Effect of the harvest time on kernel quality of several almond varieties (*Prunus dulcis* (Mill.) D.A. Webb)

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Abstract

In the present work the effects of the harvest time on variation of the quality parameters of several almond cultivars were evaluated. Studied cultivars came originally from three different countries: Italy (Supernova, Falsa Barese, Genco and Tuono); France (Ferragnes, Lauranne and Stelliette); Spain (Glorieta and Mas Bovera). The samples were collected in a field of the South of Italy during two harvest periods: at the beginning and at the end of August. Particularly, the highest free acidity content (increasing about the 24%) was observed during the ripening of Falsa Barese variety. Also the lipid content was increased and the Genco variety was that of the highest amount in both samplings. The fatty acids amount from the Mas Bovera cv almond kernels, particularly at the late harvest time, showed the best results (oleic/linoleic acids of 7.36 and high MUFAs/PUFAs value). The cluster analysis shows that this cultivar differs from the others in the oil composition. If on the first sampling some differences were observed, in the late harvest time all varieties combined in the same cluster with the exception of Mas Bovera and Ferragnes, provided of different acidic distributions. The analysis of minerals and trace element, K, Mg and Ca proved the major minerals present in all almond seeds.

Keywords:

Almond, Cluster analysis, drying, fatty acids, minerals, lipids.

1. Introduction

Almond (*Prunus dulcis* (Mill.) D.A. Webb) is one of the oldest cultivated nut trees in the world and a major nut tree crop in hot-arid countries of Mediterranean basin. In the Europe, the grow of this plant is spreading along the area included from the 36th and the 45th parallel. The nuts, in which classification the almond seeds are generally included, were very requested products and their destinations are the direct consumption after toasting, the confectionery industry and the production of sweets, cakes and sugarcoated almonds. The chemical composition of this fruit is of great importance to establish its nutritive value and its quality for the recent concern of consumers over ensuring a healthy life style. The nutritional values might be affected by kernel weights; the quality of seeds is defined in particular by moisture content, lipid content, oil composition and oil ultraviolet absorption coefficients (Nanos et al., 2002). These characters can be influenced by ecological conditions, location and technical and cultural practices (Askin et al., 2007). Moreover variety can influence the kernel properties so that almond genotypes show differences in terms of nutrients and fatty acid composition. Among agronomical operations, irrigation may be the most important factor affecting almond kernel weight , the yield and the quality, as the sugar composition, whereas no remarkable influence to the lipid content and fatty acid composition was observed (Hutmacher et al., 1994; Nieddu et al., 1989; Schirra and Agabbio, 1989, Nanos et al., 2002). An early harvest of almonds don't affect the lipid content but induces variation to the physical properties of seeds for the major hollow and brittle kernels due to the higher kernel moisture content (Connell et al., 1989). A late harvest of drupes induces a higher content of dry matter in the seed, of oil and sugars. Genetic factors, soil and weather conditions, the use of fertilizers, and the state of the plant's maturity at harvest affect also the final level of mineral components in a plant (Sanchez-Castillo et al., 1998). Also the storage conditions (inshelled, shelled, storage time, controlled atmosphere and temperature) can affect the almond quality and stability (Bigalli, 1977; Guadagni et al., 1978; Senesi et al., 1991, 1996; Harris et al., 1972; Zacheo et al., 2000). Almond kernels contain substantial quantities of triacylglycerols and polyunsaturated

fatty acids, and thus are susceptible to oxidative and hydrolytic rancidity (Watkins, 2005). The oxidative rancidity cause the formation of off-flavours that induces the most common defect of nuts perceived by consumers. This type of reaction is due to the presence of oxygen which reacts with unsaturated fatty acids to generate peroxides and their degradation gives successively the production of off-flavours. However the higher concentration of antioxidants, such as α-tocopherol, and the lower level of polyunsaturated fatty acids give to the almonds and their products a longer shelf-life in comparison with the other nuts, as previously studied by Macrae et al. (1993) and Young and Cunningham (1991). So the principal factors influencing the rancidity are the levels of oxygen and unsaturated fatty acids and the presence of antioxidants, such as tocopherols, enzymes and metals (Bewley, 1986). Moreover, previous studies reported that storage at low temperature and low oxygen atmosphere caused less off-flavours development (Bigalli, 1977; Guadagni et al., 1978; Senesi et al., 1991, 1996; Harris et al., 1972). Therefore, the aim of this work is to evaluate the influence of the harvest time and the different genotype on composition of some nutrients in almond seeds and oils.

