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Properties of Apricot Kernel and Oils as Fruit Juice Processing Waste

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ABSTRACT

Recently, more attention has been focused on the utilization of food processing by products and wastes, as well as under-utilization agricultural products. Some physical and chemical properties, mineral contents and fatty acid composition of apricot kernel and oils were determined. The oil yields from kernels changed from 42.2% to 57.2%. The crude fibre contents ranged between 4.06% and 7.63%. In addition, crude protein contents ranged between 15.1% and 24.2%. While the peroxide values of kernel oils change between 0.834 meq/Kg and 8.294 meq/Kg, acidity values ranged between 0.279% and 0.700%. The main fatty acids in apricot kernel oils were oleic, linoleic and palmitic acids. Oleic acid contents of kernel oils varied between 53.06% and 70.90%. On the other hand, linoleic acid contents ranged between 21.43% and 35,67%. As a result, the present study showed the apricot kernels of the researched species of apricot kernels from Turkey are a potential source of valuable oil which might be used for edible and other industrial applications.

Keywords: *Apricot, Kernel, Oil, Fatty acid Composition, Mineral Contents*

1. Introduction

Apricot (*Prunus armeniaca* L.) is a member of the Rosaceae family and is widely distributed in most countries of the world. The problems of industrial waste are becoming harder to solve, and much effort will be needed to develop the nutritional and industrial potential of by-products [1]. The kernels are considered as non-traditional potential resources for oils [2-3]. World apricot production is about 2.5 million ton. Turkey produces about 1/5 of total world apricot production. The apricot production in Turkey is 557.572 ton and 716.415 ton in 2007 and 2008 years, respectively. The one of highest apricot growing location in Turkey is Malatya province [4]. Some fruit seeds such as cherry, apricot, citrus and apple can be used as sources of oils. Some seed oils are already used for several purposes: blending with highly saturated edible oils to provide new oils with modified nutritional values as ingredients in paint and varnish formulations, surface coatings and oleo-chemicals, and as oils for cosmetic purposes [5]. Currently, large amounts of fruit seeds are discarded yearly at processing plants. This not only wastes a potentially valuable resource but also aggravates an already serious disposal problem. To be economically viable, however, both oil and meal from these fruits seeds must be utilized [6].

The aim of this study was to determine their physical and chemical properties of apricot kernel contents of several apricot cultivars collected from Malatya province in Turkey.

2. Material and Method

2.1. Material

Apricot cultivar (Hüdayi, Hacıhaliloğlu, Soğancı, Şahinbey, Hacıkız, Canino, Caona, Sakıt–2, Çekirge–52, Erkenağerik, 693-K, Karacabey, Ethembey, Alyanak, Kabaaşı, Hasanbey and Aprikoz) kernels were obtained by hand processing from apricots growing in Malatya province of Turkey in August 2008. Kernels were kept in glass jars until analyses at refrigerator. In all stages of trials, dry and mature kernels have been used.

2.2. Chemical Analyses

The some chemical compositions (crude fiber, crude oil, crude protein and crude ash) were analyses according to AOAC [7]. Viscosity values of kernel oils were measurement with Vibro (SV-10) Viscosimetry [7]. For oil analyses, each samples was homogenized and subjected to extraction for 6 h with petroleum ether (boiling range 30-60°C) in a Soxhlet apparatus. The extracted oil was

dried over anhydrous sodium sulphate and the solvent was removed under reduced pressure in a rotary film evaporator. Oil percentages were determined by weight difference. Ash was determined in a muffle furnace at 900°C for 8 h [7]. The nitrogen content estimated by the Kjeldahl method and was converted to protein content by using the conversion factor 6.25. The fiber and moisture were determined according to Demir and Özcan [8].

2.3. Determination of Fatty Acids

Fatty acid composition for apricot kernel samples were determined using a modified fatty acid methyl ester method as described by Hışıl [9]. The oil was extracted three times for 2 g air-dried seed sample by homogenization with petrolium ether. The oil samples (50-100 mg) was converted to its fatty acid methyl esters (FAME). The methyl esters esters of the fatty acids (1 µl) were analysed in a gas chromotography (Shimadzu GC-2010) equipped with a flame ionising detrctor (FID), a fused silica capillary column (60 m x 0.25 mm i.d.; film thickness 0.20 mikrometer). It was operated under the following conditions: oven temperature program. 90℃ for 7 min. Raised to 240℃ at a rate 5℃/min and than kept at 240℃ for 15 min); injector and detector temperatures, 260 and 260℃; respectively, carrier gas. nitrogen at flow rate of 1.51 ml/min; split ratio. 1/50 µl/min.

