingly complex relationships makes it useful to apply multivariate analysis methods and techniques, therefore on the basis of the collected responses, databases were created with the help of SPSS.20 and SmartPLS4 software aimed at detecting consumer behavior. A total of 26 variables were coded, following the order of the questions asked in the questionnaire.

The data were processed, analyzed, summarized and interpreted to describe the characteristics of the sample, to identify the main explanatory variables and to highlight the distinctive attributes that most influence consumer decision-making processes.

The research hypotheses are illustrated in graph 1: attractiveness has a positive and significant impact on consumption intention (H1); safety has a positive and significant impact on consumption intention (H2); curiosity has a positive and significant impact on consumption intention (H3); gastronomic curiosity has a positive and significant impact on safety (H4); attractiveness has a positive and significant impact on safety (H5) and gastronomic curiosity has a positive and significant impact on attractiveness (H6).

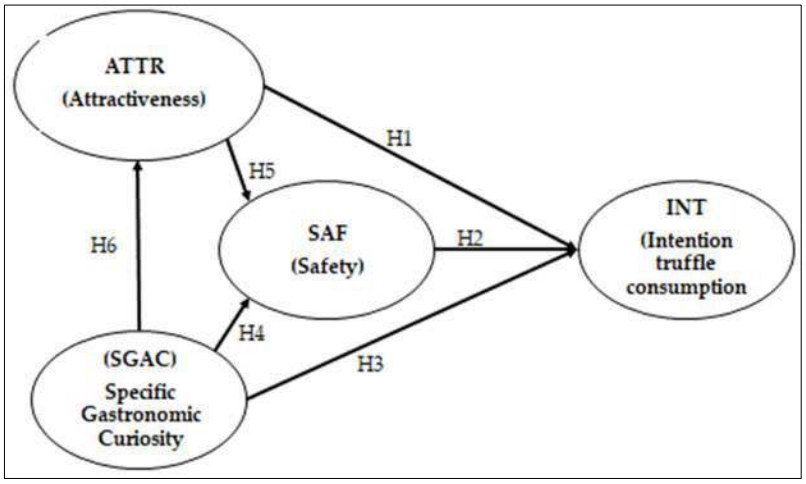


**Figure 1**. Research hypothesis. Source: the authors

In the analysis procedure, Exploratory Factor Analysis (EFA) based on Principal Component Analysis (PCA) was first applied to identify latent factors and for a first interpretation of the obtained solution. Principal components are extracted in such a way as to maximize the proportion of explained variance. The reliability of the model was assessed using the Kaiser-Meyer-Olkin (KMO) test and the spherical Bartlett test (Kim and Kwak, 2015; Lukinac and Jukić, 2022).

Theory of Planned Behavior (TPB) (Ajzen, 1991) has been used in many studies to investigate consumer intentions and behaviors. The predictive power of TPB has been successfully applied in many fields of food consumption research. Currently, structural equation modeling (SEM) has become the methodology of choice for many researchers studying complex relationships between latent constructs, such as in marketing, consumer choice, and other fields, it allows for the assessment of complex patterns and structural paths involving many variables. As highlighted by Lei and Wu (Lei and Wu, 2007), SEM represents an advanced version of general modeling procedures and is used to assess whether the theoretically hypothesized model is consistent with the collected data (Hayes, Montoya and Rockwood, 2017; Hair et al., 2019).

## Results

Table 1 shows the socio-demographic information, which indicates the percentage of male and female interviewees, equal to 47.1% and 52.9% respectively. Furthermore, 22.3% of the interviewees are between 26 and 35 years old and most of them have a degree (31.4%) or a PhD (24.8%), are employed (43.8%), have a medium-high annual income (43.0%). They live in Calabria (47.1%), in the center-North (25.6%) and in other regions of the south (27.3%).

Most of the interviewees said they like truffles (70%), 13% have never tasted them but are curious and interested in consuming them, while 17% of the interviewees said they do not like truffles and do not consume them (Table 2).

As for frequency, only 14% consume them more or less regularly both at home and at the restaurant; 56% consume them occasionally and finally the remaining 30% have not consumed them because they do not like them (17%) or because they have never tasted them (13%). As for purchase prices, the majority (85%) do not answer, do not remember or declare that they do not purchase. 9% of the interviewees purchased at a price between 50.00 and 100.00 €/100 g; only 5% of the respondents declared that they paid a price lower than 50.00 €/100 g; and, finally, the remaining 1% declared that they paid a price higher than 100.00 €/100 g.

**Table 1**. Socio-demographic characteristics of the sample

| | | n. | % | | | n. | % |
|---|---|---|---|---|---|---|---|
| Gender | Male | 57 | 47,1 | Responsible of food purchase | Interviewed | 87 | 71,9 |
| | Female | 64 | 52,9 | | Other | 34 | 28,1 |
| Age | 18–25 years old | 20 | 16,5 | Educational level | Scuola primaria | 1 | 0,8 |
| | 26–35 years old | 27 | 22,3 | | High school | 22 | 18,2 |
| | 36–45 years old | 18 | 14,9 | | University student | 30 | 24,8 |
| | 46–55 years old | 25 | 20,7 | | Degree | 38 | 31,4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | More than 55 years old | 31 | 25,6 | | Post-degree | 30 | 24,8 |
| Annual income (€/year) | No annual income | 6 | 5,0 | Occupation | Employed | 53 | 43,8 |
| | ≤15.000 | 16 | 13,2 | | Manager | 18 | 14,9 |
| | 15.001–30.000 | 45 | 37,2 | | Unemployed | 4 | 3,3 |
| | 30.001–48.000 | 52 | 43,0 | | Students | 29 | 24,0 |
| | ≥48.001 | 2 | 1,7 | | Other | 17 | 14,0 |

**Table 2.** Consumption, frequency and purchase prices declared by consumers interviewed

| | | |
|---|---|---|
| Consumption of truffles and truffle-based products | He appreciates them | 70,0 % |
| | He doesn't like them | 17,0 % |
| | He has never tasted them, but he is curious, interested | 13,0 % |
| Frequency of consumption | Regularly, at home or at a restaurant | 14,0 % |
| | Occasionally, at home or at a restaurant | 56,0 % |
| | Does not consume because does not like it | 17,0 % |
| | Has never tasted them | 13,0 % |
| Purchase prices | less than €50.0/100g | 5,0 % |
| | €50.0 and €100.0/100g | 9,0 % |
| | €100.0 more than €100.0/100g | 1,0 % |
| | Don't know, don't remember, don't answer | 85,0 % |

From a methodological point of view, the EFA processing allowed us to reduce the complexity of our database to a smaller number of variables. The analysis, performed on 12 variables, identified four “latent factors” that explain 72.3% of the total variance. An orthogonal rotation was applied with the Varimax method, allowing a simpler reading of the matrix of the extracted components. The adequacy of the sample was verified with the KMO test (the value obtained, equal to 0.781, is considered acceptable). The four extracted components are: “Attractiveness and preferences and personal experience”; “consumption intentions and motivations”; “subjective norms on attention to food safety”; “curiosity and attitude in the approach to truffle consumption”.

The application of the PLS-SEM procedure allowed to build the structural model, to examine the final results and the quality criteria of the model (Ringle et al., 2022). The most important metrics of the model evaluate reliability, convergent validity and discriminant validity.

Convergent validity is assessed by the item factor loadings and the Average Variance Extracted (AVE). The “Standardized Factor Loadings” of the 12 items

considered should be maintained in the measurement model only if their standardized loadings are equal to or greater than 0.6 (Chin, 2010; Dash and Paul, 2021). In fact, as highlighted in figure 4, the saturations of the items that make up the measurement model are all valid and between 0.620 and 0.913.

The measure commonly used to establish convergent validity is the Average Variance Extracted (AVE). It is considered acceptable with values exceeding 0.50 and indicates that the shared variance between a construct and its elements exceeds the variance of the measurement error (Hair et al., 2019). The results reveal that for all the constructs the AVE values are greater than 0.6 (Table 3), the index of the four latent factors is equal to: INT = 0.656; ATTR = 0.658; SAF = 0.609; SGAC = 0.655 respectively.

**Table 3.** Standardized loading of individual items, Composite Reliability (CR), Average Variance Extracted (AVE), and Cronbach's Alpha.

| | Fattori and Item | Standardized loading of individual items | Composite Reliability (CR) | Average Variance Extracted (AVE) | Cronbach's alpha |
|---|---|---|---|---|---|
| | **Intention truffle_consumption - INT** | | **0,851** | **0,656** | **0,741** |
| Int_1 | I rely on the advice of the seller I trust | 0,799 | | | |
| Int_2 | I consider it a sustainable product | 0,821 | | | |
| Int_3 | I prefer truffles from my area | 0,810 | | | |
| | **Attractiveness - ATTR** | | **0,884** | **0,658** | **0,827** |
| Attr_1 | I prefer to consume them at home (my own or at friends') | 0,710 | | | |
| Attr_2 | Everyone in the family likes them | 0,806 | | | |
| Attr_3 | I like/am available to consume | 0,846 | | | |
| Attr_4 | I like the aroma | 0,872 | | | |
| | **Safety - SAF (Subjective norms)** | | **0,751** | **0,609** | **0,396** |
| Saf_1 | I consider myself very health conscious | 0,913 | | | |
| Saf_2 | I follow media reports and social media for information on food safety | 0,620 | | | |
| | **Specific_Gastronomic Curiosity SGAC_** | | **0,850** | **0,655** | **0,736** |
| Sgac_1 | I am curious about food culture | 0,881 | | | |
| Sgac_2 | I like trying new foods and new food experiences | 0,789 | | | |
| Sgac_3 | For me it is important to escape from routine | 0,752 | | | |

Source: Authors' elaboration from the analysis of data from Smart-PLS4.

The reliability of the internal consistency of the model is represented by the Composite Reliability (CR), which varies from 0 to 1, with higher values indicating higher levels of reliability. This composite reliability in the four latent factors exceeds the recommended value of 0.7: INT = 0.851; ATT = 0.884; SAF = 0.751; SGAC = 0.850. As for Cronbach's Alpha, it is a conservative measure of reliability and returns relatively lower values than the CR and represents its lower limit. Therefore, it seems appropriate to report and compare both parameters. Regarding discriminant validity, the Fornell-Larcker criterion (Mustapa, Amin and Frewer, 2020) is used, which is valid when the square root of the AVE of each construct is greater than its maximum correlation with any other construct in the model. The results presented in Table 4 indicate that each construct shares a greater variance with the items assigned to it (bold values on the diagonal of the table) than with the remaining constructs in the model, thus confirming that the requirements of the Fornell-Larcker criterion are satisfied.

**Table 4.** Fornell Larcker criterion

| | ATTR | INT_ | SAF | SGAC |
|---|---|---|---|---|
| ATTR | **0,811** | | | |
| INT_ | 0,439 | **0,810** | | |
| SAF | 0,542 | 0,693 | **0,781** | |
| SGAC | 0,504 | 0,154 | 0,513 | **0,809** |

The graphical result in figure 2 shows the Composite Reliability (CR) of the constructs, the Saturations of the External Model and the Path Coefficients of the Internal Model. The size of the arrows highlights the relative value of the Paths.

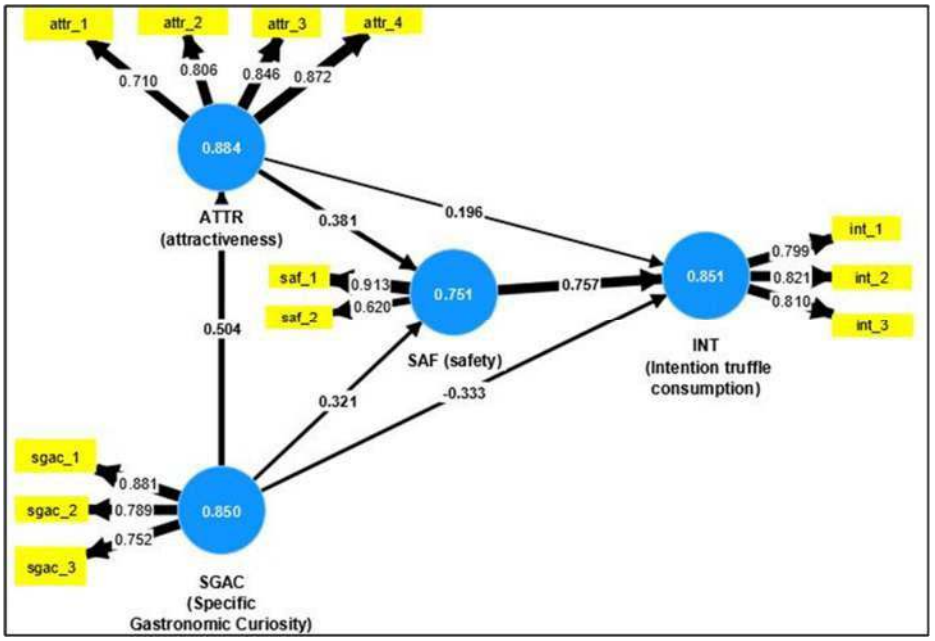

**Figure 2**. The result of PLS-SEM. Elaboration and adaptation by the authors.

The quality criteria R2, f2 and collinearity statistics are also valid (Tables 5-6). The first R2 concerns the so-called "coefficient of determination" which is a measure of the share of variance of an endogenous construct that is explained by its predictor constructs (all the constructs related to it).

The second f2 is referred to as "effect size". The guidelines for evaluating f2 are the following: values of 0.02 represent weak effects; values of 0.15 represent medium effects and values of 0.35 represent substantial effects (Cohen, 1988).

Furthermore, with reference to collinearity, all the hypothesized paths are valid since the "VIF threshold values" (Variance Inflation Factor) fall within the limits of the range 0.20-5.0 recording values between 1.0 and 1.589 (Table 6).

The value of Q2 is also valid (table 5), it represents a measure of the predictive power of the model and, as indicated by Benitez (Benitez et al., 2020) it is considered valid when it has values greater than 0.000.

**Table 5**. R2e Q2

| | $R^2$ | $R^2$ | $Q^2$predict |
|---|---|---|---|
| ATTR_(attractiveness) | 0,254 | 0,248 | 0.237 |
| INT_ (Intention truffle_consumption) | 0,559 | 0,548 | 0.006 |
| SAF (safety) | 0,371 | 0,360 | 0.244 |

**Table 6**. f2 and VIF Collinearity Statistics

| | $f^2$ | VIF |
|---|---|---|
| ATTR_(attractiveness) -> INT_ (Intention truffle_consumption) | 0,056 | 1,571 |
| ATTR_(attractiveness) -> SAF (safety) | 0,172 | 1,341 |
| SAF (safety) -> INT_ (Intention truffle_consumption) | 0,817 | 1,589 |
| SGAC_(Specific_Gastronomic Curiosity) -> ATTR_(attractiveness) | 0,341 | 1,000 |
| SGAC_(Specific_Gastronomic Curiosity) -> INT_ (Intention truffle_consumption) | 0,168 | 1,504 |
| SGAC_(Specific_Gastronomic Curiosity) -> SAF (safety) | 0,122 | 1,341 |

Table 7 shows the results of the SEM path. The t-values of the 6 paths are all supported by the analysis, the hypothesis H2 (SAF -> INT) has the highest t-value (11.729) and confirms the importance attributed by consumers to food safety, followed by the hypothesis H6 SGAC -> ATTR (7.413) which confirms how curiosity for a quality product, as well as considered luxury, both fresh and natural and proposed as a gourmet product attracts consumers a lot.

The hypothesis H5, ATTR -> SAF (4.176) confirms the importance attributed to safety even in the face of a strong attractiveness of the product for its aroma, for the pleasure of tasting it and for sharing it with others (family and/or friends). The hypothesis H3, SGAC -> INT (3.914) also confirms how curiosity and gastronomic culture lead to the intention to consume truffles. Finally, the lowest t-values are recorded for the paths SGAC -> SAF (hypothesis H4) and ATTR -> INT (hypothesis H1) which are equal to 2.978 and 2.743 respectively.

**Table 7.** Results: Convergent validity, internal consistency of the constructs and significance analysis of direct effects.

| Path coefficients | Original sample (O) | Confidence interval 97.5% (*) | t-value (\|O/DEVST\|) | p-value | Hypothesis | Results |
|---|---|---|---|---|---|---|
| ATTR -> INT | 0,196 | 0.345 | 2,743 | 0,006 | H1 | supported |
| ATTR -> SAF | 0,381 | 0.555 | 4,176 | 0,000 | H5 | supported |
| SAF -> INT | 0,757 | 0.868 | 11,729 | 0,000 | H2 | supported |
| SGAC -> ATTR | 0,504 | 0.622 | 7,413 | 0,000 | H6 | supported |
| SGAC -> INT | -0,333 | -0.172 | 3,914 | 0,000 | H3 | supported |
| SGAC -> SAF | 0,321 | 0.500 | 2,978 | 0,003 | H4 | supported |

As can be seen from Table 8, the specific indirect effects that represent the mediation effects (Zhao, Lynch and Chen, 2010), improve the t-Value compared to the direct path in the following two paths:

-in the first mediation path ATTR->SAF->INT (i.e. from attractiveness to consumption intention, mediated by a specific attention to food safety) the t-Value is equal to 4.088 (the direct value ATTR->INT is 2.743);

-in the second mediation path that we verified SGAC->ATTR->SAF (i.e. curiosity towards food safety mediated by attractiveness) the t-Value is equal to 3.370 (the direct value SGAC->SAF is 2.978).

Even in these two cases, the importance attributed to food safety is highlighted, which has the effect of mediating and improving the relationship observed between the two latent variables “Attractiveness” and “Consumption intention” and between the two latent variables “Curiosity” and “Food safety”, aspects that improve the potential for truffle consumption.

**Table 8.**

| Indirect specific effects | Original sample (O) | Confidence interval 97.5%(*) | Valori-t | Valori-p | Path Hypothesis | Sign<0,05 ? |
|---|---|---|---|---|---|---|
| ATTR_-> SAF -> INT | 0,288 | 0,426 | 4,088 | 0,000 | H5 -> H2 | YES |
| SGAC -> SAF -> INT | 0,243 | 0,411 | 2,675 | 0,007 | H4 -> H2 | YES |
| SGAC -> ATTR -> SAF | 0,192 | 0,318 | 3,370 | 0,001 | H6 -> H5 | YES |
| SGAC -> ATTR -> SAF -> INT | 0,145 | 0,241 | 3,291 | 0,001 | H6 -> H5 -> H2 | YES |
| SGAC-> ATTR -> INT | 0,099 | 0,198 | 2,390 | 0,017 | H6 -> H1 | YES |

(*) 97.5% Confidence Interval with Corrected Bias

## Conclusions

The results of this study suggest that consumers' intentions to consume fresh and processed truffles derive from a complex decision-making process that involves various factors such as consumers' personal experiences, marketing communication, food safety, organoleptic aspects, the green aspect of products and, more generally, environmental protection.

The study examined the attractiveness of truffles and truffle-based products, food safety needs, actual or potential consumption motivations and consumption intentions and looks at changes in dietary patterns and the importance that consumers attribute to the sustainability of production systems (Mancini et al., 2019; Dong et al., 2022). The role that truffles can have in maintaining forests and mountain farms, in the production of food, beauty and physical and economic well-being of internal and wooded areas has been highlighted. The activities that revolve around truffles represent a promising and constantly growing commercial driver.

This is a niche segment with a market increasingly oriented towards expanding the consumer base, also thanks to the countless truffle-based products that make its purchase more attractive and accessible. In recent decades, the European market has undergone changes due to the cultivation of truffles and the appearance of new producers in a traditional sector linked to natural production and new marketing opportunities have emerged determined by online promotion and sales that have given greater visibility to truffles.

The limitations of the study concern the number of interviews, the lack of clarity on the availability and possibility of purchasing the product.

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# CHAPTER 2. THE TRUFFLE SUPPLY CHAIN IN CALABRIA

## *2.1 Challanges*

Calabria has a high variability of soils, offering ample space for the spread of various species of truffles and different areas can be identified for its presence (Figure 3). In this context, the truffle in Calabria represents an interesting economic resource. In this region the presence and spread of truffles have been known for years.

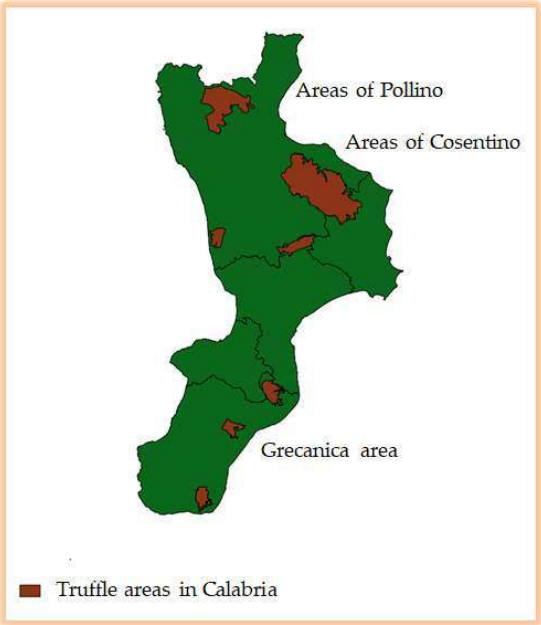


**Figure 3**. Localization of truffle areas in Calabria. Own elaboration

Ascomas are increasingly found, and their subtle and microscopic morphology has given rise in recent years to increasingly heated discussions among hunters to reach the correct identification of many specimens (Leonardi et al., 2021; Marozzi et al., 2020), to the point of stimulating interest in a more detailed study on not only morphological but also genetic aspects aimed at confirming and ascertaining a greater diffusion in the regional territory not only of the most noble species but also to identify species of lesser economic importance but still new and which can have significant importance from a naturalistic point of view, especially in terms of increasing biodiversity (Graziosi et al., 2022). In Calabria, truffles represent not only an interesting economic resource for natural truffle cultivation, but also for cultivated truffle cultivation. From studies carried out by some Calabrian researchers ('Il tartufo nero di Calabria', n.d.), nine different tubers have been identified: *Tuber aestivum, Tuber aestivum var uncinatum, Tuber borchii, Tuber magnatum, Tuber brumale Vittad, Tuber Mesentericum, Vittad, Tuber excavatum Vittad* and *Tuber rufum Pollini*.

For years, truffles have grown only spontaneously, but in recent years, we can also talk about truffle farming in Calabria.

Truffle farming is an important agricultural activity in many parts of Europe and is becoming increasingly popular throughout the world, especially in countries in the southern hemisphere that aim to produce truffles in counter-season compared to the northern hemisphere.

Truffle culture refers to the set of cultivation and management techniques for the production of truffles. Modern truffle culture was introduced in France and Italy in the 1970s after the discovery of the mycorrhizal nature of truffles. Initially, three methods were tried to inoculate plants: spore inoculation, mother plant technique, and mycellar inoculation. The mother plant technique involved planting seedlings in the root zone of a plant known to be mycorrhizal with the required truffle. While mycelial inoculation also showed promise (Chevalier & Pargney, 2014), spore inoculation soon became the method of choice for commercial plant production. In the second half of the 20th century, truffle culture spread and gained a great impetus not only in Europe but also in non-European countries.

In Calabria, the Universities and CREA (Council for Agricultural Research and Analysis of Agricultural Economics - Forestry and Wood Research Centre,in the offices present in Calabria) are trying to stimulate the creation of a "Calabrian Truffle System". On May 28, 2024, the first National Conference "Calabrian Truffle" was held in Rende (Cs), with the support of the Ministry of Agriculture, Food Sovereignty and Forests (now MASAF) and the Calabria Region and with the aim of being able to contribute to the knowledge, enhancement and protection of the Calabrian Truffle. In this same perspective, CREA Forests and Wood has created an experimental truffle ground at the Rende (CS) office. 164 trees of native forest species (Oak, Downy Oak, Holm Oak, Cork Oak, Poplar, Lime, Hornbeam) inoculated with spores of summer truffle or scorzone (*Tuber aestivum*), insist on an area of about one hectare. This artificial truffle farm can become, together with the one recently created by ARSAC (Regional Agency for the Development of Calabrian Agriculture), a concrete element of support for training and dissemination and information activities related to truffle cultivation in Calabria.

In recent years, some agro-forestry companies are testing themselves with truffle cultivation in Calabria. In fact, it is revealing new business opportunities in Calabria and has the necessary characteristics to become a form of sustainable agriculture. The Calabrian territory, thanks to the presence of local companies that have focused on truffle cultivation, is investing in the future with a view to green and sustainable development.

This new attention to truffle cultivation in Calabria is lagging behind other Italian and European regions of ancient and new tradition (Oliach et al., 2021) that are focusing on strategic alliances between mycologists, foresters,

gastronomes, farmers and politicians, creating a notable spin-off around truffles (Büntgen et al., 2017; Marcilhac & Moriniaux, 2018).

These strategies implement truffle production systems adapted to dynamic models that take into account climate change, sustainable green technologies (mycorrhized host plants, inoculation techniques, growth rates, etc.) and experimental management techniques oriented to the production of "terroir" products of *Tuber melanosporum*, capable of promoting product and territory valorization paths that can represent growth strategies and possibilities for new sources of income for farmers and operators in the supply chain.

two main purposes:

1. determine the essential elements for the production of the Calabrian Truffle in artificial truffle grounds, in controlled truffle grounds and in natural truffle grounds.
2. identify subjects and potential to promote/establish a Calabrian Truffle supply chain.

to achieve these purposes also in Calabria it is necessary to:

- identify the Mediterranean forest species that best lend themselves to forced symbiosis with truffles;
- control the adaptation, development and growth of mycorrhizae;
- identify, through field studies, the soil and climate conditions that favor the formation and propagation of a quality product.

In natural truffle grounds, in addition to protecting biodiversity, the goal is their recovery and better management. In both cases, through the best practices tested, there is the possibility of diffusion in suitable areas.

With reference to the second point, it accompanies and assists the different segments that characterize the truffle supply chain and the relationships between them, they are important to highlight the strengths and critical points, to analyze the possibilities of creating a network of actors interested in the knowledge and innovation of the supply chain itself, to encourage the sharing of their practical knowledge and to start virtuous processes of competence and professionalism. The particular characteristics of the truffle such as intense and characteristic aroma, fine and delicate taste, are well suited to the flavoring of different agri-food products and it is, therefore, possible to combine tradition and innovation with a view to developing new products starting from traditional local productions (such as olive oil, pasta, rice, creams, etc.).

The number of subjects directly or indirectly interested in the affirmation of the truffle product are many: farmers, forestry companies, nursery companies, agri-food processing companies (both family-run and agro-industrial), technicians and experts from the world of research, restaurateurs, other operators in the Calabrian truffle supply chain such as collectors, traders, distributors, other upstream and downstream companies and last but not least, consumers.

NBS (Nature Based Solutions) research results become innovations when they provide value for a diverse set of stakeholders (Strout et al., 2021):

- National, European and international policy makers and decision makers (for the contribution that innovation can bring to NBS policies);
- Local, regional and national professionals and entrepreneurs;
- The private sector (agroforestry, agri-food, nursery, catering, traders, insurance, green banks and other activities);
- Environmental groups and other non-governmental organizations (NGOs) interested in the forestation planned in the territories; in the creation of new jobs, etc.
- Academic networks working on the protection of forest ecosystems, climate adaptation, water management and the implementation of NBS (and which simultaneously concern human well-being, benefits for biodiversity, cultural and recreational services and the economy of the system);
- Specific stakeholders including local citizens and rural communities in inland and mountain areas.
- Media, interest groups, civil society and consumers

As for the different and varied activities, they range from knowledge of the territorial potential to the skills needed in the different sectors, up to the benefits brought by the truffle supply chain for all the figures and operators in the sector, passing through innovations in the various fields of research and environmental sustainability that together represent the extraordinary combination of environmental protection and recovery, sustainable production activities (Figure 4).

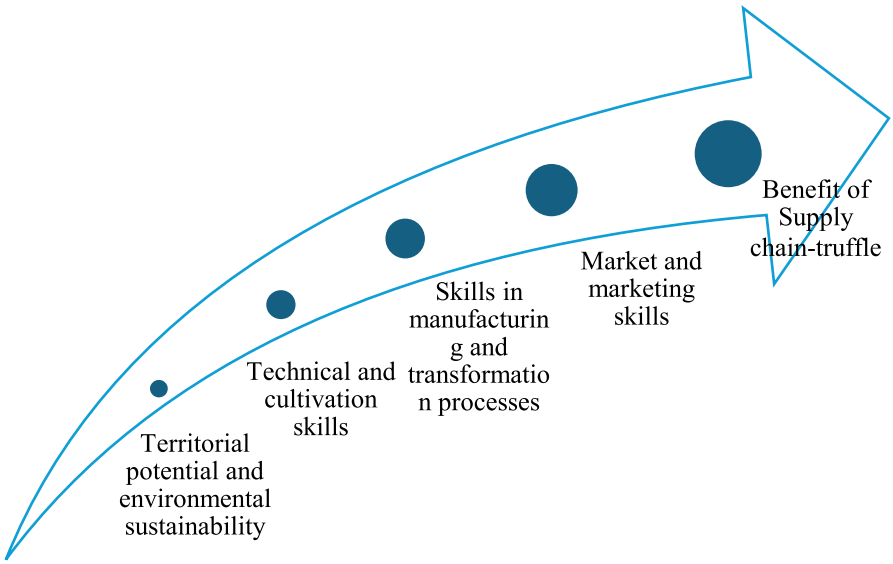


**Figure 4**. Potential growth path from the introduction of activities within the truffle supply chain in Calabria. Own elaboration

These aspects fall within the scope of Ecosystem Services (Costanza et al., 2017; Nocentini et al., 2022; Sabatini et al., 2020) to which we can add food and wine tourism that revolves around the production of truffles and truffle-based

gastronomy (fresh and/or processed) (Star et al., 2020), social farming, Forest Bathing and activities that aim at the cultural and well-being aspects of the population. In Calabria, truffle cultivation can promote sustainability and represent an important tool for the development of the territory and contribute:

- to the economic improvement of companies and farmers and increased competitiveness;
- as a driving force for other intangible forest activities and services in the context of diversification and multifunctionality, such as agritourism, rural and forest tourism and Forest Bathing (forest bathing as therapy);
- create new jobs
- promote the social use and return to the community of woods confiscated from the '*ndrangheta* for artificial installations or for the maintenance, recovery and improvement of existing natural truffle grounds.

## *2.2. Territorial analysis: Grecanic and Aspromonte areas*

The geographical, geomorphological, pedological and climatic characteristics of the Italian territory determine a high environmental heterogeneity that tends to increase if the biogeographic characterization is also considered. The combination of ecological, historical and biogeographic integration therefore determines a great and inestimable structural and functional diversity of forest formations. Calabria is from the point of view of its geological genesis, very particular but substantially homogeneous from Sila to Aspromonte. What determines the spontaneous presence of truffles and creates the conditions for their cultivation is the presence of calcium carbonate and a neutral or basic pH. With the (positive) exception of the Pollino massif, which is all a limestone massif, therefore highly suited to truffle cultivation, the rest of the region has massifs (Sila, Serre and Aspromonte) whose summits are not suitable for the presence of truffles, but all the piedmont bands of the Calabrian massifs (all) have calcareous soils potentially suitable for truffle cultivation, where the presence of truffles is proven and the production potential is high. The partnership, in fact, intends to promote truffle cultivation in all its forms throughout the regional territory: from protection, to enhancement, to the implementation of natural truffle grounds and the creation of artificial truffle grounds. Presence of all truffle species and some "hybrids" among black truffles, of great quality from a gastronomic point of view and still to be classified and enhanced. In Calabria, in fact, spontaneous truffles exist and are widespread in various areas of the region (Di Gregorio et al., 2022). Yet the importance and potential of Calabrian truffle cultivation are late compared to other Italian and European regions of ancient and new tradition. Most of these, in fact, have focused on strategic alliances between mycologists, foresters, gastronomes, farmers and politicians and have created a significant induced effect around truffles (Donnini et al., 2013). These are strategies that implement truffle production systems adapted to dynamic models that take into account climate change, sustainable green technologies (mycorrhizal host plants, inoculation techniques, growth rates, etc.) and experimental management techniques oriented to the production of

“terroir” products of *Tuber melanosporum*. All tools that aim to promote processes of valorization of products and territories and to implement growth strategies and the possibility of new sources of income for farmers and operators in the territory. This requires specific skills that can be oriented to the creation of a truffle supply chain. This, together with the products connected to it, in addition to allowing growth in the agricultural, agri-food and forestry sectors, can allow the creation of the link between truffles and the territory and increase the tourism and use potential of the territory (Star et al., 2020). The high forestry vocation of the Calabria Region, which with over 650 thousand hectares of woods boasts a woodiness index higher than 40% of the regional surface, gives it a large quantity of ecosystem services linked to wooded areas (Noy, 2008). The region has always had skills and capabilities that have leveraged the forestry world. Today the truffle supply chain can expand this precious range of products and services and can increase the incomes of forest environments. Combining innovation with experimentation in the territory is one of the means through which the actors of an economic system can come into contact with each other to contribute, each with their own skills and abilities, to making agricultural-forestry systems more competitive, more efficient in the use of resources, greener, more resilient and in better harmony with natural resources. Gastronomy has proven to be a very important lever for the development of urban and rural tourism strategies that produce positive economic and social impacts of agri-food chains. The construction of the Calabrian black truffle supply chain can increase the added value of a regionally valuable product and introduce the "know-how" of the transformation and marketing of fresh and processed truffles. Companies, in their agricultural, forestry and food activities, are called upon to face new and complex demands that come from the push of competitiveness and exogenous factors such as climate change and changes in eating habits that require constant commitment from companies to adapt and impose organizational and production models aimed at managing these phenomena effectively and efficiently. These are dynamics that also require greater qualification of human capital, a clearer orientation towards high-quality products, organizational changes and development of relational skills, destined to become increasingly relevant for the strategic choices of companies. Furthermore, agricultural and agri-food companies, in addition to playing the traditional role of economic organization oriented towards production and the market, also have a public function linked to the issues of sustainability and environmental protection. Also from this point of view, companies that deal with Calabrian Truffle can perform social and environmental functions and contribute to the sustainable management of natural resources, to the maintenance of the economic and social life of rural areas and to consumer food safety. This knowledge is of crucial importance for the truffle sector, because, by identifying the different components of the supply chain and the relationships between them, it highlights its strengths and weaknesses, allowing to evaluate the economic consequences for the territory and also the opportunity to activate processes of

product valorization and to equip oneself with tools for the defense of the local and quality product, counteracting the negative impact linked to the introduction of truffle substitutes and the use of synthetic substances in the preparation of truffle-based processed products.

# Proceedings paper: The green role of the Truffle in Aspromonte: conservation and environmental protection to rethink a geography of the mountain in marginal areas

Valentina Rosa Laganà*, Agata Nicolosi, Donatella Di Gregorio

Adapted from: IL RUOLO GREEN DEL TARTUFO IN ASPROMONTE: CONSERVAZIONE E TUTELA AMBIENTALE PER RIPENSARE UNA GEOGRAFIA DELLA MONTAGNA IN AREE MARGINALI, V. Bini, V. Capocefalo, S. Rinauro (curated by), Geografia e ecologia politica: teorie, pratiche, discorsi Società di Studi Geografici. Memorie geografiche NS 24, 2024, pp. 489-494. Isbn: 978-88-94690149 https://www.societastudigeografici.it/memorie-geografiche/

**ABSTRACT:** Recent trends in forestry policy contribute to enriching the range of ecosystem services provided by the territory. They simultaneously concern human well-being, protection of biodiversity, cultural and recreational services and the economy of the system. The aim of the research is to identify potentially truffle-producing areas, to highlight how truffle grounds (natural or cultivated) can represent a concrete economic resource. Using official data from the Calabria Region, the map was created with the help of the QGIs software. The results are encouraging and highlight the potential and importance of investing in the green sector such as the truffle sector, aiming to improve sustainable management, new entrepreneurship to guarantee resilience of the mountains and inland areas of Calabria.

**Keywords:** Truffles; Forestry Policy; Mountain

## Introduction

Truffles are a product with a strong evocative impact and are well-connected to the idea of mountains, parks, territories, communities, cultures. Therefore, it is believed that natural and artificial truffle grounds can represent a strong attractive potential and constitute a concrete economic resource and a production chain for local development projects that aim to create new income opportunities, protection and management of the agro-forestry territory (Nicolosi et al., 2019).

The document "New EU Forest Strategy for 2030", in underlining the importance of biodiversity conservation and climate change mitigation, envisaged by the European New Green Deal and the EU Biodiversity Strategy for 2030, recognizes the central and multifunctional role of forests and intends to exploit their potential (EU, COM2021/572). Italy and the regions, through the National Strategy for Internal Areas (SNAI), aim to counter the marginalization and demographic decline phenomena typical of the internal areas of our country. As part of this strategy, the Calabria region has defined a new geography for disadvantaged areas (regional SNAI) and has identified municipalities according to the type of disadvantage. In areas suitable for cultivation, artificial truffle grounds can contribute to reforestation and, with adequate support measures, can

improve sustainable management and enhance the effectiveness of decentralized planning in order to guarantee the resilience of forest ecosystems and allow forests to play their multifunctional role.

The truffle is an environmental indicator and settles in unpolluted environments: it does not tolerate chemical fertilizers and even minimal alterations to soil pH, just as it is not favored by excessive soil tillage and/or soil compaction. The truffle also fears the disappearance of the vegetation with which it has a symbiotic bond (truffle spore and root of the host plant) and the disappearance of the accessory vegetation that lives near the symbiotic plant and that contributes to creating a microenvironment necessary for the mycelium to produce the fruiting body. If the delicate environmental balance in which it settles changes, the truffle disperses and disappears. These characteristics limit its presence and make it vulnerable and precious at the same time. But other threats loom over the truffle: among these, the increase in fires, the increase in populations of wild ungulates (especially wild boars that threaten the areas of spontaneous truffles, despite their ecological role in spreading spores) and last but not least the use of chemical additives used as "truffle aroma" that reduce the prestige of the truffle (Oliach et al., 2021), a trend strongly opposed by the EU through the legislative introduction of the obligation to use only natural aroma and label in a clear and transparent way.

According to Oliach et al. and other authors (Lovrić et al., 2021; Oliach et al., 2021; Reyna and Garcia-Barreda, 2014), in recent decades the cultivation of the black truffle "Tuber melanosporum" in particular has attracted considerable interest both in regions with a Mediterranean climate and in other areas and regions. The strengths identified are based on the recognized value of truffles as a gastronomic product and their growing use in cooking. Another interesting aspect is the particular collection method (hidden product located with the help of a dog) which is perceived positively by operators and consumers. As for the mapping of existing natural truffle grounds, to date, no global database has been compiled, mainly due to the secrecy of the location of truffle plantations, which reflects on the one hand the reluctance to share specific information by truffle growers and hunters, and on the other, the need to preserve truffle grounds from excessive "searching" and from vandalism and amateur and incompetent searchers (Čejka et al., 2022).

The research work aims to identify potentially truffle-producing areas present in the Aspromonte territory in order to promote product, territory, mountain wooded areas in the province of Reggio Calabria and in particular in the Aspromonte massif area.

## European policies for forests and inland areas.

*THE EUROPEAN UNION AND FORESTS FOR 2030*

On July 2021, the EU updated the forest strategy adopted in 2013. The new strategy (COM2021/572final), although in line with the previous one in terms of active intervention objectives to address climate change and biodiversity loss, proposes new actions aimed at expanding the guarantee of forest ecosystems and the multifunctional role of forests (Zinzani, 2020). Therefore, forest protection and

restoration measures are strengthened, as well as measures aimed at improving their sustainable management and enhancing the monitoring and effectiveness of decentralized planning. Measures are also envisaged that concern innovation and the promotion of new materials and products capable of replacing their fossil-based counterparts and to boost a forest economy less based on the exploitation of wood. In addition, the focus on reforestation is maintained and strengthened, with the plan to plant at least three billion new trees in the EU by 2030. Emphasis is placed on the involvement of forest owners and managers and on the possibility of an EU contribution to the United Nations 2030 sustainable development goals, in particular goal 15, which aims to protect, restore and promote the sustainable use of ecosystems. This is a major challenge, both in terms of the number of individuals involved and the size of the territories, all of which are called upon to make a contribution given the importance of protecting biodiversity. Woods and forests also provide food and goods necessary for the life of local communities, and their maintenance is therefore a guarantee of survival for entire populations that have been caring for the territories on which they stand for millennia. Protecting and restoring forests can help reduce poverty by ensuring clean water and air and can also help mitigate the effects of climate change due to the valuable role that forests play in storing CO2.

As for the National Research Program (PNR) 2021/2027, it places importance on forestry systems for the protection and enhancement of the territory. The analysis of the expected impact highlights the value attributable to the increase in ecological quality and the production potential of goods and services of the different territories and to the reduction of the gap between urban and rural, internal and mountain areas, as well as to the optimization of territorial management and landscape conservation (Bandiera and Bini, 2020). Resources are provided to stimulate research aimed at identifying innovative strategies for the protection of the environment and for the enhancement of economic, environmental and social benefits deriving from the great Italian territorial variety, a unique and strategic characteristic to be enhanced. The PNR 2021-27 reiterates the importance of the multifunctional valorization of forest production for a sustainable approach to non-wood forest products and in relation to intangible forest services, the so-called nature-based solutions (NBS) capable of providing ecosystem services that simultaneously look at human well-being, benefits for biodiversity, cultural and recreational services and the economy of the system (Büntgen et al., 2017).

The central and multifunctional role of forests and the importance of biodiversity conservation and the need for climate change mitigation has recently been reiterated in the EU document Forest Monitoring Law. A monitoring framework for resilient European forests (COM, 2023 - 728 final 2023/0413) and the related Annex document on technical specifications (EU, COM, 2023 - 728 final ANNEXES 1 to 4).

*The National Strategy of Internal Areas as a Local Development Tool in Italy and Calabria*

The term "internal areas" refers to areas characterized by a significant distance from the main centers of service provision, in particular health, school, mobility, and by a high availability of important environmental resources (water, agricultural systems, forests, natural and human landscapes) and cultural resources (archaeological heritage, historical settlements, abbeys, small museums, craft centers). To compensate for the lower availability of services, a National Strategy has been developed aimed at promoting development projects that, leveraging cultural and natural heritage, aim to increase the value of the territory, also through the development of local production chains. This is the short-term objective associated with a long-term objective that moves with the intent of reversing the recessionary demographic trends. For several decades, internal areas have been the object of attention of the community legislator, first of all the commonly known fourth community directive, Directive no. 268/75. At that time, the EEC clearly stated two objectives that it intended to achieve: 1) Continuity of economic activities in the territory, especially agricultural ones; 2) Guarantee of the presence of man in the territory also for the purposes of preventing hydrogeological instability and conservation of the natural environment. The recent SNAI recovers the historical objectives and interprets them in a more innovative way aimed at countering the marginalization and demographic decline phenomena typical of internal areas, through the definition of Local Strategies. Thanks to specific framework program agreements (APQ), the necessary interventions and implementation criteria are defined. The strategy launched with the 2014-2020 cycle of cohesion policies, has found continuity in the 2021-2027 programming, with the forecast of 56 new internal areas and the confirmation of 67 of the 72 internal areas identified in the 2014-2020 cycle.

In Calabria the forest area covers 750 thousand hectares of woodland and represents over 42% of the regional area, a large part of these wooded areas base their culture on agricultural or forestry lifestyles, landscapes and places rich in history and traditions. Today, however, these valuable forest and woodland areas are often found in contexts in which human settlements tend to empty and many of the existing structures, once at the service of agricultural or forestry activities, memory of the use of the territory and of the past economic, social and cultural liveliness, lie in conditions of abandonment and degradation. In this context, truffles can represent an interesting economic resource not only with reference to spontaneous truffles, but also with reference to controlled and cultivated truffle grounds. Truffles offer income opportunities to different figures who in various capacities enter the long supply chain, allow for the recovery and enhancement of marginal territories, to introduce new employment, to promote potential linked to gastronomic tourism that revolves around the production of truffles and truffle-based gastronomy (fresh and/or processed). In the awareness of this growing importance of truffle cultivation and gastronomy as an integral part of broader rural and tourism development strategies in marginal European areas (Di Gregorio et al., 2022), the research examines, in the Aspromonte territory, the areas suited and compatible with the presence of truffles, proposing an adequate valorization

capable of providing new green tools for production differentiation, conservation and environmental protection to rethink a geography of the mountain in marginal areas.

Within the SNAI strategy of the Calabria Region (Fig. 1), the actions aim to block depopulation and degradation, to reduce the current economic, social and institutional gaps and to activate processes of social and entrepreneurial innovation based on the valorization of the territory's identity resources (nature, culture, agro-forestry productions) also through the full involvement of local communities to create sustainable development and good employment in the territory.

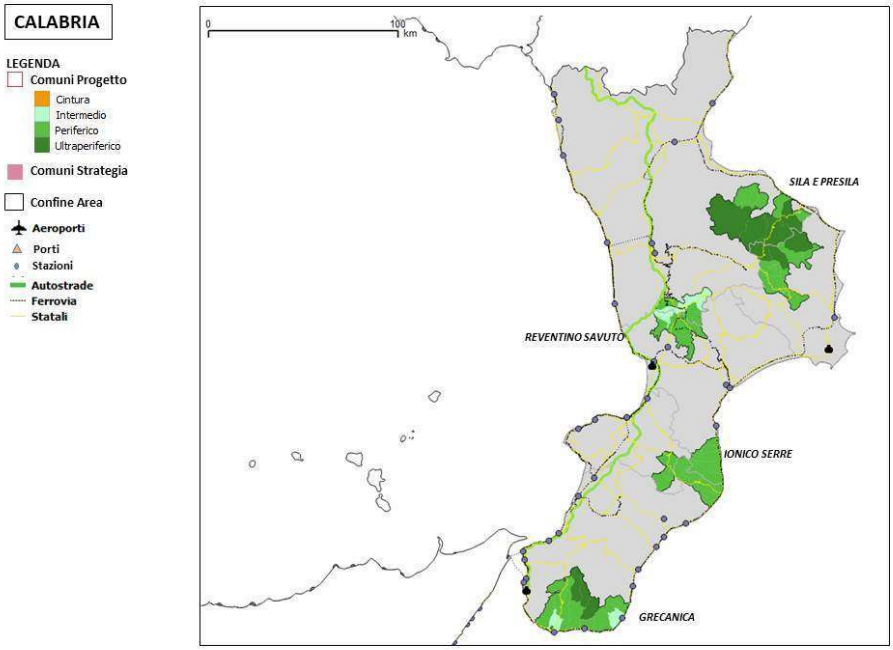


**Fig. 1** - Map of the Internal Areas of Calabria. Four Internal Areas of Calabria identified by the Strategy, including 58 municipalities, from north to south: Sila and PreSila; Reventino Savuto; Serre Ioniche; Area Grecanica. Source: Agency for Territorial Cohesion, Calabria Region (Figure directly taken from the original work)

## Methods and results

The truffle areas in the province of Reggio Calabria have been mapped in order to identify the areas suitable and compatible with truffles. This is because truffles are present naturally and/or artificially only in the presence of alkaline or sub-alkaline reaction substrates and when suitable climatic conditions are created. Starting from the official data of the Calabria Region and with the aid of the QGIS software, the map shown below was created (fig. 2). The maps were obtained through an extrapolation and re-elaboration of data. We started from the geological maps of the Calabria region at 25,000, which were first superimposed on Google

Earth and, subsequently, reported on QGIS. Subsequently, we proceeded to the delimitation of the areas of interest (province of Reggio Calabria) and to the interpolation of the same to obtain a first map of the Calabria region and in particular of the province of RC. Subsequently, the areas not suited to truffle cultivation were eliminated, leaving only the most suitable ones (presence of alkaline or sub-alkaline reaction substrates) and in particular of Miocene, Pliocene and Jurassic origin which were colored according to a conventional color: in red those of Miocene origin, in Blue those of Pliocene origin and in Yellow those of Jurassic origin. The result obtained provides indications on the areas that, at present, can be suitable for truffle cultivation, by type of soil in relation to the geological era and the species of Truffle most suitable in that area and that one can expect to find and collect.

The data collected were processed in graphic form in order to give a visual idea of the distribution and presence of compatibility conditions by identifying the areas suited to Truffle by type of soil and Species. The map provides information necessary to identify a map of the areas suitable for truffle in the province of Reggio Calabria in relation to the possibilities of real use of the land. This information is very important in the creation of a development area, as it is directly connected to the soil and climate needs of the truffle. In the strip surrounding the Aspromonte massif, the study confirms the presence of almost all valuable truffles (from *Tuber magnatum Pico* to *Tuber Aestivum Vittadini*) ascertained and documented by several authors (Cirrincione et al., 2015).

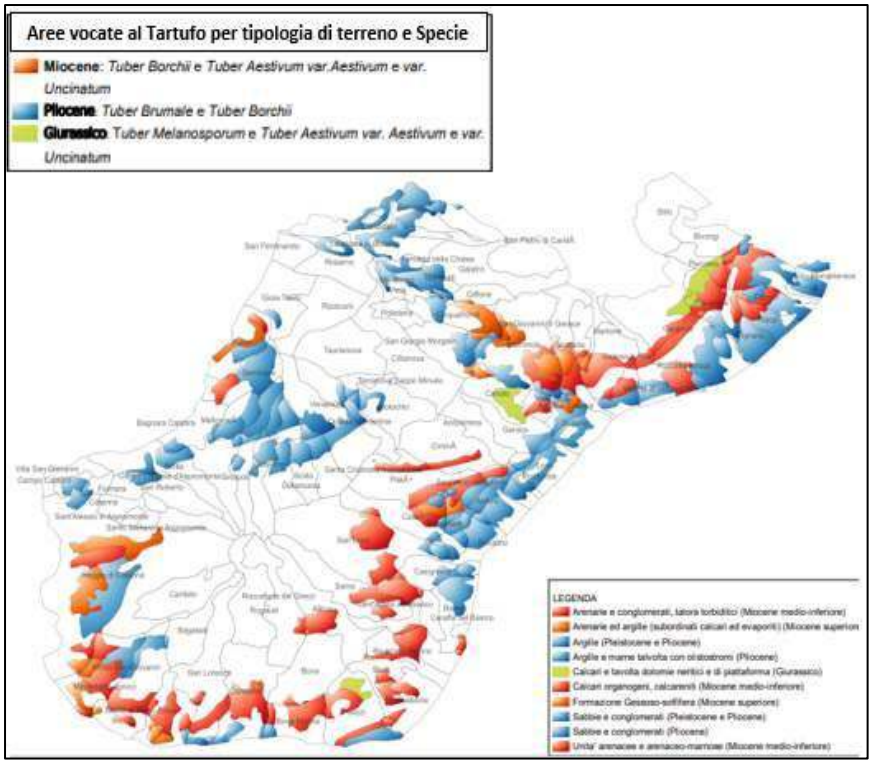


**Fig. 2** – Map of truffle-producing areas suitable and compatible with the presence of truffles (wild and/or cultivated) (Figure directly taken from the original work). Supervised by Marco Macrì.

The map allows an identification of the potentially truffle-producing areas present in the province of Reggio Calabria and in the Aspromonte territory. The mapping allows to examine the potential of the truffle to promote valorization paths of the truffle supply chain of the Aspromonte territory, in particular in relation to the following possibilities:

• Increase the wooded areas following the planting of truffle grounds with mycorrhized forest essences;

• Recover structures of the building heritage of the area that are largely abandoned or underused;

• Stimulate agro-forestry entrepreneurship through the care and maintenance of natural truffle grounds;

• Stimulate the planting of artificial truffle grounds and, in relation to the long times of obtaining production, involve young people in particular;

• Social use and return to the community of woods confiscated from the 'ndrangheta for artificial plants or for the maintenance/recovery of existing natural truffle grounds;

• Activate multiple skills that revolve around truffle grounds: cooperatives, technical assistance, nursery, breeding and training of truffle dogs, catering, production of local agricultural products flavored with natural truffle aromas, etc.;

• Promote low environmental impact tourism and food and wine tours with the inclusion of truffles.

The final product of the processing was obtained using soil, climate and cultivation characteristics in order to obtain a map depicting the areas actually suitable for truffles and the compatibility of the territories with any artificial cultivation in the province of Reggio Calabria. These are areas in which to concentrate intervention efforts to encourage this type of production (Fig. 2). Some of these areas coincide with the territories that man has exploited the most, often in an uncontrolled manner, almost completely devastating the forest in favor of grazing and crops that were later abandoned. They are areas at high risk of fire where the presence of truffles is already reported, albeit sporadic. In the pre-Aspromonte area, it is now certain that it is possible to operate on two different realities: protecting and expanding the existing truffle grounds while respecting the existing truffle heritage and encouraging the creation of artificial truffle grounds. The truffle grounds planted by man, in fact, artificially recreate the conditions existing in the areas where truffles are naturally present. And this is because all the climatic, seasonal and economic conditions exist to start the creation of afforestations to be dedicated to truffle cultivation in Aspromonte.

## Conclusion

The study conducted looks at the spread of agricultural and forestry activities for the development of internal and marginal areas in territories at risk of depopulation. Among these, the implementation and organization of supply chains

such as that of truffles, can represent an opportunity to improve the incomes of agricultural and forestry entrepreneurs, as well as the modernization of sectors towards a circular economy and towards new economic areas, and with particular attention to innovations, first among many tools for growth and development. The national policy oriented through the programs for internal areas (SNAI) and the most recent Recovery Plan itself, place at the center of their interests the recovery and development of territories and communities that live in situations of marginality compared to metropolitan areas. These territories and their communities can fully be included in a plan in which innovation and development are the main determinants of economic policy. In these territories, a national strategy is urgently needed that simultaneously involves agricultural, food and forestry systems within sustainable and inclusive development schemes, to restore momentum and competitiveness to the territories and to eliminate all disparities, be they economic, cultural or gender-based.

**Contributions**: This document is the result of the common commitment and cooperation of the three authors. Paragraph 1 was edited by Prof. Agata Nicolosi. Paragraph 2 (2.1 and 2.2) was edited by Dr. Donatella Di Gregorio. Paragraph 3 was edited by Dr. Valentina Rosa Laganà.

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## Article: Agri-food and typical products events: promotional tools for a territory in southern Italy

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# AGRI-FOOD AND TYPICAL PRODUCTS EVENTS: PROMOTIONAL TOOLS FOR A TERRITORY IN SOUTHERN ITALY

## *Eventos agroalimentarios y de productos típicos: instrumentos de promoción para un territorio del sur de Italia*

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**ABSTRACT:** For most of the hilly, mountainous and inland areas, local and typical agri-food products represent an important tool for producing income, guaranteeing food and nutritional security, providing an answer to basic human needs and the desire to improve the quality of life. The survival of these areas is strongly linked to the persistence of these products, which, in addition to having to be profitable for the communities that produce them and who live from them, must also impose themselves within the framework of the competitiveness imposed by the markets. In fact, it happens that, for many of them, although the production conditions guarantee quality and food safety, the same cannot be said about their ability to compete with most of the semi-industrial productions. Thanks to consumers survey the study proposes a reading of the relationships between food and wine events / manifestations of an internal area in Southern Italy and some local food products offered in the stalls and food stands on occasion of such events. From a methodological point of view, it was decided to apply the "Social Network Analysis" (SNA), comparing gastronomic, folkloristic and cultural events that were detected in the area and with some local food products present in the stalls and stands. The area considered is very interesting with reference to the typical and traditional products, among which the less known and widespread

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**ABSTRACT:** For most of the hilly, mountainous and inland areas, local and typical agri-food products represent an important tool for producing income, guaranteeing food and nutritional security, providing an answer to basic human needs and the desire to improve the quality of life. The survival of these areas is strongly linked to the persistence of these products, which, in addition to having to be profitable for the communities that produce them and who live from them, must also impose themselves within the framework of the competitiveness imposed by the markets. In fact, it happens that, for many of them, although the production conditions guarantee quality and food safety, the same cannot be said about their ability to compete with most of the semi-industrial productions. Thanks to consumers survey the study proposes a reading of the relationships between food and wine events / manifestations of an internal area in Southern Italy and some local food products offered in the stalls and food stands on occasion of such events. From a methodological point of view, it was decided to apply the "Social Network Analysis" (SNA), comparing gastronomic, folkloristic and cultural events that were detected in the area and with some local food products present in the stalls and stands. The area considered is very interesting with reference to the typical and traditional products, among which the less known and widespread

truffle has only recently begun to establish itself. The results showed that some of the products taken into consideration are recurrent, that is, always present in the various events in the area, others less so. The data shows the attractiveness that these events and gastronomic events are able to trigger in consumers and the interest and propensity to buy that the food of local tradition. In particular, tourists seek the experience of local gastronomy and the culture and identity of the destination visited. Reading these data provides some information on the competitive strength that food and wine events and local productions are able to arouse. Events and demonstrations such as those highlighted in the work help to preserve the identity and authenticity of local traditions.

**KEYWORDS:** Agri-food products; internal areas; Social Network Analysis (SNA); truffles; NWFP; Economical progress; Festival.

**RESUMEN:** Para la mayor parte de las zonas serranas, montañosas y del interior, los productos agroalimentarios locales y típicos representan una importante herramienta para generar ingresos, garantizar la seguridad alimentaria y nutricional, dando respuesta a las necesidades humanas básicas y al deseo de mejorar la calidad de vida. La supervivencia de estas áreas está fuertemente ligada a la persistencia de estos productos, que, además de tener que ser rentables para las comunidades que los producen y que viven de ellos, también deben imponerse en el marco de la competitividad que imponen los mercados. De hecho, sucede que, para muchos de ellos, si bien las condiciones de producción garantizan la calidad y la seguridad alimentaria, no se puede decir lo mismo de su capacidad para competir con la mayoría de las producciones semi-industriales. Gracias a una encuesta a los consumidores, este estudio propone una evaluación de las relaciones entre los eventos / manifestaciones gastronómicas y vinícolas de un área de interior del sur de Italia y algunos productos alimenticios locales que se ofrecen en los puestos de comida con motivo de tales eventos. Desde el punto de vista metodológico, se optó por aplicar el "Análisis de Redes Sociales" (ARS), comparando los eventos gastronómicos, folclóricos y culturales que se detectaron en la zona y con algunos productos alimenticios locales presentes en los puestos. El área considerada es muy interesante en cuanto a los productos típicos y tradicionales, entre los que la trufa es la menos conocida y extendida, y sólo ha comenzado a consolidarse recientemente. Los resultados mostraron que algunos de los productos tomados en consideración son recurrentes, es decir, siempre presentes en los diversos eventos de la zona, otros menos. Los datos muestran el atractivo que estos eventos y jornadas gastronómicas son capaces de suscitar en los consumidores y el interés y propensión a comprar los alimentos de tradición local. En particular, los turistas buscan la experiencia de la gastronomía local y la cultura e identidad del destino visitado. El análisis de estos datos proporciona información sobre la fuerza competitiva que pueden suscitar los eventos enogastronómicos y las producciones locales. Eventos y manifestaciones como los destacados en el trabajo ayudan a preservar la identidad y la autenticidad de las tradiciones locales.

**PALABRAS CLAVE:** Productos agroalimentarios; áreas de montaña; Análisis de Redes Sociales; trufas; NWFP; progreso económico; ferias.

## 1. Introduction

In recent years, coinciding with the growing interest of the media and with the multiplication of manifestations and events dedicated to food, agri-food products have progressively become a distinctive element of the territory and its most authentic vocations: the food and wine sector has been the soil fertile on which the concepts of typicality and tradition related to the recovery of culture, history and local knowledge have been grafted (Brunori *et al.*, 2020).

Many authors have dealt with the importance and role of the territory in the typification of local productions from different points of view (Sini, 1997; Brunori, 1999; Belletti, 2000; Arfini *et al.,* 2010). Several studies examine the participation of farmers and agri-food producers in local events and markets (Star *et al.,* 2020; Van der Lee *et al.,* 2020) and recently look at the concept of proximity economy and sustainable cities for the purpose of food supply and the need for adequate services available to the population (Vilhelmson & Elldér, 2021; Tricarico & Vidovich, 2021). Struś *et al.,* (2020), underline the importance of community support to offer an alternative to current distribution channels.

The relationship between the concepts of local products, regional products and traditional products are illustrated by (Fernández-Ferrín *et al.,* 2019) through an approach in relation to the ethnocentric tendencies of consumers with high levels of subnational ethnocentrism, who appreciate locally produced food and in which the geographical proximity gives them a superior quality in terms of taste, freshness and sustainability, which derives from tradition and geographical origin.

