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Effect of Some total phenolic, antioxidants, physico-chemical properties, mineral and heavy metal content of apricots drying types

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Özet
Kayısı bol miktarlarda A vitamini deposudur ve aynı zamanda demir, kalsiyum, fosfor ve bakır da dahil olmak üzere önemli miktarlarda mineral içermektedir. Kayısıyı incelediğimizde şekil olarak semiz, dolgun ve renk olarak turuncu ve altın sarısı olarak nitelendirilebilir. kayısının tamamen olgunlaşmış herhangi bir türü çok yumuşak olmasa da kolayca işlenebilir ve kuruma sırasında şeklini kaybedebilir. Kayısı numuneleri üç farklı kuru kayısı olarak analiz edildi bunlar; gün kurusu, islim ve taze kuru şeklinde sıralanır. Bu farklı kayısı numunelerinde, toplam fenolik madde, antioksidan, renk, kuru madde ve Ca, Mg, Na, Mn, Fe, Cu, Zn, Cr, Co Pb, Ni, Sn, Cd and Mo gibi bazı ağır metal ve mineral içeriklerinin tayini yapıldı. Kayısı numunelerinin renk değerleri,kuru madde değerleri kül tayini ve ağır metal ve mineral değerleri istatistiksel olarak incelendi. Kuru kayısı dünya çapında popular bir üründür.

Anahtar Kelime: kayısı, renolik madde ,renk, mineral and ağır metal

Abstract
Apricots are full of vitamin A and also contain significant amounts of several minerals including iron, calcium, phosphorus, and copper. Look for apricots that are plump with a uniform golden orange color. Use any variety, fully ripened but not so soft they are easily mashed or lose shape during drying. The apricots samples were analyzed difference dried samples in difference 3 types, sun drying, sulphuring and for the sweet. The apricots samples in difference were determined total phenolic, antioxidants, L, a and b colour, dry mater, ash and some mineral and heavy metal, as Ca, Mg, Na, Mn, Fe, Cu, Zn, Cr, Co Pb, Ni, Sn, Cd and Mo contents. The apricots samples were showed differences statistically on colour values, dry mater, ash and some mineral and heavy metal. Dried apricots are a popular product worldwide.
Keyword: apricot, color, phenolics, mineral and heavy metal content

Introduction

Apricot (Prunus armeniaca L.) is classified under the Prunus species of Prunoidae sub-family of the Rosaceae family of the Rosales group. Apricot has an important place in human nutrition, and can be used as fresh, dried or processed fruit. As known, the fruit of apricot is not only consumed fresh but also used to produce dried apricot, frozen apricot, jam, jelly, marmalade, pulp, juice, nectar, extrusion products etc. Moreover, apricot kernels are used in the production of oils, benzaldehyde, cosmetics, active carbon, and aroma perfume (Yıldız, 1994). Turkey is the biggest apricot producer in the world with 538.000 ton production and 20.15% share. There are 13.350.000 apricot trees in Turkey. In Turkey, apricot fruits are harvested at about 78% moisture level. Ten percentage of the product is used as fresh product, the rest of the product is traditionally stored in sacks with 20% moisture level after harvesting, sulphuring, drying and pit separation processes which is made by farmers. After that these products are processed in the regional conglomerates which have washing, sorting, and selecting-final control, drying, cutting and packaging units and then they are exported to more than 70 countries, mainly European countries (Haciseferogullari *et al.*, 2007). Apricot pits are also separated into shells and kernels in the regional conglomerates which have washing, sorting, and breaking and separation units. The resulting shells are generally used as fuel and the resulting apricot kernels are exported to the world countries, mainly European countries.

The commonly used method of drying apricots is sun drying. Generally, the fruit is spread on rooftops or on rocks without subjecting them to any pre-treatment or washing with water. This conventional method is slow and fruit is exposed to open environment and gets contaminated with dust, dirt, flies, micro-organisms and results in an unhygienic and inferior quality product. To decrease the effect of spoilage reactions, to facilitate the drying process and to improve the quality, some pre-treatment is advised. One of these treatments is sulphiting (Gonzalo *et al.*, 2009). Sulphur dioxide is used widely in the food industry to reduce fruit darkening rate during drying and storage. The oxygen-scavenging action of sulphur dioxide helps in stabilising the carotenes. When sulphur dioxide is absorbed into the fruit, it is converted mainly to the bisulphate ion, which remains free and retards the formation of Millard-type compounds, and can also be reversibly bound to certain compounds, such as the carbonyl group of aldehydes (Bolin and Jackson, 1985; Mir *et al*., 2009).

