Some Physical properties of Date Fruit (cv. Lasht)

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ABSTRACT

Knowledge of the physical properties of date fruit is necessary for the design of post harvesting equipment such as cleaning, sorting, grading, kernel removing, and packing. In this study, some physical properties of date (*Phoenix dactylifera* L.) fruit (cv. Lasht) were determined. Dry-basis moisture content of date fruits found to be 18.48% (19.60% for pitted dates and 8.69% for their pits). Other results showed that linear dimensions varied from 33.10 to 42.60mm in length, 18.20 to 25.30mm in width, and 17.40 to 24.40mm in thickness. Mean mass and fruit volume was measured as 7.16g and 7.24cm^3, respectively. The projected areas perpendicular to length (P_L), width (P_W), and thickness (P_T) were 389.31, 633.38 and 663.05mm^2, respectively. Attempt was made to model date mass by applying different physical characteristics as three different classifications based on single or multiple variable regressions of dimensions characteristic, projected areas and single variable regression of volume. The results of mass modeling showed that there were no significant relations based on dimensions and projected areas while appropriate mass model based on volume was found to be as: $\mathrm{M} = +0.7962\,\mathrm{V} + 1.3930$, $R^2 = 0.76$. The fruit density and pitted fruit density were measured 1.00 and 1.39g/cm^3 while bulk density and porosity were 0.53g/cm^3 and 46.56%, respectively. The geometric mean diameter, sphericity and surface area were obtained as 25.95mm, 0.69, and 2121.38mm^2, respectively. The mean coefficients of static friction were measured as 0.35, 0.32 and 0.26 on galvanized steel, plywood and glass surfaces, respectively.

Keywords: Date fruit, physical properties, Lasht, friction, Jahrom

1. INTRODUCTION

Date fruit is one of the most important agricultural products of Iran. Most of the date fruit processing methods employed is still traditional. There is a need for a comprehensive study of the physical properties of date to develop appropriate technologies for its processing. The development of the technologies will require the properties of this fruit. It becomes imperative to characterize the fruits with a view to understand the properties that may affect the design of machines to handle their processing. Many researchers have conducted experiments to find the physical properties of various fruits and crops. Tabatabaeefar et al. (2000) determined models for predicting mass of Iranian grown oranges. In another study, Tabatabaeefar (2002) determined the physical properties of common varieties of Iranian grown potatoes and the relationships among their physical attributes. Topuz *et al.* (2005) determined and compared several properties of four orange varities. Tabatabaeefar and

Rajabipour (2005) recommended 11 models for predicting mass of apples based on geometrical attributes. Lorestani and Tabatabaeefar (2006) determined models for mass modeling of kiwi based on physical attributes. Asoegwu et al. (2006) determined some physical properties of African oil bean seeds at 8.73 ± 0.09% moisture content (db) using standard methods as a prelude to obtaining relevant data for the design of tools, equipment, machines and systems for their processing. Keramat Jahromi *et al.* (2007) determined dimensions and projected areas of date (Barhi variety) by image processing technique. Also many studies have been reported on the physical properties of agricultural crops such as plum (Ertekin *et al.*, 2006) and gumbo fruit (Akar & Aydin, 2005).

The objectives of this study is to determine some physical properties of date fruit (cv. Lasht) in order to facilitate the design of some machines for its processing. Also An attempt was made to model date mass based on single or multiple variable regressions of dimensions characteristic, projected areas and single variable regression of volume. Up to date, no detailed study of mass modeling of date fruit has been performed

2. MATERIALS AND METHODS

In this study, the date fruit was selected from Lasht cultivar (Fig. 1). From the samples, about 500 fruits were randomly obtained from a local market in Jahrom (an important city in date production located in the south of Iran).

Fig.1. Date samples (cv. Lasht)

The fruits were transported, individually to the Physical Laboratory of Biosystems Faculty in the University of Tehran. All experiments were carried out at a temperature range of 25–30 °C in three days.

In order to obtain the moisture content, samples were kept in an oven (Iran Khodsaz) for 3 days at 105 °C. Weight loss on drying to a final constant weight was recorded as moisture content by AOAC (1984) recommended method and using the following equation (1):

$$MC = \frac{M_0 - M_d}{M_o} \times 100 \qquad (1)$$

where MC is moisture content (w.b.), M_0 is initial mass and M_d is the final mass of date fruit (g).

Mass of individual fruit was determined using an electronic balance with a sensitivity of 0.0l g. Fruit volumes were measured by water displacement method. Fruits were weighed in air and allowed to float in water. Fruits were lowered with a needle into a graduated beaker containing water and the mass of water displaced by the individual fruit was recorded. Finally, fruit densities (g/cm^3) were calculated by using the following equation (2) (Mohsenin, 1986):

$$\rho_f = \frac{M_a}{M_a - M_w} \times \rho_w \qquad (2)$$

where ρ_f and ρ_w are fruit and water densities (g/m^3); M_a and M_w are mass of date in air and water, respectively.

