

## QUALITY EVALUATION OF SOME PAKISTANI DATE VARIETIES

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Twenty one date palm (*Phoenix dactylifera* L.) Pakistani varieties were investigated for their physico-chemical characteristics. All observations were made at tamr stage (maturity) of fruit. Significant differences were recorded in the physical and chemical characteristics among varieties. The heaviest fruit weight (13.89g), flesh weight (12.89g), maximum length (4.56cm) and volume (11.94cm<sup>3</sup>) of fruit were recorded in Dhakki. Edible/non-edible ratio of different date varieties were found in the range of 1.94 (Desi simple) to 14.50 (Aseel Sindh). Maximum water activity was found in Desi basray (0.482) and minimum in Karblain (0.323). The highest peak force of puncture test as an index of firmness was recorded in Dora (59.64g) and maximum value of fruit color was observed in Desi red small (149.10CTn). Crude protein content ranged from 1.57% (Simple basraywal) to 3.51% (Desi green) and crude fiber content from 2.65% (Karblai Sindh) to 4.55% (Khopra). Total sugars content ranged from 59.03% (Desi basray) to 73.92% (Karblain), reducing sugars from 52.76% to 68.95% and non-reducing sugars from 4.65% to 7.66% among date varieties on dry matter basis. Results proved that Dhakki and Aseel are suitable for table purpose while other varieties are suitable for processing and converting into date products.

**Keywords:** Date varieties, physical properties, chemical composition, quality, texture

### INTRODUCTION

Pakistan is among the top ten date producing countries. Its production was 557.5 thousand tonnes on an area of 90.1 thousand hectares during the year 2007-08 (GOP, 2008). There are more than 150 varieties of date palm produced in Pakistan, among them the important varieties are Dhakki, Aseel, Zahidi, Fasli, Begum-jangi, Mojati, Karblain, Dora, Shungust, Choharay, Desi, Daghi, Gogna, Tota, Karwan, Halavi, and Khudravi (Nazri, 1995).

Date (*Phoenix dactylifera* L.) fall among the oldest mankind's food crop and has been used for 6000 years (Kwaasi, 2003). It plays an important role in the diet of natives of date growing regions due to high nutritional, health and economic values in addition to its aesthetic and environmental benefits. Date flesh provides 73.5g/100g carbohydrates, 2.3g/100g proteins, 1.5g/100g ash and 0.2g/100g fat. It contains unsaturated fatty acids that include palmitoleic, oleic, linoleic and linolenic acids. It also provides vitamin A, C, B<sub>1</sub>, B<sub>2</sub>, folic acid and nicotinic acid. It is a good source of at least fifteen mineral elements like calcium (39.70mg), iron (1.0mg), magnesium (43.24mg), phosphorus (56.80mg), potassium (655mg), sodium (0.8mg), zinc (0.29 mg), copper (0.288mg), manganese (0.298mg) and selenium (1.9mg) in 100g of date flesh (Al-Shahib and Marshall, 2003). The chemical composition of dates is variable due to various factors such as variety, region, climate, amount of fertilization and type of cultural practices (Al-Rawahi *et al.*, 2005).

Date fruits ripe early in the summer season and some at the end of season (August/September) depending upon varieties. All varieties of dates pass through four distinct stages of maturity naming in Arabic terms as Kimri, Khalal, Rutab and Tamr. First stage Kimri is characterized by two phases. In phase one, fruit size, weight, sugar accumulation, moisture content and acidity are increased. In phase two, the process of fruit enlargement, weight gain and sugar accumulation continue but with reduced rate, moisture content continue to increase rapidly and acidity decreases slightly. During Khalal stage, the fruit color changes from green to yellow or red depending upon variety, fruit weight, length and diameter are increased. In Rutab stage, dates begin to soften and lose water. Tamr stage is characterized by a firm texture with darker color and its good storability (Al-Shahib and Marshall, 2003).

Now the demand for table dates is decreasing, while new trends are developing in the date consumption as a component of new food products. Food industries are now producing different types of date products including date bars, date-paste, date-syrup, date-honey, date-jam, date-vinegar, date cookies, date wafers, date squares (Ahmed and Ramaswamy, 2005). Amount of sucrose can be replaced with date-paste in many food products and used as filler in food formulations (Alhamdan and Hassan, 1999).

In the present era, qualitative data generation is becoming essential which would be helpful not only for consumers and processors, but also for exporters. Chemical composition relates to nutritional and health benefits that are vital for consumers. Physical parameters are indices of maturity,

shelf life and are useful for sorting, grading and processing of dates. So the present study was designed to deal with the physical and chemical characterization of various date varieties.

## MATERIALS AND METHODS

Twenty one commercially available date varieties, all at tamar stage (stage of full maturity), Karblain, Aseel, Zaidy, Dhakki, Dora, Shungust, Choharay, Khopra, Karblai Sindh, Desi green, Desi basraywal, Desi simple, Desi red small, Desi small, Desi basray, Dora basraywal, Dora desi, Simple basraywal, Aseel Sindh and Hillavi were collected from "Date Palm Research Center, Jhang", Horticulture garden, Directorate of Horticulture, Ayub Agricultural Research Institute, Faisalabad and local market of different areas of Pakistan for this study. Samples were selected randomly without any preference to size, shape, color, appearance and firmness, and stored at 4°C. Analytical grade chemicals were purchased from Sigma Aldrich (Seelze, Germany) and Lab-Scan (Dublin, Ireland) available in the local market.