2. Materials and methods

2.1. Plant material

The almond kernels from Italian, French and Spanish cultivars: Falsa Barese, Ferragnes, Genco, Glorieta, Lauranne, Mas Bovera, Stelliette, Supernova and Tuono were used for the experiments. The drupes were collected at an early phase in the beginning of August (EH) and in the end of the same month (OH) in a experimental plot located in San Marco Argentano, Cosenza (Italy). For each cultivar three trees were chosen as replicates and subsequently the drying process was carried out in a laboratory pilot dryer (model of "Scirocco", Società Italiana Essiccatoi, Milan, Italy), equipped with automatic temperature and air moisture control devices. Air flows tangentially to the fruits, while an air recycling system allows mixing exhaust with fresh air and then reheating and redirecting to the product, in order to achieve the desired air moisture. The fruits were placed on 56 cm diameter steel food trays and loaded into the drier, where they were dried until a reaching a

predetermined dry matter (d.m.) value higher than 92% (based on weight loss calculation). The process was carried out at 50 °C and the relative humidity of the air was approximately 40%, while the air volume was 1840 m^3 /hour. Afterwards almond seeds were opportunely powdered to form a homogeneous mass from which samples were collected for chemical analyses.

2.2. Analyses

Dry matter (%) was determined in a oven at 100°C following the routine method (AOAC, 1990) and ash quantity of kernel was determined after the samples were burnt at 500°C in oven for 8-10 hours. The water activity was measured by an Aqua lab (3TE, Decagon devices Inc., Washington) apparatus. For the determination of mineral contents about 5 mL of diluted ashes were charged with about 5 mL of 37% HCl and then filled up to the volume of 100 mL with bidistilled water. Calcium, Magnesium, Potassium, Iron, Copper, Zinc and Manganese contents were determined by Atomic Absorption Spectrophotometer (Perkin Elmer AAnalyst 100) measuring the amount of light absorbed at a specific wavelength by using a hollow cathode lamp as the primary light source, a monochromator and a detector. A deuterium arc lamp corrected for background absorbance caused by non-atomic species in the atom cloud and a mixture of acetylene:air was used for flame alimentation. The software AA WinLab™ was employed. Total free acidity analysis of samples was determined by titration with NaOH 0,01N and the results were expressed as mEq/Kg of dry matter. The lipid content (%) was determined by the method reported by Folch et al. (1957). For the determination of fatty acid composition, the analysis followed the analytical methods described in EC Regulations. The methyl esters were prepared by vigorous shaking of a volume of oil added of hexane (0,2 g in 5 mL) with 0,5 mL of 2N methanolic potash, and analyzed by GC with a Perkin Elmer 8600 model chromatograph equipped with a FID detector and a injector split-splitless. A fused silica column (10 m length x 0,32 mm i.d.) coated with Mega 10 phase (0,25 μm thickness; Mega, Italia) was used. Helium was employed as carrier gas with a pressure of 12 psi. The temperature of the injector and detector was set at 250°C, while the oven temperature was

programmed as following: 140 °C for 40 min, an increase of 1 °C/min to 180 °C; an increase of 5 °C/min to 220 °C and a final isotherm of 10 min.

2.3. Statistical analysis

One-way and two-ways analysis of variance (ANOVA) were applied to the data to determine the presence of significant differences (Duncan's test, significant level $P<0,05$). Eventual differences between cultivars in the fatty acids composition of extracted oils were tested with Hierarchical cluster analysis (HCA). For classification, the single linkage method was utilized. The squared Euclidean distance was employed as similarity measure in the analyses. SPSS Software (Version 11.0, SPSS Inc., Chicago, IL, USA) was used for data processing.

