PAPER

INFLUENCE OF PRE-PROCESSING STORAGE CONDITIONS ON PEELED ALMOND QUALITY

INFLUENZA DELLE CONDIZIONI DI CONSERVAZIONE PRE-LAVORAZIONE SULLA QUALITÀ DI MANDORLE PELATE

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ABSTRACT

The study was carried out to determine the effect of storage conditions (in-shell, shelled, storage time and temperature) before peeling and packaging on the quality of peeled "Supernova" almonds. The influence of the storage temperature after packaging was also determined. From the results of the chemical analyses carried out on the lipid fraction (peroxide value, FAMEs, spectrophotometric characteristics, tocopherols), and of the physical characteristics (texture, colour) and sensory measurements, it was determined that high quality peeled almonds can be

RIASSUNTO

Sono riportati i risultati di una ricerca tesa a valutare la possibilità di ottenere mandorle pelate, pronte per il consumo, a partire da frutti della cultivar "Supernova" conservati per tempi diversi prima della lavorazione con modalità differenti (in guscio a temperatura ambiente e sgusciate a 2°C). Sulle mandorle pelate, conservate sia a temperatura ambiente che a 2°C, sono state eseguite a intervalli di 4 mesi analisi chimiche (numero di perossidi, indici spettrofotometrici, composizione in acidi grassi e in tocoferoli), fisiche (consistenza, colore) e sensoriali. I risultati

- Key words: lipid oxidation, peeled almonds, pre-processing storage, sensory analysis. -

obtained either with nuts processed immediately after harvesting, or with in-shell almonds stored for four months at ambient temperature (18°-25°C) or with shelled almonds stored in cold conditions (2°C) for up to eight months before processing. Moreover, in order to have high quality almonds up to 12 months, it is best to store peeled nuts at 2°C.

dimostrano che è possibile ottener mandorle pelate di buona qualità si lavorando i frutti subito dopo la rac colta, sia conservandoli in guscio temperatura ambiente per 4 mesi sgusciati a 2°C fino a otto mesi prim della lavorazione. Conservando, inol tre, le mandorle pelate a 2°C, è possi bile avere dei prodotti di elevata qualit fino a 12 mesi di conservazione.

INTRODUCTION

To increase the sales of almond (*Amygdalus communis*) products, the quality of the nuts and consumer demand should be considered. Ready-to-eat almonds, i.e. shelled, peeled and packaged kernels, are considered a convenience food and can be consumed directly or used by the food industry as a semi-finished product. The quality of these products depends on the raw material (i.e. cultivar, agronomic factors, year and climate), and on the storage conditions. One of the most important factors causing quality degradation is lipid oxidation. Hence, any treatment that can minimize this should be implemented.

It has been reported that peeled almonds are less stable than in-shell and shelled almonds (GUADAGNI et al.,1978; RIZZOLO et al., 1994), thus protective techniques should be used to delay the onset of lipid oxidation (HARRIS et al., 1972).

In a previous experiment on Ferraduel almonds (SENESI et al., 1991), it was found that peeled kernels could be stored for up to nine months without a serious loss in quality when packaged in high barrier packaging, such as flexible plastic pouches (transparent or metallized), regardless of the storage temperature (4°C or ambient). Beyond this time, quality can be maintained only by using metallized film under nitrogen and refrige ation. Moreover, RIZZOLO et al. (199 reported that peeled almonds could stored up to one year using low b- -i packaging (polyethylene film) only cultivar has a particularly high conte of tocopherols (natural antiox(t).

The objective of this work wa- -o op up new perspectives for peeled almo marketing by studying i) the effects of t storage protocol (in-shell, shelled, st age time and temperature) before peeli and packaging, and ii) the influence the storage temperature after packa ing.

