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NUTRITIONAL EVALUATION OF *FICUS CARICA* INDIGENOUS TO PAKISTAN

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ABSTRACT

The nutritional composition of *Ficus carica* commonly known as fig is of great interest as it is considered a good source of energy and minerals. Seven samples of fig, cultivated in Pakistan were studied for their physico-chemical properties. All samples had little moisture, less amounts of ash and high volatile matters. Low moisture is favorable in preventing the fermentation of the fruit while high volatiles are responsible for its unique taste. The energy content of the samples ranged between 337.60 - 364.70 kcal/100g. The samples were found to be a good source of potassium (3.82-6.11 g/kg), magnesium (0.11-0.20 g/kg), calcium (78.72-132.80 mg/kg) and sodium (5.58-17.69 mg/kg). The mineral and trace contents of the indigenous samples were compared with the samples cultivated in the USA, Turkey and Iran. The samples cultivated in Pakistan were found to have good nutritional values especially higher calorific value and iron content compared to the reported data. The Ca/P ratio in the indigenous variety lies as recommended by nutritionists. This feature made the indigenous variety distinct as the patients suffering from stone formation in kidney may also use it safely. The high potassium in fig is beneficial not only to patients of hypertension but also prevents the bones from rapid thinning by neutralizing the increased urinary calcium loss. Significant correlations were found between iron and potassium, copper and potassium and zinc and copper ($p<0.05$). The positive correlations are either due to higher uptake of metals by the plant or the excess availability of the metals in the soil. Analysis of means (ANOM) was applied to evaluate the compositional variations between the samples. The study provides an overview of the physico-chemical properties of fig samples indigenous to Pakistan. The results offer useful information not only to consumers who want to buy the best quality fruit, but also to producers interested in increasing the competitiveness of fig cultivation.

Key words: *Ficus carica*, minerals, calorific value, acidity

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INTRODUCTION

Dry fruits have substantial quantities of essential nutrients in a rational proportion [1]. They have considerably more energy than fresh fruits because the nutrients are concentrated in solids when the water is removed. Fig fruit (*Ficus carica*) is one among such nutritious dry fruits, which is available throughout the year.

Pakistan's climatic condition provides an ideal opportunity for its growth as it requires at least eight hours a day of sunlight to ripen. Figs must be allowed to ripen fully on the tree as they do not ripen if picked prematurely. The nutrient uptake of the plant increases during fruit development. The matured "fruit" has a tough brown skin, often cracking upon ripeness, and exposing the pulp beneath. The inner white skin contains a seed mass bound with jelly-like flesh. This flesh mainly contains water, volatile matter, minerals, vitamins and calories while the seeds are responsible for the characteristic nutty taste of the figs.

Fully ripened fresh figs have a shelflife of 2–3 days if refrigerated. They take 4 - 5 days to dry in the sun and 10 -12 hours in a dehydrator. Dried figs can be stored for six to eight months [2], and are considered a rich source of nutrients especially essential minerals and energy [3-5]. Limited data have been reported on the physico-chemical composition of the fruit but none is available on the physical properties and mineral contents of the samples that are indigenous to Pakistan [6-8]. The composition of fruit may be influenced by the physiological and environmental factors such as soil chemistry, climatic conditions, mode of cultivation and method of dehydration used. Therefore, a variation in the physico-chemical data between the indigenous varieties is a question of considerable interest with regard to the cultivars and users.

Fig is a cheaper dry fruit and easily available throughout the year; therefore, the primary object of the present study was to assess the nutritional characteristics of the indigenous fruit by studying some of its physico-chemical properties. Analysis of means (ANOM) was applied on the data to evaluate the difference between the varieties.

MATERIALS AND METHODS

Sampling

Seven samples (S1-S7) of *Ficus carica* indigenous to Pakistan were purchased from the local markets during June 2008. Four samples (coded as S1-S4) were cultivated in Baluchistan province, two samples (S5 and S6) were grown and utilized in Sindh, and the remaining one sample (S7) was cultivated in Punjab. Composite sampling technique was adopted to make the samples representative by taking 500 g of each variety from at least three different local markets. The samples were labeled and stored in polythene bags at -3 °C for subsequent analysis.