The typicality of agri-food products is intimately connected to the territory, to which it owes, in addition to most of the distinctive elements, the specific recognition on the market (Belletti, 2000). The typical product materializes a perfect synthesis between material and intangible collective resources, makes use of well-established techniques of manipulation and conservation of valuable agricultural resources, but above all, it is the guardian of the culture, history and traditions of a territory (Nicolosi *et al.,* 2020). The notoriety of typical or traditional products is the basis of the mechanism that gives value to them, transforming

social and cultural surplus value into economic surplus value (De Sainte Marie & Casabianca, 1995).

The typical product is therefore a collective intangible resource and its notoriety or reputation, which refers to the territory, is itself an instrument and purpose for valorisation.

Freed from the anonymity to which they were relegated, some local food products have become the witnesses of a rediscovered food and wine identity and the vehicle of a positive message for the tourist image of the territories. In terms of marketing, each geographical area is committed to the effort to create the conditions for the differentiation of the offer aimed at capturing the growing interest and multiplication that revolves around exhibitions and events dedicated to food.

Hence the importance of animation, an activity through which opportunities for meeting, reflection, discussion and debate among the actors of the local community are created within the rural territory and between the territories, aimed at encouraging acquisition and sharing of knowledge and awareness and, on this basis, the will / ability to take an active part in the development of one's own territory.

Star *et al.,* (2020) in their study highlight the importance of food festivals and how, in developed countries, many rural communities have sought to stimulate their local economies through agritourism and food and wine events (Goulding *et al.,* 2014; Henderson, 2019; Walmsley, 2010). Other international studies have highlighted the importance for tourism of local economies of events also linked to culture, the environment, music, cinema and food. Food festivals, in particular, have gained increasing attention and an important role in local economies in promoting rural tourism and regional development (UNWTO, 2021).

The UNWTO's Committee on Tourism and Competitiveness (CTC) defines gastronomic tourism as a type of tourism activity that is characterized by the visitor's experience related to food and related products and activities while traveling. In addition to authentic, traditional and / or innovative culinary experiences, food tourism can also encompass other related activities such as visiting local producers, attending food festivals and attending cooking classes.

Sustainable tourism experiences or events are increasingly assuming an important role in the business models of artisanal agri-food producers, allowing them to eliminate intermediate steps in the supply chain and to sell their product directly to consumers with the possibility of adding value through tourist experiences (Stephen *et al.,* 2008; Arru *et al.,* 2021). Local products are a component of a territorial system that can become the symbolic capital of a place capable of making the products of the territory known and of transmitting reputation, trust, consent. In other cases, the agritourism offer is combined with social activities, with business innovation (Nicolosi *et al.,* 2021). The propensity for innovation, in fact, can become an important driver capable of increasing corporate profitability in agritourism businesses (Arru *et al.,* 2021; Roman & Grudzień, 2021), in particular for the farmer who, in addition to tourism activity carries out social activity (Nicolosi *et al.,* 2021).

The proposed study looks at the relationship between the food and wine events proposed by local governance and the offer of local products in an internal agroforestry area of Southern Italy. From a broader perspective, in fact, promotion and rural animation, in internal areas such as those under study, may be able to develop marketing strategies oriented to forms of integration of the territories by leveraging on specific characteristics as an instrument of collective strengthening, also to overcome competitive mechanisms that may emerge between the neighboring territorial realities. (Urry, 2010)

In the case of inland and mountain areas there is a wide range of agricultural productions in addition to those coming from the forest. Many authors also highlight the value of non-wood forest products (Lovric *et al.,* 2020) and their role inside of ecosystem services both in terms of cultural heritage (Sacchelli *et al.,* 2021; Pardo-de-Santayana *et al.,* 2007), and in relation to the recreational and therapeutic function of forests (Droli *et al.,* 2021; Kangas & Markkanen, 2001; Sievänen *et al.,* 2004; de Aragón *et al.,* 2011; Pettenella, 2009; Cai *et al.,* 2011).

Paper aims to examine some research question and in particular:

1. Gastronomic events can constitute promotion occasion and trigger marketing strategies to support local agricultural entrepreneurship.
2. Events and gastronomic events are able to trigger in participants propensity and interest to buy food of local tradition?
3. Gastronomic events could improve travel satisfaction of tourists and vacationers?
4. How consumers preferences could influence purchase proximity products during gastronomic events?

As for consumers, reference is made to a sample interviewed in Calabria in the period 2017-2019 as part of research carried out on consumption preferences and places of purchase (Nicolosi *et al.,* 2020).

Visitors to events and gastronomic events increasingly ask for the experience of local food and cuisine, contact with nature, healthy nutrition, culture and identity of the place. As Stone et al point out in their research, (Stone *et al.,* 2019) dining experiences can also impact travel satisfaction and influence and engage others. The memory of food can influence the image of the place, attitudes, behaviors and future purchases (Stone *et al.,* 2019). The link with sustainable tourism can attract new forms of responsible tourism and guarantee alternative incomes to small agricultural production units (Arru *et al.,* 2021) and this also during the COVID-19 pandemic (Roman & Grudzień, 2021).

Among the agri-food products of the hilly / mountainous and inland a reas, the truffle deserves a privileged place, both for the strong evocative impact that is well attached to the idea of mountains, parks, territories, communities, cultures; either because of the commercial pe-

culiarities and the significant economic importance for the production regions (Pampanini *et al.,* 2012) although it is a niche market with an extremely fragmented supply and a demand that presents characteristics of oligopoly and monopsony in the stages of transformation and distribution. Italy is a leader in the world market: An Umbrian company currently holds (2019) 67% of the global market and operates in 70 countries around the world with a wide range of products from the truffle supply chain.

In this paper, topics highlighted above have been organized into five sections. The second section describes the methodological approach required, the data collection and the survey area study. In the third and fourth sections the results are illustrated and discussed, while in the fifth section some concluding considerations are outlined.

## 2. Materials and Methods

### *2.1. Methodological Approach*

In the analysis carried out, it was decided to apply the Social Network Analysis (SNA) "or" Analysis of Social Networks ". It is a method that analyzes human resources and intervenes on them by reading and interpreting them as social networks. use of rigorous methodologies and specific calculation algorithms, graphical and metric representations are produced that allow us to understand how the organization works, which models it is inspired by, how people are placed in the network of relationships. Social Network Analysis also provides a formal and conceptual means to talk about social aspects (Wasserman & Faust, 1994). It is a quick application tool and allows you to represent a fluid and evolving reality (Carrington *et al.,* 2005). In general, it is from the diffusion of theoretical notions that great impetus has been given to the development of network methods (Wasserman & Faust, 1994). As part of this study, it was decided to use a particular type of bimodal network, the "Affiliation Network". The method has some properties that distinguish it, including the fact that a set of actors is related to a set of events in which the actors participate, thus allowing to study a relational system from a double perspective. In addition, the connections between the components of each set are obtained starting from the links established by each component of a set with the components of the other set (Breiger, 1974; Wasserman & Faust, 1994). We speak, in fact, of dual networks, precisely to emphasize the perspective in which the links between the actors are mediated by their participation in the event, and the events are connected to each other through the sharing of members. Starting from the affiliation matrix, two other matrices can be derived through matrix algebra operations. The networks obtained are uni-modal representations relating to the set of actors and that of events; the transition from the bi-modal network to two uni-modal networks involves obtaining matrices with value starting from a dichotomous and non-directional matrix, which reflect the intensity or frequency of the link (Wasserman & Faust, 1994). For the purposes of analyzing the level of cohesion of the network, the following were considered: density, distance and centrality. These three aspects, each under a different profile, serve to provide information on the degree of cohesion of the network. The reading of this information is possible through some indexes that allow, for each aspect, the attribution of particular dimensions. Therefore, we will have as a measure of density the average density index, as a measure of distance the Average Distance and the Distance-based Cohesion and for the centrality measures the Degree, Close and Between indices.

The consumer analysis is inspired by a large sample of consumers interviewed on several occasions in Calabria in the period 2017-19 as part of research carried out on consumption preferences and places of purchase. The interviews involved 1,029 people intercepted by eight researchers adequately trained to administer the questionnaires. They were carried out "face to face" in crowded places where you could meet a sample with not very homogeneous characteristics, such as bus terminals, main roads, or intercepted at fairs and gastronomic events, near supermarkets, municipal markets, etc. The questionnaires administered look in particular at:

- the consumption of proximity local products
- to the place of purchase
- the reason for the choice

In this contribution, consumers were selected who agreed to buy typical local products on the occasion of gastronomic events organized by local authorities representing 26.6% of the interviewees (274 people, of which 31 tourists). The calculations look at the socio-economic aspects and the answers provided on a likert scale from 1 to 5 with reference to five questions regarding the following reasons for enjoying local artisan food:

1. Willingness to acquire knowledge of the local culture and have a new gastronomic experience;
2. Opportunities for sharing, meeting people and / or being together with the family;
3. Desire for prestige in the eyes of others, take pictures, tell friends and suggest the experience.

### *2.2. Data Collection and Study Area*

This study focused on the Locride area in the province of Reggio Calabria. The area is characterized by economic and social fragility with unsatisfactory levels of growth and employment and which, to some significant extent, can be traced back to socio-economic factors such as widespread depopulation, especially in the innermost areas, the aging of the population, the abandonment of agricultural land, the abandonment of houses. However, the territorial context in its broadest sense, despite having numerous social and economic constraints, is endowed with innumerable material and intangible resources, territorial capital and human capital (environmental and cultural assets, productive excellence, secularized human capital, etc.) that the territory is able to express and systematically underutilized. Locride, in fact, is among the most evocative geographical areas of

Calabria: a strip of land squeezed between the last eastern buttresses of the Aspromonte and the Ionian coast, some of the municipalities that make up the area fall within the National Park of Aspromonte. The area is characterized by the suggestive medieval villages suspended on the Aspromonte hills. Locri, Gioiosa Ionica and Gerace are the most popular places. These villages, rich in history and tradition, frame a landscape full of contrasts and, without a doubt, one of a kind. The Locride area is also characterized by its traditions and its gastronomic specialties: in such a varied area there are many typical quality products, such as meats, oil and cheeses, mushrooms, berries, honey, to which add products of value like truffles. The survey of which we present the results, stems from the consideration that agri-food products have progressively become a distinctive element of the territory and its most authentic vocations in which the food and wine sector and the growing interest that revolves around local events and events dedicated to food, represent the essence on which the concepts of typicality and tradition related to the recovery of culture, history and local knowledge have been grafted.

Furthermore, through the festivals, fairs and events dedicated to food and gastronomy, they represent an occasion of celebration and meeting for residents and an attraction for vacationers and tourists looking for gastronomic experiences to taste and experience the local gastronomy and traditional. On these occasions, tourists and vacationers meet and communicate with the local population and their culture. It thus becomes a way to get in touch with the historical heritages of a territory and its community, consolidating the relationship between the "typical" local community, territory and tourist, historicizing and consolidating this relationship. As several authors have pointed out, the triad of food, places and communities is enriched by the spread of festivals and special events (Frost & Laing, 2013; Silkes *et al.,* 2013; Dimitrovski *et al.,* 2021), which they play a significant role in stimulating local economies as the activities and experiences that attract tourists favor job opportunities for local communities (Cafiero *et al.,* 2019). Such events can therefore represent a development opportunity for a territory and create income and employment through a virtuous chain that involves all operators who, for various reasons, come into play in the agri-food, food and wine and tourism system. It is crucial to note for the purposes of a complete vision of the possible solutions to the weaknesses deriving from the low economic impact on the territory of interest, which often lacks one, or more than one, of the following strengths: 1) the lack of a true and concrete will of aggregation between producers, even in the basic regulation of production processes - collection - treatment – transformation, etc.; 2) the absence of a prodromal "story telling" of the product and its links with traditions, communities and the territory itself, which is now indispensable in image sales processes. In this work we focused in particular on 18 events organized in 2018/2019 by 11 municipalities in the Locride area in the province of Reggio Calabria and focused on 16 main local gastronomy products proposed by local producers. As for consumers, surveys carried out in the province of Reggio Calabria on a sample of 1029 interviewees in the period 2017-2019 showed that about 27% of the interviewees (274 people) buy local gastronomy products at fairs, food and wine events, among they about 11% are tourists.

In some cases, the gastronomic specialties present on the occasion of these local events are known and marketed on national and international markets; while others are produced in limited quantities and consumed only locally. We have paid particular attention to the truffle, "flag product" of the Locride area and to the possibility of enhancing the "Calabrian Truffle" in the belief that it is extremely necessary to activate promotional tools to collect all the economic and social opportunities that can be activate for local populations, in the same way as what has been done in other regions of Italy.

In the study, a basket of typical or traditional products of the Locride area was identified, for which it is proposed that specific forms of joint marketing can be activated in order to create virtuous synergies between producers (Maso *et al.,* 2006) and applied to such a *portfolio* of products, the Affiliation Network. In particular, in the Affiliation matrix that we have created, the rows indicate the actors / producers of 16 main agri-food and typical products, while the columns indicate the 18 events organized in 2019 by 11 municipalities of the investigated area and in which the producers participated (festivals, gastronomic events, fairs, etc.). Once collected, the data is organized in the Affiliation matrix, a dichotomous matrix formally referred to as:

$$A = \{aij\}$$

where aij = 1 if the actor row i participated in the event column j, or aij = 0 otherwise.

On the basis of the information collected, the incidence and adjacency matrices were constructed to examine the network relationships based on the choice of manifestations / events in which to participate.

For data processing, the UCINET 6.0 ver. 6.631, while for the graphic representation the NETDRAW ver.2.161.

To examine the network analysis, some network cohesion measures have been developed, in particular the density which represents one of the main indicators of the degree of cohesion of a network (Salvini & Miller, 2005) and the centrality, which measures how much a node is an actor important of the network. Density, in particular, represents one of the main descriptive measures adopted to investigate the degree of cohesion of the network. This index is given by the quantity of relationships and corresponds to the ratio between the number of links actually present in the network and those potentially activated.

With reference to consumers who buy local gastronomy products. The elaborations, after a brief description of the socio-economic characteristics of the interviewees, examine, through a specific question, on the reasons that lead them to seek and taste local foods, both in general and in particular for those who attend and buy at food and wine events.

## 3. Results

### *3.1. Products and events*

As mentioned, the analysis related a set of food and wine events and events and a set of products. The events were organized in the municipalities of: Martone, Ciminà, Ardore, Africo, Bovalino, Bivongi, Bianco, Platì, Locri, Mammola and Gerace. The area is a portion of the larger one known as the Locride in the province of Reggio Calabria. The products considered are chestnuts, caciocavallo, Greek wine from Bianco, Gerace wine, Mantonico wine, caciotto, pecorino from Locride (PAT), lemoncetta, EVO oil, IGT wine from Locride, smoked ricotta, prickly pear shovel juice, Mammola stock, Mammola breech, mushrooms and truffle (Figure 1).

In the municipalities of the Locride area, various events were organized in the period 2017-19 that represent an attraction for the local population and for tourists and vacationers, these are cultural events and conferences, gastronomic festivals, festivals, fairs, exhibitions-market of local products, patronal festivals. Table 1 identifies the flagship products and the participation of local producers in the various types of events.

The producers participating in the events obviously have a diversified range of sales and marketing of their products, both locally and nationally and, in some cases, even internationally. However, their participation in the Events and Shows organized by the municipalities has a social value of belonging and presence in the territory. The most well-known products such as those that can boast a quality marks (PDO, PGI, Slow Food, etc.), represent an additional attraction for participants in gastronomic events, the niche ones, which are more difficult to find, represent an opportunity for consumers to be found.

Network analysis applicated examines only the products present during various events. The density represents one of the main indicators of the degree of cohesion of the Network. As can be seen from the table below (Table 2), the density value is 57.5% and represents a good degree of cohesion, confirmed by the standard deviation of 0.4943. The Geodesics distances also show that the pairs of actors are close together and that the producers are well connected to each other.

Table 3 examines the Network Centrality measures.

In the empirical analysis of social networks, the con-

Figure 1. Some of mentioned products. From the top left: Mushrooms, Stocco, Truffles and Caciocavallo di Ciminà.
*Figura 1. Algunos de los productos mencionados. Desde arriba a la izquierda: Champiñones, Stocco, Trufas y Caciocavallo di Ciminà.*

Table 1. Local products and participation of producers by type of events (in the period 2017-2019).
*Tabla 1. Productos locales y participación de productores por tipo de eventos (en el periodo 2017-2019).*

| Flagship product | Presence in gastronomic events in the Locride area% |
|---|---|
| Castagne (Chestnuts) | 50.0 |
| Caciocavallo di Ciminà (Ciminà "Caciocavallo cheese") | 50.0 |
| Vino Greco (Greco wine) | 55.6 |
| Vino Gerace (Gerace wine) | 55.6 |
| Vino Mantonico (Mantonico wine) | 44.4 |
| Funghi (Mushrooms) | 55.6 |
| Tartufi (Truffles) | 33.3 |
| Caciotto (Caciotto cheese) | 16.7 |
| Pecorino (Pecorino T.A.P) | 33.3 |
| Locrese Lemoncetta | 5.6 |
| Olio EVO locale (Local extra virgin olive oil) | 61.1 |
| Vino DOC locale (D.O.C local wine) | 50.0 |
| Ricotta affumicata (Smoked ricotta) | 22.2 |
| Succo di Pala di fico d'india ( Prickly pear juice) | 5.6 |
| Stocco di mammola (Stocco fish of Mammola) | 55.6 |
| Culatta di Mammola (Cured meat of Mammola) | 16.7 |

Source: own elaborations

Table 2. Network cohesion measures. Density expressed in percentage values.
*Tabla 2. Medidas de cohesión de la red. Densidad expresada en valores porcentuales.*

| ***Debsities, Standard deviation*** | |
|---|---|
| Density (matrix average) | 57.50% |
| Standard deviation | 0.4943 |
| ***Geodesic distance*** | |
| Average distance (among reachable pairs) | 1.182 |
| Distance-based cohesion ("Compactness") | 0.629 |
| Distance-weighted fragmentation ("Breadth") | 0.371 |

Source: own elaborations

cept of centrality takes on particular relevance as it allows you to position an actor in your network in purely relational terms. Centrality can be expressed in three ways: Degree Centrality, Closeness Centrality and Between ness Centrality.

Table 3. Descriptive statistics: Degree, Close, Between.
*Tabla 3. Estadísticos descriptivos: Grado, Cercano, Entre.*

| | (InDegree) NormInDegree % | InCloseness % | nBetweenness |
|---|---|---|---|
| Chestnuts | (12) 80.000 | 83.333 | 0.517 |
| Ciminà Caciocavallo cheese | (15) 100.000 | 100.000 | 2.200 |
| Greco wine | (13) 86.667 | 88.235 | 0.759 |
| Gerace wine | (15) 100.000 | 100.000 | 1.446 |
| Mantonico wine (white) | (9) 60.000 | 71.429 | 0.163 |
| Mushrooms | (12) 80.000 | 83.333 | 4.643 |
| Truffles | (5) 33.333 | 53.571 | 0.254 |
| Platì Caciotto cheese | (2) 13.333 | 7.143 | 0.000 |
| Pecorino T.A.P | (5) 33.333 | 9.091 | 0.068 |
| Locrese Lemoncetta | (1) 6.667 | 6.667 | 0.000 |
| Local extra virgin olive oil | (15) 100.000 | 100.000 | 1.446 |
| D.O.C local wine | (12) 80.000 | 83.333 | 0.782 |
| Smoked ricotta | (3) 20.000 | 7.692 | 0.000 |
| Prickly pear juice | (1) 6.667 | 6.667 | 0.000 |
| Stocco fish of Mammola | (15) 100.000 | 100.000 | 1.584 |
| Cured meat of Mammola | (3) 20.000 | 7.692 | 0.425 |
| Statistiche descrittive | | | |
| Max | (15) 100.000 | 100,000 | 4.643 |
| Min | 6.667 | 6.667 | 0,000 |
| Mean | (8.625) 57.500 | 26.541 | 0,893 |
| Std Dev | (5.395) 35.969 | 27.989 | 1,174 |

Source: own elaborations

The first measure is the simplest and looks at the choices made by the actors (Products). The values indicated respectively represent: The Index the number of participation in the events (the table is indicated in brackets); while the Norm In Degre is a standardized data (divided by n-1) indicated as a percentage.

The second measure examines the distance between the points, so a node is more central if it is located at the shortest distance from many other nodes, i.e. it is closer to many other points (in our study the reference is relative to the other products / events) also the value of this measure is a standardized datum.

The third measure examines to what extent a product is able to trigger an intermediation, in our case it repre-

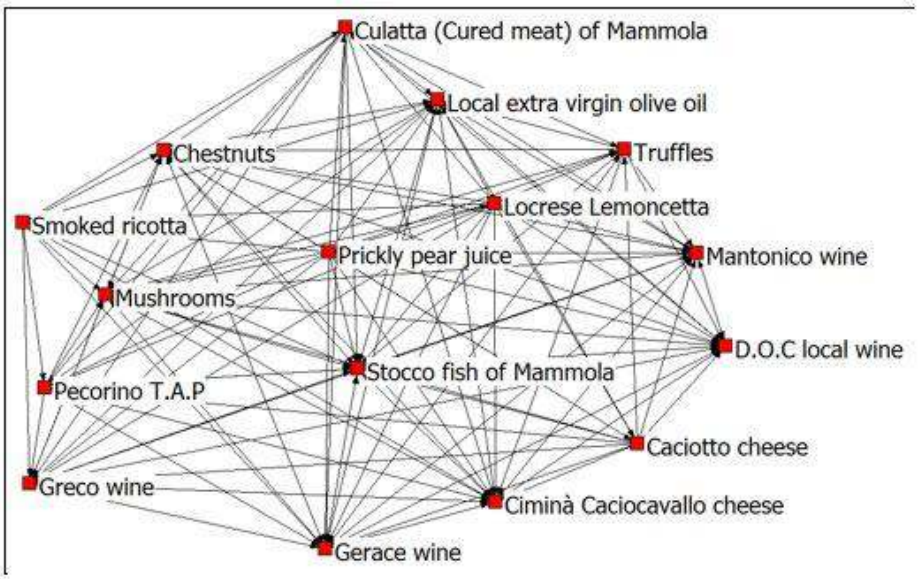


Figure 2. Sociometrist network of relations between products present in food and wine events organized in the area from municipalities. Source: own calculations.

*Figura 2. Red sociométrica de relaciones entre productos presentes en eventos gastronómicos y enológicos organizados en el territorio desde los municipios. Fuente: Elaboración Propia*


Figure 3. Map of the networks of relations resulting from the application of the SNA: recognition of the products present in the events organized by the municipalities of Locride. The blue squares are the names of the municipalities while the red dots are the products. Source: own elaborations. In the map, the authors wanted to leave the names of the products in the original language to emphasize the importance of the connection with the territory.

*Figura 3. Mapa de las redes de relaciones resultantes de la aplicación del SNA: reconocimiento de los productos presentes en los eventos organizados por los municipios de Locride. Los cuadrados azules son los nombres de los municipios mientras que los puntos rojos son los productos. Fuente: elaboración propia. En el mapa, los autores han querido dejar los nombres de los productos en el idioma original para enfatizar la importancia de la conexión con el territorio.*

sents a push towards the fruition of events show more links in the various events of Locride are highlighted: Olio Evo, Ciminà Caciocavallo cheese, Gerace wine and Stocco di Mammola, followed by Greco wine, Mushrooms and Chestnuts. The lowest links was recorded by Lemoncetta and prickly pear Pala juice (just 6.6%), the other products show links at events ranging from 20% to 60%. In the case of Closeness Centrality, it is a question of examining the most central and most peripheral nodes in relation to the distance between the points. It means that a node is more central if it is located closer to the other nodes. Also in this case, what is shown with the measure relating to density is confirmed, therefore Olio Evo, Gerace wine, Ciminà Caciocavallo cheese and Stocco di Mammola have the greatest incidences (100%), while pecorino PAT, Culatta di Mammola, smoked ricotta, caciotto, Lemoncetta and prickly pear shovel juice remain the most peripheral products (from 6.6% to 9.0%) in relation to their ability to participate in food and wine events in the Locride area.

Finally, the measure of Centrality as an interposition (Betweenness Centrality), does not look at the direction of the bond, but indicates how much a person is intermediary between two other people within the group. In our case Mushrooms (4,643), Caciocavallo di Cimunà (2.200), Stocco di Mammola (1.584), Gerace wine and Local extra virgin olive oil (1.446) are the most central and significant products in the representation of the potential of the productive reality of Locride.

Figure 2 shows the sociometric network of relations between producers and food and wine events (exhibitions, fairs, conferences, etc.) in the Locride area, as you can see each relationship is represented by an oriented arrow, as the relationship is considered asymmetrical.

Figure 3 shows the map of the relationship networks resulting from the analysis. Specifically, it is a survey of the products present in the events organized by the municipalities of Locride. The names of the products have been indicated in the original language.

### *3.2. Consumers*

From the elaborations (Table 4) it emerges that most of the consumers interviewed are aged between 31 and 50 years (38.7%), with a slight prevalence of women (50.3%). The highest percentage for the scholastic level is recorded between the high school (31.2%) and the degree (40.2%). Household income is equally distributed between the upper middle and lower middle classes (32.8% in both cases). They are residents of Calabria (55.8%), about 11% say they are on vacation at the time of the interview. The preferred shopping places also for local handicraft products in the proximity are large-scale distribution and retail (55.7%). About 20% of the interviewees shop at the City market. Those who buy these products regularly or occasionally at events, festivals and food and wine events represent 24.4% of the sample. The events,

Table 4. - Descriptive statistic of the sample
*Tabla 4. Estadística descriptiva de la muestra*

| **Indication** | | **n.** | **%** |
|---|---|---|---|
| Gender | Male | 511 | 49.7 |
| | Female | 518 | 50.3 |
| Age | 18-30 years | 361 | 35.1 |
| | 31-50 years | 398 | 38.7 |
| | 51-60 years | 138 | 13.4 |
| | >60 years | 132 | 12.8 |
| Education | Middle school | 113 | 11.0 |
| | High school | 321 | 31.2 |
| | University Degree | 414 | 40.2 |
| | Post University | 181 | 17.6 |
| Family Income | High | 65 | 6.3 |
| | Upper middle | 338 | 32.8 |
| | Lower middle | 337 | 32.8 |
| | Low | 88 | 8.6 |
| Why at place of survey | Live there | 459 | 55.8 |
| | Work there | 128 | 15.6 |
| | Holiday | 91 | 11.1 |
| | Other | 144 | 18.5 |
| | No answers | 207 | 20.1 |
| Preference per the place of purchase of local/artisan product | City market | 205 | 19.9 |
| | Hypermarket/retail | 573 | 55.7 |
| | Gastronomic events | 251 | 24.4 |

Source: own elaborations

Table 5. - Reasons to enjoy proximity local / artisanal food
*Tabla 5. Razones para disfrutar de la comida local/artesanal de proximidad.*

| | 1(*) | 2(*) | 3(*) | 4(*) | 5(*) | total |
|---|---|---|---|---|---|---|
| Willingness to acquire knowledge of the local culture and have a new gastronomic experience; | 6.2 | 8.9 | 21.8 | 32.7 | 30.4 | 100.0 |
| Opportunities for sharing, meeting people and / or being together with the family; | 8.0 | 10.4 | 17.1 | 27.6 | 36.9 | 100.0 |
| Desire for prestige in the eyes of others, take pictures, tell friends and suggest the experience.; | 18.7 | 8.9 | 23.1 | 26.2 | 23.1 | 100.0 |

(*) Percentage values on Likert scale from 1 (not at all important) to 5 (very, very important). Source: own elaborations

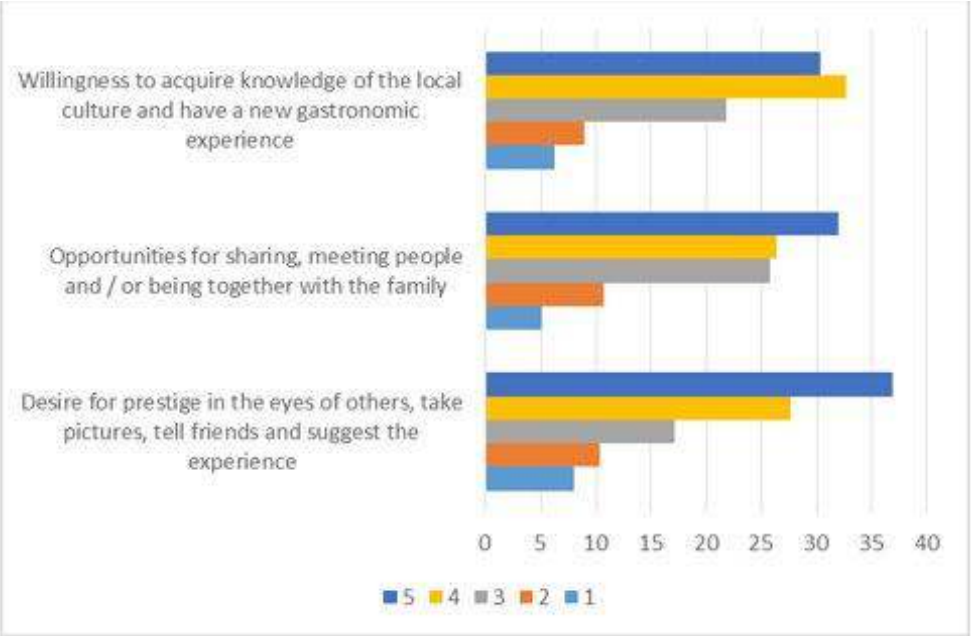


Figure 4. Reasons to enjoy proximity local foods
*Figura 4. Razones para disfrutar de la comida local de proximidad*

in many cases, also represent an opportunity for a family outing for local consumers.

The results of the Table 5 show that for the interviewees the link with the territory and the desire to acquire local knowledge and culture through local food is important, linking them to new gastronomic experiences, local culture and the possibility of meeting people, 63.1% responded positively (32.7% a lot and 30.4% a lot). Consumers affirm the importance of associating specific sensory emotions such as aromas, taste, touch, well-being experienced to that place, linked to the social matrix given by the food of that territory and the surrounding landscape (58.4% a lot and a lot) and for 21.8% it is on average important. To escape the routine is one reason deemed less important than the other reasons (52.4%). Food experienced as conviviality and an opportunity for sharing to meet people and be together with friends and family is considered very and very important (64.5%), only 18.4% consider it of little or no importance. Finally, the desire to obtain prestige and tell friends about their experiences on vacation also through the description of local dishes and foods records a high interest in 49.3%, while this aspect is of no or little interest to 27.6% of the interviewees.

## 4. Discussion

In the study presented, through the examination of the structure of the relationship of the group of typical or traditional products, an initial assessment of the relational capacity of producers was proposed. The study of centrality, for example, provides information on their degree of social integration. For many, if not all of these productions, the best criterion for valorization appears, without a doubt, the transformation of the simple gesture of consumption into an experiential opportunity for

direct tasting on the production sites (Pencarelli *et al.,* 2015). Moreover, this is confirmed by the fact that these productions activate various points of consumption (the most representative example is the case of the Mammola stocco). On the other hand, the situation is more complex with reference to other products which, in fact, are present with a slightly lower degree. For these, it is the case of the Truffle, the Gerace wine or the Caciocavallo, and even more so for the Greco di Bianco wine, much still needs to be done, in terms of consumption opportunities but also in terms of production, given that it deals with rather limited productions but which show interesting potential.

In particular, with reference to the Calabrian Truffle, the natural presence of the truffle in the area under analysis justifies the attention paid. In particular, in the pre-Aspromonte area it is now certain that it is possible to operate on two different realities: protecting and expanding the existing truffle grounds while respecting the existing truffle heritage and encouraging the creation of artificial truffle grounds. After all, it is known that, despite the truffle market, it has niche dimensions, its economic importance for the territory and its image inextricably linked to food and wine is relevant for the production regions, given the concentration in limited territorial areas (Bencivenga & Baciarelli Falini, 2012; Pampanini *et al.,* 2012).

The truffle can therefore be seen as an economic-territorial development tool (Samilis *et al.,* 2008). Furthermore, in terms of image, the link between truffles, woods, parks and the territory is very strong and not fully explored in terms of potential for attraction from a tourist point of view in Aspromonte. This bond has offered large spaces and opportunities to all the regions that have exploited its potential in Tuscany, Abruzzo, Umbria (Marone, 2011; Bencivenga & Baciarelli Falini, 2012; Brun & Mosso, 2013). Artificial truffle fields allow to recover and enhance marginal territories, to introduce new employment and new income opportunities, allow to promote potentialities related to gastronomic tourism that revolves around the production of truffles and gastronomy based on truffles (fresh and / or processed). Furthermore, recent studies reveal that in the Mediterranean regions, although cultural practices could lead to genetic mixing, no difference in genetic diversity was detected between spontaneous and cultivated populations (Taschen *et al.,* 2016).

As is evident, it is a question of promoting growth strategies for Calabria and of providing new tools for productive differentiation, employment and income for farmers in marginal areas otherwise destined for depopulation and degradation.

The various operators of the truffle supply chain (quarrymen, agricultural entrepreneurs, traders, processors, distributors, restaurateurs, chefs), show very strongly the interest that revolves around the sector which is perceived as very attractive in the light of the economic crisis and offers opportunities. of promising commercial activities.

Moreover, the propensity of the modern consumer is to explore more and more the link between the territory and the quality of the food purchased and to recognize the social and cultural value of "place / economic space" where the product is born and developed (Hjalager & Richards, 2002; Nicolosi *et al.,* 2019; Oostindie *et al.,* 2016; Resano *et al.,* 2011; van Ittersum *et al.,* 2007).

Consumer surveys also highlight the importance of food and wine events in the promotion of food and territory. The reasons are related to the places where you live or are on vacation or at work. For the interviewees, therefore, there is a strong desire to strengthen or acquire local knowledge and cultures through local food, linking them to new gastronomic experiences, affirming the importance of associating specific sensory emotions such as touch, perfumes and the surrounding landscape, the well-being you feel. Sensations linked to the social matrix given by the typical food of a specific territory. Food is experience as a conviviality and an opportunity for sharing to meet people, to obtain prestige and to tell the experiences of one's friends through the description of local dishes and foods.

## 5. Conclusions

Finally, it is necessary to make a brief reflection on the meaning of the events and manifestations considered in the study. These are significant promotional opportunities in which the products themselves become the real protagonists. Above all, these events make it possible to shift the enhancement and promotion from the companies to the territory with a view to commonality and sharing. Events and manifestations such as those highlighted in the work help to preserve the identity and authenticity of local traditions in order to generate work and employment. Food and wine represents an opportunity to encourage and diversify tourism, promote local economic development, involve many different professional sectors and bring new uses to the primary sector, enhancing and rewarding authenticity. The typicality of agri-food products is intimately connected to the territory, to which it owes, in addition to most of the distinctive elements, specific recognition on the market. The typical product materializes a perfect synthesis between material and intangible collective resources, makes use of consolidated techniques of manipulation and conservation of valuable agricultural resources, but above all it is the guardian of the culture, history and tractions of a territory and is, at the same time, a tool and purpose of enhancement (Nicolosi *et al.,* 2020).

Finally, with reference to the limits of the contribution, an in-depth study could include the possibility of interviewing the producers, as protagonists of the gastronomic proposal and themselves, an active part among the actors of the events.

Finally, the experience of COVID 19 made us understand how important it is to have naturalistic paths and trails in the open air and in health safety, where it is the territory that guarantees and delivers ecosystem services. The Locride area, rich in history, culture, natural landscapes of high environmental and socio-cultural interest and valuable products, has all the potential to activate virtuous processes of sustainable development from an economic point of view and social potential which, if adequately

protected, can lead to the improvement of the structure of local communities, thanks to a balanced and eco-sustainable use of the territories and to communication and environmental education actions.

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# Article: The Impact of COVID-19 on Municipal Food Markets: Resilience or Innovative Attitude?

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*Article*

## The Impact of COVID-19 on Municipal Food Markets: Resilience or Innovative Attitude?

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**Abstract:** The pandemic has accelerated the search for innovative product/process/service solutions in city markets as well as the search for "open innovation challenges" more in line with current needs. The aim of the research is to understand the adaptation mechanisms of the local food system and, in particular, of the public space of the market system. The article analyses the change produced by the COVID-19 pandemic in the municipal markets of Sant Feliu de Guixols, Costa Brava, Spain. The data were collected through a semi-structured questionnaire administered to food sellers and contextually to a group of consumers. Factor analysis and the AGIL model were applied to the data collected and were confirmed with cluster analysis. The analysis highlights that the resilience of sellers is no longer sufficient and in many cases, they have equipped themselves with innovative solutions to meet the new customer demands arising from the pandemic (food delivery, e-commerce, take-away food, digital media, etc.). The document concludes with a discussion of food markets and innovations introduced in this period. Further studies can focus on the relationships between food practices and the transformation of urban spaces so that the food market can support new social practices that promote the food transition. The change would represent a switch which would provide traditionally less powerful actors, such as producers, the opportunity to reformulate the food supply chain in a way more linked to the territory. It would also create a resilient dimension for managing other possible food crises and present a challenge to achieving the ultimate goals of the businesses.

**Keywords:** COVID-19; municipal food market; seller survey; consumer survey; factor analysis; cluster analysis; AGIL model; open innovation



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## 1. Introduction

On 11 March 2020, the WHO (World Health Organization) declared COVID-19 to be a pandemic. Concerns about the resilience of food systems spread throughout Europe as a result of this pandemic [1]. Although food scarcity was not a real threat, the crisis increased awareness of the potential exposure of food systems to new shocks and crises, especially related to food access [2,3] consumer behaviour, small-scale production, and alternative food networks [4]. Many European countries established restrictive measures to avoid contact between people and reduce their movements. This changed in a perturbing way the relationship between public spaces and facilities and personal environments and habits. It highlighted the fragility of the food system and its social role [5]. The unusual situation accelerated processes that were already underway. Such a profound, sudden change provided the opportunity to test the capacity to adapt at various levels. In the process, the food system demonstrated its ability to support a disruptive event for food production and transport. The global emergency made visible the unsustainability and vulnerability of the food system at all societal levels [6], highlighting its weaknesses and fragility [7,8]. Moreover, after the possible origin of the pandemic at Huanan wet market in Wuhan and the relation between the pandemic and climate change were communicated to

the public, the need to question how food is produced, distributed, consumed and disposed of became more urgent [8]. The national press in Italy and Spain have focused during the pandemic on the role of the food chain, including different levels that are usually invisible, such as producers or food transporters.

Unlike in Asia or Africa, the entire food system in Europe proved that it had resilient capacity [8]. Unconventional food distribution at food markets also demonstrated a capacity for resilience and innovation. Markets have historically played the role of providing a fresh food supply to the local community. More recently, they have been included as authentic attractions in touristic destinations [9], thereby modifying their role and actors. The literature in the last ten years has also focused on municipal markets (MM) as specific public spaces and infrastructures that provide an essential service for community development [10,11] by improving food innovation.

Public indoor or street food markets have historically played a primary role as a place of connection between territory and city and as a driving force in local life and retail. Markets are urban spaces for meeting and socialising, and they represent an important heritage of local gastronomic culture and a link to healthy and traditional eating habits [12]. Food markets have been at the centre of urban life for centuries, and despite changes in the distribution structure of the agri-food trade and the rapid evolution of large-scale retail, they still provide affordable food and work opportunities for millions of people across the world [10,13].

Since the 1950s, many American and European markets have undergone redevelopment as part of urban regeneration projects and transformation processes with the broad, complex involvement of institutions and city governance. These trends are still pushing towards the transformation of food markets in the urban fabric of cities. In many cases, the direction is gentrification or touristification, which reduces the diversity of products sold, discourages lower class consumers and the cheapest sellers, and encourages local producers to make room for "foodies" and low-cost and low-value products specifically designed for tourists. These projects also transform the retail structure around markets. They improve to varying degrees the "traditional" aspect of the market and introduce "innovation" to compete with supermarkets or other forms of selling [14]. In different contexts and depending on market types and location, there are multiple trends that drive markets to transform and all lead to modification of urban and rural places and landscapes as part of the food chain.

Before the Coronavirus pandemic (COVID-19), the challenge for municipal markets [15,16] was their management as a public service in relation to socioeconomic and historical contexts and constant competition with the "new way of selling and shopping", including the increasing demand for online shopping [17]. After the 2015 Milan Urban Food Policy Pact, the role of the food market across Europe became associated with the ability of essential infrastructures to address the fragility of the agri-food system as a place to implement the United Nations Sustainable Development Goals (SDGs); such as, for example, sustainable cities and communities (SDG 11) and responsible consumption and production (SDG 12). The European urban food policies set out in the New Green Deal must also be implemented to guarantee the right to food and activate circular economy models that require the mobilisation of a wider spectrum of public and private actors.

From spring 2020, numerous studies have been published on the shift in perceptions about food and the effects of disruption of the food chain at different level [18–23]. Food appears to be an essential issue to address again in Europe and developed countries [24–26]. Our study focusses on the social dimension at the community level and aims to address the capacity of food sellers to adapt to the changing behaviour of consumers as observed during the pandemic.

Researchers have highlighted the food system's varying capacity for resilience depending on location and have focussed on the impact of breakdowns or bottlenecks in any part of the food supply chain (FSC) [27,28]. In addition, numerous articles on the FSC have

focused on calls for transformative change in food systems to support local markets and producers [7,29–31].

Consumers have also become more sensitive to the environment and the negative effect of the food chain on climate [32,33]. Changes in behaviour have been observed in terms of healthier habits in food consumption [3,34,35]. Since the COVID-19 pandemic, the food industry has been increasingly challenged by changes in consumer behaviour, consumer purchasing behaviour, and consumption patterns [36].

These changes are affected by factors such as economic, regional and sociodemographic diversity [37]. There is growing awareness of responsible production [38] and consumption, and there are habits that are considered more social because they are based on the formation of solidarity groups that work on access to food for specific collectives [39,40]. The pandemic period has also affected the consumption way of life, for example, food distribution channels have become more resilient and purchasing patterns show the use of digital technology, such as online delivery platforms and food retail applications [41]. Food consumption is associated with sustainable cities and societies and healthy food with a demand for fresh and kilometre zero products. An emphasis has also been placed on support for local entrepreneurs [42].

The aim of the research is to understand the mechanisms of adaptation of the local food system, specifically the public space of the market system. This study focuses on the evolution of the municipal market during the COVID-19 pandemic in relation to the necessary changes in a model towards a sustainable food transition/innovation. The question is raised of whether the changes that have taken place are only related to the capability of resilience or form part of an ongoing process of transformation of the food system and of retail [18,43,44].

Resilience theory scholars [45] have mainly focused on the capacity of socio-ecological systems to deal with disruptive change, such as a pandemic. They have addressed three main types of resilience: resilience of persistence through steady movement; resilience of adaptation without any innovation; and resilience of transformation which includes innovation. These concepts are the basis of the theory of evolutionary resilience [46,47].

Our main question is whether the adjustments that occurred in the food market represent a steady movement or indicate an ongoing process of transformation and innovation. In this latter case, the food market could represent not only a tradition but also a renewed innovation hub for the food transition and a central place for the future "15 min city" [48] which implies a new type of public space able to have different and diverse functions during the day.

In this context of innovation, we can place the concept of open innovation. Open innovation was first introduced by Chesbrough [49]. It refers to internal and external knowledge flows to improve internal innovation (open inbound innovation) and expand the markets for external exploitation of innovation (open outbound innovation). Open innovation that utilises all available resources has come to be recognised as an essential strategy for firms. The target of open innovation has been expanded from technology to product development and business models. Currently, open innovation is one of the keys to a successful business. There is extensive literature on the concept. Valdez-Juarez et al. [50] considered open innovation from a consumer perspective and examined the relationship between online buyers and technology. The significant drivers of open innovation are innovation networks, collaboration with stakeholders in the supply chain, innovation ecosystems, and digital technology which are crucial issues for businesses and policymakers [51]. Miralles et al. [52] studied the organization of the Alternative Food Networks (AFN) in Valencia.

Our article focuses on the innovation observed in seller strategies and consumer behavioural changes in the municipal markets (MM) of Sant-Feliu de Guíxols, a middle-sized touristic city on the Costa Brava, Spain, to highlight the adaptation strategies in selling and buying caused by COVID-19 and the change in the use of this public space. In particular, even in city markets, the pandemic has accelerated the search for innovative

product/process/service solutions and the search for "open innovation challenges" more in line with current needs.

The research questions were:

What impact did the COVID-19 pandemic have on agri-food sellers in the market?

What impact did the COVID-19 pandemic have on food purchasing habits in the market?

In addition, the study examined other relevant aspects related to the strategic dynamics involved in the changes, in particular:

What changes were promoted by consumers and sellers?

Did the suggested changes reflect adaptation or a step towards food transition/innovation and expanded food governance?

In the long-term, what are the impacts and perspectives that the pandemic has opened regarding the links between cities and food systems?

Food distribution is considered a holistic system involving the producer, distributor, and retailer of local products in which the market becomes a commercial, cultural and social mediator within the transaction chain and in which governance could be represented by the network of buyers and sellers. Sant Feliu de Guíxols in the province of Girona in Catalonia, Spain, is a medium-sized touristic city with three municipal markets. In this context, the markets can become real nodes on two scales, namely the urban and the territorial.

The exploratory survey consisted of two semi-structured questionnaires which were administered to sellers and consumers interviewed at the Sant Feliu de Guíxols food market during March and July 2020.

In this paper, the content of the topics has been organised into sections: first, we examined the survey area and its main characteristics and features; second, we described how the survey was conducted, including the methodological approaches adopted for the interviews with the sellers and with consumers, including their preferences; finally, we discussed the results, and at the end, outlined some concluding considerations.

## 2. Case Study: Sant Feliu de Guíxols

Our study is focussed on Sant Feliu de Guíxols, a touristic coastal town of 21,925 inhabitants (data 2019) situated in the southwest of the fertile agrarian Baix Empordà region in the province of Girona, Catalunya. Sant Feliu de Guíxols used to be one of the most important centres of the traditional cork industry and was a relevant port for the transportation of cork. This town has always been the biggest on the Costa Brava in terms of population—a result of its industrial, commercial and tourism activities—and has traditionally been regarded as the capital of the Costa Brava. The open market dates from the Middle Ages, while the Municipal Market Hall was built in 1929 to meet the demands of population growth resulting from to the vital cork industry. The Municipal Market Hall along with the Town Hall are located at the end of the commercial axis of Carrer Major in a town square. The main aim of this market was to supply food to the increasing population and to control the quality of food, principally meat and fish, and prices. Since the 1960s, Sant Feliu de Guíxols has been fully integrated into tourism, which over the years has shifted to international mass tourism. Tourism is now the main activity, and this has influenced the town's retail food structure, including the municipal market. The town has a degree of complexity that could be comparable to other tourist towns in Spain that have shifted from an industrial, commercial economy to one relying on tourism, including gastronomy.

The rise of mass tourism stemming from the 1980s has significantly changed the urban structure of food retailing and has resulted in the conversion of many of the shops into restaurants. Up until now, the municipal market where most of the remaining food shops are still located has played a role as a driver for the food commerce around it.

## 3. Materials and Methods

### *3.1. Methodology and Data Collection*

The methodology used was a combination of qualitative and quantitative analysis. Urban planning uses mostly quantitative and geographical analyses to provide statistical results that are contextualised in the territory and social space. Qualitative analysis is a complementary way of listening to and interpreting the city and the food retailing system related to markets, flows, and movements. It is a suitable tool for highlighting the actors involved in urban life and current trends as well as indicating possible innovations, improvements or disruptions.

The main role has been attributed to actors involved in the life of the market and, in particular, to sellers and consumers. Sellers are people who have an authorised place in the market and who can be either retailers (they sell food produced by others) or agricultural sellers/producers who sell their own products. Consumers were interviewed at the same time as sellers to examine their preferences, consumption habits, and changes in purchasing caused by COVID-19.

Consumers opinions were compared with those of retailers or producers/sellers in the covered market (CM), daily street markets (DSM), and weekly street markets (WSM).

The main attributes of the sellers and consumers and the influence of the pandemic on the dynamics of the urban functions of the markets in Sant Feliu de Guíxols were examined through semi-structured questionnaires administered to the actors.

We interviewed (Figure 1):

- All 34 vendors present in three markets, namely 16 agricultural seller/producers who sold their products and 18 retailers at their stalls in the three types of market: CM, DSM, and WSM.
- A total of 30 consumers intercepted in the CM, DSM, and WSM. The use of masks and sanitary regulations made it difficult to carry out further face-to-face interviews the time and place of the interviews with sellers and consumers corresponded.

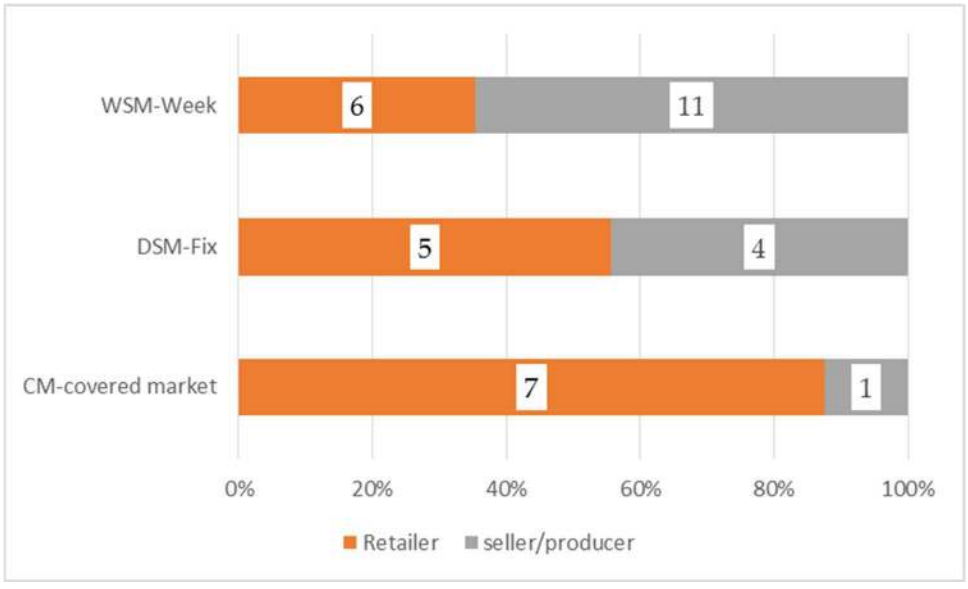


**Figure 1.** Type of market by type of vendors (retailers or sellers/producers). Source: The authors.

Ten-minute personal interviews with sellers and consumers were conducted anonymously based on two semi-structured questionnaires. The questionnaires were used during March and July 2020. Three people who were trained administered the questionnaires. Questions focused on the impact of COVID-19 on the municipal market.

The methods used for gathering data were:

1. Participant observation: on-site examination of the food retail urban structure in the central area of the town and in the food markets.
2. One-to-one interviews with:
   a. Food retailers at MM;
   b. Sellers/producers at MM;
   c. Consumers at MM.
3. The data obtained were processed using quantitative statistical analysis, topological analysis, and qualitative analysis. Most of the processing was done using SPSS version 21.

The research questions were related to the current situation in the covered, fixed and weekly street markets and in the agri-food trade in the vicinity of the market (open stalls, product sold, origin of the product, type of consumers, and type of sellers) in order to understand:

- Changes in users' food purchasing habits during the COVID-19 lockdown, differentiating between loyal and sporadic customers;
- Changes experienced by vendors during the COVID-19 lockdown, differentiating between sellers/producers and retailers and their abilities to adapt to a changing situation.

### *3.2. Factor Analysis and AGIL Model*

The questionnaire administered (see Table A3) to sellers examined some aspects related to personal characteristics and the difficulties they encountered during the lockdown period as well as any changes they implemented and/or encountered. Here, we considered the variables of type of place (internal stall or external stall), daily or non-daily presence in the San Feliu market, whether they were producers/sellers or retailers, the origin of the products they offered (local or otherwise), the distance from their place of residence, the years of activity, the type of business, and any online sales.

Participants were also asked for their perceptions of difficulties and problems due to the pandemic as well as how they dealt with the changes that had taken place, for example, with respect to willingness to take orders by phone, make home deliveries and meet customers in various ways. We asked whether there were concerns and problems with the market structure during the pandemic. Other parts of the seller questionnaire were designed to highlight aspects of company organisation and problems and changes that the sellers faced in the period of the COVID-19 health emergency. Questions that we focused on for the factor analysis and subsequent processing are indicated in Table 1.

**Table 1.** Main variables chosen for processing, coding of the name, and methods of recording the interviews with Sant Feliu de Guíxols market sellers.

| Variable n. | Variable Name | Description | Modalities |
|---|---|---|---|
| V1 | Food stall—place | Exterior stall, Interior stall | 1–2 |
| V2 | Market type | Covered market (CM), daily street market (DSM), weekly street market (WSM) | 1–3 |
| V3 | Retailer or Seller/producer | Retailer, Seller/producer | 1–2 |
| V4 | Production place | Sant Feliu de Guíxols, Girona, Palamos and Calonge, Llagostera, Castell d'Aro, Torrella de Mongri, More places (Lloret, Vidreres, Gaverres, Palafrugell, Tossa de Mar, Roses, Cassà de la Selva, Mercat de las Flores) | 1–7 |
| V5 | Distance from the place of production (proximity < 25 km) | 0 km, 1–25 km, 26–50 km, over 50 | 1–4 |
| V6 | Years of activity | Less than 10 years, 11–30 years, 31–50 years, 51–100 years, no reply | 1–5 |

**Table 1.** *Cont.*

| Variable n. | Variable Name | Description | Modalities |
|---|---|---|---|
| V7 | Family business | Family business, not a family business | 1–2 |
| V8 | Residence of the seller/producer | Sant Feliu de Guíxols, other places (Calonge, Llagostera, Girona, Palamos, Castell d'Aro, Cassà de la Selva, Palafrugell, Tossa de Mar) | 1–2 |
| V9 | Distance from residence | Residence in Sant Feliu de Guíxols, residence 1–20 km away, residence 21–50 km away, residence 51–90 km away | 1–4 |
| V10 | Membership in associations | Traders' association, producers, market sellers, No | 1–4 |
| V11 | Products types per food stall | Fish, meat, cheese, dried food, vegetables and fruit, herbs/spices, wine, other products | 1–8 |
| V12 | Online distribution | Yes, No | 1–2 |
| V13 | Revenue generated from sales or consumption | Consumption, sales | 1–2 |
| V14 | Types of customers | Loyal customers, not loyal customers | 1–2 |
| V15 | Frequency of other markets | Yes, No | 1–2 |
| V16 | Sale in other spaces | Yes, No | 1–2 |
| V17 | Number of days in Sant Feliu market | 1 day, 2 days, 7 days | 1–3 |
| V18 | COVID-19: number of consumer changes | Yes consumers increased, No consumers did not increase, no reply | 1–3 |
| V19 | COVID-19: changes in sales | Yes sales increased, No sales did not increase, no reply | 1–3 |
| V20 | COVID-19: new loyal customers | Yes, No, no reply | 1–3 |
| V21 | COVID-19: different ways of buying after lockdown | +Face-to-face, +Online, +Telephone, In any case, no reply | 1–5 |
| V22 | COVID-19: purchase changes after lockdown | Yes, No, No reply | 1–3 |

Source: The authors.

The factor analysis allowed us to reduce the complexity of a problem described by a consistent number of variables to a smaller number of latent variables/factors that could capture a significant percentage of the overall variability of the departure data [53]. Analyses were applied in the literature even to small samples [52,54–57].

In the context of multivariate statistics, principal component analysis (PCA) and factor analysis (FA) are techniques used for data simplification. The reduction in complexity occurs by limiting the analysis to the main factors (by variance) among the new variables. For the choice of the number of components (sufficient to reproduce the starting data with a good approximation), we proceeded through the graph of the eigenvalues or screen. In the graph, the number of components corresponding to the "elbow" point of the line are chosen [58]. They were used in the factor analysis procedure to identify and analyse the main explanatory variables and to highlight the main problems that emerged after the COVID-19 pandemic. Socioeconomic characteristics, sales habits, and any adjustments that retailers adopted after lockdown due to the health emergency were also examined. In this case, the most important contribution was the introduction of multidimensionality in the structure of the attitudes of retailers or producers in the market.

We subsequently tried to explore whether the factors which emerged from the factor analysis might outline the subsystem of the AGIL scheme, namely the Parson's AGIL

method. This qualitative-quantitative methodology of multidimensional analysis is frequently applied in qualitative studies and has been proved to be valid and effective both for the rapidity of obtaining results and for its relatively low cost [59,60].

This methodology has also been recently improved and consolidated for its generalisation and applicability in other studies and in marketing studies for food products [61,62].

As highlighted in the papers by Sciulli [63] and Sciortino [64], the basic assumption underlying Parsons' [65] sociological paradigm is that every social system must meet four basic requirements or functional problems to survive and develop. These requirements are indicated by the acronym AGIL: Adaptation (A); Goal attainment (G); Integration (I); and Latent pattern maintenance (L).

The AGIL scheme is based on a conceptual grid that breaks down a complex phenomenon into four parts and a number of indicators. In line with this methodology, the components that emerged from the factor analysis were analysed, outlined, and explained using the AGIL scheme.

Thanks to this modelling, the potentialities of the open innovation challenge that can help overcome the system crises caused by the pandemic were examined.

This multidimensional qualitative-quantitative analysis uses a methodologically suitable model to measure the different aspects of a complex system and has proved to be valid and effective in many studies [66–68].

According to the AGIL scheme of Talcott Parsons, the four functional needs of the system represent the "actions", the set of socioeconomic activities implemented to allow the social system to survive and develop [61]. In particular, A and G look at the problems and needs for change, while I and L aim to coordinate, develop and implement change in order to overcome obstacles.

According to Parsons' method, community development is closely related to the development of the four main elements of the subsystem:

Adaptation (A) means that the system has to cope with situational needs that come from the outside. It must adapt to the environment and adapt the environment to its needs (in our case, the pandemic).

Goal attainment (G) identifies the allocation and use of resources for the achievement of priority social purposes (in our case, the sale and maintenance and/or recovery of clients).

Integration (I) concerns the necessary coherence between the choices and actions of the structures that make up the social system (subsystems, groups, roles); the system must regulate the relationship of the parts that are its components (in our case, for example, joining online sales).

Latent pattern (L; maintenance of the model) means the system must integrate, maintain, and renew individual motivation and the cultural models that create and maintain this motivation (in our case, entrepreneurial solidity and the tendency towards associations).

The methodological approach chosen uses multiple criteria and was also validated by the subsequent application of cluster analysis.

## 4. Results

### *4.1. The Market as a Central Node of the Local City*

Participant observations for the survey of open food shops, including caterers in the historic centre and their positions on maps revealed the presence of a dense system, with an increasing presence of bars and restaurants (73%) as one of the features of a touristic place and a lack of shops selling food and fresh produce (Table 2 and Figure 2). Those that existed were mainly concentrated close to the market. Butchers (6%) and supermarkets (5%) were the most common. Bars and restaurants were closed during the lockdown from 14 March to 30 June 2020.