MATERIALS AND METHODS

Almonds and storage conditions before processing

Fully mature, freshly harvested Sup nova almonds, grown in the Metapon area (Matera, Basilicata, Italy), we divided into five lots (4 kg each), a processed after different storage time on arrival at the laboratory and 4 and months after harvesting, according the sampling scheme reported in Fig. The two lots of in-shell kernels - PI4 a PI8 - were stored before proces jute bags at ambient temperature (18 25°C) for four and eight months, resp tively, while the other two lots of shell

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almonds - PS4 and PS8 - were stored in net bags in a normal atmosphere cold room at 2°C for four and eight months, respectively.

Processing, packaging and storage

Regardless of the pre-processing storage time, the almonds were subjected to mechanical shelling, hand peeling after steam treatment (2 min at 98°C), dried with air at 55°C and packaged in polyethylene film pouches (size: 215 mm x 160 mm; film thickness: 25 µm; WVTR=6 g/m^2 x day; OTR= 4200 mL/m^2 x day x atm) under partial vacuum (residual pressure 600 mm Hg). All the pouches were filled with about 250 g of peeled almonds.

Half of each lot was stored at ambient temperature (18°-25°C) on open shelves, while the other half was stored in a normal atmosphere cold room at 2°C. The post-processing storage time was 12 months for P0 samples, 8 months for PS4 and PI4 samples and 4 months for PS8 and PI8 samples.

Analytical methods

Analyses were carried out on all the samples at four month intervals during the storage time. Each sample consisted of three replicates of two pouches, each.

On arrival at the laboratory almonds were analysed for chemical composition (moisture, protein, fat, alcohol-insoluble solids) according to AOAC method numbers 27.005, 27.007, 27.006 and 32.012, respectively (AOAC, 1980). The oil fraction was checked for peroxide value, acidity, spectrophotometric characteristics, fatty acid methyl esters (FAME) composition, and tocopherol content. Moreover water activity (a_w), colour and texture were determined and the morphological parameters were measured on thirty nuts.

The oil fraction from all the samples was extracted according to AOAC method number 21.006 (AOAC, 1980), under a flow of nitrogen and in the dark and analysed for peroxide value, acidity, spectrophotometric characteristics, FAME and tocopherol composition; kernels were

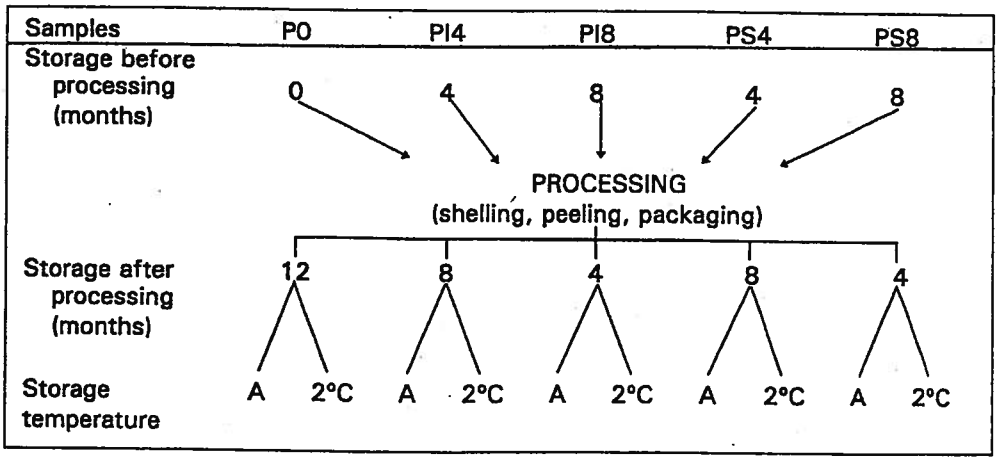

Fig. 1 - Flow-sheet of pre-storage and post-storage treatments of almonds. A= 18°-25°C; P0= processed almonds at harvest, PI4= in-shell almonds processed after four months of pre-processing storage, PI8= in-shell almonds processed after eight months of pre-processing storage, PS4= shelled almonds processed after four months of pre-processing storage, PS8= shelled almonds processed after eight months of pre-processing storage.

also checked for specific physical indexes (colour, texture).

