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Physical and Chemical Properties of a Type of Almond Called "Akbadem" Grown in the Aegean Region in Turkey

Nizam Mustafa NİZAMLIOGLU[*1], Sebahattin NAS[2]

[1]Food Technology Department, Vocational School of Technical Sciences, Karamanoglu Mehmetbey University, Yunus Emre Yerleskesi, 70200, Karaman, Turkey
[2]Food Engineering Department, Faculty of Engineering, Pamukkale University, Kınıklı Campus, 20070, Denizli, Turkey

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Abstract: A type of almond, called "Akbadem", grown in the Aegean region in Turkey were evaluated in terms of several physical and chemicial properties of nut and kernel. The average length, width, thickness, arithmetic mean diameter, geometric mean diameter, particle size and surface area of nuts were 39.04±2.94 mm, 23.56±1.88 mm, 15.60±1.15 mm, 26.07±1.19 mm, 24.29±1.75 mm, 5053.05±1100.12 mm^3 and 1565.14±225.63 mm^2 respectively. Corresponding values for kernel were 28.25±1.92 mm, 14.28±1.17 mm, 6.87±0.53 mm, 16.46±1.05 mm, 14.03±0.87 mm, 887.05 ± 167.28 mm^3 and 533.90±65.86 mm^2 respectively. "Akbadem" nut shell has a significant impact on the dimensional properties. Dimensional properties were decreased significantly than the almond nut to almonds kernel. The average almond nut shell thickness was determined as 3.35±0.34 mm. Akbadem nut gravimetric properties; thousand seed weight, seed density and bulk density were determined 4950±0.01 g, 1140±0.001 kg/m³ and 375±5.00 kg/m³ respectively. Corresponding values for "Akbadem" kernel were determined 1430±0.08 g, 1080±0.003 kg/m³ ve 485±5.00 kg/m³ respectively. Internal efficiency of Akbadem was determined as 30±0.50%. The "Akbadem" kernel was determined *L*-value 59.56±1.98, *a*-value 5.68±0.79 and *b*-value 16.74±0.54. "Akbadem" kernel shell is quite dark as shown in Hunter color values. Chemical composition of Akbadem kernel; moisture, total oil, total ash, protein, oleic acid, linoleic acid, palmitic acid and palmitholeic acid were 3.57±0.15%, 52.32±1.21%, 3.15±0.01%, 20.57±0.07%, 76.11±1.18%, 17.71±1.14%, 6.14±0.05% and 0.04±0.01%. "Akbadem" is seen that fatty acids and the relatively high amount of protein.

Keywords: Almond, "Akbadem", Physical Properties, Chemicial Properties

1. INTRODUCTION

Dental Almonds (*Prunus amygdalis var. dulcis*) are members of the family Rosaceae and the fruit is classified as a drupe in which the edible seed or kernel is the commercial product [1]. The almond is a nutritionally important and valuable specialty crop grown in many temperate and sub-tropical regions in the world [2]. Almonds originated in the Middle East and have been cultivated for 4000 years [3-6]. It is believed to have originated in Middle East but is now grown more widely, including in southern Europe, Africa, Southern Australia, and California [7].

*Corresponding Author E-mail: munizam@kmu.edu.tr

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Almond fruit consists of the hull, shell, and kernel (nut) [6, 8]. The edible kernel or nut is separated and collected for commercial uses [9]. Almond also grows well in different regions of Turkey. Almond is grown in inner Anatolia, the Mediterranean and the Marmara regions of Turkey [10-12]. Almond cultivation in Turkey is concentrated in the Aegean region [13, 14]. Datça Peninsula, cultivated radiant, white, row almond, etc. as varieties, is the most widely grown in the Aegean region [15]. Aegean region in terms of number of trees and almond production takes first place in Turkey. Akbadem variety meets 30% of the production of almonds Aegean region of Turkey [16-18]. According to 2013 data Turkey ranks seventh in the world almond production with 69.838.00 tons [19]. In recent years, production of almonds in Turkey has increased considerably, where cultivation has increased, due to the improvement of agricultural techniques and selection of new almond cultivars [20].

Almonds and other tree nuts, are nutrientdense foods that can be a valuable plant source of lipids and protein in the diet. Researchers have identified that the contents of dietary fiber, vitamin E, phytosterols and several key micronutrients found in almonds and other nuts contribute to a healthy nutrient profile [21, 22].

