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Effects of Different Packaging on Quality of Organic Dried Apricot Fruit During Shelf Life

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Abstract
The study was conducted to determine the effects of different packaging on quality changes occurring in organic dried apricots at shelf life conditions. Organic sun dried apricots (cv. Hacihaliloglu) was placed into the craft box, doypack, tray, quadro and PE bags. Dried apricots were stored at 20°C and 50-65% relative humidity for 6 months. Packaging type affected the moisture content of dried apricot fruits and resulted in increase or decrease of the water activity and water and total soluble solid contents. Water content of dried apricots was the highest in doypack and the lowest in craft box after 2 and 4 months storage. After 4 months of storage, the water content of dried apricot fruits in doypack and craft box packages decreased by 4% and 18%, respectively. During the shelf life, changes in the water activity of dried apricot fruits in doypack were limited, and the water activity value decreased from 0.66 to 0.64. In general, effects of packaging on colour and other quality parameters analyzed were limited. The results showed successful storage of organic dried apricots at shelf life conditions for 6 months. Based upon the results, doypack packages are recommended for dried apricot storage. There might be some problems in dried apricots stored in craft box packages related to some of the quality parameters.
Keywords: Organic dried fruits, storage, package, storability, moisture content .

INTRODUCTION

Turkey, which ranks first in dried figs, dried apricots and dried raisins production in the world, has a big potential not only for the quality of its range but also for the ecological superiorities it has. Turkey ranked first in the world in dried apricot exportation with 71.239 tons in 2016 [1].

The organic agriculture in Turkey has started with these traditional products of ours. Therefore, dried figs, dried raisins and dried apricots are the leading products of organic agriculture. There are many businesses and exporter companies that process these organic dried products. In order to protect and increase Turkey's share in the production and commerce of organic dried fruits in the world, it is very important to protect the quality of the product during the shelf life and decrease the amount of potential losses. Apart from that, it is important to keep up with thechanges in customer demands in product quality, process and marketing. Produced dried apricots with organic certificates are exported to developed countries such as 500 ton for the EU countries, 100 tons for the UK, 526 tons for the USA, 20 tonsfor Australia and 25 tons for Japan [2].

Since dried fruits are dehydrated, thus gaining durability, due diligence needed during the storage period and shelf life is usually ignored. However, the longer the waiting period is the greater the degree of decompositionwill be [3; 4; 5]. Change of color, appearance, texture, the rehydration feature, changes in the taste and aroma, microbial generation and insect pests seen on organic dried apricots during the shelf life may cause severe quality loss.

The manner of packaging and the material the package is made of are of great importance on this loss of quality occurring in organic dried apricots during the shelf life. Because the features of the package used in the marketing period of organic dried apricots may affect the quality of fruit and cause it to go bad or lose its consumability. Especially with the extension of shelf life, this situation becomes more visible in inappropriate packages.

