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MINERAL, VITAMIN AND PHENOLIC CONTENTS AND SUGAR PROFILES OF SOME PROMINENT DATE PALM (*PHOENIX DACTYLIFERA*) VARIETIES OF PAKISTAN

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Abstract

In this study, fruits of date (*Phoenix dactylifera* L.) varieties were analyzed to assess their nutritional characteristics. Mineral profile analysis of twenty-one date varieties grown in Pakistan was performed. The results of mineral profile analysis proved that dates were a good source of minerals like potassium, calcium, iron and magnesium, but were deficient in sodium content and hence are very suitable fruit for hypertensive people. Sugar profile analysis showed that the maximum glucose content was recorded in Zaidy (44.44%) and fructose content in Karblain (33.21%) and the maximum sucrose percentage was found in Hillavi (6.99%). Vitamin (B_1, B_2, and B_3) analyses revealed that vitamin B_1 was not present in detectable amount in the date varieties. The highest concentration of vitamin B_2 was detected in Khopra (0.031 mg per 100g), while the highest concentration of vitamin B_3 was verified in Zaidy (2.73 mg per 100g). The range of the total phenolic contents ranged from 142.52±0.64 to 298.02±0.95 mg gallic acid equivalent per 100 g on fresh fruit weight basis. All date varieties proved to be a good source of phenolic compounds, therefore, they possess high antioxidant capacity. It was concluded that Dhakki, Hillavi and Aseel Sindh varieties might suit well for diet because of their good nutritional properties.

Keywords: Dates, Minerals, Vitamins, Sugars, Phenolics

Introduction

Dates play an important role in disease prevention and human's health promotion because they are a rich source of dietary fiber, polyphenols, carotenoids, vitamins, minerals, glucosinolates, and several other bioactive compounds. Date palm is considered as a multi-purpose tree as it can be used for food, feed, and shelter and is highly supported for its national inheritance in many areas of the world. These qualities, along with its tolerance ability against harsh environmental conditions, have brought a sharp increase in its production in recent years. Main priority of date palm growers is the development of date export and marketing competence (Alabdulhadi *et al.*, 2004).

In 2011, date production in Pakistan was ranked 7th among all other date producing countries. Pakistan produces more than 150 varities of dates including Zahidi, Begum Jangi, Dhakki, Aseel, Khudravi and Halavi widely grown in Balochistan, Sindh and in some districts of Punjab. Dhakki and Aseel are dominant varieties. The date fruits are clasified as soft, semi-soft and dry dates (Ismail *et al.*, 2008). Most of the date varieties in Pakistan fall under the category of semi-dry dates which are rich in sugars (~81-88%, mainly fructose, glucose and sucrose), dietary fibre (~5-8.5%), and meager quantity of other nutrients (Nadeem *et al.*, 2011). Date fruits include many nutrients such as protein, sugar, fat, pectin, crude fiber, minerals, vitamins, antioxidants, and polyphenols (Haider *et al*., 2018). Dietary fiber, sugar and other minerals (phosphorus, calcium, potassium, iron, riboflavin, thiamin, and nicotinic acid) makes dates nutritionally more important for humans (Ashraf & Hamidi-Esfahani, 2011; Dogan *et al.*, 2013; Ahmad *et al.*, 2018).

Because of functional and dietetic constituents, dates share a significant part of human health and diet. Dates are rich source of both fat-soluble and water-soluble vitamins (Anon., 2004) and are considered as rich source of minerals as it contains 15 different minerals (Ahmed & Ramaswamy, 2006). Vitamins are needed by human body for development, waste elimination and metabolism (Khan *et al.*, 2018a). Minerals take part in many biological activities and act as catalysts in the metabolic reactions in human body (Ugulu & Baslar, 2010; Ugulu, 2012; Unver *et al.*, 2015; Ugulu *et al*., 2016; Khan *et al.*, 2018b); they are essential for metabolism, digestion and generation of nerve impulse and absorption of all food nutrients (Durkan *et al.*, 2011; Ugulu *et al*., 2012; Dogan & Ugulu, 2013; Dogan *et al*., 2014; Ugulu, 2015).

