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Fruit Properties and Nutritional Composition of Some Walnut Cultivars Grown in Pakistan

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Abstract: Walnuts (*Juglans regia* L.) are rich source of a number of important nutrients that have a very positive effect on the human health. In this study nuts of six different walnut cultivars grown in Pakistan namely Chitral-1, SW-1, Chitral-3, Chitral-2, SW-3 and Dir-2 were selected and evaluated for their physical properties, proximate and mineral composition. The nut length was found in the range of 35.17-41.37 mm, nut diameter (31.72 mm-34.32 mm), Nut thickness (32.21-35.10 mm), nut weight (10.30 g-19.22 g), Kernel weight (5.81 g-9.24 g), Kernel ratio (43.19-65.14%), shell thickness (0.81-1.35 mm), moisture content (2.76-4.20%), ash content (1.27-1.95%), fats (63.54-69.92%), protein (15.96-19.15%) and total carbohydrates (8.04-12.14%). Kernels of Dir-2 and Chitral-2 cultivars were determined to contain high protein content (>18% protein) while Chitral-1 and SW-1 contain high carbohydrates content of >10%. The energy value of the kernels of these cultivars was determined in the range of 698.10-732.44 Kcal/100 g, which shows that the fruits of these varieties are rich source of energy. In minerals the level of sodium is 40.9-64.5 ppm, K (3551-4827ppm), Ca (925-1250 ppm), Fe (30.08-41.20 ppm), Zn (11.75-25.5 ppm), Mg (1059-1765 ppm), Cu (1.96-2.75 ppm) and Pb (0.69-1.06 ppm). The fruit properties indicates that Chitral-3, Chitral-2 and SW-3 are superior walnut cultivars in terms of their physical properties than the rest of the cultivars and they could be cultivated and developed as standard varieties in Pakistan. Moreover, kernels of all the cultivars studied are rich in K, Ca, Mg, Na and Fe.

Key words: *Juglans regia* L., fruit properties, nutritional composition, proximate composition, energy content

INTRODUCTION

Walnut (*Juglans regia* L) a member of *Juglandaceae* family is one of the finest nuts of temperate regions (Ozcan, 2009). Walnuts are of a high economic interest for the food industry (Martinez *et al*., 2008) and its nuts are highly appreciated for its unique organoleptic characteristics (Lopez *et al*., 1995), hypocholesterolemic effects (Sabate and Fraser, 1994; Abbey *et al*., 1994; Savage, 2005; Dogan and Akgulb, 2005; Pereira *et al*., 2008) and antihypertensive effect (Sabate and Fraser, 1994; Mexis *et al*., 2008; Arranz *et al*., 2008). The bark of *Juglans regia* (locally called Dandasa) is regularly used as miswaks for teeth cleaning (Ibrar *et al*., 2007). Walnut species are important sources of nuts and timbers in the temperate zones across the world (Zhang *et al*., 2009; Li *et al*., 2007; Khan and Khatoon, 2007). A valuable edible nuts produced by walnut trees are well appreciated because they are enriched with unsaturated fat (linoleic, oleic acid). The walnut plant has a high nutritional value and high-quality wood. In addition, walnuts have significant economical value and medicinal importance for human health because of their biochemical composition of polyunsaturated fatty acids, especially 18:2 and 18:3 and protein value (Savage *et al*., 2001). They also contain other beneficial components like plant protein (e.g. arginine, leucine), carbohydrates (e.g. dietary fibre), vitamins (e.g. vitamin A, E), pectic substances, minerals (magnesium, potassium, phosphorus, sulphur, copper and iron), plant sterols and phytochemicals (Kris-Etherton *et al*., 1999; Savage *et al*., 2001; Prasad, 2003; Colaric *et al*., 2006). In Pakistan there are up to 50 different walnut cultivars growing in different regions of Pakistan like Chitral, Dir, Swat, Gilgit, Kaghan, Baltistan, Kurrum and Muzafarabad. However, the literature describing physical properties, proximate and mineral composition of walnut fruits is very limited. The present study was designed to evaluate the fruits of walnut cultivars grown in the Chitral, Swat and Dir districts of Pakistan for their physical parameters, proximate composition and mineral composition.

MATERIALS AND METHODS

Walnut seed from six walnut cultivars namely Chitral-1, SW-1, Chitral-3, Chitral-2, SW-3, and Dir-2, were collected from the selected areas of Swat, Chitral and Dir (Lower and Upper) districts of Pakistan in September, 2008 from the trees which were 25-40 years

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old. These areas are at altitudes of 1550-1750 meters. The storage conditions and time until analysis were similar for all cultivars. Physical analysis was quickly determined and kernel samples were kept at -18°C before chemical analyses. There were at least three repetitions in proximate chemical analyses and ten repetitions in physical analyses.