3. Results and discussions

The chemical characteristics of almond kernels belonging to the several cultivars are reported in Table1. The moisture content described is related to drying process and does not statistically differ among cultivars. The lipid content of early harvested almonds (EH) varied between 31 and 46% on dry matter without differences among cultivars as revealed by statistical analysis. In contrast with Connell *et al.* (1989), in this study the lipid content for the grams on dry matter increased during the late harvest (significant difference among the OH samples). Probably this trend was caused by oil production and the loss of water content while the fruit remained on the tree. Lipid percentages were between 58,35 (Genco cv) and 40,85 (Falsa Barese cv); an evident increment was observed in OH sample "Supernova" comparing with EH sample. Contrarily, the lipids quantity did not vary largely in Ferragnes variety and lower results were observed than those studied previously in Greece (Nanos et al., 2002). As reported in table 2, the cultivar characteristics, the harvest time and the combined two variables influenced the lipid content in all samples, as revealed by the two-ways ANOVA. This result was also observed for the total acidic amount. The highest total acidity content for the EH samples was of Glorieta cv (84,18 mEq/kg d.m.) and for OH samples was that of Falsa Barese variety (104 mEq/kg d.m.). The value of acidity in the samples is positively correlated with oleic acid content. Effectively the increasing of acidity depended on the fatty acid content that in the

late harvest time was higher. In the Tables 3-4 the fatty acids mean percentage values of palmitic (C16:0), palmitoleic (C16:1), margaric (C17:0), margaroleic (C17:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), arachidic (C20:0), gadoleic (C20:1), behenic (C22:0) and lignoceric (C24:0) acids of almond oils for each harvest time and for each studied cultivars are reported. Oleic acid, followed by linoleic and palmitic acids were represented in highest quantity. Stearic acid was also representative in the samples. The other fatty acids amounts were lower than 1%. The harvest time and so the ripeness significantly influenced the oleic and linoleic (P=0,00) and the palmitic (P=0,01) acid content in all almond varieties. The variation of the stearic acid concentration observed from the early to the late samplings was not significant (P=0,31) (data not shown). A detailed observation of the fatty acids trends revealed an increasing of oleic acid during the first stage of maturation of fruits (higher MUFAs/PUFAs value), whereas the palmitic, stearic, linoleic and linolenic acids generally decreased (with the exception of Supernova, Genco and Gloriette for the oleic acid and Tuono and Falsa barese for the palmitic acid). This trend was due to the biosynthesis of triglycerides during the almond ripening. This process induces the increasing of the oleic acid amount and so a rise of unsaturated/saturated acids and oleic/linoleic acids values. From these results the almonds seem to be very important for the human nutrition, because a MUFAs-rich diet can regulate the low-density of lipoprotein cholesterol and total cholesterol levels as reported in literature (Zacheo et al., 2000; Sabate & Hook, 1996; Sabate et al., 1996). The highest amount of oleic acid and the lowest quantity of linoleic acid was found in Mas Bovera variety (7,36 of oleic to linoleic acid ratio) harvested at the end of August. The two-ways ANOVA applied in all samples (early and lately ripened) demonstrated that the variables “cultivar”, “harvest time” and their combination had a great influence on palmitic, oleic and linoleic acids contents, as reported in Table 5. Comparing the fatty acid profile for all studied almond cultivars by cluster analysis, in the first sampling Mas Bovera variety can be considered rather singular respect to the other varieties that were differentiated in two clusters at a dissimilarity level of 10 in the hierarchical scheme. Cluster I included Lauranne, Stelliette, Supernova, Ferragnes, Glorieta, Falsa Barese and Tuono

cultivars; Cluster II was represented by Genco, Trianella and Pepparudda samples (Fig. 1). For the late sampling, a wider group was differentiated at the same distance into the dendrogram as reported in Fig. 2. Cluster analysis discriminated the samples cultivars in several groups (all almond cultivars, with the exception of Ferragnes and Mas Bovera). Resuming briefly: in the early harvested samples the Cluster I was characterized by fruits with an oleic to linoleic ratio higher than 3,20 and MUFAs/PUFAs value not higher of 3,80; in the Cluster II samples showed a maximum value of 3 and 3,02 for the first and the second indices respectively. Mas Bovera cv was distinguished by the best results of the oleic to linoleic ratio of 3.94 and the MUFAs/PUFAs value of 4. Regarding the samples harvested latter, the same indices values are reported as follow: Cluster I with a maximum of 6,10 and 6,15; Ferragnes with 6,27 and 6,3 and Mas Bovera with 7,36 and 7,4. The mineral and the trace element contents of almond seeds are presented in Table 6. Data revealed that K, Mg and Ca were the most aboundant minerals, followed by Fe, Zn, Cu and Mn. In the early harvested samples the content of some components, as Mg, K and Zn, did not varied significantly among cultivars. The opposite trend was observed in the late ripened samples that presented significant differences ($P < 0,05$) in the amounts of principal minerals. In effect, in the OH samples the K level ranged from 793,86 (Stelliette cv) to 525,46 (Trienella cv) mg/100 g of d.m.; the Mg varied between 275,87 (Mas Bovera cv) and 154,15 (Lauranne cv) mg/100 g of d.m., and Ca values were between 176,50 (Lauranne cv) and 89,97 (Glorieta cv) mg/100 g of d.m. In Table 7 the difference of response on mineral content of the cultivars and the influence of harvest time (and their combination) are illustrated as result of the two-ways statistical analysis of variance. It could be observed that in all samples the different varietal characters did not influenced the K amount at all. Otherwise the contents of Ca, Mg, Na, Fe and Zn varied more significantly than other minerals. Differently the harvest time of almond kernels influenced the several elements contents (no effect for Ca, Mg, K and Mn). Finally, the two combined variables demonstrated an important influence in the nutritive property of kernels.