**Table 2.** Food stores in the centre of Sant Feliu de Guíxols (2017 and 2020).

| | Sant Feliu de Guixols 2017 | | Sant Feliu de Guixols 2020 | |
|---|---|---|---|---|
| | n. | % | n. | % |
| Meat | 5 | 7.4 | 5 | 5.4 |
| Fish | 3 | 4.4 | 1 | 1.1 |
| Fruit and vegetable | 4 | 5.9 | 1 | 1.1 |
| Bakery | 6 | 8.8 | 3 | 3.3 |
| Patissery | 2 | 2.9 | 3 | 3.3 |
| Gourmet | 4 | 5.9 | 1 | 1.1 |
| Food store | 1 | 1.5 | 6 | 6.5 |
| Organic product | 1 | 1.5 | - | - |
| Dry fruits and sweet | 1 | 1.5 | - | - |
| Deli | 3 | 4.4 | 1 | 1.1 |
| Ice-cream | 1 | 1.5 | - | - |
| Bar-restaurant | 33 | 48.5 | 67 | 72.8 |
| Supermarket (>400 mq) | 4 | 5.9 | 4 | 4.3 |
| Total food retailing | 68 | 100.0 | 92 | 100.0 |

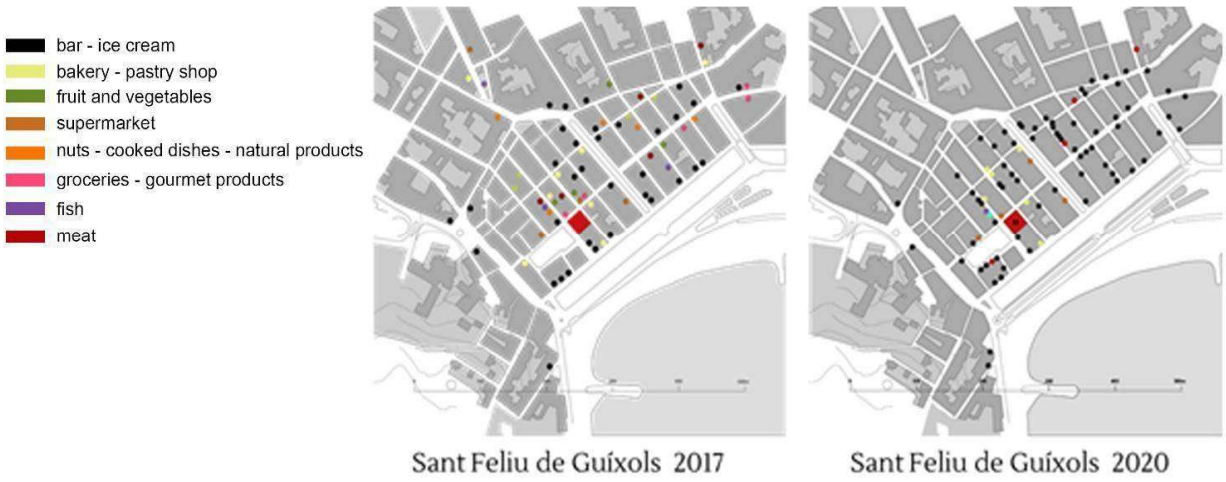


**Figure 2.** Food retailing historical analysis (2017 and 2020). Left: Food vs. restaurant businesses. The area with the greatest concentration coincides with the market location. In 2017, 45% of food shops were restaurants and bars. In 2020, they represented 73%. Source: Maximiliano Monsalvo González, Joaquim Perea i León.

The municipal market system consists of a covered market (CM) and two street markets, one that was daily (DSM) and was located right in front of the covered market and the second that was once a week on Sundays (WSM) and was located on the maritime promenade to attract consumers from the surrounding areas (Figure 3).

The CM sells fresh vegetables, confectionery, gourmet food, and groceries, but what distinguishes it from the other markets is fish and meat. The DSM is specialised in fresh produce, fruit, and vegetables.

During the pandemic, the CM was open regularly from Tuesday to Sunday from 9:00 to 13:30 and on Fridays and Saturdays in the afternoon. However, the DSM and WSM had a drastic reduction in the number of stalls and had to change from their regular positions at the market because of the COVID-19 open public space restriction. For example, in the Plaça del Mercat where the CM and the DSM are located, the presence of new or larger terraces complicated the presence of market stalls.

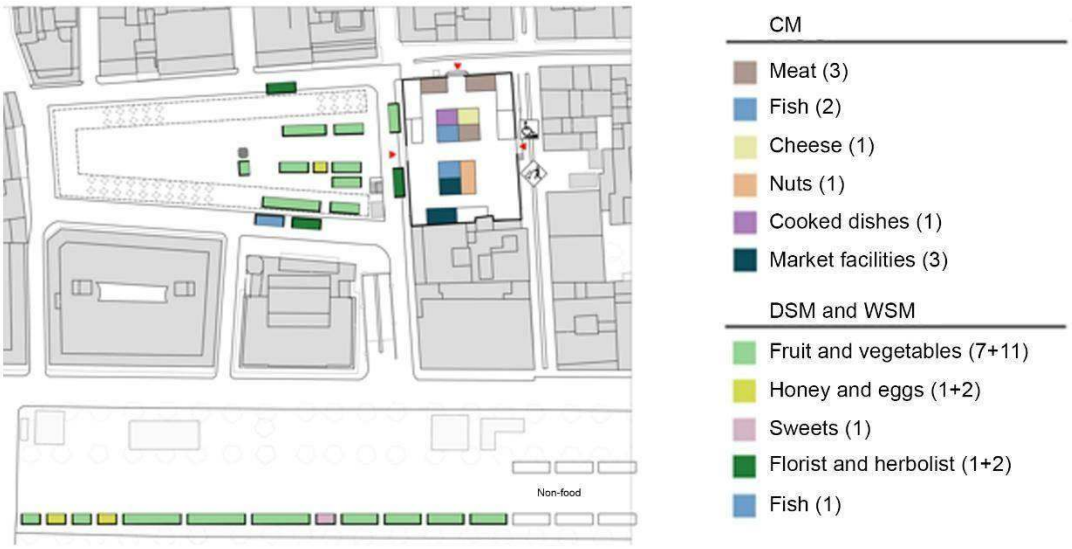


**Figure 3.** The Sant Feliu de Guíxols system of three markets. Source: Maximiliano Monsalvo González, Joaquim Perea i León.

*4.2. Factor Analysis, AGIL Method, and Cluster Analysis*

The factor analysis applied to sellers/producers identified six main components which in combination represented 74.889% of the total variance. In the study, 22 variables were considered (indicated in Table 1). Verification of the adequacy of the sample was examined with the Kaiser–Meyer–Olkin (KMO) test. The value obtained was 0.605 (values > 0.60 are considered acceptable). Complete tables with the results of the total variance explained and of the rotated component matrix have been included in Table A1.

Factor analysis allowed us to reduce the complexity of our database from several variables to a smaller number of variables or latent factors that can capture a significant percentage of the overall variability of the starting data. We proceeded through the eigenvalue graph or screen plot (included in Figure A1). In the graph, the number of components corresponding to the "elbow" point of the broken line was chosen [69]. This was used in the factor analysis procedure to identify and analyse the main explanatory variables and, in particular, to highlight the distinctive attributes that have the greatest impact on decision-making processes and the choices of the interviewed sellers.

An orthogonal rotation (see Table A2) was applied with the varimax method to allow easier reading of the matrix of the extracted components. To simplify the reading of the results, only the values that characterise the six extracted components are indicated and illustrated in Table 3.

The first latent factor extracted (23.576% of variance explained) identifies the *consolidated habits of sellers*. The grouped items are place/type of food stall (external or internal position according to the MM), type of market (CM, FSM, DSM), origin of the products, residence of the interviewee, distance of residence from the market, and sale in other spaces.

The second latent factor extracted (18.7%), which we called *the new challenges of the sellers*, includes the number of days in the Sant Feliu market and the variables concerning the aspects that retailers had to face in the COVID-19 emergency phase: number of consumer changes, changes in sales, new loyal customers, different ways of buying after lockdown (different ways of purchasing by consumers: present, online or telephone).

The third latent factor extracted (9.6%) focuses on *family businesses* and frequency of other markets.

The fourth latent factor extracted (9.55%) concerns aspects related to the *sale of products*.

The fifth latent factor extracted (7.7%), which we called *diversification*, includes years of activity, attendance at other markets, types of loyal consumers, and purchase changes after

lockdown (such as restaurants and hotels, citizens who have remained loyal by adapting to new needs).

Finally, the sixth latent factor extracted (5.7%), refers to the *retailer's propensity for forms of association*. The choice to keep this latent sixth factor is based on the combination of some criteria: eigenvalues over 1; scree plot; the percent of cumulative variance; a very high loading over 0.8 (see Comrey and Lee, who classify the loadings above 0.71 as excellent) [70].

**Table 3.** Results from the factor analysis. Rotated component matrix [a]—factors extracted by component.

| | | | | Factors | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Place | 1.76 | 0.43 | 0.695 | | | | | |
| 2 | Market type | 2.26 | 0.83 | 0.878 | | | | | |
| 3 | Seller/producer | 1.47 | 0.51 | | | | 0.736 | | |
| 4 | Production place | 7.76 | 70.12 | 0.682 | | | | | |
| 5 | Distance from the place of production | 3.23 | 10.74 | −0.623 | | | | | |
| 6 | Years of activity | 2.94 | 10.61 | | | | | 0.731 | |
| 7 | Family business | 1.12 | 0.41 | | | 0.733 | | | |
| 8 | Residence of the seller/producer | 5.06 | 40.99 | 0.888 | | | | | |
| 9 | Distance from the residence | 1.74 | 0.83 | 0.881 | | | | | |
| 10 | Membership of associations | 3.59 | 0.96 | | | | | | 0.831 |
| 11 | Product types per food stall | 5.91 | 30.19 | | | | 0.437 | | |
| 12 | Online distribution | 1.47 | 0.51 | | | | -0.509 | | |
| 13 | Revenue generated from sales or consumption | 1.97 | 0.17 | | | | 0.550 | | |
| 14 | Types of loyal customers | 1.09 | 0.29 | | | | | 0.684 | |
| 15 | Frequency of other markets | 1.56 | 0.50 | | | -0.739 | | | |
| 16 | Sale in other spaces | 1.76 | 0.43 | −0.850 | | | | | |
| 17 | Number of days in Sant Feliu market | 2.00 | 0.98 | | 0.888 | | | | |
| 18 | COVID-19: number of consumers changes | 2.00 | 0.65 | | 0.918 | | | | |
| 19 | COVID-19: changes in sales | 1.97 | 0.67 | | 0.770 | | | | |
| 20 | COVID-19: new loyalists | 1.91 | 0.71 | | 0.732 | | | | |
| 21 | COVID-19: different ways of buying after lockdown | 3.65 | 10.07 | | 0.762 | | | | |
| 22 | COVID-19: purchase changes after lockdown | 1.88 | 0.73 | | | | | 0.598 | |
| | Percent of total variance explained | | | 23.6% | 18.7% | 9.6% | 9.6% | 7.7% | 5.7% |
| | Total variance explained by Factors 1–6 = 74.9% | | | | | | | | |

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. [a] Rotation converged in 16 iterations.

As for the negative loads (as can always be seen from Table 3), they represent the sign of the difficulties of the sellers: variable 5 "Distance from the place of production" highlights that the goods also arrive from distances of over 100 km; variables 15 and 16 underline the difficulties related to traveling to attend other markets and to sell in other spaces; and finally on-line sales, the difficulties of promoting distance selling via the internet. However, these aspects represent the greatest challenges to be faced.

By applying the AGIL method, it was possible to capture all the varied aspects sought by sellers to adapt to the market changes caused by COVID-19. In fact, even in city markets, the pandemic accelerated the search for innovative product/process/service solutions. This is because in some cases, it was no longer just a question of resilience but of the ability to innovate and to research/use external open innovation challenge tools that were more in line with current needs: the network, e-commerce, associations, new requests by clients, such as food delivery, takeaway food and street food, influencers, and digital media.

Furthermore, with the application of the AGIL method, the main results of the factor analysis have been reinterpreted to understand the type of resilience or innovation implemented by the San Feliu market sellers during the pandemic crisis. The total variance explaining the main factors extracted was redistributed in the four quadrants of the AGIL scheme. The previously identified latent factors and the corresponding grouped items were considered for each subsystem.

Table 4 shows these groupings. Like Parsons' original scheme, the four systems of the acronym AGIL have been identified and the extracted factors have been considered as subsystems of the scheme.

**Table 4.** AGIL scheme model of adaptation of the sellers/producer—sellers of the San Feliu market to the health crisis arising from COVID-19. For each quadrant, the subsystem and variables are indicated.

| | |
|---|---|
| GOAL ATTAINMENT (G)<br>*Subsystem—Management the system defines the goals achievement: Power, ability to reach the sales target despite COVID-19*<br>Variables:<br>- Type of sellers/sellers-producers (V3)<br>- Product types per food stall (V11)<br>- Online distribution (V12)<br>- Revenue generated from sales/consumption (V13) | ADAPTATION (A)<br>*Subsystem—Ability to adapt to the health emergency from COVID-19*<br>Variables:<br>- Number of days in Sant Feliu market<br>- COVID-19: number of consumer changes (V18)<br>- COVID-19: changes in sales (V19)<br>- COVID-19: new loyal customers (V20)<br>- COVID-19: different ways of selling after lockdown (V21) |
| INTEGRATION (I)<br>*Subsystem—Community*<br>*Power of established habits and the ability to associate*<br>Variables:<br>- Type of Food stall—place (V1)<br>- Market type (V2)<br>- Production place (V4)<br>- Distance from the place of production (V5)<br>- Residence of the seller/producer (V8)<br>- Distance from residence (V9)<br>- Sale in other spaces (V16)<br>- Membership of associations (V10) | LATENT PATTERN MAINTENANCE (L)<br>*Subsystem—Corporate culture*<br>*Power of family businesses*<br>Variables:<br>- Family business (V7)<br>- Frequency of other markets (V15)<br>- Years of activity (V6)<br>- Types of customers (Loyal customers, not loyal customers) (V14)<br>- Purchase changes after lockdown (V22) |

Source: The authors.

- Adaption (A): This subsystem relates to the ability to adapt to the health emergency resulting from COVID-19 and indicates the possibility of rationalising decision-making processes and finding the solution with the resources available. This aspect is important because it identifies the changes that have occurred due to the pandemic, the sales and new demands of consumers, and security problems.
- Achievement of the goal (G): This subsystem indicates the ability to achieve the goal of the sale. The principle of the realisation of business income follows.
- Integration (I): This subsystem indicates the main characteristics of the sellers in the markets, such as the location of the stalls (CM, DSM, WSM), internal or external, the origin and distance of the products sold, the established habits, and the ability to associate.
- Maintenance of the latent pattern (L): This subsystem captures the corporate culture, with the power of family businesses, the years of activity, the dynamism and presence in different markets, and the loyalty of customers taking on importance.

Table 5 examines the factors extracted from the factor analysis and the relative variance explained within the conceptual framework of the AGIL scheme. To proceed with the construction of the model, both the latent factors extracted through factor analysis and the variance explained in each factor (%) were identified and catalogued in relation to the four main action systems of the model which, therefore, responded to the related subsystem. For example, action system Integration (I) which has the highest percentage (39%) includes factors extracted from factorial analysis 1 and 6. In the same way, the Latency (L) action system includes factors extracted from factorial analysis 3 and 5. The percentage significance of the action system has been calculated using an equality between ratios (applying the mathematical formula of proportions). Finally, the meaning of the AGIL model actions in resilience/resistance strategies of sellers due to the pandemic were defined.

**Table 5.** Components extracted from the factor analysis, percentage variance from each component, action system and subsystem of the AGIL scheme relative weight of the components on the total and meaning of the AGIL action system in the resilience/resistance model of vendors to the health emergency from COVID-19.

| Factor Extracts | Variance Explained in Each Factor (%) | Action System and Subsystem | Significance of Action System (%) | Meaning of AGIL Action System in the Resilience/Resistance Model |
|---|---|---|---|---|
| Factor extract 2 Effectiveness of adaptation | 18.743 | **Adaptation (A)** Capacity to adapt to the COVID-19 health emergency | 25.028 | Different ways of selling after lockdown, ability to change |
| Factor extract 4 Effectiveness of the sale | 9.557 | **Goal Attainment (G)** Ability to achieve the goal of the sale | 12.762 | Online networks, diversification (increase in product types per food stall) |
| Factor extract 1 + 6 Effectiveness of habits. Propension to association | 29.302 | **Integration (I)** Power of established habits. Associations consolidated | 39.127 | value attributed to the place of origin of the products |
| Factor extract 3 + 5 Effectiveness of family businesses, attendance in other markets | 17.288 | **Latency (L)** Power of family businesses | 23.085 | Attractiveness of local markets and family business |
| Total | 74.889 | AGIL | 100.000 | |

Our adaptation of the AGIL from Ingrassia M et al., 2020 [61]. Source: The authors.

The AGIL model made it possible to highlight and structure in detail the relevant social drivers and the identified qualitative scenarios through integration with scientific theories. It also allowed the identification of gaps in knowledge.

Adaptation (A): Action/ability to adapt to COVID-19 and the health emergency. This action is important; it represents 25% of the shares of the AGIL scheme. The elements of the sub-action highlight the salient aspects of the adaptation, such as the regularity in the days of presence of the sellers in the San Feliù market. In fact, 47% of the sellers (mostly producers) were present every day. The predisposition to increase or decrease the number of consumers, sales, and loyal consumers plays an important role in influencing the changes in attitude induced by the pandemic.

Achievement of objectives (G): The action concerns the ability to achieve the goal of the sale. This action represents 12% of the total scheme and has the lowest incidence; the pandemic has put a strain on the sellers of the San Feliù market. However, some sellers have adapted by introducing online sales (53%), focussing on the vast production range offered for sale (47% sell fruit and vegetables) and focussing on diversification (21% sell additional products). The type of seller—retailer (53%) or seller/producer (47%)—can also influence the action.

Integration (I): This action looks at the social group in the community that revolves around the market. The subsystem has the greatest weight (39%) on the total of the AGIL scheme. Eight variables among those detected have an important role in this action: the place where the stall is located if the position is internal (76% of cases) or external to the MM; if the activity is carried out in the covered market (open from Tuesday to Sunday from 9:00 to 13:30 and on Fridays and Saturdays in the afternoon); if the FSM which completes the market's offer of fruit and vegetables is covered (with the same timetable) and the DSM which also sells plants, fish, and sweets. Another important aspect in this action is the origin of the production, with 44% of the products sold coming from neighbouring areas (within 25 km) and 14% of the products sold coming from a distance within 100 km. In the

sphere of the community, the residence of the sellers in San Feliù (47%) or at most within 20 km (35%) plays a role in the integration and in the link with the territory, and the sale in other municipal markets in the area is limited (23%). In this action, we also find the associative aspect (about 20%) which, however, should increase.

Maintaining the latent pattern (L): This action affects a total of 23% and is mainly represented by the attractiveness of neighbouring local markets (44%) and family tradition. In 91% of cases, it is an activity that has been handed down in the family, and in 29.4% of cases, the years of activity are between 50 and 100 years. In the action and sub-action, factors 3 and 5 of the factor analysis were accumulated, which is also characterised by the presence of loyal consumers (91.2%) who have not changed their buying habits very much but have changed their buying methods (in 47% of cases).

### *4.3. Cluster Analysis*

The next step was to carry out a cluster analysis to group the subjects involved. A hierarchical clustering was carried out using the Ward method (quadratic Euclidean distance). A cluster analysis was developed to identify the profiles of the sellers through their main socioeconomic characteristics. This made it possible to identify the potential and ability of sellers to adapt their marketing strategies due to the evolution of the health emergency.

Three clusters were identified, the largest with 21 subjects (61.8%), the second with eight subjects (23.5), and the third with five subjects (14.7%).

The main characteristics of the individual clusters are:

- Cluster 1—*permanent sellers, attentive and available to the needs of the consumer* (61.8%). The sellers in this group were mainly farmers, that is, producers/sellers (57%), the remaining were retailers (43%). The products and food that they sell came from nearby places in 90% of the cases (from distances less than 25 km). Almost all of the sellers have a family business. All subjects in the group stated that they have loyal consumers. They sell seven days a week in San Feliu (76%). The health problem caused by COVID-19 has neither increased sales nor increased the number of loyal consumers. It has definitely not caused changes in sales.
- Cluster 2—*occasional regular and open to consumer needs* (23.5%). These are mainly sellers/traders, most with a stall in the covered market. In this case, the proximity of products prevails (from distances of less than 25 km). The businesses are family ones. Almost all of them also sell online. They have loyal consumers and all are present at the San Feliu market one to two days a week and also have stalls at other markets. During the COVID-19 lockdown period, some changes in sales occurred. There was an increase in consumers and sales. They stated that they gained some new loyal consumers.
- Cluster 3—*occasional regular* (14.7%). This small group mainly contains farmers. The products come from areas that are more distant (25 km and up to 90 km). They do not sell online. They only stand at the San Feliu market one two days a week and sell at other markets. Due to COVID-19, they have not increased sales or attracted new consumers. They have not activated any different types of sale and have not registered any changes in requests for product sales.

Thanks to the applied methodologies, a group of sellers with a greater ability to use open innovation tools strongly emerges (group in Cluster 2). These sellers are vendors who keep themselves informed via the media, have a greater sensitivity to adapt to changes, and have an ability to develop trust through relationships and their marketing strategies, for example, offering a delivery service.

### *4.4. Loyal Consumers, New Loyalties, and Seller Innovation*

The loyal consumer is synonymous with the circle of trust which can be found at the basis of the concept of proximity living and the circular economy. As shown in Figure 4, 63% of interviewees claimed to be loyal market shoppers. This leaves a high percentage of sporadic consumers. Only 40% of interviewees stated that they were over 61 years old,

which was a novelty because market buyers before COVID-19 tended to be elderly people who had time to shop at the market in the morning.

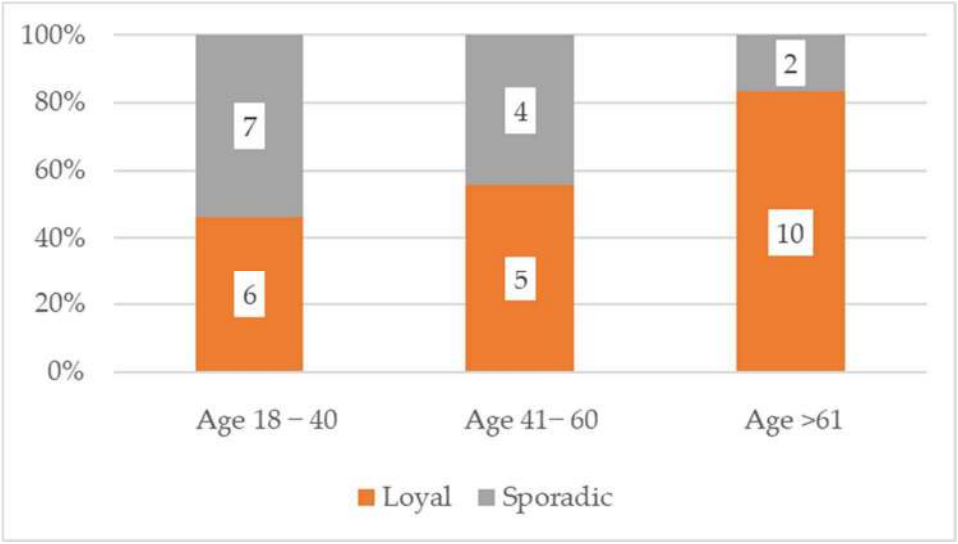


**Figure 4.** Attendance and loyal and sporadic consumers. Source: The authors.

The results show differences between consumers who describe themselves as loyal and sporadic in several dimensions.

For example, loyal consumers gave more reasons for shopping at the market, from quality and diversity to costs and aspects that were more closely related to social factors, such as supporting the local economy. In contrast, sporadic customers were mainly focussed on aspects related to food quality and local origin (Figure 5).

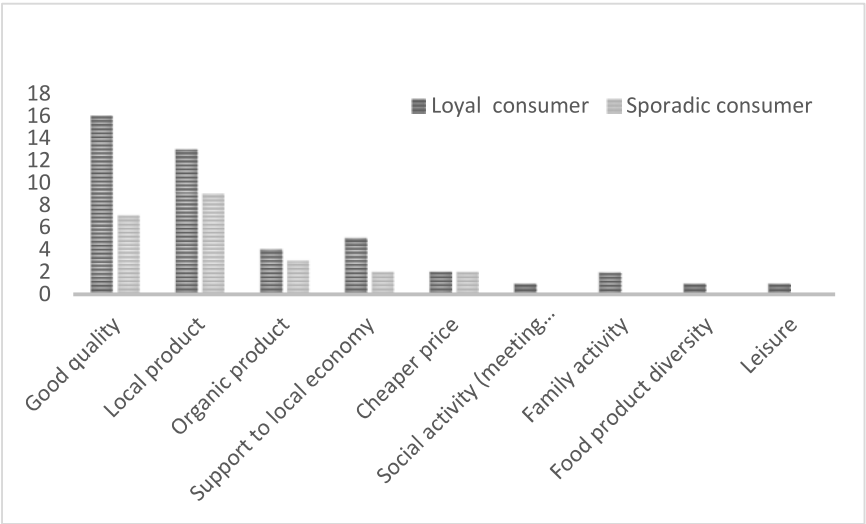


**Figure 5.** Consumer's motivation for attending the food markets. Source: The authors.

Moreover, suggestions for improving market conditions from loyal and sporadic consumers included the need to identify who are the sellers or retailers, to change the opening hours and to enable the creation of more small markets in the town.

A total of 43.8% of producers and only 16.7% of retailers, comprising a total of 60.5%, stated that they had experienced new customer loyalty since the lockdown period (see Figure 6).

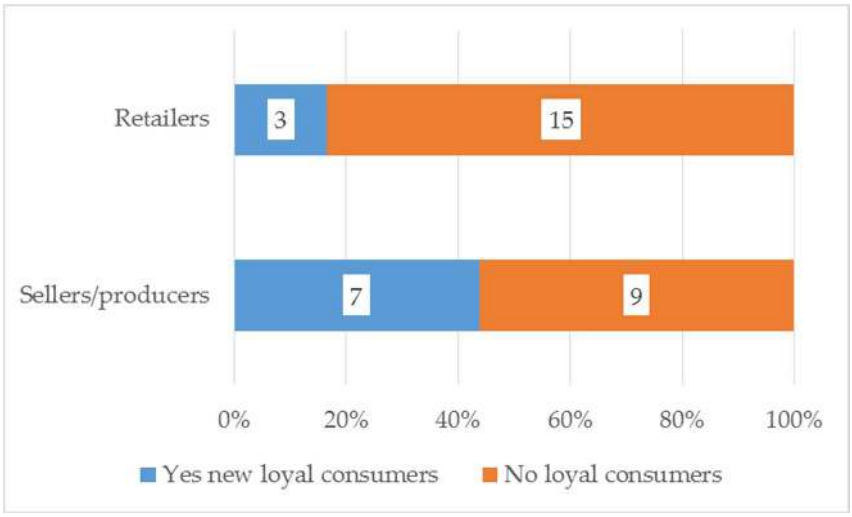


**Figure 6.** New loyal consumers %. Source: The authors.

During the period of the pandemic, 61.8% of vendors (producers and non-producers) had innovated in sales by investing in staffing to create consumer loyalty by means of take-away food or by investing in websites and complying with COVID-19 health regulations (see Table 6).

**Table 6.** Seller/producer and retailer innovation.

| | Application of Innovations | | |
|---|---|---|---|
| | Yes | No | Total |
| Sellers/producers | 32.3% (n° 11) | 14.7% (n° 5) | 47.1% (n° 16) |
| Retailers | 29.4% (n° 10) | 23.5% (n° 8) | 52.9%(n° 18) |
| Total | 61.7% (n° 21) | 38.2% (n° 13) | 100.0 (n° 34) |

Source: The authors.

In contrast, most of the retailers did not experience an increase in sales. In this context, the sellers are the group with the highest increase in sales, which could be associated with the fact that only 15% of the consumers who were interviewed claimed to want to improve their diet during the pandemic.

## 5. Discussion

### *5.1. Adaptation or Transformation of the Food System after Pandemic*

An analysis of the results shows different forms and paradoxes due to adaptation to the pandemic by market sellers and food consumers in order to manage the crisis. It also shows a response to problems that emerged before the pandemic, such as the need for innovation in the food chain to increase sustainability and an increasing awareness of climate change and its effects related to food sectors.

Consumers had to respect sanitary regulations and avoid any unnecessary movements and to purchase their home food supplies from local shops or food markets.

It emerged from the application of the AGIL scheme that some customers had changed habits but not the quality of the food purchased nor the seller. The most notable change was in social awareness of the pandemic, which led some people to decrease the frequency of purchase. Sellers invested in staff as the demand for home selling increased. The types of purchase requests also increased: by phone, via WhatsApp, and remotely. Some sellers invested in web pages for online sales. Investments/adjustments were necessary to adapt to health regulations (purchase of masks, disinfectants, etc.) and to improve and adapt to spacing regulations, such as parking lots for loading and unloading goods into stalls.

The research also used cluster analysis and identified three main groups of sellers/producers: permanent sellers, attentive and available to the needs of the consumer;

occasional regular and open to consumer needs; and occasional regular, closed and blocked in the face of difficulties. These groups confirmed that the social and economic context has an enormous impact on the capacity to adapt.

The increasing demand for door-to-door delivery shows the need to organise collectively by enlarging food governance, not only to construct a seller/producer network but also to promote consumers as active agents in the food chain. In the Mediterranean city, the food market represents a social space with great potential for the exchange of goods as well as skills and competences, and for the construction of greater governance. Markets can be places to locate pick-up points or for food cooperatives to distribute their products. A space could also be created for disseminating the food dimension of the city, with the concession of the public administration.

In the frame of neoliberalism, governance has received criticism for being a process that transfers responsibility for issues arising from complex structural problems to individuals [71]. In the case of a municipal market, the complicity between vendors and buyers in a public space could be interpreted in such a way as to expand the citizen governance involved in the food chain with reference to innovation and evolutionary resilience.

These innovations attracted new customers, especially in the age range of young families. During the pandemic, shopping became more of an individual experience. The necessity to contribute to access to food for elderly people, people with young children or homeless people led to the creation of support groups [72]. In addition to greater sensitivity to food-related issues, people had the opportunity to go to the market or to spend more time ordering local food online while they were working from home. The time factor that resulted in having more time in many cases was at the root of many of the changes and the construction of new social networks of food sellers and buyers. The partnership and cooperation of buyers and sellers in the emergency period open a new chapter in which to focus on the transition to food sustainability, with an innovation based on a broader spectrum of actors involved in the food chain.

### *5.2. The Possibility of Open Innovation in Food Industry including Restaurant*

The restaurant sector is key in the cultural economy of a country as they have to adapt to changes in consumer habits while being influenced by new experiences or technological changes. Open innovation is essential for the success of restaurants, generating new business lines. Competition fosters product innovation in restaurant companies, but investment in Information and Communications Technology (ICT) and in staff training has been shown to be the main determinants of product and process innovation in the restaurant industry [73–75]. Open innovation in restaurants proposes that customers should be seen as co-creators of the value of cuisine [76]. Innovation in haute cuisine restaurants contributes to stimulating the creation and development of gastronomy tourism products through innovation processes that add quality to the products and services offered by gastronomy tourism. Open innovation in the food industry is in a growth phase [77,78], having to face problems of the integration of the concept in the innovation management process. There is a growing interest of these companies in opening their innovation processes, obtaining benefits from collaboration with universities and other sources of knowledge [79,80]. The main characteristics of the current food industry refer to the increasing number of actors in the food chain and the heterogeneous needs of consumers. Consequently, open innovation should be considered a generalized corporate practice. Within the food industry, open innovation plays an important role in restaurant success. There is literature on key cases of the restaurant ecosystem [81], where an open innovation framework was used to analyse how to grow. At the bases need building a successful business ecosystem that shares knowledge, encourages individual growth, and embeds trust among participants, generates sustained growth models, thereby expanding "open innovation" with stakeholders.

This is also true for the Municipal Markets and for the farmers' markets which for some years have been the subject of renewed interest and urban reorganization and transformation. [11,82]. The Market as an urban space for exchanges and relationships, a place

for everyday life and conviviality [83]. For some years now, many European municipal markets have been moving in this direction, promoting social innovations, sustainable consumption, online services and home deliveries, the fight against waste, etc.

The market changes the face of the spaces and/or shops with the sale of fresh and dried fruit products, vegetables, butchers, cheeses, and various foodstuffs; at certain times of the day, they appear in a new function, becoming restaurants ready to welcome citizens, people in transit, and tourists. Open innovation has become an emergent topic in innovation management founded on the assumption that the development of innovative processes may lie outside the companies' boundaries. In particular, this paper has pursued to address one gap in existing research on open innovation, namely the investigation of its relationship with market orientation that promotes continual processes of innovation leading to higher customer value.

## 6. Conclusions

### *6.1. Theoretical and Practical Implications of this Study*

The pandemic situation in Spain and in other countries has led to an enormous increase in supermarket and online shopping. On the positive side, people have also been demanding more local food. In April 2020, food delivery reached all-time highs in Google searches globally. However, local vendors that had over time constructed a circle of trust with buyers could manage the crisis mutually with their buyers [71].

During the pandemic, small sellers/producers were affected in different ways, depending on the country. In touristic places, the appearance of the disease resulted in a lack of demand through the usual selling channels, such as hotels, restaurants, and cafes [72]. In Sant Feliu de Guíxols, the effects of border closing reduced the presence of mass tourism in the city. These disruptive effects of the pandemic involved other aspects as well, such as the possibility of innovating and expanding the consumer network using basic online tools, including WhatsApp, email or existing Internet pages. In our case study, the most accepted innovation was one-to-one delivery. Home delivery has some contradictions. First, it is costly in term of capital investment for delivering the product the problematic "last mile". Second, it is socially and environmentally unsustainable. From the perspective of poor working conditions for delivery drivers and time pressure for perishable food, which is a challenge for small delivery companies or producers, the social sustainability of this form of transport is questionable. In addition, this kind of transportation implies a lack of direct contact between sellers/producers and consumers. It disrupts the social role of the market's urban space. If the direct link between retailers and buyers is interrupted, producers become invisible and cannot communicate sustainability issues in food supply chains [73].

From the perspective of environmental sustainability, door-to-door transport is expensive in terms of its CO2 footprint. It is necessary to monitor to what extent this innovation will be disruptive for a food system that aims at a transition towards environmental, social, and economic sustainability and to screen between those adaptations that aim towards a sustainable and solidarity-based model and those which return to the previous reality. The distances are not only physical but also social and economic along the food chain.

### *6.2. Limits and Future Research Topics*

Our main question was whether these changes have just been temporary adaptations or whether they point to more profound changes in the structure of the role of food markets in the city from the urban perspective and that of its actors.

The transition to a sustainable food supply chain should be placed at the centre of urban policies [76,77], much like the market system and the local distribution of food. This is one of the main issues that is currently being solved by the private sector, especially in small towns where institutional structures are usually little interested in these issues. In the case of food markets (and the adaptations introduced in this period), there is a need for further studies focused on the relationships between ordinary food practices and urban

space. We can imagine transformations which envision the model of the "15 min city" to understand how the food market could support new social practices that are able to not only promote the food transition/innovation but also a renewed urban space. Open innovation from this perspective can be seen as a strategy for sustainable development. The intensive development of open innovations in agriculture is one of the main directions to take to ensure the sustainability of food markets. The need for open innovation lies in the fact that with the proper organisation of active cooperation between farmers, they will be able to access the world's best technologies and competencies as quickly as possible. They will also be able to use their technologies and competencies to approach new and diverse threats to the sustainable development of food consumption and agriculture [78,79].

A consumer-driven open innovation strategy plays a vital role in business model design and appears to be a novel opportunity for driving food consumption. The change would provide an opportunity for traditionally less powerful actors, such as producers, to reformulate the food chain in a way that is more closely linked to the territory with a resilience dimension for handling other possible food crises [7] and a challenge to reach the ultimate business goal.

**Author Contributions:** Conceptualization N.F. and A.N.; methodology N.F. and A.N.; formal analysis, N.F., A.N. and V.R.L.; investigation, N.F.; resources, N.F., A.N. and V.R.L.; data curation, N.F., A.N. and V.R.L.; writing—original draft preparation, N.F. and A.N.; writing—review and editing, N.F., A.N. and V.R.L. All authors have read and agreed to the published version of the manuscript.

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**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Milan Urban Food Policy Pact (http://www.milanurbanfoodpolicypact.org/) (accessed on 20 April 2021); Google trends (https://trends.google.com/trends/explore?date=all&q=%2Fg%2F1224tf85) (accessed on 20 April 2021).

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

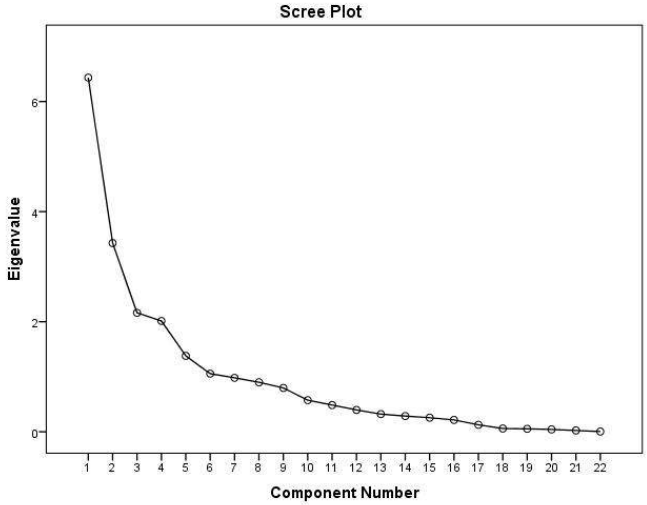


**Figure A1.** Scree plot of Factorial analysis. Source: The authors.

**Table A1.** Results of the factor analysis. Total variance explained.

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 6.435 | 29.250 | 29.250 | 6.435 | 29.250 | 29.250 | 5.187 | 23.576 | 23.576 |
| 2 | 3.429 | 15.587 | 44.837 | 3.429 | 15.587 | 44.837 | 4.123 | 18.743 | 42.319 |
| 3 | 2.163 | 9.830 | 54.667 | 2.163 | 9.830 | 54.667 | 2.113 | 9.603 | 51.922 |
| 4 | 2.014 | 9.153 | 63.819 | 2.014 | 9.153 | 63.819 | 2.103 | 9.557 | 61.479 |
| 5 | 1.379 | 6.269 | 70.088 | 1.379 | 6.269 | 70.088 | 1.691 | 7.685 | 69.163 |
| 6 | 1.056 | 4.802 | 74.889 | 1.056 | 4.802 | 74.889 | 1.260 | 5.726 | 74.889 |
| 7 | 0.980 | 4.457 | 79.346 | | | | | | |
| 8 | 0.899 | 4.088 | 83.434 | | | | | | |
| 9 | 0.796 | 3.620 | 87.055 | | | | | | |
| 10 | 0.575 | 2.612 | 89.667 | | | | | | |
| 11 | 0.485 | 2.206 | 91.873 | | | | | | |
| 12 | 0.397 | 1.805 | 93.679 | | | | | | |
| 13 | 0.321 | 1.460 | 95.138 | | | | | | |
| 14 | 0.286 | 1.298 | 96.437 | | | | | | |
| 15 | 0.256 | 1.164 | 97.601 | | | | | | |
| 16 | 0.216 | 0.980 | 98.581 | | | | | | |
| 17 | 0.127 | 0.575 | 99.156 | | | | | | |
| 18 | 0.060 | 0.273 | 99.429 | | | | | | |
| 19 | 0.054 | 0.244 | 99.673 | | | | | | |
| 20 | 0.043 | 0.1195 | 99.868 | | | | | | |
| 21 | 0.024 | 0.109 | 99.977 | | | | | | |
| 22 | 0.005 | 0.023 | 100.000 | | | | | | |

Extraction method: principal component analysis. KMO and Bartlett's test: Kaiser–Meyer–Olkin measure of sampling adequacy = 0.605. Source: The authors.

**Table A2.** Results from the factor analysis. Rotated component matrix [a].

| | | Factors | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Place | 0.695 | 0.267 | −0.279 | 0.473 | 0.141 | 0.021 |
| 2 | Market type | 0.878 | −0.083 | −0.144 | 0.391 | 0.088 | 0.034 |
| 3 | Seller/producer | 0.117 | −0.036 | −0.231 | 0.736 | 0.163 | −0.069 |
| 4 | Production place | 0.682 | −0.080 | 0.478 | −0.059 | 0.192 | −0.070 |
| 5 | Distance from the place of production | −0.623 | 0.429 | 0.142 | −0.485 | −0.045 | −0.240 |
| 6 | Years of activity | 0.014 | −0.114 | −0.014 | 0.230 | 0.731 | −0.166 |
| 7 | Family business | 0.112 | 0.275 | 0.733 | −0.118 | 0.071 | 0.094 |
| 8 | Residence of the seller/producer | 0.888 | −0.146 | 0.094 | −0.105 | −0.060 | −0.078 |
| 9 | Distance from the residence | 0.881 | −0.271 | −0.046 | −0.008 | −0.160 | −0.097 |
| 10 | Membership of associations | −0.057 | 0.135 | 0.101 | −0.039 | −0.211 | 0.831 |
| 11 | Product types per food stall | 0.360 | 0.149 | 0.430 | 0.437 | 0.188 | 0.262 |
| 12 | Online distribution | 0.029 | 0.343 | −0.486 | −0.509 | −0.048 | −0.283 |
| 13 | Revenue generated from sales or consumption | 0.137 | 0.062 | 0.267 | 0.550 | −0.113 | −0.392 |
| 14 | Types of loyal customers | −0.470 | −0.097 | −0.165 | 0.023 | 0.684 | 0.013 |
| 15 | Frequency of other markets | 0.354 | 0.251 | −0.739 | 0.011 | 0.042 | 0.085 |
| 16 | Sale in other spaces | −0.850 | 0.303 | 0.002 | −0.222 | 0.058 | −0.008 |
| 17 | Number of days in Sant Feliu market | −0.069 | 0.888 | −0.033 | 0.119 | −0.122 | −0.091 |
| 18 | COVID-19: number of consumers changes | −0.087 | 0.918 | 0.012 | 0.074 | −0.058 | 0.004 |
| 19 | COVID-19: changes in sales | −0.392 | 0.770 | 0.058 | −0.094 | −0.097 | 0.082 |
| 20 | COVID-19: new loyalists | 0.021 | 0.732 | 0.021 | −0.096 | −0.084 | 0.348 |
| 21 | COVID-19: different ways of buying after lockdown | −0.259 | 0.762 | −0.019 | −0.147 | 0.263 | −0.003 |
| 22 | COVID-19: purchase changes after lockdown | 0.187 | 0.061 | 0.289 | −0.063 | 0.598 | −0.039 |

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. [a] Rotation converged in 16 iterations. Source: The authors.

**Table A3.** Questions posed to vendors. Source: The authors.

| Questions | Answers |
|---|---|
| Food stall—place | Exterior stall [ ]<br>Interior stall [ ] |
| Market type | Covered market (CM) [ ]<br>daily street market (DSM) [ ]<br>weekly street market (WSM) [ ] |

**Table A3.** *Cont.*

| Questions | Answers |
| --- | --- |
| Retailer or Seller/producer | Retailer [ ]<br>Seller/producer [ ] |
| Production place | Sant Feliu de Guíxols [ ]<br>Girona [ ]<br>Palamos and Calonge [ ]<br>Llagostera [ ]<br>Castell d'Aro [ ]<br>Torrella de Mongri [ ]<br>Lloret [ ]<br>Vidreres [ ]<br>Gaverres [ ]<br>Palafrugell [ ]<br>Tossa de Mar [ ]<br>Roses [ ]<br>Cassà de la Selva [ ]<br>Mercat de las Flores [ ] |
| Distance from the place of production (proximity < 25 km) | 0 km [ ]<br>1–25 km [ ]<br>26–50 km [ ]<br>over 50 [ ] |
| Years of activity | Less than 10 years [ ]<br>11–30 years [ ]<br>31–50 years [ ]<br>51–100 years [ ]<br>no reply [ ] |
| Family business | Family business [ ]<br>not a family business [ ] |
| Residence of the seller/producer | Sant Feliu de Guíxols [ ]<br>Calonge [ ]<br>Llagostera [ ]<br>Girona [ ]<br>Palamos [ ]<br>Castell d'Aro [ ]<br>Cassà de la Selva [ ]<br>Palafrugell [ ] |
| | Tossa de Mar [ ] |
| Distance from residence | Residence in Sant Feliu de Guíxols [ ]<br>residence 1–20 km away [ ]<br>residence 21–50 km away [ ]<br>residence 51–90 km away [ ] |
| Membership in associations | Traders' association [ ]<br>Producers association [ ]<br>market sellers association [ ]<br>No [ ] |
| Products types per food stall | Fish [ ]<br>Meat [ ]<br>Cheese [ ]<br>dried food [ ]<br>vegetables and fruit [ ]<br>herbs/spices [ ]<br>wine [ ]<br>other products [ ] |

**Table A3.** *Cont.*

| Questions | Answers |
| --- | --- |
| Online distribution | Yes [ ]<br>No [ ] |
| Revenue generated from sales or consumption | Revenue generated from sales [ ]<br>Revenue generated from Consumption [ ] |
| Types of customers | Loyal customers [ ]<br>not loyal customers [ ] |
| Frequency of other markets | Yes [ ]<br>No [ ] |
| Sale in other spaces | Yes [ ]<br>No [ ] |
| Number of days in Sant Feliu market | 1 day [ ]<br>2 days [ ]<br>7 days [ ] |
| COVID-19: number of consumer changes | Yes consumers increased [ ]<br>No consumers did not increase [ ]<br>no reply [ ] |
| COVID-19: changes in sales | Yes sales increased [ ]<br>No sales did not increase [ ]<br>no reply [ ] |
| COVID-19: new loyal customers | Yes [ ]<br>No [ ]<br>no reply [ ] |
| COVID-19: different ways of buying after lockdown | Face-to-face [ ]<br>Online [ ]<br>Telephone [ ]<br>In any case [ ]<br>no reply [ ] |
| COVID-19: purchase changes after lockdown | Yes [ ]<br>No [ ]<br>No reply [ ] |

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**Proceedings paper: "Innovation for weekly food markets after the Covid-19 pandemic**

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# Innovation for weekly food markets after the Covid-19 pandemic

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# Innovation for weekly food markets after the Covid-19 pandemic

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***Abstract*** **– The Covid-19 pandemic has accelerated the search for innovative solutions throughout the food chain. Open innovation challenges must be resolved in line with current needs for food transitions according to the Farm and Fork strategy, which is included in the European Green Deal objectives to make food systems fair, healthy and environmentally friendly. The radical transformation of the food system under the banners of agroecology urbanism requires a reconfiguration of the social and cultural connection between agricultural producers, urban consumers and their relational and inclusive space. The purpose of this research is to recognize the adaptation and innovation mechanisms of the local food system over the last two years and, in particular, to identify sustainable practices at weekly food markets which could be used to foster the food transition. A total of 149 semi-open questionnaires were given to food market vendors and factor analysis was used to highlight latent factors and how much the open market is rooted in the territory. The results shows that a territorial approach can foster "innovation" in these traditional weekly food markets, which otherwise could lose their social potential for food transition.[1]**

***Keywords*** **– open food markets, factor analysis, innovation, Girona Province**

## INTRODUCTION

This article presents part of a study carried out in the framework of a Territorial Specialization and Competitiveness Project (PECT) entitled the Sustainable Food System, funded by the Province of Girona and the European Union, with the collaboration of the Mediterranean University in Italy. As part of PECT, our project is called MeDiTrac (Markets, Distribution and Traceability). Our research group "Architecture and Territory" is working on the role of weekly food markets in food distribution in the Province of Girona to determine how to introduce innovation into the "traditional way of selling" in order to be attractive for workers and young people who are used to going to the supermarket because of opening times, the diversity of products including food, groceries and others, and the presence of sales or offers.

The Covid-19 pandemic made visible the unsustainability and vulnerability of the global food system at all societal levels, highlighting its weaknesses and fragility (Clapp et al., 2020; Fanza et al., 2020). At the same time, it revealed great resilience in Europe. weekly markets (WM) demonstrated their resilience and role as a source of supplies and as a public space and space for socialization, which is known as the third nature of the market (Marsden, Banks and Bristow, 2000; Renting, Marsden and Banks, 2003).

The pandemic accelerated the search for innovative solutions to food distribution in the context of short and long food chains. Open innovation challenges must be resolved in line with current needs for food transitions according to the Farm and Fork strategy, which is included in the European Green Deal objectives to make food systems fair, healthy, and environmentally friendly. The trend is for transformation of the food system under the banners of sustainability, resilience and agroecology urbanism. To achieve this requires a reconfiguration of the social and cultural connection between agricultural producers, vendors and urban consumers. Our project focuses on their relational space with the territory, considering not only the market as a public space, but also the functional and cultural connection with productive areas and the threshold of producers and consumers at the weekly food market. For this reason, we consider the market at two levels: as a contextualised agency at municipal level, and as a potential agency at territorial level, considering the area delimited by the "range" of distance that consumers and vendors are prepared to travel to purchase or sell goods.

The cluster concept was adopted by Walter Christaller in his Central Place Theory for interpreting the system of markets at territorial level in south Germany. This concept was also adopted by geographer Pau Vila ( Burgueño, 2003) in Catalunya when he was defining new criteria to demarcate the natural *comarques* (1931), using a survey sent to all municipalities in Catalonia. He suggested three questions, two focused on the relationship between citizens and the place where they usually bought food. The questions were: Which region do you think belongs to your people? Which market do you usually go to? Do you go to another market? The results of the survey led to the first map of Catalonia in which public food markets (open air or covered) were the main pole structure of the region and the main pole of every *comarca* (Fig.1).

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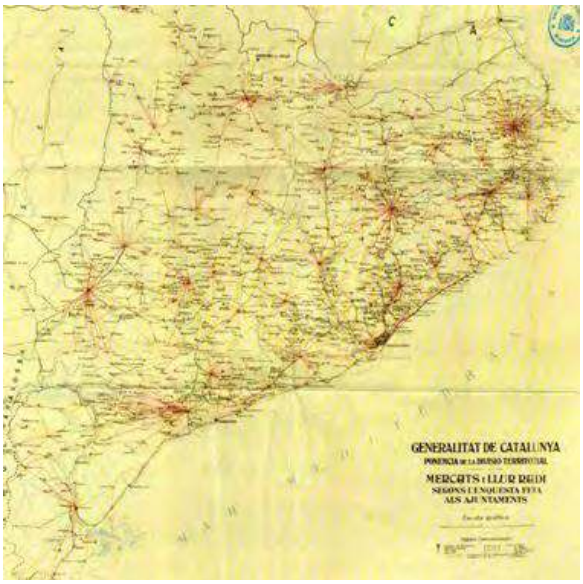



*Figure 1. Results of the survey conducted by Pau Vila in 1931 in which you can appreciate the attraction exercised by the market. From Burgueño, 2003.*

We decided to adopt the cluster of markets concept to take a territorial approach to the presence of markets (Kassai et al., 2018), instead of focusing exclusively on diversity or the context difference of every municipality. Cluster analysis has been used to study farmers markets from a social perspective and in performance economic metrics. We are interested in territorialising the cluster analysis to verify the relationship with productive areas.

This research explores the extent to which WM clusters could help to understand if the WMs reflect the relationship between rural and urban territory; whether they represent fair, healthy and environmentally friendly food systems; and what their relationship is with the territory.

Our hypotheses were as follows. First, in the province of Girona WMs are a complex network that could respond to the objectives of the European policy but are not valued by the local municipality or provincial administration. Second, the WMs could be included in clusters in relation to the mobility system and the "range" of attraction of the vendors, consumers and food production. Third, WMs adaptability during the Covid-19 pandemic should be studied to determine what innovations to implement.

For this region, our research questions were as follows. What does this market provincial system consist of? What could be defined as market clusters and for which region could this concept be relevant? What could be the indicators of the "health" of a market or in line with EU policies? Does the market serve as a retail incubator for farmers/ranchers to start up? What is the market's ability to attract and serve new farm vendors?

## METHODOLOGY

Our study is focused on the Province of Girona in Spain, adjacent to the border with France. It is composed of nine *comarques*, which in total have 788 inhabitants (2020), in a territory of 5,910 km$^2$ and a density of 132.28 inhab/km, with the highest density of population along the coast and in the capital of the *comarca*. The province has a highly diverse landscape, with mountains at the border with France, an agrarian plain in the central zone and the touristic coast of Costa Brava.

The mobility system has a main north-south corridor which connects France with Barcelona and central Spain, and a more capillary system that connects the inner or coastal area from east to west. Since the Middle Ages, Girona Province has had open markets that in some cases have continued until today with great resilience.

The methodology used was a combination of qualitative and quantitative analysis. Urban planning and open market analysis (Nicolosi, Pulina and Laganà, 2016; Wolnik, Cheek and Weaver, 2018; Fava, Laganà and Nicolosi, 2022) use mostly quantitative and geographical analyses to provide statistical results that are contextualised in the territory and social space. Meanwhile, qualitative research gave us information about innovation carried out in the pandemic period. To determine the number of markets to analyse out of a total of 96 (Fig. 2), we used the sample size with a confidence interval in an estimated 95% ratio with 10% accuracy. The resulting sample was of n=49 markets. Before we used the random system to define which market to visit, we prioritised visiting at least 40% of every cluster, the biggest market in every cluster, all the markets in the *comarcal* capital and the markets that are recognised for good practice. So far, we have visited 27 markets and interviewed over 60% of the sellers. The main role was attributed to actors involved in the life of the market sellers and consumers. To date, we have carried out onsite 149 semi-open interviews with the sellers. We divided the sellers into three categories: food retailers (FR), seller producers (SP) and sellers of local producers (SLP). This division helps us to understand the relation between WM and the territory. Ten-minute personal interviews with sellers were conducted anonymously and face-to-face, based on semi-structured questionnaires. The questionnaires were administered between January and September and July 2022.

The methods used for gathering data were:

1. Participant observation: on-site examination of the food retail urban structure in the centre of the town and in the food markets.

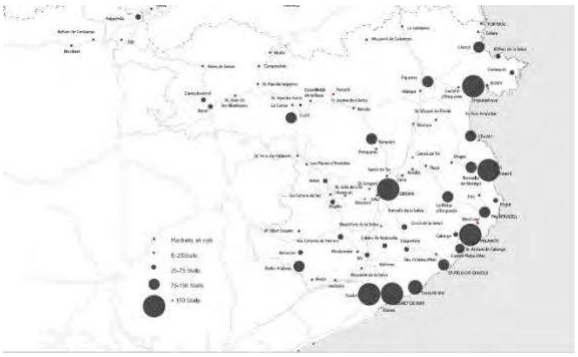


*Figure 2. Weekly markets (WMs) in Girona Province according to the total number of stalls, 2018.*
*From: Fava N. et al. (2022).*

2. One-to-one interviews with food retailers (FR), seller producers (SP) and sellers of local producers (SLP).
3. Statistical and geographical analysis of the results.

## PROVISIONAL RESULTS

The weekly markets along the touristic coast of the Costa Brava are the biggest and most active. In remote areas, some of them are at risk and some of them could not withstand the pandemic in 2019. For these reasons, the first step in the analysis was to identify the active markets, because no updated list was available and the last publication of the Generalitat of Catalunya was from 2005 (Llibre Blanc, 2005).This shows the lack of interest in this social and economic capital in the territory. We detect 96 weekly active markets, even if with very different number of stalls.
The second step was to identify the cluster (Fig. 3), in relation to connection by road and the weekly day of market opening. We identified 17 clusters, with widely varying size.
In each cluster, each market is connected to the other by no more than a 15-minute drive, and the surrounding production landscape is similar.

*Figure.3 Market cluster hypothesis, Girona Province. Author: Marta Carrasco i Bonet.*

*Demographic*
Of the 149 people interviewed, 90 were men and 59 were women. A total of 28.3% of the sellers interviewed were over 46 years old. A total of 30% of the stallholders had been working for over 40 years on the market, because it was a family business. Eighty per cent of sellers stated that their stall was a family business.

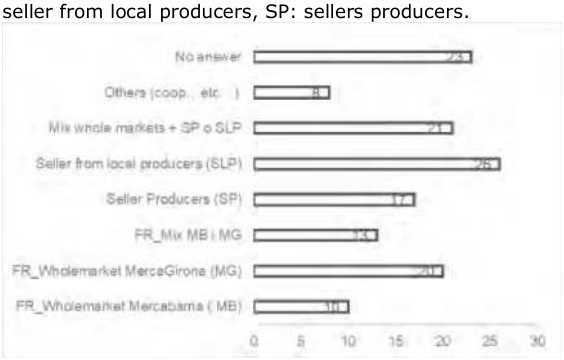
*Type of sellers*
A total of 59% of sellers are resellers, while only 32% are direct producers.

**Table 1. Type** of sellers

| Type of sellers | N. | % |
|---|---|---|
| Food reseller | 82 | 57% |
| Sellers Producers | 47 | 32% |
| Sellers of Local Producers | 13 | 9% |
| No answer | 3 | 2% |
| **Total** | **145** | |

*Origin of the food purchase*
A total of 46% are resellers from the wholesale market, of which 7% are from Mercabarcelona (MB), 15% form Mercagirona (MG), 9% from both MB and MG, and 15% a mix of MB and MG and producers. The 32% are SP and 9% are SLP

**Table 2.** Origin of purchased food. FR: food retailers, SLP: seller from local producers, SP: sellers producers.




*Factor Analysis*
Participants were asked for their perceptions of difficulties due to the pandemic as well as how they dealt with the changes that had taken place, for example, with respect to willingness to take orders by phone, make home deliveries. Other parts of the seller questionnaire were designed to highlight aspects problems and changes that the sellers faced in the period of the COVID-19 health emergency. Questions that we focused on for the factor analysis and subsequent processing are indicated in Table 1. In the study, 18 variables were considered (indicated in Table 3). The factor analysis applied to sellers/producers identified six main components which in combination represented 69.99% of the total variance. (Table 3). Factor analysis allowed us to visualize latent factors that can capture a significant percentage of the overall variability of the starting data.

**Table 3.** Variables identified in the factor analysis.

| | Communalities | | |
|---|---|---|---|
| | | Initial | Extraction |
| 1 | Years of activity | 1 | 0,656 |
| 2 | IT- App | 1 | 0,696 |
| 3 | Hub mob | 1 | 0,751 |
| 4 | IT activities | 1 | 0,678 |
| 5 | Afeternoon work | 1 | 0,613 |
| 6 | City | 1 | 0,746 |
| 7 | Age | 1 | 0,657 |
| 8 | COVID: what changes | 1 | 0,766 |
| 9 | COVID19: different ways of buying after confinement | 1 | 0,81 |
| 10 | COVID19: online distribution | 1 | 0,568 |
| 11 | COVID19: number of consumers changes | 1 | 0,883 |
| 12 | Family business | 1 | 0,696 |
| 13 | Membership of associations | 1 | 0,563 |
| 14 | COVID19: purchase changes after confinement | 1 | 0,703 |
| 15 | Variety of products | 1 | 0,797 |
| 16 | Stand size | 1 | 0,596 |
| 17 | Reseller/producer | 1 | 0,729 |
| 18 | Markets of origin or own production | 1 | 0,69 |

To simplify the reading of the results, only the values that characterise the six major extracted components are considered and illustrated in Table 4.

**Table 4.** Results from the factor analysis. Rotated component matrix a—factors extracted by component. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. a Rotation converged in 8 iterations

| | | Factors | | | | | |
|---|---|---|---|---|---|---|---|
| % variance | | 1 | 2 | 3 | 4 | 5 | 6 |
| 19.8% | Years of activity | **0,656** | 0,444 | 0,119 | -0,065 | -0,104 | -0,002 |
| | IT- App | **0,684** | 0,054 | 0,225 | 0,414 | -0,041 | 0,044 |
| | Hub mob | **0,8** | -0,175 | 0,209 | 0,144 | -0,12 | 0,037 |
| | IT activities | **0,806** | -0,111 | 0,084 | 0,074 | 0,046 | 0,028 |
| | afternoon work | **0,745** | -0,081 | 0,145 | 0,175 | -0,017 | 0,003 |
| 12.4% | City | -0,332 | **0,748** | 0,234 | 0,111 | 0,042 | 0,088 |
| | Age | -0,053 | **0,736** | 0,186 | -0,065 | 0,231 | -0,142 |
| | COVID: what changes | 0,323 | **0,584** | -0,2 | 0,468 | 0,2 | 0,149 |
| 11.6% | COVID19: different ways of buying after confinement | 0,199 | 0,12 | **0,855** | 0,067 | 0,132 | 0,055 |
| | COVID19: online distribution | 0,467 | 0,104 | **0,512** | 0,271 | -0,027 | 0,057 |
| | COVID19: number of consumers changes | 0,28 | 0,194 | **0,845** | 0,205 | 0,1 | 0,038 |
| 11.6% | Family business | 0,243 | -0,085 | 0,189 | **0,757** | 0,019 | 0,141 |
| | membership of associations | 0,087 | 0,092 | 0,126 | **0,716** | -0,017 | -0,136 |
| | COVID19: purchase changes after confinement | 0,437 | 0,466 | 0,114 | **0,5** | 0,139 | 0,113 |
| 11.5 % | Variety of products | -0,086 | 0,098 | 0,054 | 0,202 | **0,858** | -0,005 |
| | stand size | 0,055 | -0,343 | -0,199 | 0,288 | **-0,603** | 0,005 |
| 7.8% | Reseller/producer | 0,02 | -0,219 | -0,042 | -0,128 | 0,244 | **-0,777** |
| | Markets of origin or own production | 0,099 | -0,256 | 0,072 | -0,131 | 0,277 | **0,718** |
| | Percent of total variance explained | **19.8%** | **12.4%** | **11.6%** | **11.6%** | **11.5%** | **7.8%** |

The first latent factor extracted (19.8% of variance explained) identifies the "Important innovations for sellers". The grouped items are the years of established activity of the sellers, the importance attributed to the following technological innovations: App; Hub mob., consumer attraction activities (tastings, fun activities for children and families, music, and others)

The second latent factor retrieved (12.4%), concerns the location of the market, the age of the seller, and the changes implemented to satisfy consumer demands (taking requests online, by phone, etc.) and can be defined as "readiness for change".