Physical analysis: Physical analysis include nut fruit properties (i.e. nut diameter, nut length, nut thickness, nut shape, nut size, nut weight, shell thickness, shell roughness) and kernel properties (kernel weight and Kernel ratio) were determined according to the Turkish Standard Institute (TSI, 1990 and 1991).

- Shape of the nuts was determined by the following formula:

$$\text{Nut index} = \frac{\text{Nut length (mm)}}{(\text{Nut diameter} + \text{nut thickness})/2}$$

Nut index < 1.25 were taken as sphere shape
Nut index ≥ 1.25 indicate the oval shape of the nuts

- Kernal ratio was determined by the formula:

$$\text{Kernel ratio (\%)} = \frac{\text{Kernel Wt. (g)}}{\text{Nut Wt. (g)}} \times 100$$

- Size "extra" for the nuts if,

Nut diameter ≥ 27 mm for sphere
Nut diameter ≥ 26 mm for oval

All these analysis were determined at least for 10 of each of the samples from each Cultivar.

Chemical analysis: For the Chemical analysis AOAC methods were used. Fats contents were determined by using AOAC 22.034, protein content AOAC, PN-75/A-04018 and percent moisture by AOAC 22.003 (AOAC, 1990). Percent ash was determined as described by Ali *et al.* (2008). % carbohaydrates were determined by difference.

For mineral composition, the concentration of Na+ and K+ was determined with the help of flame photometer (Jenway PFP7) by the method describe by Khan and Zeb (2007). Heavy metals like Ca, Cu, Fe, Mg, Zn and Pb were determined with help of Atomic Adsorption Spectrometer (Perkin Elmer, model Analyst 700) with air/acetylene flame at 2200-2400K (photo multiplier tube detector), against the standard as described by Hanlon (1992).

Total energy values were calculated by multiplying the amounts of protein and carbohydrate by the factor of 4 kcal/g and lipid by the factor of 9 kcal/g as described by Ullah *et al.* (2010) and Colak *et al.* (2009).

All the parameters were determined at least in triplicate and the results were presented in mean±Standard Deviation (SD).

RESULTS AND DISCUSSION

Fruit properties of the walnuts: Walnut cultivars and their locations from where they were collected are shown in Table 1. The fruit dimensions and shape properties of the six walnut (as shown in Table 2) shows the maximum nut length of 41.37±0.72 mm for SW-3 while the minimum (35.17±0.86 mm) was recorded for the SW-1. The maximum nut diameter of 34.32±1.17 was determined for the Chitral-1 while minimum (31.72±0.83) was found for SW-3. The nut thickness was in the range of 35.10±1.13 mm (Chitral-1) to 32.21±1.25 (SW-3). Nut shape was determined to be spherical for Chitral-1, Swa-1, Chitral-2 and Dir-2 while oval for Chitral-3 and SW-3. Nut size was determined extra for all the cultivars.

Table 1: Walnut verities and their locations used in this study

Name of cultivar	Local market name	Location of cultivar (District)
Chitral -1	Chatral No. 1	Chitral, NWFP
Swat-1 (Kaghzai)	Kaghazi No. 1	Swat, NWFP
Chitral-3	Chitral 3	Chitral, NWFP
Chitral-2	Chitral 2	Chitral, NWFP
SW-3 (Kaghazi)	Kaghzi No. 2	Swat and Dir Upper, NWFP
Dir-2	Dir 2	Sawat and Dir Lower, NWFP

The results regarding the fruit properties of the walnut cultivars are shown in Table 3. Nut weights were in the ranged of 19.22±0.73 g (Chitral-3) to 10.3±0.86 (Swat-1). Kernel weight ranged form 5.81±0.59 g (Dir-2) to 9.24±0.47 g (Chitral-2). Kernel ratio (%) was in the range of 43.19±2.56 % (Dir-2) to 65.14±2.31% (Swat-1). Kernel ratios were <50% for Chitral-1 and Dir-2 while the rest of the cultivars were >50%. Shell thickness of were in the range of 0.81±0.09mm to 1.35±0.72mm for Swat-1 and Chitral-1, respectively. The Swat-1 and SW-3 Cultivar is locally known as kaghazi variety and is valued for its thin shelled nuts.

