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Abstract

Designing, building and operating a “green” building means that it considerably reduces the negative impacts and increase the positive ones on the climate and the natural environment. Thanks to green buildings it is possible to preserve natural resources and improve the quality of people’s life.
Ethnobotany is a science that describes the relationships between humans and plants, in particular by describing and analyzing the traditional uses that are made of them. In addition to the most common food, medicinal and religious uses, there are artisanal ones and in particular for building purposes.
The main goal of this work is to present a synthesis of the traditional uses of plants as a building material, useful for constructing ecologically sustainable buildings.
Among the most common species for this last purpose are two species belonging to the Poaceae family: *Ampelodesmos mauritanicus* (Mauritania grass) and *Arundo donax* (giant reed). These species have very strong fibres and a high potential in carbon sequestration too: therefore, in addition to representing a valid

	natural resource that can be re-evaluated in modern and more technological terms, they could guarantee a valid aid for the abatement of greenhouse gases. Even ethnobotany, therefore, can actively contribute to determining environmental policy choices that guarantee an effective fight against climate change.
Keywords (separated by '-')	Ethnobotany - Green buildings - Green districts - Post-carbon city - Natural products

The Use of Plants for Building Purposes in the Popular Tradition

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AQ1 **Abstract.** Designing, building and operating a "green" building means that it considerably reduces the negative impacts and increase the positive ones on the AQ2 climate and the natural environment. Thanks to green buildings it is possible to preserve natural resources and improve the quality of people's life.

Ethnobotany is a science that describes the relationships between humans and plants, in particular by describing and analyzing the traditional uses that are made AQ3 of them. In addition to the most common food, medicinal and religious uses, there are artisanal ones and in particular for building purposes.

The main goal of this work is to present a synthesis of the traditional uses of plants as a building material, useful for constructing ecologically sustainable AQ4 buildings.

Among the most common species for this last purpose are two species belonging to the Poaceae family: *Ampelodesmos mauritanicus* (Mauritania grass) and *Arundo donax* (giant reed). These species have very strong fibres and a high potential in carbon sequestration too: therefore, in addition to representing a valid natural resource that can be re-evaluated in modern and more technological terms, they could guarantee a valid aid for the abatement of greenhouse gases.

Even ethnobotany, therefore, can actively contribute to determining environmental policy choices that guarantee an effective fight against climate change.

Keywords: Ethnobotany · Green buildings · Green districts · Post-carbon city · Natural products

1 Introduction

1.1 For a Green Planet: From the Past to the Future

"Green" is a word that is used a lot nowadays to mean anything or action that is environmentally friendly [1]. The issue of "Green buildings" is very topical and has been

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dealt with in various scientific contributions about both their ecological retrofitting and valuation [2–5] and price market premium [6–12]. In order to be able to deal with these issues in a broader and more integrated way, the concept of "Green district" is increasingly affirming itself [13–17], as a generalization of the "Green Buildings" strategy, up to the creation of the "post-carbon city", thanks to the consolidated naturalistic characterization of energy efficiency obtained with natural materials which come from plant species very useful for carbon sequestration [18–23]. Furthermore, a city can be considered sustainable if it is built with materials whose extraction and processing do not have a strong impact on the environment and whose ecological footprint can be easily mitigated [24].

For this purpose, there are numerous examples of building interventions carried out with panels of granulated cork: they are very useful to prevent mould, provide insulation from the cold and the warm (reducing at the same time energetic costs and CO_2 emissions) and act as igro-regulators [3, 4, 14, 17, 25]. Furthermore, it has been demonstrated that "healthier", "greener" and with better energy performance buildings can be sold at higher prices [9–11, 26, 27].

This model today followed is the same of the past, ac-cording to which peoples have always resorted to natural resources to meet their primary needs, including housing: all this knowledge is studied by Ethnobotany.

1.2 What is Ethnobotany?

Ethnobotany is the scientific study of the complex and dynamic relationships between peoples and the plant heritage that characterizes their natural environment [28]. People established a relationship with plants by looking first and foremost those with which to feed himself, cure himself of diseases, manufacture tools, tools for daily use in the fields and at home, create artifacts, toys and hobbies [29–34].