Proximate Composition

The proximate composition of the fruit (water content, volatile matter and ash content) was determined using thermogravimetric analyzer (TGA-2000, Navas Instruments, Spain). A constant gas flow was set in all the tests to obtain a low-noise signal. The precision of micro-balance and thermocouple for mass and temperature measurements in TGA were ± 0.2 mg and ± 1 °C, respectively.

During thermal decomposition, the loss in sample mass was measured as a function of temperature [9]. For the estimation of water content, the samples were held at 105 °C in nitrogen atmosphere to remove water until a constant weight was obtained. The water content was calculated by taking into account the difference between initial mass and the constant mass at 105 °C. For volatile measurement, the temperature of the furnace was increased with a ramp rate of 16 °C min^{-1}. The amount of volatile matter was estimated after a constant heating at 950 °C for 7 minutes in a nitrogen environment to ensure complete devolatilisation [10, 11]. The samples were then maintained at 500 °C for 10 minutes. To determine the ash content, the furnace temperature was increased again to a constant temperature of 750 °C with the same ramp rate in an air flux of 20 ml min^{-1} [10, 11]. The results of thermal analysis for water content, and ash were reported on constant weight basis, while the results of volatile matter were estimated by fixed time method.

Calorific Value

The calorific values of the samples were determined by burning a weighed sample in oxygen, in a calibrated Adiabatic Bomb Calorimeter (Parr, model 6400) under controlled conditions [12]. The calorimeter was standardized by burning benzoic acid. The calorific value of the sample was computed from temperature observation made before, during and after combustion, making proper allowances for heat contributed by other processes, and for thermometer and thermo-chemical corrections.

Spectrophotometric Analysis

Analyses of metals of interest were performed by Perkin Elmer atomic absorption spectrophotometer (PE-3300) using the hollow cathode lamps. Flame technique was employed for Ca, Mg, K, Na, Fe, Zn, Cu, Co and Ni determinations. Duplicate solutions were prepared for each sample and a minimum of three separate readings were taken to minimize error. The mean values were used to calculate the concentrations.

Phosphorus content in fruit was estimated by spectrophotometric molybdovanadate method [13].

Sample Preparation and Treatment

Sub-sample (2 g wet mass, each) were taken randomly from the composite sample and digested in a mixture of 65 % HNO_3 (3 ml) and 30 % H_2O_2 (2 ml) in closed PTFE vessels of CEM MDS-200 microwave (CEM, USA), digestion system. The digested samples were diluted to 25 ml in volumetric flask and stored in polyethylene vessels. The analyses have been carried out within fifteen days of sample preparation. For Ca and Mg determinations, the samples were diluted with 0.1 % (w/v) lanthanum chloride solution [14].

Standards

Standard solutions of metals (1000 mg/L in 0.1 N HNO_3), calcium (Ca), cobalt (Co), copper (Cu), iron (Fe), magnesium (Mg), nickel (Ni), phosphorus (P), potassium (K), sodium (Na) and zinc (Zn) were purchased from Merck (Darmstadt, Germany). Stock solutions were prepared from the standard solutions. Working standards were prepared by diluting the stock solutions.

Quality Assurance

AnalaR grade chemicals were used to establish accuracy, reliability and reproducibility in the results. Volumetric glassware of class "A" quality was used for solution preparation. Double distilled water was used for solution preparation and dilution purpose. Two commercial reference materials Spectroquant CombiCheck 30 and CombiCheck 40 (Darmstadt, Germany) were used as the quality control samples.

Statistical Data Analysis

Data were statistically analyzed to investigate the correlations between the physico-chemical properties. Variations in proximate and mineral contents in all samples were measured by Analysis of Means (ANOM). All statistical measurements were performed using statistical software Minitab version 14.