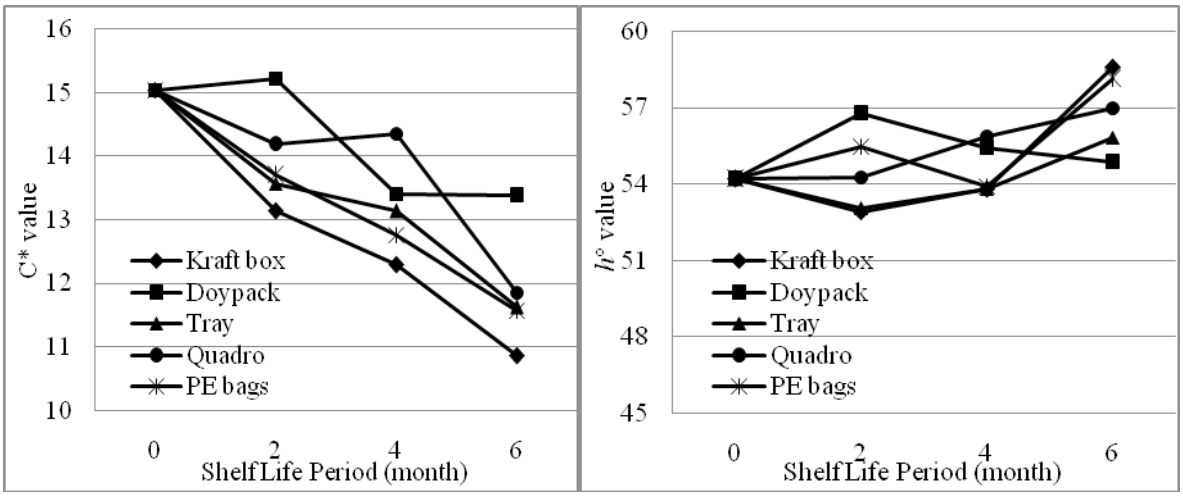
It was observed that dried apricots conserve their sensory features in modified atmosphere storage. Modified atmosphere storage has increased the shelf life of the dried apricots by delaying browning and preventing oxidations[6]. Altug et al.[7] informed that processed natural dried apricots could be stored for 30 weeks without decomposing under modified atmosphere packaging conditions at 5±1ºC. Upon 9 month-long storage of processed natural dried apricots packaged with two different packaging techniques (shrink packaging and modified atmosphere packaging) under 20±7ºC and 8±3ºC, it was detected that they preserve their quality best in modified atmosphere package under 8±3ºC and 85% relative humidity[8].

This study was conducted with the aim of demonstrating the effects of different packages on the change of quality of the organic dried apricots during the shelf life.

MATERIALS and METHODS

Materials

The study was carried out on organic dried apricots provided by IsikTarimUrunleri San. ve Tic. A.S. Organic dried apricots were acquired through sun-drying Hacihaliloglu type of apricots organically grown by a producer from the Balaban village of the Darende district of the province of Malatya with farmer code 02 ADD. Hacihaliloglu is the most important type of apricot which is used for obtaining dried apricots in Malatya. It is widely grown in the area and it forms the 70-75% of all the apricot trees. Its trees are tall,



Figue 1. The effect of different packages on the *C** and *h°* values of organic dried apricots.

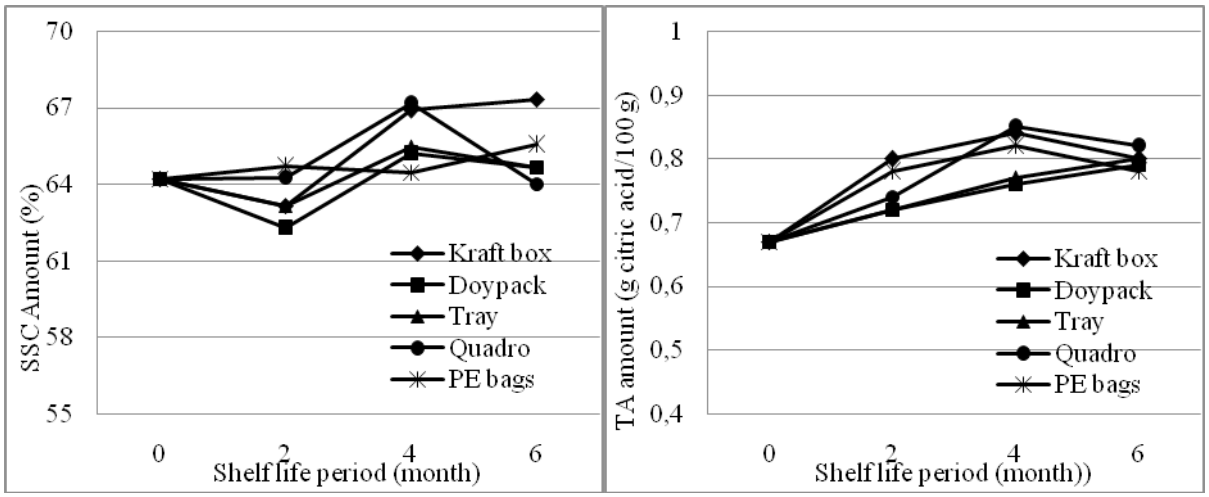


Figure 2. The effect of different packages on the SSC and TA amounts of organic dried apricots