Kernel size, and the closely correlated kernel weight, is variable from year to year, though less variable in almond than in other Prunus species. In addition to overall kernel size, its linear dimensions of length, width, and thickness are also important for certain commercial applications [1, 8]. Kernel size is commercially important, and larger sizes generally confer greater value [6]. In addition to kernel characteristics, shell and hull characteristics are also important determinants of a variety's market acceptance. For these reasons, for optimum threshing performance, processes of pneumatic conveying, storing and other processes of almond nut, its physical properties must be known. The physical parameters of different European and Californian almond cultivars are readily measured.

2. MATERIAL and METHODS

Freshly harvested raw almonds in shell (Akbadem) were supplied from the ''Sındı Village Agricultural Development Cooperatives'' (Datça/Muğla/Turkey).

Examples of almonds (40 g) were finely ground for color analysis in the grinder. Color analyzes were performed as triplicate. The color of the samples was measured using a Color Flex CX2733 Hunter Lab (Hunter Associates Laboratory, USA). The *L*, *a* and *b*-values are the three dimensions of the measured color which gives specific color value of the material [23, 24]. Moisture was determined by gravimetrically using moisture analyzer (OHAUS MB45, USA) at 105°C, ash amount was performed according to AOAC [25] method using burning in a furnace (Nuve MF 110, Turkey) at 650±25°C. Total protein was determined by nitrogen determination according to Dumas method (combustion) using nitrogen analyzer (NDA 701, Italy) [26, 27]. Total oil was performed according to AOAC [28] method using Soxhlet extraction systems (Gerhart Soxtherm Multistat, UK).

Measurement of the three major perpendicular dimensions of the seed was carried out with a digital compass (Mitotoyo, Japan) with an accuracy of 0.01 mm. The arithmetic mean diameter (D_a), geometric mean diameter (D_g) and and sphericity ($\emptyset$) were calculated by using the aquations (1), (2), (3), respectively (29).

$$D_a = \frac{L+W+T}{3} \quad (1)$$

$$D_g = \sqrt[3]{L \times W \times T} \quad (2)$$

$$\emptyset = \frac{D_g}{L} \quad (3)$$

Where, D_a, arithmetical mean diameter, L is length (mm), W is width (mm), T is thickness (mm) D_g, geometric mean diameter and ∅, sphericity.

The one volume (V) and surface area (S) were calculated by using the aquations (4), (5), (6), respectively (30).

$$V = \frac{\pi B^2 L^2}{6(2L-B)} \quad (4)$$

$$S = \frac{\pi B W L^2}{2L-B} \quad (5)$$

$$B = \sqrt{W \times T} \quad (6)$$

Where V is volume, S is surface area.

The bulk density is the ratio of the mass of a sample of seed to its total volume. The bulk density was determined with a weight per hectolitre tester which was calibrated in kg per hectolitre. The nuts and kernels were poured in the calibrated bucket up to the top from a height of about 15 cm and excess amount was removed by strike off stick [31]. Seeding density was determined using a gas pycnometer (Mikromeritics Accupyc II 1340 Gas Pycnometer, USA) [32]. Thousand grain weight of the almond samples were measured with electronic precision balance with 0.001 g sensitivity [31].

Gas chromatography standard method of AOAC [33] International was used for the determination of fatty acid composition.

3. RESULTS and DISCUSSIONS

3.1. Chemical Composition of Almonds

The Oils and proteins are the most intensive components of almonds. Variability in oil content and fatty acid composition, as well as tocopherol (vitamin E) content, depends mainly on the almond genotype. Chemical composition of Akbadem kernel; moisture, total oil, total ash, protein, oleic acid, linoleic acid, palmitic acid and palmitoleic acid were 3.57±0.15%, 52.32±1.21%, 3.15±0.01%, 20.57±0.07%, 76.11±1.18%, 17.71±1.14%, 6.14±0.05% and 0.04±0.01% (Table 1). The chemical properties of Akbadem samples shows similarity to the literature. Moisture, protein, fat, and ash content of the major almonds maketing in the US as was reported as between 4.35% - 5.86%, 16.42% - 22.17%, 53.59% - 56.05%, and 2.69 - 2.93%, respectively by Sathe [34]. In addition Yildirim et al. [35] reported that total oil, protein, ash, humidity content of the 14 almond genotypes (province of sparta/Turkey) was between 44.25 - 54.68%, 21.23 - 35.2%, 2.75 - 3.81%, 3.41 - 4.52%, respectively. Dimensional characteristics of the Akbadem seed were found higher than other almond seed. Fruit weight with shell, kernel weight and kernel ratio of 5 almond types were reported between 0.67 to 2.07 g, 0.44 to 1.18 g and 44.44% to 59.29 %, respectively by Simsek et al. [36].