No less important are the third and fourth factors, which also account for similar percentages to the third and respectively 11.6% and 11.5% of variance explained, and which deal with the presence of consolidated family businesses and diversified way of selling products.

The fifth and sixth factors extracted (7.8% and 6.8% variance respectively) emphasise the importance of the variety present in the stalls and the size of the stalls.

## Discussion and conclusion

Clusters are examined as a hypothesis to consider the WM such as territorial system. When coupled with the mobility system, this approach could give rise to a redefinition of market territories and the concept of daily food shopping. In addition, clusters are designed so that consumers have alternative places on weekdays to buy fresh products, without using a car if they are at a distance that can be reached by bicycle or, in any case, without having to increase CO2 footprint.

The data collected to date show that over half of the sellers are not linked to the territory, even though approximately 40% are producers or resell products bought from local producers. More concern is the average age of the sellers. The issue of generational turnover arises usually for the buyers, who are usually elderly, but in this case also the sellers have the same problem. The one-to-one interviews revealed that some young producers perceive the WM such as an opportunity, not only for selling, but also for promoting the territory and experimentation, as they feel in contact with other agricultural realities, and they feel to belong to the community of small producers.

The data processing is in a preliminary state because we are waiting to complete the interviews, which are difficult because there is real/perceived vendor reluctance to share information. Furthermore, we have to carry out the interviews when the market is open and consequently there is consumers presence. In addition, the WMs can have considerable seasonal variations, especially in a province like Girona with strong influxes of tourism. However, the sellers decides to go to one place or another, and analysing the global system, it is not a real problem for the purpose of analysing the data.

## Acknowledgement

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# CHAPTER 3. - SUPPLY CHAIN OPERATORS: INVESTIGATIONS AND EXPERIENCES

## *3.1 Focus Group and interviews with opinion leaders*

In order to identify the strategic planning function for the development of the black truffle supply chain in Calabria, the analysis examined the strengths / weaknesses and opportunities / threats. The growing demand for truffles, together with their importance for the rural economy, pushed us to explore and investigate the appropriate strategies to adopt through a SWOT analysis. This type of qualitative analysis helps to clarify the risks and opportunities to make a diagnosis of the current development status and the prognosis of future development of the situation. Since this is a niche market (characterized by limited information, confusion regarding quality standards and the absence of established institutions), rather difficult to decode and therefore to study, the SWOT Analysis is an appropriate research method for this study. In particular, the evaluation matrix of strengths, weaknesses, opportunities and threats is an analysis tool that allows to comprehensively consider the market demand and the potential one (Kotler & Zaltman, 1971). Furthermore, it allows to study the macro and micro environmental factors (Beckeman & Skjöldebrand, 2007) that influence the market of a niche product. In this study, the method was adapted to the specific case of the truffle market in the area of investigation and the strengths, weaknesses, opportunities and risks were determined by the people interviewed on the basis of a grid of questions prepared by the working group. Attitudes and social models are constantly evolving and underline the importance of the potential of the product without neglecting the limits and risks present in the Calabrian truffle sector. Through interviews with opinion leaders, operators, collectors, processors and restaurateurs, the potential present in the territory was identified and the strengths and weaknesses of the sector were highlighted, as well as the opportunities offered by the economic system and the needs raised by the operators who in various capacities deal with truffles in the Calabria Region. We conducted a series of in-depth interviews with an intentional sample of key informants. A total of 24 in-depth interviews were carried out with the support of the tutor and co-tutor: 6 interviews with experts (researchers, agronomists, forestry agronomists and communicators) and 14 interviews with other representatives of an intentional sample identified by the desk review. In particular, 5 agroforestry and agri-food companies interested in truffle cultivation, 3 restaurateurs and 15 collectors/diggers. In the latter case, since the subjects were available only through direct contact or through a network of friends or relatives, we followed a snowball sampling: a non-probability sampling technique in which existing study subjects recruit subjects to interview among their acquaintances (Kirchherr & Charles, 2018). The sample group grows like a rolling snowball (Noy, 2008; Shaghaghi et al., 2011). The first interviewee reported other collectors, friends, relatives who indicated the reference collector/digger and so on. The interviews were conducted anonymously on the basis of a semi-structured questionnaire. The interviews were carried out only after receiving informed

consent to the processing of sensitive data. We conducted meetings/interviews lasting approximately 1 hour (both individual and through the focus group) in the spring of 2022. The interviews were carried out with the co-tutor from the co-tutor to manage in-depth interviews..

### *3.2. Truffle farms: case studies in the Ionian area*

In this study, the research activity was specifically focused on the Ionian area (Grecanic area and Locride area). In the case studies examined, controlled truffle grounds were planted with mycorrhized Mediterranean forest essences, for the creation of controlled truffle grounds for the production, diffusion and valorization of the Calabrian Truffle. They can represent examples capable of promoting, supporting and developing the Calabrian Truffle supply chain aiming to spread the cultivation of truffles in suitable areas of the investigated territory in order to conserve, requalify, promote an activity capable of guaranteeing additional income (even in disadvantaged and fragile areas); attract new economic flows from sustainable tourism, stimulate territorial marketing and gastronomy based on fresh and processed truffles. In the investigated territory, to date there are only two companies, even if a certain number of agroforestry companies declare themselves available for cultivation (which could spread in suitable areas of the territory). The case studies can represent innovative agroforestry companies and are illustrated below.

- Case study n° 1:

Between 2019 and 2020, the farm started growing mycorrhized forest species with certified truffle-producing plants (supplied by a nursery located in the province of Catanzaro) to create an artificial truffle ground of about 10 hectares. The following species were planted: *Quercus Pubescens, Quercus Ilex, Ostrya carpinifolia and Pinus halepensis* mycorrhized with *Tuber Aestivum var. scorzone and Tuber Melanosporum*. To promote the development and growth of mycorrhized forest crops, the chemical-physical characteristics of the soil must be adequate. In fact, on the farm the soil is calcareous in nature with a landslide skeleton of Jurassic origin. The climatic and microclimatic conditions are also suitable for the growth and development of truffles, in particular the prized black truffle (*Tuber Melanosporum*) and the summer truffle (*Tuber Aestivum var. scorzone*).

In May 2019, the company carried out a series of interventions and agricultural operations for the preparation and subsequent planting of mycorrhized forest species. The intervention area is terraced and, conventionally, has been divided into three areas (Figure 5):

- The area in red is affected by forest species mycorrhized with *Tuber Melanosporum*: Downy Oak 627 plants, Holm Oak 72 plants, Hornbeam 144 plants;
- in the area in blue we find forest species mycorrhized with *Tuber Aestivum*: Downy Oak 422 plants, Holm Oak 228 plants, Hornbeam 648 plants. In this area there are also non-mycorrhized *Quercus Ilex* crops.

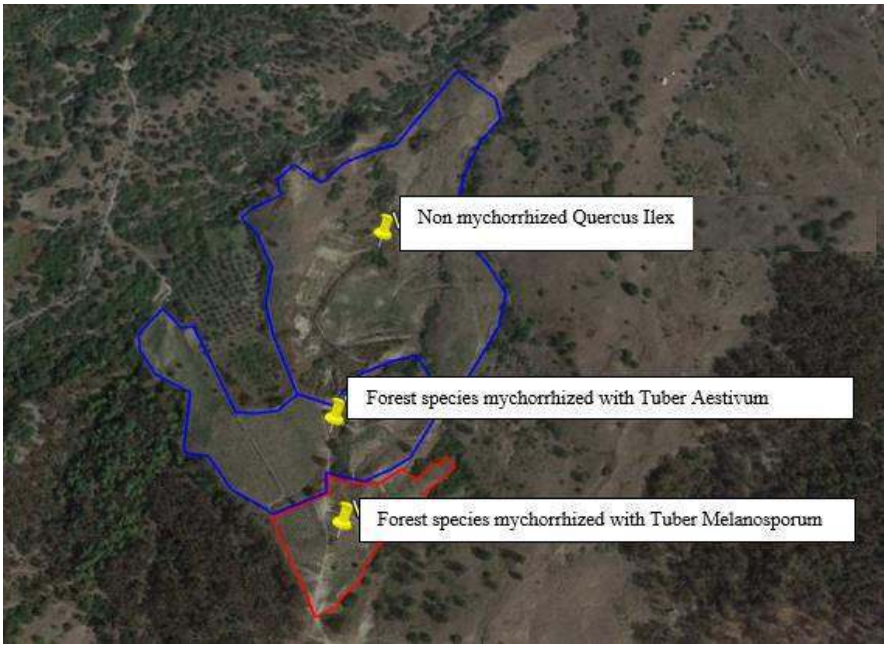


**Figure 5**. Areas affected by truffle grounds in the first case study. (adaptation from Google Maps)

As is known, cultivated truffle grounds enter into production 8-10 years after planting, therefore the truffle ground has not yet entered into production. In the spring of 2023, the physio-vegetative state of the plants was good (Figure 6) with an average height of the plants of approximately 1.50/1.80 m. However, in 2024 during the inspection, the truffle ground appeared to be suffering due to the excessively hot and dry climate trend, caused by the lack of rain and the limited emergency irrigation carried out by the company.

**Figure 6**. Situation of the first business case study before and after the investment. Photo Agata Nicolosi

- Case study n° 2:

In the second case study, the agroforestry company planted typically Mediterranean forest essences in 2017: *Quercus Ilex, Quercus Pubescens, Pinus Halepensis*. The truffle ground concerns a part of the plantation (2,141 forest

essences) mycorrhized with *Tuber Melanosporum, Tuber Borchii and Tuber Aestivum.*

In addition, a part of the plants (2,141) were mycorrhized as follows:

- Downy oak: 422 plants with *Tuber Aestivum* and 627 plants with *Tuber Melanosporum*;
- Holm oak: 228 plants with Tuber Aestivum and 72 plants with *Tuber Melanosporum*;
- Black hornbeam: 648 plants with Tuber Aestivum and 144 plants with *Tuber Melanosporum*.

Also in this case, the intervention area is terraced and, as shown in figure 5, has been conventionally divided into three areas(Figure 7):

- the orange area is affected by the species of Oaks and Holm Oaks mycorrhized with *Tuber Melanosporum* (the "precious black" truffle);
- in red, the areas in which species of Oaks, Holm Oaks and Domestic Pines mycorrhized with *Tuber Aestivum Vitt*. (the "summer black" truffle, also called "Scorzone") have been planted;
- in green is identified the area that hosts species of Aleppo Pine mycorrhized with *Tuber Borchii* (the "Bianchetto" truffle). Furthermore, the water points, from which the water supply pipes to the crops branch off, are indicated in blue.

**Figure 7**. Aerial view of the areas affected by truffle grounds in the second study case (adapted from Google Maps)

### *3.3. Processing and transformation*

The processes of social transformation underway in recent decades are also changing the world of food and the agri-food sector. Attention to production processes, ethical behavior of entrepreneurs, aspects of food safety and traceability are also becoming increasingly the object of attention, hence the growing interest in purchasing typical and locally sourced products. By adding truffles, the agri-food sector (industrial and artisanal) increases the added value of various products such as cheeses, pates, pasta, pizzas, sauces or oils, giving them luxury and gourmet attributes (Torregiani et al., 2017; Wernig et al., 2018). Typically, when consumers talk about truffle products, they refer to the species *Tuber melanosporum* (black truffle) or *Tuber magnatum* (white truffle), due to their unique aroma and high economic value (Campo et al., 2017; Khalifa et al., 2019;

Lee et al., 2020; Patel et al., 2017). However, there is a certain tendency within the food industry to add lower-value truffle species with morphological similarities, such as *Tuber indicum and Tuber aestivum* for black truffle products, or Tuber borchii for white truffle products (Oliach et al., 2021). By product, black truffle had the largest market share of 66.9% in 2022 (according to Grand View Research 2023 Market Analysis Report, https://www.grandviewresearch.com/ ) and is the most popular truffle variety as it is used in the production of various black truffle products such as truffle oil, truffle sauce, truffle butter, truffle cheese, truffle vinegar, etc. The added value recognized to the agri-food product depends on the fact that the consumer buys in its context and this is an example of the ability of local actors to create a susceptible process and capture the willingness to pay of consumers associated with the environment of the product. The sale of territorial quality is therefore achieved thanks to the integrated offer of food, environmental and social quality. The territorialization of the relationships between consumers and producers highlights that there are territorial solutions of flexible organization of quality agri-food production. A problem related to the food industry is that many of the truffle products that are sold in retail are characterized by the use of truffle species of low economic value and the addition of flavoring substances. In most cases, the added flavorings do not mimic the aroma of fresh truffles and do not correspond to the truffle species that appear in the list of ingredients and in the declaration of identity. The truffle aroma is a complex mixture of many different volatile aromatic compounds (AVCs). Among them, sulfur compounds, such as dimethyl disulfide (DMDS) and dimethyl sulfide (DMS), are the most relevant (Costa et al., 2015; Culleré et al., 2010; Tejedor-Calvo et al., 2023). However, food processing or preservation technologies can dramatically change or reduce the complexity of this aroma profile (Campo et al., 2017). In Europe, all flavorings for use in food and food products are regulated by Regulation (EU) No 872/2012 and their labelling is regulated by Regulation (EC) No 1334/2008. Since fresh truffles deteriorate and lose flavor rapidly after harvest, post-harvest processing of fresh truffles is necessary to maintain their sensory characteristics for extended year-round supply (Rivera et al., 2010). Different preservation techniques such as refrigeration, freeze-drying, freezing, hot air drying, canning and irradiation have been studied in the past (Culleré et al., 2010), but each method has its limitations. Refrigeration is the most commonly used preservation technique (Sorrentino et al., 2018), but it is too short to cover the low season since fresh truffles could last at most 2 weeks in vacuum-packed packages (Savini et al., 2017); freeze-drying, freezing, hot air drying and canning are considered long-term preservation techniques. Heat treatment during hot air drying and canning seriously affects the aroma quality of truffles (Al-Ruqaie, 2006; Murcia et al., 2003).

The demand for truffles is closely linked to the restaurant, processing and tourism industries and is highly seasonal. It usually reaches its peak in the months of October-November, as it follows the harvest calendars. In addition, every year the fairs and events organized around this product multiply, which leads to talking about a real truffle tourism, which attracts thousands of visitors.

The offer of derived products has expanded significantly in recent years, as consumers can taste truffles in a more convenient format and at a less prohibitive price.

In order to proceed with marketing and sales, all those who produce and collect truffles must have a certification for the traceability of the product and each collector is required to declare a series of information for each truffle specimen, such as the species, the date and area in which it was collected, the number and total weight of all the products collected. Every truffle hunter must ensure that the products sold are always fresh, well-ripened, healthy and, above all, free from any foreign bodies and impurities that could compromise their freshness and harm consumers. Truffles must be sold with a special sign that indicates the name of the species and variety in both Latin and Italian, and the geographical indication that specifies the place of origin of the truffle. It is also necessary to indicate the net weight of the product specified in grams and any indications if the truffles have been freed from their peel. Both occasional and professional truffle hunters and collectors are required to follow the rules imposed by law, in order to avoid being sanctioned. Currently, in Calabria, truffles are collected spontaneously and marketed through unorganized channels with tacit contractual methods that oversee the regulation of transactions along the supply chain, without any real formality for marketing the product. The world of truffles in Calabria is difficult to identify and often the Calabrian product, once collected, is marketed outside the region.

However, some interesting realities emerge in the Calabrian territory proposing the truffle as a driving force for the relaunch of local gastronomy in a sustainable way.

The Pirro company: the company deals with the production of pasta in the province of Cosenza. Since 2018 it has enhanced the Calabrian truffle by linking it to traditional specialties through a series of truffle-based products (Tagliatelle, tagliolini, rice, sauce, oil, vinegar, etc.). These products are purchased by consumers (both with online sales methods, through large-scale retail trade and through small retailers) and restaurateurs who use it to enrich meat or fish dishes, thanks to the marked versatility of the truffle. The origin of the truffle used in their products is identified with the support of specialized mycologists and the company works in accordance with the regulations with certificates of origin. The Pirro brothers have invested in the protection of the Calabrian truffle heritage, which makes their company one of the leading companies in the sector.

The company “Sassone tartufi”, also in Cosenza: For over thirty years it has been committed to the protection and promotion of the Calabrian truffle. The company offers a multitude of products, which do not only concern the fresh product but also truffle-based products that can be purchased by the consumer or by the catering sector with the same sales methods listed above (online sales, through large-scale distribution and through small retailers). The product line ranges from sauces, to pasta and rice, vinegars, oils and mayonnaise, dairy products such as butter and cheese. The company boasts participation in various events

related to the Truffle, both nationally and internationally as well as dedicated conferences and festivals. The company's mission is to protect and promote the Calabrian truffle, a hidden treasure of Italian gastronomy that will give the opportunity to further expand its activities, involving more and more actors in the protection of the truffle and in the promotion of the rural areas of Calabria.

***Nutritional and benefits of Truffles***

Truffles possess some nutritional qualities that are attractive to health-conscious people. They are rich in antioxidants, cholesterol-free, and can impart an umami flavor to dishes without excessive amounts of added fat or salt. As consumers seek natural, unprocessed ingredients to enhance the flavor of their meals, truffles are increasingly viewed as a valuable and nutritious addition. Their composition includes multiple nutritional and medicinal benefits. They are rich in various types of essential nutritional products including carbohydrates, proteins, fats, minerals, lipids, and amino acids, also rich in phenols, terpenoids, polysaccharides, and phytosterols that are related to their anti-tumor, antioxidant, antibacterial, hepatoprotective, anti-inflammatory, and immunomodulatory properties (Lee et al., 2020; S. Wang & Marcone, 2011). Truffles also show great variation in both mineral content and quantity. Minerals including Si, K, Na, Ca, Mg, Mn, Fe, Al, P, S, Cu, and Zn have been found in truffles. The minerals potassium, phosphorus, iron, and calcium have been found to be particularly abundant in European truffles (Saltarelli et al., 2008).

-Antioxidant properties: Black truffles contain antioxidant compounds, such as polyphenols and flavonoids, which help protect cells from oxidative stress and premature aging.

-Anti-inflammatory potential: Some studies suggest that compounds in black truffles may have anti-inflammatory properties, which may be beneficial for people with chronic inflammatory conditions.

-Immune system stimulation: The presence of bioactive compounds in black truffles may help strengthen the immune system, improving the body's ability to fight off infections and diseases.

-Mood enhancement: It has been observed that consuming black truffles can stimulate the release of serotonin, a neurotransmitter related to emotional well-being and mood regulation. In fact, truffles contain small amounts of an amino acid called tryptophan, a precursor to serotonin. Serotonin is a well-known neurotransmitter in the brain that causes feelings of well-being and happiness. An example is when serotonin is released when you exercise, and afterwards, your mood is usually much more positive and happy. While truffles alone will not cure depression or anxiety, incorporating them into your diet can be a small but enjoyable step toward better mental health.

***Distribution channel and classification of activities***

Based on the distribution channel, the B2C distribution channel segment held a market share of 55.2% in 2022. In the B2C distribution channel of the market, truffles are sold directly to individual consumers. One of the B2C distribution

channels is farmers markets, which offer fresh truffles directly to consumers. In farmers markets, local truffle growers or truffle hunters participate and create a unique shopping experience where consumers interact with truffle hunters, learn about truffles, and subsequently make their purchases. The availability of truffles through online platforms, specialty grocery stores, and gourmet markets has increased consumers' access to truffles. This increased accessibility, along with increased awareness through food media, cooking shows, and social media, is expected to drive the growth of the market with the help of the B2C distribution channel. The B2B segment is expected to grow at a significant CAGR of 7.1% from 2023 to 2030. The growing demand among consumers for truffle products such as oils, salts, sauces, and snacks is driving the market growth in this segment. In addition, the growing demand for highly appreciated gourmet cuisines and healthy food options is another factor fueling the demand for truffles among B2B companies. As for the classifications of economic activities, reference is made to ATECO, which is the classification of economic activities adopted by Istat for statistical purposes, i.e. for the production and dissemination of official statistical data, and the NACE code, which is an acronym for "Statistical classification of economic activities in the European Community", is a broad categorization system used to standardize and harmonize the definitions of economic and industrial activities in the countries of the European Union. The collection of wild products: mushrooms, truffles, berries, nuts, balata and other gums similar to rubber, cork, shellac and resins, balsams, plant hairs, sea hairs, acorns, horse chestnut fruits, mosses and lichens fall into a specific economic category defined in ATECO and involve two categories:

- A Agriculture, forestry and fishing 02 Forestry and use of forest areas 02.3 Collection of wild non-wood products 02.30 Collection of wild non-wood products
- C manufacturing activities 10 food industries 10.3 processing and preservation of fruit and vegetables 10.39 Other processing and preservation of fruit and vegetables10.39.0 Processing and preservation of fruit and vegetables (except fruit and vegetable juices)10.39.00 Processing and preservation of fruit and vegetables (except fruit and vegetable juices).

NACE System Information:

- Section A Agriculture, Forestry and Fisheries, Division 02, Group 02.3, Class 02.30 Harvesting of wild non-timber products. (part of Division Group Class ISIC Rev. 4 0230)

## *3.4. SWOT analysis of truffle cultivation in Calabria*

The SWOT analysis aims to evaluate the strengths (S), weaknesses (W), opportunities (O) and threats (T) and can be used for the purposes of strategic planning of truffle cultivation in the territory (Miller et al., 2022). The strengths have been identified in relation to the tangible or intangible heritage. The weaknesses represent the difficulties of the local economic system. The opportunities have been identified in terms of sustainability, enhancement and

growth of the territory (induced). And finally the threats concern broader environmental influences that could include political, social or economic factors (Table 5).

All the operators interviewed reported the interest that revolves around the sector which is perceived as very attractive in light of the economic crisis and offers opportunities for promising commercial activities.

The participants interviewed during this study (gatherers, producers, traders, retailers, distributors, chefs, restaurateurs, agronomists and forestry technicians, researchers) indicated that truffles are a promising and growing business. Discussions with professionals indicated that there would be no problems in selling the products of the supply chain, as long as the truffles are of good quality.

However, the levels of knowledge and experience of potential producers and consumers are very low. Therefore, promotional strategies must be designed in order to increase awareness of the potential of truffle farming among producers and processors and stimulate the consumption and purchase of truffles and truffle-based products.

Interviews among the interviewed truffle gatherers highlighted the motivations that drive them in this activity, and in particular: pleasure, interest in the forest environment, new gastronomic experiments and additional earnings.

The interviewed truffle hunters are 18, all males with an average age of 45, and range from a minimum of 23 to a maximum of 68. About 60% of them are professional hunters. They are all licensed truffle hunters, use dogs trained to locate natural truffle grounds and are careful about the care of the land and the truffle ground. The remaining 40% of them do it as a hobby. 22% have a high school diploma, another 22% have a middle school diploma and a good 56% of the interviewees have a degree. 28% have been hunting for mushrooms and truffles for less than 10 years, 33% say they have been hunting for about 30-40 years while the remaining 39% have been hunting for about 10-29 years. The professionals, based on the quantities of mushrooms and truffles collected, sell to traders and partly to restaurateurs. For the others, since it is a hobby activity, they self-consume and/or give away the collected quantities.

Calabrian starred chefs make the products of the Region's gastronomy famous and are found at the top of international restaurants. The pleasure and search for fine food, gastronomic excellence, landscape and well-being moves the economies of the territories, pushes and promotes dialogue and the aggregation of skills, of mastery. Furthermore, retailers consider it very important to inform consumers about the possible ways of cooking truffles, also in order to buy them and prepare them at home by themselves.

As highlighted in the Table 5 the strengths are inherent to the diversified potential present in Calabria both in terms of forest and environmental heritage, and in relation to the presence of multifunctional companies able to make the best use of the resources of natural capital, human capital (especially youth) and social capital present. At the same time, the weaknesses relate to the lack of awareness of

the potential present, to infrastructural and social brakes and to the presence of organized crime that limits entrepreneurship and dynamism for fear of threats and intimidation. Among the weak points is the lack of brands and/or certifications that attest to the origin and recognizability of the Calabrian truffle, which has always been exported to other places. This aspect has also affected the use/processing of truffles into food products, slowing down the specialization of processing companies. Among the opportunities, we recall the importance of the induced effects and the economic consequences in terms of income and employment in many agricultural, agri-food, tourism sectors, etc. Reforestation plays important roles: for the conservation of forest biodiversity; for the provision of ecosystem services, such as carbon storage (reforestation enters the carbon cycle, contributing to the fixation of carbon dioxide, one of the greenhouse gases that contributes to the increase in temperature with serious damage to the environment).

**Table 5**. SWOT Analysis of Truffle Farming in Calabria

| **Strengths** | **Weaknesses** |
|---|---|
| 1. 1. The Calabrian forest/environmental heritage is potentially suitable in many areas for the production of truffles (presence of calcareous soils highly suited to truffle cultivation)<br>2. 2. Business multifunctionality, diversification of production and increase in income of agro-forestry and agri-food companies thanks to supplementary income from truffle cultivation<br>3. 3. Truffles are a unique gastronomic product and highly appreciated by consumers<br>4. 4. Great potential to promote knowledge of the different ways of cooking/preparing truffles at home.<br>5. 5. The cultivation of black truffles is sustainable.<br>6. 6. Truffles are an organic product and compatible with environmental conservation<br>7. 7. Enhancement of the relationship between man and truffle dog: the care and training of a good truffle dog is an essential investment for the relational potential of the activities carried out in the company of the dog.<br>8. 8. Potential for ecotourism, food and wine tourism (Di Gregorio et al., 2022) and experiential tourism (Marcilhac & Moriniaux, 2018; Star et al., 2020), forest bathing routes (N. Wang et al., 2024)<br>9. 9. Truffles can be used for reforestation of agricultural land and for the productive use of private woods<br>10. 10. Promote the social use and return to the community of woods confiscated from the ‘ndrangheta for artificial plants or for the maintenance/recovery of existing natural truffle grounds | 11. 1. Lack of awareness and knowledge in Calabria of the presence of truffle production<br>12. 2. Lack of infrastructure and services adequate to business needs<br>13. 3. Long period between planting and harvesting (6-10 years)<br>14. 4. Lack of awareness and knowledge of the potential of the territory<br>15. 5. Lack of valorization of environmental/productive capital, human capital and social capital<br>16. 6. Lack of a certification mark and low possibility of recognizing the origin of Calabrian truffles<br>17. 7. Lack of specialization of processing companies<br>18. 8. Presence of organized crime (risk of threats and intimidation) |
| **Opportunities** | **Threats** |

| | |
|---|---|
| 19. Opportunities | 27. 1. Use of chemical additives used as "truffle flavorings" that reduce the prestige of the truffle |
| 20. 1. Increase in employment and growth of related industries: consolidation of activities related to nursery, production, harvesting, processing, distribution and consumption of truffles) | 28. 2. Centralization of production in the hands of a few traders |
| 21. 2. New entrepreneurial activities for the development of cultivation | 29. 3. Economic crises generated by global events such as the current pandemic, wars, |
| 22. 3. Development of low environmental impact tourism and food and wine tourist itineraries with the inclusion of truffles (a valuable and excellent product) | 30. 4. Presence of improvised and incompetent collectors |
| 23. 4. Increase in woodland areas and related valuable productions | 31. 5. Absence of control bodies |
| 24. 5. Reforestation enters the carbon cycle contributing to the fixation of carbon dioxide | 32. 6. Fires that affect truffle production |
| 25. 6. Activation of synergies and Networks for operators in the supply chain | 33. 7. The increase in wild boar populations that threatens especially wild truffle populations |
| 26. 7. Possibility of using European Funds and Regional Funds | |

Source: Adapted from Nicolosi et al (2019) https://doi.org/10.14633/AHR160

As for the threats, first of all we must remember the use of chemical additives used as "truffle flavoring" that reduce the prestige of the truffle. No less important in Calabria as in all of Italy are those that derive from fires and the increase in the wild boar population. The presence of improvised collectors that risk compromising the production of natural truffles. From the marketing point of view, there is a centralization of production in the hands of a few traders and the absence of control bodies.

# Proceedings article: Consumer preferences for truffles and truffle-based products: trends and opportunities for Calabria”

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Adapted from: Abstract Book, Primo Convegno Nazionale “Il tartufo di Calabria”, curated by Vincenzo Bernardini e Innocenzo Muzzalupo ISBN 9788833853604 https://tartufodicalabria.crea.gov.it/programma.php

The recent trends of the post-2020 Common Agricultural Policy are increasingly oriented towards the protection of agroforestry ecosystems in recognition of their contribution and the wide range of ecosystem services provided in terms of human well-being, benefits for biodiversity and cultural and recreational services in the economy of the system. With reference to the PNR 2021-2027, in the context of nature-based solutions (NBS), particular importance is given to the multifunctional valorization of forestry production.

The main objective of the work is to analyze the habits and preferences of consumption of truffles and truffle-based products in order to highlight how the truffle supply chain can contribute to the promotion of growth strategies for Calabria.

The study looks at changes in food models and the importance that consumers attribute to the sustainability of products, highlighting the role that truffles can have in the maintenance of forests and mountain farms, in the production of food, beauty and physical and economic well-being of internal and wooded areas. The activities that revolve around truffles represent a useful tool for enhancing the economy of the territories involved (Oliach et al. 2021).

Consumer behavior was explored through a survey. The survey tool consists of a grid of choice questions, to collect binary or multiple choice answers (from three to 4 types of choice) and some on a Likert scale (from 1 to 5 points). The answers were collected online in the period of February/March 2022 and were processed using multivariate analysis techniques. Factor analysis (Factor Analysis) and Multiple Correspondence Analysis (MCA) (2018) were applied. The first to identify the latent factors that simplify, summarize and explain the observed scores to interpret the solution obtained, the second in order to identify and better interpret the motivational profiles of consumers of truffles and truffle-based products. The following main consumption characteristics were considered: at home or away from home; purchase in shops or through the short supply chain (markets, fairs, miners); any reasons for non-consumption or occasional consumption (high prices, poor availability, etc.); the motivations for enjoying truffles (aroma, taste, sustainability, green role of truffles, etc.). The analyses allow us to highlight the distinctive attributes that most influence

consumers' decision-making processes for the consumption of truffles and truffle-based products and for their eventual purchase.

The results reveal four main consumer figures, as highlighted in figure 1.

In the positive semi-axis for dimension 1 we find truffle consumers divided into the following two typologies: "Passionate" consumers, i.e. those with a high and medium-high income and willing to spend more than 100 euros/100 grams to purchase truffles; buy directly from the diggers and consume truffles mainly at home or at friends' houses and "occasional" consumers, that is, all those who appreciate truffles a lot, consume them mainly in restaurants and at events and are those who buy truffles at fairs or directly from the diggers. In the negative semi-axis for dimension 1, on the other hand, we find "Potential" consumers, that is, all those who have never tasted them but are curious and available to purchase, declare a poor availability of fresh and processed products and are concerned about the high price. The last group of consumers called "Not interested" are subjects who do not like truffles, are not interested in purchasing them, because they do not like the product.

The study shows that, for the potential marketing strategies that can be implemented for the promotion of fresh and processed truffles, we should aim to: expand the assortment and range, thus increasing the availability and processed products at more accessible prices; increase the loyalty of the occasional consumer and attract potential consumers; identify the truffle with a brand by providing narrative labels. Strengthening resilience, halting biodiversity loss and building a healthy and sustainable food system, already highlighted for some time, have become essential priorities following the crisis triggered by COVID-19 which has shown all the fragility.

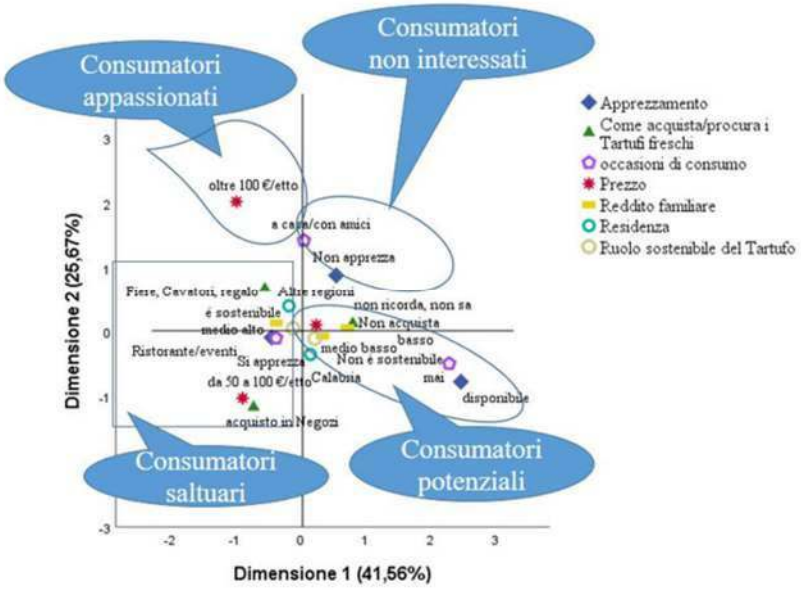


**Figure 1.** MCA Chart and Consumer Profiles (Figure directly taken from the original work)

Another tool for the valorization of fresh and processed truffles is territorial marketing for food and wine tourism activities as a driving force for other diversification and multifunctionality activities (forest bathing, agritourism, etc.); promoting the social use and the return to the community of lands and woods confiscated from the '*ndrangheta*. In the first case to encourage the creation of artificial truffle grounds in suitable areas and in the second case for the maintenance, recovery and improvement of existing natural truffle grounds.

Since interest in these prized mushrooms has increased in recent years, in the areas where these special forest products are present, the Truffle in Calabria can represent an interesting economic resource both with reference to spontaneous truffles and those coming from the recent introduction of artificial truffle grounds (Nicolosi et al. 2019). These activities allow multiple advantages such as: i) the possibility of income for different figures who in various capacities enter the long supply chain; ii) the recovery and valorization of marginal territories; iii) the introduction of new employment and new income opportunities; iv) the promotion of potential linked to gastronomic tourism revolving around the production of truffles and truffle-based gastronomy (fresh and/or processed) (Büntgen et al. 2017).

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# Contribution on Volume: Truffles in Calabria: precious resource between protection and valorization

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Adapted from Volume “Il tartufo nero di Calabria, l’inizio di un nuovo racconto” curated by Francesco Maria Spanò and Claudio Mattia Serafin edited by Gangemi Editore spa ISBN 978-88-492-5018-3

Once considered exclusively for the production of wood resources, today the enormous role that forest areas play for humanity as a whole is finally beginning to be clear with the production of goods and services with multiple supply, the so-called ecosystem services [1]; [2]. These are services generically classified into four large defined categories: support, supply, regulation and cultural. This is because woods and forests are essential for the nutrient cycle, for food supply, for climate regulation aspects and last but not least for their contribution in cultural, educational and social terms. In Calabria, given the marked woodland nature of the region, which derives from almost 700 thousand hectares of woodland and a forest area exceeding 40% of the regional area, the three national parks (Aspromonte, Pollino and Sila) offer a great contribution in terms of ecosystem services. Most of the woodland areas of the region base their culture on agricultural or forestry lifestyles, landscapes and places rich in history and traditions. Today, however, these valuable forest and woodland areas are often found in contexts where human settlements tend to be emptied and many of the existing structures, once at the service of agricultural or forestry activities, a memory of the use of the territory and of the past economic, social and cultural vitality, lie in conditions of abandonment and degradation. It is difficult to imagine a reversal of these trends, which are very common for most of the Italian forest areas. What can be hypothesized, for the purposes of recovery and maintenance of areas and places so precious for humanity as a whole, is the development of profitable agro-forestry activities, with the consequent possibility of livening up these areas and allowing the recovery of buildings and constructions present in the territories. Naturally, this requires a multidisciplinary effort that is at the same time economic, architectural, social, cultural and also geographical-environmental, aimed at investigating the interconnections between these aspects also in relation to the changes produced by modernity [3] [4].

Among the profitable agro-forestry activities, the truffle occupies a prominent place. The truffle supply chain represents an interesting economic resource both with reference to wild truffles, since in the areas where these special forest

products are present in recent years the interest in these prized mushrooms has increased, and with reference to artificial truffle grounds, because they offer income opportunities to different figures who in various capacities enter the long supply chain, allow for the recovery and valorisation of marginal territories, for the introduction of new employment and new income opportunities, for the promotion of potentialities linked to gastronomic tourism [5] which revolves around the production of truffles and truffle-based gastronomy (fresh and/or processed). Furthermore, recent studies reveal that in the Mediterranean regions, although cultural practices could lead to genetic mixing, no difference in genetic diversity has been detected between wild and cultivated populations [6]. In Calabria the presence, sometimes abundant and spontaneous, of various types of truffle is confirmed. This is because two ideal conditions exist: the presence of water and the nature of the soil. Water, which is one of the limiting factors for the growth of truffles, is present in adequate quantities, indeed, for certain types of truffles it is even optimal. In the Aspromonte territory, both on the Tyrrhenian and Ionian sides, especially in the so-called "Area Grecanica", the calcareous soils that reach from the sea up to 700-800 m above sea level, reveal a marked aptitude for the cultivation of Tuber Melanosporum. This suitability has been confirmed by geological research, in situ surveys and laboratory analysis of the soils: these are soils whose parent rock originates in the Jurassic period, highly calcareous and rich in iron. The presence of truffles in the wild has pushed a group of agronomists, professors and university researchers and entrepreneurs to identify and introduce truffle-producing plants in areas very close to those where truffles are already present, an experience already known in several Italian regions that boast a widespread diffusion of truffle cultivation [7].

The “Tartuforest” Project, funded by the Calabria Region under measure 16.1.1 of the PSR-Calabria, falls within this scope with the aim of bringing the importance of a long-neglected high-quality green product to the attention of all operators, in various capacities interested in truffle production in Calabria.

To achieve the objectives of the project, a transparent and responsible process was used to plan and implement the activities envisaged by the project. The privileged research area is the province of Reggio Calabria, in particular the area of Locride and the Aspromontano massif.

The activities undertaken and the first results achieved are encouraging despite the difficulties raised by the COVID-19 health emergency and the crisis triggered by the war in Ukraine. Technical-economic innovations have been introduced in the pilot companies, which represent leading companies for the territory and capable of triggering emulation processes and economic benefits for operators. On the other hand, the priorities and importance of innovative paths, already highlighted for some time in Calabria, have become urgent priorities following the crises triggered by the aforementioned events that have highlighted the fragilities of the Italian and Calabrian agri-food system in particular. At the same time, these events have highlighted the role of rural areas for the well-being of

the entire society and their specific contribution in tackling the climate crisis, the green transition and the digital transition [8] [9].

The first meetings between researchers and forestry technicians of the territory took place in the spring of 2019. To develop the project idea, we proceed through visits to natural truffle grounds, to the identification of agro-forestry companies interested in experimenting with mycorrhized essences and agri-food companies interested in processing and transforming truffles into food products based on Calabrian truffles. Visits and inspections follow one another. One of the companies participating in the research project decides to undertake the investment for an artificial truffle ground, it was also the first experience in Calabria. In the meantime, the research group carries out the first interviews and summarizes in a SWOT analysis (reported below) the strengths, weaknesses, opportunities and threats of the truffle sector in Calabria [10] [11].

| **Strengths**<br>**Forest heritage, subjects and companies involved** | **Weaknesses. Points of Weakness**<br>**Difficulties of the local economic system** |
|---|---|
| 1. Historical, cultural, archaeological and architectural heritage of Aspromonte and pre-Aspromonte areas<br>2. Forest/environmental heritage and potential production for truffles (presence of calcareous soils highly suited to truffle cultivation)<br>3. Business multifunctionality, diversification of production and increase in income of agro-forestry and agri-food businesses thanks to additional income from truffle cultivation<br>4. Calabrian food and wine heritage and importance of the truffle, recognized as a unique gastronomic product and highly appreciated by consumers<br>5. Reforestation of agricultural land and productive use of private forests<br>6. Social use and return to the community of forests confiscated from the ‘ndrangheta for artificial installations or for the maintenance/recovery/improvement of existing natural truffle grounds | 1. Lack of infrastructure and services adequate to business needs<br>2. Low awareness and knowledge in Calabria of the presence of truffle production<br>3. Low awareness of the potential of environmental and productive capital of the territory<br>4. Long period between planting and harvesting (8-10 years)<br>5. Absence of a certification mark and low possibility of recognizing the origin of the truffle<br>6. Presence of organized crime (risk of threats and intimidation) |
| **Opportunities. Opportunities**<br>**Enhancement and growth of the territory (induced)** | **Threats**<br>**External environment threats** |
| 1. Increase in employment and growth of related industries (consolidation of activities related to nursery, production, harvesting, distribution and consumption of truffles)<br>2. New entrepreneurial activities for the development of cultivation<br>3. Development of low environmental impact tourism and food and wine tourist itineraries with the inclusion of truffles (a product of value and excellence)<br>4. Increase in woodland areas and related quality productions | 1. Increase in wild boar populations<br>2. Centralization of production in the hands of a few traders<br>3. Fires that affect wild truffle production<br>4. Spread of improvised and incompetent collectors<br>5. Absence of control bodies |

| | |
|---|---|
| 5. | Possibility of using European Funds and Regional Funds and contribution that truffle cultivation can provide to the entire economic-territorial system |

Source: Reworking from: Nicolosi A., Cannavò S., Guida A., Laganà V., Di Gregorio D., Quality Productions, Protection and Recovery of the Internal Areas of Aspromonte: the Role of Truffle, in ArcHistoR (Extra n. 6/2019): The Mediterranean towards 2030. Studies and research on historical heritage and anthropic landscapes, between conservation and regeneration [10]

Interviews with opinion leaders, operators, collectors, processors and restaurateurs, consumers, highlight some elements that represent the potential of the truffle product, in the hypothesis of the development of a truffle supply chain in Calabria, but also the difficulties or weaknesses of the system. Furthermore, the analysis highlights the opportunities that such a supply chain could bring and the threats.

The truffle is a product with a strong evocative impact and is well linked to the idea of mountains, parks, territories, communities, cultures, all aspects that can still be strongly valorized in the Aspromonte areas. This is one of the reasons why it is believed that it can represent a strong attractive potential. However, in order for a concrete production chain to be established, it is important that there is adequate awareness of agricultural entrepreneurs in technical and operational terms and it is crucial that agricultural entrepreneurs are supported by experts and mycologists in the choice and in the good technical agronomic practices to be followed for the success of the plants [12].

The establishment of a supply chain linked to truffles could bring advantages not only directly linked to the collection and consumption of the product, but also indirect ones, with possible positive effects for the territories involved, as has been ascertained for other typical products of the internal areas of the province of Reggio Calabria [13] [14] [15].

Protecting existing natural truffle grounds and identifying areas suited to the introduction of artificial truffle grounds can represent for the Calabria Region a tool for the recovery and enhancement of marginal areas, for the promotion of new activities and for the development of eco-sustainable gastronomic tourism linked to the production and consumption of truffles, as well as to artisanal gastronomic production activities based on truffles. To the induced effects offered by the forest through the production of ecosystem services, we can add the social use of the forests confiscated from organized crime in order to promote virtuous processes of economic and social legality, also to support Calabria in a path of sustainable development, solidarity economy, responsible tourism and ethical agri-food production [16] [17].

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# CHAPTER 4 - CONCLUSIONS

## *-Discussions*

This study investigates the importance and potential of truffle cultivation in Calabria.

Compared to other Italian and European regions with old and new traditions in the production and valorization of truffles and truffle-based products, Calabria is behind, despite the proven and documented existence of almost all valuable truffles (‘Il tartufo nero di Calabria’, n.d.).

New trends in Europe and in Italy see strategic alliances between mycologists, foresters, gastronomes, farmers and politicians, to aim at creating a significant induced effect around truffles. These strategies are useful to implement truffle production adapted to dynamic models that take into account ongoing climate change (Čejka et al., 2022), sustainable green technologies (mycorrhizal host plants, inoculation techniques, growth rates, etc.) and experimental management techniques (Büntgen et al., 2017; Čejka et al., 2022). These strategies represent alternative and competitive innovation tools for the territory aimed at producing "terroir" truffle and truffle based products that can promote the valorization of internal areas, supporting growth strategies and opportunities for new sources of income for farmers and operators in the truffle supply chain and to stimulate the creation of networks of actors interested in knowledge and innovation of the supply chain itself.

The research has developed several analyses starting from the demand and the requests and preferences of consumers and has explored the segments that can characterize the management of the truffle supply chain and the relationships between them. The knowledge of these aspects represents an interesting perspective to highlight strengths and weaknesses. The holistic and multidisciplinary approach applied in this study has made it possible to integrate local knowledge and skills, thus providing valuable insights both in the theoretical and marketing fields.

The research hypotheses H1, H2 and H3 are addressed in the first chapter. The results of the research carried out suggest that knowing the attitude and intention to consume truffles and truffle-based products is important for the consequences in the territorial system. The application of multivariate analysis has allowed us to identify the decision-making process through which consumers organize and formulate their choices of consumption of fresh and processed truffles. The results of this study suggested that the intentions to consume fresh and processed truffles derive from a complex decision-making process that involves different factors, such as consumers' personal experiences, marketing communication, food safety, organoleptic aspects, the search for products with a green reputation and, more generally, the pursuit of environmental protection. Trying to clarify how these aspects can influence consumption choices is also of great importance for the adoptions that must be made by stakeholders.

Hypotheses H4 and H5 are addressed to study the production component closely linked to the territory in terms of truffle potential. The mapping carried out in the research responds to this important potential connected to the possible increase in production and to the capacity of the stakeholder system to create critical mass by increasing product and income for operators in the sector.

Another theme is linked to the implementation of the offer of "ecosystem services": they are increasingly recognized as harbingers of very important environmental and social impacts on hilly and mountainous areas. There is no shortage of examples at a national level: in all the areas where such productions have spread and been promoted, the socio-economic impacts are recognized as very positive. For this reason, the cartographic approaches have made it possible to identify the potentially truffle-producing areas present in the province of Reggio Calabria, then examining the potential of the truffle to promote enhancement paths of the truffle supply chain of the Aspromonte territory. The application of Geographic Information Systems has allowed us to obtain fundamental information to map the areas suited to truffles in relation to the possibilities of real use of agro-forestry systems. This information is very important for the creation of a development area, as it is directly linked to the soil and climate needs of truffles.

As highlighted in the studies of Oliach et al (Oliach et al., 2020) and Pinuela et al (Piñuela et al., 2024) ,habitat is more important than climate in structuring soil fungal communities associated with truffles. In Mediterranean and temperate regions, soil fungal communities present in wild truffle farms and in artificial facilities (where *T. melanosporum* and *T. aestivum* coexist) were compared, and it was found that soil fungal community composition and ectomycorrhizal species composition are driven by habitat type rather than by climatic regions. (the influence of soil pH, organic matter content, C:N ratio). According to Cejka et al (2022) (Čejka et al., 2022) based on climate model simulations, lands suitable for truffle growth will aridify 50% faster than the rest of the global land surface, with significantly higher heat waves between 2070 and 2099 AD. Overall, truffle production rates will decrease by 15%, while associated price levels will increase by 36%. According to the authors, truffle farms will need to adapt their irrigation systems and management strategies to future climate change.

In this scenario, the stakeholder system is a valid springboard for the development of the sector and can be a useful tool for organizing the valorization of truffles (for example through fairs, events, etc.), framing it in a coordinated model of promotion and valorization of the product. From the considerations on the results detected by the focus group, it is desirable to protect the production sector, through the creation and strengthening of entire truffle supply chains. Such initiatives can be able to connect the different actors, creating new opportunities for the internal areas. The interviews with opinion leaders, operators, collectors, processors and restaurateurs, consumers, have highlighted useful elements and suggestions that can promote the potential of the truffle product, in the hypothesis of developing a truffle supply chain in Calabria; however, the difficulties or

weaknesses of the system have also emerged. The SWOT analysis highlighted how the strengths are inherent in the diversified potential present in Calabria, both in terms of forestry and environmental heritage, but also for the presence of multifunctional companies capable of making the best use of the resources of natural human and social capital. At the same time, the weaknesses are linked to the lack of awareness of the potential present, the lack of brands and/or certifications that can attest to the origin and recognizability of the Calabrian truffle, which has always been exported outside the Calabria region. This aspect has also influenced the use/processing of truffles into food products, slowing down the specialization of processing companies. Among the opportunities, we recall the importance of the induced effects and economic repercussions in terms of income and employment in many agricultural, agri-food, tourism sectors, etc.

In the areas suited to proper forest management plays an important role in the conservation of biodiversity and the provision of ecosystem services. As for threats, we must first mention the use of chemical additives used as "truffle aroma" which reduces the prestige of the truffle.

As for the transferability of results, the research hypothesis H5, looks at recent orientations that use multi-actor approaches, under the aegis of the PEI-Agri, which represents a strong characterization element of the programming for European research and innovation (Horizon 2020; Horizon Europe; Measure 16 of the Rural Development Programmes). This approach aims to make the research results more useful and used by potential end-users, reorienting it towards the resolution of concrete problems or opportunities of agricultural, forestry or other entrepreneurs.

At the heart of the PEI-AGRI approach is the "interactive innovation model", defined as: "collaboration between various actors to make the best use of complementary types of knowledge (scientific, practical, organizational, etc.) in view of the co-creation and dissemination of solutions/opportunities ready to be implemented in practice". As reported by Fieldsend et al. 2021 (Fieldsend et al., 2021), innovation cannot be observed in isolated cases and innovators are not the only agents of change. Innovation is a complex process (Lundvall, 2016) where solutions are created through complementary and transversal knowledge with an “interactive model” that connects farmers, researchers, intermediate actors (input suppliers, experts, processors, distributors) and consumers. This approach, also known as Multi-Actor Approach (MAA), describes how actors, working together in project activities from conceptualization to post-execution, become key elements for a transdisciplinary approach that can have the potential to address future challenges in forestry and agri-food systems.

Therefore, modeling and implementing an innovative supply chain can represent a growth opportunity for agroforestry and agri-food companies that promote the production of the Calabrian Truffle. Open Innovation can highlight the driving factors of innovation (productivity, growth, visibility, networks, etc. of the companies involved) (Roper et al., 2008) and represents the starting point of the strategic implementation process of the studied methods, the applied

technique, the services, the new products and the new and improved knowledge capable of creating value for the user and for the territory (Dogan, 2017).

This new approach to innovation should have a faster impact in which the subjects are called to apply the "multi-actor approach". However, with reference to truffles in Calabria it is struggling to advance and for several broad and complex reasons (the crisis triggered by COVID-19, the wars in Ukraine and the Middle East, galloping inflation, etc.) that have slowed down the social and political-economic system, highlighting all the fragilities in place in the Calabrian agri-food system. These weaknesses are particularly evident in the Grecanic and Aspromonte area of the province of Reggio Calabria, where this study focuses. Furthermore, natural truffle grounds have been, in many cases, damaged by forest fires, deforestation, the increase in the population of wild boars fond of truffles, the lack of water and a climate with particularly hot and dry summer seasons. As for artificial truffle grounds in Calabria, they have not yet started the production processes and companies show clear signs of environmental, social and economic suffering. A positive signal comes from CREA (Council for Agricultural Research and Analysis of the Agricultural Economy) which in 2024 set up an experimental truffle farm to implement an interesting transfer of know-how in the use of mycorrhized plants with native truffles, following up on important initiatives to promote and enhance local truffle cultivation, proposing interesting coordination signals for an effective improvement of the truffle value chain. Therefore, modeling and implementing an innovative supply chain can represent a growth opportunity for agroforestry and agri-food companies that promote the production of the Calabrian Truffle.

H6 and H7 aspects related to gastronomy and consequently to the involvement of operators downstream of truffle cultivation.

In fact, in Calabria, truffle cultivation can represent an important tool for the development of the territory, as it can contribute to the economic improvement of companies and farmers, who in turn are the driving force for the entire social community. It is desirable to create a supply chain of excellence for the Calabrian Truffle, which combines science, sustainability and business, accompanying the development and tourist enhancement of the numerous regional territories dedicated to it, constituting a precious economic driver for the entire region.

The particular characteristics of the truffle, such as the intense and characteristic aroma, the fine and delicate flavor, are well suited to the flavoring of various agri-food products; therefore, it is possible to combine tradition and innovation with perspectives that could develop new products, starting from traditional local productions (such as olive oil, pasta, rice, creams, cheeses and cured meats with truffles, etc.). Furthermore, there are many actors interested in promoting the truffle product: farmers, agri-food processing companies (both family-run and agro-industrial), restaurateurs and other operators in the Calabrian truffle supply chain. Thanks to the specific levels of remuneration of the product, the truffle can generate additional income and new employment for local

communities, especially in inland areas, thus also generating benefits, both direct and indirect.

### *-Limitations and implications for future studies*

This study has some limitations, regarding some characteristics that determine consumers' expectations towards fresh and processed truffles and may have been overlooked. In addition, there are also many infrastructural and social constraints as the presence of improvised collectors that often compromise the production of natural truffles and presence of few traders without any control institution. Therefore, the results obtained from this study should be considered mainly exploratory and would therefore benefit from further tests based on the use of larger and more representative consumer samples and more in-depth studies on processing and marketing firms, to investigate in more depth the tacit or formal contractual modalities that govern the regulation of transactions between the parties. Further market research on consumers is needed in the future. Their attitudes, willingness to pay for purchase/consumption and information on the preferred attributes and characteristics of fresh and processed truffles should be further explored. Furthermore, although this study involved many value chain stakeholders in the interviews, further studies are needed in the future to capture any progress that is made and to effectively inform all operators.

### *-Concluding remarks*

The PLS-SEM methodology applied in the consumer study examines the variables that influence the propensity to purchase of Italian consumers and provides food for thought for companies that want to approach the production of truffles and truffle-based products, indicating which levers to act on. In fact, consumers declare that they appreciate the taste, aroma and all the organoleptic characteristics of truffles and that they orient themselves towards the point of sale based on the type of product they intend to purchase. The aspect relating to safety and sustainability is also confirmed as consumers state that they can consider truffles a green product. These results are in line with the studies of Parashar et al. (2023)(Parashar et al., 2023), which highlighted how much interest in sustainable foods and healthy lifestyles has increased. Furthermore, aspects related to multiculturalism, openness and curiosity towards new products and foods are also appreciated factors, as is the recent trend of relying on social media for knowledge and purchases. Truffle collectors carry out this activity for pleasure, interest in the forest environment, new gastronomic experiments and additional earnings. They use dogs trained to locate natural truffle grounds and are careful about the care of the land and the truffle ground. All interviewed operators reported the interest that revolves around the sector which is perceived as very attractive in light of the economic crisis and offers opportunities for promising commercial activities.

However, the levels of knowledge and experience of consumers are still insufficient. Therefore promotional strategies must be designed in order to

increase awareness of the products and stimulate the consumption and purchase of truffles and truffle-based products.

In the areas investigated in the province of Reggio Calabria, there are all the climatic and pedological conditions to start the creation of afforestation to be dedicated to truffle cultivation (soils suitable for planting mycorrhized plants, presence of surface water and groundwater that optimizes and stabilizes production, in almost all potential sites. Finally, the possibility of incentivizing agro-forestry entrepreneurs through financing for afforestation interventions through the forestry measures of the PSR Calabria and/or for specific measures for truffle cultivation is important, raising awareness among entrepreneurs about the transfer of innovations with the support of experts and mycologists in the choice and good technical-agronomic practices to be followed for the success of the plants (Brun, 2016).

The gastronomic products of the Calabria Region are known and appreciated if to this is added the pleasure and search for fine food, gastronomic excellence, landscape and well-being, a push emerges that is able to boost the economies of the territories, pushes and promotes dialogue and the aggregation of skills (Nicolosi et al., 2019). Furthermore, retailers consider it very important to inform consumers about the possible ways of cooking truffles, also in order to buy them and prepare them at home by themselves.

All participants who were interviewed during this study (collectors, producers, retailers, distributors, chefs, restaurateurs and consumers) indicated that truffles are a promising and continuously growing business.

The results achieved with this study can also help policy makers in creating investment objectives towards the promotion of plants, towards research and towards the different downstream stages of production (marketing and processing) to incentivize and promote the truffle value chain in Calabria.

# APPENDIX

## Norms on truffle and truffle products

To date, there is no international legislation regulating the marketing of truffles and truffle products, although the UNECE has published a non-mandatory standard for the marketing and control of the commercial quality of truffles (Unece Standard FFV-53, United Nations, 2017). This recommendation classifies truffles only from a morphological and weight point of view, and associates the scientific name of the different truffle species with their common names. The major truffle producing countries have specific regulations (Tejedor-Calvo et al 2023) ( Table A1 ).

**Table A1** . General and specific legal provisions relating to truffle products. Own adaptation from (Tejedor-Calvo et al 2023).

| Country | Norm | Specification |
|---|---|---|
| Spain | Royal Decree nº 30/2009 establishing the sanitary conditions for the marketing of mushrooms for food use. | Regulates the sanitary quality of truffles intended for human consumption. Includes the list of allowed species that can be marketed fresh and canned: *T. aestivum*, *T. borchii*, *T. brumale*, *T. indicum*, *T. magnatum*, *T. melanosporum*. |
| France | Decree nº 2012-129 on the marketing of truffles and foodstuffs containing them. | Only allows the word 'Truffle' in products with minimum 3% of *T. melanosporum, T. brumale or T. magnatum.*<br>Include genus and species in products with more than 1% of other species<br>'Truffle juice' and 'Aromatized truffle juice' in products with minimum 3% of *T. melanosporum* and *T. brumale.*<br>Includes a list of common names: T. melanosporum (Black truffle, Perigord truffle, Perigord black truffle), T. *brumale* (Brumale truffle), and *T. magnatum* (Alba white truffle, Piedmont white truffle). |
| Italy | Law 752/85 Framework legislation on the collection, cultivation and trade of fresh or preserved | Indicates which types of companies can manufacture truffled products and includes a list of species allowed to be processed (with corresponding common name): *T. magnatum* (white truffle), *T. melanosporum* (black truffle), *T. brumale* var. moschatum (muscat |

| | | |
|---|---|---|
| | truffles for consumption. | truffle), *T. brumale* (black winter truffle or black trifola), *T. aestivum* (summer truffle), *T. aestivum* var. uncinatum (truffle uncinate), *T. borchii* (bianchetto or maruolo), *Tuber macrosporum* (smooth black truffle), *Tuber mesentericum* (ordinary black truffle). |
| United Nations | Unece Standard FFV-53 concerning the marketing and commercial quality control of Truffles 2017 Edition. | *T. melanosporum* (Black Truffle, Périgord Truffle, French Truffle, Périgord Black Truffle), *T. brumale* (Winter Truffle), *T. brumale var. moschatum* (Musky Truffle), T. indicum, (Asian Black Truffle), T. aestivum (Summer Truffle), *T. mesentericum* (Bagnoli Truffle), *T. aestivum var. uncinatum* (Burgundy Truffle), *T. magnatum* (White Piedmont Truffle), *T. borchii* (Whitish Truffle, Bianchetto Truffle), *T. macrosporum* (Smooth Black Truffle), and *Tuber gibbosum* (Oregon White Truffle). |

France has the strictest legislation, being the only country that regulates the terms 'Truffle', 'Truffle juice' and 'Flavored truffle juice' in reference to food products and associates scientific names with common names. Italian legislation indicates which types of companies can produce truffle products and includes a list of the species authorized for processing, with their common names. Finally, Spain has general legislation on mushrooms that only includes a list of permitted truffle species. The lack of clear regulation and consensus on the production and labeling of truffle products means that nowadays the denomination 'truffle'/'tartufo' and images of highly prized truffle species can be found on any label despite the truffle species used in the truffle products. product or the presence of flavoring substances. This "regulatory gap" creates confusion among consumers, devalues this highly prized product and has a strong negative impact on truffle producers.