**Physical analysis:** Twenty fruits from each variety were selected randomly for physical measurements and each fruit represented one replicate. Fruit weight was measured with top load balance; diameter and length were measured with the help of a micrometer caliper. Volume of the fruit was determined by using water displacement method and density was recorded as weight over volume. After pitting, flesh and pit weights were recorded as described by Ismail *et al.* (2006).

Texture of the different date varieties was determined according to Piga *et al.* (2005) with some modifications by using a texture analyzer (Mod.TA-XT2 Stable Microsystems, Surrey, UK) with a 5kg load cell. The Texture Expert Program version 4.0.9.0 was used for data analysis. Textural determinations were made by using a needle probe (2mm diameter and 50mm length) for puncture test. Date samples were punctured to determine structural characteristics present inside or on the surface. Samples for puncture test were placed centrally on heavy duty plate form under the needle probe. Both the load cell and probe were calibrated before each test. Firmness measurement of samples by puncturing involved plotting force (g) versus time (sec). The maximum force (g) was used as an index of firmness for the puncture test (Table 1).

Water activity of different date varieties was determined at ambient temperature (30±1°C) by using an electronic hygropalm water activity meter (Model Aw-Win, Rotronic, equipped with a Karl-Fast probe). Hygropalm water activity meter is a portable humidity temperature indicator, having 9 volts battery. Date varieties were analysed according to Piga *et al.* (2005).

**Table 1. TA-XT2 Settings for comparison of firmness of different date varieties by penetration with a 2mm Needle probe**

Mode	Measure Force in Compression
Option	Return to Start
Pre-Test Speed	1.0 mm/s
Test Speed	0.5 mm/s
Post-Test Speed	10.0 mm/s
Distance	1 mm
Trigger Force	Auto - 5g
Tare Mode	Auto
Data Acquisition Rate	400pps

The color values of different date varieties were determined with the help of color meter (Color Test-II; Neuhaus Neotec) according to method described by Rocha and Morais (2003) with some modifications. The color meter was calibrated by using standards (54 CTn for dark and 151 CTn for light). The color of the date varieties was determined by placing the date samples under the photocell. Sample readings were compared with the standard.

**Chemical analysis:** Moisture, ash, crude fat, crude protein, crude fiber and NFE in date varieties were determined by method Nos. 920.36, 900.02, 920.39, 920.87, 985.29 and 920.62 respectively given in AOAC (2000). Reducing sugars, total sugars and non-reducing sugars were determined according to Lane and Eynon method No. 935.64 given in AOAC (2000). Results obtained from each attribute were statistically analyzed by using analysis of variance technique with the help of statistical package 8.1 and means separation was done ( $p \leq 0.05$ ) by using Least Significant Test (LSD) (Steel *et al.*, 1997).

## RESULTS AND DISCUSSION

**Physical properties:** Data of fruit weight of different date varieties showed a significant ( $p \leq 0.05$ ) difference among varieties. Results regarding mean values of fruit weight are tabulated in Table 2. Out of 21 date varieties studied, Dhakki indicated the heaviest fruit (13.89g) followed by Aseel Sindh (13.64g). The fruit of cultivars Choharay, Dora basraywal and Hillavi were also of good size i.e. 12.08g, 11.87g and 11.72g, respectively, whereas the smallest fruit weight was observed in case of Desi simple (3.04g). Mean values for fruit weight of other varieties ranged from 4.60g to 11.62g.

