Misr J. Ag. Eng., 36 (4): 1209 - 1226 PROCESS ENGINEERING

EFFECTS OF MOISTURE CONTENT ON SOME PHYSICAL AND MECHANICAL PROPERTIES OF APRICOT FRUITS AND KERNELS

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ABSTRACT

The physical and mechanical characteristics of agricultural products are the most important criteria for determining the optimal design for post-harvest systems and are very important for understanding the behavior of the product during trading, such as harvesting, transportation, sorting, settlement, packaging and storage. The main objective of this work is to study some physical and mechanical properties of apricot fruits and kernels to form an important database for this crop. This experimental work was conducted to study some physical and mechanical properties as a function of the moisture content of Egyptian apricot fruits. With an increase in the moisture content of the apricot fruits from 72.5 to 83.52%, the length increased from 41.11 to 41.95 mm, width increased from 36.98 to 37.46 mm, thickness increased from 33.97 to 34.5 mm, geometric mean diameter increased from 37.10 to 37.51 mm and surface area increased from 4324.12 to 4420.22 mm^2 .Sphericity increased from 90.25 to 89.42%. The mass increased from 31.20 to 34.56 g and its volume increased from 28.94 to 33.62 cm^3. The true density increased from 1078.09 to 1027.96 kg / m^3. The porosity and the bulk density decreased from54.77 to 54.23 % and 487.6 to 470.5 kg / m^3 respectively, the *thousand apricot fruits Mass (M_{1000}) increased from 30.1 to 30.5 kg. This study was conducted to study some physical and mechanical properties as a function of the moisture content of Egyptian apricot fruits. With an increase in the moisture content of the apricot kernels from 3.25% to 13.56%. The length increased from 15.1 to 15.4 mm, width increased from 10.1 to 10.4 mm, thickness increased from 5.3 mm 5.7 mm, geometric mean diameter increased from 9.29 to 9.68 mm, surface area s_1 increased from 271.13 to 294.37 mm^{2}and surface area S_2 increased from 229.005 to 248.31 mm^2 , Sphericity increased from 61.52 to 62.86 %. The mass increased from 0.43 to 0.48 g and the volume increased from 0.43 to 0.475 cm^3 and the true density increased from 1000 to 1010.53 kg / m^3.*

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The porosity increased from 42 to 46.55 % and the bulk density decreased from 580 to 540 kg / m^3. the thousand apricot kernels Mass (M_{1000}) increased from 1.440 to 1.482 kg. The coefficient of friction on all surfaces (wood, glass, galvanizing, fibrous glass panels) increased with increasing the moisture content for both apricot fruit and kernel.

1. INTRODUCTION

Cultivated area of fruits in Egypt is 1.20 million fed. Apricot is the major horticultural crops in Egypt. It is cultivation area is about 17.786 fed, production of apricot in Egypt is about 5.3 ton/fed. and the total production is about 62.613 ton. (Agric. Statistics Economic Affairs Sector, 2016). Apricot considered from fruits with stone-fruits, 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)**. Apricot has an important place in terms of human health. Apricot is rich in minerals such as potassium and vitamins such as β-carotene. β-carotene 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. **(Haydar et al 2007)** mentioned that properties are necessary for the design of equipments for harvesting, processing, and transportation, separating and packing. Technological properties such as length and diameter of fruit, mass, volume of fruit, geometric mean-diameter, sphericity, bulk density, fruit density, porosity, projected area, static and dynamic coefficient of friction were determined at 83.27 %, 77.79 %, 82.1 %, 79.79 %, 82.31 % and 77.37% moisture content. The values of length, mass, geometric mean-diameter and sphericity of six different apricot fruits were established between 29.26 and 46.98 mm, 14.35 – 41.48 g, 28.99 – 41.15 mm, 0.876 – 0.991 %, respectively. **Hojat et al (2008)** 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/m3, 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. **Hojat Ahmadi, etal (2008).** Mentioned that design and fabricate the equipment related to the Engineering, University of Tehran for its support. Process, the physical and mechanical properties of the fruits, nuts and kernels are important design parameters. Many studies have reported on the physical and mechanical properties of kernels, seeds and fruits such as **Dutta et al.(1988)** for gram, **Gupta and Das (1997)** for almond nut and kernel**, Ogut (1998)** for white **Lupin, Aydin (2002)** for **Hazel nuts, Kaleemullah and Gunasekar (2002)** for arecanut kernels, **Gezer et al. (2002)** for apricot pit and its kernel, Sahoo and **Srivastava (2002)** for okra seed, **Konak et al. (2002)** for chickpea seeds, **Puchalski, Brusewitz and Slipek(2003)** for Apple. **Aydin (2003)** for Almond nut and kernel, **Baryeh and Mangope (2003)** for pigeon pea, **Khazaei and Mann (2004)** for Sea. **Buckthorn Berries, Mamman, Umar and Aviara (2005)** for Balanites Aegyptiaca Nuts, **Kashaninejad et al(2005)** for pistachio nuts and kernels, **Karababa (2006)** for popcorn kernels, **ElMasry et al(2006)** for Potato. **Oluwole, Aviara, and Haque for Sheanut, Keramat Jahromi et al (2007)** for Date Fruit (cv. Lasht),**Keramat Jahromi et al(2007)** for Bergamot (Citrus medica) Fruit. **Vairagar and Prasad (2008)** for Chick Pea Split (Cicer arietinum L.). It is clear that investigating the physical and mechanical properties of apricot kernel is very essential and practical for its processing, transportation, sorting and separating. Then for achieving this aims, some important physical properties of apricot fruits and kernels such as axial dimensions, thousand grain mass, true and bulk density, porosity, spherisity and angle of static friction on four different types of surfaces after harvest were determined.