straight, the branches are broad and strong and it is a fast-growing tree. It fruits every year on strong and well-watered soil. Its yield it medium; it is a kind which is sensitive to frost, draught and monilia and freckle diseases. Trees that are not taken good care of are prone to periodicity. Its fruits are medium sized, weigh 25 to 30 grams, have an oval and symmetrical shape, the rind and flesh are of yellow color; they are prone to form a hard textured red side. The rind is thin and the fruits are durable on the road. The fruit is little watery, very sweet, aromatic, the amount of water soluble solid contents is high[9].

All the production control and certification procedures of the organic dried apricots samples having completed the 3 year-long transition period were carried out by KiwaBcsÖko-GarantieOrganikTarimSertifikalandirmaHizmetleri Ltd. Sti. Organic agriculture was practiced in accordance with the Organic Agriculture Law numbered 5262 and the Regulation on the Principles and Practice of Organic Agriculture numbered 27676 of Turkey.

Processing of organic dried apricots

Upon CO_2 application under atmospheric conditions for pest control, the organic dried apricots were stored in a cold storage warehouse belonging to IsikTarimUrunleri San. ve Tic. A.S. at 4 to 5 ^oC degrees of temperature and 60-65% relative humidity during 5 months. Sizing, washing and drying processes were respectively applied to the dried apricots during the packaging phase.

Packaging properties and shelf life conditions

Kraft box: This package consists of carton + polyolefin = cellophane (PO) and it has a thickness of 2mm, length of 10 cm, width of 7.5 cm, height of 3.5 cm and weight of 20 grams.

Doypack: This package is made of polyethylene terephthalate (PET) + aluminum (AL) + polyethylene (PE) and has a thickness of 130 microns, O_2 permeability of<0,0002 cc/1 Atm./24h/m^2, length of 18 cm, width of 15 cm and weight of 9 grams.

Tray (Vacuum tray): This package is made of polypropylene (PP) and has a thickness of 1mm, length of 11.5 cm, width of 9 cm, height of 4.5 cm and weight of 11 grams.

Quadro: This package is made of PET and unoriented polypropylene and has a thickness of 62 microns, O_2 permeability of 110 cc/1 Atm./24h/m^2, length of 21 cm, width of 9.5 cm, height of 7 cm, weight of 3 grams and the thickness after the product is placed is 7 cm.

PE bag: This package is made of low density polyethylene (LDPE) and has a thickness of 60 microns, length of 44 cm,

Table 1. The effect of different packages on the water amounts of organic dried apricots.

Package	Shelf Life Period (month)			
	0	2	4	6
Kraft box		21.83 c[z**]	19.97 c**	20.74ö.d.
Doypack		23.92 a	23.40 a	21.20
Tray	24.37	23.63 a	22.58 ab	21.50
Quadro		23.51 ab	22.64 ab	21.20
PE bags		22.70 b	22.17 b	20.15

[z]The differences between the averages on every line were determined through the Duncan test in accordance with $P \leq 0.05$.

ö.d. insignificant, **, significant for $P \leq 0.01$

Table 2. The effect of different packages on the a_w value of organic dried apricots.

Package	Shelf life period (month)			
	0	2	4	6
Kraft box		0.61 b[z**]	0.58 c**	0.60 b*
Doypack		0.65 a	0.65 a	0.64 a
Tray	0.66	0.64 a	0.62 b	0.63 ab
Quadro		0.64 a	0.63 b	0.63 ab
PE bags		0.62 b	0.63 b	0.61 b

[z]The differences between the averages on every line were determined through the Duncan test in accordance with $P \leq 0.05$.

Significant for *, $P \leq 0.05$ or **, $P \leq 0.01$.