Table 2. Physical characteristics of date varieties

Varieties	Fruit weight (g)	Stone weight (g)	Flesh weight (g)	Stone weight (%)	Flesh weight (%)	Edible/non-edible ratio
Karblain	5.38 ± 0.01hi	0.85 ± 0.01ij	4.53 ± 0.03i	15.75 ± 0.01efg	84.25 ± 0.03hij	5.36 ± 0.01ij
Aseel	6.98 ± 0.08ef	0.80 ± 0.07j	6.19 ± 0.09fg	11.41 ± 0.01jkl	88.59 ± 0.13cde	7.89 ± 0.09f
Zaidy	11.62 ± 0.04b	1.01 ± 0.04fgh	10.61 ± 0.07bc	8.67 ± 0.01mn	91.30 ± 0.07ab	10.82 ± 0.10c
Dhakki	13.89 ± 0.06a	0.99 ± 0.06fgh	12.90 ± 0.03a	7.18 ± 0.01n	92.82 ± 0.03a	13.02 ± 0.06b
Dora	7.65 ± 0.04de	1.01 ± 0.04fgh	6.64 ± 0.06ef	13.30 ± 0.01hij	88.84 ± 0.06efg	6.59 ± 0.04gh
Shungust	9.45 ± 0.05c	1.04 ± 0.06efg	8.41 ± 0.12d	11.16 ± 0.01kl	86.70 ± 0.12cd	8.29 ± 0.08ef
Choharay	12.08 ± 0.09b	1.17 ± 0.09cd	10.91 ± 0.08b	9.85 ± 0.01lm	90.15 ± 0.08bc	9.42 ± 0.09de
Khopra	6.41 ± 0.05fg	0.95 ± 0.05ghi	5.46 ± 0.18gh	15.20 ± 0.01fgh	84.80 ± 0.18ght	5.92 ± 0.08hij
Karbala Sindh	11.51 ± 0.04b	1.11 ± 0.04def	10.39 ± 0.10bc	9.73 ± 0.01lm	90.27 ± 0.10bc	9.72 ± 0.12cd
Desi green	4.94 ± 0.03hi	1.02 ± 0.03fgh	3.92 ± 0.13ij	20.82 ± 0.01cd	79.19 ± 0.13kl	3.88 ± 0.03kl
Desi basraywal	7.13 ± 0.04ef	0.99 ± 0.04fgh	6.14 ± 0.08fg	13.94 ± 0.01ghi	86.10 ± 0.08fgh	6.26 ± 0.04ghi
Desi simple	3.04 ± 0.02j	1.04 ± 0.01efg	2.00 ± 0.14k	34.20 ± 0.01a	74.72 ± 0.14n	1.94 ± 0.01m
Desi red small	4.65 ± 0.02i	1.17 ± 0.02cde	3.49 ± 0.14j	25.28 ± 0.01b	65.81 ± 0.14m	3.01 ± 0.02lm
Desi black	5.70 ± 0.02gh	1.00 ± 0.02fgh	4.69 ± 0.16hi	17.65 ± 0.01e	82.35 ± 0.16j	4.86 ± 0.06jk
Desi small	4.60 ± 0.02i	1.03 ± 0.02efgh	3.57 ± 0.13j	22.48 ± 0.01c	77.51 ± 0.13l	3.51 ± 0.03l
Desi basry	6.92 ± 0.05ef	1.39 ± 0.05b	5.53 ± 0.13g	20.35 ± 0.01d	79.65 ± 0.13k	3.99 ± 0.03kl
Dora basraywal	11.87 ± 0.06b	1.89 ± 0.06a	9.98 ± 0.11c	16.00 ± 0.01ef	84.03 ± 0.11ij	5.38 ± 0.05hij
Dora desi	8.18 ± 0.07d	1.12 ± 0.06def	7.06 ± 0.13e	13.81 ± 0.01ghi	86.20 ± 0.13fgh	6.44 ± 0.06ghi
Simple basraywal	8.29 ± 0.05d	1.26 ± 0.05c	7.04 ± 0.18e	15.46 ± 0.01fg	84.54 ± 0.18hi	5.77 ± 0.07hij
Aseel Sindh	13.64 ± 0.07a	0.90 ± 0.07hij	12.74 ± 0.06a	6.67 ± 0.01n	93.33 ± 0.06a	14.50 ± 0.16a
Hillavi	11.72 ± 0.03b	1.44 ± 0.03b	10.28 ± 0.05bc	12.31 ± 0.01ijk	87.68 ± 0.05def	7.17 ± 0.03fg

Data with different letters in each column differ significantly according to LSD test at &lt;0.05

Dia= Diameter

Vol= Volume

Results regarding mean values of stone weight are tabulated in Table 2. Data reflect significant ( $p \leq 0.05$ ) difference in stone weight. Stone weights were in the range of 0.80g (Aseel) to 1.89g (Dora basraywal). The heaviest stone weight was found in Dora basraywal (1.89g) however, the lowest mean values of stone weight were observed in Aseel (0.80g) followed by Karblain (0.85g). The highest mean value of stone weight percentage was found in Desi simple (34.19%) and the lowest in Aseel Sindh (6.67%) followed by Dhakki (7.18%) and Zaidy (8.70%). Maximum flesh weight was recorded in Dhakki (12.90g) followed by Aseel Sindh (12.74g) while minimum in Desi simple (2.0g). However, maximum mean value of flesh weight percentage was recorded in Aseel Sindh (93.33%) followed by Dhakki (92.82%) and Zaidy (91.30%), while minimum mean values of flesh weight percentage were observed in Desi red small (65.81%) followed by Desi simple (74.72%) and Desi small (77.51%).

Data regarding mean values of fruit diameter and length are presented in Table 3. The data revealed that varieties were found significantly ( $p \leq 0.05$ ) different with respect to fruit diameter and length. Maximum mean value for diameter of fruit was recorded in Aseel Sindh (2.40cm) and for length in Dhakki (4.56cm), while minimum mean value for diameter and length of fruit were recorded in Desi simple 1.30cm and 2.08cm, respectively.