2. MATERIALS AND METHODS

2.1.Materials:

2.1.1. Fruits used in this investigation:

Fresh ripe apricot fruit (a variety of Canino) was used for experimental work. 100 fruit samples were collected from a private sector farm. The fruits were cleaned to remove all foreign materials such as dust, dirt, fruit and immature fruits. They were left in the atmosphere of the room and then divided into four groups. The measurements of the physical properties were taken to the laboratory in Agricultural Engineering Research Institute (ENRI), Dokki, Giza, Egypt. And the mechanical on the same day on the first group and after every 3 days measurements are made on another group. To find moisture content, samples of apricot fruits were taken for each group after weighing and dried in a 78 °C oven for 48 hours. To determined moisture of content the Apricot March on Dry Basis (AOAC, 1984).

2.1.2. Apricot kernels used in this investigation

The apricot kernels used in this study were collected from (a variety of Canino). Broken pits and external issues such as dust, dirt, stones and straw were removed from 7 kg of apricots and then 4 kg of apricot kernel was obtained. The apricot kernels were cleaned by exposing it to the air screen cleaner. All products were kept at room temperature to measure the physical and mechanical properties of each group at intervals of 5 days after harvesting the apricots. The moisture content of the kernels was determined using the same method used in apricot fruit.

2.2.Instruments:

-Digital balance: With accuracy of 0.2 g, to measure mass of fruit.

-Digital caliper with venire: With accuracy of 0.01 mm, to measure different dimensions of fruits.

-Graduated cylinder: Of 1000 ml with accuracy of 25 ml, to determine the real density and volume of fruit by immersion in water.

-Friction and rolling-angle measuring device: Used to measure friction and rolling angle, with accuracy of 0.1 degree.

2.3. Methods:

Physical and Mechanical properties of the apricot fruits and kernels (Mohsenin, 1986): A random sample of one hundred fruits was taken from apricot (Canino variety) to measure physical properties.

2.4. Dimensions:

For each apricot fruit, three linear dimensions were measured, that are length L(mm),, width W(mm),, and thickness T(mm),

2.4.1. The geometric mean diameter (D_g)

The geometric mean diameter (D_g) was calculated according to(Mohsenin,1986) the following equation:

$$D_g = (LWT)^{0.333} \quad \ldots\ldots 1$$

Where:

D_g = geometric mean diameter (mm),

L = length of apricot fruit (mm),

W = width of apricot fruit (mm),

T = thickness of apricot fruit (mm),

2.4.2. Sphericity (%),

$$\Phi = (Dg/L)*100 \ldots\ldots 2$$

Where: Φ = sphericity (%),

2.4.3. Surface area (S)

Were calculated (Mohsenin, 1986) of Apricot fruit

$$S= \pi D^2 g \ldots\ldots 3$$

Where: S = surface area (mm^2) of Apricot fruit. The above experiments were performed in 40 replicates.