A Standard fatty acid methyl ester mixture (Sigma Chemical Co.) was used to identify sample peaks. Commercial mixtures of fatty acid methyl esters were used as reference data for the relative retention times [10]. Quantitative analyses of the fatty acids were performed using the heptadecanoic acid methyl ester as internal Standard. The results are mean values of three replicates.

2.4. Determiation of Mineral Contents

About 0.5 g of dried and apricot kernels were put into burnig cup with 15 ml of pure NHO_3. The sample was incinerated in a MARS 5 microwave oven (CEM corporation Manufactura) at 200ºC. Distilled deionized water and ultrahigh-purity commercial acids were used to prepare all reagents, standards and apricot kernel samples. After digestion treatment. samples were filtrated through whatman No 42. The filtrates were collected in 50 ml Erlenmayer flasks and analysed by ICP-AES (Varian). The mineral contents of the samples were quantified against standard solutions of known concantrations which were aralyjed concurrently [11].

Working conditions of ICP-AES:

Instrument	:ICP-AES (Varian-Vista
RF Power	:0.7-1.5 kw (1.2-1.3 kw for Axial)
Plasma gas flow rate (Ar)	:10.5-15 L/min. (radial)
	15 " (axial)
Auxilary gas flow rate (Ar)	:1.5"
Viewing height	:5-12 mm
Copy and reading time	:1-5 s (max.60 s)
Copy time	:3 s (max. 100 s)

2.5. Statistical Analyses

Results of the research were analysed for statistical significance by analysis of variance [12]. This research was performed by three duplicates with a replicate.

3. Results and Discussion

The physical and chemical properties of some apricot kernels collected from Malatya province in Turkey are given in **Table 1**. The crude fibre, crude ash, crude protein, crude oil and kernel weigh values of apricot kernels were determined. According to variance analyses, important differences were found between crude cellulose, crude fibre, crude ash, crude protein, crude oil and their weighs and kinds as statistical, p < 0,01 level.

The oil yields of kernels varied from 42.2% (Canino cv) to 57.2% (Sakıt-2 cv) of the dry weight. The oil contents of kernels changed among the varieties to more than about 50% of each. However, because of economical value of the oil, these kernels could be used as potential sources of oils. Sakıt-2 cultivar had the highest oil content, followed by Çekirge-52 cv (54.4%), Erkeneğerik-cv (54.7%), Şahinbey cv (54.1%), Ethembey cv (53.9%), Kabaşı cv (53.9%), Hacıkız cv (53.5%) and Hacıhaliloğlu cv (52.7%). The crude fibre contents ranged between 4.06% (Sakıt-2 cv) and 7.63% (Aprikoz). While crude ash contents change between 2.138% (Kabaaşı cv) and 3.454% (Aprikoz), crude proteins of kernels ranged between 15.1% (Kabaaşı cv) to 24.2% (Caona cv). In addition, kernel weights changed between 0,300 g/unit and 0,576 g/unit (Alyanak cv), Femenia *et al*. [1] had reported that kernels of bitter and sweet apricots collected from Mallorca (Spain) contained oil between 39.7% and 47.2%; 49.8% and 56.1% oil, respectively, In other study, kernel oil contents of almond were determined between 45.9% and 61.7% [13]. Dry kernels of plum, apricot and peach contained 32%, 37% and 43% of oil, respectively [3]. Kappor *et al*. [14] obtained values of up to 67g/100 g for oil content in sweet apricot varieties. Özcan [15] determined moisture (4,91-5.12%), crude oil (45.3-51.4%), crude protein (23.58-27.70%), crude fibre (13.49-17.98%), crude ash (2.10-2.67%) and mass of 100 kernels (28.72-49.6 g) values of four apricot cultivars. These properties are effected mainly by variety [16]. However, higher protein contents (37-45 g/100g) have been reported by several authors [6,16]. The results in this work are in general agreement with these results.

Our results related to apricot (47.55 to 55.45%) was found similar values those of Kappor *et al.* [14], Femenia *et al.* [1], Özcan [15] and Matthaus and Özcan [17].

Some chemical and physical properties of kernel and oils are shown in **Table 2**. According to variance analyses, differences between varieties to peroxide value,

acidity, refractive index and viscosity were found statistically important at the p < 0,01 level. While the peroxide values of kernel oils change between 0.834 (Soğancı) and 8.294 meq/Kg (Karacabey cv), acidity values ranged between 0,279% (Kabaaşı cv) and 0,700% (Karacabey). The highest peroxide values were established in Hasan-

Table 1. Physical and chemical properties of apricot kernel.