The mean values of fruit volume and density of different date varieties have been presented in Table 3. Significant ( $p \leq 0.05$ ) variations in fruit volume and fruit density exist among different varieties. Mean values for fruit volume of different dates varieties were found in the range of 3.10cm<sup>3</sup> (Desi simple) to 11.94cm<sup>3</sup> (Dhakki). Maximum fruit volume was recorded in Dhakki (11.94cm<sup>3</sup>) followed by Dora basraywal (11.60cm<sup>3</sup>) and Aseel Sindh (11.39cm<sup>3</sup>), while minimum in Desi simple (3.10cm<sup>3</sup>) followed by Desi small (3.89cm<sup>3</sup>) and Desi red small (4.64cm<sup>3</sup>). Fruit density in different date varieties ranged from 0.92g/cm<sup>3</sup> (Karblain) to 1.24g/cm<sup>3</sup> (Shungust). Shungust excelled in terms of fruit density (1.24g/cm<sup>3</sup>) followed by Choharay (1.24g/cm<sup>3</sup>) and Desi basry (1.23g/cm<sup>3</sup>), while minimum fruit density was recorded in Karblain (0.92g/cm<sup>3</sup>) followed by Desi simple (0.98 g/cm<sup>3</sup>) and Desi red small (1.01g/cm<sup>3</sup>). Fruit density of other varieties ranged from 1.0 g/cm<sup>3</sup> to 1.12 g/cm<sup>3</sup>.

Edible/non-edible ratio is an important fruit quality parameter. Mean values of edible/non-edible ratio of different date varieties were found in the range of 1.94 (Desi simple) to 14.50 (Aseel Sindh). The data regarding edible/non-edible ratio have been presented in the Table 2. The highest mean value of edible/non-edible ratio was recorded in Aseel Sindh (14.50) followed by Dhakki (13.02) and Zaidy (10.82), while the lowest mean value for edible/non-edible ratio was observed in Desi simple (1.94) followed by Desi red small (3.01) and Desi small (3.51).

Results regarding mean values of water activity are tabulated in Table 3. Data reflect significant ( $p \leq 0.05$ ) differences in water activity. Water activity was in the range of 0.323 (Karblain) to 0.482 (Desi basray). Maximum water activity was found in Desi basray (0.482) followed by Desi simple (0.479) and Desi red small (0.478). However, the minimum mean values of water activity were observed in Karblain (0.323) followed by Zaidy (0.333) and Dora (0.346), whereas water activity of other date varieties ranged from 0.353 to 0.466.

The mean values of fruit color of different date varieties have been presented in Table 3. Significant ( $p \leq 0.05$ ) variations in fruit color exist among different varieties. Mean values for fruit color of different dates varieties were found in the range of 77.40CTn (Choharay) to 149.10CTn (Desi red small). Maximum mean values of fruit color were recorded in Desi red small (149.10CTn) and Desi small (149.10CTn) followed by Dora (130.80CTn) and Desi green (130.20CTn), while minimum mean values of fruit color were observed in Choharay (77.40CTn) followed by Aseel Sindh (83.10CTn) and Khopra (95.50CTn).

Results regarding mean values of Texture are presented in Table 3. Data showed significant ( $p \leq 0.05$ ) differences in texture among different date varieties. The highest force was recorded during needle penetration as maximum firmness from the peak of graph (Fig. 1). The highest mean values of peak force as hardness were found in Dora (59.64g) followed by Dhakki (50.94g) and Karblain (42.48g) and the lowest mean values of peak force were recorded in Desi simple (14.58g) followed by Desi basry (15.05g) and Desi basraywal (17.17g).

