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DETERMINATION OF SOME PHYSICAL PROPERTIES OF DATE PALM FRUITS (CV. KHADRAWY AND MEDJOOL)

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A b s t r a c t. The present investigation was carried out to evaluate some physical properties of date palm fruits cv. Khadrawy and Medjool. Pulp moisture content, seed moisture content, fruit dimensions (Major and minor intercept), arithmetic mean diameter, geometric mean diameter, sphericity, colour values (L, a, b), bulk density, true density, porosity and coefficient of static friction were determined for both the varieties. The determined properties had significant difference in their values which may be due to the distinctive features of both the varieties.

K e y w o r d s: date palm, physical properties, Khadrawy, Medjool

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruit crops of the arid regions of Arabian Peninsula, North Africa and the Middle East. They are considered to be a major source of income as well as staple food for the local population in the countries where they are cultivated (Chao and Krueger, 2007). Dates contain dietary fibre, pectin, tannins, some vitamins, minerals, low quantities of organic acids, with very little or no starch, and a number of antioxidant anti-mutagenic compounds (Biglari *et al.* 2008). Because of its nutritional properties, date fruit as such can have an extensive range of applications, but at present the processing applications are very limited (Kamal-Eldin *et al.* 2012).

The knowledge of some important physical properties such as spatial dimensions, bulk density, true density, and porosity of different fruits/vegetables/grains is essential for the design of storage structures, processing equipments, and processes (Vishwakarma *et al.* 2012). Linear dimensions and colour values are required especially for the design of equipments related to sorting and grading. Estimation of bulk density is required to

determine the capacity of storage and transport, while the true density is useful to design proper separation equipment. Porosity of the fruit mass determines the resistance to air-flow during aeration and drying operations. Information about the frictional properties is essential to understand the behaviour of the fruits during handling operations and for the design of handling equipments (Jahromi *et al.* 2008). Varietal difference of fruits is also one of the prominent reasons for having deviations in physical properties.

There are plentiful studies which include the determination of physical properties of different fruits with varietal differences. Few among them include five date cultivars, viz. Gash Gaafar, Gash Habash, Shahla, Bushibal and Lulu (Al- Hooti *et al.* 1997), mango cv. Dashehari (Jha *et al.* 2006), three sweet cherry varieties (*Prunus avium* L.) (Vursavus *et al.* 2006), guna fruits (Aviara *et al.* 2007), date fruit cv. Lasht (Jahromi *et al.* 2007), date fruit cv. Dairi (Jahromi *et al.* 2008) and wild mango cv. Irvingia gabonensis and wombolu (Ehiem and Simonyan, 2012). However, information involving the determination of physical properties of date palm fruits cv. Khadrawy and Medjool has not been reported. Therefore, the objective was framed accordingly to investigate some physical properties of date palm fruits cv. Khadrawy and Medjool. The properties, viz., pulp moisture content, seed moisture content, fruit linear dimensions (length, width, thickness), arithmetic mean diameter, geometric mean diameter, sphericity, colour values (L, a, b), bulk density, true density, porosity and coefficient of static friction were determined.

MATERIAL AND METHODS

Fruits of date palm cv. Khadrawy were procured from Regional Research Station, PAU Ludhiana, Abohar, and fruits of cv. Medjool were procured from the farm orchard of ICAR-CIPHET, Abohar (Fig 1). The fruits were cleaned before using for further experimentation.

Fig. 1. Pictorial view of date fruits (Khadrawy and Medjool) – date fruit: (a) cv. Khadrawy; (b) cv. Medjool

Average size of the randomly selected fruits was determined by measuring three linear dimensions specified as length (*L*), width (W) and thickness (*T*) by digital vernier callipers (Mitutoyo Corporation, Japan) (least count 0.01 mm). Some other associated parameters like geometric mean diameter (D_p), arithmetic mean diameter (D_a) and sphericity (Φ_s) of the seeds were also calculated using the relationship given by (Mohsenin 1970).

$$D_p = (L \times W \times T)^{1/3} \tag{1}$$

$$D_a = \frac{L + W + T}{3} \tag{2}$$

$$\Phi_s = \frac{(LWT)1/3}{L} \tag{3}$$

Surface area (*S*) was found by analogy with a sphere of the same geometric mean diameter, using the following relationship as reported by Altuntases *et al.* (2005). It is calculated and represented in mm^2.

$$S = \pi D_p^2 \tag{4}$$

Bulk density was measured using a wooden box with inside dimensions of 100×100×100 mm. Fruits were poured into the box of known volume, removing excess fruits by rolling a measuring scale on the rim of the box without compaction. The weight of the poured box was taken and the procedure was repeated ten times and average bulk density was calculated by dividing the weight of the poured box by the volume of the box (Dutta *et al.* 1988). True density was determined using the toluene displacement method in which the volume of toluene displaced was estimated by immersing the weighed quantity of fruits in toluene. Porosity (ε) was calculated using the relationship given by Vursavus *et al.* (2006):

$$\varepsilon = 100(1 - \rho_b/\rho_t) \tag{5}$$

where, ε is porosity (%), ρ_b is bulk density (g cm^{-3}) and ρ_t is true density (g cm^{-3}).