Peroxide value, acidity and spectrophotometric characteristics were determined according to the Italian Official Methods for Fats and Oils numbers C-35, C-10 and C-40 (NGD, 1976). FAMEs, tocopherols, colour, texture and a_w were measured according to previously reported methods (SENESI et al., 1991). Chemical analyses were repeated twice. Data of peroxide value, acidity, FAMEs and tocopherols are all expressed on oil content basis.

Sensory analyses

The samples stored at 2°C were subjected to sensory analysis; as regards the samples stored at ambient temperature, sensory analysis was performed only on P0 samples after 4 months. Sensory analysis was carried out using the preference test (LARMOND, 1977), with a semi-trained panel of ten members. Randomly coded samples were scored for external colour, taste and acceptance on the basis of a hedonic scale ranging from 1 (extreme dislike) to 9 (extreme like) (SENESI et al., 1991). The samples were randomly offered to the tasters once a day on two different days.

Statistical methods

Data were submitted to analysis of variance; when ANOVA results were significant, the averages were compared by Tukey's test.

RESULTS AND DISCUSSION

Almonds

Table 1 shows the data of the analyses of the "Supernova" almonds on arrival at the laboratory. This cultivar showed a relatively high yield and a low kernel texture, when compared to the data obtained for other Italian cultivars (POLESELLO et al., 1990; MASPERI, 1988). The oil fraction had spectrophotometric characteristics and FAME composition typical of a very good quality oil (HARRIS et al., 1972; SALVO et al., 1986). The amount of total tocopherols was very high (more than 400 mg/100 g of oil), significantly higher, from 10 to 70 mg/100 g of than the total tocopherol content reported for other almond cultivars grown in Italy (SALVO et al.,1986; MASPERI, 1988).

Table 1 - Analysis of almonds at time 0 before treatments. Values are the average ± standard deviation of 30 nuts.

Kernel length (mm)	24.9 ± 2.3
width (mm)	15.3 ± 1.9
thickness (mm)	7.6 ± 1.4
weight (g)	1.53 ± 0.42
texture (kg)	8.64
a_w	0.74
moisture (%)	4.31
fat (% d.m.)	64.5
protein (% d.m.)	17.5
A.I.S.* (% d.m.)	20.1
FAMEs:	
C16:0	6.82
C16:1	0.42
C18:0	1.88
C18:1	76.44
C18:2	14.33
tocopherols (mg/100 g oil)	
α-tocopherol	451.63
β-tocopherol	0.93
γ-tocopherol	7.53
UV indices:	
K232	0.46
K268	0.024
K232/K268	19.20
acidity (% oleic acid)	0.29
peroxide value	0.35
colour:	
L*	81.38
a*	- 0.16
b*	21.14
hue (a*/b*)	- 0.0086
Yellowness Index (YI)	37.11

* A.I.S. = alcohol insoluble substances

Chemical properties of lipids

Overall, the peroxide value for all the samples in all conditions ranged from 0.16 to 1.86 (Table 2), indicating the low degree of oxidation of the oil fraction. P0 almonds had a significantly higher peroxide value after 4-8 months of storage. Storing peeled kernels at 2°C appears to slow down the oxidation, without blocking it.

The storage protocol before processing influenced the peroxide value; in fact, after four months of storage shelled almonds had the highest peroxide value, while in-shell almonds had the lowest; prolonging the pre-processing storage time, these differences in peroxide value were less and not significant. Comparing the peroxide values of the almonds after 4 months and 8 months, it could be argued that the peeling process at 4 months has a stabilizing effect on the oil fraction. This effect could be further proved by using a cold pressure extraction of the almond oil to exclude any possible influence of the solvent and temperature on the lipid fraction.