Traditionally, apricots are harvested by shaking branches and letting fruit fall to the ground. The fruit is then either eaten fresh, sun-dried or heaped in fields prior to pit removal. This practice, common in many countries, of shaking the trees and letting the fruit fall to the ground, results in damaged, bruised and dirty fruit. A high quality dried apricot cannot be produced from a poor quality apricot so this method of harvesting should be discouraged. In order to reduce damage, fruit can collect in outspread sheets held above ground level. The apricots should be picked by hand and placed carefully in a harvesting basket. The harvesting basket and the hands of the harvester should be clean. Sun drying produces a dried apricot with a more desirable colour than artificial drying. Solar drying can be used to reduce dust and dirt contamination. If the harvest coincides with the rainy season, an artificial drier may be essential. The apricots should be washed in clean water. Sulphur-dioxide will prevent browning of the apricots. Many people prefer the taste of fruits that are not treated with this preservative. It is important to ensure that good quality fruit is used that is over-ripe. Also, the fruit pieces should be thinly sliced to speed up the drying process. Apricots are full of vitamin A and also contain significant amounts of several minerals including iron, calcium, phosphorus, and copper. Look for apricots that are plump with a uniform golden orange color. Use any variety, fully ripened but not so soft they are easily mashed or lose shape during drying. The apricots samples were analyzed difference dried samples in difference 3 types, sun drying, sulphuring and for the sweet.

Material and Method

In the Turkey Traditionally, apricots are harvested by shaking branches and letting fruit fall to the ground. Sun drying produces a dried apricot with a more desirable colour than artificial drying. Solar drying can be used to reduce dust and dirt contamination. The apricots should be washed in clean water. Sulphur-dioxide will prevent browning of the apricots. Many people prefer the taste of fruits that are not treated with this preservative. It is important to ensure that good quality fruit is used that is over-ripe. Also, the fruit pieces should be thinly sliced to speed up the drying process. Use any variety, fully ripened but not so soft they are easily mashed or lose shape during drying. The apricots samples were analyzed difference dried samples in difference 3 types, sun drying, sulphuring and for the sweet.

Physicochemical Analyses

Dry matter content was determined by oven-drying 5 g samples at 105°C until a constant weight was obtained. Determination of the ash content of the samples was performed by the method described (AOAC, 2000). 5g of sample was weighed into a clean dry pre weighed silica dish. Then the sample was ignited slowly over a Bunsen flame in a fume cupboard until no more fumes are evolved. Then the dish was transferred to muffle furnace and incinerated until it was free of black carbon particles and turn into white in color (about three hours). Dish was removed carefully and cooled in desiccators. Weight was taken after cooling. Process of ashing, cooling and weighing was repeated till no further loss in weight was indicated.

Color Characteristics Analyses

The colour of apricot samples was measured using the CIELAB system with a colorimeter (Minolta CR 400, Minolta Camera Co. Ltd, Osako, Japan) calibrated with a white tile (Minolta calibration plate, No. 21733001, Y = 92.6. x = 0.3136. y =0.3196) at 2° observation angle with a C illuminant source. *L** (lightness; 100 = white, 0 = black), *a**(redness; +, red; -, green) and *b** (yellowness; +, yellow; -, blue) values were recorded. The apricot samples were put into an optically flat glass dish for measurements.

Total Phenolic Analyses

Extraction of samples: dried apricot samples acidified methanol (methanol containing 100 µl conc. HCl) 12 hours apricot samples kept in shaker at room temperature, and then the extract was filtered over Whatman No.1 paper under vacuum, solid parts were removed. Total phenolic content was done according to the method of Thaipong *et al*. (2006) with some modification. The 20 µL of extract, 1580 µL of pure water, and 100 µL of 0.25 N Folin-Ciocalteu reagents were combined in a plastic vial and then mixed well using a Vortex. The mixture was allowed to react for 3 min then 300 µL of 1.0 N Na_2CO_3 solution was added and mixed well. The solution was incubated at room temperature in the dark for 2 hours. The absorbance was measured at 760 nm using a spectrophotometer. Results were expressed as milligrams of gallic acid equivalents per 100 gram.