The bulk density was determined using the mass/volume relationship (equation 3) (AOAC, 1984; Owolarafe et al., 2007) by filling an empty plastic container of predetermined volume and mass with the fruits were poured from a constant height, and weighed.

$$\rho_b = \frac{M}{V} \qquad (3)$$

where ρ_b is the bulk density (g/cm^3), M and V are bulk mass of fruit (g), and the plastic container volume (cm^3), respectively. This method was based on the work of Owolarafe et al (2007), Fraser *et al.*, (1978) and Suthar *et al.*, (1996).

Porosity (ε) was calculated as the ratio of the differences in the fruit and bulk densities to the fruit density value and expressed in percentage (Jain and Bal, 1997; Vursavus *et al.*, 2006; Owolarafe et al., 2007):

$$\varepsilon = \left(\frac{\rho_f - \rho_b}{\rho_f}\right) \times 100 \qquad (4)$$

Linear dimensions, i.e. length, width and thickness and also projected areas, were determined by image processing method. In order to obtain dimensions and projected areas, WinArea-_UT_06 system (Mirasheh, 2006) was used (Fig. 2).

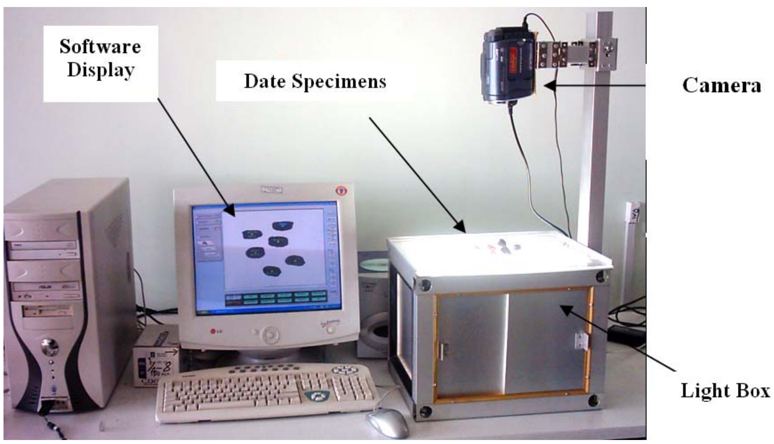

Fig.2.WinArea_UT_06 system

WinArea_UT_06 system comprises following components:

1. Sony photograph camera Model CCD-TRV225E (with resolution of 800*600 pixels)
2. device for preparing media to taking a picture
3. Card capture named Winfast model DV2000
4. Computer software programmed with visual basic 6.0

Captured images from the camera are transmitted to the computer card which works as an analog to digital converter. Digital images are then processed in the software and the desired user needs are determined. Total error for those objects was less than 2%. This method have been used and reported by several researchers (Rafiee et al., 2006; Keramat Jahromi et al., 2007; Khoshnam et al., 2007). From Fig. 3, L, W and T are perpendicular dimensions of date fruit namely length, width and thickness and P_L, P_W and P_T are the projected areas taken along these three mutual perpendicular axes.

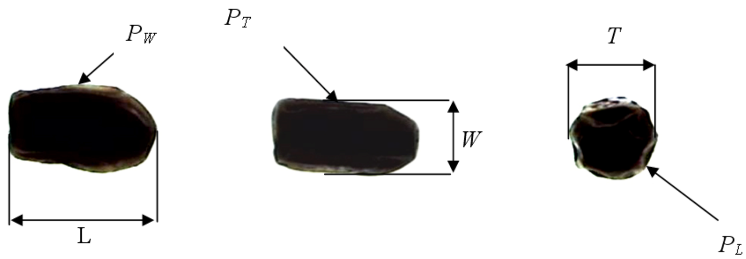

Fig. 3.Three major dimensions and projected areas of date fruit

Geometric mean diameter (D_g), sphericity (Φ) and surface areas (S) were calculated by using the following equations:

$$D_g = (LWT)^{1/3} \qquad (5)$$

$$\Phi = D_g / L \qquad (6)$$

$$S = \pi . D_g^{\ 2} \qquad (7)$$

As reported by Mohsenin (1986) and Kabas *et al.* (2006).

The coefficients of static friction were obtained with respect to three different surfaces namely galvanized steel, plywood and glass surfaces by using an inclined plane apparatus as described by Dutta *et al.* (1988). The inclined plane was gently raised and the angle of inclination at which the sample started sliding was read off the protractor with sensitivity of one degree. The tangent of the angle was reported as the coefficient of friction (Dutta *et al.*, 1988):

$$\mu = \tan \phi \qquad (8)$$

where, μ is the coefficient of friction and ϕ is the tilt angle of the friction device. All the friction experiments were conducted in three replications for each surface.