Few, but significant changes in the peroxide value were also found by FOURIE and BASSON (1989) in almonds stored for 16 months at 30°C, while MEHERAN and FILSOOF (1974) could not detect changes in the peroxide value even after 12 months of storage. All these findings confirm the good stability of almond lipids to rancidity during storage.

The acidity of almonds processed on arrival at the laboratory (P0, 0 month of storage) was of the same order as those established for almonds of other origins (ROMOJARO et al., 1988; GARCIA OLMEDO and MARCOS, 1971). As for the changes of acidity with storage (Table 3), P0 kernels showed a significant increase in acidity after four months of storage at both storage temperatures. The storage temperature of the packaged kernel influenced the acidity for PI4 and PI8 samples. In fact, only PI4 stored at ambient temperature and PI8 stored at 2°C showed no significant changes in acidity with the storage time. All the other samples showed a significant increase, except for PI4 stored at 2°C, which showed a decrease. Similar to the findings of HADORN et al. (1980 a, b) none of the samples reached high acidity, indicating that almond lipids do not undergo noticeable lipolytic activity with storage. However, the statistically significant differences found could indicate there are actually some changes in the lipid structure, which could be explained by the a_w value found at the beginning of storage (0.74, Table 1). According to TROLLER (1989), this value makes the

Table 2 - Peroxide values of almonds at different temperatures and storage times.

	Time months	Storage temperature Ambient	2°C
P0	0	0.35 a	0.35 a
	4	0.61 b	0.70 b
	8	0.55 b	1.13 c
	12	0.37 a	0.18 a
PI4	0	0.62	0.62 b
	4	0.87	0.16 a
	8	0.52	0.20 a
PS4	0	1.86 b	1.86 b
	4	0.99 a	0.82 a
	8	0.47 a	0.40 a
PI8	0	1.85 b	1.85 b
	4	0.32 a	0.21 a
PS8	0	1.31 b	1.31 b
	4	0.45 a	0.21 a

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
Sample captions: P0=processed almonds at harvest; PI4 and PI8=in-shell almonds stored at ambient temperature for 4 and 8 months before processing; PS4 and PS8=shelled almonds stored at 2°C for 4 and 8 months before processing.

Table 3 - Acidity (% oleic acid) of almonds at different temperatures and storage times.

	Time months	Storage temperature Ambient	2°C
P0	0	0.29 a	0.29 a
	4	0.71 b	0.61 b
	8	0.60 b	0.62 b
	12	0.73 b	0.68 b
PI4	0	0.71	0.71 b
	4	0.65	0.55 a
	8	0.73	0.51 a
PS4	0	0.70 a	0.70 a
	4	0.71 a	0.66 a
	8	0.81 b	1.09 b
PI8	0	0.60 a	0.60
	4	0.75 b	0.61
PS8	0	0.52 a	0.52 a
	4	1.16 b	0.64 b

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
For sample captions, see Table 2.

lipids susceptible to autoxidation.

There were some significant changes in the FAME composition during storage time (Table 4), above all in the percentages of C18:1, C18:2 and C16. Decreases occurred only in P0, PI4 and PS8 samples, regardless of the storage temperature.

Tocopherol content decreased with storage time (Table 5), regardless of the storage protocol: beta- and gamma-tocopherols disappeared by the end of storage in all the samples, and alpha-tocopherol decreased to 63.79 mg/100 g of oil after eight months for the P0 sample and to 62.09 and 59.79 mg/100 g of oil for samples PI4 and PS4 four months after storage. As for PI8 and PS8 kernels, alpha-tocopherol content ranged from 50 to 56 mg/100 g of oil and did not significantly change with storage. The stor age temperature did not significantl influence the amounts and the trends c the tocopherols.

The amounts of tocopherols foun twelve months after harvesting, regard less of the pre-processing storage tim and the storage protocol after processing were similar to the tocopherol conten found in other cultivars at harvest tim (MASPERI, 1988). This is an importan feature, as tocopherols are antioxidant that play an important role in main taining the stability of food product (SCHULER, 1990). So, high content toco pherol almonds could be suitable fo long term storage as well as for industria purposes.