This work aims to review the traditional uses of plants as a building material, with a low environmental impact and the ability to reduce the concentration of CO_2 in the atmosphere, in order to demonstrate how it is possible to plan modern buildings using "green" materials.

2 Traditional Uses of Plants in Buildings

There are many traditional uses of plants that have been found for different building purposes. Among them, we consider here two species belonging to the Poaceae family: *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz (Mauritania grass) and *Arundo donax* L. (giant reed). *Ampelodesmos mauritanicus* is very common throughout the Mediterranean basin, from the Iberian Peninsula to Greece, including Northern Africa, growing from the coastal to the hilly areas (up to 1,200 m.a.s.l.) [35]. *Arundo donax* is a perennial grass growing spontaneously in temperate and tropical zones almost all over the world and can act as an invasive species [36].

There are very few building uses found for *A. mauritanicus.* Once dried, the stems of *A. mauritanicus* were mowed and cleaned of the leaves, cut to size and used to build domestic shutters [37]. Its stems were used until the 1950s to make roller shutters [38].

In general, its fibers were used in the construction of the roofs of the huts due to their durability, strong resistance to water and heat insulation [39].

The roofs of the rural houses were also made with the stems of *A. donax*: after cutting the stems to the appropriate extent and cleaned from the leaves, they were tied together with thin iron wire in order to obtain large mats. The stems were placed laterally on the skeleton of the roof which was made up of load-bearing wooden beams. A mixture of plaster was spread on the cane mats and finally the tiles were laid in an imbrice [39, 40]. The barrel roofs of town houses were also made with the reeds [40]. In southern Iraq, "Mudhif", an imposing building used as a meeting place for ceremonies and for the reception of foreign guests, were built with large and thick columns realized with *A. donax* stems folded up to arches. This building system creates a pre-stressing of the arches that are initially inserted into the soil at opposing angles [41, 42]. In Calabria, after the earthquake of 1783, a reconstruction plan of the collapsed buildings was initiated by providing a load-bearing structure framed in wood and a sheath which, in the "poorer" solution, adopted above all in rural areas, consisted of two layers of *A. donax* covered by a plaster layer: this building system is still evident in some abandoned house [43]. In the XIX century, *A. donax* was introduced from the Mediterranean area into North America for roof thatching [44]. In Sicily, some ethnobotanical studies reported, through interviews carried out to the rural population, that the stems of *A. donax* were used for the construction of raftered ceilings: from the ridge of the roof, some beams were putted on the perimeter walls. Above them were applied bundles of reeds which previously had been well cleaned of the residues of the leaves and cut to size and, then, were arranged tying them together with string or wire. A layer of lime was spread over this roof and the tiles rested on it [45, 46].

Arundo donax and *A. mauritanicus* are very good for carbon sequestration [47, 48]. It has been shown that *A. donax* has carbon accumulation rates (3.7 to 4.9 t has year^{-1}) far greater than those in tree biomass of other species, e.g. *Eucalyptus cladocalyx* F.Muell. of the south of Australia [49]. However, *A. donax* is native to western or southern Asia, cultivated for millennia in the Mediterranean regions and in others with similar climate, where it is now completely naturalized and sometimes invasive: this allowed it to outcompete native plant species, dramatically altering riparian habitats [50]. It is considered as one of the 100 world's worst invasive alien species [51]. Its widespread use is due to its robustness which has also been demonstrated experimentally by various authors: in fact, the *A. donax* fiber has a very high tensile strength [52]. The production of panels made with particles obtained from the grinding of stems and rhizomes of *A. donax* with low thermal conductivity and excellent mechanical properties is demonstrated [53].

3 Conclusions

Numerous scientific evidences confirm that natural resources increasingly represent a precious source of useful resources for various purposes, including construction. Thanks to these works, with our review we can confirm: a) the technical efficiency of different materials of plant origin for the energy efficiency of buildings; b) the considerably reduced environmental impact they have; c) Ethnobotany can be considered as an useful tool for investigating the traditional uses of plants for building purposes. Therefore, we

can again affirm that man must move more and more convinced towards a sustainable use of natural resources. Only in this way will we be able to obtain both significant energy savings in economic and ecological terms, and respect for nature that will allow us to slow down the ongoing process of climate change, which is already causing irreversible damage to our planet, including habitat and biodiversity erosion [54–58].

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Chapter 160

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