Antioxidant activity Analyses

Antioxidant activity was determined by DPPH (1,1-dipheynl-2-picrylhydrazyl) assay. For the determination of free radical scavenging activity, the samples were extracted with methanol (methanol containing 100 µl conc. HCl) by using a shaker at room temperature for 12 hours. Then, and then the extracts were filtered over Whatman No.1 paper under vacuum. Free radical scavenging activity was measured according to the principle of Nakajima *et al*., (2004) with some modifications reported by Chiou *et al*. (2007). Fifty microliters of the diluted extracts were added to 1.0 mL of 6×10^{-5} mol L^{-1} DPPH (free radical, 95%, Sigma–Aldrich Chemie GmbH, Steinheim, Germany) in methanol. The mixture was shaken and left at room temperature for

30 min; the absorbance was measured with spectrophotometer at 515 nm. Methanol was used as the experimental control. The percent of reduction of DPPH was calculated according to the following equation: % DPPH reduction= (Ac –As/Ac) ×100 Where A_c is the absorbance of control and A_s is the absorbance of added sample (Tural and Koca, 2008).

Mineral elements analysis

In order to determine the mineral and heavy metal contents of the samples, 2 g of each treatment samples were ashed in a porcelain crucible, solubilized with 10 ml of 6 N HCl, quantitatively transferred into 50 ml volumetric flasks, and diluted to volume with double-deionized water and filtered after 5-6 hours with blue-band filter paper and again regulated to 50 ml (AOAC 2000). Concentrations of calcium (Ca), sodium (Na), magnesium (Mg), zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), molybdenum (Mo), cadmium (Cd), cobalt (Co), chromium, Stannum (Sn), (Cr), nickel (Ni) and lead (Pb) were measured by Inductively Coupled Plasma Optical Emission Spectrometer (ICP–OES, Varian Vista-Pro, Australia). All the analyses were performed in duplicate and the results reported as mean values.

Statistical analysis

The study was designed according to randomized design using 3 apricot samples factorial experiments. Square root transformation was applied to the apricot samples on each chemical, physical and sensory parameter of the samples were estimated by ANOVA using the SSPS® (2000) statistical software. Duncan's Multiple Range Test was used for the determination of statistically different groups.

Result and Discussion

Effect of drying types on colour values of apricot samples

*L** value is an estimation of food whiteness. The appearance of foodstuffs is the only permitted way to evaluate food products. In that respect, colour is a clue for many qualities of food such as flavor, naturalness or maturity, and drives consumers' choices. An attractive aspect is therefore a key for food marketing, and this has led the food industry to devote much effort in offering pleasant and suggestively colored products (Dufosse *et al*., 2005). The colour characteristics of apricot samples dried with differences types methods are shown in Table 1. As shown in Table 2, *L** (lightness) values of apricot samples were affected with dried methods significantly (P<0.05). When compared with other samples, lowest *L** values were determined samples in the sun drying method. This is probably because of tone of apricot samples colour. These results are in good agreement with the findings of Suna *et al*. (2014) for colour characteristics of the apricot pestil samples. As shown at Table 1, *a** (redness; +, red; -, green) and *b** (yellowness; +, yellow; -, blue) values of apricot samples were showed important between dried types statistically (P<0.05). The apricot samples in sulphuring drying types showed the lowest values in *a** colour while the lowest *b** values were detected for samples in sun drying. The values of a* and b*color are in good agreement with the findings of Suna *et al*. (2014) for colour characteristics of the apricot pestil samples, but as b* color values higher Turkyilmaz *et al*. (2013) for apricots colour containing sulfur dioxide different intensity. This situation was also acceptable in the industrial production of apricot dried types for which colour intensity of the product needs to meet the consumers' demands.