The spectrophotometric characten.. showed a significant increase ... K23 (Fig. 2A) and a significant decrea ... th K232/K268 ratio (Fig. 3A) for P0 sample after four months of storage.

The storage protocol before processin and the storage temperature influence the trend of the spectrophotometric cha acteristics. Storing the samples at amb ent temperature resulted in a statisticall significant increase in K232; P0, PI4 an PI8 samples stored at 2°C showed decrease at the end of storage, whil PS4 and PS8 samples stored at 2°C ha a constant value of K232 throughou storage time (Fig. 2).

Regardless of the storage protoc before processing and the storage tem perature, the K232/K268 ratio (Fig. showed a decrease at the end of storag in all the samples, because of an increas in K268, probably due to the appea ance of unsaturated ketones (ROMOJAR et al., 1988).

Physical indexes

The most noticeable change i ... h colour parameters (Table 6) was a which showed a tendency to increas regardless of the storage protocol befo and after processing. This trend ... no

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Table 4 - FAME composition of almonds at different storage temperatures and storage times.

	Time months	Storage temperature: Ambient					Storage temperature: 2°C				
		C16	C16:1	C18	C18:1	C18:2	C16	C16:1	C18	C18:1	C18:2
P0	0	6.92	0.42	1.88	76.44ab	14.33	6.92b	0.42	1.88	76.44	14.33
	4	6.13	0.40	2.06	77.92b	13.48	5.90ab	0.40	1.96	78.09	13.67
	8	6.21	0.45	1.74	76.64ab	14.96	5.01a	0.33	1.43	80.13	13.10
	12	7.59	0.33	2.13	75.47a	14.64	6.34b	0.32	2.05	76.68	14.52
PI4	0	5.98a	0.42	2.07b	78.45b	13.06a	5.98a	0.42a	2.07b	78.45	13.06
	4	6.35b	0.47	1.87a	76.06a	15.25b	6.45b	0.37a	1.85a	77.36	14.21
	8	6.74c	0.45	2.09b	76.53a	14.20ab	6.75c	0.50b	2.27c	77.02	13.43
PS4	0	6.35	0.45	2.07	77.39	13.68	6.35	0.45b	2.07	77.39	13.66
	4	5.95	0.43	2.02	78.33	13.60	5.80	0.35a	1.84	78.12	13.59
	8	6.67	0.43	2.09	76.44	14.32	6.40	0.29a	1.82	74.63	14.46
PI8	0	5.78	0.42	2.09	76.24	14.90	5.78	0.42	2.09	76.24	14.90
	4	6.47	0.44	2.14	76.90	14.02	6.48	0.45	1.80	77.03	13.83
PS8	0	4.73a	0.33	1.38a	80.71	12.60a	4.73a	0.33	1.38	80.71	12.60a
	4	7.02b	0.41	2.10b	75.89	14.57b	6.35b	0.33	1.88	76.13	15.36b

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
For sample captions, see Table 2.

Table 5 - Tocopherol content (mg/100 g of oil) of almonds at different temperatures and storage times.

	Time months	Storage temperature: Ambient			Storage temperature: 2°C		
		alpha	beta	gamma	alpha	beta	gamma
P0	0	358.70 d	0.89 d	6.16 c	358.70 c	0.89 c	6.16 d
	4	320.90 c	0.76 c	6.56 c	342.38 b	0.85 c	5.69 c
	8	63.79 b	0.25 b	2.45 b	56.99 a	0.28 b	2.00 b
	12	52.80 a	0.00 a	0.00 a	53.81 a	0.00 a	0.00 a
PI4	0	358.70 c	0.89 c	6.16 c	358.70 b	0.89 c	6.16 c
	4	62.09 b	0.32 b	2.54 b	56.54 a	0.33 b	2.26 b
	8	56.03 a	0.00 a	0.00 a	55.33 a	0.00 a	0.00 a
PS4	0	430.75b	0.96 c	7.13 c	430.75 b	0.96 c	7.13 c
	4	59.79 a	0.26 b	2.41 b	60.15 a	0.26 b	2.77 b
	8	57.45 a	0.00 a	0.00 a	53.77 a	0.00 a	0.00 a
PI8	0	55.85 a	0.18 a	2.40 b	55.85 a	0.18 a	2.40 b
	4	51.78 a	0.00 a	0.00 a	53.61 a	0.00 a	0.00 a
PS8	0	54.54 a	0.25 b	2.15 b	54.54 a	0.25 b	2.15 b
	4	54.49 a	0.00 a	0.00 a	50.02 a	0.00 a	0.00 a