Dates are also a good source of many antioxidants, especially phenolics and carotenoids. The antioxidant properties of dates are due to the vitamin C and E especially phenolic, carotenoids and flavonoids (Al-Farsi & Lee, 2008). The phenolic compounds in 100 g dried dates range from 193.7 mg to 239.4 mg. These compounds are increased in some date varieties after drying which may be due to the release of phenolic compounds from tannins after degradation by heat and enzymes maturation (Biglari *et al.*, 2008). Dates also have polyphenols and tannins which are useful to cure intestinal problems (Habib & Ibrahim, 2011).

In this direction, the present study was aimed to determine mineral, vitamin and phenolic contents and sugar profiles of some prominent date palm (*Phoenix dactylifera*) varieties of Pakistan and to evaluate their nutritional characteristics.

Materials and Methods

Collection of materials: Commercially grown 21 date varieties (*Phoenix dactylifera* L.) like Zaidy, Dhakki, Dora, Choharay, Karblain, Desi small, Aseel, Dora basraywal, Shungust, Khopra, Desi green, Karblai sindh, Desi simple, Desi basraywal, Simple basraywal, Desi red small, Desi basray, Hillavi, Dora desi and Aseel sindh were gathered from "Date Palm Research Center, Jhang". Samples were selected randomly without any preference to shape, firmness, color, size and appearance and stored at 4ºC. Chemicals used for the analysis were procured from Lab-Scan (Dublin, Ireland) and Sigma Aldrich (Seelze, Germany) available in the local market.

Mineral analysis: Samples for mineral analysis were prepared by the wet digestion method. 0.5 g of dried date sample was first digested at low temperature (60-70°C) with 10 mL HNO_3 for 20 min in a 100-mL conical flask on hot plate, then it was digested at high temperature (190°C) with 5 mL 60% $HClO_4$ till the contents of flask became clear. The digested sample was transferred to 100mL volumetric flask and the volume was made with double distilled de-ionized water and then filtered. The filtered sample solution was analyzed by the atomic absorption spectrophotometer (Model: Varian AA-240). The mineral contents of the samples were determined by using the respective standard curve prepared for each element (Anon., 2000b). Sodium and potassium values were estimated by flame photometer (Sherwood Flame Photometer 410, Cambridge, UK) according to the method given in Anon., (2000a).

Vitamin B analysis: Vitamins B_1, B_2 and B_3 were determined according to the method as described by Kirk and Wawyer (1991). The date samples were weighed in a conical flask. 65 mL of 0.1N HCl were added to it and homogenized. The homogenized mixture was digested for 30 min on boiling water. The digested mixture was cooled to room temperature and then the acidity of the mixture was adjusted to pH 4.0-4.5 using 2.5 M sodium acetate. After that, 5 mL of 10% Taka-diastase enzyme solution was added to the misture and was incubated for three hours at 45-50°C. Thereafter, the ready solution was cooled, filtered and then diluted to 100 mL by using distilled water. The sample was filtered again before passing through 0.2 µ filter paper.

Standard preparation: Vitamin B_1 standard stock solution of 100 mL was prepared by dissolving Thiamin hydrochloride (43.4 mg), while vitamin B_2standard stock solution of 100 mL was prepared by dissolving riboflavin (30.6 mg) in de-ionized water. The 100 mL solution of nicotinic acid (53.9 mg) gave the stock solution of vitamin B_3. The working standard solution of each vitamin was prepared by taking 1 mL of each respective stock solution and making final volume upto 50 mL with de-ionized water. Before injection, 0.2 µ syringe filter was used for filtration of all these solutions.

Mobile phase and buffer preparation: 50 mM solution of 2.5 pH was prepared by dissolving 7.8005 g of $NaH_2PO_4.2H_2O$ (Sodium phosphate monobasic) in de-ionized water. The volume of the solution was raised to 1000 mL in a marked volumetric flask. The pH of the solution was adjusted to 2.5 pH by using 0.1 M HCl. The filter paper (0.4 µ) was used for the filtration of buffer solution. 50 mM phosphate buffer was dissolved in methanol (99.9%, HPLC grade) in 90:10 ratios to prepare mobile phase 'A'. For mobile phase 'B', 50 mM phosphate buffer was dissolved in methanol (99.9%, HPLC grade) in the ratio 10:90. A and B phases were filtered again by passing through the filter paper (0.4 µ) and sonicated for 10 min. at room temperature.