Cultivars	Crude fibre (%)	Crude ash (%)	Crude protein (%)	Crude oil (%)	Kernel weight (g)
Hüdayi	5.221cd	2.261ef	19.172bc	50.550defg	0.471ef
Hacıhaliloğlu	4.459fgh	2.500bcde	17.342cde	52.710bcde	0.503de
Soğancı	4.714def	2.447bcde	17.932bcde	51.975bcde	0.457fg
Şahinbey	4.159fgh	2.510bcde	20.278bc	54.110abc	0.569a
Hacıkız	4.638efg	2.808ab	18.126bcd	53.470bcd	0.552ab
Canino	6.928a	2.761bc	18.001bcde	42.195ı	0.359h
Caona	4.068gh	2.310def	24.201a	49.840efgh	0.425g
Sakıt–2	4.060h	2.577bcde	14.948bc	57.185a	0.545abc
Çekirge–52	5.099cde	2.766bc	19.265bc	54.370ab	0.554ab
Erkenağerik	4.681def	2.763bc	15.980de	54.735ab	0.521bcd
693-K	5.437bc	2.747bcd	17.403cde	47.545gh	0.566a
Karacabey	4.426fgh	2.358bcde	20.589ab	51cdef	0.552ab
Ethembey	5.371c	2.707bcd	19.215bc	53.915abc	0.511cd
Alyanak	4.195fgh	2.455bcde	17.573cde	48.300fgh	0.576a
Kabaaşı	6.027b	2.138e	15.106e	53.895abc	0.487def
Hasanbey	5.165cde	2.789bc	18.632bcd	50.370defg	0.568a
Aprikoz	7.638a	3.454a	20.879ab	47.170h	0.300ı

Table 2. Physical and chemical properties of apricot kernel oils.

Cultivars	Peroxide value (meq/Kg)	Acidity (%)	Refractive index (n^{20}_D)	Viscosity (Mpa)
Hüdayi	1.907bc	0.641bd	1.543bc	40.300a
Hacıhaliloğlu	1.026def	0.474ef	1.535ef	24.500h
Soğancı	0.834f	1.562a	1.538de	23.300k
Şahinbey	1.888bc	0.416f	1.530gh	26.350n
Hacıkız	0.932ef	0.696b	1.542bcd	27.350f
Canino	0.833f	0.474ef	1.546ab	34.700c
Caona	1.235def	0.447ef	1.543bc	29.350e
Sakıt-2	1.422cde	0.306ef	1.545ab	16.250n
Çekirge-52	0.986def	0.615bcd	1.533fg	23.575ık
Erkenağerik	2.210b	0.609bcd	1.543bc	14.550o
693-K	1.339def	0.528de	1.549a	13.600p
Karacabey	8.294a	0.700b	1.545ab	25.900g
Ethembey	1.199def	0.446ef	1.543b	31.150d
Alyanak	1.267def	0.584cd	1.539cd	17.550m
Kabaaşı	1.481cd	0.279ef	1.527h	35.200b
Hasanbey	7.673a	0.444ef	1.535ef	21.100l
Aprikoz	1.384cde	0.639bc	1.538de	23.85ı

bey cv (7,673 meq/Kg) and Karacabey cv (8,294 meq/Kg) samples. Refractive index was determined between 1.527 (Kabaaşı) and 1,549 (693-K cv). In addition, viscosity values of kernel oils were measured between 13,600 (693-K cv) and 40,300 (Hüdayi cv). Generally, the highest viscosity values were established in Hüdai, Canino, Kabaaşı and Ethem Bey cultivars. Differences among the

values of *Prunus* varieties can probably be because of growing conditions, climatic, environmental conditions and analytic conditions.

Fatty acid composition of apricot kernel oils is given in **Table 3**. Results showed that the oils of all varieties used in this experiment had higher oleic acid content (between 53,06% and 70,90%) than those of other fatty acids. On

Table 3. Mineral contents of apricot kernels (mg/Kg).