The K, Mg and Ca together with phosphorus (content not measured) are generally the principal in almonds seeds: the calcium, in particular is very important for nutritional aspect even if not ever assimilated by organism because of its form of oxalate. Field conditions like rain, snow, dew, mist, and fog can all lead to losses of minerals from plants. The chemical composition of the medium in which the food grown (Peterson, 1979) is also important and can be affected by the addition of fertilizers, the age of a tissue, etc. The ability of certain plant species and varieties to absorb more or fewer nutrients, even when rooted in the same soil, may relate to their different minimum requirements. It could be due to differences in the activities of specific transport enzymes in cell membranes or simply to differences in the growth characteristics of root systems (Sanchez-Castillo et al., 1998).

4. Conclusions

Almond cultivars can be characterised by a combination of several parameters, including morphological and physiological characters. In this study, the influence of harvest time on the quality of the seeds, comparing between an early and a late time of harvesting (beginning and end of August) was evaluated. During the ripening an increase of fat and acidic content was observed in all cultivars. The nutritional value of almond kernel is also determined by the quality of the obtained oils. This property was characterised by seeds belonging to the second sampling and, particularly, Mas Bovera cv showed the best results in those growing conditions. A further study of genetic similarity for the same character “fatty acid content” by cluster analysis revealed some differences among samples. Genco, Trianella and Pepparudda differed from the others in the first sampling; subsequently they were included in a bigger group, showing a mutual proximity for chemical oil characters as the response for the environmental conditions. Mas Bovera and Ferragnes oils revealed different characteristics and Mas Bovera manifested the most important nutritional values.

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Table 1 Chemical characteristics of almond seeds

Samples	cv	Dry matter (%)	Total acidity (mEq/kg d.m.)	Lipids (% on d.m.)	a_w
EH	Supernova	93,30	57,91g	31,15	0,51
	Ferragnes	93,10	58,71f	40,98	0,55
	Lauranne	93,01	77,23c	33,21	0,48
	Genco	93,15	84,03a	46,49	0,50
	Stelliette	93,33	55,03h	40,64	0,52
	Pepparudda	93,24	45,01i	38,68	0,51
	Glorieta	93,81	84,18a	31,51	0,51
	Tuono	92,50	64,13e	34,99	0,61
	Falsa Barese	93,50	78,57b	33,59	0,51
	Mas Bovera	94,42	68,70d	40,32	0,52
	Trianella	93,30	76,80c	44,43	0,50
Sig.		n.s.	**	n.s.	n.s.
OH	Supernova	94,95	77,40h	52,13b	0,49
	Ferragnes	95,52	80,71g	41,19i	0,48
	Lauranne	95,35	75,75i	45,75g	0,53
	Genco	95,24	88,63e	58,35a	0,55
	Stelliette	95,40	99,65b	47,38e	0,55
	Pepparudda	94,87	92,86c	50,72d	0,53
	Glorieta	95,96	85,48f	41,91h	0,50
	Tuono	94,80	89,46d	47,18e	0,54
	Falsa Barese	95,98	104,00a	40,85l	0,50
	Mas Bovera	95,45	88,68e	51,57c	0,54
	Trianella	94,95	69,18l	46,59f	0,54
Sig.		n.s.	**	**	n.s.