Table 1. The chemical composition of the Akbadem samples

Moisture (%)	3.57±0.15
Total oil (%)	52.32±1.21
Total ash (%)	3.15±0.01
Protein (%)	20.57±0.07
Oleic acid (%)	76.11±1.18
Linoleic acid (%)	17.71±1.14
Palmitic acid (%)	6.14±0.05
Palmitoleic acid (%)	0.04±0.01

3.2. Physical Composition of Almonds

Different almond varieties of is kernel size highly variable. Their particular of almond kernels has characteristic dimensions, shapes, appearances, membrane thickness and flavors. Akbadem shell has a significant impact on the dimensional properties. There are significant differences between nut almonds with almonds kernel example.

Table 2 shows the size distribution of the almond nuts and kernels. The almond nuts have a length ranging from 31.76 to 46.52 mm, width ranging from 19.13 to 27.58 mm, and thickness ranging from 13.22 to 19.13 mm. The almond kernels have a length ranging from 22.82 to 32.52 mm, width ranging from 11.60 to 17.15 mm, and thickness ranging from 5,87 to 8.77 mm. The average values of geometric mean diameter, arithmetic mean diameter and sphericity of almond nuts and almond kernels were calculated as 26.07, 16.46 mm 24.29, 14.03 mm and 0.62, 0.50 mm respectively.

Table 2. The dimensional characteristics of the Akbadem nuts and kaernels

	Almond Nut			Almond Kernel		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Length (mm)	39.04 ± 2.94	31.76	46.52	28.25 ± 1.92	22.82	32.52
Width (mm)	23.56 ± 1.88	19.13	27.58	14.28 ± 1.17	11.60	17.15
Thickness (mm)	15.60 ± 1.15	13.22	19.13	6.87 ± 0.53	5.87	8.77
Arithmetic mean diameter (mm)	26.07 ± 1.19	21.88	30.30	16.46 ± 1.05	13.43	18.80
Geometric mean diameter (mm)	24.29 ± 1.75	20.34	28.11	14.03 ± 0.87	11.58	15.99
Sphericity	0.62 ± 0.02	0.58	0.67	0.50 ± 0.02	0.46	0.58
Volume (mm^3)	5053.05 ± 1100.12	2895.15	7864.19	887.05 ± 167.28	496.58	1371.32
Surface area(mm^2)	1565.14 ± 225.63	1090.32	2085.54	533.90 ± 65.86	361.07	682.73
Compact	Almond Nut			Almond Kernel		
Bladed	56			-		
Elongated	44			-		
Very bladed	-			66		
Very elongated	-			33		

Individual measured values were projected on to triangular diagrams by using the tri-plot spread sheet method. As can be seen from Fig 1 and Table 2, shape indices of ungraded Akbadem nut were dimensions were classified in bladed (56%) and elongated (44%) depends on their perpendicular. Shape indices of ungraded Akbadem kernel dimensions were classified in very bladed (66%) and very elongated (33%) depends on their perpendicular.