Cultivars	Al	Ca	B	Cd	Cu
Hüdayi	22.415abc	1273.606bcd	11.729b	0.104a	2.941de
Hacıhaliloğlu	24.297abc	1238.389bcd	17.421ab	0.040a	5.987abc
Soğancı	22.239abc	1642.718abcd	12.566b	0.050a	2.642de
Şahinbey	19.510abc	2061.658abc	11.192b	0.056a	5.675abc
Hacıkız	18.003abc	1942.221abcd	11.749b	0.077a	4.306cd
Canino	19.497abc	1371.717abcd	9.743b	0.072a	1.07f
Caona	32.850a	2220.799a	57.249a	0.065a	6.496a
Sakıt–2	29.968ab	1921.818abcd	16.432ab	0.063a	6.361a
Çekirge–52	27.887ab	2238.786a	15.440b	0.057a	7.070a
Erkenağerik	17.439abc	1462.969abcd	10.522b	0.081a	1.058f
693-K	25.602abc	1792.290abcd	17.105ab	0.047a	4.474bc
Karacabey	25.480abc	2032.622abc	16.385ab	0.082a	6.214ab
Ethembey	17.697abc	1867.853abcd	11.310b	0.030a	6.222ab
Alyanak	28.882ab	2159.571ab	15.742ab	0.122a	4.283cd
Kabaaşı	9.926c	1063.019d	8.544b	0.033a	1.905ef
Hasanbey	25.779abc	1607.618abcd	11.015b	0.018a	6.004abc
Aprikoz	13.972bc	1215.081cd	10.208b	0.056a	1.317ef
Hüdayi	6090.986h	1726.441gh	187.085cd	3442.016abcd	28.529cd
Hacıhaliloğlu	8383.253f	1952.767bcde	245.196bcd	3762.980a	35.053abcd
Soğancı	8537.620ef	1931.137cdef	603.326abcd	3177.026d	28.812cd
Şahinbey	8136.141fg	1971.202bcde	705.950ab	3409.697bcd	25.051d
Hacıkız	10234.682bc	1874.072defg	862.535a	3456.812abcd	33.147bcd
Canino	9385.655cde	2040.736abcd	346.035abcd	3494.124abcd	28.954.cd
Caona	6206.455h	2028.789abcd	843.767a	3480.659abcd	42.469abc
Sakıt–2	8828.335def	1836.232efg	718.226ab	3550.150abc	53.004a
Çekirge–52	9712.421bcd	2115.933a	699.388abc	3514.461abcd	30.923bcd
Erkenağerik	9706.068bcd	1607.314hı	585.373abcd	3209.966cd	32.794bcd
693-K	8927.422def	2043.620abc	426.582abcd	3689.357ab	32.695bcd
Karacabey	7308.140g	1929.373cdef	782.416a	3583.744ab	34.604bcd
Ethembey	8389.089f	2114.926ab	452.838abcd	3471.977abcd	33.212bcd
Alyanak	8630.503ef	1995.662abcde	552.593abcd	3448.382abcd	45.766ab
Kabaaşı	8614.027ef	1959.762bcde	155.921d	3613.276ab	42.467abc
Hasanbey	10334.982b	1778.782fg	777.275a	3547.449abc	33.483bcd
Aprikoz	12715.908a	1513.934ı	503.524abcd	3399.972bcd	22.489d

the other hand, linoleic acid contents of kernel oils ranged between 21.43% (Sakıt-2 cv) and 35.67% (Aprikoz cv), As an be observed, the proportions of the most abundant fatty acids (oleic acid) of the kernel oils varied among different varieties. This proportion was also higher than that in other fruit seed oils; mahaleb (35,4%), cherry laurel (53,7%), peanut (56,27%), date pit (49,54%), walnut (13,8-33,0%) [18-21]. Palmitic acid is the main saturated component in all apricot cultivars. Palmitic acid is differed in the different apricot cultivars. Its percentage was found between 4,56% (Caona cv) and 6,03% (Aprikoz cv). The high concentration of linoleic acid in apricot kernel oils make these oils have high nutritional value as linoleic acid is one of the three essential fatty acids [11]. These results are in good agreement with in fatty acid composition for several *Prunus* kernels [1,3,15,17,20,22]. Matthaus and Özcan [17] determined from 43.9% to 78.5% oleic, from 9.7% to 37.0% linoleic and from 4.9% to 7.3% palmitic acids in some *Prunus* cultivars.

The ability of some unsaturated vegetable oils to reduce the serum cholesterol level may focus attention on the apricot kernel oil due to its high unsaturated oil content [1]. Our results are similar in fatty acid composition when compared to the values in the literature.

The mineral contents of apple kernels were determined by ICP-AES. The mineral compositions of kernels are summarized in **Table 4**. Mineral elements were found to vary widely depending on different apricot cultivar kernels. According to variance analyses, dif-

ferences between apricot cultivars to Cu, K and Mg were found statistically important at p < 0,01 level. Also, differences of cultivars had important at the p < 0,05 on Zn element.