Data followed by different letters are significantly different by Duncan's multiple range test. * significance at $P < 0.05$. ** significance at $P < 0.01$, n.s. not significant.

Table 2 Influence of varietal characters and harvest time on lipid content and total acidity in almond samples.

	Lipids	**Total acidity**
Cultivar	**	**
Harvest time	**	**
Cultivar x harvest time	**	**

* significance at $P < 0.05$. ** significance at $P < 0.01$, n.s. not significant.

Table 3. Fatty acid content in oils obtained from early harvested seeds.

Fatty acids (%)	EH Samples											Sig.
	Supernova	Ferragnes	Lauranne	Genco	Stelliette	Pepparudda	Glorieta	Tuono	Falsa Barese	Mas Bovera	Trianella	
C16:0	6.96d	6.84f	7.24c	6.47g	6.97d	6.42h	6.42h	8.32b	8.47a	5.94i	6.90e	**
C16:1	0.37g	0.33hi	0.47c	0.50b	0.32i	0.32i	0.42d	0.40f	0.67a	0.41e	0.33h	**
C17:0	0.06d	0.05e	0.06d	0.06d	0.07c	0.13a	0.05e	0.08b	0.05e	0.06d	0.05e	**
C17:1	0.10e	0.11cde	0.11cde	0.12c	0.11cde	0.10e	0.71a	0.12cd	0.16b	0.11cde	0.11de	**
C18:0	2.02b	1.45f	1.22l	1.49e	1.51d	2.20a	1.35g	1.67c	1.33h	1.13m	1.30i	**
C18:1	69.78c	70.29b	68.90d	66.38g	69.00d	67.11f	69.80c	67.47e	69.65c	73.09a	66.50g	**
C18:2	19.54h	20.01f	21.21d	24.10a	21.17d	22.38c	20.11g	21.00e	18.88i	18.54l	24.00b	**
C20:0	0.14b	0.12bc	0.09cd	0.10cd	0.09d	0.19a	0.09cd	0.10de	0.06e	0.08d	0.10de	**
C18:3	0.05bc	0.05bc	0.07a	0.05de	0.04f	0.05bc	0.04f	0.05b	0.02g	0.05cd	0.05e	**
C20:1	0.10	0.09	0.10	0.09	0.07	0.11	0.44	0.08	0.07	0.10	0.09	n.s.
C22:0	0.03d	0.06b	0.02f	0.02f	0.02f	0.05c	0.02h	0.02h	0.09a	0.02g	0.03e	**
C24:0	0.01b	0.01bc	0.01f	0.01cd	0.01e	0.02a	Tr.g	0.01cd	Tr.g	0.01d	0.02a	**
UFAs/SFAs	9.75i	10.65e	10.52f	11.20c	10.46g	10.00h	11.54b	8.74m	8.95l	12.75a	10.84d	**
MUFAs/PUFAs	3.59d	3.53d	3.27e	2.78h	3.28e	3.02g	3.54c	3.23f	3.73b	3.97a	2.79h	**
C 18:1/ C 18:2	3.57c	3.51d	3.25g	2.75m	3.26f	3.00i	3.47e	3.21h	3.69b	3.94a	2.77l	**

Tr.: Traces (concentration less than 0.01 of the total fatty acids). Data followed by different letters are significantly different by Duncan's multiple range test. * significance at $P < 0.05$, ** significance at $P < 0.01$, n.s. not significant.

Table 4. Fatty acid content in oils obtained from seeds harvested at late time.