Akca and Sen (1995) showed nut length as 39.97 mm, nut diameter as 33.59 mm and nut thickness as 34.75 of the promising walnut genotype. This notion is in agreement with our results. Khattak *et al.* (2000) determined the nut weight (12.30-1.90 g), kernel weight (5.43-8.94 g) and kernel ratio (43-47%) for the four walnut cultivars (Kurrum-1, Kurrum-2, Kurrum-3 and Kurrum-4) grown in Kurrum agency, Pakistan. Our results are better than that shown by Ozkan and Koyuncu (2005), who studied the walnut cultivars grown in Turkey and found nut weights (11.09 g-8.43 g), kernel weight (6.32 g-4.35 g), kernel ratio (57.41%-48.89%), shell thickness (0.83 mm-1.47 mm), nut thickness (33.45 mm-29.24 mm), maximum nut length (37.88) and maximum nut diameter (31.12 mm). This could be due to differences in the ecological and genetic properties of walnut cultivars growing in Pakistan and Turkey.

The results of the fruit properties shows that fruits of Chitral-3, Chitral-2 and SW-3 cultivars have superior physical properties and they could be cultivated and developed as standard cultivars in Pakistan.

Table 2: Fruit dimension and shape properties

	Chitral-1	SW-1	Chitral-3	Chitral-2	SW-3	Dir-2	Mean±SD
Nut length	39.51±1.52	35.17±0.86	41.25±1.37	39.71±0.86	41.37±0.72	36.56±1.39	38.93±2.531
Nut diameter	34.32±1.17	32.71±0.65	32.86±1.34	33.25±0.96	31.72±0.83	33.68±1.27	33.09±0.89
Nut thickness	35.10±1.13	33.05±0.76	32.89±0.89	33.47±0.83	32.21±1.25	34.14±1.17	33.47±1.02
Shape	Spherical	Spherical	Oval	Spherical	Oval	Spherical	-
Size	Extra	Extra	Extra	Extra	Extra	Extra	-

Mean±Standard Deviation (SD)

Table 3: Fruit properties of walnut cultivars

	Chitral-1	SW-1	Chit. 3	Chit. 20	SW-3	Dir-2	Mean±SD
Nut wt. (g)	13.51±0.15	10.3±0.86	18.22±0.73	18.15±0.41	16.13±0.69	13.45±0.86	14.96±3.107
Kernal wt. (g)	6.34±0.52	6.71±0.35	9.15±0.41	9.24±0.47	8.20±0.53	5.81±0.59	7.575±1.485
Kernal ratio (%)	46.92±1.96	65.14±2.31	50.21±2.1	50.90±2.41	50.3±1.9	43.19±2.56	51.11±7.465
Shell thickness (mm)	1.35±0.72	0.81±0.09	0.98±0.18	0.95±0.25	0.92±0.07	1.27±0.76	1.046±0.213
Shell roughness	Rough	Median and Porous	Smooth	Medium	Smooth	Rough	-

Mean±Standard Deviation (SD)

Table 4: Proximate composition of the walnut Cultivars

	Chitral-1	SW-1	Chitral-3	Chitral-2	SW-3	Dir-2	Mean±SD
Moisture (%)	3.34±0.12	3.56±0.37	3.42±0.37	2.76±0.51	2.83±0.31	4.2±0.35	3.352±0.527
% Ash	1.56±0.02	1.95±0.009	1.36±0.15	1.63±0.13	1.27±0.08	1.38±0.39	1.525±0.247
Fat (%)	63.54±2.53	66.72±2.25	69.25±3.72	68.85±2.53	69.92±3.46	67.35±3.35	6.76±2.323
Protein (%)	19.15±1.19	15.96±1.06	17.84±1.08	18.66±2.17	17.75±1.17	18.92±2.16	1.804±1.169
Carbohydrates (%)	12.41±1.03	11.81±0.95	9.22±0.83	8.10±1.17	8.04±1.07	9.24±0.97	9.803±1.87
Energy (kcal/100 g)	698.10±11.05	711.56±12.04	731.49±10.06	726.69±9.75	732.44±12.79	718.79±11.05	719.845±13.29

Mean±Standard Deviation (SD)

Proximate composition: Proximate composition is shown in the Table 4. Moisture content was found to be in the range of 2.76±0.51% (Chitral-2) to 4.20±0.35% (Dir-2). Ash content was in the range of 1.27±0.08% (SW-3) to 1.95±0.009% (Swat-1). Fat content (%) was determined to be in the range of 63.54±2.53 % (Chitral-1) to 69.25±3.72% (Chitral-3). Protein content was in the range of 15.96±1.06% (SW-1) to 19.15±1.19% (Chitral-1). Carbohydrate content was found in the range of 8.04±1.07% (SW-3) to 12.41±1.03% (Chitral-1). The proximate composition shows that the fats were the highest constituent and ash was present in the lowest quantity in the nuts. The results of the present study show that Chitral-3, Chitral-2 and SW-3 are physiochemically superior walnut cultivars than the rest of the cultivars.