Surface area was calculated (Mohsenin, 1986) of Apricot kernels:

$$S1 = (\pi Dg)^2 \quad \ldots\ldots 4$$

$$S2= \frac{\pi BL2}{2L-B} \ldots\ldots 5$$

Where: $B = (WT)^{0.5}$

2.4.4. True density (Td)

Fruit density was determined by the water displacement method (Dutta et al., 1988). Randomly selected apricot fruits were weighed on a digital balance with 0.01 g accuracy. The fruits were lowered with a metal sponge sinker into measuring cylinder containing water such that the fruits did not float during immersion in water; weight of water displaced by the fruit was recorded. The volume and, in aftermath, average fruit density (average fruit density other than fruit density because of different density of tissue, kernels, skin, etc.) was calculated by the following equations (Mohsenin, 1986):

$$V_W = m_w / \rho_w \quad \ldots\ldots 6$$

Where:

V_W = volume of displaced water (cm^3),

m_W = mass of displaced water (g),

ρ_w =density of water ($kg\ m^{-3}$), and

$$Td = m/V_W \quad \ldots\ldots 7$$

Where Td: = true density ($kg\ m^{-3}$),

m = mass of apricot fruit (g).

2.4.5. The bulk density (Bd)

The bulk density ($kg\ m^{-3}$) was determined using the mass and volume relationship by filling an empty plastic container of predetermined volume and weight. The fruits were left to fall from a constant height, striking off the top level and weighting. The average fruit density value is the ratio of mass to volume values,

2.4.6. Porosity% (P).

was calculated by follow equation.

$$P = Td - Bd / Td \quad \ldots\ldots 8$$

Where: P= porosity (%), Bd = bulk density (kg m-3).

2.4.7. Friction-angle measurement (Ɵ):

The fruits are placed as a group bounded together on a horizontal surface then the angle of inclination is gradually increased until the fruits begin sliding without rolling. For each fruits group of an average sample (10), the friction angles were determined

2.4.8. Coefficient of static friction (µ):

Coefficient of static friction (µ) of apricot fruits 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 motion, tangent of slip angle was showed the coefficient of friction Baryeh et al. (2003) and Dutta et al. (1988) had used similar methods.

3. RESULTS AND DISCUSSION

The results of the measurements of the physical and mechanical properties of the fruits and the kernels of the apricot are at different levels of moisture content for both of each of them. The fruits were at moisture content of 72.5, 79.51, 79.23 and 83.52 (%w.t). While the kernel moisture content were 3.25, 5.1, 8.95 and 13.56 (%w.t) as shows in tables 1 to 6 and the results could be persecuted as following:

3.1 Geometrical Properties of canine apricot fruits.

3.1.1.Dimensions

Effects of moisture content on geometry dimension, such as length, width and thickness of apricot fruits, were shown on table (1). It is clear that there is strong correlation between them. Reason for these phenomena is cellules inflation and penetration of water in the porous area. Also by increasing moisture content, Geometrical mean diameter was increased. The positive relationship of dimension and geometric mean diameter with moisture content were also observed by other research works such as Gezer et al. (2002) and Kashaninejad et al. (2005) for apricot kernel and pistachio nut.

$L = 0.091\ Mc + 41.16$ $\qquad R^2 = 0.970$

$W = 0.051\ Mc + 36.97$ $\qquad R^2 = 0.983$

$T = 0.057\ Mc + 33.98$ $\qquad R^2 = 0.992$

3.1.2.Geometric Mean Diameter (D_g)

By increasing the moisture content, the geometric mean diameter increases. An inverse relation between the dimension and the mean diameter of the geometric diameter with moisture content was observed through other research work such as Gezer et al. (2002) and Kashaninejad et al. (2005) for apricot kernel and pistachio nuts.

$Dg = -0.048\ Mc + 37.50$ $\qquad R^2 = 0.996$

3.1.3.Sphericity (Φ)

Sphericity is a measure to determine shape of fruit as described in table1. In the present study, change in spherically percentage with moisture content, were measured. Results show that spherically at 72.5% to 83.52%

moisture content were increased from 90.25 to 89.42%, respectively. And the following equation illustrates this relationship.

Sphericity % Φ = - 0.06 Mc + 90.8 $R^2 = 0.996$

Gezer et al.(2002) and Desphande et al. (1993) have found an increasing relationship between sphericity and moisture content in their experiments with apricot kernel and soybean.