RESULTS

Physical and Proximate Composition

All samples of dry *Ficus carica* were spherical in shape, with light brown to dark brown rough surface. The weight of individual samples was 4.66 - 13.82 g with an average value of 8.06 g and the diameter was 2.86 – 4.51 cm (average = 3.57 cm). The water content in the samples was in the range of 12.89 – 17.50 g/100g (average = 14.86 g/100 g). The amount of ash and volatiles ranged from 1.39-2.31 g/100 g (average: 1.95 g/100 g) and 79.81–82.25 g/100 g (average: 80.77 g/100 g), respectively (Table 1). Calorific values ranged from 337.60-364.70 kcal/100g (average: 350.34 kcal/100g). Acidity values of the samples were expressed in g/100g of oxalic acid and ranged from 0.35-0.69 g/10g.

Mineral Nutrient Content

The mineral content of *Ficus carica* is shown in Table 2. Potassium was the major mineral element found in all samples. Its range of variation was 382.4-611.5 mg/100g when all samples were taken into account. Mg ranged from 110.50-202.40 mg/100g, Ca from 78.72–132.80 mg/100g, Na from 5.58–17.84 mg/100g, Fe from 5.69–10.09 mg/100g and P from 31.91-76.96 mg/100g. Concentrations of Cu and Zn were lower; the ranges of variations were 0.25-0.42 and 0.32-0.62 mg/100g, respectively. Nickel and cobalt contents were found to be below the detection limit (0.1 mg/l for both elements) in all samples.

DISCUSSION

Moisture content in all the fig samples was in the range of the standard values for moisture allowance in dried figs (moisture limits for dried figs = 24-30 g/100 g) [15]. Low water content decreases the possibility of fermentation in the fruit, while high volatiles are linked to the unique taste and flavor of the fruit. The high calorific value [16, 17] makes the fruit more nourishing and hence, it may be recommended for people who are involved in physical activities or for children who burn a lot of calories during their continuous activities. Figs contain a considerable amount of oxalates, which can interfere with the absorption of calcium in the body; persons already suffering from kidney or gallbladder problems are advised to avoid them [18]. However, a person with a healthy digestive tract can obtain significant benefits from consuming figs. Table 2 shows that indigenous fig samples contain high amount of potassium (382.4 – 611.5 mg/100g) coupled with low sodium (5.58 – 17.84 mg/100 g). Potassium is a blood pressure controlling mineral; therefore, figs may be recommended for the patients suffering from hypertension. Additionally, the potassium in figs may also neutralize increased urinary calcium loss caused by the high-salt diets, thus helping to prevent bones from thinning out at a fast rate [19].

Calcium/phosphorus ratios in the indigenous samples are expressed in Table 3. For every gram of phosphorus ingested in the diet, the body needs another gram of calcium before the phosphorus can be absorbed through the intestinal wall into the bloodstream. If the required calcium is not available from the diet, the body will obtain it from the stored depots in the bones. Most nutritionists recommend that the ideal levels are somewhere between 1.2-2 parts calcium to 1 part phosphorus [20]. The Ca/P ratio found in indigenous samples is ideal, ranging from 1.18/1-2.89/1 (Table 3). This ratio is in accordance with the results (1.65/1 and 1.63/1) of Greenbro [20] and Morton [21].

The mineral contents of the indigenous samples were comparable with the USA, Iranian and Turkish samples [22] (Table 4). The low content of calcium and potassium and high content of iron in the local variety is probably due to the difference in the environmental conditions such as origin of cultivars, fertilizer, mode of cultivation or ripening, and composition of soil.

Currently, enormous amounts of food supplements are available in the market, which may be helpful in getting the nutrients required for the human body. With all these advantages, it is reported that taking higher than recommended doses of supplements such as vitamin E may be harmful and possibly toxic. On the other hand, natural food offers an array of health benefits, such as being high in fiber, protein, and other vitamins and minerals and low in saturated fat and cholesterol as well [23]. Due to these nutritional

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advantages, dried *Ficus carica* is claimed to have a significant importance in the field of health sciences [24].

Statistical Analyses

Table 5 shows the significant correlations between iron and potassium (r^2 = 0.837, $p<0.05$), copper and potassium (r^2 = 0.775, $p<0.05$) and zinc and copper (0.843, $p<0.05$). The correlation between other parameters was less strong ($p>0.05$).

