American-Eurasian J. Agric. & Environ. Sci., 3 (5): 703-707, 2008
ISSN 1818-6769

Some Physical and Mechanical Properties of Apricot Fruits, Pits and Kernels (C.V Tabarzeh)

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Abstract: Physical and mechanical properties of apricot fruits, pits and kernels are necessary for the design of equipments for harvesting, processing and transportation, separating and packing. In this study some physical and mechanical properties such as dimensions, geometric mean diameter, sphericity, surface area, bulk density, true density, porosity, volume, Mass, 1000- unit mass, coefficient of static friction on various surface and rupture force in 3 axes, were determined at 84.19, 17.01 and 17.46% moisture contents for apricot fruits, apricot pits and apricot kernels respectively. Bulk densities of fruits, pit and kernels were 449.5, 440.78 and 406.79 kg/m^3, the corresponding true densities were 1037.5, 892.63 and 983.38 kg/m^3 and the corresponding porosities were 56.66, 50.62 and 52.32%, respectively. The volumes, mass and surface area of fruits were larger than those of nuts and kernels. The static coefficient of friction of fruit on all surfaces studied (wood, glass, galvanize sheet and fiber glass sheet) were the highest as the surface is viscous and hardness is less. Rupture force of fruit, pit and kernel were 8.23, 372.75 and 16.20 N through length, 6.31, 297.34 and 32.25N through width and 5.87, 300.45 and 91.22N through thickness.

Key words: Apricot · Fruit · Pit · Kernel · Physical properties · Mechanical properties

INTRODUCTION

Apricot (*Prunus armenia* L.) is classified under the *Prunus* genus, *Prunaidea* sub-family and the *Rosaceae* family of the Rosales group. This type of fruit is a cultivated type of zerdali (wild apricot) which is produced by inoculation [1]. Apricot has an important place in human nutrition and apricot fruits can be used as fresh, dried or processed fruit.

Stone-fruit crops, including apricot are temperate fruits which are grown in climates with well-differentiated seasons. Mechanisms against the impact of low winter temperatures and frost damage have been developed by species growing under these conditions. Dormancy and freezing tolerance are the main mechanisms developed against these difficulties and, although they could be independent [2], freezing tolerance cannot be developed adequately without growth cessation [3], which marks the onset of dormancy.

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 [4]. Apricot has an important place in terms of human health. Apricot is rich in minerals such as potassium and vitamins such as b-carotene. β-carotene, which is the pioneer substance of mineral A, is necessary for epithelia tissues covering our bodies and organs, eye-health, bone and teeth development and working of endocrine glades. Moreover, vitamin A plays important role in reproduction and growing functions of our bodies, in increasing body resistance against infections.

Iran is the second apricot producer in the world with 275580 ton production and 8.2% share [5]. In Iran, the most widely produced types are Tabarzeh, Kardi Damavandi, nakhjavan and etc. Turkey, Iran, Italy, Pakistan and France are the principal apricot countries. Trees are also grown in Spain, Japan, Syrian Arab Republic and Algeria. Iran has exported more than 680 tones to different countries in 2007 [5]. The trees of these types of apricot are high, strong and grow rapidly and have wide and shallow branches. They bear fruits every year in fertile and irrigated soils. The distance between trees is approximately 10 m, average fruit weight ranges between 20 and 60 g, dried substance percentage in fruit is 18–28%, pH value is between 4.0 and 5.0 and their color are yellow. Their harvesting phase is between the last of June and the beginning of July. The first three of these varieties are evaluated as dry products; the other three are evaluated as fresh products.

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The agriculture of apricot needs extensive labor and energy. In Iran, apricot fruits are harvested at about 77% moisture level [6]. 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. The physical properties of apricot are important for the design of equipments for harvesting and post-harvesting technology transporting, storing, cleaning, separating, sorting, sizing, packaging and processing it into different food. Since currently used systems have been generally designed without taking these criteria into consideration, the resulting designs lead to inadequate applications. These results in a reduction in work efficiency, an increase in product loss. Therefore, determination and consideration of these criteria have an important role in designing of these equipments. Other studies have reported on the chemical and the physical–mechanical properties of fruits, such as Olajide and Igbeka [7] for Groundnut kernels, Nimkar and Chattopadhyay [8] for green gram, Aydin [9] for Hazelnut, Kaleemullah & Gunasekar [10] for arecanut kernels, Demir *et al*. [11] for hackberry, Gezer *et al*. [12] for apricot pit, Konak *et al*. [13] for Chick pea, Aydin [14] for Almond nut and kernel, Bart-Plange and Baryeh [15] for Category B cocoa bean, Calisir and Aydin [16] for cherry laurel, Altuntas and Yildiz [17] for faba bean grain, Dursun and Durson [18] for Caper seed, Kashaninejad, *et al*. [19] for pistachio. As it can be found from literature review, there was no published paper about the physical properties of apricot kernel, except for Gezer *et al*. [12], who studied some of their physical properties have been evaluated as a physical of moisture content.