Ca, K, Mg, Na and P contents of all the apricot cultivar kernels were generally found very high. In addition, other minerals were determined very low. The levels of Ca of samples ranged between 1063.0 mg/Kg (Kabaaşı cv) and 2238.8 mg/Kg (Çekirge-52 cv), K contents were determined between 6206.5 mg/Kg (Caona cv) and 12715.9 mg/Kg (Aprikoz). While Mg contents are established between 1513.9 mg/Kg (Aprikoz cv) and 2115.9 mg/Kg (Çekirge-52 cv), P contents of kernels were found between 3177.0 mg/Kg (Soğancı cv) and 3762.9 mg/Kg (Hacıhaliloğlu cv). According to report of Femenia *et al.* [1], phosphorus, magnesium and calcium amounts ranged between 1100-1200 mg/100 gin apricot kernels. Also, the other essential elements; iron, manganese, copper, and zinc, account for 7-9,5 mg/100 g [1]. Average mineral contents of apricot varieties were found to be between 2.73-3.68% for Na, 1.06-2.94 ppm for P, 0.35-0.64 ppm for K, 0.08-0.11 ppm for Ca, 0.23-0.26 ppm for Mg, 10.7-74.9 ppm for Fe, 11.80-42.35 ppm for Zn, 0.73-1.46 ppm for Mn and 1.10-4.76 ppm for Cu [15].

These differencies of cultivars minerals may be due to growth conditions, varieties, genetic factors, harvesting time, soil properties, geographical variations and analytical procedures [23,24]. Calcium is the major component of bone and assists in teeth development [25]. Other elements

Table 4. Fatty acid composition of apricot kernel oils (%).

Cultivars	K	Mg	Na	P	Zn
Hüdayi	6090.986h	1726.441gh	187.085cd	3442.016abcd	28.529cd
Hacıhaliloğlu	8383.253f	1952.767bcde	245.196bcd	3762.980a	35.053abcd
Soğancı	8537.620ef	1931.137cdef	603.326abcd	3177.026d	28.812cd
Şahinbey	8136.141fg	1971.202bcde	705.950ab	3409.697bcd	25.051d
Hacıkız	10234.682bc	1874.072defg	862.535a	3456.812abcd	33.147bcd
Canino	9385.655cde	2040.736abcd	346.035abcd	3494.124abcd	28.954.cd
Caona	6206.455h	2028.789abcd	843.767a	3480.659abcd	42.469abc
Sakıt–2	8828.335def	1836.232efg	718.226ab	3550.150abc	53.004a
Çekirge–52	9712.421bcd	2115.933a	699.388abc	3514.461abcd	30.923bcd
Erkenağerik	9706.068bcd	1607.314hı	585.373abcd	3209.966cd	32.794bcd
693-K	8927.422def	2043.620abc	426.582abcd	3689.357ab	32.695bcd
Karacabey	7308.140g	1929.373cdef	782.416a	3583.744ab	34.604bcd
Ethembey	8389.089f	2114.926ab	452.838abcd	3471.977abcd	33.212bcd
Alyanak	8630.503ef	1995.662abcde	552.593abcd	3448.382abcd	45.766ab
Kabaaşı	8614.027ef	1959.762bcde	155.921d	3613.276ab	42.467abc
Hasanbey	10334.982b	1778.782fg	777.275a	3547.449abc	33.483bcd
Aprikoz	12715.908a	1513.934ı	503.524abcd	3399.972bcd	22.489d

which may contribute to biological processes, but which have not been established as essential, are barium, cadmium [23]. The high quantity of potassium, phosphorus, magnesium, and calcium, together with the small proportion of sodium plus the content of the essential elements as iron, manganese, copper, and zinc and allows the apricot, as well as the almond, to be considered as an excellent source of bioelements [26].

4. Conclusions

The accurate quantification of these analyses has very important applications for the nutrition sciences, because fatty acids, protein, oil and mineral contents in particular seed have a very important effect on health. These results of the experiment presented have shown that apricot cultivars have some distinctive chemical and physical properties, fatty acid and mineral content profiles. Kernels in apricot varieties can be a good source oil due to their abundance in the kernels and their high oil content. Such utilization of apricot fruits processing wastes could provide extra income and at the same time help minimize a waste disposal problem. The mineral contents of apricot cultivar kernels collected from Malatya province of Turkey were established by ICP-AES. The contents of most minerals such as Ca, K, Mg and P are at adequate levels. Mineral elements were found to vary widely depending on different apricot kernels. Apricot kernels were found to be important sources of nutrients and essential elements. In addition, it is apparent that apricot kernels are good sources of micro-and macro minerals, and consumed as a food ingredient to provide the human nutrient.

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