## National norms

As previously mentioned, the main regulatory reference is Law 752/85, on collection, cultivation and trade. The current state legislation identifies the species of truffles intended for fresh consumption and marketing, imposing a ban on any species other than those indicated in the regulatory text and listed here:

a) *Tuber melanosporum Vitt.;*

b) *Tuber magnatum Pico*

c) *Tuber brumale var. moschatum De Ferry*;

d) *Tuber aestivum Vitt.;*

e) *Tuber uncinatum Chatin;*

f) *Tuber brumale Vitt.;*

g) *Tuber Borchii Vitt. o Tuber albidum Pico;*

h) *Tuber macrosporum Vitt.;*

i) *Tuber mesentericum Vitt.*

The most relevant points of the Law can be summarized as follows:

a. identification of truffles intended for fresh consumption (art. 2): the nine species of truffles legally recognized for fresh consumption are indicated and there is a reference to Annex 1 of the Law, in which the relative botanical and organoleptic characteristics are specified;
b. right to research and collection (art. 3, first paragraph): the areas in which these activities are not subject to constraints of any kind are identified: in woods and uncultivated land;
c. exam and card (art. 5, from paragraph 1 to paragraph 6 inclusive): the minimum requirements for the validity of the collection authorization card are indicated - personal details and photograph - and the obligation to pass an exam to verify the knowledge of the candidate collector is prescribed; instructions are also given so that the Regional Administrations can decide on the responsibilities relating to the issuing of the card and the carrying out of the exam;
d. methods of searching and collecting (art. 5, paragraph 7): instructions are given on which tools are permitted – the spade – and on the presence of a dog trained to search for truffles;
e. calendar and times (art. 6): there are indications of the periods and any times in which free searching and collecting of truffles are permitted, with the specification that the Regions are responsible for further establishing the terms, in relation to their own territorial reality;
f. general prohibitions (art. 5, last paragraph and art. 6, last paragraph): the Framework Law imposes a set of prohibitions such as: the continuous working of the land during the truffle

collection period, the collection of immature truffles; the failure to fill the holes opened for collection; the search for and collection of truffles during the night hours from one hour after sunset to one hour before dawn, except for different regional provisions in relation to local customs; the marketing of any type of fresh truffle during periods when its collection is not permitted, etc.

The Law (art. 4) allows the establishment of voluntary consortia of agricultural and forestry companies for the protection of truffles, and gives them the possibility of harvesting, marketing, creating new truffle grounds and access to contributions. As regards the sale of fresh truffles (art. 7), the law imposes requirements on the conditions of fresh products so that they can be put on sale: definitions of "whole" truffles, "pieces" and "shredded" truffles; it is also prescribed that the information relating to the species and provenance of the truffle be written on the printed card that must accompany the fresh truffles on sale. As regards protection and enhancement (art. 6, first paragraph), the law promotes regional activities for the protection and enhancement of the public truffle heritage. As regards the criteria for processing truffles and their marketing, the law (articles 8, 9) establishes rules for the preparation of processed products and indications on which subjects are authorized to carry out this activity, as well as for the packaging and marketing of processed truffles for which minimum indications are established with an indication on the label of the processed products put on sale.

The Regions are authorized to grant a regional tax, just as they are obliged to delimit the geographical areas of origin of truffles within their territory and to establish sanctions and supervision (art. 18). Cultivated and controlled truffle grounds deserve a different discussion (art. 3, paragraph 2 and following), dealt with by the Law in relation to:

- definition;
- property rights on the truffles produced therein;
- delimiting tables and their specifications;

In this regard, recent legislation, although still in a completely fragmentary way, has attempted to regulate and provide protection also for these products and - in an embryonic way - for the related supply chains. See for example Legislative Decree 34/2018 known as the Consolidated Law on Forests and Forest Supply Chains, the purpose of which is to guarantee sustainable management of the forest that also passes through the development of supply chains of spontaneous non-wood products that can provide an income. Among the many prestigious supply chains, that of the truffle seems to assume a primary role (Marone 2011)

## Regional norms in Calabria

The collection and marketing of epigeal and hypogeal mushrooms in Calabria is regulated by Regional Law 26 November 2001, n. 30 and subsequent amendments "Regulations for the collection and marketing of fresh and preserved epigeal and hypogeal mushrooms". The collection of spontaneous epigeal and hypogeal mushrooms is subject to possession of the regional nominative card and/or the required permits

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# Factors Driving Consumption Preferences for Fresh Mango and Mango-Based Products in Italy and Brazil

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**Abstract:** In many European countries the consumption of tropical fruit is constantly growing, and people are increasingly turning to diets rich in fruit and vegetables. In this context, mango is considered a super-food for its nutritional medium-high energy value. Produced mainly in developing countries, tropical fruits animate an interesting international market. Production in Mediterranean countries is also growing and is increasingly requested in European markets. The aim of this work is to investigate the factors that drive the inclination to purchase fresh mango and mango food and drinks in Italy and Brazil in order to observe consumer preferences in the two countries. The personal experiences, motivations and choices of consumers regarding fresh mango and mango-based products were taken into consideration. Through an online survey, a semi-structured questionnaire was administered in Italy and Brazil which led to a total sample of 453 participants. The data were statistically analyzed, and a PLS-SEM model was used to empirically examine the factors influencing the consumption of fresh mango and mango food and drinks. The research hypotheses are all supported. For a comparison between the two countries, a multigroup analysis (PLS-MGA) was performed. In Italy, consumers are attentive to the quality and safety of the fruit; they choose the point of sale where they buy fresh mango or mango foods because they trust the seller to guarantee the fruit's origin and transformation. In Brazil, new consumer trends are emerging especially in gastronomy; since they are local foods, they are considered safe, sustainable and healthy by consumers. The study addresses a little-explored topic and aims to enrich the debate on consumer orientations, preferences and reasons for buying mango and mango products.

**Keywords:** mango; tropical fruit; consumers; PLS-SEM; PLS-MGA; semi-structured questionnaire; mango quality; mango post-harvest; Italy; Brazil



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## 1. Introduction

Mango is a tropical fruit prized for its fresh and sweet flavor [1] and is one of the most consumed fruits in the world. In many nations it is an integral part of culture and history. Mango was first cultivated in India more than 5000 years ago. It is a fruit that belongs to the Anacardiaceae family, scientific name *Mangifera indica*. Strictly speaking, tropical fruits are defined as fruits produced in warm and humid regions, situated between the Tropic of Cancer and the Tropic of Capricorn, with an average temperature of around 27 °C [2,3]. The utilization of exotic fruit is rapidly growing in many European countries. This growing demand can be explained by the attractiveness of exotic fruit, global communication, international travel experience, interest in fruit consumption in general and, consequently, increased health awareness among consumers, as well as by the demographic increase in ethnic minorities in Europe [4–6].

Some of these products have long been appreciated by consumers, such as banana, pineapple, mango and avocado. In addition, lesser-known exotic fruits such as tamarind,

feijoa, litchi, guava, rambutan and many others are developing a presence in European markets, where interest in new flavors and varieties is extending. Following this positive orientation, producers and retailers are spreading an increasing number of exotic fruits with high nutritional value, also known as "superfruits", onto the market. This word is generally used to indicate the high health benefits of these fruits, being rich in fiber, vitamins, minerals and antioxidant elements, such as phenolic acids, flavonoids and anthocyanins.

As indicated by Euromonitor reports and Mintel's Global Food and Drink Trends 2030, a growing number of consumers are becoming aware of functional foods with the aspiration of obtaining further benefits for their health. Furthermore, the actual demand for healthy and convenient foods has accentuated, and consumers are increasingly choosing processed fruit, such as dried fruit, jam and fruit snacks [7–9]. This growing desire for more nutritious foods is pushing the food industry to innovate and make greater use of tropical fruits as ingredients for a rich range of food products, both as a means of varying flavors and to meet consumer interest in new and innovative products [10].

Furthermore, the production of tropical fruits and their supply to the world market supports the employment of a significant part of the populations of developing countries, represents an opportunity for income for their families and equates to foreign exchange earnings for the countries concerned. At the same time, for the countries that import them, they currently represent a relevant element in satisfying the needs of their citizens for fruit and berry products in terms of volume, assortment and availability during the entire year. Considering that the Food and Agriculture Organization of the United Nations declared 2021 "International Year of Fruits and Vegetables" [11], the market for fruit juices and nectars is growing significantly and has attracted the interest of farmers, distributors and the juice and nectars industry to meet the demand [12].

Mango, thanks to its high nutritional and bioactive peculiarities, is considered the most commonly consumed fresh fruit in the world [13,14]. Mango is widely accepted by consumers for its sweet taste and exotic flavor and is an important tropical fruit for human nutrition in different parts of the world. Mango pulp and agro-industrial residues contain various bioactive compounds, including nutritive and non-nutritive substances with biological properties.

Even in Italy, interest in mangoes in the last five years has resulted in a constant increase in imports equal to +37%. This interest is fueled and encouraged by ever-increasing consumption recorded throughout Europe, particularly for mango and avocado. The products obtained in the Mediterranean areas where the cultivation of mango and other tropical fruits has been introduced are highly appreciated in Europe for their excellent production quality and record-high sales prices.

Given the importance of mango in many different markets, it is useful to understand consumers' perception of quality and how this influences their purchase and consumption decision-making process. This information can enable industry players to improve their actions to meet consumer demand [15]. This also encourages opportunities for actors across the industry to work more efficiently and improve profitability [16].

Advances in transportation, trade agreements and shifting consumer preferences in favor of these fruits have led to growth in trade. However, tropical fruits are highly perishable during the different steps of production and distribution, and these aspects represent the main obstacles to the quality of the fruit and the guarantee of supply to international markets. In this context, few studies have investigated consumer preferences for tropical fruits.

The aim of our study is to determine the predominant aspects that influence the demand for mango and mango-based products to understand their role, purchasing propensity and preferences. To obtain this objective, different drivers and attributes were carefully studied to classify homogeneous market parts for tropical fruit, based on consumer attitudes and lifestyles. In particular, this work focuses on the consumption preferences regarding fresh and processed mango in the city of Bahia in Brazil and in some Italian cities with the aim of grasping the main product characteristics and to study the different

consumption habits and preferences in the two countries, one of ancient tradition and the other recently introduced.

## 2. Hypothesis Development

### *2.1. Theoretical Background*

The "Theory of Planned Behavior" (TPB) aims to understand the processes that lead individuals to intentions in their consumer choices. This theory is one of the most widespread in behavioral data analysis and socio-psychological analysis as it allows us to study the interrelationships between variables that are not directly measurable (latent variables or factors), and it has been frequently applied to behavioral studies on food and beverage consumption [17–19]. In recent times, many scholars who deal with food and drink consumption have added other constructs to those indicated by Ajzen [20], for example, to delve deeper into aspects related to organic food [21], to sustainability [22], to food waste [23], to moral standards [24], to behavior in choosing local food [25], to the study of innovative products including functional food or even to healthy and dietetic nutrition [6].

In the academic field, other theories have joined the TPB by integrating and enriching the marketing approach. For example, Rituparna Basu and other authors (2023) [26], in their article, carry out an in-depth review of postmodern marketing practices and highlight a growing interest among researchers in consumer vulnerability, reiterating a concept examined by Hill & Sharma (2020) [27] and by Riedel et al. (2022) [28], highlighting many of the aspects that revolve around the effects that modern markets have on current culture and societies. In "postmodern" consumption, products are differentiated, demand is highly segmented, markets are unstable, and territory plays a decisive role. In this condition, individual freedom influences consumer choices just as the environment, the social and cultural context and health aspects do [29]. As early as the 1990s some authors identified the postmodern consumer [30,31] as someone who satisfies his own needs within a cultural model that is independent from the act of consumption, concepts reaffirmed in the 2000s [32,33].

Gilal et al. in 2019 [34] and Cassia and Magno in 2024 [23] address the role and value of self-determination theory (SDT) in marketing studies. They highlight, within the framework of the theory of human motivation (proposed by Deci and Ryan in 1985 [35] and taken up by the same authors in 2000 [36]), a person's commitment to a specific behavior to distinguish, explain and predict intrinsic and extrinsic motivations for purchasing decisions.

Pang et al., 2021 [21] propose in their study Roger's (1975) [37] Protection Motivation Theory (PMT), an extension of the Health Belief Model (HBM). The theory is usually used as a theoretical foundation for the study of protective behaviors in terms of attention to an individual's health.

SDT and PMT represent a valid integration of the theory of planned behavior to empirically explore consumption behaviors. These different theories were a useful starting point for us to address and study the propensity to consume mango and mango-based foods and beverages. In fact, in this work, once the factors that influence the intention to consume fresh mango and mango-based foods and beverages were determined, a PLS-SEM model was developed.

According to Magno, Cassi and Ringle [38], partial least squares structural equation modeling [39,40] allows researchers to estimate models with constructs [39] where the application of advanced PLS-SEM methods can enrich both existing theories and business practices in marketing actions [40,41]. PLS-SEM offers researchers multiple advantages, such as handling small sample sizes, estimating complex models and balancing predictions and explanations [39,42]. In business research, the method is particularly suitable for research on success factors or for exploring the sources of competitive advantages [43]. Furthermore, in light of recent studies [38,44,45] that apply the PLS-SEM method to building research models, in a second phase we added the PLS-MGA multigroup approach with reference to the two countries, Italy and Brazil, in order to compare preferences, motiva-

tions, consumption habits and propensity to purchase. To achieve this goal, we asked the following research questions:

- Are the nutritional values of mango considered significant among consumers in the two countries?
- Do lifestyles and fruit consumption habits influence the intention to consume mango and mango-based foods?
- To what extent does an awareness of environmental and social sustainability influence mango consumption choices?
- How important are quality, safety and organoleptic characteristics in the intention to consume and purchase mangoes and mango-based products?
- Do mango-based products such as aperitifs, ice cream, desserts, jam, smoothies, etc. attract Italian and Brazilian consumers?
- In which stores do consumers prefer to buy fresh mango and mango-based products?
- Are curiosity and gastronomic culture for new uses and new dishes relevant factors in the consumption of mango and mango food in the two countries?

Our results will increase the understanding of consumer attitudes to these products: in Brazil they allow us to examine and strengthen the knowledge of consumer orientations and preferences, while in Italy, where fresh mango and mango foods and drinks are emerging products, analyses can offer valuable insights to supply chain figures with the aim of developing a tailored marketing plan to effectively meet consumer expectancy.

### *2.2. Research Hypothesis*

The conceptual framework of this work is observable in Figure 1, which shows the potential motivations influencing the behavioral intention to purchase fresh mango and mango food and drinks. The interest of Italian and Brazilian consumers in mango is different: in Italy only in the last decade has there been an increase in consumption and a greater propensity to purchase (this above all in relation to the attraction for this exotic fruit and the wide range of mango-based products present in Italian stores), while in Brazil (the third-largest mango producing country in the world) the fruit, both fresh and processed, is widespread, well-known and highly appreciated.

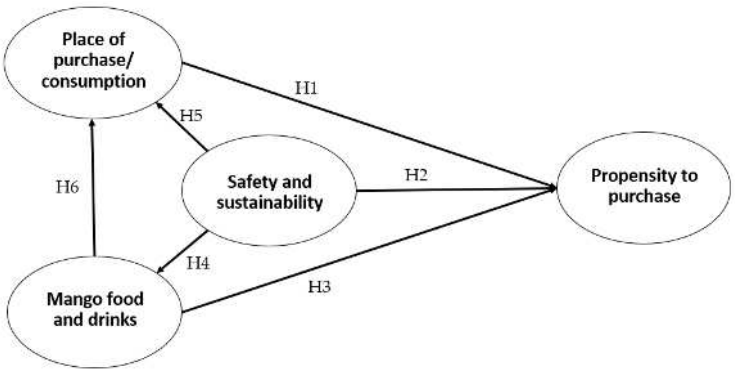


**Figure 1.** Conceptual model hypothesized in the analysis. Source: Authors' elaboration from data analysis in Smart-PLS4.

The model shows four main drivers that guide consumers' choices and their propensity to purchase: motivation; knowledge of and attraction to fresh mango and mango-infused foods and drinks; consumer expectations on food safety; and environmental sustainability. The points of sale preferred by consumers also come into play in these choices, including the availability and possibility of online purchasing.

#### 2.2.1. Propensity to Purchase

The quality and organoleptic characteristics of a food reflect the qualities perceptible through one or more sense organs. Appearance, color, shape, aroma, flavor and consistency

and characteristics connected to it (fluidity, viscosity, friability) are just some of the most important and well-known organoleptic characteristics. Even at the beginning of the 1990s, Harris [46] recognized the importance of tropical fruits in the history of cuisine and in the development of modern gastronomy [47]. In Italian gastronomy, the introduction of tropical fruits offers a large range of benefits, such as the combination of flavors, use in decorating and embellishing dishes, cocktails or desserts, experimentation with traditional Italian dishes using ingredients and flavors of other cultures and the creation of new and unique dishes [48]. Mango, thanks to its singular flavor, has also conquered the taste of European and Italian consumers, and rather than naturally as a fruit, it is mostly consumed in the form of drinks and cocktails (along with other fruits such as pineapple, orange, etc.), ice creams, desserts and mango biscuits, all of which have recently been increasingly appreciated in gastronomy (poké, salads, sauces, fresh and tasty gourmet dishes, etc.), and is often used in the kitchen in recipes both in Italy and in Brazil. Sgroi et al. [48] state that mango currently attracts and intrigues young Italians looking for gastronomic experiments.

Another aspect that favors the propensity to purchase is the search for information on social media. Changes in consumer behavior have been studied due to the effect of social media and the Internet. Consumers are now immersed in a virtual space. The network has become a tool to activate connections and interactions. Often, when consumers purchase, they are unable to obtain sufficient and complete information [49]; for this reason, social media represent a support tool. This also happens with reference to mango and mango-based products to be purchased online and consumed at home and away from home both in Italy and in Brazil. The wide range of mango products and mango-based foods and drinks to purchase or prepare encourages consumers to take part in discussion groups to ask for advice, recipes, information and assistance in the decision-making process before purchasing [50,51].

The propensity to purchase is increasingly connected to practicality of use and to the expansion of the range of mango-based products, and it is encouraged by the food industry, which has increased the use of mango and tropical ingredients both in Brazil and in Italy. Furthermore, particularly in Europe and Italy, demographic diversification, the emergence of multi-ethnic and multicultural societies and the presence of different ethnic groups bearing different cultural and food heritages leads to a tendency and propensity towards new tastes and gastronomic curiosities. Even in Brazil, new and alternative methods of mango consumption are becoming more and more widespread due to the influence of other cultures and eating habits. This is the case, for example, with sushi prepared with mango and other tropical fruits, which is becoming very popular in Brazil.

#### 2.2.2. Points of Sale

As regards the choice of sales points, i.e., where consumers buy mangoes and mango-based products, consumers have widely varying habits, and often they buy both in green-grocers and specialized shops and in supermarkets both fresh mango and artisanal mango-based products (such as ice cream and desserts, aperitifs, jam, etc.) and/or non-artisanal ones by purchasing packaged industrial products. The possibility of purchasing ready-to-use and practical products is very important [52]

Konuk [53] underlines that the role of the store image, in relation to perceived quality, trust in the store and the seller and perceived value, influences consumers' purchasing intentions. Indeed, trust is defined as "the consumer's expectation of the reliability of the services provided and the fulfillment of promises by the supplier" [54]. Manufacturing companies are trying to find market space and face strong competition. The store image is one of the most important distinctive aspects that provides a substantial advantage for retailers. It represents the set of a consumer's perceptions of a store with reference to different attributes. Thus, the point of sale (shop or open-air market) is viewed as a space for socializing and creating a climate of trust in the quality of the goods and the availability of the retailer. Loyalty is "the willingness to rely on a trusted business partner" [53,55]. The

theory of trust commitment gives particular importance to the concept of trust. This is even more relevant when considering online purchasing.

Considering that the choice of the point of sale has relevance to the propensity to purchase:

**Hypothesis 1 (H1).** *The identification of the point of sale has a positive and significant effect on the propensity to purchase.*

2.2.3. Safe and Sustainable: Health and Environmental Awareness

Fundamental elements in purchasing decisions are the aspects concerning food safety, the loss of biodiversity and health in general. Lately, to these traditional aspects have been added those that consider the risks linked to climate change and the sensitivity of respect for the environment.

Sustainable attitudes, identifiable in food choices that concern attention to products such as fruit and vegetables, involve an increasingly large part of consumers. This also involves production methods compatible with the environment and with the health of consumers, for a healthy diet and an adequate lifestyle [56–60].

Many elements determine consumer choices: raw materials used, nutritional aspects, production and marketing itself. Conscious purchasing is increasingly closely linked to food safety and the desire to purchase environmentally friendly food [61], even if all this is combined with the consumer's knowledge and experience.

These are consumption habits that are influenced by friends and family, which influence individual choices [61].

Safety and environmental sustainability attributed to food by the subjects interviewed are critical factors that influence value aspects, ethical and social orientations and behavioral intentions [62].

The values of consumers and their socio-economic environment shape and influence sustainable food attitudes and models. These consumers will be more likely to orient themselves towards consuming and purchasing food with sustainability requirements.

Consumer health and lifestyles have attracted much multidisciplinary research. The awareness of the significant implications of healthy eating for well-being and consumer interest in more nutritious foods, have gained momentum. Several studies [63] have demonstrated a direct link between lifestyle and life satisfaction or subjective well-being. The impact of healthy lifestyle behaviors on health is well-known, particularly the association between lifestyle behaviors and well-being.

The following hypotheses are formulated.

**Hypothesis 2 (H2).** *The aspects of safety and sustainability have a positive and significant impact on consumers' propensity towards purchasing mangoes and mango-based products.*

**Hypothesis 4 (H4).** *The safety and sustainability aspects have a positive and significant impact on the consumption of fresh mango and mango-based products.*

**Hypothesis 5 (H5).** *Safe, sustainable, ethical and responsible consumption has a positive and significant impact on the choice of sales outlets.*

2.2.4. Mango Based Products

Sulistyawati et al., 2020 [64], state that mango fruits are highly valued for their taste [65,66], for their exotic appearance and for the health advantages they provide. The transformation of fresh fruit into dried fruit, for example, is of interest to the global market since the dried product has a longer availability and high versatility in different food products, including breakfast cereals, fruit bars and mixtures with nuts [9,67]. Previous studies on consumer preferences on dried fruit have shown that health-related attributes, such as nutritional content, have a positive influence on health and that, among intrinsic

attributes, functional ingredients are considered important [8,68]. Information on consumer preferences for health and sensory properties is particularly useful for understanding which attributes could help increase the value of dried mango and other mango products for the relevant markets. Both types of information are essential for successful consumer-oriented product development.

**Hypothesis 3 (H3).** *The wide range of mango-based foods and products has a positive and significant impact on the propensity to purchase.*

**Hypothesis 6 (H6).** *Preferences for mango foods and drinks has a positive and significant impact on the choice of outlets from which to purchase them.*

## 3. Mango and Tropical Fruits: International Trade and Market Strategies in Italy

### *3.1. World Export-Import*

World mango production grew from 25 million tons in 2000 to over 57 million in 2021. The volume of mango exports from 2000 to 2021 grew from 0.62 to 2.3 million tons, with an average annual growth of 26% [69]. Although tropical fruits play a limited part in global agricultural trade in terms of overall volume, accounting for only 3% of global agricultural food exports, their high average unit export value, well above $1000 per ton, places them third in value behind bananas and apples. Trade in tropical fruits generates notable revenues for small-scale producers, as well as significant export earnings for many producing countries, thus contributing to their food security. It is estimated that approximately 99% of tropical fruit production occurs in developing countries, mainly in Asia and Latin America and a smaller share in Africa (Table 1). In most production areas, tropical fruits continue to be grown at a subsistence level rather than commercially. Combined exports of the four big tropical fruits represent only 5% of the total production volume, with the remainder consumed or otherwise used domestically. India is by far the biggest producer of mangoes globally, with a production quantity of around 25 million tons in 2022; however, due to the strong domestic demand for mangoes in the country, production is aimed almost exclusively at the internal market.

**Table 1.** Mango import and export by continent in 2023.

| Continents | Mango Exports | | Mango Imports | |
|---|---|---|---|---|
| | (Tons) | % | (Tons) | % |
| Asia | 866,138 | 39.0 | 813,535 | 35.8 |
| Africa | 222,233 | 10.0 | 130,597 | 5.8 |
| Central America and the Caribbean | 520,994 | 23.4 | 11,123 | 0.5 |
| South America | 611,726 | 27.5 | 43,650 | 1.9 |
| Northern America | - | - | 697,077 | 30.8 |
| Europa | - | - | 567,906 | 25.0 |
| Oceania | 1902 | 0.1 | 6133 | 0.3 |
| World | 2,292,721 | 100.0 | 2,270,021 | 100.0 |

Authors elaboration from FAOSTAT 2023.

World exports in 2023 amount to 2,292,721 tons. The main world mango exporting countries are: Mexico (Central America and the Caribbean), which in 2023 exported 482,640 tons (equal to 21.1%); Thailand, India and Pakistan (Asia), which exported, respectively, 341,418 tons (14.9%), 145,499 tons (6.3%) and 123,617 tons (5.4%). In South America the main exporting countries are Brazil and Peru, which respectively export 275,818 tons (12.0%) and 266,045 tons (11.6%).

North America and the European Union are among the main world importers, with import shares of 30.8% and 25%, respectively. In particular in North America, the United States imports 19.0%, and Canada 11.7%. In these markets, consumer demand for mangoes has increased, driven by an increasing awareness of the nutritional and health values

attributed to these fruits. The growth of imports in these markets was further supported by strong production supply in Mexico, Peru and Brazil, which are the three main mango exporting countries to the United States and the European Union. In Asia, the main importers of mangoes and mangosteens are China (which imports mainly from Thailand), Saudi Arabia and the United Arab Emirates.

Even in Italy, avocado and mango are increasingly at the center of consumer preferences. Mango imports by Italy highlight the growing interest in this product; in fact, they went from 13.5 million kg imported in 2018 to 18.5 million kg in 2022 (+37%).

### *3.2. Made in Italy Tropical Fruits*

Mediterranean countries such as Israel, Palestine occupied, Egypt, Spain and southern Italy are taking on an increasingly interesting role in the production of tropical fruits.

In southern Italy, the increasing interest among producers in mango cultivation is demonstrated by the high organoleptic quality of the product obtained and the economic interest fueled by the increases in consumption recorded throughout Europe. The cultivations of exotic fruit created in Italy have multiplied in recent years and are present in Sicily, Puglia and Calabria, where, more and more often, real tropical fruit plantations are first experimented with and then started, growing bananas, mango, avocado, lime, passion fruit, sour apple, feijoa and other minor ones [70,71]. The surfaces affected by mango cultivation are mainly found in coastal areas. In Sicily, the northern coastal area of the island is particularly suitable. In general, in Mediterranean-sub-tropical climate conditions, plants maintain a smaller size.

Southern Italy grows exotic fruit against the effects of climate tropicalization, a challenge of resistance and adaptation which in recent years has translated into concrete income opportunities for farmers.

A national survey shows that tropical fruit cultivation in Italy has tripled in five years, going from 500 hectares to the approximately 1200 currently cultivated in Puglia, Sicily and Calabria. This phenomenon is driven by the effect of climate change, which is radically modifying the map of agricultural production in these regions. More and more often, therefore, in the southern regions, real plantations of tropical and sub-tropical fruit never seen in the past in Italy are being experimented with and started, from the best-known—mango, avocado, lime and passion fruit—up to annona, feijoa, casimiroa, black zapote and litchi. More and more often, young farmers are choosing to bet on these new crops, sometimes recovering abandoned land due to the climate crisis. The increasingly long and scorching summers have pushed us to invest more and more in the cultivation of tropical fruit, which finds an optimal habitat in southern Italy. The challenge of adapting to the new climate pushes farmers to be resilient and innovative. Suffice it to consider that the production of tropical fruit in Italy, from a simple initial curiosity grown in a few hectares, is currently a real market phenomenon, recording, in the 2023–24 vintage, a strong demand for "made in Italy" mangoes both from the Italian markets as well as from the European ones. Compared to fruits coming from tropical countries, which have to face a long journey by ship or plane and for this reason are harvested at the first stages of maturation with significant repercussions on the quality of the product, mangoes of Italian origin are highly appreciated, even if they possess smaller dimensions than those from the areas of origin. The trend is motivated by the greater degree of freshness but also by concerns about guarantees of product traceability and safety and by concerns for the environment [72]. In Italy, the fruit entered the Istat basket in 2018, and, increasingly, large-scale retail consumers are looking for mangoes and other local tropical fruits on the shelves.

### *3.3. Quality, Food Safety and Pre- and Post-Harvest Problems*

Mango is widely cultivated in tropical and subtropical regions. It is an economically very notable agricultural product for the production countries; therefore, an accurate

evaluation of the ripening phase is fundamental for the harvest and, above all, for the post-harvest management of mango.

Among the most important aspects that aid the acceptance of high-quality fresh mango by consumers are organoleptic aspects and chemical components, which mainly depend on the level of ripeness. These aspects are particularly important throughout the supply chain, particularly for export markets [73].

The quality of fruits can be evaluated thanks to a large range of indicators, such as physical aspects (e.g., size, shape, color) and chemical aspects (e.g., sugars, acids, polyphenols). The gustatory quality of a fresh fruit is heavily linked to the sweetness of the fruit, which reflects the recognized sweet taste of the sugars contained in the fruit. However, the recognized sweetness does not depend only on the total sugar content but, above all, on the internal balance of the various soluble sugars [74,75]. Another factor involved in the quality of fruit flavor is the acidity of the fruit [76,77]. Fruit acidity can be evaluated via different approaches and indicators, from simple pH measurements to measurements of individual acidity levels. Titratable total acidity (TTA) is a typically used indicator of fruit acidity that provides wider information than pH without requiring the measurement of all acids [78]. The balance between acidity and soluble sugars is surely one of the most important aspects of fruit flavor quality.

Many authors report that, in most of the main production areas of the world, mango fruits are susceptible to various defects and physiological problems (spongy tissue, tip pulp, jelly seeds, soft nose, seed rot, fruit diose, tapered tip) [79,80].

Kiran et al. [81] detect pre-harvest and post-harvest losses in India, mainly caused by environmental variables including climate change, global warming and numerous diseases and pests (spongy tissue and fruit fly). Furthermore, mechanical damage, storage conditions and the transportation and handling of mango have a major impact on post-harvest losses.

During the transportation and marketing period, mango fruit may suffer from severe losses caused by Mango anthracnose disease (MAD). MAD is the most common disease in post-harvest mango and the most serious damage factor for mango cultivation worldwide [82,83]. Recent taxonomic revisions have led to the identification of several Colletotrichum species involved in the disease, initially referred to as the *C. gloesporioides* and *C. acutatum* species complex, including *C. aeschynomenes*, *C. alienum*, *C. asianum*, *C. dianesei*, *C. fructicola*, *C. musae*, *C. nupharicola*, *C. siamense*, *C. tropicale* and *C. karstii* [84]. In Italy, associated to MAD, were recovered *C. gloeosporioides*, *C. kahawae* subsp. *ciggaro* and *C. karstii* [85].

Infections can affect many plant organs, but major losses occur on fruits, where infections remain dormant until the fruits begin to ripen, causing brown or black sunken necrotic lesions on the peel, enlarging during postharvest and reaching the pulp [31]. On the other hand, fruit and vegetables are highly perishable, and, principally due to fungal pathogens, high losses of harvested production can be found in both industrialized and developing countries. Fungicides are used to control these microorganisms in pre- and post-harvest application. To reduce and eradicate its use, several post-harvest methods that are not harmful to the consumer have been applied to the mango fruits, including cold storage, hydrothermal treatment, UV, edible coatings and 1-MCP. Improved efficacy in post-harvest control can be achieved with the synergistic application of these different methods [86]. However, to pursue the best fungal disease control on fruits, an integrated approach among chemical, physical and biological methods is often necessary both pre- and post-harvest, starting from the planting of resistant, or less susceptible, cultivars to anthracnose. This approach reduces the need for fungicide application in the field, making it more cost-effective and sustainable.

Many scholars report new alternative and sustainable methods to replace synthetic fungicides, and non-synthetic materials using essential oils extracted from natural sources are increasingly being used to control anthracnose [83,87,88]. For this purpose, waste and processing residues of other agricultural products are used, turning them from waste into

resources. These new trends bring together environmental perspectives and food safety. On the other hand, consumers are increasingly aware of the importance of a lifestyle rich in fruit and vegetables, and the demand for high-quality, safe products free from pesticide residues, toxins and harmful microorganisms is increasing.

In Italy, despite their great economic impact on the European market, very few studies on mangoes have been conducted so far. Investigations conducted since 2014 by Leonardi et al. [89] have led to the detection of serious symptoms of woody canker, downy mildew and decay on mango plants in the major cultivation area of north-eastern Sicily. In this species, the onset of fungal and bacterial infections before and after harvesting can compromise plant growth and fruit quality. Luckily, to date only a few diseases affecting mangoes have been reported in Italy. Some pathogens (wood cankers and rots, necrosis, etc.) can limit mango production and lead to substantial crop losses, changes in quality, decrease in market value and, sometimes, post-harvest losses, in particular during maturation and storage. For this reason, with the aim of developing effective management strategies in mango orchards, it is needful to investigate the diseases that affect these crops in the cultivation areas of southern Italy because they could represent a limiting factor for production.

In the European market, the demand for tree-ripened fruit has recently grown. However, the qualitative response and marketability aspects of mango fruits ripened in trees grown in the Mediterranean area are still little evaluated, as for example in the case of nectarines and consumer preferences indicated by Christofides et al., 2022 [90].

Furthermore, the possibility of the sustainable use of mango waste, which falls within the scope of the circular economy, is underlined, such as the use of textile fibers derived from fruit with the aim of reducing the impact on the consumption of natural resources and on pollution. In the constant effort to reduce the environmental impact of the fashion industry, an innovative vegetable fabric similar to leather made from mango waste is produced in the Netherlands. This initiative not only reduces food waste but also offers a promising sustainable option in the world of fashion.

Finally, it is necessary to underline the aspects connected to the problems regarding the environmental sustainability of air and maritime transport. If, from a productive and economic point of view, the increase in global demand for mango makes the product extremely interesting, from an environmental point of view, the production from tropical countries arriving in Europe after long journeys by ship or plane causes a significant carbon footprint [91]. In the air transport and maritime transport sectors, we recall the proposal for a European regulation on guaranteeing equal conditions for sustainable air transport and Regulation (EU) 2023/1805 [92] on the use of renewable and low carbon emission fuels in maritime transport, which aim to promote the production and diffusion of sustainable alternative fuels in transport aviation and maritime as the entry into the market of low-emission and zero-emission powertrain solutions is indicatively expected by 2030 or even later.

## 4. Materials and Methods

*Workplan and Data Collection*

The paper examines the consumption of fresh mango and mango products in the city of Bahia in Brazil and in Italy, in the following cities: Milan and Turin (Northern Italy); Rome and Pesaro (Central Italy), Reggio Calabria and Catania (Southern Italy). The objective is to consider how well this fruit and its processed products are known, consumed and appreciated. We also look at consumption habits and the factors that determine preferences and propensity to purchase.

The collection of data useful for the investigation was achieved thanks to the use of specific questionnaire forms administered online in the respective languages from 17 July 2021 to 3 September 2021 in a post-covid period. The current trend seems to confirm the attitudes, habits and preferences of mango and mango food consumers. The questionnaire was shared via email, WhatsApp, Instagram and the Facebook portal. In the period indicated, 453 consumers responded to the questionnaire (163 Italians and 285 consumers

intercepted in Brazil). A questionnaire was used to collect information from the sample on the following: habits, frequency, prices, aroma, taste, seller trust and recommendation, attention to food safety, curiosity and aptitudes, opinion.

The questions collected predict binary, multiple-choice answers, while others use a five-point Likert scale.

The participants declared themselves available for the interview and were informed of the guarantee of anonymity and of the use of the data collected for research purposes only and in an aggregate manner. A snowball sampling method was used. The choice of this method of sampling is linked to motivations related to the duration and cost of the investigation. The questionnaire was pre-tested to ensure clarity and consistency in the wording of the questions [93,94].

The collected data were analyzed using multivariate analysis techniques. Databases were created thanks the use of the SPSS.26 and SmartPLS4 ver. 4.1.0.3 software [95]. For a first identification of latent factors that influence consumers in the process of choosing mango and mango-based products, an exploratory factor analysis (EFA) based on principal component analysis (PCA) was carried out. Reliability was evaluated with the use of the Kaiser–Meyer–Olkin (KMO) test and Bartlett's spherical test [96,97]. Subsequently, the model PLS-SEM was used to test the research hypotheses and the relationship between the determining factors and consumer attitudes [22,98,99].

In this work, PLS-SEM was used as the data analysis method for the research model based on both the "measurement model" and the "structural model" of the research components [39,100,101]. "Model reliability", "convergent validity" and "discriminant validity", the bootstrap procedure, have been considered.

Finally, multi-group analysis (PLS-MGA) was applied, in order to better interpret the motivations that influence the behavioral intentions regarding purchasing mango and mango-based products of consumers in the two segments "Italian consumers" and "Brazilian consumers". The analyses were applied to identify and analyze the specific path coefficients for each segment. The multi-group analysis allows us to verify whether the differences between the specific path coefficients of the groups are statistically significant. For this purpose, the parametric approach most frequently used by researchers, based on "t" tests, was applied. It allows us to highlight the paths, research hypotheses and distinctive factors that most influence the decision-making processes of consumers for the purchase of mango and mango-based foods.

## 5. Results

### *5.1. Sample Characteristics*

Table 2 gives the socio-demographic characteristics of the sample. Those interviewed were aged between 18 and 75, with an average age of 37.7 years. Males represent 41.1% of respondents, and females 58.9%. Furthermore, 34.7% of interviewees belong to generation Y, called Millennials (between 29 and 43 years old), followed by generation Z (18–28 years old); the majority of those interviewed have a high school diploma (45.7%) or a degree (26.9%), are employed (37.1%) and have a medium-high annual income (58.5%).

As visible from Table 3 below, Italians have a greater preference for sweets/ice creams, habitually consuming mainly drinks, cocktails, ice creams, desserts and mango delicacies in approximately 39–45% of cases and consuming them often and very often in approximately 12% of cases. Mango juice is also highly appreciated by Italian consumers (34% of habitual consumption and in 20% of cases often or very often). As for Brazilians, they generally have higher consumption frequencies than Italians with respect to products whose habitual consumption frequency is 53–59% (jam, drink-cocktails and mango delicatessen), while, in the majority of cases, sweets (63.1%) and juice (59.6%) are consumed often and very often, respectively having a habitual consumption by 31.9% and 36.8%.

**Table 2.** Socio-demographic characteristics of the sample.

| Indication | | % Total | % Italy | % Brasil |
|---|---|---|---|---|
| Gender | Male | 41.1 | 42.3 | 40.4 |
| | Female | 58.9 | 57.7 | 59.6 |
| Age generation (years) | Gen Z 18–28 | 31.8 | 35.7 | 29.5 |
| | Gen Y 29–43 | 34.7 | 25.6 | 40.0 |
| | Gen X 44–59 | 24.3 | 26.8 | 22.8 |
| | Baby boomer | 9.3 | 11.9 | 7.7 |
| | Not answer | 0.0 | 0.0 | 0.0 |
| Annual income | Low | 2.4 | 0.4 | 2.0 |
| | Medium-low | 19.2 | 19.3 | 19.3 |
| | Medium-high | 58.5 | 65.5 | 54.4 |
| | High | 19.9 | 14.3 | 23.2 |
| Food purchasing responsible | Interviewed | 92.9 | 81.0 | 88.1 |
| | Other | 7.1 | 19.0 | 11.9 |
| Components of the family | 1–2 components | 19.4 | 24.4 | 16.5 |
| | 3–4 components | 62.9 | 63.1 | 62.8 |
| | >4 components | 17.7 | 12.5 | 20.7 |
| Educational level | Middle school | 17.4 | 3.6 | 25.6 |
| | High school | 45.7 | 40.5 | 48.8 |
| | Degree | 26.9 | 47.0 | 15.1 |
| | Post-degree | 9.9 | 8.9 | 10.5 |
| Occupation | Employed | 37.1 | 41.1 | 34.7 |
| | Self-employed | 22.1 | 16.7 | 25.3 |
| | Retired | 3.3 | 3.0 | 3.5 |
| | Students | 22.7 | 26.8 | 20.4 |
| | Other occupation | 14.8 | 12.4 | 16.1 |

Source: the authors.

**Table 3.** Frequency of consumption of fresh mango and mango foods in Italy and Brazil.

| | Italy % | | | | | | | Brazil % | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh | Dried | Juice | Jam | Sweets and Ice Cream | Drink | Gastronomy | Fresh | Dried | Juice | Jam | Sweets and Ice Cream | Drink | Gastronomy |
| Never | 22.6 | 58.3 | 25.6 | 63.1 | 24.4 | 25.0 | 41.0 | 0.4 | 7.7 | 0.7 | 6.7 | 0.7 | 3.2 | 2.0 |
| 1–2 times/year | 15.5 | 26.2 | 16.7 | 14.3 | 15.5 | 17.0 | 12.5 | 2.1 | 13.0 | 2.8 | 9.5 | 1.4 | 6.7 | 2.8 |
| 1–2 times/month | 33.9 | 11.3 | 33.9 | 17.3 | 44.6 | 45.3 | 39.3 | 24.0 | 46.0 | 36.8 | 54.0 | 31.9 | 53.0 | 59.0 |
| 1–2 times/week | 13.7 | 1.8 | 16.7 | 2.4 | 8.9 | 8.3 | 4.2 | 26.0 | 13.0 | 33.3 | 14.7 | 36.6 | 19.6 | 19.6 |
| More than 2 times a week | 14.3 | 2.4 | 2.9 | 3.0 | 2.4 | 3.6 | 3.0 | 47.4 | 20.0 | 26.3 | 15.1 | 26.5 | 17.5 | 16.1 |

### *5.2. PLS-SEM Model*

In detail, factor analysis was applied to 18 variables. The KMO (Kaiser–Meyer–Olkin) test value is 0.937. This index can take values between 0 and 1, and the closer the value is to 1, the more the adequacy of the sample improves.

Bartlett's test of sphericity is a test that provides the *p*-value must be less than 0.05 to consider the model valid. In the study, the *p* value was found to be 0.000. Four components were extracted which identify four groups of latent factors, explaining 71.891% of the total variance. Thanks to this, it was possible to associate the main drivers of the choice of preferences with each component. Moving on to the application of the PLS-SEM model, "the internal consistency" and "convergent validity" have been evaluated. To verify the reliability and validity of the construct, the following criteria are examined: the factor loadings are all greater than 0.7, the composite reliability (CR), the average variance extracted (AVE) and Cronbach's Alpha are valid, and the values are found based on the literature following the indices of model adaptations as indicated by many authors [39,44].

The PLS-SEM model results in Figure 2 and Table 4 show that the standardized loadings of all measurement items are above the acceptable cut-off level.

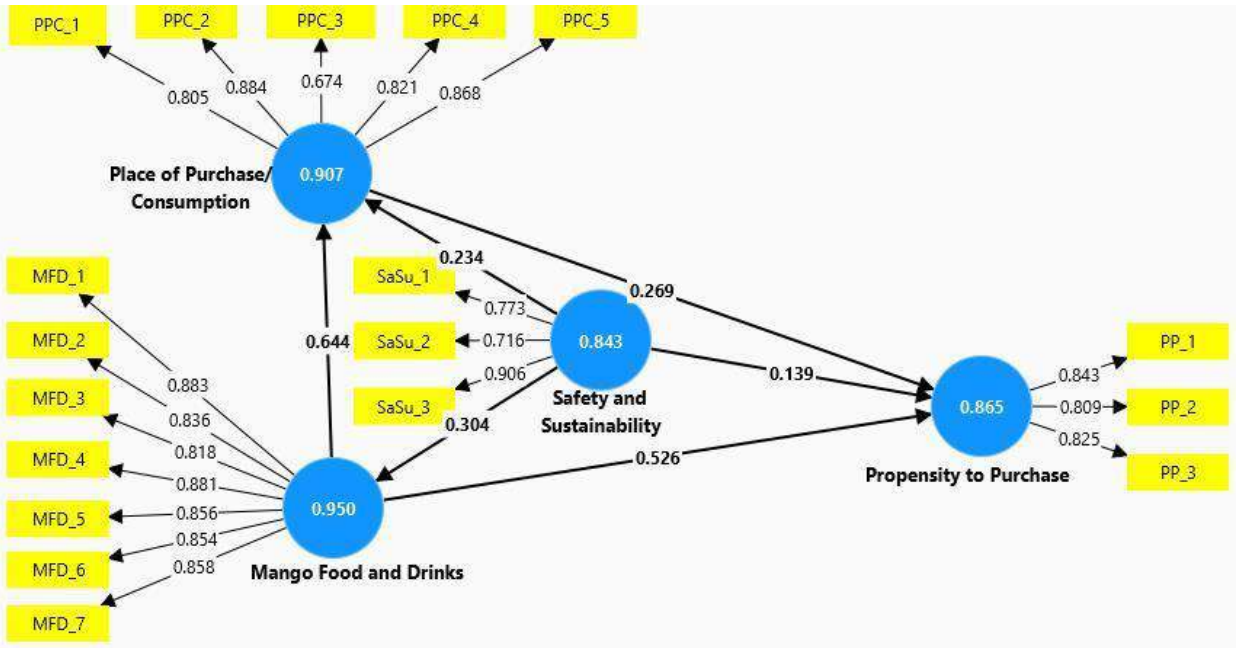


**Figure 2.** PLS-SEM model results. Source: Authors' elaboration from data analysis in Smart-PLS4.

**Table 4.** Standardized factor loading.

| | External Saturations | Cronbach's Alpha | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|---|---|---|---|---|
| Propensity to Purchase | | 0.768 | 0.865 | 0.682 |
| PP_1 when I buy mango and mango food, taste and organoleptic qualities are important | 0.843 | | | |
| PP_2 when I buy mangoes and mango food I use the information acquired through social media | 0.809 | | | |
| PP_3 when I buy mango and mango food, curiosity about new foods and gastronomic multiculturalism count | 0.825 | | | |
| Mango Food and Drinks | | 0.939 | 0.950 | 0.732 |
| MFD_1 consumption of ice cream and sweets at home and/or away from home | 0.883 | | | |
| MFD_2 consumption at home and/or away from home fresh natural mango | 0.836 | | | |
| MFD_3 consumption of mango juice at home and/or away from home | 0.818 | | | |
| MFD_4 consumption of mango jam at home and/or away from home | 0.881 | | | |
| MFD_5 consumption at home and/or away from home dried mango | 0.856 | | | |
| MFD_6 consumption at home and/or away from home mango drink-aperitifs | 0.854 | | | |
| MFD_7 consumption at home and/or away from home mango gastronomy | 0.858 | | | |
| Place of Purchase/Consumption | | 0.870 | 0.907 | 0.662 |
| PPC_1 city markets | 0.805 | | | |
| PPC_2 Away From Home | 0.884 | | | |
| PPC_3 organic market | 0.674 | | | |
| PPC_4 online | 0.821 | | | |
| PPC_5 retail stores (GDO, retail, etc.) | 0.868 | | | |

**Table 4.** *Cont.*

| | External Saturations | Cronbach's Alpha | Composite Reliability (CR) | Average Variance Extracted (AVE) |
|---|---|---|---|---|
| Safety and Sustainability | | 0.736 | 0.843 | 0.644 |
| SaSu_1 importance of place of origin | 0.773 | | | |
| SaSu_2 importance of nutritional values | 0.716 | | | |
| SaSu_3 importance of environmental and social sustainability | 0.906 | | | |

Note: GFI fit statistics = 0.947; AGFI = 0.388; SRMR = 0.074. Source: the authors.

Reliability was assessed by exploring the "standardized loadings of the items" that make up the measurement model. As recommended by Chin [102], the model is valid when the standardized charges of the elements that compose it all have a value greater than 0.6. In our case study they are between 0.674 (consumption of mango juice) and 0.906 (health-conscious and sustainable consumer). In particular, items with a loading value equal to or greater than 0.7 were found to be valid.

Moreover, according to the indications of Dash and Paul [45], the items should be kept in the measurement model only if their standardized loadings are equal to or greater than 0.6. Since in the model the loadings of the variables are all higher than 0.7, except one which is in any case higher than 0.6 (PPC3), the values fall within the acceptable range.

As for composite reliability (CR) values, all factors exceeded the recommended value of 0.7 [100,103,104]. This also applies to the AVE value, which is considered acceptable when it is equal to or greater than 0.50. As you can see, the variance shared between a construct and its items exceeds the variance of measurement error [39].

Among the goodness-of-fit indices, the Goodness-of-fit statistic (GFI) was evaluated, which estimates the proportion of variance provided by the expected covariance of the population. This index ranges from 0 to 1, and, usually, the widely recommended threshold is 0.90. However, for small samples and lower factor loadings, it should be higher than 0.95 [105]. In our example, GFI = 0.947 is within the valid value. Furthermore, regarding the "Adjusted goodness-of-fit statistic" index (AGFI), the value is well within the valid range (AGFI = 0.388). PLS-SEM is a random predictive method; Schuberth et al. (2023) [106] argued that among the goodness-of-fit indices, the standardized root mean square residual (SRMR) should also be included to examine the method. SRMR values should not be higher than 0.08 [45] In our processing, the SRMR index (equal to 0.074) was also valid [106]. AVE values have a score greater than 0.6, which confirms the validity of the applied model, as well as Cronbach's Alpha.

The discriminant validity of the model is examined with the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) correlation ratio.

The results illustrated in Table 5 show that each construct shares more variance with the items assigned to it (bold values on the diagonal of the table) than with the remaining constructs in the model, thus confirming the requirements of the Fornell–Larcker criterion who are satisfied [98].

**Table 5.** Discriminant validity: Fornell–Larcker criterion results.

| Fornell–Larcker | Mango Foods and Drinks | Propensity to Purchase | Point of Sale | Safety and Sustainability |
|---|---|---|---|---|
| Mango foods and drinks | 0.855 | | | |
| Propensity to purchase | 0.761 | 0.826 | | |
| Point of sale | 0.715 | 0.705 | 0.814 | |
| Safety and sustainability | 0.304 | 0.414 | 0.429 | 0.803 |

Source: the authors.

Many authors suggest using the HTMT correlation ratio because it has higher performance than the Fornell–Larcker criterion. The Heterotrait–Monotrait Matrix (HTMT) is useful for assessing discriminant validity in PLS-SEM. It should be less than 0.85 or equal to 0.90, according to a more lenient threshold, or significantly less than 1 [107,108]. As shown in Table 6, all HTMT values are less than 0.85/0.90, thus indicating good discriminant validity.

**Table 6.** Discriminant validity: Results of Heterotrait–Monotrait matrix (HTMT).

| Heterotrait-Monotrait Matrix (HTMT) | Mango Foods and Drinks | Propensity to Purchase | Point of Sale | Safety and Sustainability |
|---|---|---|---|---|
| Mango foods and drinks | | | | |
| Propensity to purchase | 0.884 | | | |
| Point of sale | 0.784 | 0.844 | | |
| Safety and sustainability | 0.324 | 0.506 | 0.513 | |

Source: the authors.

Table 7 highlights the results of the PLSpredict CVPAT procedure. As indicated by benchmarks [100,107], Q2 predict values are valid when they are greater than zero (0.000). Also valid are the evaluation metrics related to the "coefficient of determination $R^2$", which indicates the percentage of variance of the dependent variable explained by the independent variables of the model, Hair et al. (2017) [105] recommend $R^2$ values equal to 0.75, 0.50, 0.25 (substantial, moderate and weak).

**Table 7.** $R^2$ e $Q^2$ predict.

| | $R^2$ | $R^2$ Correct | $Q^2$ Predict |
|---|---|---|---|
| Mango foods and drinks | 0.092 | 0.090 | 0.085 |
| Propensity to purchase | 0.648 | 0.645 | 0.162 |
| Point of sale | 0.560 | 0.558 | 0.177 |

Source: the authors.

Table 8 highlights the results of the bootstrap procedure. To examine the formative measurement model, the indicators to be validated are also in this case the convergent validity (construct reliability and validity) and the statistics relating to collinearity (VIF indicators). Hair et al. (2017) [105] consider multicollinearity valid when the value is below the threshold value five and the minimum tolerance level of 0.20. Additionally, in this case, the statistics found with reference to collinearity are valid (Table 8).

**Table 8.** Results of the PLS-SEM process.

| Hypothesis | Paths | Path Coefficients | Confidence Intervals | | t-Value | *p*-Value | VIF | $F^2$ |
|---|---|---|---|---|---|---|---|---|
| | | | 2.5% | 97.5% | | | | |
| H3 | Mango foods and drinks → Propensity to purchase | 0.526 | 0.437 | 0.614 | 11.799 | 0.000 | 2.043 | 0.385 |
| H6 | Mango food and drinks → Point of sale | 0.644 | 0.581 | 0.701 | 20.931 | 0.000 | 1.102 | 0.854 |
| H1 | Point of sale → Propensity to purchase | 0.269 | 0.176 | 0.356 | 5.943 | 0.000 | 2.274 | 0.091 |
| H4 | Safety and sustainability → Mango foods and drinks | 0.304 | 0.206 | 0.404 | 5.985 | 0.000 | 1.000 | 0.102 |
| H2 | Safety and sustainability → Propensity to purchase | 0.139 | 0.062 | 0.222 | 3.354 | 0.001 | 1.226 | 0.045 |
| H5 | Safety and sustainability → Point of sale | 0.234 | 0.160 | 0.306 | 6.297 | 0.000 | 1.102 | 0.113 |

Source: the authors.

According to Cohen (1998) [109], to evaluate $F^2$ specifies the following values apply: 0.02 is a small effect, 0.15 is a medium effect, and 0.35 is a large effect.

As can always be seen from Table 8, all the hypothesized paths are valid. In particular, paths H6 and H3 are those with a greater effect and greater t-value, followed by H5 and the others. They are the PLS-SEM paths with the t-values and *p*-values of the different hypothesized paths.

In detail, "Mango drinks → Point of sale" (respectively t-value = 20.931 and *p*-value = 0.000), followed by H3 "Mango foods and drinks → Propensity to purchase" (11.799 and 0.000), and by H5 "Safety and sustainability → Point of sale" (6.297 and 0.000).

Also valid are paths H4 "Safety and sustainability → Mango foods and drinks" (t-value 5.985 and 0.000 significance), H1 "Point of sale → Propensity to purchase" (t-value 5.943 and 0.000) and finally H2 "Safety and sustainability → Propensity to purchase", with the lowest value of t-value 3.354 and a *p*-value equal to 0.001.

### *5.3. Multi-Group Analysis (MGA)*

Multi-group partial least squares analysis (PLS-MGA) was also applied in this work to help analyze the influences of differences in factors within groups

The recommended approach in the PLS-SEM multi-group analysis which considers two groups—in our case, Italy and Brazil—is non-parametric

Multigroup analysis (MGA) gives us the opportunity to test differences in group-specific parameters (external weights, external loads and path coefficients). The results are based on the bootstrap of each group: in detail, the two groups, from Italy and Brazil, were selected, and all the procedures were performed to evaluate any significant differences in the parameter estimates (external weights, loadings external and path coefficients). All data sets selected in the Italy Group were compared with all data sets and research hypotheses selected in the Brazil Group.

The data are verified with the FIMIX segmentation procedure, which is an approach based on latent classes that allows for the identification and treatment of heterogeneity not observed in PLS-SEM. The permutation procedure checks whether the predefined data groups have statistically significant differences in the estimates of the group-specific parameters and also supports the MICOM (Measurement Invariance Assessment) procedure.

The MGA was conducted with reference to the two countries under investigation, Italy and Brazil, to examine and compare the path coefficients, ensuring that all the constructs in the two groups are reliable and valid. The results of bootstrapping the models are shown in Table 9.

**Table 9.** Multi-group analysis: Bootstrap results—Path coefficients.

| | | **Path Coefficients** | | **Average** | | **DEVST** | | **t-Value** | | ***p*-Value** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Hypothesis** | **Brazil** | **Italy** | **Brazil** | **Italy** | **Brazil** | **Italy** | **Brazil** | **Italy** | **Brazil** | **Italy** |
| Mango foods and drinks → Propensity to purchase | H3 | 0.361 | 0.544 | 0.361 | 0.544 | 0.055 | 0.059 | 6.591 | 9.262 | 0.000 | 0.000 |
| Mango food and drinks → Point of sale | H6 | 0.493 | 0.479 | 0.493 | 0.482 | 0.057 | 0.058 | 8.643 | 8.279 | 0.000 | 0.000 |
| Point of sale → Propensity to purchase | H1 | 0.274 | 0.310 | 0.273 | 0.310 | 0.058 | 0.071 | 4.744 | 4.380 | 0.000 | 0.000 |
| Safety_and sustainability → Mango foods and drinks | H4 | 0.443 | 0.392 | 0.446 | 0.396 | 0.052 | 0.073 | 8.494 | 5.365 | 0.000 | 0.000 |
| Safety_and sustainability → Propensity to purchase | H2 | 0.350 | 0.006 | 0.352 | 0.008 | 0.055 | 0.060 | 6.401 | 0.097 | 0.000 | 0.923 |
| Safety_and sustainability → Point of sale | H5 | 0.339 | 0.281 | 0.340 | 0.284 | 0.060 | 0.065 | 5.683 | 4.338 | 0.000 | 0.000 |

Source: the authors.

As can be seen, all paths except one are valid and significant with reference to individual countries. The research hypothesis H2 "Safety and sustainability towards purchasing propensity" is not supported for Italian consumers (*p*-value = 0.923). A greater difficulty

therefore emerges for Italy when making purchase decisions. However, it does not manifest itself when choosing the product (H4) and/or the point of sale (H5) in detail due, most likely, to the trust placed in the seller and/or in the labeling to guarantee the origin and processing of the product. The difference between the two countries is also highlighted with reference to the t-value (Brazil = 6.401 and Italy = 0.097).

In Italy there is a greater propensity to purchase mango foods and drinks (H3), thanks to the wide range of products available on the market; in fact, in Italy a t-value = 9.262 was recorded compared to the Brazilian value equal to t-value = 6.591. On the contrary, in Brazil mango foods and drinks are local products and considered safer, healthier and more sustainable than in Italy (H4). The t-values in Brazil are a little higher than in Italy (8.494 and 5.365 respectively). In the other hypotheses the paths are very similar and differ slightly.

## 6. Discussion

In our study, we highlight how consumption preferences influence the acceptance and subsequent propensity to purchase fresh mango and mango-based products. In particular, hedonic variables and sensory feelings, such as organoleptic characteristics, are important predictors of consumption and purchase intentions regarding fresh mango and mango-based products; nevertheless, we highlight an increasing interest in sustainable nutrition and lifestyles oriented towards health and food safety [110].

These results are in line with the work of Kiloes et al. (2021) [73], which illustrates the importance of general consumer expectations for fresh and processed tropical fruit. The authors present a systematic review of the literature on consumers' perception of mango quality, summarize the intrinsic and extrinsic quality aspects (identified in the various scientific articles consulted) and report that taste and sensory experiences in particular play a predominant role in shaping consumer satisfaction and therefore in the acceptance of mango and tropical fruits in general.

Our study also highlights a preference for mango-flavored food and drinks purchased and consumed primarily because they are liked (in fact, taste and organoleptic qualities are considered important) and secondarily for the trust given to the place of purchase and sellers. The PLS-SEM analysis approach that we applied in the study shows, in fact, a particular attention to the choice of the point of sale (Hypothesis H6, "mango food and drinks → Point of sale") expressed by the consumers interviewed, which records a t-value equal to 20.931 and $F^2$ 0.854; this preference is followed by the research hypothesis H3 on the propensity to purchase "Mango food and drinks → Propensity to purchase" (t-value = 11.799 and $F^2$ = 0.385).