High performance liquid chromatography (HPLC): Vitamin analysis of aliquots were performed by Agilent 1100 HPLC equipped with Zorbax SB-C8, 4.6×150 mm. The ambient temperature of column was adjusted, and the UV detector was calibrated at 245 nm. The flow rate of 1.2 mL/min was provided throughout the analysis. For each vitamin, calibration curve was obtained by introducing five different volumes of respective working standard solution injections verses peak areas. The calculation was performed by linear least square regression and the estimation of vitamins was achieved by regression equation in divers' date complex.

Sugars profile analysis

Extraction*:* Sugars in date samples were extracted according to the protocol of Sawaya *et al.,* (1982). Five batches were selected randomly from each variety comprising of five date fruits. 20 g fruit piece was blended along with 80 mL boiling distilled water into a blender till homogeneous mixture. The resultant solution was filtered through filter paper (Whatman#1) and the solution was dried under vacuum in a rotary evaporator and stored at 4°C in an air tight container.

Derivatization: Samples were derivatized before running through gas chromatography (GC-FID). Derivatization was required for determination of monosaccharides with an oximation trimethyl silyl method with slight modifications. 0.6 mg of obtained sample was taken in test-tube (16×75 mm) and 0.5 mg phenyl β-d-glucopyranoside (an internal standard) was added to the test tubes. Then hydroxylamine hydrochloride (12.5 mg; Sigma-Aldrich) and undiluted pyridine (0.5 mL; 99% purity; Sigma-Aldrich) were poured in a test tube. Teflons-lined cap was used for sealing followed by gentle shaking and was kept at 70ºC for five minutes on water bath and cooled to almost 22ºC. Hexamethyldisilazane (0.5 mL; 99% purity; Sigma-Aldrich) and undiluted trifluoro-acetic acid (0.4 mL; 98% purity; Sigma-Aldrich) were also poured in the test tube. The mixture made in the test tube was shaken continuously and allowed to stay at 22ºC for 10 min for reaction. Then undiluted isooctane (0.5 mL; 99% purity; Sigma-Aldrich) and de-ionized water (4 mL) were mixed in the test tube for dissolving salt residues in the aqueous phase. At the end, isooctane layer was transferred to the vials for analysis.

Determination of monosaccharides: Monosaccaride contents, which were collected in the extract, were determined through gas chromatography (GC-MS Agilent 6890), attached to the FID. 30 m long DB-5 fused silica capillary column with 1.0 µm film thickness and inner dia was used. A multi-ramp column oven temperature program was used for sugars separation. A preliminary temperature was set at 180ºC for 4 min, then gradually increased at a rate of 1.5ºC per minute to 200ºC and kept for a minute. After that, temperature was increased at a rate of 10ºC per minute to 260ºC and kept for 2 min and then temperature was increased at a rate of 6ºC per minute to 290ºC for 8 min. The injection temperature was adjusted at 280ºC and detector port temperature at 300ºC. The carrier gas was nitrogen, with about 1 mL per minute flow rate. The individual sugars, glucose, fructose and sucrose were quantified after the injection of 2.0 µL sample.

Extraction of total phenols: Date fruit samples of each variety (25 g) were extracted with 100 mL of 80% (v/v) ethanol in a mechanical shaker for 6 h. It was centrifuged at 10,000 rpm for 20 min. The supernatants were filtered using filter paper (Whatman No.1) and dried at 40°C in a rotary evaporator under vacuum. The dried extract obtained was again diluted to 100 mL with distilled water and kept at -21°C in air tight conditions until further use.