To evaluate the test weight (100 fruits), 100 fruits were selected randomly and weighed by means of an electronic balance (Goldtech, India) (least count of 0.01 g). Coefficient of static friction on four different surfaces, namely plywood, mild steel, stainless steel and cast iron, was measured by the inclined plane method (Singh and Goswami, 1996). A single fruit was kept on an adjustable tilting plate and the

slope was increased gradually. The angle at which the material just started to move downward was recorded (α). Coefficient of friction was calculated from the following relationship given by Dutta *et al.* (1988):

$$\mu = \tan \alpha \tag{6}$$

Table 1. Some physical properties of date palm fruits (Khadrawy and Medjool)

Parameters	Variety	
	Khadrawy	Medjool
Pulp moisture content (% d. b)	78.12 ± 2.37	69.46±1.21
Seed moisture content (% d. b)	42.47 ± 0.66	39.08±0.31
Length (L) mm	41.75 ± 2.41	48.26 ± 2.49
Width(W) mm	19.46 ± 1.08	29.05 ± 1.75
Thickness (T) mm	19.54 ± 1.09	28.80 ±1.56
AMD	26.92 ±1.19	35.37 ±1.41
GMD	1.09 ± 0.063	2.20 ± 0.062
Sphericity	0.60 ± 0.03	0.71 ± 0.024
100 fruits weight (g)	860.45 ± 4.64	2199.6± 13.30
100 fruit pulp weight (g)	685.40 ± 5.25	1717 ± 8.39
100 fruit seed weight (g)	136.60 ± 7.86	213 ± 6.97
Bulk density (g cm^{-3})	0.56 ± 0.017	0.59 ± 0.014
True density (g cm^{-3})	0.93 ± 0.02	0.85 ± 0.015
Porosity	0.40 ± 0.01	0.34 ± 0.007
Pulp: fruit	0.890	0.833
Seed: fruit	0.166	0.111
Seed : pulp	0.199	0.124
L	61.3 ± 4.08	61.56 ± 2.81
a	35.57 ± 5.95	34.79 ± 5.74
b	38.87 ± 6.90	30.22 ± 1.68
Coefficient of static friction (Plywood)	0.19 ± 0.04	0.24 ± 0.055
Coefficient of static friction (GI)	0.17 ± 0.02	0.21 ± 0.038
Coefficient of static friction (MS)	0.15 ± 0.05	0.22 ± 0.030
Coefficient of static friction (SS)	0.13 ± 0.06	0.20 ± 0.037

All values are average with 10 replications, with representation (Average value ± S.D)

RESULTS AND DISCUSSION

The moisture content of both pulp and seed of cv. Khadrawy was found to be higher than that of cv. Medjool. In the case of Khadrawy variety, moisture content (% d b) of pulp and seed was 78.12±2.37 and 42.47±0.66, respectively, while for Medjool variety the values for pulp and seed were 69.46±1.21 and 39.08±0.31, respectively.

Three principal dimensions *i.e.* length, width and thickness of date palm fruits of both cv. Khadrawy and cv. Medjool were determined. For Medjool variety, average values of *L*, *W* and *T* were 48.26±2.49 mm, 29.05±1.75 mm and 28.80±1.56, while for cv. Khadrawy the values were 41.75±2.41 mm, 19.46±1.08 mm and 19.54±1.09 mm, respectively. Arithmetic and geometric mean diameter was found to be 26.92±1.19 mm and 1.09±0.063 for Khadrawy; 35.37±1.41 mm and 2.20±0.062 for Medjool variety, respectively.

Sphericity of cv. Khadrawy and Medjool was 0.60±0.03 and 0.71±0.024, respectively. Fruits of date palm cv. Medjool, being larger in size, attained more roundness, which resulted in higher values of sphericity. 100 fruits weight was 860.45±4.64 g for cv. Khadrawy and 2199.6±13.30 g for Medjool variety. There was an increase of around 155% in the 100 fruit weight of Medjool variety as compared to Khadrawy variety. Hundred fruit pulp mass was 685.40±5.25 g and 1717±8.39 g for cv. Khadrawy and Medjool, respectively. This was due to the proportional increase in the size of Medjool fruit as compared to Khadrawy. Hundred fruit seed mass was 136.60 ± 7.86 g and 213± 6.97 g for cv. Khadrawy and Medjool, respectively. This increase of about 56% corresponds to the seed mass of Medjool variety as compared to Khadrawy variety.

Bulk density of fruits of date palm cv. Medjool (0.59±0.014) g cm^{-3} was slightly higher than of that of cv. Khadrawy (0.56±0.017) g cm^{-3}. True density of cv. Khadrawy (0.93±0.002) g cm^{-3} was higher than of cv. Medjool (0.85±0.015) g cm^{-3}. Porosity of date palm fruits decreased from 0.40±0.01 to 0.34±0.007 with Khadrawy and Medjool date palm, respectively.