As for the hypotheses H4 "Security and sustainability → Mango Food and Drinks" and H1 "Point of Sale → Propensity to Purchase", consumers manifest a very similar interest even if less strong (respectively, for the H4 T hypothesis-Value = 5.985 $F^2$ = 0.102, and H1 T-Value = 5.943 $F^2$ = 0.091). Finally, with reference to the H2 research hypothesis "Safety and sustainability → Propensity to Purchase" (T-Value = 3.354 and $F^2$ = 0.45), it is evident that the inseci-spas have also emerged from the PLS-MGA analysis manifested by especially Italian consumers. In less recent years, some authors also reported that consumers are not willing to compromise on taste for a promise of better nutritional and health value [111,112].

In this framework, the propensity to consume novel foods and the tendency towards gastronomic multiculturalism, together with the influence of nutritional information on mango, tropical fruits and their processed products, have been the object of further attention in this study as suggested by Sabbe et al. (2009) [111] "*Other issues to be explored in future studies are the effect of other extrinsic characteristics, like origin (e.g., country and production system) and neophobia on the acceptance of novel fresh and processed tropical fruit products. Additionally, further investigation is recommended on nutrient composition and dietary contribution of tropical fruits to human nutrition to find more objective reasons to promote tropical fruit consumption*".

Food safety and environmental and social sustainability influence the propensity to consume and purchase fresh mango and mango-based products both directly (H2) and indirectly, through the mediation connected to the point of sale (H5) and the mediation determined by the wide range of mango foods and the different varieties of mango products available on the market (H4), both in Italy and in Brazil. Among these, in the third position we find the hypothesis H5 relating to the path "safety and sustainability → Point of sale" (t-value = 6.297 and $F^2$ = 0.113) which confirms the importance for the consumer to purchase or consume fresh mango and mango-based products in the "right place" either for the type of product purchased (greengrocer, retail, large-scale distribution or consumed outside the home in bars, restaurants, etc.), or for the relationship of trust with the shop or the place of consumption. As for the hypothesis H2, the path "safety and sustainability → Propensity to purchase" highlights, both overall and in the comparison between the two countries, major discrepancies, confirming how in Italy there is a greater need for consumers on the importance of food safety and environmental and social sustainability.

In detail, the variables that characterize the latent factor relating to safety and sustainability are the importance for consumers of nutritional values, place of origin and environmental and social sustainability. Therefore, food and nutrition and ethical and social values are important predictors and guide the choice of products to purchase. They represent relevant aspects for an overall vision of market dynamics, further accentuated by the current surge in consumer demand for mango and fresh and processed tropical fruit.

In particular, the relationship between taste and nutritional aspects highlights how perceptions related to health and nutritional aspects can influence a person's taste experience [113] and supports the findings of the literature according to which consumers are inclined to purchase mangoes for their peculiarities such as taste and nutritional content, usually associated with health and well-being and an awareness of the importance of a diet rich in fruit and vegetables.

As for sustainable content, it is met with consumer approval in both countries and is characterized by interest in quality and the origin of the products purchased/consumed and concern for the environmental impact of the production, transportation and processing of mangoes. The results that emerged highlight the importance of the origin of the product (by variety and place of cultivation), the preference in both Brazil and Italy for local production and the increasing demand for high-quality and environmentally friendly food products, safe and free of pesticide residues, toxins and harmful microorganisms. These are ethical values that encourage sustainable practices among contemporary consumers, preserve the environment and promote long-term common well-being. Responding to these needs is important to support the mango supply chain in formulating appropriate strategies to improve the quality, traceability and tracking of products, labeling, sustainable packaging and green certifications [111,114].

The work provides useful information in both the theoretical and marketing fields. From a theoretical perspective, the study enhances the growing body of empirical evidence in the field of consumer preferences, paving the way for an exploration of the impact of food values on the purchasing behavior of tropical fruits, especially mango. Furthermore, the findings have actionable implications for marketing strategies. For example, the study suggests that product knowledge can be improved through information campaigns that describe in detail the characteristics and provenance of mangoes. Furthermore, consumer interest in nutritional aspects and product origin should push for better and more effective product labeling to provide more information and stimulate mango consumption.

## 7. Limitations and Implications for Future Studies

This study presents some limitations, relating to the research method used and the nature of the data analyzed. A first limitation arises from the choice of the interviewees through online sampling. Due to this recruitment plan, the results cannot be generalized beyond the characteristics of the sample. Another limitation is that analyses and clusters were not applied for socio-demographic characteristics and their relationship with the

expectations and acceptability of tropical fruits and derived products. Consequently, important characteristics that determine consumers' expectations of fresh and processed tropical fruit products may have been overlooked in this work. Therefore, the results achieved from this study should be considered mainly exploratory and would therefore benefit from further testing based on the use of larger and more representative consumer samples.

In this work, a relationship between taste and health and nutritional benefits of tropical fruits was studied. Since some tropical fruits have nutritional and health values, more research needs to be conducted to gain a better understanding of taste, i.e., hedonic benefits, and other benefits such as health advantages. In this framework, the influence of nutritional information on the acceptance of tropical fruits and their products deserves further attention, for example, in relation to sports activities, well-being and healthy, safe and quality dietary patterns. Other issues to be addressed in future studies are the effect of other characteristics such as origin (country or place of provenance and production system) and neophobia on the acceptance of new fresh and processed tropical fruit products. Furthermore, further investigations are recommended on the nutrient composition and dietary contribution of tropical fruits to human nutrition to find more objective motivations to promote tropical fruit consumption [22,56,111,113].

## 8. Concluding Remarks

The PLS-SEM methodology applied in the study examines the variables that influence the propensity to purchase of Italian and Brazilian consumers and provides food for thought for companies that want to approach the production of mango and mango-based products, indicating which levers to act on. In fact, consumers say they like the taste, the aroma and all the organoleptic characteristics of mango, both fresh and processed, and that they orient themselves towards the point of sale based on the type of product they intend to purchase. The aspect relating to safety and sustainability is also confirmed as consumers say they can consider local productions as green products both in Brazil and, subject to availability, in Italy. These results are in line with the studies by Parashar et al. (2023) [56], who highlighted how much interest in sustainable foods and healthy lifestyles has increased. Furthermore, aspects related to multiculturalism, openness and curiosity towards new and exotic products and foods are also appreciated factors in both countries, as well as the recent trend of relying on social media for knowledge and purchases. The consumption of fresh fruit is subject to transformations; in particular, young people are attracted by new products. Mango, like other fruits, is often consumed ready to use and/or accompanied by salads and first courses, both in Italy and in Brazil.

For some years in southern Italy, tropical fruits have contributed to enriching the local cultural heritage thanks to its favorable geographical position, mild climate and suitable growing conditions. Tropical fruits grown in Southern Italy can be harvested at the right time of ripeness, ensuring maximum freshness and maintaining their nutritional and organoleptic characteristics unaltered. The consumption of tropical fruit and in particular mango has also had an interesting expansion in Italy and a strong boost that has contributed to broadening and enriching the Italian gastronomic panorama.

From these considerations it emerges that the issues that revolve around early harvesting, especially for export markets, have become very important in assessing the quality of fruit along the entire supply chain up to the consumer [79]. Accurately detecting the correct maturity of the mango crop is essential to ensure a product with optimal qualities since the quality of the crop is very often linked to its level of maturity; in fact, the ability to accurately determine the optimal time for harvest is essential to maintain fruit quality, ensure high market value and minimize post-harvest losses that may arise during the transportation and marketing period. In post-harvest handling, mango fruits can be affected by pathogens; the presence of these pathogens can generate post-harvest losses of between 5 and 30% of mango production.

These aspects, while confirming the high potential of southern Italy for mango production [115], are very important in developing countries producing tropical fruits, which

represent not only a fount of nutrition but also a source of income generation for farmers who produce them for export. However, if Western consumers appreciate the fruit in its varied and composite declinations, from guacamole to poké up to oil for cosmetic and food uses, this development would not occur without consequences in the places of production, and it is necessary to distinguish an ethical and sustainable diet from a trendy diet. Furthermore, climate change and irregular weather events increasingly represent a particularly serious challenge for the cultivation of tropical fruit because the vast majority of production is obtained in small farms of less than 5 hectares where cultivation depends heavily on rainfall.

On the other hand, tropical fruits are a relatively new group in global commodity trade and have only emerged as important in the international market since 1970. Export volumes of fresh tropical fruits from emerging or developing countries show the fastest average annual growth rates among internationally traded food commodities. These countries have become global agricultural suppliers. In this regard, the international community must manage and combine environmental protection and the growth of an export-based economy, so that cultivation does not expand at the expense of forests and human rights, aiming for more sustainable alternatives in terms of $CO_2$ emissions, the preservation of ecosystems and safeguarding the dignity of the most disadvantaged populations [116]. Value chains are vulnerable to risks and shocks that are beyond the control of any single actor. Therefore, concerted actions can benefit all stakeholders in the sector. FAO is leading the project "Building responsible global value chains for sustainable tropical fruit production and trade", also known as the "Responsible Fruits Project". The aim is to connect production systems with consumers and ensure their continuity of operation is essential for local and global food security, in the awareness that agricultural markets, supply chains and sustainable development are at the heart of the development process.

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# Habits, Health and Environment in the Purchase of Bakery Products: Consumption Preferences and Sustainable Inclinations before and during COVID-19

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**Abstract:** The aim of the research is to investigate whether purchasing decisions about bakery products (bread, snacks and biscuits) are influenced by concerns about health, climate change, biodiversity loss and food waste. The exploratory survey was carried out in two successive moments before and during the health emergency from COVID-19. Before the health emergency, face-to-face interviews were carried out using a structured questionnaire. Data were analyzed by factor analysis, reliability tests and descriptive analysis. Structural equation modeling (SEM) was employed to test the research hypotheses. The results of the modeling analysis of the structural equations highlighted that health and the environment represent an important background in the consumer experience of the respondents and influence the attitude and intention to purchase safe and environmentally friendly bakery products. Furthermore, the results suggest that informed, modern and aware consumers have direct and indirect effects on the intentions to adopt sustainable attitudes. On the contrary, the perception relating to the shops where consumers buy bakery products does not always show a significant influence on the propensity for sustainability. During the health emergency, the interviews were conducted online. Families confined to their homes, buying less in stores, have prepared many baked goods manually at home. The descriptive analysis of this group of consumers shows a growing attention to points of sale and the tendency to use online shopping. Furthermore, the changes in the type of purchases and the importance attributed to the need to reduce food waste emerge.

**Keywords:** bakery products; sustainable foods; consumers; exploratory factor analysis; PLS-SEM



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## 1. Introduction

The processes of social transformation underway in recent decades have radically changed the world of food and the agri-food sector [1–3]. The COVID-19 crisis has changed people's daily routines: isolation, remote working, increased sedentary lifestyle and the frequency of meals and snacks, mood changes, anxiety and health concerns have conditioned the choices and reasons for food preferences, the choice of outlets and purchasing methods [4–8]. In the current post-COVID-19 period, the European consumer is looking for quality and healthy foods with natural ingredients to protect themselves from disease, protect the environment and provide sustainability to local economies [9–11].

The scientific literature is full of theories concerning the consumer, not only and not so much with reference to aspects of a strictly economic nature (consumption/production) but also to social, psychological and environmental aspects linked to respecting and protecting the environment. Ethics, responsibility, ecological orientation and sustainability are some of the new models that individuals are looking for, also subjecting their food choices to continuous revisions and reflections [12]. Sharing platforms, social media, influencers, attention to food waste, social networking networks, etc., represent a new economic and cultural approach to dealing with food [13–17].

Bread and baked goods are products linked to every moment of the day (meals, sweet and/or savory snacks, parties, sports, etc.) to the daily life of Italians and many populations, and also enjoy a continuous demand for innovative products that reflect the interest of producers in the request for long leavening times and the careful selection of raw materials (unrefined flours, lots of fiber, little gluten). Consumers have renewed interest in preventing food waste and increasing interest in bread in many areas of Southern Italy; people do not throw it away but instead use it for other preparations and/or for other uses. Furthermore, aroma, fragrance and flavor are associated with pleasure and health. Consumers are becoming increasingly attentive to nutritional profiles; even bread and bakery products have become the object of research in terms of well-being, not only physical, but also psychological [18,19].

Even in Italy, food consumption has long since reached a defined phase of satiety; on this basis, the main needs are now satisfied, and the nutritional availability is higher than the physiological needs of the population. The demand for bread and bakery products has also changed: the consumption of bread has decreased, and the requests for a wide range of bakery products have increased. This situation has led to the development of new food consumption patterns and the emergence of new products with specific production and quality standards adapted to the rules that protect the consumer. Today, consumers are more attentive and inclined to make purchasing decisions with greater awareness. They are more informed and prefer food that meets the requirements of food safety and environmental, social and economic sustainability without neglecting the ethical aspects related to the protection of territory, biodiversity, working conditions and, in general, the resources to be handed over to future generations [20]. The new characteristics of the demand (based on a vast range of food products that focus on quality) have been implemented by the players in the supply chain who have adapted to the new market conditions to create products that meet the new needs of consumers [21–23].

In light of these new needs requested by the consumer, in addition to guaranteeing the safety, digestibility and palatability of the product, companies aim to use food processing processes that lean toward circular economy production models and the reuse/recycling of by-products and waste as resources to obtain new products. In recent years, food has become increasingly industrially processed [21,24,25]. Companies are also looking to improve shelf life and make it easier for consumers to prepare meals when needed [22]. Product and process innovations that introduce new nutrients and improve the shelf-life of sustainable food and packaging are also aimed at reassuring consumers in terms of ethics and attention to the environment, climate and biodiversity [23,26].

The purpose of this analysis is to investigate the decision-making process of consumers' choices when purchasing bakery products and, in particular, in relation to the following: 1. The importance attributed to environmental, social and economic sustainability; 2. The attention they pay to health and food safety requirements; 3. Curiosity and the search for information; 4. Preferred points of sale for the purchase of different types of bakery products (bread, snacks and biscuits). The study explores the degree of awareness of a sample of consumers in Southern Italy regarding the attention to food quality and safety and the adoption of virtuous and sustainable behaviors into their lifestyle.

Many researchers have explored a number of factors that influence people's perception of their inclination toward sustainable food and environmental and social sustainability [20,27–30]. Some studies have attempted to combine various psychological determinants into a predictive model of behavioral intentions [31–34].

In the first period of the survey, to analyze the possible choice preferences of the people interviewed face to face, the research questions revolved around the reasons for the choice, such as quality and safety, taste, experience, habits, points of sale and, in particular, the focus was to grasp the critical awareness of the interviewees in terms of environmental and social issues and the importance of the drivers of preference in their choice of store.

Our hypothesis is that consumer behavior responds differently on the basis of predisposition and inclination toward sustainability.

To confirm our intuition, we applied a methodology that included factor analysis and partial structural least squares equation modeling (PLS-SEM), which has recently received increasing attention in research and practice in various disciplines, such as management, marketing, political and environmental sciences, and other fields.

A separate discussion relates to the online interviews carried out during the lockdown. People were confined to their homes and, especially women, responded quickly and willingly to the structured questionnaire in a simpler and more direct way. The main objective, in this case, was to investigate the changes in terms of family organization during the lockdown in relation to the purchase and preparation of food, particularly bakery products.

The paper is structured as follows: The introductory section is followed by a description of the bakery products sector. Subsequently, the conceptual framework and the research method are outlined. The latter presents the results examined before and after the COVID-19 pandemic, discussion and conclusion.

## 2. Bakery Products

The bakery products sector includes a large and varied set of products, and in 2021 a total production of 1,310,412 tons was recorded in Italy, up by 2.6% from 2020, for a total value of 6310.8 million euros, an increase of 6.7 percentage points compared to the previous year.

The pandemic, war in Ukraine, inflation and energy price increases have led to a marked increase in the price of bread which, according to Eurostat monitoring, grew in August 2022 by 18% on average compared to the same month in 2021. Eurostat notes that the consequences of the Russian invasion of Ukraine (two giants in cereal exports), are at the basis of the widespread increase in prices. The largest increases in the cost of bread in the period August 2021–August 2022 were recorded in Hungary (+66%), Lithuania (+33%), Estonia and Slovakia (+32%). The least-affected countries were instead France (+8%), Holland and Luxembourg (+10%). In this context, Italy ranks below the EU average (+13.5%). To highlight the sensational jump in prices, for a comparative purpose, the European Institute of Statistics recalls that between August 2020 and August 2021, the average increase in the price of bread in the EU was 3%.

However, despite the difficulties, bread, a food symbol of the Mediterranean culture and diet, has not lost its centrality in the daily life of Europeans and confirms itself as a refuge food, even in times of crisis.

In fact, bread unites the nations of the Mediterranean "making/(producing) bread" helps to strengthen the image of a united and plural Mediterranean that, still today, perpetuates traditions and cultural identities.

The model of bread consumption is diversified; from the 2020 data, the highest levels are recorded in Romania, with 88 kilos per capita per year, followed by Germany (80 kilos every year), followed by the Netherlands (57 kilos), Poland (52 kilos), Spain (47 kilos), France (44 kilos) and the United Kingdom, with 43 kilos per capita, and lastly, Italy, which consumes 41 kilos of bread each year.

Among the products protected by the trademarks of the European Union we find in category 2.3: "Bread, pastry, cakes, confectionery, biscuits and other baker's wares", relating to bakery products, there are 101 certifications, and the sector is constantly evolving. In particular, the EU site "eAmbrosia: is a legal register of the names of agricultural products and foodstuffs, wine, and spirit drinks that are registered and protected across the EU. It provides direct access to information on all registered geographical indications, including the legal instruments of protection and product specifications". The Italian segment has four Protected Designation of Origin (PDO) products and 12 Protected Geographical Indication (PGI) products (Table 1).

**Table 1.** Class 2.3. Bread, pastry, cakes, confectionery, biscuits and other baker's wares. Product type Food, PDO and PGI in Italy (Data of January 2023).

| File Number | Name | Status | Date * |
|---|---|---|---|
| PDO-IT-01016-AM01 | Pane Toscano | Published | 29 September 2022 |
| PGI-IT-02467 | Pampepato di Terni/Panpepato di Terni | Registered | 23 October 2020 |
| PGI-IT-02392 | Südtiroler Schüttelbrot/Schüttelbrot Alto Adige | Registered | 24 July 2020 |
| PDO-IT-01016 | Pane Toscano | Registered | 4 March 2016 |
| PGI-IT-01290 | Cantuccini Toscani/Cantucci Toscani | Registered | 26 January 2016 |
| PGI-IT-01323 | Pampapato di Ferrara/Pampepato di Ferrara | Registered | 8 December 2015 |
| PGI-IT-0944 | Focaccia di Recco col formaggio | Registered | 14 January 2015 |
| PGI-IT-1067 | Piadina Romagnola/Piada Romagnola | Registered | 4 November 2014 |
| PGI-IT-1101 | Torrone di Bagnara | Registered | 14 August 2014 |
| PGI-IT-0795 | Panforte di Siena | Registered | 22 May 2013 |
| PGI-IT-0666 | Ricciarelli di Siena | Registered | 19 March 2010 |
| PDO-IT-0577 | Pagnotta del Dittaino | Registered | 18 June 2009 |
| PGI-IT-0372 | Pane di Matera | Registered | 22 February 2008 |
| PDO-IT-0136 | Pane di Altamura | Registered | 19 July 2003 |
| PGI-IT-0120 | Coppia Ferrarese | Registered | 18 October 2001 |
| PGI-IT-1553 | Pane casareccio di Genzano | Registered | 25 November 1997 |

Source: eAmbrosia is a legal register of the names of agricultural products and foodstuffs, wine and spirit drinks that are registered and protected across the EU. * Last registration/modification Date.

Bakery products obtained by cooking a leavened dough prepared with floured wheat, water and yeast, with or without the addition of common salt, is called "bread". The bread can be sold loose by weight or pre-packaged and pre-wrapped.

The generic term "bakery products" refers to foods obtained by cooking leavened dough, in which the basic ingredients are flour, water, yeast and salt. In Italy, these products fall within a specific economic category defined in the ATECO, and the products that fall within it can be traced back to six sub-categories: biscuits, crackers, baked sweets, focaccia, pizzas and cakes [35]. For bakery products, there are two classes involved, class 10.71 and 10.72. According to the international ISIC system, it is Class 1071, Manufacture of bakery products; in NACE Rev2, these activities are included in class 10.71 [36,37].

Most of these products are part of the traditions and history of individual countries, while others are the result of contamination and globalization that is found both in uses and in food. Increasingly, the current trend is to replace wheat with various grains, corn, fiber and other foods, which include various proteins. This has caused a substantial increase in the production and consumption of alternatives such as crackers, rusks, bread sticks and sliced bread; especially in countries with advanced economic development, there is a tendency toward the contraction of bread consumption [38].

These are longer-lasting products that are much more compliant with consumption which, in a more frenetic lifestyle, often does not facilitate the use of foods that must be purchased on a daily basis. After all, specific surveys on consumer behavior show that fresh bread is among the main foods subject to food waste, and this is due to the need for daily consumption [39]. Bread and bakery products form an essential component of the human diet worldwide [19] and constitute a very important segment of the global food industry [40]. The interest of scholars is great, with very diversified research on bakery products and alternatives to them [41,42], including the diffusion of functional bakery products [43–47].

## 3. Survey Method

### *3.1. Work Plan, Data Collection*

The data were collected before and during the COVID-19 pandemic. In 2017, before the health emergency, the sampling scheme envisaged a random system for the identification of the consumer. The data collection was carried out face-to-face with consumers who were willing to be interviewed and intercepted in Southern Italy (especially in Calabria and

Sicily). A semi-structured questionnaire with free and/or preformulated answers was used. In order to meet a sample with non-homogeneous characteristics and intercept consumers with different purchasing methods and abilities, the questionnaire was administered in particularly crowded places, such as bus terminals, railway stations and ports, main roads, retail outlets, mass-market retailing (MMR), local markets and local food and wine events. The forms prepared were tested on various occasions, allowing for modifications to be made to the questionnaire to better adapt and perfect it for the purposes of the research. In total, 742 questionnaires were completed, of which 22 were discarded, with a valid response rate of 97% (720 valid responses).

The questions in the questionnaire aimed to identify the following:

- Socio-demographic characteristics of the interviewees;
- Information on the consumption and type of bakery product purchased (artisanal/local or industrial)
- Information on the place of purchase of the products;
- Frequency and quantity purchased;
- Description of buying behavior.

In this last section of the questionnaire, particular attention was paid to consumer awareness of the sustainability implications of the products purchased. The questions concerned the conditions of choice on food quality and safety, taste, experience, habits and attention to environmental and social issues that can influence preference. In particular, consumers were asked if they pay attention to the origin of the raw materials, the information on the label, the importance of biodiversity, packaging, certification marks, nutritional information, the reputation of the manufacturing company, traceability and tracking, the clarity of the transformation procedures, the possibility of purchasing online and the adequacy and correctness of advertising.

This study used closed-ended questions that were prepared by taking into account the research of studies present in the literature and that were useful for measuring the tendency and sustainable inclination of consumers on the purchasing choice processes. The questions were arranged to collect both binary (yes/no) answers and multiple choice. The scoring is based on a five-point Likert scale, with responses indicating the following: 1 = not relevant, and 5 = very relevant. The compilation of the questionnaire was carried out by the authors and by collaborators/researchers educated and trained in field research [31,48,49].

The extent and complexity of the survey tool used have made it possible to obtain an abundant mass of data and information. The database was created through the use of SPSS V20 and PLS3 software. In total, 35 variables (previously coded) were entered, following the order of the questions posed in the questionnaire, in order to create a database aimed at detecting consumer behavior.

In 2020, the interviews were carried out online, and 474 consumers scattered across various regions of Southern Italy were intercepted. This approach has allowed us to examine some attitudes regarding the consumption preferences of bakery products.

We structured the questionnaire administered online in 2020 during the confinement period caused by the COVID-19 pandemic in a simpler way with a specific set of predefined questions in order to obtain greater participation. The data were collected from March to April 2020. In that period, the state of the pandemic was in force in Italy.

In Italy, we were going through the so-called phase 1, which lasted from February to May. A distinctive element of this phase was home isolation: Italians were obligated to stay at home, only being able to go out for the exceptions of proven work needs, situations of primary necessity or health reasons. During these months, the use of electronic devices and the internet became increasingly frequent, and the power of sharing through social networks increased (the hashtag #stayhome has been typed in by Italian users 245,000 times). Combining the restrictions of the lockdown and the possibility of resorting to a remote survey methodology, we have formulated an online questionnaire that can be filled out online and which is written in an intuitive language that is accessible to everyone, launched using the Microsoft Forms platform. Of all the social networks used for sharing,

including the WhatsApp messaging application and the Instagram platform, the one that played a crucial role was the Facebook portal.

The questionnaire was, in fact, published on the electronic bulletin boards of various groups, obtaining a particularly significant response from women, representing approximately 75% of the entire sample of users. This clear female majority is dictated by the fact that these groups have been used a lot by women to exchange useful advice in various fields: domestic/culinary, above all.

From a methodological point of view, the online survey is configured as snowball sampling. In addition to being a forced choice by the pandemic, the choice of this type of sampling also made it possible to reduce the time and costs of the investigation. The technique allows for the acquisition of data through one's acquaintances together with the use of social networks and in which each study subject recruits other subjects among his/her acquaintances [50,51], a sort of chain reaction.

The questionnaire was relaunched and advertised several times through online social networks. A total of 486 questionnaires were completed, of which 12 were rejected, resulting in a valid response rate of 97% (474 valid responses).

### 3.2. Methodological Approach

The methodological approach adopted for this research followed two directions before and during the COVID-19 pandemic, as illustrated in the data collection phase.

The data collected before the COVID-19 pandemic were processed using multivariate analysis techniques. To identify which drivers move consumers in the process of choosing the baked goods to be purchased/consumed, an exploratory factorial analysis (EFA) was carried out based on the analysis of the main components (PCA). The model aims to reduce the number of predictors in the factor dimensions by minimizing the loss of variance [50,52]. The analyses highlight latent factors. The reliability of the model was evaluated using two different tests: Kaiser–Meyer–Olkin (KMO) and Bartlett's spherical test [53,54]. Subsequently, the analysis of the models of structural equations was carried out (PLS-SEM) to test the hypotheses concerning the relationship between the determining factors and the sustainable behavior of consumers [32,33,55–57].

In the context of the literature concerning food consumption, many studies have applied the Theory of Planned Behavior (TPB) [58] to investigate the intentions and behaviors of consumers. The predictive power of TPB has been successfully applied in many research fields on food consumption, such as those concerning healthy behaviors [59,60], healthy eating, pro-environmental behaviors and the consumption of organic foods [55,61,62].

The modeling of structural equations (SEM) has become the methodology of choice for many researchers who study complex relationships between latent constructs, such as in marketing, consumer choices, and other fields. Its ability to evaluate complex measurement models and structural paths that involve many variables and construction levels has allowed researchers to investigate complex relationships that previously could not be easily examined. As highlighted by Lei and Wu [56], SEM represents an advanced version of the general modeling procedures and is used to evaluate "*if an hypothesized model is consistent with the data collected to reflect [the] theory*" [56].

The theoretical framework in this study resumes the model widely used by Partial Least Squares Structural Equation Modeling (SEM). The model allows for the explanation of more statistical relationships simultaneously [57] to understand the relationship between latent constructs (factors), generally indicated by different sizes, and adopts a confirmation approach after examining the data with exploratory analysis, and latent factors are explained through dependence reports [63]. SEM provides a single complex model that includes various dependence and independence relationships between constructs. Recently PLS-SEM) has become rather popular among researchers/scholars [64–68].

In this study, PLS is used as the data analysis tool for the research model. PLS is an SEM analysis technique based on regression analysis, which is a statistical method derived from path analysis. Using PLS analysis, it is possible to examine both the mea-

surement model of the research instrument and the structural model of the research component [65,69–71]. Furthermore, PLS can also be used with a smaller sample size. Compared to other analysis models, PLS requires multivariate constant assumptions and is better at predicting and has greater flexibility [67,68]. The PLS analysis software used in this study is SmartPLS3 and uses the blindfolding procedure to check the significance of the paths in the structural model.

### 3.3. Research Hypothesis

The conceptual framework for this study is presented in Figure 1, which illustrates the potential reasons that influence the behavioral intention to identify a sustainable inclination of consumers. The perceptions of risks concerning climate change, the loss of biodiversity and food safety and the perception of the benefits related to environmental and social respect and health are considered predominant factors that contribute to the adoption of sustainable behaviors. When individuals or groups of consumers perceive that there are potential benefits from attentive behavior to the environment and society, they are more inclined to adopt sustainable food choices, especially for widely consumed products, such as baked goods.

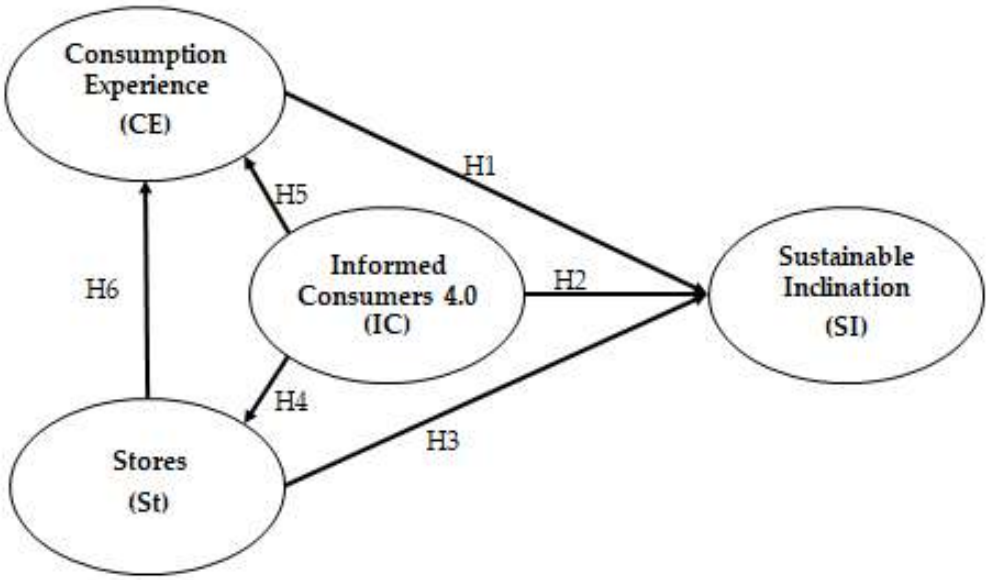


**Figure 1.** Conceptual model hypothesized in analysis. Source: Authors elaboration from data analysis in Smart-PLS3.

The favorite points of sale in terms of consumers, availability and the possibility of online purchase also come into play in these choices. When consumers perceive that clean and sustainable production and transformation methods could lead to major well-being in society, that technology can improve the quality of life, that it is worth trying new food products and that food is important for a healthy lifestyle, then consumers have a greater possibility of perceiving greater benefits and fewer risks to their health and the environment, accordingly, they adopt adequate choices and behaviors.

#### 3.3.1. Consumption Experience (CE): Health Awareness and Environmental Awareness

Health awareness and well-being expectations are thought to be key variables influencing buyer intent [59,62].

Food safety, nutritional aspects, the flour and raw materials used, production and marketing are important elements for consumers. Therefore, health consciousness evaluates an individual's readiness to take health-related actions and represents the most significant reason for the conscious purchase and the consumption of food with safety requirements

related to bread and baked goods and is an important predictor of the intention to purchase such foods.

Furthermore, hedonistic variables and sensory emotions, such as aroma, flavor, freshness, crunchiness and product appeal, are important predictors of purchase intentions and highlight a growing interest in sustainable food and health-oriented lifestyles [72].

Environmental awareness also plays an important role with regard to the sustainable inclination and intention to buy environmentally friendly food. It refers to the *"emotional point of view of individuals on the environment"* [31]. Issues relating to environmental friendliness are applied by consumers to food in relation to the origin of raw materials and information concerning production, processing, marketing, etc. The environmental awareness of consumers encourages their positive attitude toward the purchase of foods that meet environmental sustainability requirements.

Awareness of health and environmental aspects represents the consumer's wealth of knowledge and the consumer's experience. These are subjective norms derived from consumption habits that are influenced by social stress from others, such as friends and family, causing individual motivation to engage in and respect group behavior [31]. The subjective norm is a critical factor affecting social influences and behavioral intentions. Previous analyses have also revealed a significant relationship between attitude and subjective norms [73]. If people who are meaningful to consumers offer positive opinions and attitudes toward sustainable food patterns, consumers will be more likely to have a positive intention to buy food with sustainability requirements.

In this regard, a study of two developing nations, namely Tanzania and Kenya, found that health consciousness, along with personal attitude and individual norms, are important parameters influencing the intentions behind consumer purchases [31].

Based on these arguments, the following hypothesis is formulated.

**Hypothesis 1 (H1).** *The consumer experience (CE) and subjective norms has a positive and significant impact on consumers' inclination towards a model of safe, sustainable, ethical and responsible consumption.*

#### 3.3.2. Informed Consumers 4.0 (IC) and Choice of Points of Sale (St)

In the past, consumers were mainly informed about food by newspapers, magazines and television advertisements, and the main motivation for purchasing organic food is that individuals believe it is more beneficial for their health. However, when consumers buy products in the market, they cannot obtain complete information [69]. To overcome this information asymmetry, social media has become an indispensable part of the promotion of food (organic, with certifications, ethical, etc.), also providing information within the category of bread and bakery products.

In fact, in the last 10–15 years, consumer society and the globalized world have strongly influenced the changes in lifestyles and consumer habits. The Internet and the use of social media offer information that has influenced important changes in people's behavior. Currently, social networks (including blog forums) represent a virtual space in which users can create and share multimedia content and interact with other users interested in the same topics. Consumers can now participate in discussion groups to ask for advice, information and assistance in the decision-making process before purchasing [13,74]. The development of relationships between consumers within social networks results in the formation of social and even emotional ties.

Consumer 4.0 is a modern, informed and aware consumer. They seek innovation and pay great attention to health. They tend to buy certified products but with a critical sense. They represent the fusion between tradition and contemporaneity, respect the history of their territory and also project into the future.

Based on the observations highlighted, we hypothesized that informed consumers 4.0 (CI) have a direct effect on sustainable inclinations.

**Hypothesis 2 (H2).** *Informed consumer 4.0, it deals with a mindful, innovative and digital consumers who have a positive and significant impact on inclination towards a model of safe sustainable, ethical and responsible consumption.*

As for the choice of points of sale, that is, where to buy bread and bakery products, consumers have very diversified habits and, in many cases, they buy both in bakeries and in supermarkets, artisanal bread and/or packaged sandwich bread and thus also biscuits and snacks.

Konuk [75] states that the role of the store image, in relation to perceived quality, trust in the store and in the seller and perceived value, influences consumers' purchasing intentions. In fact, trust is defined as *"the consumer's expectation for the reliability of the services provided and on the fulfillment of the promises by the supplier"* [76]. The retail market has been facing stiff competition, and companies are struggling to differentiate themselves in the market. In this context, the image of the store is one of the most important distinguishing features that provides a substantial advantage for retailers. It represents the set of perceptions of a consumer with respect to a store with reference to different attributes. In other words, the point of sale (shop or open-air market) is experienced as a space for socializing and creating an atmosphere of trust in the quality of the goods and the availability of the shop's staff [8,75]. Loyalty is like *"a willingness to rely on a trusted trading partner"* [75]. The trust theory of commitment emphasizes that trust is a prerequisite for maintaining long-term relationships with the firm. Based on the observations highlighted, we hypothesized that the choice of store made by consumers has a direct effect on the inclination toward sustainability.

**Hypothesis 3 (H3).** *The choice of stores has a positive and significant impact on the inclination towards a safe, sustainable, ethical and responsible consumption model.*

Furthermore, two research hypotheses concern informed consumers 4.0 (CI). The first concerns the experience and the Experience of Consumer (CE) and pertains to the influences that come from the information obtained from social media, etc.

**Hypothesis 4 (H4).** *Informed consumers 4.0 have a positive and significant impact on the perception of choice of stores where you can buy baked goods.*

The second hypothesizes the influence of informed consumers on the behavior and choice of places to purchase.

**Hypothesis 5 (H5).** *Consumer informed 4.0 have a positive and significant impact on the perception of consumer experience.*

In this context, information concerning how the store's image, perceived quality, seller trust and private label also influence consumers' purchasing intentions for food and bakery products. The hypothesis formulated is the following:

**Hypothesis 6 (H6).** *The choice of stores has a positive and significant impact on the consumer experience.*

## 4. Results

### *4.1. The Sample Data before and during COVID-19*

The socio-demographic characteristics of the subjects interviewed in the two periods of investigation are illustrated in Table 2, which distinguishes between those who were interviewed in face-to-face mode before the pandemic and those who were interviewed during the COVID-19 period when the lockdown was in force in Italy (home insulation).

**Table 2.** Descriptive characteristics of the sample of consumers interviewed.

| Variable | Before COVID N° 720 Interviewed Face to Face | During COVID N° 474 Inteviewed Online through Social Media |
|---|---|---|
| Gender | | |
| Male | 50.3% | 74.7% |
| Female | 49.7% | 25.3% |
| Age: average; SD | Average 43.86 years; SD = 16.83 | Average 39 years; SD = 17.4 |
| Min; Max | Min 18 years; Max 89 years | Min 18 years; Max 76 years |
| Age class | | |
| 18–29 years | 27.2% | 32.7% |
| 30–49 years | 34.3% | 35.4% |
| 50–69 years | 31.3% | 30.2% |
| >69 years | 7.2% | 1.7% |
| Level of education | | |
| Elementary and Medium school | 18.7% | 7.8% |
| High school | 47.4% | 50.2% |
| Degree | 30.1% | 35.2% |
| Post degree | 3.9% | 6.8% |
| Income | | |
| High > 48,000 EUR/year | 6.0% | 2.3% |
| Medium High 30,001–48,000 EUR/year | 38.3% | 35.6% |
| Medium Low 15,001–30,000 EUR/year | 43.3% | 51.1% |
| Low < 15,000 EUR/year | 12.4% | 11.0% |
| Number of family members | | |
| 1 member | 8.8% | 3.8% |
| 2 members | 19.7% | 13.7% |
| 3 members | 24.0% | 26.2% |
| 4 members | 30.7% | 37.6% |
| 5 members | 12.1% | 15.6% |
| More than 5 members | 4.5% | 3.2% |

Source: Authors elaboration.

In the pre-COVID-19 period, the sample interviewed face to face is characterized by consumers of a medium–high cultural level (34% are graduates), with a slight majority of men (50.3%). The average age is 43.86 years (from a minimum of 28 years to a maximum of 89). The standard deviation is 16.83%.

By entering greater detail of the socio-demographic characteristics of the sample interviewed, it can be observed that the most represented age class is between 30 and 49 years (34.3% of the sample), those who are more than 49 years old are 38.5%, and young people aged 18 to 29 are 27.2%. Schooling highlights a greater presence in graduate subjects (47.4%). Graduates represent 34%. Most interviewees say they receive a medium–low (43.3%) or medium–high (38.3%) family income and 12.4% have a low family income. In a few cases, their income is high (6%), and the most represented number of family members is families made up of four people (30.7%), while the largest families (equal to or greater than five people) represent 4.5% of the sample. The interviews carried out during the COVID-19 period show a very different situation. First of all, the greatest presence of women due to their greater presence and participation on Facebook and social groups in general emerges. As was to be expected, there is a lower average age (39 years). About 68% of the participants are in an age range from 18 to 49 years old with average higher schooling; 50% graduated, and 42% are post-graduates (of which 6.8% attended post-graduate courses). Family income is mainly medium–low (51%), followed by medium–high income (35.6%) and low (11%).

The shopping habits we observed demonstrate a clear distinction in the purchase of bread, snacks and biscuits both before and during the COVID-19 period.

In Southern Italy, the purchase of artisanal bread prevails (about 70%), while packaged bread is preferred in 14% of cases. Furthermore, some interviewees buy one or the other type of bread indifferently (16%). People prefer to buy it mainly at the bakery (63%), the hypermarket (23%), in the city market or from small retailers (14%).

The opposite situation is found for snacks and biscuits, whose prevailing preferences are for packaged products (38% and 44%, respectively), purchased mainly from MMR. A group of consumers declares that they prefer artisanal snacks (25%) and artisanal biscuits (14%) purchased at the bakery. Finally, a group of consumers interviewed purchased both artisanal and industrial snacks and biscuits (32% and 37% of cases, respectively). Finally, about 5–6% of those interviewed do not buy them or did not answer the question.

During the health emergency due to COVID-19, there was an increase in the online purchase of packaged baked goods in the face of high home preparation of baked goods. During the lockdown, families prepared bread, focaccia and snacks and sweets at home in 75%–85% of cases. Only 5.3% stated that they had not prepared baked goods at home. In the remaining cases, they were regularly purchased in stores.

### *4.2. The Results of the Multicriterial Analysis Applied to the Data Collected before COVID-19*

#### 4.2.1. Factorial Analysis

Factorial analysis was applied to 16 variables. The value of the KMO test is 0.802. To be considered reliable, the value of the KMO test should be between 0.5 and 0.7. At the end of this first analysis, four components were extracted that identify four groups of latent factors that explain 57% of the total variance (see Table S1 and Figure S1 in Supplementary Materials files).

Table 3 reports the loads of the rotated components that allow for a description of the predictive models synthesized of preferences by reducing the multidimensionality of the variables. In this way, it was possible to associate each component with the main drivers of the choice of preferences.

**Table 3.** Factorial analysis Rotated Component Matrix [a].

| | | Latent Factors Group | | | |
|---|---|---|---|---|---|
| | | **Sustainable Inclination (SI)** | **Consumption Experience (CE)** | **Stores (St)** | **Informed Consumers_4.0 (IC)** |
| I believe that the shelf-life of bakery products can help reduce food waste and improve sustainability | Si1 | **0.782** | 0.002 | −0.002 | 0.101 |
| I believe that the label and green labels are important for understanding the bakery supply chains that support circular economy models and environmentally friendly production systems | Si2 | **0.738** | 0.299 | −0.009 | −0.129 |
| For me, the reputation of companies and their social, ethical and sustainable responsibility are important | Si3 | **0.679** | 0.16 | −0.031 | 0.238 |
| The use of eco-sustainable and differentiable food packaging is one of the main ways to reduce pollution | Si4 | **0.624** | 0.174 | −0.005 | 0.376 |
| We need to protect biodiversity and safeguard local varieties | Si5 | **0.590** | 0.324 | 0.054 | 0.05 |
| I use 0 km products for my experience and to support small local businesses | Ce1 | 0.195 | **0.640** | 0.05 | 0.027 |
| It is important to support farmers with a fair price for quality and food safety guarantees | Ce2 | 0.171 | **0.593** | −0.071 | 0.35 |
| Clarity and transparency in the production technique and in the processing and marketing phase of food products are important for quality and safety | Ce3 | 0.286 | **0.517** | −0.121 | 0.28 |

**Table 3.** *Cont.*

| | | Latent Factors Group | | | |
|---|---|---|---|---|---|
| | | **Sustainable Inclination (SI)** | **Consumption Experience (CE)** | **Stores (St)** | **Informed Consumers_4.0 (IC)** |
| Eco-sustainable products with quality certification mark (PDO, PGI, Organic, etc.) affects on my food choices | Ce4 | 0.36 | **0.482** | −0.047 | 0.043 |
| When buying bakery products I try to pay attention to Food Safety and Quality (control of toxins, pathogens, pesticides, etc.) | Ce5 | 0.285 | **0.632** | −0.04 | −0.286 |
| The price influences my choice and propensity to purchase bakery products | Ce6 | −0.135 | **0.622** | 0.025 | 0.365 |
| I choose to buy cookies from my favorite retailer | St1 | −0.015 | −0.031 | **0.899** | 0.05 |
| I like the idea of buying salted snacks and other bakery products from different stores | St2 | 0.095 | −0.083 | **0.883** | −0.102 |
| When I buy bread from my favorite retailer, if necessary, I can receive information and suggestions | St3 | −0.08 | 0.038 | **0.788** | 0.125 |
| The availability and possibility of buying online influence my food choices | Ic1 | 0.144 | 0.004 | 0.025 | **0.767** |
| I follow social, advertising, food blogs and media that may influence me to buy sustainable food (including bakery products) | Ic2 | 0.186 | 0.338 | 0.098 | **0.620** |

[a] Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. KMO Test: Kaiser–Meyer–Olkin Measure of Sampling Adequacy = 0.802. Bartlett's Test of Sphericity: Approx. Chi-Square = 3391.38; df = 120; Sig. = 0. Source: Authors elaboration from data analysis in SPSS Ver. 20.

As regards the first component (17.5% of the variance explained), it can be identified as "sustainable attitudes/inclination" (factor 1); the variables involved are the expiry date (0.78) and the information on the label (0.74), the reputation and ethics of manufacturing companies (0.68), sustainable and differentiated packaging (0.62), the raw materials used and respect for biodiversity (0.59), and finally, local km0 products (0.195).

The second component, which represents 15.1% of the total variance explained, can be described as "consumer experience" (latent factor 2) since many attributes included in this component are directly or indirectly related to quality and safety (0.63), at a fair price, both for consumers (0.62) and for producers (0.59); also, the interviewees hold a lot of importance on the clarity and correctness of the transformation techniques (0.52) and the importance attributed to PDO, PGI brands (0.48).

The third component, whose variance explained 14%, can be defined as "stores", and concerns the importance of the store.

Finally, the fourth component, which represents 10.3% of the variance explained, describes the most current thrusts, such as online purchases (0.77) and the demand for transparent and correct communication, advertising and marketing (0.62) and identifies a group of consumers, "Consumers informed 4.0".

#### 4.2.2. The PLS-SEM Model

The PLS–SEM path analysis algorithm estimates the standardized partial regression coefficients in the structural model after approximating the measurement model parameters. After carrying out the CFA (confirmation factorial analysis), the validation of the study model and hypotheses took place through the modeling of the structural equations (SEM) following the indices of the model adaptations [67]. The outcome of CFA shown in Table 4 indicates that the standardized loads of all the remaining elements in the measurement model were above the acceptable cut-off level. The standardized charges of the elements that make up the measurement model are between 0.622 and 0.950. The quality of the measurement model was tested by examining the indicator reliability, internal consistency, convergent validity and discriminant validity. Indicator reliability was assessed by exploring the standardized loadings of items with their respective construct. According to the

indications of Dash and Paolo [57,77], items should be retained in the measurement model only if their standardized loadings are equal to or greater than 0.6. Since the model of the Loadings of the CE5 and CE6 items were lower than the recommended threshold value, they were removed from the measurement model and from further analysis, which led to values that were in the acceptable interval for all three indices of the internal coherence of the construct. The validation of the study model and hypotheses took place through the modeling of the structural equations (SEM) following the indices of the model adaptation recommendations [67]. The values of the correlation matrix of the constructs analyzed are examined in Figure 2 and in Table 4.

**Table 4.** Standardized factor loading Composite Reliability (CR) Average Variance Extracted (AVE) and Cronbach's Alpha.

| | Factor and Item | Standardized Factor Loading | Composite Reliability (CR) | Average Variance Extracted (AVE) | Cronbach's Alpha |
|---|---|---|---|---|---|
| | **Sustainable Inclination (SI)** | | **0.848** | **0.528** | **0.779** |
| Si1 | I believe that the shelf-life of baked goods can help reduce food waste and improve sustainability | 0.702 | | | |
| Si2 | I believe that the label and green labels are important for understanding the bakery supply chains that support circular economy models and environmentally friendly production systems | 0.729 | | | |
| Si3 | For me, the reputation of companies and their social, ethical and sustainable responsibility are important | 0.756 | | | |
| Si4 | The use of eco-sustainable and differentiable food packaging is one of the main ways to reduce pollution. | 0.742 | | | |
| Si5 | We need to protect biodiversity and safeguard local varieties | 0.703 | | | |
| | **Consumption Experience (CE)** | | **0.792** | **0.491** | **0.650** |
| Ce1 | I use 0 km products for my life and to support small local businesses | 0.622 | | | |
| Ce2 | It is important to support farmers with a fair price for quality and food safety guarantees | 0.763 | | | |
| Ce3 | Clarity and transparency in the production technique and in the processing and marketing phase of food products are important for quality and safety | 0.759 | | | |
| Ce4 | Eco-sustainable products with quality certification mark (PDO, PGI, Organic, etc.) affects on my food choices | 0.646 | | | |
| | **Informed Consumers 4.0 (IC)** | | **0.806** | **0.678** | **0.546** |
| Ic1 | The availability and possibility of buying online influence my food choices | 0.726 | | | |
| Ic2 | I follow social, advertising, food blogs and media that may influence me to buy sustainable food (including bakery products) | 0.910 | | | |
| | **Stores (St)** | | **0.881** | **0.717** | **0.824** |
| St1 | I choose to buy cookies from my favorite retailer | 0.950 | | | |
| St2 | I like the idea of buying salted snacks and other bakery products from different stores | 0.894 | | | |
| St3 | When I buy bread from my favorite retailer, if necessary, I can receive information and suggestions | 0.669 | | | |

Source: Authors elaboration from data analysis in Smart-PLS3.

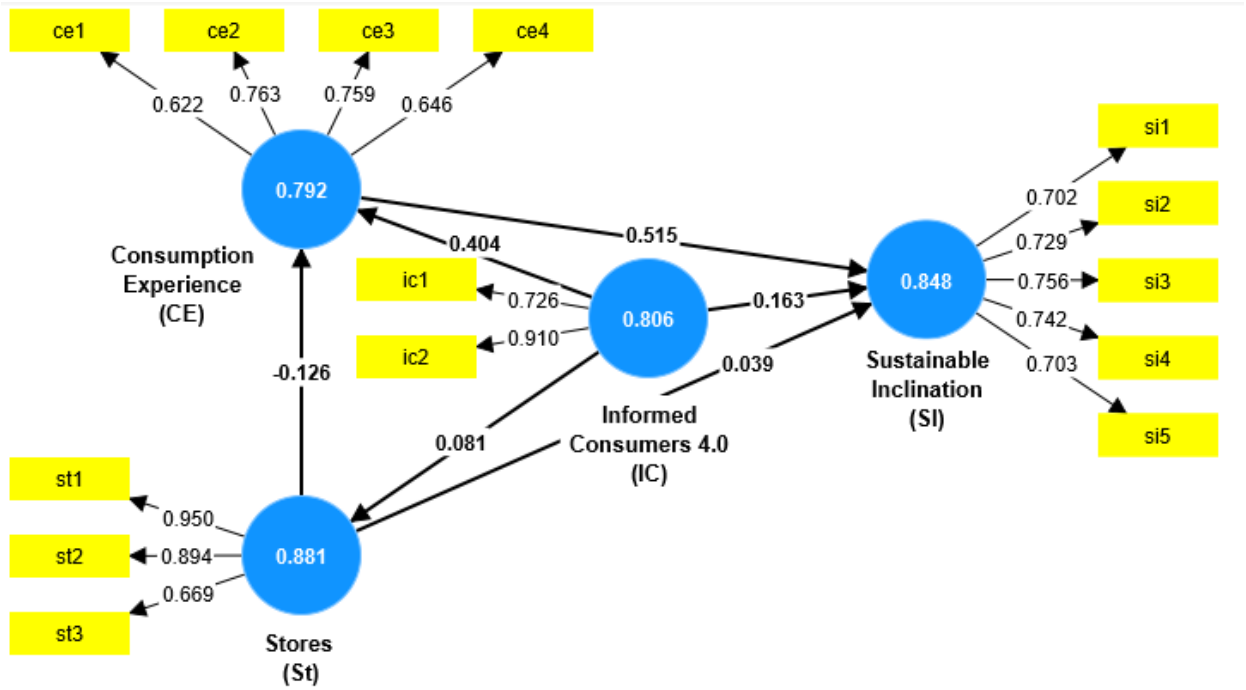


**Figure 2.** SEM (PLS algorithm). The values in the constructs are Composite Reliability (CR) Source: Authors elaboration from data analysis in Smart-PLS3.

The study used PLS-SEM to study the relationships between the constructs using SmartPLS3, an effective statistical tool that deals with complex models and is suitable for small and large datasets [78].

The first fundamental step in the development of the measurement model was to evaluate the convergent validity through the following criteria: the loading factors, composite reliability and the average variance extracted (AVE). Subsequently, all of the other indicators were taken into consideration, as in the literature by many authors.

As shown in Table 4, the standardized loading of the items was greater than 0.6 for all factors, as recommended by Chin [79]. In particular, the elements with a loading value equal to or greater than 0.7 were significant. The composite reliability values (CR) of all factors exceeded the recommended value of 0.7 [71,80,81].

An AVE value of 0.50 or greater is considered acceptable because it indicates that the variance shared between a construct and its elements exceeds the variance of the measurement error [78]. However, in our study, the values of AVE have a score greater than 0.5, all except one, which is slightly lower (consumption experience, with an AVE equal to 0.491). However, these data did not affect the results and validity of the applied model.

In fact, the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) correlation ratio are valid (Tables 5 and 6).

**Table 5.** Discriminant validity—Fornell–Larcker criterion.

| | (CE) | (IC) | (St) | (SI) |
|---|---|---|---|---|
| Consumption Experience (CE) | **0.700** | | | |
| Informed Consumers 4.0 (IC) | 0.394 | **0.823** | | |
| Stores (St) | −0.093 | 0.081 | **0.847** | |
| Sustainable_Inclination (SI) | 0.576 | 0.369 | 0.004 | **0.727** |

Source: Authors elaboration from data analysis in Smart-PLS3.

**Table 6.** Heterotrait–Monotrait results.

| | (CE) | (IC) | (St) | (SI) |
|---|---|---|---|---|
| Consumption Experience (CE) | - | | | |
| Informed Consumers 4.0 (IC) | 0.621 | - | | |
| Stores (St) | 0.132 | 0.106 | - | |
| Sustainable_Inclination (SI) | 0.794 | 0.535 | 0.068 | - |

Source: Authors elaboration from data analysis in Smart-PLS3.

As for the Fornell–Larcker criterion [33], it states that the square root of the AVE of each construct should be greater than its highest correlation with any other construct in the model. The results presented in Table 5 indicate that each construct shares more variance with the elements allocated to it (bold values on the table diagonal) than with the remaining constructs in the model, thus confirming that the requirements of the Fornell–Larcker criterion are satisfied.

In addition, the HTMT correlation report is an alternative approach to evaluate the discriminating validity in PLS-SEM. It has been reported that this method has higher performance than the Fornell–Larcker criterion. The HTMT should be lower than 0.85 (a stricter threshold) or 0.90 (a more lenient threshold), or significantly smaller than 1 [82,83]. As shown in Table 6, all of the HTMT values are lower than 0.85, thus indicating a good discriminating validity.

The results of the SEM path are shown in Table 7, which shows that the T-Values for the routes of H1 (15,292), H5 (12,796), H2 (5096) and H6 (2540) are higher than the value standard. The hypothesis that the consumer experience, informed consumers 4.0 and the choices of the stores have a positive influence on the sustainable inclination of consumers when they buy baked products. However, the perception of the bakery product stores does not show a significant influence on sustainable inclinations (both directly and through informed consumers); consequently, hypotheses H3 (0.849) and H4 (1620) are rejected.

**Table 7.** Summary convergent validity and internal consistency of constructs.

| Hypothesis | Estimate (β) | *t.* Value | *p*-Value | Hypothesis | Conclusion |
|---|---|---|---|---|---|
| Consumption_Experience->Sustainable_Inclination | 0.515 | 15.292 | 0.000 *** | H1 | Supported |
| Informed Consumers->Consumption_Experience | 0.404 | 12.796 | 0.000 *** | H5 | Supported |
| Informed Consumers->Stores | 0.081 | 1.620 | 0.105 | H4 | Rejected |
| Informed Consumers->Sustainable_Inclination | 0.163 | 5.096 | 0.000 *** | H2 | Supported |
| Stores->Consumption Experience | −0.126 | 2.540 | 0.011 ** | H6 | Supported |
| Stores->Sustainable_Inclination | 0.039 | 0.849 | 0.396 | H3 | Rejected |

** *p*-Value < 0.01; *** *p*-Value < 0.001 Source: Authors elaboration from data analysis in Smart-PLS3.

The blindfolding procedure was applied to verify the significance of the paths in the structural model of the effect sizes ($F^2$), the Q2 construct and the multicollinearity model. As indicated by the reference indices [71,82], the values of Q2 are above 0. As far as $F^2$ is concerned, it highlights and confirms what has already been stated by the supported or rejected paths (Tables 8 and 9).

**Table 8.** Structural model—Multicollinearity check (Variance Inflated factors—VIFs).

| | (CE) | (St) | (SI) |
|---|---|---|---|
| Consumption Experience (CE) | | | 1.206 |
| Informed Consumers 4.0 (IC) | 1.007 | 1.000 | 1.204 |
| Stores (St) | 1.007 | | 1.026 |

Values below 3.3 indicate an acceptable level of correlation among constructs. Source: Authors elaboration from data analysis in Smart-PLS3.

**Table 9.** Construct cross-validated Communality.

| | Q2 |
|---|---|
| Consumption Experience (CE) | 0.167 |
| Informed Consumers 4.0 (IC) | 0.120 |
| Stores (St) | 0.454 |
| Sustainable_Inclination (SI) | 0.293 |

An acceptable model has Q2 values above 0, which can be small (0.02), medium (0.15) or large (0.35). Source: Authors elaboration from data analysis in Smart-PLS3.

### *4.3. Consumption and Choices of Agri-Food Products during the Lockdown: Changes and Trends for Bakery Products*

The COVID-19 emergency has profoundly changed various aspects of the life of Italians. Consumption dynamics and purchasing behavior have led to changes that did not seem possible before. The new eating habits that emerged from the survey have found a place in Italian lives: preferring quality over quantity, rewarding small producers and short supply chains by giving a different value to food waste and sustainability. The interest in the new Italian routine and the variation in consumption dynamics were examined to capture the changes in aspects relating to consumer habits. We have detected changes in both pre-COVID-19 and during COVID-19, with reference to the points of sale where shopping is done, the frequency of purchase, the type of baked goods purchased and the possible replacement of the latter with homemade products. The attitude toward food waste, the possible tendency to reuse food leftovers and attention toward environmental sustainability were also noted. In this context, bakery products have had particular importance because they are among those that have been made at home in families to a greater extent.

Based on the ISMEA data, as a result of the emergency, consumers' attitudes are changing both with respect to the products purchased and the sales channels used. There is a trend toward the procurement of preservable products (pasta, rice, fish preserves, tomato preserves, etc.) to create household stocks and to make bread, pizza and desserts at home.

The cereal supply chain was the one that presented the most critical issues during the lockdown: at first, the run-up to the supply of flour and pasta caused a sudden peak in demand. Subsequently, slowdowns in imports caused difficulties in ensuring an adequate rate of national self-sufficiency. This difficulty in finding these products led to an increase in prices, in particular, wheat, both soft and durum. This situation lasted until the end of April, and then decreased from May onwards: both the prices and the demand for cereals stabilized, and the self-sufficiency difficulties gradually resolved.

With reference to the other sectors and production chains, increases in the consumption of fruit and vegetables were recorded during the months of the lockdown. Greater purchasing preferences were directed toward more easily storable fruit and vegetables, such as apples, kiwis, cabbage, dried legumes and potatoes, as well as frozen vegetables. During the quarantine, with the greater availability of time for preparing meals, there was a strong increase in the purchase of fresh, full-range and home-prepared products. Conversely, there have been decreases in the purchases of fresh-cut products (that is, packaged and ready-to-eat fresh vegetables).

The dairy supply chain was penalized by a production surplus of cheese and dairy products, mainly due to the closure of the Ho.Re.Ca channel (the main outlet channel for many companies, Hotellerie, Restaurant, Catering). However, in the months between February and June, there was an increase in the purchase of UHT milk by consumers and packaged hard cheeses at large-scale distribution, as they are characterized by greater shelf lives, which was to the detriment of fresh milk and soft cheeses. Beef and sheep meat had a fluctuating trend during the period. The poultry supply chain (chickens, turkeys and eggs) reacted better when compared to the other meat supply chain after the spread of COVID-19.

Table 10 and Figure 3 show the shopping choices at the points of sale before and during the pandemic declared by the consumers interviewed. As can be seen, a very clear change

emerges: the small shop close to home records an increase in the percentage variation of +222%, followed by the online market, with +40%. The direct channel with farmers registers +10%. The closure of open-air markets during the period of restrictions shows the greatest percentage reduction (−100%), followed by super and hypermarkets (−22%), which, however, maintain just over 50% of the preferences.