Table 3. The effects of different packages on the pH values of the organic dried apricots during the shelf life

Package	Shelf life period (month)			
	0	2	4	6
Kraft box		5.35ö.d.	5.40ö.d.	5.36ö.d.
Doypack		5.42	5.37	5.36
Tray	5.50	5.40	5.37	5.36
Quadro		5.47	5.46	5.01
PE bags		5.38	5.37	5.38

ö.d. insignificant.

width of 33 cm and weight of 16 grams.

Organic dried apricots packed in different packages were brought to the Department of Horticulture of the Faculty of Agriculture of the Ege University within the same day and stored under the shelf life conditions of 20±1ºC degrees of temperature and 50-65% of relative humidity during 6 months. Samples were taken from organic dried apricot once every 2 months in order to carry out physical, chemical and sensory analyses and monitor insect generation. The study is planned to be carried out in 3 frequencies in accordance with the randomized block design and each package was considered a frequency.

Quality analyses

Fruit color

The fruit color of 15 dried apricots taken in each frequency was measured using a colorimeter from the both sides of the equator region (CR-400, Minolta Co., Tokyo, Japan) in CIE *L* a* b**. Using the *a** and *b** data obtained, the Chroma (*C**) and hue angle (h^o) were calculated in accordance with the $C^*= (a^*2+b^*2)^{1/2}$and $h°= \tan^{-1} (b^*/a^*)$ equations. *C** value represents the color saturation (0=matte, 60=saturated). h^o value is the angle coordinate on CIE *L* a* b** scale (0º=red-purple, 90º=yellow, 180º=blueish green and 270º=blue) [10].

Water content

Upon running the organic dried apricots taken in each frequency through the grinder machine, a certain amount was weighted and dried in a drying oven (UM400, Memmert, Germany) at 65ºC until the weight became constant and re-weighted in order to detect the amount of water in %.

Water activity

In order to determine the water activity in organic dried apricots, the samples ran through the grinder machine were placed inside the container of the machine in a manner to fill the 2/3 of the container, were placed in the water activity measuring device (TH 500, Novasina, Switzerland) and the water activity values (a_w) were measured at 25ºC degrees.

Water soluble solid content amount

Water soluble solid content (SSC);upon adding 100 ml of pure water to 15 grams of grinded dried apricot sample, it was shredded in a shredder for 4 hours. After the filtering process, the SSC amount was detected with a digital refractometer (PR-1, Atago, Japan) and the results were given in %.

Titrable acidity

The filtrate ran through the grinder machine and shredded with water was used in order to detect the titrable acidity (TA) and to read the SSC. The acidity was carried out as recommended in TSE [11]. The citric acid % was indicated by calculating the results obtained.

pH value

The pH value of the filtrate used in detecting the SSC and TA was determined using a pH meter (MP220, Mettler Toledo, Germany).

Insect damage

Whether or not there is insect damage, and if there is, the extent of the damage it caused was examined in the Department of Plant Protection of the Faculty of Agriculture of the Ege University.

Statistical analysis

A variant analysis was carried out on the data obtained as a result of the experiment using the IBM® SPSS® Statistics 19 (IBM, NY, USA) statistics package program. The differences between the averages for each shelf life period for organic dried apricot were determined separately with Duncan test ($P \leq 0.05$).

RESULTS

Change of color (*C** and h^o values) of the organic dried apricots in accordance with different packages is given on Figure 1. The effect of packages on the *C** and h^o values of dried apricots has not shown a significant difference during the shelf life period. At the end of a 6 month-long shelf life period the *C** and h^o values of the dried apricots have changed between 10.86-13.37 and 52.90-58.58 respectively in accordance with packages. While the *C** value of the dried apricots has decreased by (15.04) in comparison with the starting value, the changes in the h^o value have been limited.

While the effect of packages on the water content of organic dried apricots was significant ($P \leq 0.01$) after 2 and 4 month-long shelf life, it was insignificant after 6 month-long shelf life. The water content of dried apricotsin doypack packages at the end of 2 and 4 month-long shelf life was the highest while that of dried apricots in kraft box packages

was the lowest. This difference between the packages has disappeared at the end of 6 month-long shelf life and the amounts of water has become similar (20.15% - 21.50%). The water content of dried apricots has dropped by 14.0% in comparison with the starting value at the end of the shelf life (Table 1).