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
For sample captions, see Table 2.

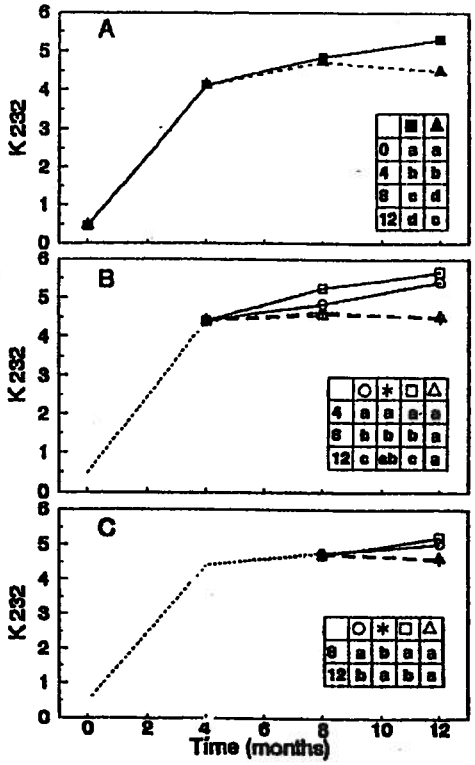

Fig. 2 - Spectrophotometric characteristics: K_{232} during storage time. A= Processed almonds at harvest (■= P0 ambient; ▲= P0 2°C); B= Processed almonds after four months of pre-processing storage (○= PI4 ambient; ✳ = PI4 2°C; □ = PS4 ambient; ∧= PS4 2°C); C= Processed almonds after eight months of pre-processing storage (○= PI8 ambient ; ✳ = PI8 2°C; □ = PS8 ambient; ∧= PS8 2°C). Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.

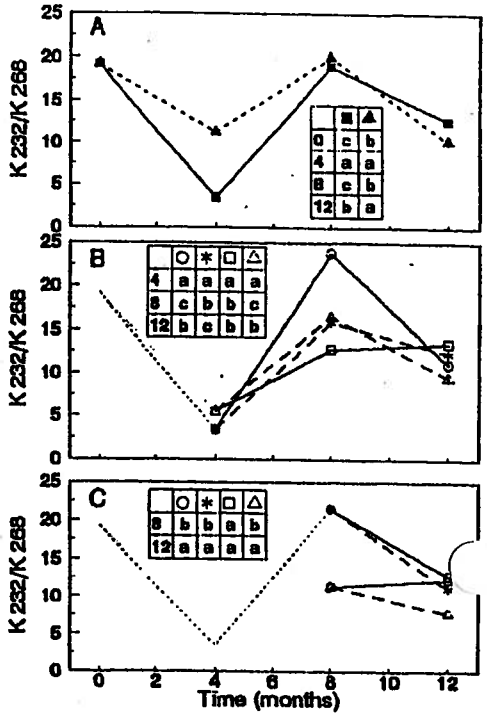

Fig. 3 - Spectrophotometric characteristics (R= K232/K268) during storage time. For captions, see Fig. 2.

evident in samples stored at ambient temperature. L* and b* values significantly changed only in P0 samples, where L* increased and b* decreased. The Yellowness Index (YI=1000b*/7L*) is more useful for describing the colour changes during storage than L* and b* alone (Fig. 4).