3.1.4.Surface Area (S)

In this study, the effect of moisture content on surface area of apricot fruits was investigated. According to table (1), results show that relationship between surface area (S) and moisture content at 72.5% to 83.52% (w.b)% showed that, surface area were increased from 4324.12 to 4420.22 mm^2 with increasing moisture content from72.5% to 83.52% (w.b)% respectively. The following equation links the moisture content and the surface area (S):

S = -2.888 Mc + 4357. $R^2 = 0.953$

Table (1): Effect of moisture content on geometrical properties of apricot fruit.

Geometrical properties	Moisture content			
	72.5%	76.51%	79.23%	83.52%
Length (mm)	41.11	41.52	41.73	41.95
Width (mm)	36.98	37.15	37.25	37.46
Thickness (mm)	33.97	34.18	34.31	34.5
Geometric mean diameter (mm)	37.10	37.36	37.35	37.51
Sphericity (%)	90.25	89.98	89.50	89.42
Surface area 1 (mm^2)	4324.12	4384.94	4382.54	4420.22

3.2. Gravimetrical Properties of fruit

3.2.1. Volume (V) and Mass (M).

With increasing the moisture content from 72.5% to 83.52% (% w.b) volume and mass of fruits increased from 28.94 to 33.62 g and from 31.2 to 34.56 g respectively. Trend of change in volume of fruits with moisture content, were also shown on table (2) . The following equation is used to relate moisture content to volume and mass:

V = -0.524 Mc + 33.17 $R^2 = 0.934$

M = -0.376 Mc + 34.63 $R^2 = 0.997$

Similar results have been reported by Desphande et al. (1993) for soybean, Ogut (1998) for white lupine, Gezer et al.(2002) for apricot kernel, and Karababa (2006) for popcorn kernels.

3.2.2.True Density (Td).

As shown in table (2), true density of apricot fruits at different levels of moisture contents ranged between 1078.09 and 1027.96 kg/m3. The following equation can be used for determining the relationship between density and moisture content. . Aydin (2003) reported that the effect of moisture content on true density of almond nut and kernel showed an increase in kernels volume with moisture content. A negative relationship was also observed by Desphande et al. (1993) for soybean.

$T_d = -3.358\ Mc + 1067.$ $\quad\quad R^2 = 0.977$

3.2.3.bulk density (Bd).

According to table (2), bulk density of apricot fruits at different levels of moisture content decreased from 487.6. to 470.5 Kg/m3 as the following relationship:

$Bd = -1.893\ Mc + 487.3$ $\quad\quad R^2 = 0.998$

The negative relationship of bulk density with moisture content was also observed by Aydin (2003), and Gupta and Das (1997) for almond nut and kernel, and sunflower seeds, respectively.

3.2.4.Porosity% (P).

Reverse relation between porosity and moisture content of apricot kernels (with value 54.77% to 54.23 %) given in the below equation. Table 2 shows trend of this variation.

$P = -1.066\ Mc + 74.85$ $\quad\quad R^2 = 0.990$

3.2.5.Thousand kernels Mass (M_{1000}).

Effect of moisture content on the range from 72.5% to 83.52% on thousand mass of apricot fruits were shown in table(2). Thousand fruits mass at this range of moisture content was between 30.1 to 30.5 kg. Its equation was:

$M_{1000} = 4.517Mc + 424.8$ $\quad\quad R^2 = 0.9458$

Similar results have been reported by Karababa (2006) for soybean, white lupine, millet, pigeon pea, and popcorn kernels, respectively.

Table (2): Effect of moisture content on gravimetrical properties of apricot fruit.

Geometrical properties	Moisture content			
	72.5%	76.51%	79.23%	83.52%
Volume (cm^3)	28.94	29.5	31.2	33.62
Mass (g)	31.2	32.4	33.6	34.56
True density (kg/m^3)	1078.09	1098.3	1076.9	1027.96
Bulk density (kg/m^3)	487.6	481.3	475.8	470.5
Porosity (%)	54.77	56.18	55.82	54.23
Thousand fruit mass (kg)	30.1	30.2	30.3	30.5

3.3-Frictional Properties.