The effect of different packages on the a_w values of the dried apricots during the shelf life has been found to be significant. While the a_w value of the dried apricots in doypack packages has been the highest during the shelf life, that of the dried apricots in kraft box packages has been found to be the lowest. The a_w value of the dried apricots in doypack packages at the end of the 6 month-long shelf life was 0.64 while that of the dried apricots in kraft box was found to be 0.60. The change in the a_w value of the dried apricots which was 0.66 before the shelf life remained limited during the shelf life (Table 2).

The change of SSC and TA amounts of the organic dried apricots during shelf life in accordance with different packages is given on Figure 2. The effect of packages on the SSC and TA amounts of the dried apricots has been similar during the shelf life. At the end of 6 month-long shelf life the SSC and TA amounts of the dried apricots have changed by 64.00% - 67.33% and 0.78 – 0.82 citric acid/100 g respectively. While the change of the SSC amounts of the fruits at the end of the shelf life has been limited in comparison with the starting value, a slight increase was observed in the TA amount.

The effect of different packages on the pH values of the organic dried apricots during the shelf life has been similar. The pH value of the dried apricots has changed between 5.01 and 5.47 during the shelf life. The pH value of the dried apricots which was 5.50 before the end of the shelf life reached a value between 5.01 and 5.38 at the end of the shelf life (Table 3).

Insect damage

There was no insect damage found in the examinations done on organic dried apricots. The CO_2 application on dried fruitsunder atmospheric conditions before storage and taking necessary measures played an important role on this.

DISCUSSION

It is thought that the starting color of the dried apricots was effective on the fact that different packages did not have a significant effect on the color (C^* and h^o values) of the organic dried apricots. The fact that the organic dried apricots are of a dark color has limited the change of color. However, a decrease was noted in the color parameters (*L*, a*, b**) of dried apricots stored in a higher temperature (25ºC) for a longer time (30 weeks) [7].

The fact that the water content in organic dried apricots in doypack packages was the highest and that of the dried apricots in kraft box packages was the lowest coincides with dried raisin results where similar packages were used [12]. These results show that doypack packages limit water loss more compared to kraft box packages. It is thought that this difference between the water contents of the dried apricots is related to the difference in water permeability of the packages due to their compositions. The decrease observed in the water content of the dried apricots at the end of the shelf life is a development that occurs with stored dry fruits. Thus, similar results were observed in studies carried out on dried fruits [12; 13; 14; 15].Elmaci et al. [16] indicated that the water content of unsulphured dried apricots dropped during their storage for 48 weeks under 25ºC.

The effect of packages on the a_w values of the dried apricots during shelf life was similar to their water amount and the a_w values of dried apricots in doypack packages were the highest while that of the dried apricots in kraft boxes were the lowest. The packaging features have been effective on the limited changes in the a_w values of the dried apricots during the shelf life.

The effect of packages on the SSC and TA amounts of organic dried apricots during shelf life has been similar. It is thought that the fact that the changes in the water contents of dried apricots are not on such a scale to affect the values of these parameters has been effective on this situation. Besides, limited change in the TA amount during the shelf life is a desirable development. Swift increases in the TA amount may be related to microbial developments. Sen et al. [15] have informed that a microbial activity may have been effective on the significant increase in the amount of acid in sulphurized apricots at the end of 9 month-long shelf life.

As a result, while the change in the water content and a_w value of dried apricots in doypack packages stayed limited during the shelf life, decreases have been significant in kraft box packages. The effects of the packages on the color and other examined quality parameters of the organic dried apricots have been limited. It was detected that organic dried apricots conserved their quality during the 6 month-long shelf life. The results have shown that the doypack package is recommendable for organic dried apricots while kraft box packages may cause some quality parameters related problems.

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