Pereira *et al.* (2008) determined fats (68.83%-72.14%), Proteins (14.38%-18.03%), Carbohydrates (3.75%-7.16), moisture (3.85%-4.50) and ash (4.26%-3.31%) for the six walnut cultivars grown in Purtagal. The results of this study are in good agreement with this notion except for the percent carbohydrates and ash contents. Al-Bachir, (2004) determined the moisture content (3.48%), proteins (22.85%), fats (67.35%) and ash (1.26%). The results of the moisture content, fats content and ash content are in agreement with the results of this study but there is variation in term of protein content. These differences and variations can be attributed to environmental conditions, horticulture procedures and genetic parameters which influence the chemical composition of walnut fruits.

Energy content: The energy value of the kernels of these cultivars (shown in Table 4) was determined in the range of 698.10 Kcal/100 g (Chitral-1) to 732.44 Kcal/100 g (SW-3), which shows that the fruits of these varieties are rich source of energy. The differences in the energy level are due to differences in the proximate composition of the varieties.

Mineral composition: The results of the mineral composition are shown in Table 5. It shows the level of sodium is 40.9-64.5 ppm, K (3551-4827 ppm), Ca (925-1250 ppm), Fe (30.08-41.20 ppm), Zn (11.75-25.5 ppm), Mg (1059-1765 ppm), Cu (1.96-2.75 ppm) and Pb (0.69-1.06 ppm). Mineral composition of six Pakistani walnut cultivars showed high levels of Potassium, Magnesium, Calcium, Sodium and Iron while that of lead was the lowest. The lowest concentration of the toxic metal lead is an advantage. Ozcan (2009) determined the mineral content of the walnut fruits grown in Turkey and found Ca (1108.6 mg/kg), K (4627.6 mg/kg), Na (44.7 mg/kg) and Fe (32.4 mg/kg), Mg (1089.9 mg/kg), Zn (26.4 mg/kg), and Cu (3.8 mg/kg). The concentration of Na, K, Ca, Mg and Fe are in agreement with the results of the present study while that of the Zn and Cu shows higher values in Turkish walnut fruits as compared to the present study. Our data of mineral composition is in agreement with Lavedrinea *et al.* (2000) except for the concentration of Ca, Fe, Cu and Pb.

Table 5: Mineral Composition of the Walnut kernels. All the values are given in ppm

	Chitral-1	Swat-1	Chitral-3	Chitral-2	SW-3	Dir-2
Na	64.5±5.5	52.6±5.2	40.9±4.7	45.2±4.12	60.12±4.51	45.7±3.1
K	3586±32.2	3551±55.7	4500±54.1	4827±30.11	4541±32.06	3825±40.85
Ca	1250±25.07	1125±45.12	925±40.24	1170±41.03	1204±15.04	1249±12.5
Fe	38.5±2.10	41.20±1.54	36.14±3.75	30.51±1.06	31.26±2.09	30.08±1.40
Zn	25.5±2.15	12.26±1.12	11.75±1.09	17.39±1.68	18.05±2.46	17.85±2.76
Mg	1532±27.6	1765±25.09	1059±20.08	1065±25.14	1270±20.49	1530±25.57
Cu	2.12±0.09	2.17±0.81	2.09±0.56	1.96±0.84	1.98±0.99	2.75±1.08
Pb (Lead)	1.06±0.009	0.81±0.001	0.97±0.05	0.94±0.01	0.69±0.04	1.01±0.005

Mean±Standard Deviation (SD)

Conclusion: The data indicate that fruits nuts of these cultivars vary greatly in term of nut weight, kernel weight, kernel ratio, shell thickness, moisture content, protein content, carbohydrates content, energy contents and mineral content. The variability observed in these parameters is due to both genetic and environmental factors which may influence the individual parameter describing fruit properties, mineral composition and nutritional parameters including chemical composition and weight distribution of the endosperm. Moreover, kernels of Dir-2 and Chitral-2 cultivars were determined to contain high protein content (>18% protein) while Chitral-1 and SW-1 contain high carbohydrates content of >10%. In minerals the concentration of K, Ca, Mg, Na and Fe were found high while that of Pb was the lowest. These results will be useful to know about the nutritional properties of the local walnut cultivars and may guide us in designing strategies that maximize the utility of walnut germplasm.

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