Estimation of total phenols: UV spectrophotometer (Irmeco U-2020) was used to determine the total phenolic contents by using Folin-Ciocalteu reagent with some modifications (Singleton *et al.,* 1999). Gallic acid was used to make a standard solution for calibration curve. The results of total phenolics were expressed as µg of gallic acid equivalents (GAE) per mL of sample. The tests were performed in triplicate. 500 µL of prepared sample was taken in different test tubes, making three replicates of each sample. 1000 µL of 10% folin solution was added in test tubes and left to stay for 6 minutes. 2000 µL of 20% Na_2CO_3 was added and left for 60 minutes at 300ºC. Spectrophotometer was calibrated with blank before running the samples and absorbance was taken at 760 nm. Same procedure was followed for standard readings of all gallic acid concentrations.

Statistical analysis: Results were analyzed statistically by using analysis of variance (ANOVA) technique. The significance of means was at 0.01 probability level as suggested by Steel *et al.,* (1997).

Results and Discussion

Mineral estimation of date varieties: Minerals are inorganic elements which are required by every living cell for proper functioning and structure maintenance. Sodium (Na) is important for proper functioning of living cells and 500mg per day is the recommended amount for daily Na intake. High intake of Na can cause high blood pressure (Biesalski & Grimm, 2005). The minimum Na contents were found in sample Basraywal (1.07±0.18) while the maximum amount was recorded in Zaidy (10.40±0.27 mg/100 g) (Table 1). It can be said that the low Na contents of dates make them suitable for patients of hypertension.

Potassium (K) acts as electrolyte and takes parts in functioning of kidneys, muscle cell contraction and nerve impulse (Youn & McDonough, 2008). Constipation, irregular heart beat and muscle cramps are common symptoms of low level of blood K. Daily recommended amount of K per day is 2000 mg for adults. In the present study, K contents (on dry weight basis) in the fruits of the different date varities varied between 533.9±0.95 and 1013±0.86 mg/100g. The highest amount of K was determined in Hillavi variety (986.3±0.89 mg/100 g) (Table 1). In this directiom, 50% of daily requirement of K can be fulfilled by intake of 100 g Aseel Sindh or Hillavi varities.

Calcium (Ca) is required as structural part of teeth and bones (Jackson *et al.,* 2006). Daily recommended intakes of Ca help in reducing blood pressure and risk of colon cancer (Lappe *et al*., 2007). Ca recommended daily allowance (RDA) is 800 mg/day for adults while it is 1200 to 1500 mg/day for teenagers (Otten *et al*., 2006). On dry weight basis, Ca contents varied from 81.40±0.27 mg/100 g (Dora) to 195.18±0.18 mg/100 g (Dhakki) in different date varities. Karblain (178.95±0.39 mg/100 g) and Hillavi (181.73±0.18 mg/100 g) varities are also rich in terms of Ca (Table 1). According to the results of the present study, Hillavi, Karblain and Dhaki (100g fresh fruit) varieties contributes almost 25% of daily requirement in adults.

Magnessium (Mg) is important for proper functioning of nerves, heart and over 200 enzymes (Grundy *et al.,* 2006). 60% of Mg is deposited in bones while 40% circulates in blood and cells. RDA of Mg is 350 mg for a man while it is 280 mg for a woman. The minimum Mg contents were found in Desi simple (30.46±0.40) while the maximum amount was recorded in Zaidy (76.74±0.52 mg/100 g). Shungust (71.66±0.48 mg/100 g) and Aseel Sindh (74.59±0.03 mg/100 g) are rich in Mg (Table 1). More than 20% of daily requirement of Mg can be provided by the consumption of 100 g of Shungust, Zaidy and Aseel Sindh varities.

The most significant function of iron (Fe) is to contribute in transport of oxygen inside the human body. The Fe deficiency is a major cause of anemia (Wood & Grusak, 2007). In different date varities, Fe contents were recorded between 0.46±0.01 (Desi black) and 2.52±0.05 mg/100 g (Dora) (Table 1). Recommended daily allowance of Fe is 10 mg/day for a man while a woman needs 15 mg/day. Dates can be used instead of synthetic sources supplementation of Fe for meeting daily Fe requirements.