Fatty acids (%)	OH Samples											Sig.
	Supernova	Ferragnes	Lauranne	Genco	Stelliette	Pepparudda	Glorieta	Tuono	Falsa Barese	Mas Bovera	Trianella	
C16:0	7.02b	5.79g	6.45f	7.28a	6.55d	4.97m	6.81c	6.50e	5.53h	5.15l	5.34i	**
C16:1	0.39f	0.39f	0.52d	0.79a	0.51d	0.38f	0.66b	0.44e	0.51d	0.59c	0.44e	**
C17:0	0.07c	0.10a	0.04e	0.05de	0.10a	0.08b	0.05de	0.06cd	0.06cd	0.06cd	0.06cd	**
C17:1	0.13ab	0.11cd	0.12bc	0.12abc	0.11cd	0.12bc	0.12abc	0.09e	0.13a	0.12abc	0.01d	**
C18:0	1.58c	1.35e	1.11h	1.30f	1.42d	2.03a	1.31ef	1.79b	1.42d	1.24g	1.10h	**
C18:1	74.12i	78.89b	74.26h	74.15i	76.59d	75.53e	74.80g	74.96f	76.79c	81.07a	74,99f	**
C18:2	15.79c	12.59i	16.74b	15.65d	13.95h	15.80c	15.48e	15.09f	14.85g	11.01l	16.77a	**
C20:0	0.11b	0.08d	0.12a	0.05e	0.08d	0.09c	0.10b	0.12a	0.04f	0.09c	0.08d	**
C18:3	0.03de	0.04cd	0.05a	0.03cde	0.02f	0.04cd	0.06a	0.04cd	0.03de	0.04c	0.03ef	**
C20:1	0.07d	0.08c	0.08c	0.04f	0.06e	0.10b	0.07d	0.08c	0.06e	0.10a	0.08c	**
C22:0	0.04a	0.01e	0.03b	0.02d	0.02c	0.02c	Tr.f	0.04a	Tr.f	0.01d	0.01d	**
C24:0	0.02	0.01	0.02	Tr.	0.05	0.01	Tr.	0.06	Tr.	0.01	0.01	n.s.
UFAs/SFAs	10.24m	12.55e	11.81f	10.43l	11.09g	12.77d	11.03h	10.58i	13.10c	14.17a	13.61b	**
MUFAs/PUFAs	4.72h	6.30b	4.47l	4.79g	5.53c	4.81g	4.87f	4.99e	5.21d	7.41a	4.49i	**
C 18:1/ C 18:2	4.69l	6.27b	4.44m	4.74i	5.49d	4.78h	4.83g	4.97f	5.17e	7.36a	6.10c	**

Tr.: Traces (concentration less than 0.01 of the total fatty acids). Data followed by different letters are significantly different by Duncan's multiple range test. * significance at $P < 0.05$, ** significance at $P < 0.01$, n. s. not significant.

Table 5 Influence of varietal characters and harvest time on the principal fatty acids in almond samples.

	C16:0	C18:1	C18:2
Cultivar	**	**	**
Harvest time	**	**	**
Cultivar x harvest time	**	**	**

* significance at P < 0.05. ** significance at P < 0.01, n.s. not significant.

Table 6. Mineral content in the almond seeds[†]

Samples	cv	Ca	Mg	K	Fe	Cu	Zn	Mn
EH	Supernova	112,84de	217,56	672,43	5,54a	2,16ab	5,30	1,26ab
	Ferragnes	137,80bc	233,23	661,26	4,48cd	2,14abc	4,89	1,04bc
	Lauranne	166,41a	245,75	737,22	4,97abcd	2,18ab	5,93	1,22abc
	Genco	138,55bc	253,56	571,61	4,29d	1,83cde	4,69	1,16abc
	Stelliette	155,31ab	241,50	698,88	4,27d	1,76de	5,53	1,21abc
	Pepparudda	131,17cd	223,49	745,51	3,45e	2,27a	4,99	0,95c
	Glorieta	101,85e	245,06	693,88	4,36d	1,93bcde	5,55	1,11abc
	Tuono	127,11cd	222,53	741,29	5,11abc	2,04abcd	5,10	1,21abc
	Falsa Barese	137,50bc	254,43	725,59	4,45cd	1,98abcde	5,51	1,27ab
	Mas Bovera	128,96cd	256,40	785,64	4,73bcd	1,68e	5,46	1,39a
	Trianella	124,83cd	241,08	727,33	5,38ab	2,06abcd	5,37	1,20abc
	Sig.	**	n.s.	n.s.	**	*	n.s.	*
OH	Supernova	126,72bc	234,19bc	659,15c	6,49a	2,89c	3,25ab	0,93c
	Ferragnes	128,27bc	225,85c	695,37bc	3,42bc	3,80b	3,71ab	1,46a
	Lauranne	176,50a	154,15d	652,41c	4,45b	3,76b	4,45a	1,44a
	Genco	138,02b	235,77bc	674,09bc	1,82cd	3,90b	3,95ab	1,29ab
	Stelliette	175,68a	248,83b	793,86a	4,09b	3,72b	4,37a	1,32ab
	Pepparudda	118,30cd	246,54b	728,69b	2,84bcd	8,61a	1,08c	0,89c
	Glorieta	89,97e	249,14b	727,27b	6,10a	3,85b	4,66a	1,12abc
	Tuono	106,03d	225,48c	676,55bc	2,71bcd	3,58	4,30a	1,38a
	Falsa barese	142,23b	235,39bc	689,89bc	3,13bcd	3,38bc	2,83b	1,01bc
	Mas Bovera	102,58de	275,87a	732,62b	1,56d	3,82b	3,88ab	1,11abc
	Trianella	105,91d	225,80c	525,46d	2,80bcd	3,74b	4,38a	1,16abc
	Sig.	**	**	**	**	**	n.s.	n.s.