3. RESULTS AND DISCUSSION

The average dry-basis moisture content of date fruit samples was found to be 18.48% (19.60% for pitted dates and 8.69% for their pits). Results showed that mass and volume varied from 3.99 to 9.95g and from 3.99 to 10.71g/cm^3 with mean values of 7.16g and 7.24g/cm^3, respectively. Dimensions varied from 33.10 to 42.60mm in length, 18.20 to 25.30mm in width, and 17.40 to 24.40 mm in thickness, with average values of 37.82, 22.08, and 20.95mm, respectively. The importance of dimensions is in determining the aperture size of machines, particularly in separation of materials as discussed by Mohsenin (1986). These dimensions can be used in designing machine components and parameters. For example, it may be useful in estimating the number of fruits to be engaged at a time. The major axis has been found to be useful by indicating the natural rest position of the fruit. The mean projected areas perpendicular to length, width, and thickness were obtained as 389.31, 633.38 and 663.05 mm^2, with variation of 292 to 500, 477 to 833 and 487.00 to 854mm^2, respectively. It was found that the projected area, perpendicular to thickness, showed higher values than that of other areas. The results of mass modeling based on single or multiple variable regressions of dimensions characteristic, projected areas and single variable regression of measured volume showed that there were no significant relations based on dimensions and projected areas, while mass model based on measured volume was obtained as relation: $\text{Mass} = +.7962\,(\text{Volume}) + 1.3930$, $R^2 = 0.76$.

Grading fruit based on weight reduces packing and handling costs and also provides suitable packing patterns (Khoshnam et al., 2007). The whole fruit density and pitted fruit density were measured and found to be between 0.80 to 1.21 and 1.33 to 1.44g/cm^3 and with average values of 1.00 and 1.39g/cm^3, respectively. Bulk density and porosity obtained were found to be 0.53g/cm^3 and 46.56%, respectively. The geometric mean diameter, sphericity and surface area varied from 22.21 to 29.5 mm, 0.63 to 0.74, and 1549.51 to 2734.73 mm^2 while mean values were 25.95 mm, 0.69, and 2121.38 mm^2 , respectively. Also mean coefficient of static friction, on galvanized steel, plywood and glass surfaces, were obtained as 0.35, 0.32 and 0.26, respectively. Result of analysis showed that the surface materials had a significant difference ($p<0.01$) on the static coefficient of friction. The static coefficient of friction on plywood was higher than that on glass and lower than that of galvanized steel surface. This is due to the frictional properties between the fruits and surface materials. These properties may be useful in the separation process and the transportation of the fruits. A summary of results of the determined physical parameters is shown in Table1.

Table1. Some Physical properties of date fruit (Lasht cultivar)

Properties of date	Number of observations	Minimum value	Maximum value	Mean value	Standard deviation
Mass, g	100	3.99	9.95	7.16	1.41
Volume, cm^3	100	3.99	10.71	7.24	1.54
Length (L), mm	100	33.10	42.60	37.82	2.18
Width (W), mm	100	18.20	25.30	22.08	1.32
Thickness (T), mm	100	17.40	24.40	20.95	1.38
Projected area along L, mm	100	292.00	500.00	389.31	44.36
Projected area along W, mm	100	477.00	833.00	633.38	70.01
Projected area along T, mm	100	487.00	854.00	663.05	69.75
Fruit density, g/cm^3	100	0.80	1.21	1.00	0. 10
Pitted density, g/cm^3	5	1.33	1.44	1.39	0.04
Geometric mean diameter, mm	100	22.21	29.50	25.95	1.39
Sphericity, %	100	0.63	0.74	0.69	0.02
Surface area, mm^2	100	1549.51	2734.73	2121.38	227.24
Bulk density, g/cm^3	3	0.51	0.55	0.53	0.02
Porosity, %	3	44.44	48.49	46.56	2.03

Static coefficient of friction	Galvanized steel	3	0.34	0.36	0.35	0.01
	Plywood	3	0.31	0.33	0.32	0.01
	Glass	3	0.25	0.27	0.26	0.01

The physical properties of date fruit were described in order to better design of a specific machine for post-harvesting operations.

4. CONCLUSIONS

1- The average mass and volume for date (cv. Lasht) were found to be 7.16g and 7.24cm^3, respectively.
2- The fruit density and pitted fruit density were measured as 1.00 and 1.39g/cm^3, respectively.
3- The bulk density and porosity were 0.53 g/cm^3 and 46.56%, respectively.
4- Linear dimensions ranged from 33.10 to 42.60mm in length, 18.20 to 25.30mm in width, and 17.40 to 24.40mm in thickness.
5- The mean projected area perpendicular to length, width, and thickness were determined as 389.31, 633.38 and 663.05 mm^2, respectively.
6- The geometric mean diameter, sphericity and surface area were calculated as 25.95 mm, 0.69 and 2121.38 mm^2, respectively.
7- The mean coefficients of static friction, on galvanized steel, plywood and glass surfaces, were obtained as 0.35, 0.32 and 0.26, respectively.

5. ACKNOWLEDGEMENT

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