3.3.1. Coefficients of static friction.

Table (3): shows the relationships between the static friction coefficient on three surfaces (wood, glass, and galvanized steel) and the moisture content of apricot fruits. By increasing the moisture content, the static friction coefficient for all surfaces increases, but with different values according to table (3).

Table (3): Effect of moisture content on coefficient of friction of apricot fruit.

Geometrical properties	Moisture content			
	72.5%	76.51%	79.23%	83.52%
wood	0.53	0.54	0.57	0.59
glass	0.49	0.52	0.56	0.58
galvanized sheet	0.63	0.65	0.67	0.69

3.4.Physical properties of Canino apricot kernels.

3.4.1.Geometrical Properties.

3.4.1.1.Dimensions .

Effects of moisture content on geometry dimension, such as length, width and thickness of apricot kernels is shown on table 4.It is clear that there is strong correlation between them. Reason for these phenomena is cellules inflation and penetration of water in the porous area. Also by increasing moisture content, Geometrical mean diameter was increased. A positive linear relationship of dimension and geometric mean diameter with moisture content were also observed by other research works such as Gezer et al. (2002) and Kashaninejad et al. (2005) for apricot kernel and pistachio nut, respectively.

$L = -0.020\ Mc + 15.39$ $R^2 = 0.959$

$W = -0.019\ Mc + 10.40$ $R^2 = 0.990$

$T = -0.023\ Mc + 5.645$ $R^2 = 0.997$

3.4.1.2. Geometric Mean Diameter (D_g).

By increasing the moisture content, the geometric mean diameter increases. An inverse relation between the dimension and diameter of the geometric area with moisture content was observed through other research work such as Gezer et al. (2002) and Kashaninejad et al. (2005) for apricot kernel and pistachio nuts, respectively

$D_g = -0.017\ Mc + 9.58$ $R^2 = 0.943$

3.4.1.3.Sphericity (Φ).

Sphericity is a measure to determine shape of kernel which can describe figure of it. In the present study, change in spherically percentage with levels of moisture content, were measured. Results show that spherically at 3.25%,5 till 13.56% moisture content were from 61.52%to and 62.86%, respectively. Sphericity was increased with increasing in moisture content (Table 4). Gezer et al.(2002) and Desphande et al.(1993) have found an increasing relationship between sphericity and moisture content in their experiments with apricot kernel and soybean, respectively.

Sphericity $\Phi = -0.046\ Mc + 62.72$ $R^2 = 0.92$

3.4.1.4. Surface Area (S).

In this study, effect of moisture content on surface area of apricot kernels investigated. According to table Table (5), results show that equation S_1 with moisture content 3.25, 5.1, 8.95 and 13.03% surface area 1 were 271.13, 277.54, 284.13, and 294.37 $mm^2$and with equation S2 it was 229.005, 234.406, 234.911 and 248.310 mm^2, respectively.

$S1 = -1.051\ Mc + 296$ $R^2 = 0.959$

$S2 = -0.932\ Mc + 251.1$ $R^2 = 0.940$

Equation S1 show more surface area than equation S_2 which this difference related to change in data apparatus act on the equations. Similar trends were reported for many other seeds (Mohsenin, 1970). Desphandeet al.(1993) found that the surface area of soybean grain increased from 0.813 to 0.952 cm^2, when the moisture content was increased from 8.7% to 25% db.

Table (4): Effect of moisture content on geometrical properties of apricot kernel.

Geometrical properties	Moisture content			
	3.25%	5.1%	8.95%	13.56%
Length (mm)	15. 1	15.2	15.3	15.4
Width (mm)	10.1	10.2	10.3	10.4
Thickness (mm)	5.3	5.4	5.5	5.7
Geometric mean diameter (mm)	9.29	9.40	9.51	9.68
Sphericity (%)	61.52	61.84	62.16	62.86
Surface area 1 (mm^2)	271.13	277.59	284.13	294.37
Surface area 2 (mm^2)	229.005	234.406	239.911	248.310

3.5.Gravimetrical Properties apricot kernel.

3.5.1.Volume (V) and Mass (M).

As shown in table (5) with increasing in moisture content from 3.25 % to 13.56% volume and mass increasing from 0.43 to 0.475 and from 0.43 to 0.48 for apricot kernels respectively. Trend of change in volume of kernels with moisture content, were shown in table(5) .The volume and mass were increased with increasing moisture content and its relation is as below:

$$V= -0.003\ Mc + 0.472 \qquad R^2 = 0.978$$

$$M= -0.003\ Mc + 0.478 \qquad R^2 = 0.979$$

Similar results have been reported by Gezer et al.(2002) for apricot kernel, and Karababa (2006) for popcorn kernels.