**Table 10.** Percentage variation of favorite points of sale by consumers and spending frequency during the week interviewed before and during the health emergency from COVID-19. Source: The authors.

| **Favorite Points of Sale by Consumers** | | | | | **% Change** |
|---|---|---|---|---|---|
| | **Before COVID-19** | | **During COVID-19** | | |
| MMR | 306 | 64.6 | 238 | 50.2 | −22.2 |
| Local market | 28 | 5.9 | 0 | 0.0 | −100.0 |
| Discount | 66 | 13.9 | 65 | 13.7 | −1.5 |
| Proximity retail | 40 | 8.4 | 129 | 27.2 | 222.5 |
| Market online | 15 | 3.2 | 21 | 4.4 | 40.0 |
| Direct sale | 19 | 4.0 | 21 | 4.4 | 10.5 |
| **Spending frequency during the week** | | | | | |
| Once a week | 121 | 25.5 | 377 | 79.5 | 211.6 |
| Two-three times a week | 268 | 56.5 | 87 | 18.4 | −67.5 |
| Four or more times a week | 85 | 17.9 | 10 | 2.1 | −88.2 |

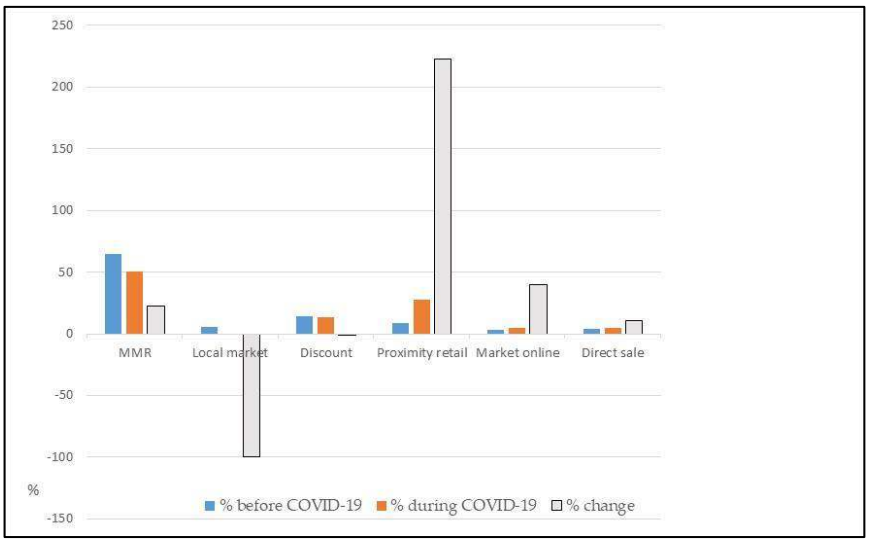


**Figure 3.** Changes in choosing the stores before and during COVID-19 Source: The authors.

In choosing the procurement channel, the most evident change is the tendency to use online shopping. According to the ISMEA data, in the same period, Italy experienced exponential growth in just a few weeks, causing the delivery system to go haywire (up to +160% on an annual basis).

A direct consequence of what has been highlighted is the decrease in the frequency of purchases (also, these data are explained in Table 10 and Figure 4). Before COVID-19, people went shopping several times a week or several times a day.

The way Italians carry out their shopping has been turned upside down: users who shop for food once a week represent as much as 80%, against 25.5%% in the pre-pandemic period (an increase of 55%). The percentage of citizens who shop two or three times a week has decreased, reaching 18%. At the same time, only 2% maintained the habit of shopping four times a week in the post-pandemic period. In addition to the frequency with which to shop, with the lockdown, Italians have changed their preferences toward what they put in their cart.

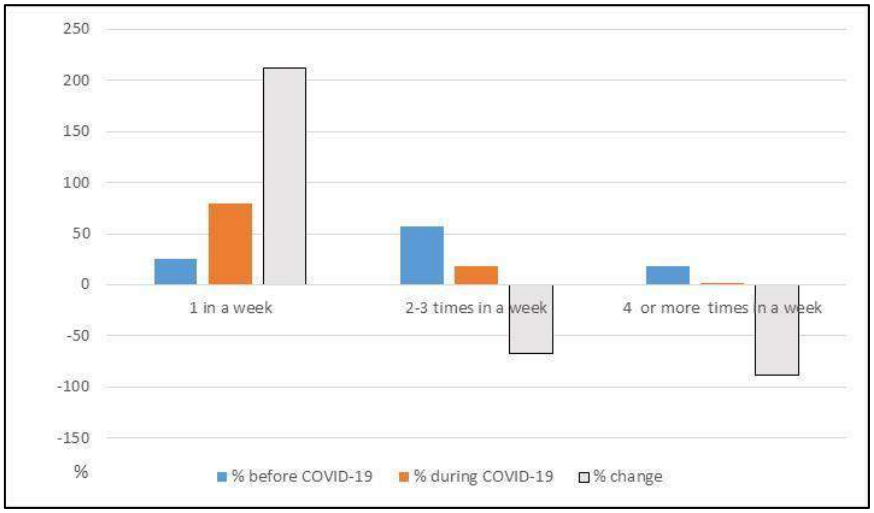


**Figure 4.** Changes in the weekly spending frequency before and during COVID-19. Source: The authors.

The obligation of home isolation due to the need to avoid gatherings has favored the trend toward the purchase of products with prolonged durability and usability in many cases as raw materials for homemade food preparations, but also canned and frozen foods have been placed in the cart. In total, 46% of the respondents said they increased their purchases during the lockdown.

Milk, butter and yoghurt are mostly purchased by 67.30% of users. These products have played an important role during the pandemic as they are the basic ingredients for many dishes, both savory and sweet.

Baked goods and breakfast items, such as biscuits and snacks, are purchased by a third of consumers. However, the most interesting aspect is that as many as 76.4% said they prepare sweets and biscuits for breakfast at home. Furthermore, among the baked goods that were mostly prepared at home in families during the lockdown, there are also bread (84.2% of cases), pizzas, focaccias and savory snacks (79.3%). Only 5.3% stated that they had not prepared baked goods at home.

The survey also made it possible to detect the attention paid by the interviewees to the origin and certifications of various products. A group of consumers declared that they continued to purchase organic food products (14.2%), proximity products at Km0 (13.1%) and products with PDO, PGI, Controlled Denomination of origin (DOC)-certified brands (11.4%).

Finally, consumers show increased attention to food waste. In total, 52% of consumers have increased their commitment compared to the pre-COVID-19 period, and 41% said they maintained their attention, only 7% stated that they had reduced their commitment.

Sensitivity to environmental sustainability and the high reuse of food leftovers are declared to be 90%.

## 5. Discussion and Conclusions

It is increasingly evident that consumer preferences for consumption choices are conditioned not only by liking the products but also by the knowledge that the consumers have [84]. An increasing number of these consumers choose not only what they like but, above all, what is good for them [85], consciously or unconsciously changing their consumption decisions. This is visible from the diffusion of products made with unrefined flour, whole-meal bread and biscuits and products with low gluten content. Precisely this last point seems to be linked to the problems connected to intolerance or allergy to gluten; once almost unknown, it is very widespread among the population today. Basically, the food industry is increasingly sensitive to nutritional aspects, even for traditional products, such as bread and bakery products, a trend that is characterizing new consumption patterns and also new products [42,86,87], aspects that were increasingly accentuated by the pandemic

crisis and the greater attention given to health and food safety [88]. In fact, consumers are increasingly paying attention to the sustainability of production processes in support of the local economy and companies [89]. They show a growing interest in the purchase of typical products of the territory of origin and aim to reward the ethical behavior of companies, traceability and food safety [90]. As a result, producers have begun to adapt to new needs to meet consumer demands and transition toward food systems that require a radical transformation in light of the Sustainable Development Goals.

The results of this study suggest that the intentions of Southern Italian consumers to adopt sustainable inclinations in the purchase of bakery products derive from a complex decision-making process involving various factors, such as personal consumer experiences and marketing communication and concerns about health, climate change and the environment.

The analysis developed with PLS-SEM on interviews before COVID-19 tested the hypotheses regarding the relationship between determinants and sustainable consumer behavior. The hypotheses of H1 and H2 have been ascertained, and the results show that there is a positive relationship between the inclination for sustainable consumer behavior and the attitude and beliefs they manifest when purchasing food and bakery products. In fact, this survey shows that consumers who declare attention toward green experiences and those IC are positively influenced by a new, more responsible and more coherent consumption model with green trends. This implies that even when they consume bread and baked goods, they have responsible behavior toward the environment and an awareness of health. Additionally, in the hypotheses of H5 and H6, consumers have a positive attitude toward the aspects related to CE, research on the label, the origin of the food, biodiversity, local food, the importance of recognizing a fair price for farmers and the traceability and reputation of the manufacturing companies. However, hypotheses H3 and H4 are rejected because when consumers choose the point of sale where to buy bakery products, they are not always attentive to the sustainability factors highlighted by the attention gained with the consumer experience, and the same goes for informed consumers who are very selective about the point of sale.

With the COVID-19 pandemic, the virtuous behaviors of consumers seem confirmed, and we seem to be able to say that the state of uncertainty experienced has influenced sustainable behavior and the inclination toward this behavior.

In the coming years, it will be possible to verify whether the behavior toward environmental values and healthy and sustainable consumption will persist [91,92].

The implications of this study are linked to the tools it can provide in terms of knowledge and opportunities in the new economic context for producers, retailers and the distributors of bakery products and foods, in general, to develop adequate green marketing strategies with a message that should be explicit and as detail-oriented as possible concerning sustainability, including the production process and how it positively affects the health of consumers.

The main limitation of this research is that the interviewees were geographically located in Southern Italy; therefore, the results may not reflect the entire nation's intention to purchase sustainable foods, including bread and bakery products. The consumer trend is shifting toward sustainability and health to maintain health as population aging is on the rise; therefore, further research should follow market trends to determine what future consumers will need. Future studies should also be replicated in the same areas and/or in other geographical contexts or countries to better highlight the changes caused by the pandemic.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/foods12081661/s1, Table S1: Results of the factorial analysis. Total Variance Explained. Source: The authors; Figure S1: Scree Plot of factorial analysis. Source: the authors.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. All participants were fully informed of the anonymity of the collected data.

**Data Availability Statement:** Eurostat: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn202209191; accessed on 13 January 2023 ISMEA: (https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10464) accessed on 13 January 2023; eAmbrosia: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/ accessed on 13 January 2023.

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# Local Proximity Cheeses: Choices That Guiding Consumers and Orienting Producers—Case Studies

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**Abstract:** In Italy, in ten years, the national production of sheep's cheese has gone from 60 thousand tons to almost 80 thousand tons at present, a sign of a lively dynamism of the sector mainly due to a growth in demand. The significant leap in production is accompanied by that of consumption and is mainly due to pecorino (fresh and seasoned), which, together with fresh ricotta, is gaining acceptance in the national and international markets. The objective of the paper is to examine, in a study area of southern Italy, consumer preferences for locally produced pecorino cheese near kilometer zero and the profit margins of the dairy companies producing pecorino. The interviews with consumers made it possible to explore purchasing preferences based on the reasons for choosing and the points of sale where consumers buy the cheese. The interviews with the manufacturing companies highlighted a different business organization of the single production units whose economic results show, despite the difficulties, the resilience of the companies. The company's net margins per quintal of processed milk are more or less satisfactory and supported by the positive interest of consumers. As for the latter, they show increasingly pushed trends towards the purchase of niche products at Km0, made with more sustainable production systems.

**Keywords:** dairy industries; livestock farms; pecorino cheese; dairy farm; economic results; production cost; net margin; economic sustainability



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## 1. Introduction

The production of sheep's milk and its subsequent processing are typical activities of the Mediterranean countries: these countries, in fact, as a whole, produce two-thirds of the sheep's milk in the world [1].

The production of sheep's milk accounted for around 2.8 million tons, and 1.9 million tons went to the dairy. The leaders in Europe include Greece, Turkey, Romania and Italy. Almost all of the sheep milk produced is used for cheese-making, whether on the farm or in industrial dairies. Spain, Italy and France produced 93% of the total EU production of cheese from ewe's pure milk [2].

In the Italian dairy panorama, sheep cheeses, as well as goat cheeses, represent a decidedly relevant reality, which, although with fluctuating trends, has maintained a positive trend over the last ten years, reaching a production of cheese from ewe's pure milk of around 80 thousand tons [3].

In Italy, farms are mainly located in the center and south of the country and constitute an important resource for the economy of the hilly and mountainous areas where other activities are difficult to develop [4]. Their existence also potentially allows the protection of natural resources [5], the conservation of lifestyles and the prevention of rural exodus [6]. In these territories, sheep farming has very ancient roots [7]. Multiethnic influences mean that very similar productions are identified with different denominations, sometimes depending on the places of production, as well as the maturing time: in Southern Italy, toma is the fresh unsalted cheese, sold as soon as it is made; primosale is the semifresco subjected to

salting; and pecorino is the cheese subjected to salting over 20 days. Overall, pecorino, fresh and semi-seasoned, and ricotta are fueling a lively growth market, so much so that the national production of sheep's milk has gone from 300 thousand tons to over 460 thousand at present, while, with reference to the cheeses produced, has gone from 60 thousand tons to almost 80 thousand today [3,8].

With over ten GIs (POD, GPI), the sheep sector is characterized by a strong incidence of geographical indication productions. Pecorino cheeses, in the various PDO and generic meanings, increasingly represent Italian consumption and rank among the top 10 cheeses consumed, both in terms of the overall volume of purchases and in terms of the number of family buyers: 53.5% of Italian families and therefore more than one in two (over 13 million families) makes at least one purchase of pecorino cheeses every year [9]. The role of PDOs in local development is extremely significant, above all, because they seem to intercept many of the main values required by modern consumers, such as the aspects of quality, tradition, taste and sustainability [10–12].

Given the importance of the GI, it should be emphasized that at the local level, the production of generic pecorino cheese is significant, widespread in the territories of southern Italy, historically maintained by local businesses and appreciated by consumers [3]. In support of this consumption is the type of product and not the reputation of the brand [13], which plays a secondary role, and the formats and packaging methods are also marginal factors of choice [3]. Moreover, the great strength of the sheep sector, not only Italian but also French and Greek, lies in the fact that the cheeses obtained are typical products that have no competition at the European level, which is why they enjoy the possibility of strong exports advantageous [14]. The only exception was the period of the COVID-19 pandemic when, due to the restrictive anti-COVID measures that led to the almost total closure of the Ho.Re.Ca channel (Hotel/Restaurant/Cafè-Catering) and the sharp contraction in catering, the segment of fresh food and products from the table with a strong resizing of demand. In this case, however, the destination of sheep's milk above all towards long-matured products has led to a stabilization in prices and, in some cases, as in that of Pecorino Romano, to an increase in sales prices up to 6–7 points percentages [10,11,15].

As pointed out by Bizikova et al. [16], Heather Paxson [17], Nicolosi [18] and Brunori [19], the place of origin of food products has become a powerful attraction for consumers. In particular, cheeses produced in specific areas increasingly influence the perception and propensity to purchase by the consumer. In fact, terroir products are recognized and appreciated for the qualitative aspects and for the economic, social, environmental and ethical values that the producers invest in the production [2,12,13,15]. They identify in the "terroir" the taste of the place to identify a wide range of environmental, social, agricultural and gastronomic values that are summarized in the production of local cheese.

Furthermore, both producers and consumers are increasingly interested in traditional food, and regional and traditional specialties have become an important part of the tourist experience. At the local level, traditional products are increasingly a vehicle for promoting tourism and strengthening the local cultural heritage [14,16].

In this study, the research objective is two-fold: (1) analyze the propensity of the consumers interviewed for the proximity pecorino cheese produced at Km0; (2) identify the conditions of economic convenience of the transformation of milk into pecorino cheese of a group of companies that operate in the sheep chain in a region of Southern Italy, Calabria.

The contribution is organized into three sections. An introductory part opens up to the dairy sector and to the dairy production of the sheep segment in the international and national context. Subsequently, the study is described in two different segments, that of consumption and that of production of local pecorino. Followed by the methodology adopted, data collection, processing and results obtained on both study segments. The latter allows us to advance certain conclusive considerations and reflections.

## 2. Sheep Breeding and Dairy Production

Sheep breeding is a traditional activity in many regions of the world, especially in difficult areas that offer limited alternatives to agroforestry destinations, where this activity sometimes represents the only possibility of economic exploitation. In these areas, sheep production, as well as goat, is often fundamental to guarantee the existence of economic and social activities and to keep the vegetation out of the danger of fire [20]. Therefore, it has an important role in the protection of the territory [21] by positively contributing to the equilibrium of rural areas by favoring the associated increase in plant diversity and promoting the maintenance of ecosystem services [20,22,23], as well as in preventing the rural exodus of the population to urban and periurban areas [4]. In Europe, sheep farming is limited to a few environments, of which two are representative: the Mediterranean basin and the Balkan area [20,21,23].

These areas are also important worldwide: over 80% of the sheep's milk collected in the world comes from these areas. In both cases, these are territories not suitable for the development of intensive agriculture. Rocky soils and poor pastures with too hot or too cold climates that do not lend themselves to other forms of breeding, such as cattle, are well suited to small ruminants with lower nutritional needs [24,25]. Outside these two areas, other sheep farming areas, albeit more limited, are to be considered in the central-western part of France and in the Netherlands [20]. Conversely, in northern and central Europe, over time, most of the semi-natural grasslands have been destined for intensive agriculture, with the consequent disappearance of the areas used for the breeding of small ruminants [26]. All this is under the impetus of past EU policies designed to increase the production of animal products in need of large quantities of forage resources [27].

In Italy, the sheep sector is historically linked to the environments and economies of the central–southern areas of the peninsula, where, by virtue of the triple attitude of the animals (wool, milk and meat), it has provided essential goods to satisfy the primary needs of rural communities [28] and where sheep production, together with goat ones, represent an important resource, especially for the economy of the hilly and mountainous areas [4]. Following the strong territorial concentration, this sector assumes an important role in the economic performance of some regions, especially Sardinia [29], whose sector accounts for over 18% of the total value of agriculture [3]. By the number of farms and heads, Sardinia is the region most affected (17%), followed by Sicily (10%), Lazio (9%) and Calabria (8%). Compared to the past, in almost all these territories presently, sheep farming has an economic significance almost exclusively for the production of milk for cheese-making, and, to a lesser extent, for the production of meat. If the production of cheeses from sheep's milk is a specific activity for Italy and Greece, sheep farming for meat is prevalent in Spain, which is a leading country in sheep farming for meat [20,30].

## 3. Consumers

### *3.1. Materials and Methods*

#### 3.1.1. Study Design and Sample

The survey was conducted between the end of 2019 and the first two months of 2020, with consumers available for interview and intercepted in the territory of the province of Reggio Calabria (Italy). A total of 378 useful questionnaires were administered face to face in order to observe the ways in which consumers organize their purchases, in particular, to examine the appreciation or not for pecorino cheese and for local/artisan cheeses of proximity to Km Zero made in local dairies. In order to validate the representativeness of the sample, two variables were considered: age and sex. The breakdown by sex and age between the sample and the population present in the province of Reggio Calabria for people aged 15 or over in 2019 is compared in Table 1. The interviewed sample has an average age of 45 years, ranging from a minimum of 17 years to a maximum of 89 years.

**Table 1.** Comparison between gender and composition of the age group between the sample of consumers interviewed and the population in Calabria (percentage values).

| Calabria [a] Population in 2019 | | Sample [b] 2019–2020 | |
|---|---|---|---|
| male | 49.0% | Male | 51.6% |
| female | 51.0% | Female | 48.4% |
| 18–29 age | 20.68% | 18–29 age | 21.16% |
| 30–39 age | 15.44% | 30–39 age | 16.67% |
| 40–49 age | 17.02% | 40–49 age | 17.20% |
| 50–59 age | 17.52% | 50–59 age | 17.72% |
| 60–69 age | 14.50% | 60–69 age | 14.55% |
| >69 age | 14.85% | >69 age | 12.70% |

[a] Official Istat 2019 data. [b] Source: the authors.

The research questions included in the questionnaire were designed to evaluate the respondents' attitudes and preferences toward pecorino cheese and to identify the frequency of purchase and preferred points of sale. The reasons for the purchase were identified, and the influences exercised in the purchase by the conscience and ethical sensitivity; the sustainability of the production process; the perception of the quality of food, from the safety and nutrition aspects; from one's own experience; from gastronomic habits; the support you want to give to the territory; and, finally, by the trust placed in the brand and/or the seller.

The preferences for the place of purchase can be motivated by loyalty to the point of sale, to the brand and to the seller. It can be a choice of convenience (it is close to the house, has parking, meets friends, etc.).

In particular, we addressed the following main research questions concerning perceptions/representations, impacts and motivations regarding the consumption of pecorino cheese and whether, for the interviewees, each of the indicated variables influenced "little" or "a lot" in their decision of purchase based on research hypotheses: constructs, measures and choices foreseen in the questionnaire for the purchase of cheese by consumers in the province of Reggio Calabria.

#### 3.1.2. Methodological Approach

In order to examine the ways in which consumers organize their food purchases, the survey used simple correspondence analysis (CA) and multiple correspondence analysis (MCA) followed by the hierarchical cluster analysis HCA.

From a technical point of view, CA is used to highlight buying habits, and the MCA is used to analyze a set of observations described by a set of nominal variables. We refer to the literature for more detailed information on the properties and objectives of MCA [31–35]. MCA attributes factorial scores to each observation and to each category in order to express relative frequencies in terms of distances between individual rows and/or columns in a low-dimensional space.

The multivariate analysis techniques applied to the study applied MCA in order to identify consumer profiles based on their choices. This technique is widely used by researchers to observe the variables that characterize consumer behavior.

In this case, a simple correspondence analysis was first conducted, followed by the MCA and HCA.

The simple correspondence analysis was carried out by comparing two variables: age and places of purchase preferred by consumers. The "Points of sale" variables were therefore used in five ways: hypermarket, retail, city market, dairies and fairs/festivals/events. Six modalities have been envisaged for the "age groups": 16–29 years; 30–39 years; 40–49 years; 50–59 years; 60–69 years; >69 years.

Therefore, we used the questions posed in the questionnaire, which predict dichotomous answers, and coded them as binary variables: 1 for the answer "a lot" and 2 for the answer "little" (slightly); the missing answers were discarded. Or categorical responses

organized into sub-ranges (e.g., age classes, frequency of purchase, gender, education level, income, etc.).

After running the MCA, an HCA was conducted for validation [32]. In the HCA, hierarchical clustering was performed, then optimized with K-mean clustering [35,36]. Analyses were performed using IBM SPSS Statistics (version 26).

The consumer profiles were identified through the representation in a small space, planned on the basis of the components. The MCA is obtained using a standard correspondence analysis on a matrix of indicators (X). This is a J × M matrix where J k is the level vector for each nominal variable K (with ΣJ k = J) and M is the number of observations. Running MCA on X will yield two sets of factorial scores. These factor scores are, in general, reduced so that their variance is equal to their corresponding auto-value.

In our case, the number of observed variables (k) was 10, to which cluster number 1 and cluster number 2 were added as additional variables as a result of the clustering computations performed.

Since our overall goal is to understand the psychosocial processes that contribute to the selection process in the choice preferences of pecorino cheese, we drew and used qualitative data from questionnaires provided to consumers. The dataset, properly organized and structured, was used for the MCA, which allowed us to identify the key issues to follow/raise/propose hypotheses based on the data and to be tested in further research.

The questionnaire also revealed the socio-demographic characteristics of the consumers interviewed. This allowed the segmentation of the sample to verify the preferences of cheese consumption (mainly from the proximity or from other places) on the basis of age groups, sex and income (Table 2).

**Table 2.** Questions reported in the questionnaire. Source: the authors.

| | |
|---|---|
| **1.** | **Do you mainly buy local cheeses, local cheeses or industrial cheeses?** |
| a. | I mainly buy local cheeses |
| b. | I mainly buy industrial cheeses |
| c. | I don't buy cheeses |
| **2.** | **The consumer buys proximity cheese for the following reasons:** |
| d. | to contribute to environmental and agricultural sustainability |
| e. | because he considers himself an ethical consumer |
| f. | for the craftsmanship of the production process |
| g. | for taste and sensory characteristics; |
| h. | because it is a product of its own territory, at km 0, and for the link with the territory and for the knowledge of the product (consumer experience, family habits); |
| i. | to support the local economy and help local agricultural producers; |
| j. | for the advice of the trusted seller; |
| k. | for the reputation of the product and the manufacturer; |
| l. | for the presence of a certification mark (POD, PGI, etc.) |
| m. | because it is a safe and quality product. |
| **3.** | **which points of sale does the consumer mainly buy the cheese?** |
| a. | Hypermarket |
| b. | Retail |
| c. | City Market |
| d. | In addition to the previous ones, it buys: in dairies, at fairs, festivals, events; |
| e. | He does not buy them. |
| **4.** | **how often do you buy cheese?** |
| a. | several times a week; |
| b. | once, twice a month; |
| c. | once every two to three months; |
| d. | never. |

For each of the questions, the interviewees replied with the following categorical methods (declared preferences): 1 = a lot; 2 = slightly; 0 = don't answer (don't buy). Source: the authors.

The collected data were processed, analyzed and first interpreted through descriptive analyses to highlight the main characteristics, and the MCA multivariate analysis technique was applied.

In the analysis, consumers were grouped on the basis of whether or not they buy local pecorino cheese from 0 km, where they buy it, with what frequency and why. Consumer preferences and reasons for their choices were analyzed.

### *3.2. Consumption Preferences: Results*

#### 3.2.1. Characteristics of the Sample of Consumers Interviewed

Consumers interviewed were Male in 51.6% and Female in 48.4% of cases; they were aged between 18 and 89 years. The average age is 45 years, and a standard deviation of 17,811 (Table 3).

**Table 3.** Characteristics of the sample.

| Indication * | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Gender | 1.48 | 0.500 | 1 | 2 |
| Age | 45.22 | 17.811 | 18 | 89 |
| Education | 2.21 | 0.953 | 1 | 5 |
| Employment | 2.60 | 1.411 | 1 | 5 |
| Income | 2.55 | 1.022 | 0 | 4 |
| N° of family members | 3.37 | 1.401 | 1 | 6 |
| Place of purchase | 2.59 | 1.238 | 1 | 7 |

* Gender: 1—male; 2—female. Education: 1—middle school; 2—high school; 3—bachelor's degree; 4—master's degree; 5—no reply. Occupation: 1—employee; 2—self-employed; 3—retired; 4—unemployed; 5—students, housewives, other. Family income: 1—high; 2—medium–high; 3—medium–low; 4—low; 0—no reply. Place of purchase: 1—retail; 2—city market; 3—hypermarket; 4—not buy; 5—fairs and festivals.

From the following table (Table 4), a balance emerges between the age groups of the consumers interviewed. This ensures that the results are representative of the age groups of the population. In 38% of cases, the consumers interviewed were aged between 18 and 39, followed by those between 40 and 59 (35%) and those over 59 (27%). A total of 51.6% were men, and 48.4% were men.

**Table 4.** Descriptive statistics of the sample. Age class and number of members of the family unit.

| Age Class | % | Number of Family Members | % |
|---|---|---|---|
| 18–29 | 21.2 | 1 | 10.1 |
| 30–39 | 16.7 | 2 | 19.0 |
| 40–49 | 17.2 | 3 | 24.1 |
| 50–59 | 17.7 | 4 | 25.1 |
| 60–69 | 14.6 | $\geq 5$ | 21.7 |
| >69 | 12.7 | | |

A total of 67% had secondary school and high school qualifications, and 39% of the interviewees were graduates. The occupations of the interviewees were different; in particular, the highest percentages relating to employees (29%) were recorded. Family income is mainly low–medium (35.4%) and high–medium (32.8%); in 18.5% of cases, the interviewees report a low income, and in 4%, they did not answer the question (Table 5).

**Table 5.** Descriptive statistics of the sample: education, income, employment, purchase preferences, place of purchase of cheese.

| Education | % | Income | % | Employment | % | Place of Cheese Purchase | % |
|---|---|---|---|---|---|---|---|
| Middle school | 23.5 | High | 9.3 | Employee | 29.9 | Retail | 22.0 |
| High school | 43.4 | Medium–high | 32.8 | Self employee | 22.0 | City market | 27.5 |
| Bachelor degree | 23.8 | Medium–low | 35.4 | Retired | 22.0 | Hypermarket | 31.0 |
| Master's degree | 7.1 | Low | 18.5 | Unemployed | 10.6 | Company, fairs and festivals | 14.2 |
| No reply | 2.1 | No answer | 4.0 | Students, housewives, other | 15.6 | Not buy | 6.6 |

Moreover, Table 5 shows that 56.3% of the consumers prefer to buy local pecorino cheese at Km0, while 37.0% buy cheeses from other production areas. Just under 7% of the interviewees said they never buy pecorino because they do not like it, the price is high or for other reasons. Consumers buy cheeses at the specialized shop/retail shop (22%); at the hypermarket (31%); at the city market (27.5%); or through the short chain (14.2%), for example, directly from producers on the farm, in dairies, in festivals and fairs. About 15% of the interviewees buy in several stores depending on the occasion (supermarket + city market and/or short chain). Many follow the seller's advice "in part or a lot" (157).

#### 3.2.2. Consumption Preferences: Correspondence Analysis (CA) e Multiple Correspondence Analysis (MCA)

Table 6 indicates dimensions and inertia. The maximum number of dimensions obtained is four. The first two dimensions explain 80% of the cumulative inertia. Correspondences Analysis sees the youngest (18–29 years old) orient themselves towards the purchase of cheeses on the city market (Table 6 and Figure 1); consumers over >69 years old buy at the hypermarket, and the 40–49 age group is in an intermediate situation between purchases at both the city market and the supermarket (See Appendix A Table A1).

**Table 6.** Correspondence analysis application summary.

| Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dimension | Singular Value | Inertia | Chi Square | Sig. | Proportion of Inertia | | Confidence Singular Value | |
| | | | | | Accounted for | Cumulative | Standard Deviation | Correlation 2 |
| 1 | 0.233 | 0.054 | | | 0.485 | 0.485 | 0.051 | −0.039 |
| 2 | 0.188 | 0.035 | | | 0.316 | 0.801 | 0.049 | |
| 3 | 0.145 | 0.021 | | | 0.189 | 0.989 | | |
| 4 | 0.035 | 0.001 | | | 0.011 | 1.000 | | |
| Total | | 0.112 | 42.348 | 0.002 [a] | 1.000 | 1.000 | | |

[a] 20 degrees of freedom.

Those who are 60–69 years old go more specifically to retailers, while as you can see from the map of simple correspondences, those who are 50–59 years old buy in dairies, companies, or at fairs and festivals (Figure 1).

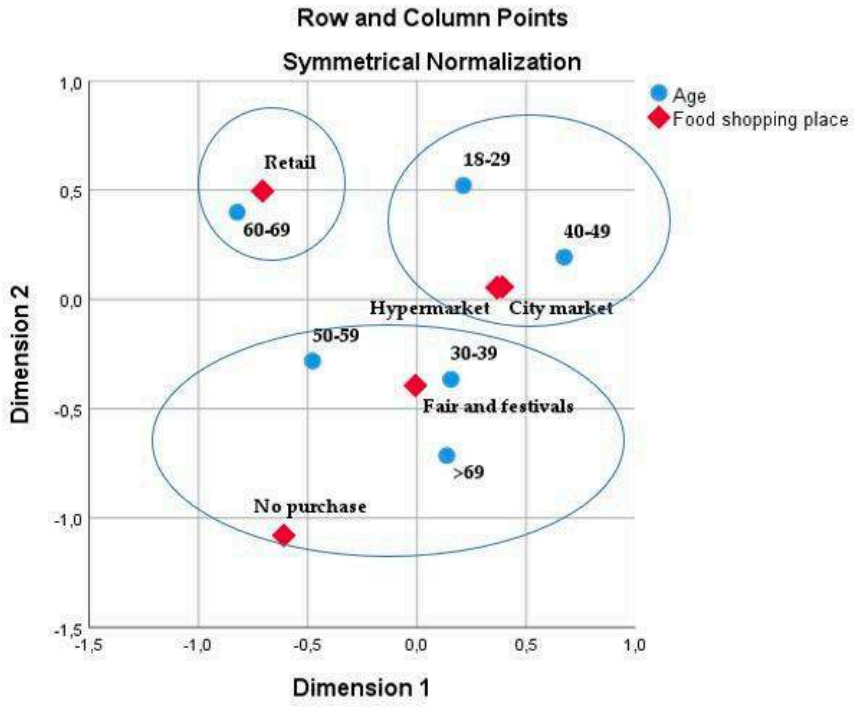



**Figure 1.** Correspondence analysis map: preferences for choosing places of purchase based on the age of consumers.

The results of the MCA conducted among the intercepted consumers show that the acceptance of all the variables considered are placed in the seminal axis for dimension 1; they represent the main discrimination measures for the consumers interviewed (see Figure 1 and Table 7). The results of the MCA conducted among intercepted consumers show that the acceptance of all the variables considered are placed in the semi-negative axis for dimension 1; they represent the main discrimination measures for the consumers interviewed.

**Table 7.** Model summary.

| Dimension | Cronbach's Alpha | Variance Explained | | |
|---|---|---|---|---|
| | | Total (Eigenvalue) | Inertia | % of Variance |
| 1 | 0.821 | 3.824 | 0.382 | 38.238 |
| 2 | 0.046 | 1.043 | 0.104 | 10.432 |
| Total | | 4.867 | 0.487 | |
| Media | 0.655 [a] | 2.433 | 0.243 | 24.335 |

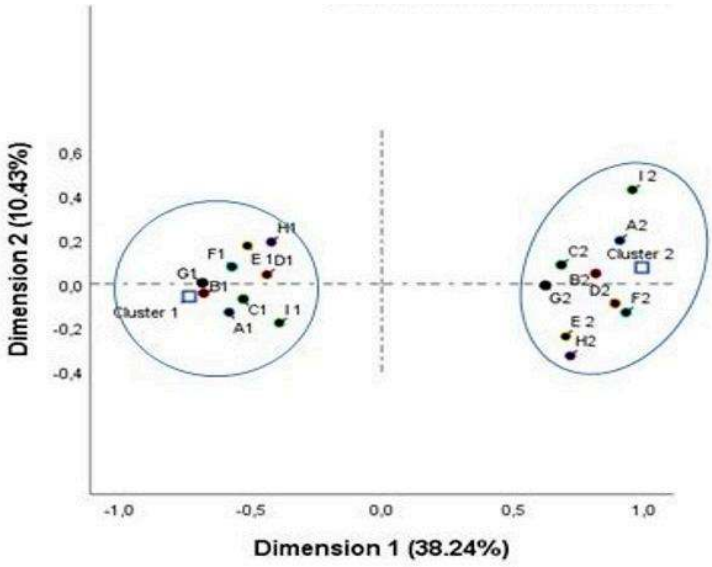
[a] Cronbach's alpha mean is based on the mean of the eigenvalue. Source: The authors.

MCA was determined after identifying the motivational variables that together show the greatest percentage of variance explained. The description of the study carried out is entrusted to the two-dimensional solution as it is more effective. In the MCA, in the first dimension, the inertia is 0.38238 (38.24% of the explained variance); in the second dimension, the inertia is 0.10432 (10.4% of the explained variance). In total, this gives an eigenvalue of 4,867 and inertia of 0.487 (48.7% of the explained variance), as shown in the model summary (Table 7).

The results of the application of the cluster are highlighted in Figure 2. The latter shows the results of the MCA conducted among consumers show that in the negative axis for dimension 1 all the variables of Cluster 1 are grouped, with a profile that we can define as "loyal consumers" and which identifies all those who have expressed appreciation and

consent for all the variables considered (they declared "a lot") for all variables (57.4% of the interviewees).

These are people who prefer pecorino cheeses and local cheeses near Km0 and choose them for their taste or their reputation, or they have a strong bond with the territory and want to help support the local economy. They also appreciate the advice of their trusted supplier and are generally attentive to brands and safety, declare themselves ethical consumers and are attentive to environmental sustainability. In this cluster, men are slightly prevalent (53%), and the most represented age group is that of 50–59 years. As for educational qualification, high school graduates represent 46.1%, followed by graduates at 24.4%, and the prevalent income is medium–high (37.8%). In Cluster 2, the profile traces the "indifferent consumers" who choose pecorino cheese without paying attention to the origin and who are not particularly linked to their own territory. In this group, the youngest age group (18–29 years) is predominant (they are 25.5%); the consistency of men and women is the same. As for the educational qualification, they are mainly high school graduates (39.1%); the prevailing income is medium–low (40.4%).




| LEGEND - **Reasons and conditions that influence the choice of purchase of Pecorino cheese** Question posed to survey Respondents |
|---|
| A How important is the aspect relating to the environmental and agricultural sustainability of producers? |
| B Do you define yourself as an ethical consumer? |
| C How important is the craftsmanship of the production process? |
| D Do you buy Pecorino cheese for its taste? |
| E How much does the bond with the territory and its experience influence your purchase of cheeses? |
| F How important is it in your food purchases to support the local economy? |
| G Does the seller's advice affect your food purchases? |
| H Does the reputation of the product and the producer influence your purchases of Pecorino cheese? |
| I How much does the presence of a certification mark (POD / PGI, etc.) affect your food purchases? |

**Figure 2.** Results of the MCA carried out on consumers: joint plot on perceptions and preferences of consumers who purchase pecorino cheese in the province of Reggio Calabria.

## 4. The Pecorino Producing Companies in the Survey Area

### *4.1. Material and Methods*

#### 4.1.1. The Types of Companies Examined

In order to maintain a vision that adheres to traditional local transformation, the study examined two types of companies that transform sheep's milk into pecorino cheese: these are dairies which, according to the ATECO classification, are divided into dairy industries "Dairy industries" (D.I.), in particular in our case for the production of cheese and curd, and "livestock farms" (L.F.).

The D.I are companies that fall within the economic activity of ATECO 10 (food industries), within the Economic Category 10.51.20 (production of cheese and curd); the L. F. are companies that fall within the scope of the economic activity of ATECO 01.45 (breeding of ovines and goats). The difference is substantial: the former are manufacturing activities, and the latter are agricultural activities, but both are authorized for the processing of raw sheep's milk and the production of pecorino. The following table shows the main distinctions (Table 8).

**Table 8.** The dairies examined distinguished on the basis of the NCE/ISIC/ATECO coding by main technical–economic characteristics.

| Types of Dairies/ BusinessesExamined | Economic Activity of Reference Codes | Labor Used | Quantities Processed (milk) Min and Max in the Case Studies Examined | Location of Farms | Local for Processing |
|---|---|---|---|---|---|
| Dairy Industries (DI) | NACE 10.51 ISIC 10.51.20 ATECO 10.51.20 | They make use of external staff | From a minimum of 525 tons to a maximum of 1950 tons | They are located in urban areas | They own production facilities and ad hoc premises |
| Livestock Farms (LF) | NACE 0145 ISIC 02.14 ATECO 1.45 | Only family members | From a minimum of 80 tons to a maximum of 0.880 | Located Agroforestry in areas | They make use of exceptions with reference to processing and storage premises |

In Italy, the ATECO classification is the classification that the National Institute of Statistics has introduced to respect the NACE classification, which represents the one adopted in Europe and which, in turn, derives from the international one (ISIC). NACE is a derived classification of ISIC: categories at all levels of NACE are defined to be identical to individual ISIC categories or to form subsets of them. All three classifications are in harmony with each other in order to make economic activities homogeneous.

In order to be able to homogeneously compare the investigated production realities, it was decided to collect information regarding the products obtained: fresh pecorino, seasoned pecorino and ricotta. These are products made with a curd obtained from whole raw sheep's milk. Fresh pecorino has a drying period of 3/4 weeks (and the product obtained is called primosale), while semi-matured pecorino requires at least two months of maturation. Both have the typical flavor of sheep's cheeses, less strong due to the freshness, and more incisive and spicy than the semi-aged pecorino. Ricotta, on the other hand, is a joint product that is obtained from the pecorino production process after adding a minimum percentage of milk to the whey of the pecorino production.

In the pecorino production process, the processing of the milk follows the following stages. The milk is measured, filtered, analyzed and subjected to a short heat treatment. The milk is then placed in the coagulation tanks, where a ferment composed of an association of thermophilic lactic acid bacteria is added. The milk coagulates by means of rennet. Once the optimal hardening of the curd is ascertained, the cheesemaker proceeds to break it until the curd clots reach small dimensions. Subsequently, the curd is divided into blocks and placed in molds for pressing in a warm and humid environment for an optimal time for

purging the whey. This is followed by the stage of cooking the curd. After cooling, salting takes place totally or partially dry according to an ancient and complex artisan technique. Finally, the wheels reach the maturing cells where required by the market.

#### 4.1.2. Collection and Processing of Data from Production Companies

The methodology followed to identify the D. F. and L. F. to be analyzed used an exploratory, qualitative and instrumental case study approach.

Territorial analyses were carried out both preliminarily to collect the information necessary for subsequent interviews with business owners and, subsequently, to integrate and complete the information collected. For this purpose, various local operators in the sector were consulted, such as associations of breeders, local technicians and local public managers. Secondly, we turned to local farmers, some of whom deliver the milk to the D.I. In order to identify the dairies to be interviewed in the investigated area, we intercepted 10 companies using the "snowball" approach [37,38]. In choosing the specific non-probabilistic method, the existing study subjects recruit subjects to be interviewed from among their acquaintances. The sample group grows like a rolling snowball. The first interviewee reported other friendly producers, relatives who indicated the reference dairy, etc. This method is effective in difficult situations, where the subjects to be interviewed are available only through direct contact, a network of friends or relatives. The interviews with the owners of the companies were conducted anonymously on the basis of a semi-structured questionnaire prepared to collect all the technical and economic data necessary for the purpose of identifying the company's economic results. Dairy industries (D.I.) and livestock farms (L. F.) were considered in the territory of the Province of Reggio Calabria, the southernmost province of the Italian peninsula. The companies considered, as a whole, intercept quantities of milk that are around 10% of the regional total.

The interviews were carried out only after having received informed consent for the processing of sensitive data. We used the collected data, organizing them and analyzing the transcripts of the interviews through thematic analysis [37]. Thematic analysis is one of the basic techniques in qualitative research and is particularly suitable when researchers conduct applied research.

The companies intercepted, available for the interview and to which to submit the questionnaire were 10 (6 D.I and 4 L.F). The interviewees were given the opportunity to choose the place and time of the interview. The data were collected between September and November 2021; the administration lasted between 60 and 90 min, was carried out on the basis of the objective of the study and was managed to take into account the experience already acquired by the researchers in this genre of studies. The data collection concerned the following: (1) the production process in its articulation; (2) the technical means used in this process; (3) costs relating to the means used and the raw materials used; (4) production performance; (5) the final selling prices of the produced productions.

#### 4.1.3. Methodological Approach: Company Net Margins

The study of the companies was carried out in order to be able to determine the companies' net margins. For this purpose, data were acquired to determine the following:

- The special cost or prime cost;
- The Industrial cost;
- The overall cost or economic–technical cost;

The production cost for the various types of production was obtained by reapplying the full cost or full costing methodology [39,40]. This methodology involves the debit of all cost elements found in the company, based on the contribution of the various factors used to obtain it, according to the "principle of full cost absorption". Therefore, in the processing phase, the necessary adjustments are necessary so that each cost element charged to the calculation object expresses, as correctly as possible, the contribution that the single production factor has made according to the "causal principle" [41].

In order to comply with the aforementioned objectives, a classification of the elementary costs is carried out on the basis of the type of relationship that exists between the connected production factors and the products. Costs are thus distinguished in relation to their different functions. These are, therefore, divided into two categories of direct costs and indirect costs. The elementary costs that have a specific relationship with the product are direct; that is, they concern factors whose quantity it has been possible to determine in that product. These costs are, in fact, directly attributed to the product. On the other hand, costs that have a common relationship with several products and, therefore, must be shared between the same products are indirect. In order to be correctly classified, the elementary costs must be analyzed individually.

The prime cost is the aggregate obtained by adding all the direct costs. It is an aggregate commonly obtained by adding together the consumption of raw materials, ancillary materials, as well as the costs for direct labor. With the latter expression, we refer to the costs related to the person directly employed in obtaining the product in question. It is the most easily determined aggregate since, taking into account only direct costs, it is determined objectively and does not require any attribution of "parts of cost".

The industrial cost, also known as production cost, is a cost configuration obtained by adding to the first cost a share of general production costs such as the costs of personnel assigned to production services, maintenance and repair costs, testing costs, expenses for internal movements of materials, expenses for production premises, industrial depreciation, expenses for studies and research, etc. The production costs are indirectly attributed to the object using various imputation criteria. It follows as it is easy to understand that it is an aggregate that is more difficult to determine and whose correct determination depends very much on the rigor with which it is defined. The economic–technical cost represents the most complete full-cost configuration of all. It is determined starting from the total cost and adding a portion of the notional charges. The latter are the managerial salary due to the entrepreneur who lends his work in the company, as well as the interest in calculating the capital invested in the company (see Figure 3).

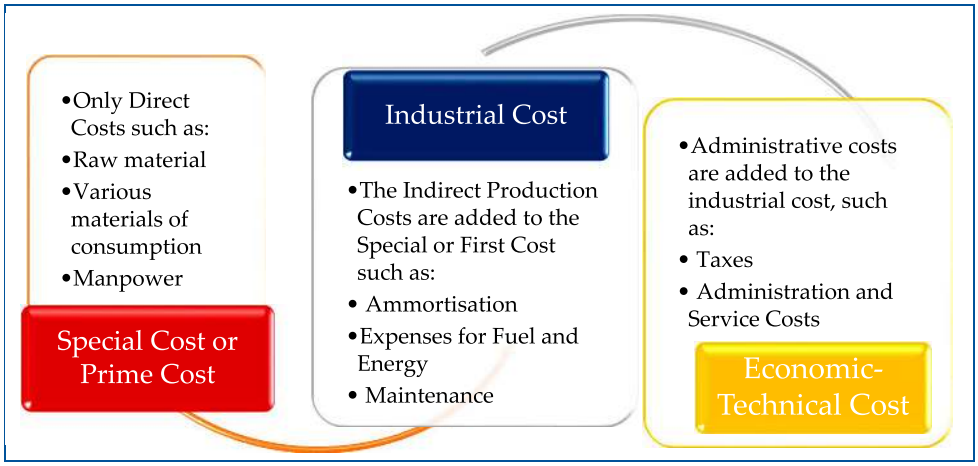



**Figure 3.** Configurations and cost items.

In the study, through the methodology used, the most complete possible synthetic cost determinations were reached. To this end, it is necessary to charge in the production cost all those elements that contributed to its achievement according to the so-called "principle of full cost absorption". However, the need to consider all costs is not sufficient, as it is also necessary that each cost element charged to the calculation object reflects, as correctly as possible, the "service" that the connected production factor has given to the object itself (causal principle). The type of relationship that exists between the connected production factors and the products is therefore defined, and it will be this relationship that will influence the methods of charging the elementary cost to the product. As seen in the

previous paragraph, this leads to a distinction between costs in the two categories of direct costs and indirect costs in relation to the different functions performed by them. Specifically, the direct (or special) costs calculated for the production of the different types of cheeses are those referable to the purchase of the raw material (sheep's milk, rennet, lactic ferments and salt), to the use of strictly necessary for carrying out operations relating to all stages of milk processing, for spending on electricity and for packaging. It is, therefore, all the cost items directly attributable to the production of the cheese from the moment it reaches the dairy until it is packaged. As regards the direct cost of labor, relating to all the transformation operations, the annual cost, gross of contributions, is the sum of two components: fixed labor (annual salary + contributions) and temporary labor (working days for the gross daily wage). The costs of the electricity used were calculated directly. Therefore, the costs for packaging were added.

By calculating all the direct costs relating to the annual transformation of milk, the special (or first) cost was calculated. The second type of cost, indirect costs, can be attributed to specific criteria for the unbundling of quotas. These include depreciation and maintenance. In the specific study, these quotas were determined with reference to the equipment. The depreciation rate was calculated by calculating the new value of the assets less the residual value (once the useful life has been completed) divided by the years of probable use. With the exception of the boiler, for which a period of use of 20 years has been foreseen, a probable period of use of 8–10 years was considered for all other technical instruments. The maintenance quotas, on the other hand, were calculated according to their actual outlay. Interest was calculated on the fixed assets to the extent of 3% of their average value.

If we add the industrial overheads to the first cost, we obtain the industrial cost. Finally, if we add to this aggregate the set of general administrative, insurance, tax and commercial costs, we obtain an overall cost or technical, economic cost.

### *4.2. Companies' Economic Results*

#### 4.2.1. Milk Processed Results

The study examined the economic accounts of the dairies in order to determine, through the analysis of the costs relating to the transformation of milk into cheese, the economic items relating to this transformation. Regarding the D.I. (dairy industries) and the L.F. (agricultural/livestock enterprises), the former (D.I.) work from a minimum of 0.525 quintals of milk per year to a maximum of 1,950 quintals (Figure 3); the L.F. work from a minimum of 0.080 quintals in the L.F.3 company to a maximum of 0.880 quintals in the L.F.1 company per year (Figure 4).

Data relating to the production process of transforming milk into cheese were collected from all the companies. All the companies respect and guarantee the hygienic-sanitary norms foreseen. D.I. produce standardized cheeses, while L.F. firms produce less standardized and more artisanal cheeses.

At present, with modern knowledge in the field of hygiene and microbiology, the production of traditional cheese takes place with a high level of food safety.

Agri-food industries must guarantee the safety of the produced foods through the application of the existing regulations by correctly implementing quality control systems. It is extremely important to monitor the industrial treatments to which it is subjected to avoid the multiplication of spoilage and pathogenic microorganisms. Raw milk must undergo strict quality controls at the primary production level based on the knowledge of the main factors that influence their quality and microbiological safety: hygienic practices, the health status of cows, frequency and moment of collection, storage temperature and time of transportation [42].

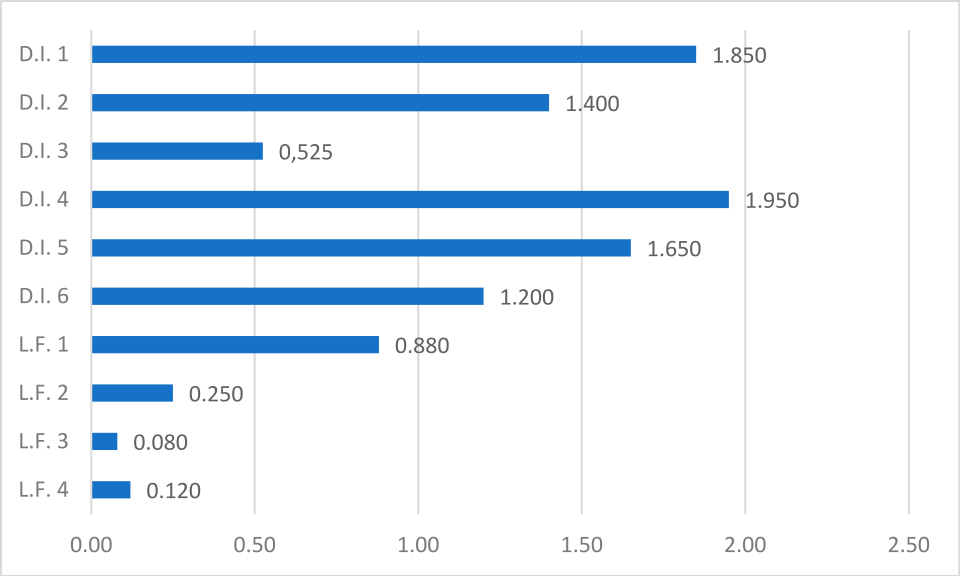



**Figure 4.** Milk per year processed from companies (D.I and L.F).

It is known that bacteria are not always dangerous: on the contrary, the lactic bacteria active in the cheese-making process help protect the cheese from dangerous bacteria [43].

The DI agri-food businesses where the survey was conducted develop on fairly small surfaces (between 100 and 400 square meters) and have masonry buildings and/or prefabricated sheds. There are basically three rooms: a milk storage and processing room, a production maturing room and a room for the direct sale of the product. The companies are run by sole proprietorships with one or two permanent workers whose function is occasionally supplemented by the use of casual labor. The equipment consists of boilers, refrigerating tanks, milk pasteurization machines, multi-purpose cheese-making tanks, double-bottomed ricotta tanks, stainless steel vats with wheels, steel stewing containers, stainless steel tables, various trolleys and vans for transport and deliveries.

The L.F companies have smaller rooms (between 30 and 100 square meters) and equipment: a room where the milk is processed, and one for the storage of the products made. They work exclusively with their own milk production from farm farms. The products made are sold to small local distribution within the province of Reggio Calabria and, to a lesser extent, directly in the company.

#### 4.2.2. Cost Analysis

The following types of costs have been calculated for each company: special or prime cost, industrial overhead costs, industrial cost and economic–technical cost. The breakdowns for artisan dairies and for livestock farms are shown below (Figure 5).

Although there is substantial homogeneity in the purchase price of milk by the companies, there is a slight difference in the selling prices of the products obtained. These have therefore been detected by us and reported in Figure 6.

Furthermore, through the economic results obtained on the basis of the costs accounted for, it was possible to determine the gross salable production. The semi-gross margin and the net margin for each company were thus obtained (Figure 7). Finally, the net margin per quintal of milk processed for the ten companies was determined (Figure 8).

The economic results obtained from the company analyses show that the D.I. performed better. In fact, the net margins of these companies range from a minimum of EUR 113,52 to a maximum of EUR 127,15 per quintal of processed milk (Figure 9). The L.F., on the other hand, achieves significantly lower net margins. In fact, these range from a minimum of EUR 96,10 to a maximum of EUR 117,31 per quintal of processed milk (Figure 9). The reasons are to be traced back to a lower efficiency of the production factors due substantially

to the lower quantities of milk processed, as well as to the higher costs associated with the movement of personnel, as the companies are all outside the inhabited centers.

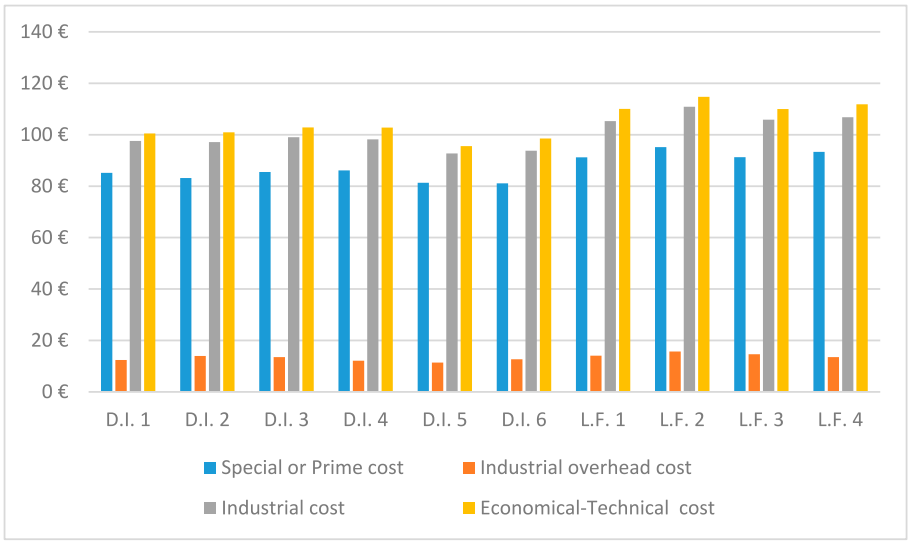



**Figure 5.** Types of costs in the companies interviewed D.I. and L.F. (EUR per quintal of processed sheep's milk).

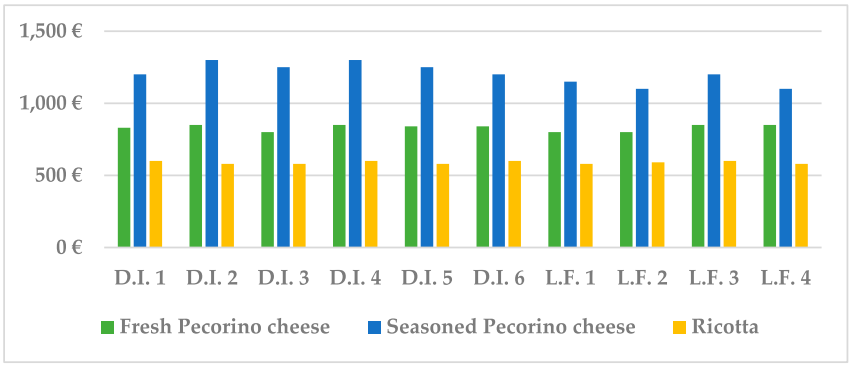



**Figure 6.** Prices obtained by type of product sold (EUR per quintal).

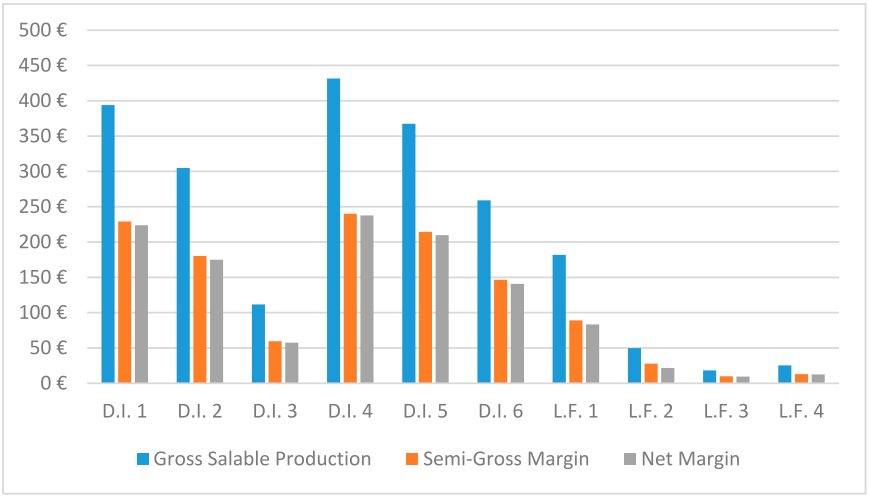



**Figure 7.** Gross salable production, the semi-gross margin and the net margin for D.I. and L.F for types of products in euros.