[†]Data are expressed as mg/100 g of dry matter. Data followed by different letters are significantly different by Duncan's multiple range test.
*significance at P < 0.05, ** significance at P < 0.01, n. s. not significant.

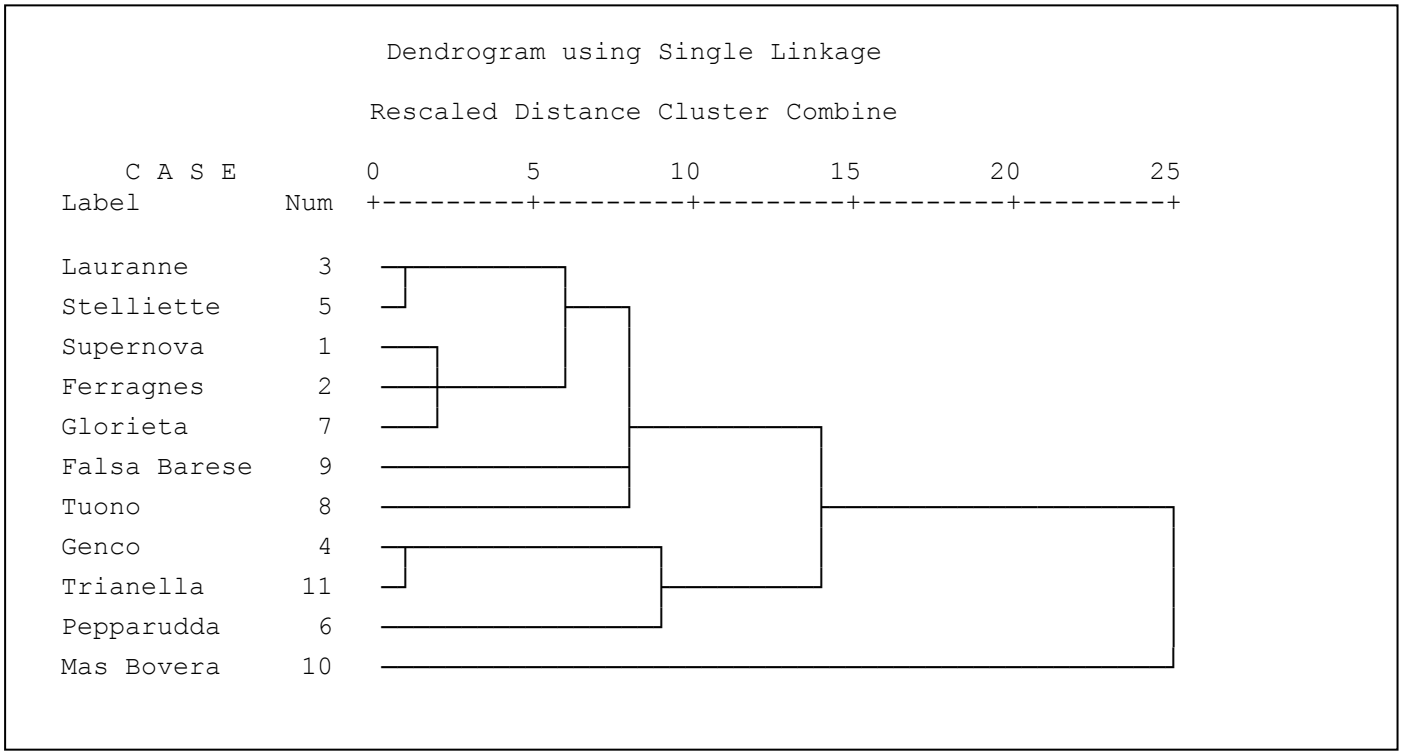
Table 7. Influence of varietal characters and harvest time on mineral content of almond samples.