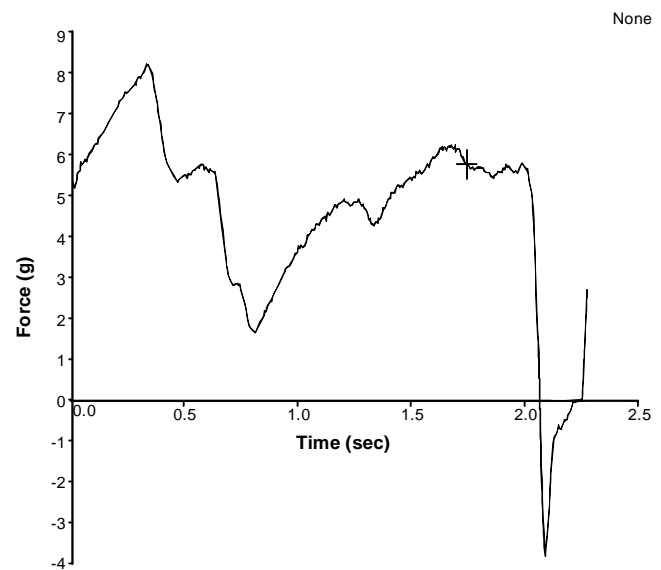


Figure 1. Representative graph of a puncture test of date fruit

Table 3. Physical characteristics of date varieties

Varieties	Fruit Length (cm)	Fruit Dia. (cm)	Fruit vol. (cm <sup>3</sup> )	Fruit Density (g/cm <sup>3</sup> )	Color (C <sup>T</sup> n)	Water Activity (Aw)	Texture Force (g)
Karblain	3.21 ± 0.01hij	1.92 ± 0.01e	5.87 ± 0.02 hi	0.92 ± 0.01 j	114.10 ± 0.09h	0.323 ± 0.01m	42.48 ± 0.22c
Aseel	3.69 ± 0.04cde	1.84 ± 0.02e	6.38 ± 0.07hi	1.09 ± 0.01def	126.40 ± 1.39c	0.402 ± 0.01ghi	38.49 ± 0.42de
Zaidy	3.53 ± 0.01ef	2.25 ± 0.01bc	10.62 ± 0.05c	1.10 ± 0.01def	103.30 ± 0.16jk	0.333 ± 0.01lm	31.15 ± 0.13gh
Dhakki	4.55 ± 0.01a	2.22 ± 0.01bc	11.94 ± 0.05 a	1.16 ± 0.01bc	96.50 ± 0.18 l	0.401 ± 0.01ghi	50.94 ± 0.36b
Dora	3.37 ± 0.01fgh	2.10 ± 0.01d	7.31 ± 0.03fg	1.05 ± 0.01fgh	130.80 ± 0.09b	0.346 ± 0.01kl	59.64 ± 0.21a
Shungust	3.41 ± 0.01fg	2.16 ± 0.01cd	7.60 ± 0.04ef	1.24 ± 0.01a	96.10 ± 0.21 l	0.418 ± 0.01efg	33.20 ± 0.30fg
Choharay	3.38 ± 0.01fg	2.16 ± 0.01cd	9.81 ± 0.08d	1.24 ± 0.01a	77.40 ± 0.16n	0.383 ± 0.01j	39.24 ± 0.27cd
Khopra	3.32 ± 0.01ghi	1.93 ± 0.01e	6.13 ± 0.03hi	1.04 ± 0.01ghi	95.40 ± 0.22 l	0.353 ± 0.01 k	30.92 ± 0.15gh
Karbalai Sindh	3.63 ± 0.01de	2.26 ± 0.01b	10.83 ± 0.06bc	1.07 ± 0.01efg	102.50 ± 0.06k	0.390 ± 0.01ij	21.51 ± 0.19j
Desi green	2.84 ± 0.01k	1.44 ± 0.01i	4.66 ± 0.03k	1.06 ± 0.01fgh	130.20 ± 0.06b	0.451 ± 0.01cd	20.92 ± 0.13j
Desi basraywal	3.18 ± 0.01ij	1.73 ± 0.01f	6.55 ± 0.05gh	1.10 ± 0.01def	117.20 ± 0.10g	0.463 ± 0.01bc	17.17 ± 0.11klm
Desi simple	2.08 ± 0.01m	1.30 ± 0.01j	3.09 ± 0.02m	0.98 ± 0.01i	122.50 ± 0.07de	0.479 ± 0.01ab	14.58 ± 0.09m
Desi red small	2.66 ± 0.01l	1.62 ± 0.01gh	4.64 ± 0.02kl	1.01 ± 0.01hi	149.10 ± 0.09a	0.478 ± 0.01ab	25.54 ± 0.11i
Desi black	3.10 ± 0.01j	1.61 ± 0.01h	5.08 ± 0.02jk	1.12 ± 0.01cde	119.00 ± 0.13fg	0.466 ± 0.01abc	19.87 ± 0.09jk
Desi small	2.56 ± 0.01l	1.55 ± 0.01h	3.89 ± 0.02 l	1.18 ± 0.01abc	149.10 ± 0.09 a	0.435 ± 0.01de	18.34 ± 0.12jkl
Desi basry	3.27 ± 0.01ghi	1.71 ± 0.01fg	5.66 ± 0.05ij	1.23 ± 0.01a	120.60 ± 0.08ef	0.482 ± 0.01a	15.05 ± 0.07lm
Dora basraywal	3.88 ± 0.01b	2.20 ± 0.01bc	11.6 ± 0.05a	1.02 ± 0.01ghi	105.60 ± 0.18 j	0.387 ± 0.01ij	26.11 ± 0.11i
Dora desi	3.42 ± 0.01fg	2.08 ± 0.01d	8.13 ± 0.06e	1.01 ± 0.01ghi	123.70 ± 0.12d	0.415 ± 0.01fgh	27.80 ± 0.19hi
Simple basraywal	3.63 ± 0.01b	2.00 ± 0.01e	7.54 ± 0.04ef	1.10 ± 0.01def	109.00 ± 0.12i	0.429 ± 0.01ef	30.64 ± 0.19gh
Aseel Sindh	3.80 ± 0.01bc	2.40 ± 0.01a	11.39 ± 0.06ab	1.20 ± 0.01ab	83.10 ± 0.07m	0.397 ± 0.01hij	41.34 ± 0.21cd
Hillavi	3.74 ± 0.01bcd	2.30 ± 0.01b	10.24 ± 0.02cd	1.15 ± 0.01bcd	95.90 ± 0.13l	0.388 ± 0.01ij	35.32 ± 0.18ef

Data with different letters in each column differ significantly according to LSD test at P&lt;0.05