Also in spite of second great apricot producer in the world is Iran, but exportation of this product and its process is so low. It is clear that investigating on physical and mechanical properties of apricot is very essential and practical for its process. Then for achieving above aims, some important physical and mechanical properties of apricot fruit, pit and kernel such as axial dimensions, 1000- unit mass, bulk density, coefficient of static friction and rupture force were determined.

Nomenclature

L	Length	V	Volume
W	Width	Td	True density
T	Thickness	Bd	Bulk density
Dg	Geometrical mean diameter	m_{1000}	1000- unit mass
ϕ	Sphericity	ϵ	Porosity
S	Surface area	μ	coefficient of static friction
m	Mass	Rs	Rapture force
Mc	Moisture content		

MATERIALS AND METHODS

Apricots of Tabarze variety which used in this study were produced on 2007 in the west Azarbayjan province of Iran. Shelled of fruit had been broken and then, by use of air pressure cleaned and separated from waste materials. All products were kept in the room temperature for two days. All measurements had been done on the apricot fruits, pits and kernels with moisture contents 84.19, 17.64 and 17.21%, respectively, which those moistures are suitable for processing of product. One hundred apricot fruits, pits and kernels randomly was selected and then technological properties such as length (L), width (W), thickness(T), weight (m), volume (V), true density (Td), bulk density (Bd), geometrical mean diameter (D_g), sphericity (ϕ) and surface area (S), coefficient of static friction (μ) on various surface, rupture force through 3-axis were measured. Geometrical dimensions and weight of apricot fruits, pits and kernels, were measured by coulisse and digital balance with accuracy 0.01mm and 0.001g,respectively.

By use of those three dimensions, geometrical mean diameter, sphericity factor and surface area (S) were obtained from fallow equations [20,21].

$$D_g = (LWT)^{(\frac{1}{3})} \quad (1)$$

$$\phi = (D_g / L) \times 100 \quad (2)$$

$$S = \pi D_g^{\,2} \quad (3)$$

In order to determining 1000- unit mass (m_{1000}), randomly 100 seed were selected and weighted. True density (Td) and volume (V) were determined by use of displacement in liquid method. We had been used toluene instead of water as liquid, because it was more advantages. As we know toluene have less surface tension and degeneration [21]. The bulk density (Bd) is the ratio of the mass sample of the kernels to its total volume. It was determined by filling a 1000 ml container with kernels from a height of about 15 cm, striking the top level and then was weighed the contents [13]. Also porosity (P) was calculated by follow equation [21,22].

$$P = 1 - (Bd / Td) \quad (4)$$

Coefficient of static friction (μ) of apricot fruits, pits and kernels on four surface including woods, glass, galvanizes steel and fiberglass was determined. In order to determining coefficient of friction, we had been put products on the surface with changeable slip. When product was started to motion, tangent of slip angle was showed the coefficient of friction Baryeh [6] and Dutta *et al*. [11] had used similar methods.

Rapture force was determined by forces that acted through the three dimensions length, width and thickness. We was put sample on desired dimension and we was selected speed of loading and after that we was applied force till product fractured. On the monitor of device was showed graph of force-displacement.

RESULTS AND DISCUSSION

Moisture content: Average of dry base moisture content of 10 Tabarze apricot fruits and their pits and kernels was shown in Table 1. Results showed that the moisture content of pit and kernel were near together. Each value is average of 10 measurements.

Geometrical properties: Table 2 shows the geometrical properties such as length, with, thickness, geometrical mean diameter, spherically and surface area of 100 Tabarze apricot fruits and their pits and kernels. Results showed that the fruits had spherically shape.

Gravimetrical properties: Gravimetrical properties such as volume, weight, true density and bulk density of Tabarze apricot fruits and their pits and kernels were showed in Table 3. Results showed that true density of kernel was more than pit but its opposite about bulk density of pit. The porosity of kernel was more than pit and it is related to it's spherically.

Frictional properties: Coefficient of static friction of fruits, pits and kernels on various surface were showed in Table 4. Results showed that static friction coefficient of fruit more than its pit and kernel on different surface but only the static friction coefficient of pit more than its kernel on entire materials.