Overall values of the coefficient of static friction were the highest for plywood surface, followed by galvanised iron, mild steel and stainless steel. This is because of the resistance of that surface for particle to flow due to the roughness of the surface. In overall, the respective values of all the determined physical properties were higher for Medjool variety as compared to Khadrawy variety.

CONCLUSIONS

This study dealt with measurement of physical properties of two date palm varieties (Khadrawy and Medjool), contributing knowledge about the changing behaviour of the determined properties with inherited varietal differences. The values for axial dimensions with respect to major and minor intercepts of Medjool variety were substantially higher as compared to Khadrawy variety. Also, the weight related parameters, *i.e.* 100 fruit weight, were observed to be higher for cv. Medjool. Pulp and seed moisture content was higher for cv. Khadrawy as well, as it has a higher pulp percentage and pulp: fruit ratio. Coefficient of static friction was found to follow a decreasing trend with the plywood, galvanised iron, mild steel and stainless steel surfaces, respectively, for both the varieties. The engineering properties were observed to be significantly affected by the varietal differences. Such information may find applicability in adequate design and development of equipments pertaining to post harvest technology and processing of these fruits.

REFERENCES

Al-Hooti S., Sidhu J.S., Qabazard H., 1997. Physicochemical characteristics of five date fruit cultivars grown in the United Arab Emirates. Plant Food Hum. Nutr., 50, 101-113.

Altuntases E.O., Zgo Z.E. Tas-er O.F., 2005. Some physical properties of fenugreek (*Trigonella foenum-graceum* L.) seeds. J. Food Eng., 71, 37-43.

Aviara N.A., Shittu S.K., Haque M.A., 2007. Physical properties of guna fruits relevant in bulk handling and mechanical processing. Int. Agrophys., 21, 7-16.

Biglari F., Al-Karkhi A.F.M., Essa A.M., 2008. Cluster analysis of antioxidant compounds in dates (*Phoenix dactilifera*): effect of long-term cold storage. Food Chem., 112, 998-1001.

Chao C.C.T., Krueger R.R., 2007. The date palm (*Phoenix dactylifera* L.): Overview of biology, uses and cultivation. Hort. Sci., 42, 1077-1082.

Dutta S.K., Nema V.K., Bhardwaj R.K., 1988. Physical properties of grain. J. Agric. Eng. Res., 39, 259-268.

Ehiem J.C., Simonyan K.J., 2012. Physical properties of wild mango fruit and nut. Int. Agrophys., 26, 95-98.

Jahromi M.K., Jafari A., Rafiee S., Keyhani A.R., Mirasheh R., Mohtasebi S.S., 2007. Some physical properties of date fruit (cv. Lasht). Agril. Eng. Int., Manuscript FP 07 019. Vol. IX.

Jahromi M.K., Rafiee S., Jafari A., Ghasemi Bousejin M.R., Mirasheh R., Mohtasebi S.S., 2008. Some physical properties of date fruit. Int. Agrophys., 22 (3), 221-224.

Jha S.N., Kingsly A.R.P., Chopra S., 2006. Physical and mechanical properties of mango during growth and storage for determination of maturity. J. Food Eng., 72, 73-76.

Kamal-Eldin A., Hashim I.B., Mohamed I.O., 2012. Processing and utilization of palm date fruits for edible applications. Recent Pat Food, Nutr Agric, 4, 78-86.

Mohsenin N.N., 1970. Physical Properties of plant and animal materials. Gordon and Breach Science Publishers, New York.

Singh K.K., Goswami K.K., 1996. Physical properties of cumin seed. J. Agric. Eng. Res., 64, 93-98.

Vishwakarma R.K., Shivhare U.S., Nanda S.K., 2012. Physical properties of guar seeds. Food Bioprocess Technol., 5, 1364-1371.

Vursavus K., Kelebek H., Selli S., 2006. A study on some chemical and physico-mechanic properties of three sweet cherry varieties (*Prunus avium* L.) in Turkey. J. Food Eng., 74, 568-575.

OKREŚLENIE NIEKTÓRYCH WŁAŚCIWOŚCI FIZYCZNYCH OWOCÓW PALMY DAKTYLOWEJ (ODM. KHADRAWY I MEDJOOL)

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S t r e s z c z e n i e. Przedstawione badania zostały przeprowadzone w celu oceny niektórych właściwości fizycznych owoców palmy daktylowej odmian Khadrawy i Medjool. Dla obydwu odmian oceniano wilgotność miąższu, wilgotność nasion, wymiary owoców (wielka i mała oś), średnią

arytmetyczną średnicę, średnią geometryczną średnicę, kołowość, wartości barwy (L, a, b), gęstość usypową, gęstość rzeczywistą, porowatość i współczynnik tarcia statycznego. Wartości badanych właściwości wykazywały znaczące różnice międzyodmianowe, które mogły wynikać z cech charakterystycznych obydwu odmian.

S ł o w a k l u c z o w e: palma daktylowa, właściwości fizyczne, Khadrawy, Medjool