Copper (Cu) is an essential element in both humans and animals. Needed only in trace amounts, the human body contains approximately 100 mg Cu (Bost *et al*., 2016). According to the findings of the analyses, copper (Cu) contents of date varities ranged from 0.14±0.01 (in Desi small) to 1.60±0.02 mg/100 g (in Zaidy) (Table 1). Cu recommended daily allowance (RDA) is 1.5 to 3 mg/day for adults (Cabrera *et al.,* 2003). 100 g of fresh fruit of Aseel Sindh, Desi black and Zaidy may contribute to almost 50% of daily Cu requirement of human body.

Table 1. Mean values for potassium (K), sodium (Na), calcium (Ca), iron (Fe), magnesium (Mg), copper (Cu), manganese (Mn) and zinc (Zn) in date varieties (mg/100g).*

Varieties	K	Na	Ca	Fe	Mg	Cu	Mn	Zn
Aseel	843.9 ± 1.03e	4.39 ± 0.38h	148.40 ± 0.30g	1.75 ± 0.01g	33.38 ± 0.23l	0.53 ± 0.01kl	0.24 ± 0.01r	0.67 ± 0.01lm
Aseel Sindh	1013 ± 0.86a	7.26 ± 0.59cd	141.72 ± 0.31h	2.18 ± 0.01c	74.59 ± 0.03a	1.50 ± 0.01b	1.70 ± 0.02a	0.48 ± 0.01op
Choharay	703.4 ± 0.57m	8.17 ± 0.24bc	88.75 ± 0.34r	1.46 ± 0.01ij	57.24 ± 0.54e	1.15 ± 0.01ef	0.33 ± 0.01q	0.62 ± 0.01mn
Desi basray	696.0 ± 0.20n	1.61 ± 0.07j	85.62 ± 0.56s	1.02 ± 0.01m	45.32 ± 0.09h	0.40 ± 0.01mn	0.89 ± 0.01i	1.08 ± 0.01hi
Desi basraywal	592.5 ± 0.60s	2.46 ± 0.38ij	98.02 ± 0.49p	2.39 ± 0.02b	60.48 ± 0.69d	0.47 ± 0.01lm	0.98 ± 0.01h	1.78 ± 0.07b
Desi black	923.2 ± 1.64c	6.62 ± 0.14de	92.87 ± 0.79q	0.46 ± 0.01r	41.69 ± 0.42ij	1.42 ± 0.02c	1.49 ± 0.01c	0.39 ± 0.01pq
Desi green	765.1 ± 0.51j	9.53 ± 0.07ab	116.34 ± 0.37mn	0.65 ± 0.01q	43.46 ± 0.39hi	0.77 ± 0.01i	0.71 ± 0.01l	1.39 ± 0.02de
Desi red small	732.3 ± 0.07k	8.68 ± 0.56ab	136.26 ± 0.70i	0.76 ± 0.02p	39.17 ± 0.17jk	0.21 ± 0.01op	1.10 ± 0.01f	1.89 ± 0.02a
Desi simple	656.9 ± 0.76p	8.76 ± 0.13ab	165.48 ± 1.03e	1.09 ± 0.01m	30.46 ± 0.40m	0.71 ± 0.02i	1.58 ± 0.02b	1.14 ± 0.01gh
Desi small	804.8 ± 1.34h	4.28 ± 0.42hi	121.72 ± 0.40l	2.05 ± 0.01d	65.20 ± 1.73c	0.14 ± 0.01p	0.51 ± 0.01no	0.98 ± 0.02i
Dhakki	913.2 ± 0.65d	4.07 ± 0.47hi	195.18 ± 0.18a	1.94 ± 0.01e	63.55 ± 0.12c	1.08 ± 0.01fg	1.33 ± 0.01d	1.48 ± 0.01d
Dora	631.0 ± 0.55q	4.61 ± 0.24gh	81.40 ± 0.27t	2.52 ± 0.05a	36.57 ± 0.37k	0.27 ± 0.02o	0.77 ± 0.01k	1.31 ± 0.02ef
Dora basraywal	834.9 ± 0.37f	5.55 ± 0.23fg	113.75 ± 0.84n	0.95 ± 0.01n	42.21 ± 0.24i	1.28 ± 0.01d	0.65 ± 0.01m	1.62 ± 0.02c
Dora desi	786.5 ± 1.04i	6.80 ± 0.51de	132.47 ± 0.81j	1.71 ± 0.01g	53.71 ± 0.73f	0.36 ± 0.02n	0.83 ± 0.01j	0.66 ± 0.01mn
Hillavi	986.3 ± 0.89b	6.50 ± 0.69cd	181.73 ± 0.18b	1.40 ± 0.01j	37.14 ± 0.23k	0.57 ± 0.01jk	1.20 ± 0.01e	0.52 ± 0.02o
Karbalai Sindh	684.9 ± 0.80o	6.33 ± 0.12ef	174.53 ± 0.63d	0.87 ± 0.01o	69.04 ± 0.44b	0.86 ± 0.02h	0.55 ± 0.01n	0.76 ± 0.01k
Karblain	721.3 ± 0.36l	5.38 ± 0.24fg	178.95 ± 0.39c	1.83 ± 0.02f	51.49 ± 0.32f	0.92 ± 0.02h	0.61 ± 0.02m	0.73 ± 0.01kl
Khopra	817.3 ± 0.85g	4.14 ± 0.58hi	117.21 ± 0.48m	1.19 ± 0.01l	32.51 ± 0.88lm	1.20 ± 0.01e	0.46 ± 0.01op	0.32 ± 0.03q
Shungust	533.9 ± 0.95u	6.24 ± 0.31ef	103.92 ± 0.41o	1.56 ± 0.01h	71.66 ± 0.48b	1.00 ± 0.02g	1.05 ± 0.01g	0.56 ± 0.01no
Simple basraywal	612.5 ± 0.07r	1.07 ± 0.18j	158.64 ± 0.30f	1.28 ± 0.02k	48.45 ± 0.31g	0.63 ± 0.02j	1.35 ± 0.01d	0.87 ± 0.01j
Zaidy	540.9 ± 0.74t	10.40 ± 0.27a	125.56 ± 0.06k	1.52 ± 0.01h	76.74 ± 0.52a	1.60 ± 0.02a	0.42 ± 0.01p	1.23 ± 0.01fg