Analysis of means (ANOM) was applied on the data to observe the difference among the indigenous samples and the foreign varieties. Selection of the metals and other parameters was based on the availability of the reported data. Since the markers for all metals (except Ca and Mg) cross the decision boundaries (Figure 1), it is concluded that there is a significant difference between the means of potassium, iron, sodium, copper, zinc and phosphorus contents ($p<0.05$) in indigenous samples. This observation shows that the metals uptake of fruit is highly dependent upon soil chemistry. The highest significant difference is observed for potassium, showing that the soil in which figs are cultivated is enriched with varying amounts of potassium.

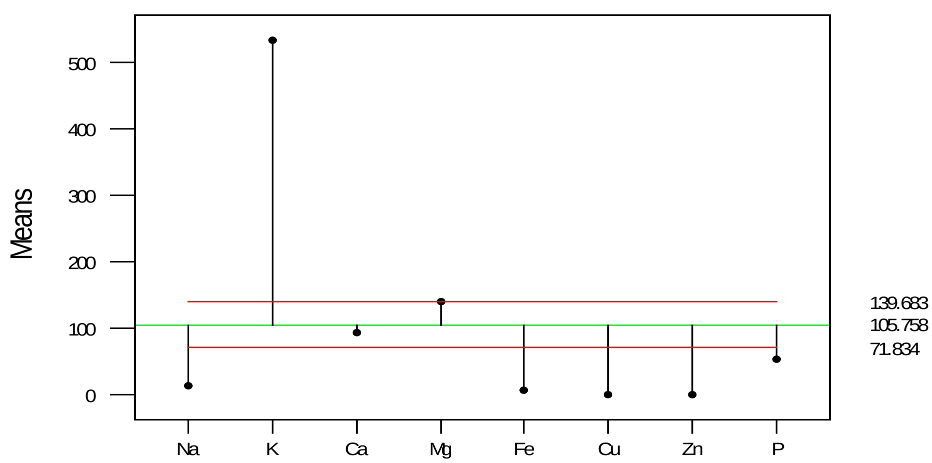

Figure 1: One-way normal ANOM for indigenous samples at α = 0.05

Figure 2 presents the ANOM applied on the data of different geographical origins of the world (Table 4). It is evident from the figure that the difference in calcium content and calorific value is insignificant ($p>0.05$) while the contents of the remaining parameters varied significantly ($p<0.05$).

It is important to note that when ANOM is applied on the indigenous samples (Fig. 1) and the samples of different geographical origins (Fig. 2), same pattern in the variations is been observed. The highest significant difference is observed for potassium in both cases. Similarly, the amount of sodium and iron also varies in the soil of each region. This observation is in accordance with the previous study, which shows that the metal content of the plant is strongly influenced by the quantity of biologically available metal in the soil in which it grows [25].

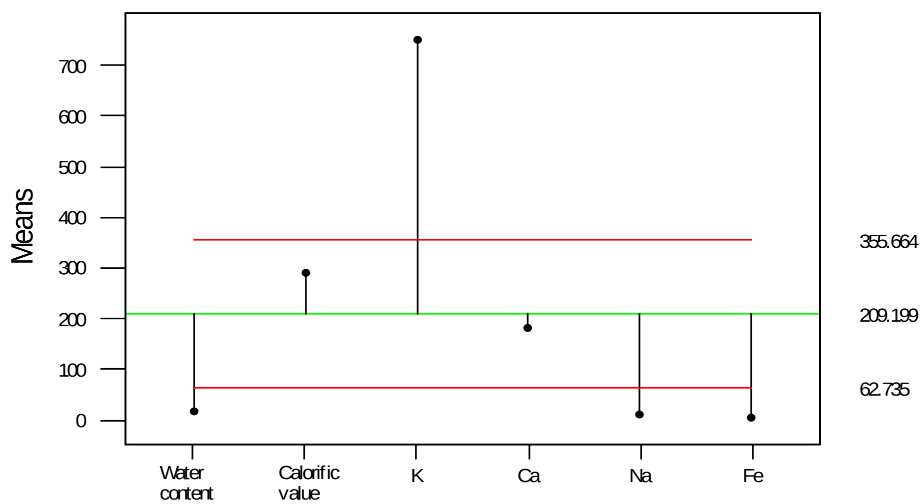

Figure 2: One-way normal ANOM for foreign sample varieties at α = 0.05

The dendrogram of cluster observations, Fig. 3 presents the similarity level between the indigenous samples. It is evident from the figure that sample S2 grouped with S4 and S1 grouped with S3 with similarity level 88.29 % and 75.23 %, respectively.