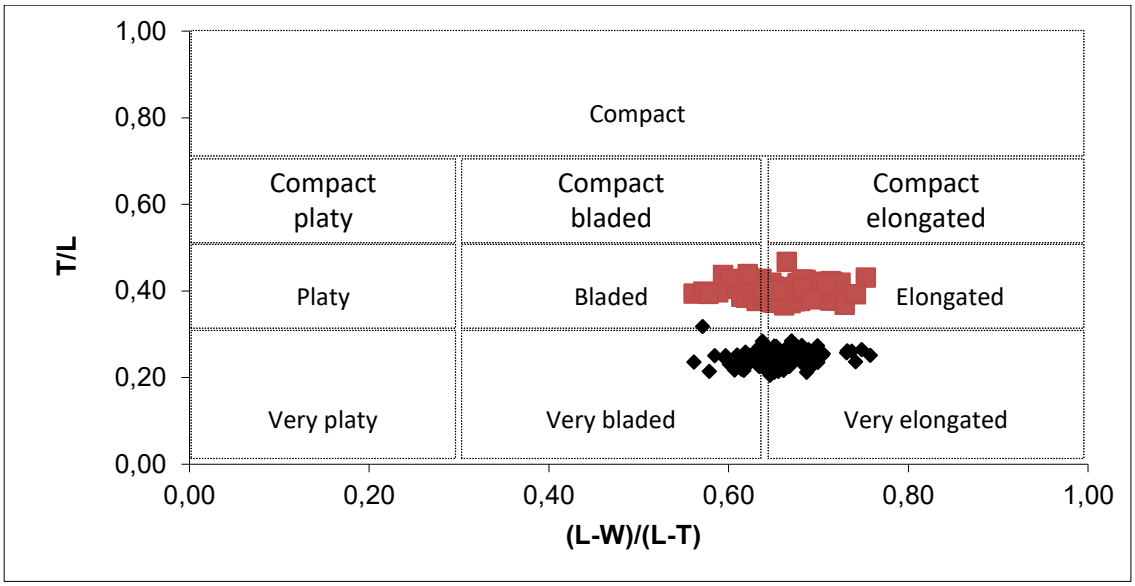

Figure 3. Sneed and Folk descriptive particle shape classes of ungraded almond nut and kernel.

Aydın [37] average length, width, thickness, geometric mean diameter, unit mass and volume of almond nuts and kernel were reported as 25.49, 21.19 mm 17.03, 14.34 mm 13.12, 6.38 mm 18.13, 11.42 mm, 2.64, 0.69 g and 2.61, 0.71 cm^3 respectively.

A summary of the results for all the measured parameters that related with gravimetric of Akbadem nut and kernel is given in Table 3. The mean one-thousand seed weight was 4950g and 1430 g for Akbadem nut and kernel, respectively. A reduction of 72% was determined in shelled grain according to the internal grain weight. Dimensional properties of almond nut were decreased significantly than the almond kernels. The average thickness and internal efficiency of almond nut shell were determined as 3.35 mm, 30% respectively.

Table 3. Gravimetric, efficiency and color properties of Akbadem nut and kernel examples.

Properties	Almond Nut	Almond Kernel
Thousand seed weight (g)	4950±0.01	1430±0.08
Seed density (kg/m³)	1140±0.001	1080±0.003
Bulk density (kg/m³)	375±5.00	485±5.00
Efficiency (kg)/(%)	300±5 / %30±0.50	
Color values		Ground almond Kernel
L		59.56±1.98
a		5.68±0.79
b		16.74±0.54

The mean seed densities and was mean bulk densities of Akbadem nut and kernel were 1140, 375 kg/m³ and 1080, 485 kg/m³ respectively. The seed density of Akbadem nut was found to be higher than that of Akbadem kernel while the bulk density of Akbadem kernel was higher than that of Akbadem nut. Aydın [37] reported a decreement from 655 to 525 kg/m^3 and an increement from 1015 to 1115 kg/m^3 for bulk density and true density in almond nut respectively. For the kernel, the corresponding values changed from 595 to 475 kg/m^3, 900 to 995 kg/m^3.

The *L*-value, indicative of the brightness, of Akbadem kernel is given in Table 3. The *L*, *a* and *b*-values of Akbadem kernel were determined as 59.56, 5.68, 16.74, respectively. According to the *L*, *a* and b-values color of Akbadem kernel shell is quite dark.

Mexis et al. [38] investigated the effect of active and modified atmosphere packaging, container oxygen barrier and storage conditions on quality retention of raw ground almonds finding a decrease at L, parameter and increase a and b values after 12 mounth of storage. The most apparent color change was determined in samples of PET//LDPE pouches stored at 20°C.

4. CONCLUSION

This study deals with the physical properties of Akbadem nut and kernel, providing useful data for its postharvest handling and industrial processing. It is recommended that making to efforts encouraging of cultivation and improving the quality of agriculture for an important kind of almond "Akbadem".

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Conflict of Interests

Authors declare that there is no conflict of interests.

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