Mean values with different letters in each column differ significantly at $p<0.01$ * = on dry weight basis

Zinc (Zn) deficiency causes poor sexual development and growth retardation (Hambidge & Krebs, 2007). Depending on the nature of a diet, almost 10 to 35% of Zn is absorbed from diet and acts as an indirect antioxidant in the maintenance of membrane stability (Rink & Gabriel, 2000). A man needs 15 mg/day of Zn and a woman needs 12 mg. In the present study, the Zn amount ranged from 0.32±0.03 (in Khopra) to 1.89±0.02 mg/100 g (in Desi red small). Dora basraywal (1.62±0.02 mg/100 g) and Desi basraywal (1.78±0.07 mg/100 g) are also rich in terms of Zn (Table 1).

Manganese (Mn) acts as a regulator of blood sugar, an activator of some enzymes and an antioxidant in human body (Emsley, 2001). In this study, Mn contents ranged from 0.24±0.01 (in Aseel) to 1.70±0.02 mg/100 g (in Aseel Sindh) in date varities. Desi black (1.49±0.01 mg/100 g) and Desi simple (1.58±0.02 mg/100 g) are also rich in terms of Mn contents (Table 1). About 2 to 5 mg of Mn is required daily. Intake of 100 g dates may fulfill almost 20% of daily Mn requirements.

The results of the present study are in line with the researches studied on various date varieties. Ismail *et al.*, (2006) determined that some macroelements i.e. Mg, K and Na ranged from 31.9 to 62.3 mg/100 g, 524 to 1164 mg/100 g and 8.5 to 69.3 mg/100 g, respectively while microelements i.e. Mg, Fe and Zn varied from 0.83 to 0.35 to 0.47 mg/100 g, 1.76 mg/100 g and 0.25 to 60.0 mg/100 g respectively, in the five different varieties. Also, Elleuch *et al*., (2008) reported that the mineral contents of two date varities ranged from 823 to 863 mg/100 g K, 47.7 to 63.0 mg/100 g Ca, 41.6 to 44.1 mg/100 g Mg, 10.1 to 10.2 mg/100 g Na and 2.0 to 2.5 mg/100 g Fe on dry matter basis. The variations in results might be due to change in variety, climate and soil type.