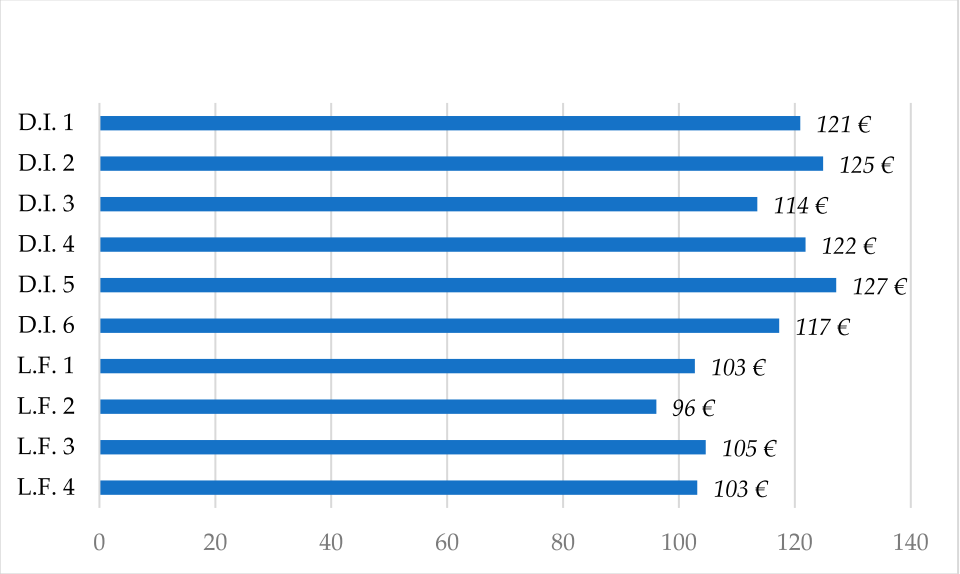



**Figure 8.** Net margin for companies D.I. and L.F. values in EUR per quintal of processed milk.

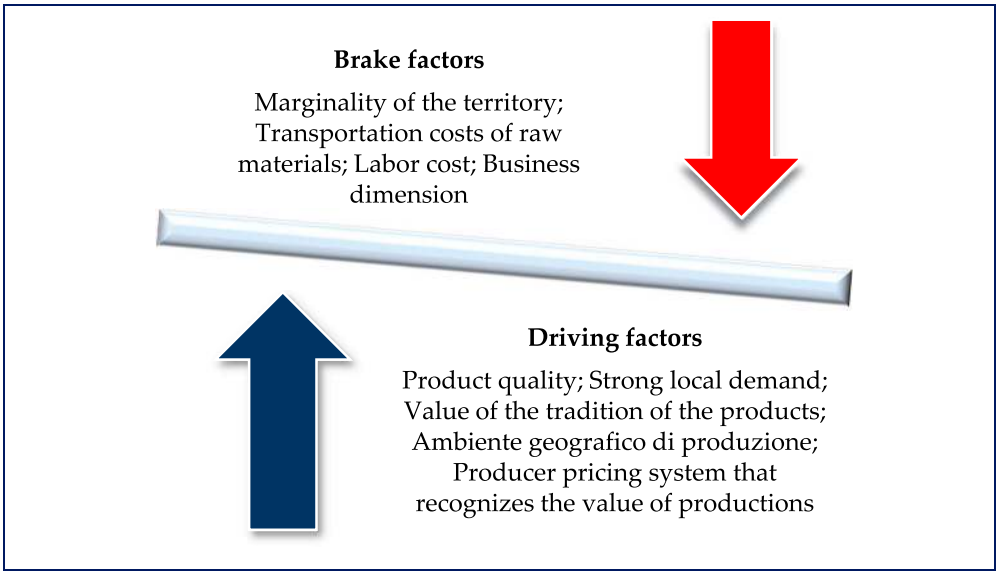



**Figure 9.** Driving and braking factors of the productions considered.

## 5. Discussion

The importance of pastoral farms in fragile areas (inland, mountain, marginal) [44] is known by virtue of their contribution to multiple aspects such as fire prevention, erosion of soil, maintenance of rural population in the territory, socio-economic contribution, etc. Less investigated is the role of dairy processing companies in maintaining the economic and social fabric in internal and marginal areas [29,45]. As Zamagni et al. [46] argued, the balanced development of local communities should create the conditions for common growth [43,44].

Sheep heads raised mainly on pasture play an important role in adding economic value to disadvantaged agricultural areas [18,19,34]. As has been pointed out in the case of agro-industrial systems in other countries [47], the agro-ecological and ecosystemic challenges that lie ahead are both opportunities and threats, and the fate of these productions is strongly linked to the ability of all the players in the local supply chain to collaborate to be able to improve the value chain.

The analysis carried out considered a group of companies that process sheep's milk for the production of fresh pecorino, aged pecorino and fresh ricotta. These are products widely consumed in the area that boasts an established tradition over time.

As for the costs that affect the profitability of the productions considered, according to the analysis of the company's financial statements, it emerges that sheep's milk (the main raw material), labor, expenses for electricity and fuel, expenses for depreciation of technical means, structures (warehouses and storage rooms, etc.) and finally expenses for administrative costs and commercial.

Overall the cost structure, the dynamics of the prices of sheep's milk destined for processing, is the one that most of all impacts the profitability of the productions carried out and which is strictly connected to the dynamics of the costs of milk production and to changes in feed prices for livestock [48]. Furthermore, sheep's milk, as well as bovine milk, is strongly conditioned by the price of production factors, primarily energy costs, but is also subject to cyclical fluctuations due to the relationship between demand and supply according to the theoretical instrument of web in which the market response is linked to the elasticity of supply and demand. This is, therefore, due to the lack of real market strategies [1], the fact that livestock farms have a rather limited number of animals, and, last but not least, the fact that they are located in quite a large territory.

In light of these considerations, some reflections are necessary. What are the driving forces and what are the braking forces for this sector in the area considered? What prospects are opening up? What and how could we intervene? Many are the criticalities of dairy production investigated. First is the company size; the transformation takes place in small-scale companies that do not allow suitable production and market strategies.

The main driving force is the quality of the production, strongly rooted in the agri-food heritage of the territory.

As pointed out by Pichierri et al. [49], one aspect to underline concerns the importance of the information on the label for food safety purposes. Clearer health claims are perceived as more useful and can increase product attractiveness and consumer intent to purchase.

The quality is mainly due to the particular geographical environment, biodiversity, human resources, craftsmanship, farms that have maintained the diversity of naturally selected breeds over time and a production system adapted to the territory (Figure 9).

In addition to being an important tool to combat abandonment, the survey on consumption shows that local production is also important in the eyes of consumers, especially the most demanding and attentive to food, who push demand for proximity products, which reflect the food traditions of the area and which are confirmed to be more sustainable, from an economic and social point of view, as demonstrated by lower costs of transport costs and lower environmental impact in terms of pollution.

## 6. Conclusions

The peculiarity of these productions lies in the maintenance of traditional production traditions and techniques and artisan dairy transformations that deviate from modern trends towards highly specialized and technically advanced production systems with commercial processing plants that mainly produce cheese and yogurt [1].

Even the internal demand for cheeses, considered solid, aware and increasing, represents a driving force, as well as the system of prices to the producer, which recognizes the value of the production.

It seems important to support traditional consumption models that respond to sustainability logic, strengthen the synergy of companies trying to optimize costs to improve relations between producers and dairy industries in compliance with the needs of both and stimulate the resilience of the territories [50]. It is also considered necessary to develop strategies that can avoid strong fluctuations in the price of milk, especially in a perspective that is a prelude to significant increases in the prices of raw materials, particularly due to the prices of energy products. The obvious risk is the inflationary processes that are taking place in this period with consequent repercussions on economies and which risk

compromising consumption. However, in our opinion, it is necessary to promote both individual and collective technical solutions compatible with the local production system, which increase the economic sustainability of the production and processing chain, also by resorting to forms of technical and professional advice for breeders and dairies.

As for the measures introduced by the European Union for companies located in internal and marginal areas, several authors underline how the transitions in dairy systems are influenced both by social, cultural, economic and environmental processes and by structural factors such as government subsidies and regulations [1,48]. For a long time now, the community policy rules have insisted on maintaining and/or increasing the quality of production, increasing the profitability of farms and improving the living conditions of farmers. Maintaining sheep farming in traditionally suited areas allows the population to remain at the same time and the maintenance of local productions and traditions, even if positive impulses for innovation must not be excluded at all. This is because if local production is important for the survival of agriculture and animal husbandry in the area, it is also important because the consumer has increased the demand for local products that are more sustainable (less transport and pollution) [51] and traditional.

Regarding the limitations of the research, three seem the most obvious: the first concerns the fact that the study is limited to a territory and consequently has a strongly localized value; the second concerns the fact that the analyses were carried out in a pre-COVID-19 period when companies and consumers were in a stable health and economic situation which was subsequently distorted: the third concerns the picture of costs and revenues of the productions considered. If, for a long time, the market conditions of both production factors and products have remained practically unchanged in the last year at a macroeconomic level, very marked price increases have been recorded in the costs of raw materials driven by energy price increases. The study photographs a valid situation in a precise moment and which is certainly subject to changes depending on the macroeconomic conditions.

Future research aims to consider other territorial realities and, with reference to the framework of costs and revenues, in a modified cost and revenue regime to study those elements of greater variability. Furthermore, the consumer analyses that we are carrying out aim to bring out the most innovative aspects linked to sensitivity relating to sustainability and proximity products. The research group expects to continue studies and research in which these aspects are considered.

**Author Contributions:** Conceptualization: all the authors.; methodology—Paragraph 3: A.N., Paragraph 4: D.D.G.; Results—Sub-Paragraph: 3.2: A.N. and V.R.L., Results—Sub-Paragraph 4.2: D.D.G.; validation: all the authors; formal analysis: all the authors; data curation: all the authors; writing—original draft preparation: all the authors; writing—review and editing: all the authors; funding acquisition: M.B. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study did not require ethical approval. There isn't no unethical aspect because all the interviews are totally anonymous.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. In all questionnaires, researchers collected the information in anonymous form and requested for study reasons.

**Data Availability Statement:** https://codiceateco.it/categoria?q=10.51.20 (accessed on 8 June 2022). https://www.codiciateco.com/sezioni/a-agricoltura-silvicoltura-e-pesca/01-coltivazioni-agricole-e-produzione-di-prodotti-animali-caccia-e-servizi-connessi/01-4-allevamento-di-animali/01-45-allevamento-di-ovini-e-caprini/01-45-0-allevamento-di-ovini-e-caprini/ (accesed on 15 June 2022).

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Correspondance analysis, overview column points and overviews row points.

| **Overview Row Points** [a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | Mass | Score in Dimension | | Inertia | Contribution | | | | Total |
| | | | | | Of Point to Inertia of Dimension | | Of Dimension to Inertia of Point | | |
| | | 1 | 2 | | 1 | 2 | 1 | 2 | |
| 18–29 | 0.212 | 0.212 | 0.521 | 0.017 | 0.041 | 0.305 | 0.129 | 0.627 | 0.755 |
| 30–39 | 0.167 | 0.156 | −0.365 | 0.008 | 0.017 | 0.118 | 0.122 | 0.542 | 0.664 |
| 40–49 | 0.172 | 0.674 | 0.193 | 0.023 | 0.336 | 0.034 | 0.780 | 0.052 | 0.832 |
| 50–59 | 0.177 | −0.478 | −0.282 | 0.015 | 0.173 | 0.075 | 0.642 | 0.180 | 0.822 |
| 60–69 | 0.146 | −0.822 | 0.399 | 0.027 | 0.422 | 0.123 | 0.839 | 0.159 | 0.998 |
| >69 | 0.127 | 0.137 | −0.715 | 0.022 | 0.010 | 0.344 | 0.026 | 0.562 | 0.588 |
| Active Total | 1.000 | | | 0.112 | 1.000 | 1.000 | | | |
| [a.] Symmetrical normalization | | | | | | | | | |
| **Overview Column Points** [a] | | | | | | | | | |
| Food Shopping Place | Mass | Score in Dimension | | Inertia | Contribution | | | | Total |
| | | | | | Of Point to Inertia of Dimension | | Of Dimension to Inertia of Point | | |
| | | 1 | 2 | | 1 | 2 | 1 | 2 | |
| Retail | 0.225 | −0.706 | 0.495 | 0.037 | 0.482 | 0.293 | 0.716 | 0.284 | 1.000 |
| City market | 0.275 | 0.391 | 0.057 | 0.019 | 0.180 | 0.005 | 0.506 | 0.009 | 0.514 |
| Hypermarket | 0.310 | 0.366 | 0.054 | 0.021 | 0.178 | 0.005 | 0.470 | 0.008 | 0.478 |
| No purchase | 0.101 | −0.609 | −1.080 | 0.031 | 0.160 | 0.623 | 0.280 | 0.712 | 0.992 |
| Fair and festivals | 0.090 | −0.007 | −0.394 | 0.005 | 0.000 | 0.074 | 0.000 | 0.570 | 0.570 |
| Active Total | 1.000 | | | 0.112 | 1.000 | 1.000 | | | |
| [a.] Symmetrical normalization | | | | | | | | | |

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*Local Food and Sustainable Attitudes*

# CIBO LOCALE E ATTEGGIAMENTI SOSTENIBILI*

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Abstract

**Consumer preferences and purchasing intentions for local food products are constantly changing. These preferences are mainly influenced by various factors such as experiences and personal needs, the levels of perception on dietary trends and on information. The aim of the paper is to understand consumer preferences and their attitude on the ethical and sustainable aspects of local food purchased. 300 consumers were interviewed on two southern Italian regions through a specific questionnaire. After an initial descriptive analysis, data were processed through multivariate analysis models by applying exploratory factor analysis and principal component analysis. The results show how the sensitivity of consumers regarding purchases and therefore consumption is connected to ethical aspects, to the improvement of local and even global environmental conditions. The data also show a particular attention of consumers to food safety, to the desire to support and sustain the local economy. The study therefore seems to confirm the thesis that sees consumers more attentive, aware and sensitive to the issue of environmental sustainability.**

KEY WORDS: *Local Food, Food Safety, Agri-food Products, Factor Analysis, Consumer Preferences.*

## 1. Introduzione

I processi di trasformazione sociale in atto negli ultimi decenni stanno modificando anche il mondo dell'alimentazione e del comparto agroalimentare [1, 2].
In modo più soggettivo, e secondo le proprie preferenze, ci si rapporta con il cibo sempre più sulla base di esigenze personali [3], attitudini [4] e risorse economiche disponibili [5]. Anche l'attenzione ai processi produttivi, ai comportamenti etici degli imprenditori, agli aspetti di sicurezza alimentare e tracciabilità stanno divenendo sempre più oggetto di attenzione, da qui il crescente interesse all'acquisto dei prodotti tipici e di provenienza del proprio territorio [6, 7].
Il cibo locale, artigianale, e di qualità [8], storicamente importante in tutta la Penisola e nella tradizione mediterranea, occupa un posto rilevante nella vita quotidiana di molti individui e consente di associare piacere a salute, sia personale che dell'ecosistema [5]. Accanto alle tradizioni nei consumi, gli studi sul comportamento dei consumatori più recenti mostrano come i consumatori sembrano sempre più orientarsi verso nuovi modelli etici [9], più funzionali ed incentrati al benessere personale e meno rivolti al consumo in quanto tale [10 - 13].
Sensibili ai cambiamenti e adattativi alle esigenze dei mercati, i produttori hanno seguito le nuove esigenze,

*Il documento nella sua interezza è frutto del lavoro congiunto degli autori. Tuttavia sono da attribuire: il paragrafo 1 a Donatella Di Gregorio; il paragrafo 2 ad Agata Nicolosi; il paragrafo 3.1. a Mariangela Petullà; il paragrafo 3.2. a Lorenzo Cortese; il paragrafo 3.3. a Valentina Rosa Laganà; il paragrafo 4 a Donatella Privitera.

anche in linea con i sistemi alimentari che richiedono cambiamenti nel rispetto degli Obiettivi di Sviluppo Sostenibile di fame zero, comunità e città sostenibili, come concordato dai 194 paesi dell'Assemblea Generale delle Nazioni Unite nel 2015 [14].
La letteratura scientifica è ricca di teorie riguardanti il consumatore, non solo con riferimento agli aspetti di natura strettamente economica, quali consumi e produzioni, ma anche a quelli sociali, psicologici, ambientali, legati al rispetto ed alla salvaguardia dell'ambiente [15 - 19]. Etica, responsabilità, orientamento ecologico, sostenibilità, sono solo alcuni dei nuovi modelli ricercati dai consumatori, sottoponendo anche le proprie scelte alimentari ad una revisione e riflessione continua [20 - 24]. Piattaforme di condivisione, attenzione agli sprechi alimentari, networks, rappresentano infine un approccio economico e culturale nuovo [16].
Le Food Community Networks (FCN) sono in crescita in tutto il mondo e definiscono quei sistemi e modelli organizzativi che prevedono un rapporto di vendita/acquisto diretto tra produttore e consumatore, determinando evidenti vantaggi per i consumatori, per i produttori, per la collettività e per l'ambiente [22].
Una maggiore comprensione del processo decisionale di scelta dei consumatori in rapporto alla loro attenzione alla sostenibilità, rappresenta l'obiettivo specifico della presente analisi. L'attenzione agli elementi di caratterizzazione e identificazione dei prodotti agroalimentari potrà costituire un'importante base per le aziende per adottare strategie di marketing volte alla promozione e valorizzazione delle produzioni, in ragione delle scelte dei consumatori. Ciò è vero in particolare per le aree interne e più fragili del Mezzogiorno d'Italia, meritevoli di attenzione e destinatari degli obiettivi strategici dell'ONU per lo sviluppo sostenibile (Agenda 2030). Infatti, valorizzazione, innovazione e riqualificazione delle aree interne [25] rappresentano priorità nell'uso sostenibile delle risorse.
Il mantenimento della cultura, delle tradizioni e dei prodotti agroalimentari locali rappresentano strumenti di resilienza e potenzialità per i territori tuttavia, in un'epoca di rapida urbanizzazione, per realizzare la sostenibilità è necessario comprendere l'interconnessione tra i sistemi urbani e i sistemi alimentari [26].
Questo studio è un contributo all'attuale dibattito sulle preferenze dei consumatori sull'esistenza di ragioni etiche e sostenibili nell'acquisto di prodotti alimentari locali. Va precisato che l'indagine è stata condotta prima che si scatenasse la terribile pandemia da Covid 19.
Oggi sappiamo che i consumi alimentari sono stati molto influenzati da tale evento. Soprattutto le misure di contenimento degli spostamenti e lo smart working hanno fortemente condizionato le spese domestiche che hanno assorbito i consumi in precedenza effettuati fuori casa, mantenendoli in ambito domestico [27].
Superato il periodo dell'emergenza, si rileva un ritorno alle precedenti abitudini con un vivace recupero di socialità e desiderio di condivisione.
La prima sezione è dedicata all'introduzione, la seconda all'approccio metodologico seguito, la terza ai risultati raggiunti, la quarta sezione mira alla discussione.
Nelle conclusioni vengono evidenziati limiti e prospettive di ricerca futura.

## 2. Metodologia

L'indagine è stata condotta attraverso la formulazione e la somministrazione di un questionario semi-strutturato a risposte libere e/o pre-formulate a 300 consumatori disponibili all'intervista, ed intercettati nell'area dello Stretto di Messina, le Isole Eolie e la provincia di Reggio Calabria. Le interviste sono state realizzate nei mesi da giugno ad ottobre 2017 in luoghi particolarmente affollati come porti, terminal bus, stazioni ferroviarie, strade principali, punti vendita al dettaglio (supermercati, GDO), mercati rionali, eventi enogastronomici locali in cui si poteva incontrare un campione avente caratteristiche poco omogenee e differenti modalità e capacità di acquisto (vedi Fig. 1).

*Fig. 1 - Localizzazione dell'area.*
*(fonte: propria elaborazione)*

Le interviste sono state effettuate in modalità "face to face". La ricerca ha fornito in primo luogo le caratteristiche socio-demografiche dei soggetti intervistati (genere, età; livello di istruzione, occupazione, reddito).
Successivamente, sono state elaborate le risposte dei

consumatori in rapporto alle abitudini di acquisto e alle motivazioni che guidano le loro scelte quotidiane.
Le ipotesi di ricerca sono state mirate alla individuazione delle abitudini di consumo ed alla sensibilità nei confronti della sostenibilità ambientale negli acquisti da parte degli intervistati. Le domande che, attraverso il questionario, sono state poste, attengono alle condizioni che influiscono sul comportamento ed alle motivazioni d'acquisto di prodotti locali (vedi Tab. 1).
Le possibilità di risposta variano su una scala Likert (da 1 non importante a 4 molto importante).

| Quanto la sua scelta di acquisto di un prodotto alimentare locale è influenzata dalle seguenti motivazioni? (Scala Likert: 1=per nulla; 2= più no che sì; 3= più sì che no; 4=molto importante. |
|---|
| Q1 Sicurezza alimentare e qualità |
| Q2 Prodotti Made in Italy |
| Q3 Prodotti a Km 0 |
| Q4 Chiarezza nelle tecniche di trasformazione |
| Q5 Prodotti biologici certificati |
| Q6 Produzioni a basso impatto ambientale |
| Q7 Commercio e marchi etici |
| Q8 Certificazione di risparmio energetico |
| Q9 Acquisto di prodotti a marchio DOP e/o IGP |
| Q10 Certificazioni di sostenibilità ambientale |
| Q11 Miglioramento ambientale della mia zona |
| Q12 Miglioramento ambientale globale |
| Q13 Tutela della biodiversità |
| Q14 Aiutare gli agricoltori |
| Q15 Etichetta chiara |
| Q16 Imballaggio ridotto e differenziabile |
| Q17 Responsabilità sociale ed eticità dell'impresa |
| Q18 Prezzo adeguato |
| Q 19 Facilità di acquisto e reperibilità online |
| Q20 Percezione di vantaggio per la mia salute |

*Tab. 1 - Domande di ricerca.*
*(fonte: propria elaborazione)*

L'estensione e la complessità dello strumento di rilevazione utilizzato ha consentito di ottenere un'abbondante massa di dati e di informazioni, funzionalmente utili alla comprensione del profilo del consumatore tipo. Sono state raccolte 300 schede valide ai fini dell'analisi, ed è stato realizzato il database con l'ausilio del software SPSS.

## 3. Risultati

### *3.1. Descrizione del campione*

Il database è stato utilizzato per elaborare, analizzare ed interpretare i dati raccolti, dapprima attraverso l'analisi descrittiva, allo scopo di evidenziare le principali caratteristiche, e successivamente, attraverso l'analisi fattoriale al fine di interpretare i profili dei consumatori intervistati.
I risultati dell'indagine effettuata hanno evidenziato un campione caratterizzato da consumatori di un livello culturale medio-elevato, in maggioranza uomini (vedi Tab. 2). Entrando in un maggior dettaglio circa i caratteri socio-demografici del campione intervistato, si può osservare che le classi maggiormente rappresentate sono quelle tra i 30 ed i 39 anni (26,67% del campione), mentre è relativamente presente la classe di età di coloro che hanno più di 70 anni d'età (5,66% del campione).
Con riferimento alla distribuzione del campione per genere, si rileva una rappresentanza maschile (50,7%) di poco superiore rispetto a quella femminile (49,3%).
La scolarizzazione evidenzia una maggiore presenza di soggetti diplomati (56,3%) rispetto ai laureati (32,7%).
Quanto all'occupazione, si evidenzia una porzione importante di dipendenti (39%) e di indipendenti (35,6%), i pensionati rappresentano il 12% del campione mentre i disoccupati il 6%. Con riferimento al reddito, quello familiare maggiormente rappresentato è piuttosto medio-basso (50%). Il numero di componenti familiari più rappresentato è quello formato da quattro persone (36,7%) mentre le famiglie numerose (uguali o superiore a sei persone) raffigurano l'1,3% del campione.

### *3.2. Descrizione delle attitudini alla sostenibilità dei consumatori nell'acquisto di prodotti locali*

Come evidenziato nella figura (vedi Fig. 2) e nella tabella (vedi Tab. 1), ai consumatori è stato chiesto quali fattori possano influenzare l'acquisto (vedi Tab. 3), indicando il grado di importanza su una scala Likert in cui 1 = per nulla, 2= più no che sì, 3= più sì che no, 4= molto importante. Dall'analisi descrittiva (vedi Fig. 2) si evince che i consumatori danno molta importanza a fattori quali il basso impatto ambientale e/o produzione biologica (45,7%), imballaggio ridotto e/o facilmente differenziabile (39%), data di scadenza più lunga (41,7%) e responsabilità sociale ed etica dell'impresa (49%).
Risultano fondamentali per il consumatore i fattori legati alle origini delle materie prime come il made in Italy (56,7%) ed a km 0 (47,3%).

| Variabile Sociodemografica | Media | Dev. Stand. | Min | Max |
|---|---|---|---|---|
| Età | 41.83 | 15.447 | 18 | 83 |
| Istruzione | 3.22 | 0.648 | 1 | 4 |
| Reddito | 2.66 | 0.668 | 1 | 4 |
| Genere (0 uomo; 1 donna) | 0.493 | NA | 0 | 1 |

*Tab. 2 - Variabili socio-demografiche, significatività e deviazione standard.*
*(fonte: propria elaborazione)*

| Domande di Ricerca | Media | Dev. Standard |
|---|---|---|
| **Q1** | 3.52 | 0.733 |
| **Q2** | 3.39 | 0.829 |
| **Q3** | 3.24 | 0.875 |
| **Q4** | 2.62 | 0.945 |
| **Q5** | 2.92 | 0.935 |
| **Q6** | 2,94 | 0,934 |
| **Q7** | 2,72 | 0,790 |
| **Q8** | 2,45 | 0,911 |
| **Q9** | 3.08 | 0.796 |
| **Q10** | 2,44 | 0,892 |
| **Q11** | 2.94 | 0,866 |
| **Q12** | 2.90 | 0,911 |
| **Q13** | 3,23 | 0,787 |
| **Q14** | 2,92 | 0,854 |
| **Q15** | 2,96 | 0,886 |
| **Q16** | 2,63 | 0,929 |
| **Q17** | 2.72 | 0,874 |
| **Q18** | 2,90 | 0,943 |
| **Q19** | 2,90 | 0,911 |
| **Q20** | 2,62 | 0,945 |

*Tab. 3 - Influenza sulla decisione di acquisto (scala Likert min 1 max 4). (fonte: propria elaborazione)*

Nei confronti dei marchi e delle certificazioni appare molto chiaro come il consumatore preferisca un prodotto a marchio che rappresenta anche una garanzia dal punto di vista dell'origine e quindi della salubrità del prodotto stesso. Il campione (vedi Fig. 2), infatti, dà molta importanza alla presenza della certificazione biologica (44,3%), a quella di risparmio energetico durante le fasi produttive (36,7%), ai marchi del commercio etico quali Libera, *slow food* o commercio equo e solidale (51%) ed alla presenza di un marchio di qualità europeo quale il DOP o IGP (48,3%).

Dalle risposte si evince inoltre che il consumatore viene poco influenzato da una maggiore reperibilità del prodotto on line (33,33%), mentre le condizioni che aumenterebbero moltissimo la propensione al consumo risultano essere: la qualità e la sicurezza alimentare (64,3%), una migliore etichetta per le adeguate informazioni sull'origine della materia prima e sulla filiera produttiva (40,3%), e la tutela della biodiversità e salvaguardia delle varietà locali (42%).

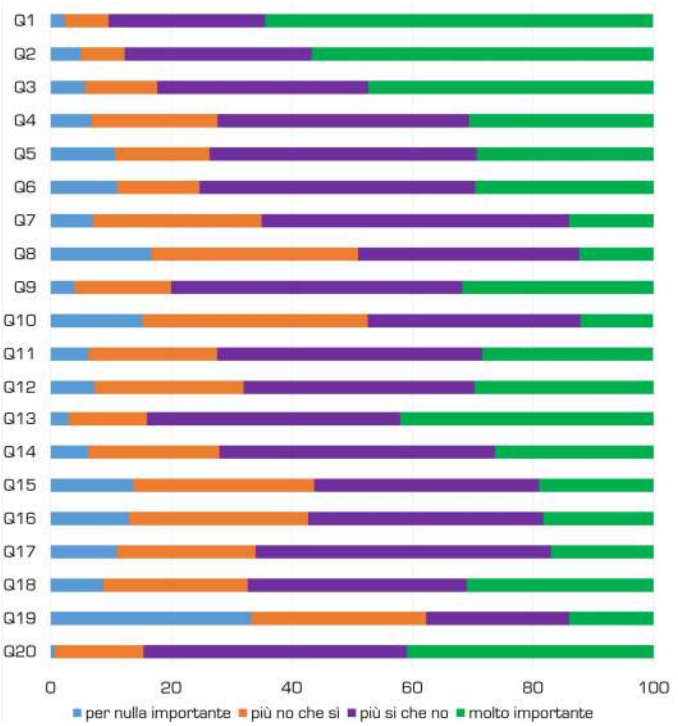


*Fig. 2 - Sensibilità ambientale ed etica dei consumatori intervistati (fonte: propria elaborazione da indagini dirette)*

Altri elementi che risultano influenzare la propensione all'acquisto sono: un prezzo più basso (36,3%), la percezione di un maggiore vantaggio per la propria salute (43,7%), prezzo equo per gli agricoltori (45,7%), la percezione di un miglioramento delle condizioni ambientali della zona in cui vive (44%) e globali (38,3%) ed infine una migliore e corretta pubblicità, promozione e marketing dei prodotti (37,3%).

### *3.3. Analisi fattoriale e individuazione di gruppi di consumatori con atteggiamenti sostenibili*

Lo scopo dell'analisi fattoriale è quello di raggruppare entità, oggetti o persone, sulla base delle loro caratteristiche misurate, in modo tale che vi sia omogeneità all'interno del gruppo e tra l'eterogeneità del gruppo [28]. L'analisi fattoriale è stata realizzata al fine di individuare alcuni significativi indicatori, e quindi gruppi di consumatori, per descrivere le motivazioni di consumo e quindi all'acquisto di prodotti locali secondo principi di etica e sostenibilità. I dati raccolti ed elaborati consentono di estrarre le componenti principali che descrivono la varianza totale a partire dalla matrice di correlazione.

Il criterio per l'individuazione dei gruppi di fattori è connesso alle variabili maggiormente correlate, considerato che ogni variabile ha saturazioni importanti su una sola componente.

Esse sono state applicate per individuare ed analizzare le principali variabili esplicative, e in particolare per evidenziare gli attributi distintivi che condizionano maggiormente i processi decisionali dei consumatori per l'acquisto di un prodotto locale tradizionale.

I cinque fattori hanno modelli significativamente diversi nella differenziazione tra i gruppi. In particolare possiamo definire la prima componente "Sicurezza informata", la seconda "Attenzione agli aspetti etici", la terza "Attenzione alla Sostenibilità ambientale", la quarta "Richiesta di packaging innovativo" la quinta componente, infine, "Consumatori pragmatici".
Le cinque componenti principali registrano una percentuale di varianza spiegata del 60,266%.

| Fattori latenti | % di varianza spiegata | % cumulativa di varianza spiegata |
|---|---|---|
| 1 | 16.407 | 16.407 |
| 2 | 13.703 | 30.110 |
| 3 | 12.937 | 43.047 |
| 4 | 9.659 | 52.706 |
| 5 | 7.560 | 60.226 |

*Tab. 4 - Varianza Spiegata Totale.*
*(fonte: propria elaborazione)*

Il primo fattore latente estratto ha una percentuale di varianza spiegata del 16,4%, questo fattore che possiamo definire di "Sicurezza informata", rappresenta acquirenti che cercano sicurezza alimentare, certificazioni biologiche e di sostenibilità (vedi Tabb. 4 e 5). Preferiscono acquistare prodotti italiani possibilmente a km 0 e sono particolarmente attenti alle etichette dei prodotti alimentari.
Il secondo fattore latente estratto, componente pari al 13,7% raggruppa coloro che "*prestano attenzione agli aspetti etici*". Infatti questi consumatori hanno uno stile di vita alimentare orientato ad una prospettiva etica.
Infatti, prediligono marchi DOP, IGP e marchi del commercio etico (Libera, SlowFood, commercio equo e solidale, ecc.), sono attenti al risparmio energetico, alla certificazione di sostenibilità ambientale ed alle certificazioni di gestione responsabile di boschi e foreste.
Il terzo fattore latente estratto, che possiamo definire "*Attenzione alla sostenibilità ambientale*" ha una percentuale di varianza del 12,9%. Risponde maggiormente a sollecitazioni che provengono dalla necessità di avere percezione di un miglioramento delle condizioni ambientali e di basso inquinamento sia della zona in cui si risiede, che a livello globale. I consumatori che rientrano in questa definizione sono sensibili alla tutela della biodiversità, considerano importante sostenere gli agricoltori ed avere chiarezza delle tecniche di produzione sostenibile.
Il quarto fattore latente estratto, che incide per il 9.6% sulla variabilità, individua dei consumatori innovativi per la "*Richiesta di packaging innovativo*", in rapporto all'esigenza di acquistare prodotti con imballaggio ridotto e/o facilmente differenziabile, e per l'importanza attribuita alla responsabilità sociale e eticità dell'impresa.
La quinta componente, infine, individua i "*Consumatori pragmatici*", incide sulla variabilità per il 7,56% e tende a dare importanza ad un prezzo adeguato dei prodotti sostenibili, alla reperibilità ed alla possibilità di acquistarli online ed infine sono molto interessati in quanto tali prodotti rappresentano un vantaggio per la propria salute. Si tratta di consumatori aperti alle informazioni, alla conoscenza ed alla sperimentazione di nuovi servizi legati al cibo e allo sviluppo di servizi ecosistemici.

| Variabili | Fattori latenti | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | Sicurezza informata | Attenzione agli aspetti etici | Attenzione alla Sostenibilità ambientale | Richiesta packaging innovativo | Consumatori pragmatici |
| Q1 | ,727 | ,044 | ,169 | -,191 | ,180 |
| Q2 | ,725 | ,060 | ,024 | ,311 | ,041 |
| Q3 | ,679 | ,016 | ,106 | ,415 | -,014 |
| Q4 | ,598 | ,158 | ,180 | ,009 | -,053 |
| Q5 | ,598 | ,478 | ,026 | ,172 | ,204 |
| Q6 | ,522 | ,278 | -,002 | ,491 | ,228 |
| Q7 | ,075 | ,830 | ,130 | ,048 | -,082 |
| Q8 | -,002 | ,761 | ,114 | ,281 | ,122 |
| Q9 | ,368 | ,716 | ,001 | -,154 | -,075 |
| Q10 | -,052 | ,700 | ,123 | ,241 | ,276 |
| Q11 | -,006 | ,112 | ,851 | ,121 | ,201 |
| Q12 | -,129 | ,094 | ,788 | ,152 | ,249 |
| Q13 | ,344 | ,118 | ,617 | ,093 | -,204 |
| Q14 | ,246 | ,082 | ,542 | ,073 | -,027 |
| Q15 | ,431 | -,038 | ,455 | ,252 | -,076 |
| Q16 | ,112 | ,055 | ,219 | ,719 | ,052 |
| Q17 | ,123 | ,270 | ,150 | ,687 | ,055 |
| Q18 | ,310 | ,070 | -,030 | ,048 | ,696 |
| Q19 | -,313 | ,083 | ,129 | ,225 | ,624 |
| Q20 | ,342 | ,053 | ,393 | -,195 | ,498 |

*Tab. 5 - Matrice delle componenti ruotati.*
*(fonte: propria elaborazione)*

*Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 8 iterations. KMO and Bartlett's Test. Kaiser-Meyer-Olkin Measure of Sampling Adequacy 0.812. of Sphericity: Approx. Chi-Square2124,442; df 190; Sig. 0.000*

## 4. Conclusioni

Conoscere la provenienza dei prodotti acquistati, prestare attenzione ai sistemi di produzione, alla sostenibilità ambientale dei produttori, alla filiera, sono segnali intangibili di una maggiore attenzione dei consumatori di prodotti agroalimentari.
Filiere produttive corte, modelli di produzione e consumi consapevoli stanno ridisegnando i rapporti tra città e campagna e stanno riducendo le distanze, non soltanto fisicamente [29]. I sistemi di produzione condizionano e disegnano i territori restando impressi sugli stessi, quasi a testimonianza delle tappe evolutive per le insostituibili funzioni economiche ed ambientali collegate [30].
La storia, la cultura, il paesaggio, la costruzione sociale e la condivisione di medesimi interessi tra le comunità umane, legano in modo indissolubile luoghi, territori e prodotti [17].
In particolari aree del Mezzogiorno d'Italia, caratterizzate

da una maggiore continuità spaziale tra aree rurali e città, si stanno riconfigurando legami tra consumatori e produttori, e ciò malgrado l'invasione di prodotti di culture lontane (maggiore consumo di frutta esotica, cibi quali sushi o kebab, ecc..), segno di una forte contaminazione culturale ed alimentare, che incide sui gusti e sulle abitudini dei consumatori. In un mondo che tende alla standardizzazione dei sapori (rafforzata dalla forza dei grandi marchi); all'aumento di consumo di *fast and junk food* (cibo di dubbia qualità, ma a prezzo ridotto e facilmente reperibile); alla perdita della naturale stagionalità dei beni agricoli (raggiunta tra i quali dal progresso tecnologico, alla riduzione dei tempi di percorrenza e dalla globalizzazione dei mercati); la ricerca condotta mostra che, malgrado tutto, esistono margini di ottimismo. I risultati della ricerca rilevano, infatti, comportamenti d'acquisto che aprono ad aspettative positive. Tra questi sembra emergere una spiccata sostenibilità ambientale, un interesse per la qualità e la salubrità, una sensibilità per la biodiversità e la ricerca di provenienza locale.

Sono questi elementi che emergono quali significativi e a condizionamento delle attitudini di consumo.

Forse a spingere in questo senso anche i molteplici eventi connessi agli scandali alimentari, all'emergere del fenomeno delle agromafie, alle emergenze sanitarie abbattutesi sui mercati agroalimentari mondiali, che hanno dato impulso alla voglia di sicurezza, genuinità e di prossimità dei consumatori di prodotti alimentari. Questa tendenza si è combinata con la ricerca della convenienza e della compressione dei tempi di acquisto e di preparazione dei pasti. Si pensi al rapporto di fiducia che si instaura tra consumatore e produttore ai fini della garanzia del prodotto che si intende acquistare, a punto tale che può non essere necessaria la certificazione formalizzata.

Costruire sistemi alimentari rurali o urbani sostenibili e resilienti di fronte ai cambiamenti dell'ecosistema è una sfida che sicuramente incontra le esigenze e richieste dei consumatori attuali. Questa sfida richiede sicuramente una rimodulazione dei sistemi dominanti in cui il cibo viene coltivato, preparato ed infine consumato.

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# Bergamot food products: consumers preferences

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**Abstract.** This study examines trends and attitudes in the consumption of bergamot food, a niche food product. Mainly used for the extraction of essential oils, in the last twenty years it has been widely used in the pharmaceutical and cosmetic industries and as a flavoring for sweets, liqueurs and herbal teas and other food products. Bergamot is currently receiving renewed interest, thanks to its recognized nutraceutical effects, the multiplicity of culinary uses and its use in addition to many food preparations. Bergamot represents a tangible example of circular economy, in fact recent studies highlight the importance of recovering industrial waste from the Bergamot Essential Oil (BEO) extraction process and their use as antioxidants and natural additives in the food industry. However, to date, no empirical studies have been conducted on consumers of bergamot and bergamot food to identify consumption and purchasing preferences and behaviours. This empirical study is based on a face-to-face questionnaire. Structural equation modeling (SEM) was used as the main practical approach for data analysis and six research hypotheses were examined. The results show that curiosity, organoleptic qualities and health aspects such as a healthy and attentive lifestyle are the major influences on the attitude towards the consumption of bergamot-based products.

**Keywords:** Bergamot food products; Consumers preferences; PLS-SEM.

## 1 Introduction

Bergamot is mainly used for the production of essential oil, obtained from the peel by washing and scraping the fruit. Bergamot essence, POD (official designation of Protected Designation of Origin by the European Union) since 1999, is widely used in the pharmaceutical industries for its antiseptic and antibacterial properties, in the cosmetic industries for its intense fragrance and freshness, and in the food industries as a flavoring for the preparation of desserts, liqueurs and tea. The uses of Bergamot linked to its beneficial properties are very interesting, especially in the most recent studies [1,2]. Think of the complex segment of functional products with particular reference to that of beverages. The latter are able to stimulate the interest of consumers, aimed at improving individual well-being by combining energy intake and stimulation of the immune system. Functional foods and drinks are products containing specific nutrients that can improve human health thanks to their recognized nutritional value. Recently,

the commercial importance of functional foods has grown, as consumers are often looking for these products [3]. If until a few decades ago they were unappetizing, today they are starting to be part of the daily diet of an ever-increasing number of individuals and fully respond to the needs of consumers who are asking for new alternatives to healthier and more useful foods for the body [4].

Another interesting aspect represents the fact that bergamot constitutes a tangible example of circular economy, in fact the by-products of processing can be used in many other ways (livestock feed, flours, bioactive compounds, functional foods, etc.), transforming waste, which is difficult to dispose of, into resources. This is in harmony with the concepts of sustainability and circularity, requirements that are increasingly essential today in the economies and activities of the territories. In fact, the industrial waste from the Bergamot Essential Oil (BEO) extraction process is very rich in antioxidant compounds and can be used as natural additives and represent a source of bioactive compounds (functional, nutritional and/or preservatives) to be reused in food field, helping to further increase the uses of bergamot.

The bergamot supply chain has also acquired growing importance in new product sectors. It is defined by many as "Green Gold" as it possesses countless and precious virtues, which have allowed it to be highly appreciated and used in a vast range of products for centuries. Among those intended for food use we remember, for example, gastronomy and pastry products (candied fruit, sweets and creams), alcoholic beverages (liqueurs, grappas, wine and beer) and non-alcoholic beverages (juices, herbal teas and tea), jams and fresh fruit. Among the "no food" products we find cosmetics (moisturizing creams, hair gels and tanning accelerators), perfumes (colognes), sanitizing detergents for people and the environment, soaps, shampoos, etc. Several studies have ascertained the effectiveness of Bergamot essential oil in aromatherapy [5]. From a strategic point of view, the inclusion of Bergamot in dishes, drinks and desserts can be a way to differentiate products and broaden the range. For some people, bergamot offers a unique combination of aroma, taste and nutrition. For others, the health and nutraceutical value represents an important reason for consumption [6].

The main world producer of Bergamot is Italy, which contributes approximately 90% of the world supply. Other regions of the world where bergamot is grown and bergamot essential oil is produced are the African continent and the Americas, and recently China. In Italy, production is concentrated in the south, in the province of Reggio Calabria. Among other producers, only Côte d'Ivoire holds a commercially important market share, with approximately 8-10% of the world's production of bergamot essential oil, although Brazil and China are emerging as global producers.

The aim of this research work is to explore the motivations and preferences for consuming bergamot food. The study was conducted through a survey of consumers intercepted face to face in Calabria. This choice was determined by the lack of knowledge and the virtual absence of consumption of bergamot and bergamot-based products among the population in the rest of Italy. Therefore, the importance of promoting and enhancing bergamot and bergamot-based food and non-food products among Italian consumers emerges overwhelmingly. There is a lot to do in terms of marketing and promotion by production companies.

The theoretical approach adopted in this study is that of the "Theory of Planned Behavior (TPB)"[7]. To identify the factors that determine the propensity to consume bergamot food, a structural equation model (SEM) was implemented. This model represents one of the most widespread methodologies in the analysis of behavioral data as it allows us to study the interrelationships between variables that are not directly measurable, called latent variables or factors. Structural equation modeling (PLS-SEM) was used to test the following research hypotheses:

H1: Specific perceptual curiosity positively relates to the attitude towards consuming bergamot-based products. H2: Sensory/organoleptic stimulus has a positive impact on the interest and curiosity to purchase new products. H3: The link with the territory and the intrinsic organoleptic qualities of bergamot positively impact the attitude towards purchasing bergamot products. H4: A healthy lifestyle has a positive impact on the attitude towards the consumption of bergamot-based products. H5: An environmental and sustainable awareness in consumer consumption positively influences his lifestyle. H6: Environmental and sustainable purchasing behavior has a positive impact on purchasing attitude towards bergamot products.

## 2 Materials and Methods

Bergamot products are still little known outside the production area, although they are gradually penetrating the market. As part of the research we interviewed around 100 people from other Italian areas (Milan hinterland, Sicily and central Italy), however we found that bergamot and bergamot-based food products in areas other than those of production are not at all or little known and consequently little or no consumption. We have therefore segmented and focused our attention on consumers in the Calabria production area of Bergamot. The survey was conducted in the first two months of 2020 (before the covid-19 pandemic). The questionnaire was administered face to face. 127 consumers were intercepted and interviewed in the province of Reggio Calabria.

The survey tool is divided into a grid of choice questions used to detect: socio-demographic, occupational and family income characteristics; the types of bergamot products consumed; consumption habits, frequency and prices; any reasons for not consuming/purchasing (not liking it, high prices, poor availability, etc.); the reasons for enjoying them (nutritional properties, aroma; taste; versatility, seller's advice, local zero-mile products, etc.); attention to ethics and food safety (sustainable packaging, ethical and social responsibility of the company; curiosity and attitudes (production techniques, sharing, possibility of online purchasing, importance of certifications).

The questions were organized so as to collect both binary (yes/no) and multiple choice answers (3-4 types of choices) and others are based on a five-point Likert scale, 1=strongly disagree; 2=disagree; 3=neither disagreement nor agreement; 4=agree and 5=strongly agree. The current tendency to study increasingly complex relationships makes the application of multivariate analysis methods and techniques useful, therefore, on the basis of the responses collected, databases were created with the aid of the SPSS.20 and SmartPLS4 software aimed at detecting the behavior of the consumers.

To identify which factors guide consumers in the process of choosing which bergamot products to consume, an exploratory factor analysis (EFA) was carried out, based on principal component analysis (PCA)[8]. The model aims to reduce the number of predictors[9–11] and highlights latent factors. Subsequently, a correspondence analysis was conducted for data validation and PLS-SEM (Partial Least Squares Structural Equation Modeling) analysis to test the hypothesis. The verification and reliability of the model is entrusted to the following tests: Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. The first is between 0 and 1, values > 0.60 are considered acceptable [12]. With the second, the correlation between the variables and the significance p-value are tested. PLS-SEM has become the methodology of choice for many researchers studying complex relationships between latent constructs, such as in marketing, consumer choice, and other fields. The model allows you to explain multiple statistical relationships at the same time, to understand the relationship between latent constructs (factors) generally indicated by different dimensions and adopts a confirmatory approach after examining the data with exploratory analysis. PLS-SEM provides a single complex model that includes various dependency and independence relationships between constructs. Recently PLS-SEM based partial least squares approach has become quite popular among researchers/scholars. Smart Pls4 software was used in this study [13]. The conceptual framework (Figure 1) in this study is a modified version of the model proposed by Chen and Wei [14].

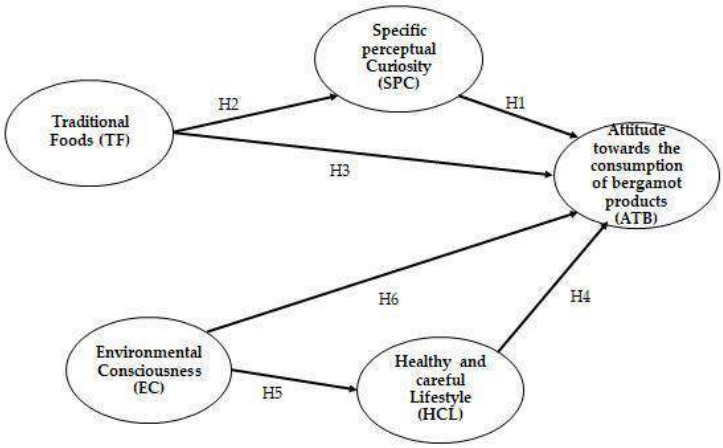


**Fig 1.** Conceptual model hypothesized in the analysis. Our adaptation from Chen and Wei [14].

The attitude towards the consumption of bergamot-based products is composed of affective, cognitive and behavioral components. Figure 1 shows our conceptual framework, which indicates that functional factors (e.g., health awareness), traditional food (including sensory factors, consumer experience) shape individuals' attitude towards the consumption of bergamot. The model also shows that both sensory and functional factors have indirect path effects on attitudes. Specific perceptual curiosity is a mediator of attitude towards the consumption of bergamot products. A healthy and attentive lifestyle mediates ethical conscience. Pennington [14] argued that affective and cognitive components are framed to reflect positive or negative evaluations of an entity or product

according to people's beliefs. The cognitive and affective components in Chen and Li's framework [15] are perceived benefits that have been reported in patterns of attitudes toward safety, lifestyle concern, and patterns of attitudes toward other contemporary issues such as functional foods.

## 3 Results

The description of the sample is highlighted in the tab. . The survey was conducted in the first two months of 2020 (before the COVID-19 pandemic) among consumers available for the interview and intercepted in the province of Reggio Calabria (Italy). A total of 127 questionnaires were administered face-to-face to observe the ways in which consumers organize their purchases. The sample, about gender is representative of the population present in Calabria, is made up of a slight prevalence of women (53.5%). Those interviewed personally deal with food purchases (63%). 70.1% live in the location of the interviews; 27.6% are on holiday or for personal reasons and 2.4% work there. Approximately 35% live in large families (of 4 or more members), 31.5% of families are made up of three members, 22.8% of two members and the remaining 11% live alone. From Table 1 the distribution by age group is quite balanced. The interviewees have a medium-high level of education. 53.5% are employed and with reference to the prevailing income the interviewees declare that they are in the medium-low range (52% settle on an annual income of 15,000-30,000 euros).

**Table 1.** Socio-economic characteristics of the sample.

| | | | | | |
|---|---|---|---|---|---|
| *Age group* | 18-29 years old | 26.8% | *Occupation* | Employed | 53.5% |
| | 30-45 years old | 29.9% | | Retirees | 20.5% |
| | 46 -60 years old | 19.7% | | Unemployed | 10.2% |
| | > 60 years old | 23.6% | | Students and housewives | 15.8% |
| *Level of education* | Lower secondary school | 23.7% | *Annual family income (euros)* | Low < 15,000 | 4.7% |
| | High school | 31.5% | | Medium low 15,000-30,000 | 52% |
| | Degree | 33.1% | | edium to high 30,000-50,000 | 37% |
| | Postgraduate | 5.5.% | | High > 50,000 | 3.9% |
| | He doesn't answer | 6.3% | | does not answer | 2.4% |

As regards consumption, table 2 highlights a wide range of bergamot-flavoured food products, some traditionally present on the tables of Calabrians and to which new ones are always being added. These are food products made both by hand and industrially processed (for example, bergamot liqueur, jam, juices), or foods made mainly at an industrial level. Among the most consumed Bergamot-based food products we find sweets and liqueurs. 74% of those interviewed consume bergamot-flavoured pastries and sweets. They buy them in pastry shops or specialized shops (34%) and at the supermarket (21%). Some receive them as gifts (7%), others prepare them at home (around 12%). The liqueur is appreciated by 68%, it is purchased in specialized shops (37%) and at the supermarket (18%), or it is given as a gift (7.1%). It is also prepared at home by 5.5% of those interviewed. Juices (61%), ice creams (54%) and drinks (45%) are also very popular, only vinegar is even less widespread (23.6%).

**Table 2.** Bergamot food consumed/purchased by the interviewees by type of production and for non-consumption reasons.

| | **Liquor** | **Ice-cream** | **Pastry and sweets** | **Juice** | **Drink** | **Vinegar** |
|---|---|---|---|---|---|---|
| *Bergamot food consumed/purchased* | *67.7* | *54.3* | *74.0* | *60.5* | *44.9* | *23.6* |
| Local/Hand crafted products | 37.0 | 29.1 | 33.9 | 23.6 | 18.1 | 5.5 |
| Industrial products | 18.1 | 21.3 | 21.3 | 22.8 | 25.2 | 18.1 |
| It's a gift | 7.1 | 3.1 | 7.1 | 3.1 | 0.0 | 0.0 |
| Homemade | 5.5 | 0.8 | 11.7 | 11.0 | 1.6 | 0.0 |
| *Non-consumption reasons* | *32.3* | *45.7* | *26.0* | *39.5* | *55.2* | *76.4* |
| I don't like it | 16.5 | 19.7 | 18.1 | 24.4 | 26.8 | 34.6 |
| Expensive products | 0.0 | 0.8 | 0.8 | 2.4 | 2.4 | 0.8 |
| Availability | 4.7 | 5.5 | 2.4 | 1.6 | 1.6 | 7.1 |
| For other reasons | 11.1 | 19.7 | 4.7 | 11.1 | 24.4 | 33.9 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: The authors.

Those who do not consume these products have intolerance problems or do not like them. Only in limited cases is it believed that the price is high or due to lack of availability.

The EFA model used appears adequate for the interpretation of the results obtained, in fact both the KMO which is equal to 0.865 (range considered more than acceptable) and the Bartlett's test of sphericity with reference to $\chi 2$ (1318.25) and the p-value (which is equal to 0.000) are verified. The interviewees answered the questions on the reasons for choosing and consuming bergamot-based products (see table 3) by answering all the questions on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). These consumer responses to the questionnaire questions were used as variables for exploratory factor analysis with an explained variance of 74.6% and five components extracted. The rotation of the factorial axes was performed with the Varimax method which allows maximizing the variance of the squares of the elements of each column of the matrix. We then applied the PLS-SEM model to test the hypothesized research questions. Table 3 highlights all the items loaded on the respective construct. All elements are above the acceptable limit level. The standardized rates of the items that make up the measurement model range between 0.654 and 0.937. Composite reliability ranges from 0.785 to 0.922. As regards the Average Variance Extracted (AVE), values between 5.91 and 0.872 are found. According to the indications of Dash and Paul [66] to evaluate the reliability of the model and the composite reliability (aggregation of indicators under a latent variable) the values should be greater than 0.6. While for the AVE the reliability should be greater than 0.5 for each construct. Therefore the coefficients are all valid and indicate good reliability of the model. For the Ethical Consciousness construct, the item “I am attentive to the ethical and social responsibility of the company” (0.937) and the item “I purchase products with sustainable and biodegradable packaging” (0.883) record rather high loads. For another construct, such as specific perceptual curiosity, the item “I am interested in the possibility of purchasing online” also has a rather high score (0.845).

Other constructs have a relatively narrow range of values: Healthy and attentive lifestyle (HCL) (between 0.710 and 0.809); Attitude towards the consumption of bergamot-based products (ATB) (between 0.728 and 0.749), Traditional foods (TF) (between 0.672 and 0.840). The validation of the study model and hypotheses took place through structural equation modeling (SEM) following the indices of the model adaptation recommendations. The values of the correlation matrix of the analyzed constructs are examined in Table 3 and Figure 2.

**Table. 3** Standardized factor loading (Sfl) Composite Reliability (CR) Average Variance Extracted (AVE) and Cronbach's Alpha Source (CA)

| | Factor and item | Sfl | CR | AVE | CA |
|---|---|---|---|---|---|
| | Specific Perceptual Curiosity (SPC) | | 0.868 | 0.571 | 0.811 |
| Spc1 | I am interested in learning about production techniques | 0.654 | | | |
| Spc2 | I like to confront and socialize experiences | 0.757 | | | |
| Spc3 | I think certifications and brands are important | 0.694 | | | |
| Spc4 | I am interested in the possibility of buying online | 0.845 | | | |
| Spc5 | I like to stay informed (advertising ecc) | 0.812 | | | |
| | Traditional foods (TF) | | 0.796 | 0.567 | 0.624 |
| Tf1 | I like the organoleptic qualities of bergamot | 0.672 | | | |
| Tf2 | I consume bergamot for its link with the territory | 0.738 | | | |
| Tf3 | I get advice from the seller about buying niche products | 0.840 | | | |
| | Environmental Consciousness (EC) | | 0.922 | 0.797 | 0.872 |
| Ec1 | Purchase products with sustainable and biodegradable packaging | 0.883 | | | |
| Ec2 | I am attentive to environmental sustainability | 0.856 | | | |
| Ec3 | I am attentive to the ethical and social responsibility of the company | 0.937 | | | |
| | Healthy and careful lifestyle (HCL) | | 0.805 | 0.580 | 0.637 |
| Hcl1 | I consider myself very health conscious | 0.710 | | | |
| Hcl2 | The purchase at Km0 affects my lifestyle | 0.809 | | | |
| Hcl3 | The wide range of bergamot products has benefits for my health | 0.761 | | | |
| Attitude towards consumption of bergamot products (ATB) | | | 0.785 | 0.549 | 0.591 |
| Atb1 | Bergamot products enjoy my trust | 0.749 | | | |
| Atb2 | When buying, pay attention to the price | 0.728 | | | |
| Atb3 | I appreciate the versatility of using bergamot | 0.745 | | | |

Source: own elaboration from data analysis in Smart-PLS4.

Regarding the Fornell-Larcker criterion, it states that the square root of the AVE of each construct should be greater than its maximum correlation with any other construct in the model. The results presented in Table 4 indicate that each construct shares more variance with the items assigned to it (values on the diagonal of the table) than with the remaining constructs in the model, thus confirming that the requirements of the Fornell-Larcker criterion are satisfied [70,71].

The results of the SEM path are shown in the table 5. All hypotheses are supported. The SEM paths “Traditional foods ->Specific Perceptual Curiosity” (16.807) and “Environmental Consciousness -> Healthy and care-ful lifestyle” (14.287) records the highest T-value. This confirms that the link with the territory and the organoleptic qualities

of bergamot have a very important role in the consumption of Bergamot for the recognition of the health and quality aspects of the lifestyle, just as it is important for consumers and who are always more curious and attracted by the presence of new bergamot products.

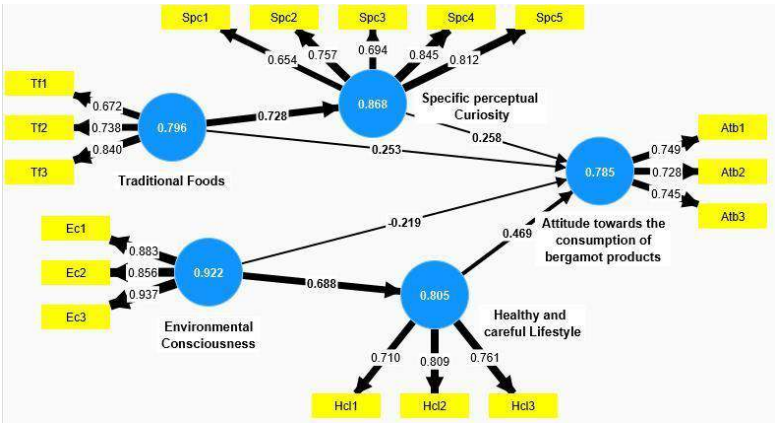


**Fig 2.** SEM (PLS algorithm). The values are in constructs are composites of reliability (CR) Own elaboration from data analysis in Smart-PLS4.

**Table 4.** Discriminant validity - Fornell Larcker criterion.

| | (ATB) | (EC) | (HCL) | (SPC) | (TF) |
|---|---|---|---|---|---|
| Attitude towards consumption of bergamot products (ATB) | 0.741 | | | | |
| Environmental Consciousness (EC) | 0.421 | 0.893 | | | |
| Healthy and careful lifestyle (HCL) | 0.712 | 0.688 | 0.761 | | |
| Specific Perceptual Curiosity (SPC) | 0.658 | 0.624 | 0.751 | 0.755 | |
| Traditional foods (TF) | 0.676 | 0.617 | 0.789 | 0.728 | 0.753 |

Source: Own elaboration from data analysis in Smart-PLS4.

**Table 5.** Summary Convergent validity and internal consistency of constructs Source: Our own elaboration from data analysis in Smart-PLS4.

| Hypothesis | Estimate (β) | *t*.Value | *p*-Value | Hypothesis | Conclusion |
|---|---|---|---|---|---|
| EC -> ATB | -0.219 | 2.090 | 0.037** | H6 | Supported |
| EC -> HCL | 0.688 | 14.287 | 0.000*** | H5 | Supported |
| HCL -> ATB | 0.469 | 3.753 | 0.000*** | H4 | Supported |
| SPC -> ATB | 0.258 | 3.333 | 0.001*** | H1 | Supported |
| TF -> ATB | 0.253 | 2.159 | 0.031** | H3 | Supported |
| TF - > SPC | 0.728 | 16.807 | 0.000*** | H2 | Supported |

*P < 0.05; **P < 0.01; ***P < 0.001

## 4. Discussion and conclusions

In recent years, food research applied to Bergamot has worked intensely on the inclusion of new products to expand the range of existing products as well as the diversified use of by-products. This trend, although born with the objective of environmental sustainability as it respects the vision of reducing production waste to a minimum to impact less on the environment, also has its significant economic value from the perspective of circularity, given which proposes the use of raw materials already the result of previous production cycles. The aim is to make the best use of all the resources that enter the food industry, even those that traditionally constituted waste [15]. For several decades, driven by initiatives proposed by the food industry and the world of universities and research, the use of bergamot juice and pulp has been experimented in an increasingly wider range of products [2]. No, despite these being emerging and niche products, consumers seem to appreciate it, both for the taste and flavor and for the characteristics and intrinsic qualities linked to bergamot. This study aims to fill a knowledge gap on the consumption, motivations and preferences of bergamot-based products, investigating the ethical and sustainable aspects that guide them in food consumption. The research confirms that the environmental aspect, tradition and the connection with the territory have an important role in the consumption of Bergamot as well as the health and quality aspects of the lifestyle and the curiosity that push the consumers interviewed to regularly consume food with bergamot. Some limitations are highlighted from the study carried out: the geographical and cultural component of the sample considered and the number of interviews. A larger sample allows for greater knowledge of these interesting niche products that are still little known and deserving of greater success and adequate marketing strategies capable of making bergamot products known to establish themselves in new and large markets and at more extensive levels.

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Azione IV.4 - Dottorati e contratti di ricerca su tematiche dell'innovazione

Azione IV.5 - Dottorati su tematiche Green

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