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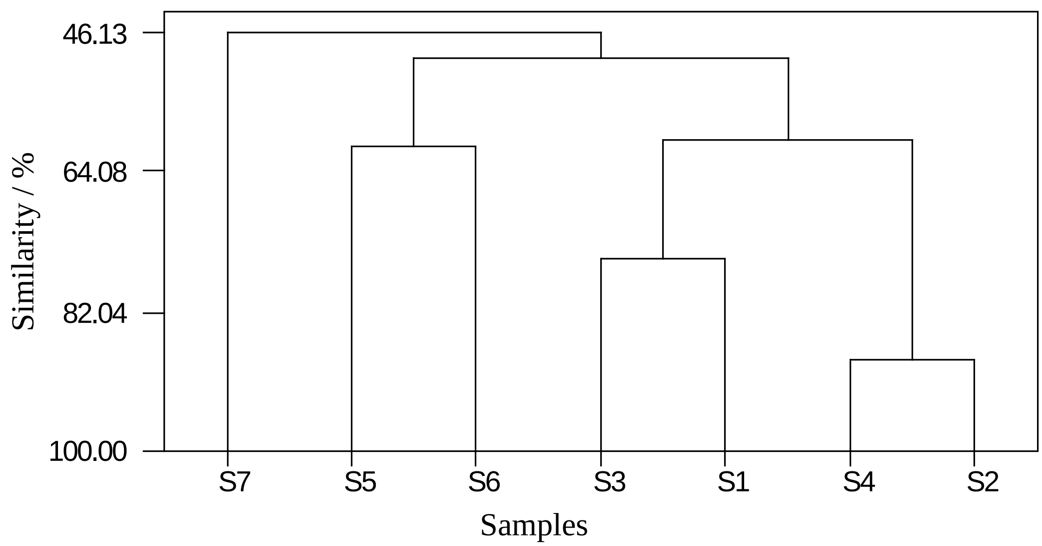

Figure 3: Dendrogram resulting from hierarchical cluster analysis

Both groups combined and formed a cluster (similarity level 60.75 %) representing Baluchistan province as the origin. The samples of S5 and S6 were separated by another distinct cluster (similarity level 60.02 %). The sample cultivated in Punjab was separated with a similarity level of 46.13%. Cluster analysis is found to be a good chemometric tool for the identification of the samples from different geographical origins on the basis of their studied properties. Fig. 2 is a good representation of the discrimination between samples according to geographical origin.

CONCLUSION

The study shows that the indigenous samples of *Ficus carica* are rich in minerals especially iron and sodium. Potassium and calcium contents of the indigenous variety are comparable with the reported data. Low moisture is favorable for storage for a long period while high calorific value makes it a potential fruit as an effective instant energy provider. Therefore, on the basis of the present study, fig fruit is recommended as a natural food supplement available round the year to provide instant energy, not only for the patients suffering from kidney stone and high blood pressure but it is also beneficial to healthy persons.

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Table 1: Physical composition of *Ficus carica*

Sample	Average weight (g)	Diameter (cm)	Water content (g/100g)	Ash (g/100g)	Volatile Matter (g/100g)	Calorific Value (kcal/100g)	Acidity (g/100g)
S1	4.78±0.59	3.12±0.21	16.19±0.03	1.90±0.02	80.19±1.08	337.60±5.24	0.55±0.02
S2	12.96±1.01	4.51±0.17	17.50±0.02	1.87±0.02	81.07±1.45	344.70±5.44	0.69±0.01
S3	4.71±0.60	2.91±0.17	13.88±0.01	1.74±0.01	81.49±1.25	343.90±8.34	0.35±0.01
S4	13.82±1.61	4.37±0.19	14.61±0.02	2.80±0.01	79.81±1.35	345.40±9.41	0.61±0.03
S5	7.55±0.80	3.45±0.24	12.89±0.02	1.62±0.02	80.78±1.14	364.70±7.49	0.49±0.02
S6	7.96±0.23	3.77±0.26	15.10±0.01	2.31±0.03	79.81±1.26	359.40±6.79	0.55±0.02
S7	4.66±0.52	2.86±0.16	13.83±0.01	1.39±0.01	82.25±1.10	356.50±5.42	0.41±0.01