Dia= Diameter

Vol= Volume

C<sup>T</sup>n=Color Test number

The physical properties of date varieties were studied by many scientists in different countries of the world (Sawaya *et al.*, 1983; Asif *et al.*, 1986; Ramadan, 1995; Al-Shahib and Marshal, 2003; Ismail *et al.*, 2006). The results of physical properties in the present study falls within the ranges as reported in previous work on different dates varieties. Ramadan (1995) reported the heaviest fruit for Saidy (8.70 g) and the lightest for Manthour (4.31g). He reported the flesh weight of different date varieties in the range of 3.43g to 7.30g, pit weight in the range of 0.86g to 1.40g, edible/non-edible ratio 3.90 to 5.22 and flesh weight percentage in the range of 79.58% to 83.91%. Al-Shahib and Marshal (2003) reported fruit weight in the range of 6.5g to 10.6g, fruit length in the range of 2.65cm to 3.88cm and fruit diameter in the range of 1.72cm to 2.35 cm in five different varieties of dates. Tafti and Fooladi (2005) gave the physical properties of Muzafati date in Iran. He found the fruit weight 10.20g, fruit length 3.4cm, fruit width 2.1cm and fruit volume 8.6cm<sup>3</sup>. Ismail *et al.* (2006) studied five different date varieties. They found that weight of date varieties ranged from 7.55g to 10.32g, length from 2.85cm to 3.66cm, diameter from 2.05cm to 2.36cm, volume 6.94mL to 9.16mL and density from 1.09g/mL to 1.15g/mL. Minor difference in physical properties of date varieties might be attributed to several factors such as amount and type of fertilizers, soil and climate and irrigation. Basha and Abo-Hassan (1982) explained that soil fertilization affected the weight, length, diameter and volume of Khudravi date fruits. Hussein and Hussein (1982b) reported that soil fertilization and irrigation contributed to physical properties of date fruits such as fruit weight, length, diameter and volume. Proper application of these two factors increased the weight, length and diameter of date fruits. Variation can also be attributed to other environmental factors such as daily temperature and length of day and post harvest treatments such as drying.

**Chemical properties:** The mean values for chemical composition of different date varieties are presented in Table 4. The moisture in dates of different varieties varied from 17.45% to 31.69% and the differences among means for moisture were significant ( $p \leq 0.05$ ). The highest mean value for moisture (31.69%) was found in Desi simple followed by (31.40%) in Desi basry and (31.15%) in Desi red small, while the lowest mean value was recorded in Karblain (17.45%) followed by Zaidy (18.13%) and Dora (19.11%). The moisture of other varieties ranged from 20.68% to 30.91%.

Concerning the crude protein content, it ranged from 1.57% to 3.51% in different date varieties (Table 4). Data regarding crude protein content varied significantly ( $p \leq 0.05$ ). Noticeable variations in crude protein content exist among different date varieties. Maximum mean value of crude protein content was found in Desi green (3.51%) followed by Desi basraywal (3.21%) and Simple basraywal (3.18%), while the lowest mean value for crude protein content was

observed in Aseel Sindh (1.57%) followed by Karblai Sindh (1.83%) and Desi simple (1.97%). The mean values of other varieties ranged from 2.09% to 2.94%.

Significant ( $p \leq 0.05$ ) variations exist in crude fat content among different date varieties. The mean values of crude fat content in date varieties ranged from 0.33% to 0.51% (Table 4). The highest mean value for fat content was found in Dhakki (0.51%) followed by Karblai Sindh (0.50%) and Aseel (0.47%), while the lowest mean value was recorded in Dora desi (0.33%) followed by Desi simple (0.35%) and Dora basrywal (0.36%).

The mean values of crude fiber content varied significantly ( $p \leq 0.05$ ) among date varieties. It was found that crude fiber content of date varieties ranged from 2.65% to 4.55% (Table 4). The maximum mean value of crude fiber content was found in Khopra (4.55%) followed by Dora basraywal (4.36%) and Choharay (4.25%), while the minimum value of crude fiber content was observed in Karblai Sindh (2.65%) followed by Aseel Sindh (2.92%) and Zaidy (2.94%).

Significant ( $p \leq 0.05$ ) differences were observed among mean values of ash of date varieties. The highest mean value of ash (1.89%) was recorded in case of Karbalin followed by Karblai Sindh (1.78%) and Aseel Sindh (1.77%), however the minimum mean value was observed in case of Desi basray (1.08%) followed by Desi red small (1.17%) and Aseel (1.31%).

Mean values of NFE in different date varieties were observed in the range of 90.41% to 93.24% (Table 4). The maximum mean value was found in case of Karblai Sindh (93.24%) followed by Shungust (92.95%) and Aseel Sindh (92.73%), whereas the minimum mean value was observed in Simple basraywal (90.41%) followed by Dora basraywal (90.80%) and Khopra (91.27%).

These results are in agreement with findings of other scientists working on different date varieties. Ismail *et al.* (2006) studied five date varieties and reported that moisture level in date varieties ranged between 20.25-22.14%, protein level ranged between 2.3-2.7% and ash level between 1.83-2.36%. Aidoo *et al.* (1996) observed moisture level in different date varieties as low as 10% to 35% in other varieties. Variations in moisture content have been reported among different date varieties grown in the same country, or the same variety in different regions, mainly due to the differences in harvest and post harvest treatments resulting in different moisture level. In comparison, little variations exist in crude protein content. The results of crude protein content are in line with the findings of other researchers. Similar to protein content, and in line with other published results, ash and fat content of different date varieties did not vary greatly. However, minor differences in chemical composition were observed, which could be attributed to the varieties and origin differences. In another study, Ismail *et al.* (2008) reported that moisture level in two date varieties