Sugar profile of date varieties: The monosaccharides in date varieties are shown in Table 2. The maximum glucose contents were found in Zaidy (44.44%) and then Dora basraywal (35.29%), while the minimum glucose contents were found in Desi red small (26.75%). It was reported that Karblain (33.21%) contained the highest fructose contents. Dora (32.78%) and Dhakki (29.63%) also contain appreciable quantity of sucrose while the minimum fructose contents were observed in Dora desi (i.e. 19.94%). The maximum value for sucrose was determined in Hillavi (6.99%) while the minimum concentration was recorded in Dora basraywal (4.17%) and Karblain (4.17%).

Dates are a rich source of monosaccharides, particularly glucose and fructose (Al-Farsi & Lee, 2008) and these monosaccharides reach up to 80% with the maturity of date fruit (Al-Shahib & Marshall, 2003). Higher glucose and fructose concentrations might be due to invertase enzymes activity that accelerates sucrose to fructose conversion.

The findings of Ismail *et al.*, (2006) showed that total reducing sugars in dates varied from 68.4 to 76.2%, fructose varied from 36.2 to 39.5% and glucose varied from 31.2 to 36.7%. Glucose ranged from 32.7 to 36.8% in two date varieties, fructose ranged from 35.9 to 38.3% and reducing sugars ranged from 69.9 to 75.2% on dry weight basis. According to other studies, Deglet-Nour contains glucose 13.7%, 52.7% sucrose and 12.6% fructose, whereas, Allige contains 29.9% glucose, 13.9% sucrose and 29.0% fructose (Elleuch *et al*., 2008). In some date varieties, glucose contents ranged from 16.41 to 54.23 g/100 g and fructose contents ranged from 12.62 to 43.31 g/100 g in fresh fruits (Sahari *et al.*, 2007). These results match with the findings of the present study.

Table 2. Glucose, fructose and sucrose values in different date varieties' flesh (%).

Varieties	Glucose	Fructose	Sucrose
Aseel	31.77	29.11	4.92
Aseel Sindh	30.84	28.58	5.92
Choharay	32.13	27.91	5.65
Desi basray	29.53	23.03	5.10
Desi basraywal	27.84	25.21	5.12
Desi black	32.95	20.83	4.86
Desi green	32.07	23.13	4.48
Desi red small	26.75	24.99	5.24
Desi simple	29.14	23.65	5.32
Desi small	35.15	21.03	6.36
Dhakki	31.04	29.63	4.74
Dora	33.35	32.78	5.00
Dora basraywal	35.29	25.11	4.17
Dora desi	34.90	19.94	6.32
Hillavi	28.92	27.87	6.99
Karbalai Sindh	32.26	28.87	5.89
Karblain	35.25	33.21	4.17
Khopra	31.63	27.43	5.29
Shungust	29.32	28.21	5.65
Simple basraywal	27.42	25.14	6.32
Zaidy	44.44	22.23	5.18

Total phenolic content of date varieties: Phenolic contents in 100 g fruit ranged from 142.52±0.64 to 298.02±0.95 mg gallic acid equivalent on fresh weight basis in different date varieties. Dhakki excelled in total phenolic content (298.02±0.95 mg GAE) followed by Aseel (279.43±1.08 mg GAE) and Hillavi (274.59±1.33 mg GAE), while the lowest value was in Desi Red Small (142.52±0.64 mg GAE) followed by Desi Black (151.15±0.67 mg GAE) and Shungust (161.46±0.84 mg GAE) (Table 3). Dates are rich sources of phenolic compounds which have several beneficial effects on health. Aseel and Hillavi also contain appreciable number of phenolic compounds. Anti-nutritional impacts may be caused by intake of higher concentrations of phenolic compounds. However, Aseel, Hillavi and Dhakki are good sources of antioxidants and can be used as an ingredient in functional foods. Phenolic contents in dates may be varied due to several factors such as environmental and growing conditions, variety, soil type and maturity stage. Al-Farsi and Lee (2008) found phenolic contents in the range of 172 to 246 mg GAE/10 g in fresh fruit in three date varieties grown in Oman. However, Biglari *et al*., (2009) reported that phenolic compounds in two varieties (Khalas, Khasa) in the range of 20.24-63.41 mg GAE/100 g. There are some varieties which contain as low total phenolic contents as 5.73 to 54.66 mg/100 g but it is dependent on development stage of fruit.