The dry matter contents of apricot samples were changed between drying types significantly (P<0.05), a group for samples of sun and sulfuring drying types. However, these results are lower than those observed by Turkyilmaz (2008) for apricots colour containing sulfur dioxide different intensity, these values similar with the findings of Suna *et al*. (2014) for colour characteristics of the apricot pestil samples. The ash contents of apricot samples did not change by drying method significantly (P>0.05). These results are higher than those observed by Haciseferoglu *et al.* (2007) for apricot fruit samples.

Table 1: colour values matter contents of apricots samples in difference types

Drying types	L	a*	b*	Dry matter	Ash content
Sun Drying	25.67±3.09b	12.39±2.98c	10.74±1.35c	90.62±0.38b	8.58±0.86a
Sulphuring	40.22±12.28a	08.23±0.61b	23.16±2.79b	91.83±0.08b	7.48±0.67a
for the sweet	49.67±1.94a	15.45±0.90a	41.29±2.63a	94.85±0.54a	7.70±0.36a

Total phenolic contents in drying apricot samples

Fruits and vegetables account for a small part of our daily caloric intake; however their benefits to health surpass their caloric contribution. The contributory factors are due to the presence of vitamins and provitamins, such as ascorbic acid, tocopherols, carotenoids and a wide variety of phenolic substances (Loliger, 1991). As shown in Table 2, total phenolic contents of apricot samples were changed between drying types significantly (P<0.05), the highest level of phenolic content of samples was found in sulfuring drying types; 263.40±9.82mgGAE/100g, while the lowest content was found in apricot samples in sun drying; 189.11±4.11mgGAE/100g, samples of the sweet types, as found 263.40±9.82 mgGAE/100g. However, these results are higher than those observed by Sultana et al. (2012) for dried apricot samples with difference drying methods and than those values 0.72-0.59 mgGAE/100g observed by Sultana *et al*. (2012) for dried apricot samples with difference drying methods apricot pestil samples, but lower than those values (4900-7310 mgGAE/100g) found by Ali *et al*., (2011)apricot varieties in growing Pakistan and found Akin *et al.* (2008) values (4233-8180 mgGAE/100g) for Malatya apricot varieties. As seen, total phenolic in apricot were decreasing by drying. It is well-known that phenolic compounds contribute to fruit quality and nutritional value by modifying color, taste, aroma, and flavor, and also by providing beneficial health effects. These compounds also play a role in plant defensive mechanisms by counteracting reactive oxygen species (ROS), thus minimizing molecular damage due to microorganisms, insects, and herbivores (Vaya and Aviram, 1997; Kamiloglu *et al*., 2009).

Table 2: total phenolic, DPPH reducing powder and fenolic matter contents of apricots samples in difference types

Drying types	Total Phenolic (mgGAE/100g)	DPPH reducing power (%)
Sun Drying	189.11±4.11a	51.72±3.90a
Sulphuring	263.40±9.82c	54.48±1.95a
for the sweet	219.64±8.11b	59.57±0.37a

DPPH reducing power (%); 2,2 diphenyl-1- picrylhydrazyl

DPPH free radical scavenging capacity in drying apricot samples

The fruit contains significant amounts of anthocyanins and other phenolics. Therefore, food industry is interested in fruits and vegetables with high content of bioactive anthocyanins with the aim of producing supplements which have preventative and therapeutic effects (Mazza *et al*., 2002). DPPH is a free radical compound that has been widely used to determine the free radical scavenging capacity of various samples because of its stability (in radical form), simplicity and fast assay (Seah *et al*., 2010). Ferric reducing antioxidant power is shown Table 2. DPPH ration determined raising no significantly 51.72±3.90% apricot samples in sun drying, with sulphuring method samples was found as 54.48±1.95% and sweet types as 59.57±0.37% (P>0.05). The results showed that the highest free radical scavenging activity was in sun drying sample that show agreement with the total phenolic content, while the lowest value was in sun drying apricot samples. The antioxidant activities of phenolic compounds are mainly of redox properties, including free radical scavenging, hydrogen donating and singlet oxygen quenching. The DPPH radical scavenging assay is commonly employed to evaluate the ability of antioxidants to scavenge free radicals. The use of the DPPH free radical is advantageous in evaluating antioxidant effectiveness because it is more stable than the hydroxyl and super oxide radicals (Liyana-Pathirana *et al*., 2006; Tarakci *et al.,* 2013). Radical scavenging activity of drying apricot types was decreased no significantly with sun drying apricot samples (P>0.05). Higher DPPH radical scavenging activity value indicates greater antioxidant activity. A general consensus has been reached during the last few years that diet has a major role in development of chronic diseases, such as cancer, coronary heart, obesity, diabetes type 2, hypertension and cataract. This consensus suggests that a predominantly plant-based diet rich in fruits and vegetables, pulses and minimally processed starchy staple foods reduces the risk for development of these diseases significantly. Fruits and vegetables contain many different antioxidant components. The antioxidant activity is most significantly correlated with the contents of total phenolics (Tarakci *et al.,* 2013).