Table 4. Chemical characteristics of date varieties

Varieties	Moistur (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Ash (%)	NFE (%)
Karblain	17.45 ± 0.10l	2.92 ± 0.01c	0.42 ± 0.01def	3.06 ± 0.02 j	1.89 ± 0.01a	91.71 ± 0.02fg
Aseel	24.79 ± 0.11fg	2.55 ± 0.01hi	0.47 ± 0.01bc	3.62 ± 0.06efg	1.31 ± 0.01k	92.06 ± 0.05de
Zaidy	18.13 ± 0.23kl	2.94 ± 0.01c	0.44 ± 0.01cdef	2.94 ± 0.01j	1.67 ± 0.02cd	92.01 ± 0.02e
Dhakki	24.40 ± 0.54gh	2.42 ± 0.01j	0.51 ± 0.01a	3.31 ± 0.05bc	1.43 ± 0.01hij	91.38 ± 0.04j
Dora	19.11 ± 0.34k	2.68 ± 0.01ef	0.41 ± 0.01f	3.60 ± 0.04efg	1.61 ± 0.01de	91.69 ± 0.05fgh
Shungust	27.02 ± 0.36de	2.09 ± 0.01k	0.42 ± 0.01def	3.07 ± 0.03ij	1.33 ± 0.01gh	92.95 ± 0.03 b
Choharay	22.28 ± 0.39i	2.51 ± 0.01i	0.41 ± 0.01f	4.25 ± 0.05hi	1.47 ± 0.01k	92.44 ± 0.03c
Khopra	20.68 ± 0.12j	2.09 ± 0.01k	0.46 ± 0.01bcd	4.55 ± 0.10a	1.63 ± 0.02cde	91.27 ± 0.08j
Karbalai Sindh	23.32 ± 0.22hi	1.83 ± 0.02m	0.50 ± 0.01ab	2.65 ± 0.01k	1.78 ± 0.02b	93.24 ± 0.01a
Desi green	29.28 ± 0.46bc	3.51 ± 0.01a	0.42 ± 0.01def	3.11 ± 0.02ij	1.52 ± 0.01fg	91.46 ± 0.01hij
Desi basraywal	30.43 ± 0.28ab	3.21 ± 0.02b	0.43 ± 0.01cdef	3.40 ± 0.09gh	1.56 ± 0.02ef	91.41 ± 0.08ij
Desi simple	31.69 ± 0.40a	1.97 ± 0.01l	0.35 ± 0.01h	3.81 ± 0.02ef	1.65 ± 0.02cd	92.25 ± 0.01cd
Desi red small	31.15 ± 0.17a	2.84 ± 0.01d	0.36 ± 0.01gh	3.77 ± 0.04de	1.17 ± 0.02jk	91.63 ± 0.06ghi
Desi black	30.91 ± 0.08a	2.83 ± 0.01d	0.40 ± 0.01def	3.55 ± 0.03fgh	1.36 ± 0.01l	92.03 ± 0.04de
Desi small	28.17 ± 0.07cd	2.58 ± 0.02gh	0.44 ± 0.01f	3.49 ± 0.09gh	1.62 ± 0.02cde	91.90 ± 0.07ef
Desi basry	31.40 ± 0.19a	2.63 ± 0.02fg	0.41 ± 0.01h	4.04 ± 0.03cd	1.08 ± 0.01m	91.90 ± 0.02ef
Dora basraywal	23.09 ± 0.10hi	2.81 ± 0.02d	0.36 ± 0.01cde	4.36 ± 0.05ab	1.59 ± 0.01de	90.80 ± 0.06k
Dora desi	26.02 ± 0.23ef	2.61 ± 0.01gh	0.33 ± 0.01h	3.48 ± 0.03gh	1.44 ± 0.01ghi	92.13 ± 0.03de
Simple basraywal	27.16 ± 0.11de	3.18 ± 0.01b	0.46 ± 0.01cde	4.25 ± 0.03bc	1.70 ± 0.01bc	90.41 ± 0.02l
Aseel Sindh	24.14 ± 0.22gh	1.57 ± 0.02n	0.41 ± 0.01f	2.92 ± 0.02 j	1.77 ± 0.03ijk	92.73 ± 0.04b
Hillavi	23.12 ± 0.11 hi	2.73 ± 0.02e	0.43 ± 0.01cdef	3.38 ± 0.08gh	1.37 ± 0.01b	91.69 ± 0.10fgh

Data with different letters in each column differ significantly according to LSD test at P&lt;0.05

ranged from 20.7% to 26.7%, protein ranged from 2.4% to 3.6% and ash 2.3% to 2.9%. Ramadan (1995) reported that moisture level in different date varieties ranged from 7.58% to 12.56% in dry dates, crude protein in the range of 2.39% to 3.81% and ash in the range of 1.62% to 1.98%. Al-Shahib and Marshal (2003) reported that moisture content in different date varieties ranged from 9.2% to 32.1%, protein in the range of 1.7% to 3.0%, ash in the range of 0.3% to 2.4% and fat in the range of 0.1% to 0.5% and crude fiber in the range of 1.7% to 4.6%. The results of present study are in close agreement and comparable to the findings of research work conducted by the previous researchers.