3.5.2. True Density (Td).

As shown in figure 7, true density of apricot kernels at different levels of moisture contents was between 1000.7 till 1010.53 kg/m^3. The following equation can be used for determining the relationship between density and moisture content. Aydin (2003) reported that the effect of moisture content on true density of almond nut and kernel showed an increase with moisture content.

$$Td= -0.56\ Mc + 1023. \qquad R^2 = 0.964$$

3.5.3. Bulk Density (Bd).

According to table (5), bulk density of apricot kernels at different levels of moisture content were 580 to 540.1 Kg/m^3 which relation as below:

$$Bd=2.85\ Mc + 540.6 \qquad R^2 = 0.976$$

The negative relationship of bulk density with moisture content was also observed by Aydin (2003), and Gupta and Das (1997) for almond nut and kernel, and sunflower seeds, respectively.

3.5.4.Porosity (P).

There is an inverse relationship between the porosity and the moisture content in the apricot kernel. By increasing the moisture content, the porosity decreases from 46.55% to 42%. Table (5) shows the direction of this difference. This is explained by the following equation:

$$P = 0.328\ Mc + 42.94 \qquad R^2 = 0.96$$

Other researchers reported similar results for gram (Dutta et al., 1988), sunflower seeds (Gupta and Das, 1997), white lupin (Ogut, 1998), hazel nuts (Aydin, 2002), chickpea seeds (Konak et al., 2002), arecanut kernels (Kaleemullah and Gunasekar, 2002), okra seeds (Sahooand Srivastava, 2002) and pigeon pea (Baryeh and Mangope, 2003).

3.5.5.Thousand kernels Mass (M_{1000}).

Table (5) shows the effect of increasing moisture content from 3.25% to 13.56% on the mass of grains from the apricot kernel. We find that with increasing moisture content, the weight of a thousand kernel increases from 1.44 to 1.482 kg. This relationship shows the following equation:

$$M_{1000} = 3.194\ Mc + 433.4 \qquad R^2 = 0.960$$

Similar results have been reported by Karababa (2006) for soybean, white lupine, millet, pigeon pea, and popcorn kernels, respectively.

Table (5): Effect of moisture content on gravimetrical properties of apricot kernels.

Geometrical properties	Moisture content			
	3.25%	5.1%	8.95%	13.56%
Volume (cm^3)	0.43	0.44	0.455	0.475
Mass (g)	0.43	0.44	0.46	0.48
True density (kg/m^3)	1000	1001	1010.99	1010.53
Bulk density (kg/m^3)	580	562.3	543.2	540.1
Porosity (%)	42	43.77	46.27	46.55
Thousand kernels mass (kg)	1.440	1.450	1.460	1.482
Surface area 1(mm^2)	282.40	285.2	290.5	298.15
Surface area 2 (mm^2)	238.6	240.30	245.50	252.40

3.6.Frictional Properties.

3.6.1. Coefficient of friction.

Table (6): The relationship between the static friction coefficient and the moisture content of the apricot kernel on four surfaces (wood, glass, galvanized steel, and fiberglass). It is evident that the increase in moisture content in the apricot kernel increases the friction coefficient of all different surfaces, as shown in Table 6. This corresponds to what Gezer et al. (2002) shows that the higher the moisture content, the greater the static friction coefficient.

Table (6): Effect of moisture content on coefficient of friction of apricot kernels.

Geometrical properties	Moisture content			
	3.25%	5.1%	8.95%	13.56%
Wood	0.345	0.377	0.384	0.411
Glass	0.159	0.177	0.185	0.188
galvanized sheet	0.188	0.200	0.207	0.231
fiberglass sheet	0.246	0.249	0.262	0.264

4. CONCLUSIONS

Physical and mechanical properties are affected and considered to be moisture content of apricot fruits. With the increase in the moisture content of apricot fruits, the length, width, thickness, average geometric diameter, surface area increased, the mass increased, the volume increased, the mass of a thousand apricots increased. While the Sphericity, decreased, the true density, porosity, and bulk density. In the case of the physical and mechanical properties of the apricot kernel. With the increase in the moisture content of the apricot kernel, the length, width, thickness, average geometric diameter, surface area 1, surface area 2, Sphericity, mass, size, true density, porosity increased, the mass of thousand kernel from the apricot while the bulk density decreased, the coefficient increased Friction on all surfaces of boards (wood, glass, galvanized iron, and fiberglass) with increased moisture content for both the fruit and the apricot kernel.