Mineral and heavy metal properties of apricot samples of difference method drying

Table 3 shows mineral contents of the apricot samples in difference drying methods. The Ca contents of apricot samples of dried differences methods were 207-218mg/100g. Mg containing of apricot samples were 132-141mg/100g, the Na contents of samples was found to be similar Ca and Mg containing were not changed, 20.47-21-67 mg/100g. Mn content was found in the sulphuring samples as 156.63 mg/100g and, Mg contents of other samples (128.75-130.04-mg/100g) were similar, Mn contents were significantly greater (P<0.05). Ali *et al.* (2011) studied on apricot fruit growing in Northern Areas of Pakistan and they found similar Ca, Na, Mg content than in the present study, but lower Mn content. Bennett *et al.* (2011) studied dried fruit products and they found lower Ca, Mg, Na contents with the present study, but higher Mn content. Haciseferogullari *et al.* (2007) reported that Ca, Na and Mg contents in apricot samples of growing in Turkey were lower than that of our findings, but lower Ca, Na and Mg contents in apricot pestil samples (Suna *et al.,* 2014). It can be explained that all the products had different mineral content, because they have different areas. Generally, minerals from plant sources are less bioavailable than those from animal sources. The more important minerals involved in the building of rigid structures to support the body, i.e. Ca, P and Mg, were well furnished by the vegetable species studied. These three elements in appreciable amounts are essential for the proper formation of bones and teeth. For example, in Ca, 99% of the total amount (i.e. 1000-1200 g in adult) occurs in bones and teeth while about 600-700 g of P is also present in bones and teeth. The two elements, together with a much smaller quantity of Mg (20-80 g), form a crystal lattice, which is largely responsible for the rigidity and strength of bones and teeth (Aletor *et al.* 2002).

Table 3: Ca, Mg, Na and Mn contents of apricots samples in difference types (mg/100g)

Drying types	Ca	Mg	Na	Mn
Sun Drying	207.85±9.78a	132.46±1.15a	21.67±0.33a	128.75±184.7a
Sulphuring	218.30±7.75a	141.73±5.69a	21.82±0.26a	156.63±206.0b
for the sweet	216.18±15.8a	137.06±5.25a	20.47±0.27a	130.04±150.7ab

[ab] Letters indicate significant differences among drying types, P<0.05.

Table 4 shows Fe, Cu, Zn, Cr and Co mineral contents of the apricot samples in difference drying methods. The Fe contents of apricot samples of dried differences methods were found between 100.71-180.23 ppm. Zn and Cu containing of apricot samples were between 52.66-64.50ppm, the Cr and Co contents of samples were changed 4.63-6.28 and 1.87-2.23 ppm, respectively. Ali *et al.* (2011) studied on apricot fruit of Pakistan and they found lower Fe, Zn, Cu and Ni content than in the present study. Bennett *et al.* (2011) found lower Fe, Zn, Cu contents with the present study, but higher Mn and Mo content. Haciseferogullari et al. (2007) reported that Fe content of apricot samples of growing in Turkey were lower than that of our findings, but similar Cr content. Fe and Cu contents of fruit and vegetable play an important role in the final quality of the products as well as their nutritional and biological role, when certain alternative reactions intervene. The presence of high Fe and Cu concentrations from adventitious contamination are damaging to product quality since in an ionized form, they catalyze oxidation reactions of the lipids with development of unusual flavors (Sancak et al. 2008).