Changes in YI were observed for P0, PI4 and PS4 samples throughout the storage time, but the most noticeable decrease in YI occurred for P0 samples, above all for P0 kernels stored at 2°C after twelve months (Fig. 4A), because of the significant decrease in the b* value (Table 6).

The storage protocol before processing greatly influenced YI (Fig. 4B-4C): for PI4 samples, YI significantly increased after four months of storage, while PS4 samples showed an opposite trend, independent of the storage temperature. By prolonging the storage time before processing, only PS8 samples stored at ambient temperature showed a significant increase in YI (Fig. 4C). So, YI and a* could be useful parameters for evaluating the colour changes of peeled almonds stored in different ways before and after processing.

Table 6 - L*, a* and b* values of almonds at different temperatures and storage times.

	Time months	Storage temperature: Ambient L*	Ambient a*	Ambient b*	2°C L*	2°C a*	2°C b*
P0	0	81.38 a	-0.16 a	21.14 a	81.38 a	-0.16 a	21.14 b
	4	83.09 b	0.76 b	20.68 a	81.85 a	0.94 c	21.17 b
	8	83.18 b	0.79 b	20.60 a	83.35 b	0.59 b	20.80 b
	12	82.91 b	0.80 b	20.35 a	84.12 b	0.43 b	19.21 a
PI4	0	84.03 b	0.46 a	19.47 a	84.03 b	0.46 a	19.47 a
	4	82.94 a	0.71 b	20.32 b	82.89 a	0.69 b	21.11 b
	8	82.76 a	1.00 c	20.03 ab	82.87 a	0.34 a	21.02 b
PS4	0	83.31 a	0.36 a	20.85 b	83.31 b	0.36 a	20.85 b
	4	83.60 a	0.71 b	19.67 a	83.78 b	0.64 b	20.09 a
	8	83.06 a	1.08 c	20.42 ab	82.59 a	0.79 b	20.28 ab
PI8	0	83.02 a	0.52 a	20.68 b	83.02 a	0.52 a	20.68 a
	4	83.41 a	0.75 b	19.82 a	82.45 a	0.46 a	20.28 a
PS8	0	83.58 b	0.51 a	20.58 a	83.58 b	0.51 b	20.58 a
	4	82.48 a	0.93 b	19.96 a	82.93 a	0.33 a	21.07 a

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
For sample captions, see Table 2.

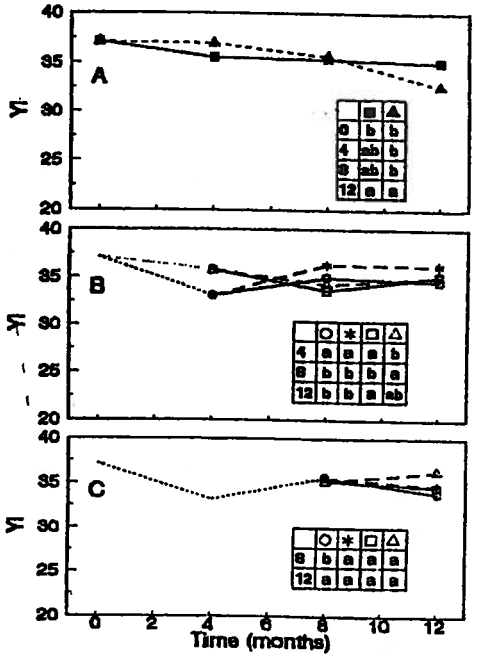

Fig. 4 - Yellowness Index (YI) during storage time. For captions, see Fig. 2.