Data are expressed as mean ± standard deviation (n=3)

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Table 2: Mineral composition of *Ficus carica* in mg/100g

S. No.	Na	K	Ca	Mg	Fe	Cu	Zn	Ni	Co	P
S1	17.84±0.14	501.1±1.06	78.84±0.99	141.70±1.64	5.95±0.16	0.32±0.01	0.43±0.01	BDL	BDL	66.96±0.14
S2	8.5±0.13	585.5±1.24	95.15±0.85	113.40±1.34	10.09±0.44	0.34±0.01	0.49±0.01	BDL	BDL	44.66±0.12
S3	16.09±0.26	470.5±1.11	98.67±1.04	141.70±1.14	6.95±0.33	0.33±0.01	0.58±0.02	BDL	BDL	68.25±0.11
S4	5.58±0.22	611.5±1.45	78.72±1.24	110.50±1.85	8.5±0.40	0.32±0.02	0.35±0.02	BDL	BDL	31.91±0.13
S5	16.44±0.11	578.9±1.23	132.8±1.10	202.40±1.06	7.76±0.12	0.37±0.01	0.59±0.01	BDL	BDL	45.93±0.13
S6	16.43±0.16	609.7±1.41	96.84±0.63	116.90±1.02	9.33±0.31	0.42±0.02	0.62±0.02	BDL	BDL	76.96±0.13
S7	17.69±0.10	382.4±1.14	79.79±0.98	161.20±1.02	5.69±0.21	0.25±0.01	0.32±0.01	BDL	BDL	41.02±0.14

Data are expressed as mean ± standard deviation (n=3)

BDL = Below Detection Limit (detection limit = 0.1 mg/kg)

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Table 3: Calcium/phosphorus ratio in indigenous samples

Sample No.	Ca/P
S1	1.18/1
S2	2.13/1
S3	1.45/1
S4	2.47/1
S5	2.89/1
S6	1.26/1
S7	1.94/1

Table 4: Variations in physicochemical properties of indigenous and foreign samples

Physicochemical property	Present study	Previous studies [19]		
		USA	Iran	Turkey
Water content (g/100g)	14.86	23	9.9	16.8
Calorific value (kcal /100g)	350.3	281.9	313	217
K (mg/100g)	534.23	609	1060	800
Ca (mg/100g)	94.4	133	363	138
Na (mg/100g)	14.08	12.2	5.2	14
Fe (mg/100g)	7.75	3.07	1.89	4.2

Table 5: Pearson correlation values (p-values are shown in parenthesis and the significant correlations are shown as bold)

	Na	**K**	**Ca**	**Mg**	**Fe**	**Cu**	**Zn**
K	-0.574						
	(0.178)						
Ca	0.217	0.322					
	(0.64)	(0.481)					
Mg	0.597	-0.353	0.651				
	(0.157)	(0.437)	(0.113)				
Fe	-0.64	**0.837**	0.256	-0.514			
	(0.122)	(0.019)	(0.58)	(0.238)			
Cu	0.006	**0.775**	0.544	-0.128	0.657		
	(0.990)	(0.041)	(0.207)	(0.784)	(0.109)		
Zn	0.302	0.411	0.735	0.164	0.406	**0.843**	
	(0.511)	(0.360)	(0.06)	(0.726)	(0.366)	(0.017)	
P	0.612	-0.021	0.069	-0.109	-0.061	0.532	0.655
	(0.144)	(0.965)	(0.883)	(0.817)	(0.897)	(0.219)	(0.111)

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