Table 1: Average of dry base moisture content of Tabarze apricot fruits and their pits and kernels

Part of fruit	N	Average of moisture content, % w.b.	Standard deviation
Fruit	10	84.19	0.896
Pit	10	17.01	0.534
Kernel	10	17.46	1.016

Table 2: Geometrical properties of 100 Tabarze apricot fruits and their pits and kernels

Geometrical properties	N	Fruit	Standard deviation	Pit	Standard deviation	Kernel	Standard deviation
Length, mm	100	41.11	0.981	27.85	2.332	15.76	1.194
Width, mm	100	36.98	0.634	16.33	1.991	11.06	0.877
Thickness, mm	100	33.98	1.267	10.15	0.311	5.45	0.712
Geometrical mean diameter, mm	100	37.09	1.142	16.60	0.999	9.79	0.686
Spherically, %	100	90.28	14.124	59.66	17.177	62.21	3.385
Surface area, mm^2	100	4332.59	35.310	863.51	67.336	302.17	60.211

Table 3: Gravimetrical properties of Tabarze apricot fruits and their pits and kernels

Gravimetrical properties	N	Fruit	Standard deviation	Pit	Standard deviation	Kernel	Standard deviation
Volume, Cm^3	100	28.94	0.354	1.62	0.714	0.46	0.109
Weight, gr	100	30.00	0.203	1.44	0.322	0.44	0.103
True density, Kg/m3	100	1037.50	6.312	892.60	98.664	983.30	165.587
Bulk density, Kg/m3	3	449.50	0.132	440.78	0.097	406.79	0.011
Porosity, %	0	56.66	-	50.62	-	51.32	-
1000- unit mass, Kg	100	29.99	1.225	1.44	0.321	0.45	0.121

Table 4: Coefficient of static friction of fruits, pits and kernels on various surface

Coefficient of static friction on various surface	N	Fruit	Standard deviation	Pit	Standard deviation	Kernel	Standard deviation
Wood	3	0.51	0.021	0.53	0.104	0.38	0.051
Glass	3	0.49	0.018	0.30	0.012	0.21	0.039
Galvanize sheet	3	0.62	0.022	0.38	0.031	0.22	0.074
Fiberglass sheet	3	0.55	0.081	0.40	0.017	0.24	0.016

Table 5: Rupture force of fruits, pits and kernels through length, width and thickness

Rupture force through 3-axis, N	N	Fruit	Standard deviation	Pit	Standard deviation	Kernel	Standard deviation
Length	20	8.23	0.341	372.75	20.644	16.20	2.089
Width	20	6.31	1.117	297.34	18.362	32.25	1.331
Thickness	20	5.87	0.068	300.45	36.251	91.22	13.509

3.5. Mechanical properties: Rupture force of fruits, pits and kernels through length, width and thickness showed in table 5. Results showed that rupture force through thickness for fruit was less than other direction and this mechanical property for pit was less through width and for kernel minimum rupture force was through the length direction. This mechanical parameter and the direction of minimum rupture is very important parameter to design post harvest machinery.

CONCLUSION

To design and fabricate the equipment related to the process, the physical and mechanical properties of the fruits, nuts and kernels are important design parameters. The post-harvest physical and mechanical properties Tabarze apricot fruits, pits and kernels, including dimensions, geometric mean diameter, sphericity, surface area, bulk density, solid density, porosity, specific surface area, volume, weight, true density, bulk density, porosity, 1000- unit mass, coefficient of static friction on various surface and rupture force in 3 axes, were determined at 84.19, 17.01 and 17.46% moisture contents for apricot fruits, apricot pits and apricot kernels respectively. Bulk densities of fruits, pit and kernels were 449.5, 440.7 and 406.79 kg/m^3, the corresponding true densities were 1037.5, 892.6 and 983.3 kg/m^3 and the corresponding porosities were 56.66, 50.62 and 51.32%, respectively. The volume, weight and surface area of fruits were larger than those of nuts and kernels. Results showed that the fruits had spherically shape. Results showed that true density of kernel was more than pit but its opposite about bulk density of pit. The porosity of kernel was more than pit and it is related to it's spherically. The static coefficient of friction of fruit on all surfaces studied (wood, glass, galvanize sheet and fiber glass sheet) were the highest as the surface is viscous and hardness is less. Results showed that static friction coefficient of fruit more than its pit and kernel on different surface but only the static friction coefficient of pit more than its kernel on entire materials. Rupture force of fruit, pit and kernel were 8.23, 372.75 and 16.20 N through length, 6.31, 297.34 and 32.25N through width and 5.87, 300.45 and 91.22N through thickness. Results showed that rupture force through thickness for fruit was less than other direction and this mechanical property for pit was less through width and for kernel minimum rupture force was through the length direction. This mechanical parameter and the direction of minimum rupture is very important parameter to design post harvest machinery.

ACKNOWLEDGMENTS

The authors wish to thank the Department of Agricultural Machinery Engineering Faculty of Biosystem Engineering, University of Tehran for its support.

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