Table 3. Mean values for total phenolic content (mg GAE)/100g* in date varieties.

Varieties	Total phenolic content
Aseel	279.43 ± 1.08b
Aseel Sindh	237.47 ± 0.34g
Choharay	202.94 ± 0.67ij
Desi basray	174.87 ± 1.23m
Desi basraywal	194.79 ± 0.34k
Desi black	151.15 ± 0.67q
Desi green	261.33 ± 1.02e
Desi red small	142.52 ± 0.64r
Desi simple	252.83 ± 1.02f
Desi small	258.97 ± 1.25e
Dhakki	298.02 ± 0.95a
Dora	171.98 ± 0.34n
Dora basraywal	219.64 ± 0.67h
Dora desi	206.95 ± 0.34i
Hillavi	274.59 ± 1.33c
Karbalai Sindh	166.87 ± 0.69o
Karblain	193.84 ± 0.67kl
Khopra	271.02 ± 0.33d
Shungust	161.46 ± 0.84p
Simple basraywal	192.02 ± 0.45l
Zaidy	201.74 ± 1.25j

Mean values with different letters in each column show highly significant difference (p<0.01) * = fresh weight basis

Table 4. Mean values for vitamin B_3 and B_2 (mg per 100 g) in fresh dates.

Varieties	Vitamin B_3	Vitamin B_2
Aseel	1.42	0.025
Aseel Sindh	1.22	0.014
Choharay	2.12	0.026
Desi basray	2.20	0.009
Desi basraywal	1.44	0.014
Desi black	2.46	0.012
Desi green	1.61	0.015
Desi red small	1.58	0.017
Desi simple	2.41	0.010
Desi small	1.09	0.021
Dhakki	1.52	0.019
Dora	2.05	0.011
Dora basraywal	2.08	0.013
Dora desi	1.15	0.012
Hillavi	1.70	0.029
Karbalai Sindh	1.41	0.012
Karblain	0.47	0.024
Khopra	2.37	0.031
Shungust	1.88	0.018
Simple basraywal	1.27	0.023
Zaidy	2.73	0.016

Vitamin B_1, B_2 and B_3 contents of date varieties: Vitamin B_1 was not detected in these varieties. The maximum (0.031 mg/100 g) vitamin B_2 was found in Khopra variety. The highest value of vitamin B_3 was recorded in Zaidy (2.73 mg/100 g) followed by Desi black (2.46 mg/100 g) and Desi simple (2.41 mg/100 g). However, the lowest vitamin B_2contents were recorded in Desi basray i.e. 0.009 mg per 100 g while those of vitamin B_3 were found in Desi small i.e. 1.09 mg per 100 g (Table 4).

Vitamins are significant for vital activities like tissue repair, waste removal, growth, proper functioning and energy production. The vitamin contents observed in this investigation are in line with the vitamin contents provided in FAO (2004) i.e., 0.01-0.05 mg per 100 g vitamin B_2 and 0.33-2.2 mg per 100 g B_3 in fresh fruit.

Conclusion

The results drawn from this research are very important for the consumers as they relate to the health and nutritional benefits. It is summarized that most suitable varities are Aseel Sindh and Hillavi and Dhakki because of their excellent nutritional characteristics. Appreciable quantities of calcium, copper, magnesium, potassium, manganese and iron are present in date varities. It is best suited food for hypertensive people due to low sodium contents. 100g of consumed dates fulfill 15% of recommended daily allowance of many minerals, including copper, iron, calcium, magnesium and potassium. Additionally, dates are also rich in terms of vitamin B_2 and B3 and total phenolic contents. Finally, it can be said that dates should be included in our daily diet due to their excellent nutritional composition and antioxidant activity.

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