Table 4: Fe, Cu, Zn, Cr and Co contents of apricots samples in difference types (ppm)

Drying types	Fe	Cu	Zn	Cr	Co
Sun Drying	121.10±8.95b	61.84±6.87a	52.66±1.80a	4.98±2.10a	1.87±0.17a
Sulphuring	100.71±7.86a	54.56±18.4a	60.44±6.05a	4.63±0.97a	2.23±0.17a
for the sweet	180.23±5.02c	64.50±19.8a	63.21±5.70a	6.28±0.28b	2.15±0.31a

[abc] Letters indicate significant differences among drying types, $P<0.05$.

Arshad *et al.* (2010) studied minerals and trace elements in dried apricot varieties grown in northern areas of Pakistan. They found Ca and Na content higher than in the present study, but lower Mg, Co, Cr, Fe, Cu and Zn content. Akin et al. (2008) studied minerals and trace elements in Malatya apricot varieties. They found Ca, Na, Fe, Zn, Cu and Mn content lower than in the present study, however, Ni was values similar. Lazos (1991) studied minerals and trace elements in apricot of Greece and they found higher Na content than in the present study, lower Cu, Fe, Z, Mg, Mn, Mo and Ni content, and they found similar Ca, Co, Cr contents with the present study.

Table 5 shows Pb, Ni, Sn, Cd and Mo heavy metal contents of the apricot samples in difference drying methods. The sources of high levels of Pb and Cd are likely to be the transferred from the tin can and salt used in the brine. The FAO/WHO has set a limit for heavy metal intakes based on body weight. For an average adult (60 kg body weight), the provisional tolerable daily intakes for lead, iron, copper and zinc are 214 µg, 48 mg, 3 mg and 60 mg, respectively (FAO/WHO, 1999). Turkdogan *et al.* (2003) studied heavy metals of vegetables and fruits grown in East Anatolian region. Their Cd results were higher than in the present study. Differences might have been due to various sources of raw materials used in the manufacture. There is overwhelming evidence that several media including road dust and plants sampled in the vicinity of roads carrying heavy traffic are contaminated by some elements (Coni *et al.*, 1999; Guler, 2007).

Table 5: Pb, Ni, Sn, Cd and Mo heavy metal contents of apricots samples in difference types drying (ppm)

Drying types	Pb	Ni	Sn	Cd	Mo
Sun Drying	0.70±0.13b	3.51±1.04a	0.42±0.02a	4.97±0.17a	1.03±0.02c
Sulphuring	0.17±0.06a	6.49±1.61b	0.41±0.01a	4.97±0.13a	0.67±0.02b
for the sweet	0.12±0.09a	4.12±3.85ab	0.42±0. 01a	4.93±0.20a	0.43±0.01a

[abc] Letters indicate significant differences among drying types, $P<0.05$.

Overall, our region was an agricultural region, substantial amounts of artificial fertilizers are used and it was also very dusty. B, Cd, Co, Pb, and Zn elements may be passed to herbs by means of wind-blown dust, soil and water. Other inorganic elements which may contribute to biological processes, but which have not been established as essential, are barium, bromine, cadmium, lead and lithium (Macrae *et al.* 1993). As a result, it is considered to be important because of their nutritive, physiological and technological significant. Also this study, attempts to contribute to knowledge of the nutritional properties of these cultivated apricot fruits. In addition, knowledge of the mineral contents, as fruits is of great interest (Haciseferogullari *et al.*, 2007). Due to the limited number of samples determined in this work, this conclusion should be for sweet apricot dried samples.

Conclusion

The results of the present study indicated that the differences among the basic nutrient, some mineral and heavy metal contents of Turkish traditional commercial dried apricot varieties were statistically significant. These dairy products are important sources of antioxidants, fhenolics, fiber, vitamins, minerals and essential fatty acids for humans in Turkey. Consumption of these products may become widespread as an antioxidants, fhenolics, fiber and mineral source. The study on these products is detailed in order to achieve more standardisation of the results. In the sensorial evaluations, samples of sun drying apricot and sulfuring apricot were preferred to other for sweet apricot samples. Apricot drying technical would be recommended for the production of sweet apricot drying method, but further investigations are need to achieve the best physicochemical and sensory characteristics of the final product.

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