Mean values of total sugars content of different date varieties have been presented in Table 5. Significant ( $p \leq 0.05$ ) variations in total sugars content exist among different varieties. Mean values for total sugars content ranged from 59.03% to 73.92% on dry matter basis in different date varieties. Maximum mean value for total sugars content was recorded in Karblain (73.92%) followed by Zaidy (72.87%) and Dora (72.01%), whereas minimum mean value was obtained in case of Desi basry (59.03%) followed by Desi red small (59.12%) and Desi simple (59.14%). The mean values for total sugars content in other varieties ranged from 59.65% to 69.39%.

Similarly, reducing sugars content varied significantly ( $p \leq 0.05$ ) among different date varieties. Data regarding

reducing sugars content was observed in the range of 52.76% to 68.95% of date varieties (Table 5). The highest reducing sugars level was recorded in case of Karblain (68.95%) followed by Zaidy (67.13%) and Dora (66.83%), however, the lowest level of reducing sugars was obtained by Desi simple (52.76%) followed by Desi basry (53.04%) and Desi red small (53.31%).

Significant variations are recorded in case of non-reducing sugars among different date varieties ( $p \leq 0.05$ ). It has been observed that mean values for non-reducing sugars ranged from 4.65% to 7.66% (Table 5). The maximum mean value was found in case of Hillavi (7.66%) followed by Dora desi (7.56%) and Desi simple (6.38%), while the minimum mean value was recorded in Aseel (4.65%) followed by Karbalain (4.98%) and Dora (5.19%).

Results regarding total sugars, reducing sugars and non-reducing sugars in the present study corroborate with the previous findings of research workers. Ismail *et al.* (2006) studied five date varieties and reported that reducing sugars ranged from 68.4% to 76.2%. In another study, Ismail *et al.* (2008) found that reducing sugars in two date varieties ranged from 69.9% to 75.2%. Shaheen and Al-Qurashi (2007) analyzed four date varieties grown in Saudi Arabia and reported that reducing sugars were found in the range of 45.02% to 54.78% and non-reducing sugars in the range of 1.94% to 5.31%. Chaira *et al.* (2007) studied two date

**Table 5. Chemical characteristics of date varieties**

Varieties	Total Sugars (%)	Reducing Sugars (%)	Non-Reducing Sugars (%)
Karblain	73.92 ± 0.36a	68.95 ± 0.55a	4.97 ± 0.22de
Aseel	67.11 ± 0.29d	62.46 ± 0.37cde	4.65 ± 0.48e
Zaidy	72.87 ± 0.35ab	67.13 ± 0.54b	5.72 ± 0.22bcde
Dhakki	66.10 ± 0.30de	60.84 ± 0.31efg	5.26 ± 0.05bcde
Dora	72.01 ± 0.35b	66.83 ± 0.37 b	5.18 ± 0.14cde
Shungust	65.11 ± 0.16e	59.20 ± 0.29gh	5.91 ± 0.16bcd
Choharay	68.77 ± 0.09c	62.58 ± 0.13cde	6.19 ± 0.07bc
Khopra	69.39 ± 0.16c	63.35 ± 0.13cd	6.04 ± 0.03bcd
Karbalai Sindh	69.08 ± 0.24c	63.76 ± 0.27c	5.32 ± 0.21bcde
Desi green	61.08 ± 0.12gh	55.64 ± 0.15jk	5.44 ± 0.12bcde
Desi basraywal	59.65 ± 0.12i	53.78 ± 0.14l	5.87 ± 0.04bcd
Desi simple	59.14 ± 0.06i	52.76 ± 0.14l	6.38 ± 0.19b
Desi red small	59.12 ± 0.06i	53.31 ± 0.14l	5.81 ± 0.20bcd
Desi black	60.00 ± 0.07hi	54.46 ± 0.24kl	5.54 ± 0.22bcde
Desi small	62.96 ± 0.05f	56.88 ± 0.27ij	6.08 ± 0.25bcd
Desi basry	59.03 ± 0.12i	53.04 ± 0.23l	5.99 ± 0.12bcd
Dora basray wal	67.11 ± 0.15d	61.83 ± 0.25de	5.28 ± 0.22bcde
Dora desi	65.00 ± 0.17e	57.44 ± 0.50hi	7.56 ± 0.57a
Simple basraywal	62.20 ± 0.13fg	55.85 ± 0.26ijk	6.35 ± 0.21b
Aseel Sindh	67.11 ± 0.29d	61.21 ± 0.35ef	5.90 ± 0.18bcd
Hillavi	67.16 ± 0.77d	59.50 ± 0.87fg	7.66 ± 0.16a

Data with different letters in each column differ significantly according to LSD test at  $P < 0.05$



varieties and reported that reducing sugars ranged from 17.74% to 55.20%, non-reducing sugars 55.08% to 5.09% and total sugars 60.29% to 72.82%. Ramadan (1995) reported that reducing sugars in different date varieties ranged from 70.28% to 80.52%, non-reducing sugars in the range of 0.59% to 3.28% and total sugars in the range of 70.87% to 83.80%.

## CONCLUSION

It was concluded that Dhakki, Aseel Sindh and Hillavi would be suitable for table purpose because of their good physical characteristics like large fruit size, higher fruit weight, flesh weight, edible/non-edible ratio, firm texture and nutritional properties. Date varieties such as Karbalain, Zahidi and Dora are suitable for processing due to low moisture content and higher sugar content.

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