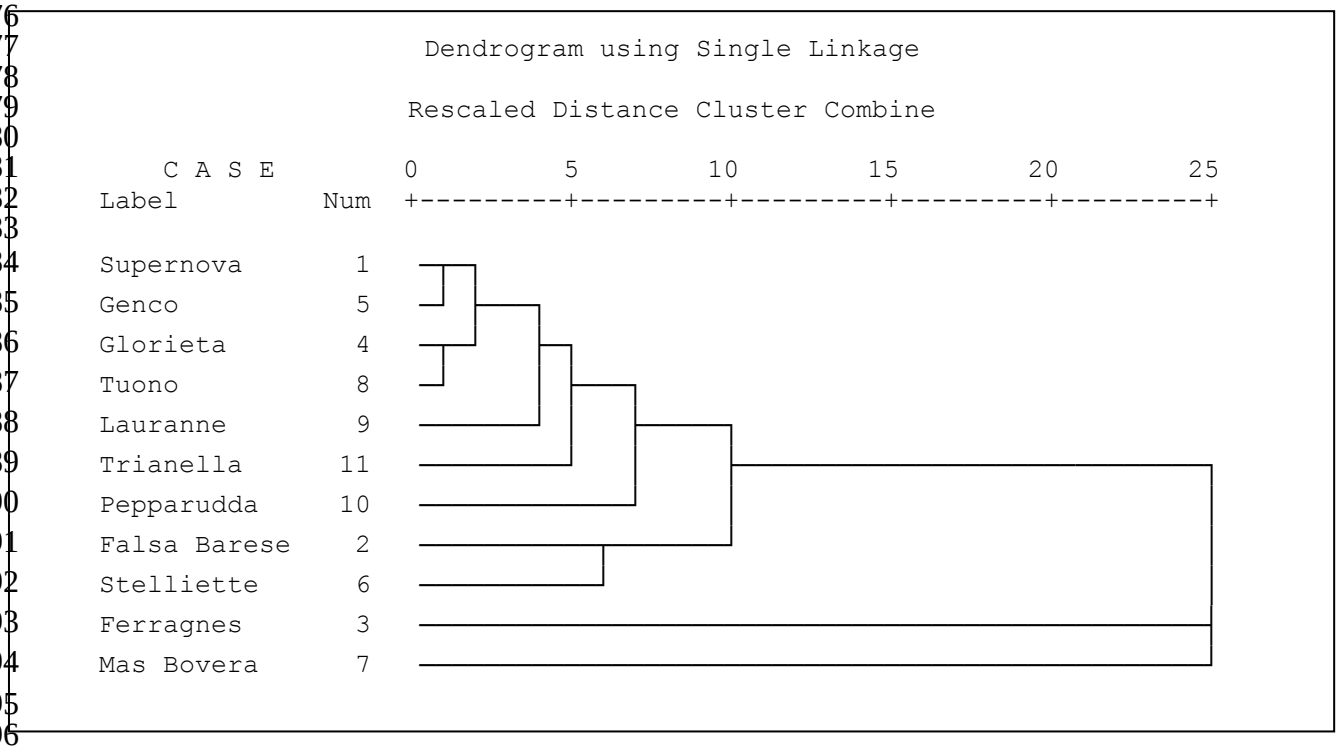
	Ca	Mg	Na	K	Fe	Cu	Zn	Mn
Cultivar	**	**	**	n.s.	**	**	*	*
Harvest time	n.s.	n.s.	**	n.s.	**	**	**	n.s.
Cultivar x harvest time	**	**	**	*	**	**	**	**

*significance at $P < 0.05$, ** significance at $P < 0.01$, n. s. not significant.

Fig. 1. Dendrogram for the classification of 11 cultivars of Prunus dulcis (EH samples) according to the fatty acids content.

Fig. 2. Dendrogram for the classification of 11 cultivars of Prunus dulcis (OH samples) according to the fatty acids content.




Dendrogram using Single Linkage
Rescaled Distance Cluster Combine
C A S E
Label Num
0 5 10 15 20 25
Supernova 1
Genco 5
Glorieta 4
Tuono 8
Lauranne 9
Trianella 11
Pepparudda 10
Falsa Barese 2
Stelliette 6
Ferragnes 3
Mas Bovera 7