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الملخص العربى

تأثيرات المحتوى الرطوبى على بعض الخواص الطبيعية والميكانيكية لثمرة ونواة المشمش

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الهدف الرئيسي من تلك الدراسة هو تعيين قيمة بعض الخواص الفيزيائية والميكانيكية لثمار ونواة المشمش لتشكيل قاعدة بيانات هامة للمشمش في مصر. تعتبر الخصائص الفيزيائية والميكانيكية للمنتجات الزراعية أهم المعايير لتحديد التصميم الأمثل لأنظمة ما بعد الحصاد وهي مهمة للغاية لفهم سلوك المنتج أثناء التداول ، مثل الحصاد والنقل والفرز والتسوية والتعبئة والتخزين. . أجريت هذه الدراسة لدراسة بعض الخصائص الفيزيائية والميكانيكية كدالة للمحتوى الرطوبى لثمار المشمش. فمع زيادة المحتوى الرطوبى للمشمش من ٧٢,٥ الى ٨٣,٥٢٪ ، زاد كلا من الطول من ٤١,١١ الى ٤١,٩٥ مم ، العرض من ٣٦,٩٨ الى ٣٧,٤٦ مم ، السمك من ٣٣,٩٧ الى ٣٤,٥ مم ، متوسط القطر الهندسي من ٣٧,١٠ الى ٣٧,٥١ مم ومساحة السطح من ٤٣٢٤,١٢ الى ٤٤٢٠,٢٢ مم^{٢} ، وزادت الكتلة من ٣١,٢٠ الى ٣٤,٥٦جم، وزاد الحجم من ٢٨,٩٤ الى ٣٣,٦٢ سم٣، وزادت كتلة الف ثمرة من المشمش من ٣٠,١ الى ٣٠,٥ كجم . بينما نقص كلا من الكروية من ٩٠,٢٥ الى ٨٩,٤٢ ٪ والكثافة الحقيقية من ١٠٧٨,٠٤ الى ١٠٢٧,٩٦ كجم / م^{٣} و المسامية من ٥٤,٧٧ الى ٥٤,٢٣ ٪ والكثافة الظاهرية من ٤٨٧,٦ الى ٤٧٠,٥ كجم / م^{٣}.

***باحث أول – معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – دقى – جيزة.**

وفى حالة الخصائص الفيزيائية والميكانيكية لنواة المشمش. مع زيادة المحتوى الرطوبى للمشمش من ٣,٢٥ الى ١٣,٥٦% زاد كلا من الطول من ١٥,١ الى ١٥,٤ مم ، العرض من إلى ١٠,١ الى ١٠,٤ مم ، السمك من ٥,٣ الى ٥,٧ مم ، متوسط القطر الهندسي من ٩,٢٩ إلى ٩,٦٨مم ، مساحة السطح ١ من ٢٧١,١٣ الى ٢٩٤,٣٧ مم٢و مساحة السطح ٢ من ٢٢٩,٠٠٥ الى ٢٤٨,٣١٦ مم٢ ؛ الكروية من إلى ٦١,٥٢ الى ٦٢,٨٦٪ ، الكتلة من ٠,٤٣ الى ٠,٤٨ جم ، الحجم من إلى ٠,٤٣الى ٠,٤٧٥ سم ٣ ، الكثافة الحقيقية من ١٠٠٠ إلى ١٠١٠,٥٣ كجم / م ٣ ، المسامية من ٤٢ الى ٤٦,٥٥ ٪ ، كتلة الف نواة من المشمش من ١,٤٤ الى ١,٤٨٢ كجم. بينما نقصت الكثافة الظاهرية من ٥٨٠ الى٥٤٠ كجم / م٣. وزاد معامل الاحتكاك على جميع أسطح ألواح (الخشب ، الزجاج ،الحديد المجلفن ، الزجاج الليفي) مع زيادة المحتوى الرطوبى لكلا من ثمرة و نواة المشمش.