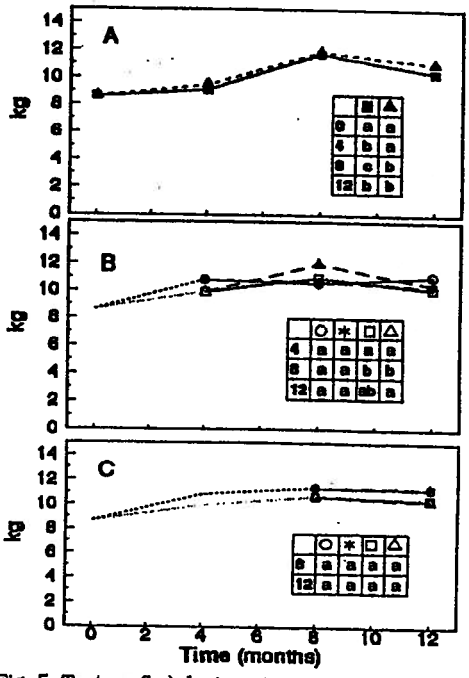

Fig. 5. Texture (kg) during storage time. For captions, see Fig. 2.

Table 7 - Sensory analysis: scores after 4, 8 and 12 months of storage.

	Colour	Taste	Acceptance
4 months			
P0 ambient	6.14	6.64	6.50
2°C	6.32	6.21	6.00
8 months (2°C)			
P0	7.23 a	6.73 a	6.82 a
PI4	5.73 b	5.04 b	5.00 b
PS4	6.09 ab	5.86 ab	5.73 b
12 months (2°C)			
P0	6.80	5.70 ab	5.75 ab
PI4	6.35	6.00 a	6.15 a
PS4	5.80	5.70 ab	5.75 ab
PI8	5.70	6.05 a	6.05 a
PS8	5.75	4.70 b	4.85 b

Means followed by different letters in the same column and within the same sample are significantly different at the 0.01% level.
For scale, see Materials and Methods section.
For sample captions, see Table 2.

The storage treatment before processing had some influence on the texture, too (Fig. 5); P0 samples showed an increasing trend, reaching a significantly higher value after eight months of storage; the same behaviour was found for PS4 samples. The texture of PI4, PI8 and PS8 samples remained almost constant over the storage period. There was no evidence that texture was affected by storage temperature.

Sensory analysis

The results of the sensory tests (Table 7) generally agreed with the data of chemical and physical analyses. P0 samples after four months of storage were rated as acceptable, i.e. 6.14-6.64, for all parameters. After eight months of storage, P0 samples received higher scores than PI4 and PS4 for all parameters, the latter being rated slightly better than the former.

After twelve months of storage, P0 samples received the highest score for colour, and PI samples were judged better than PS samples, regardless of the time of processing. Despite these differences, all the samples were judged sufficiently acceptable, with the exception of sample PS8, which was rated negatively for taste and acceptance.

The better maintenance of the organoleptic characteristics observed in P0 samples could be due to the stabilizing effect achieved by steam peeling after harvesting and followed by refrigerated (2°C) storage. As regards the storage protocol before processing, the storage of in-shell almonds at ambient temperature seems to offer more advantages than refrigeration of shelled almonds; probably the almond shell itself could be an effective natural package in preventing oxidative deterioration during storage at 18°-25°C.

CONCLUSIONS

The lipid fraction of "Supernova" almonds showed great resistance to oxidation and this feature could well be due to the high tocopherol-polyunsaturated fatty acid ratio of the "Supernova" lipids. In fact, in spite of the low barrier packaging used in this experiment, "Supernova" almonds stored at 18°-25°C did not undergo the modifications of the lipid fraction found in "Ferraduel" peeled kernels packaged in high barrier film pouches and stored both at ambient temperature and 4°C in a previous storage test (SENESI et al., 1991)

In order to have a high quality, stored, peeled almond packaged in low barrier material, the aspects to be taken into account are: a) the tocopherol content of the cultivar chosen; b) immediate steam peeling at harvesting followed by refrigerated storage and c) when the process

ing has to be delayed, almonds should be stored in-shell. These considerations are effective in preventing lipid oxidation as well as changes in the colour parameters and sensory characteristics.

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