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PROXIMATE AND ESSENTIAL NUTRIENTS EVALUATION OF SELECTED VEGETABLES SPECIES FROM KOHAT REGION, PAKISTAN

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Abstract

Eight vegetable species viz., *Solanum melongena, Trianthema portulacastrum, Abelmoschus esculentus, Spinacia oleracea, Praecitrullus fistulosus, Luffa acutangula, Cucurbita moschata* and *Cucumis sativus* were evaluated for their nutritional values using standard techniques for proximate, macro and micronutrient analysis. In proximate analysis, ash, carbohydrate, proteins, fiber, fats and moisture (both dry and wet) were assayed while Cu, Ni, Zn, Pb, Co, Cd, Fe, Cr, Ca and Na were evaluated in micronutrients analysis using AOAC methods and atomic absorption spectrometric techniques. The species showed variable results in proximate analysis, however, *Cucurbita moschata* have revealed higher percentage of carbohydrates, fibers, and energy values. The results showed that *Trianthema portulacastrum* (a wild vegetable) had the highest concentrations of the micronutrients like Cu, Zn, and Fe compared to the other seven species while it had highest concentration of Ca. Proximate and nutrient analysis of such wild and cultivated vegetables can help us to determine the health benefits achieved from their use in marginal communities.

Introduction

Food demands have been accelerated with the exponential human population growth resulting in marginal land resource availability for growing food crops especially vegetables. Among alternatives available to meet the food demands cultivable and wild vegetables are regarded as cheep source of food for the marginal communities (Hussain *et al*., 2009a). According to the Food and Agricultural Organization (FAO), there are about 840 million undernourished people in 1998–2000, of whom 799 million are in developing countries, 30 million in the countries in transition and 11 million in the industrialized countries (Sartaj, 2001; Diouf, 2002; Gilani *et al*., 2010; Dini *et al*., 2005). To apprehend the situation, interests have been centralized on the exploitation, quantification and utilization of food plants, especially the vegetables (Dini *et al*., 2005). Vegetable being the rich source of carbohydrates, fats and proteins, which form the major portion of the human diet, are the cheaper source of energy. The importance of these biochemicals has been recorded by various scientists (Sreedevi & Chaturvedi, 1993; Mathews *et al*. 1999; Kalita *et al*., 2007; Hussain *et al*., 2009a). Besides these biochemicals, the moisture, fiber, and ash contents and the energy values of individual vegetable and plant species have also been regarded important to the human health and the soil quality (Wahrmund-Wyle *et al*., 2000; Chevaux *et al*., 2001; Cummings *et al*., 2004; Mcsweeney *et al*., 2005; Hussain *et al*., 2010a,b).

Kohat is a medium sized town in Khyber Pukhtonkhowa Province of Pakistan. It is located at 33°35'13N 71°26'29E with an altitude of 489 metres (1607 feet) (Ahmed, 1997). Kohat region, a semi arid region, having fewer land resources to the locals to

satisfy their food demands through agriculture (Anon., 1998). Along with the seasonal crop (wheat), people are dependent on vegetables for their nourishments. Eight different species of wild and cultivated vegetables i.e., *Solanum melongena, Trianthema portulacastrum, Abelmoschus esculentus, Spinacia oleracea, Praecitrullus fistulosus, Luffa acutangula, Cucurbita moschata, Cucumis sativus* are cooked in various combinations and are used as food items by the local communities of the Kohat regions (Table 1). *Trianthema portulacastrum* is collected from wild and local people use it for food while rests of the species are either cultivated at large scale or in household gardens. To know the nutritional status, the selected species were assayed for their proximate (moisture, ash, fiber, crude fats, proteins and carbohydrates) and essential nutrients (Cu, Ni, Zn, Pb, Co, Cd, Fe, Ca, Na and Cr) analysis.

Material and Methods

Plants collection: Whole parts of the selected eight vegetable species were collected from various areas of Kohat region. Plants were packed in the Kraft paper and herbarium sheets were prepared. These plants were identified and classified by a plant taxonomist of Botany Department, Kohat University of Science and Technology, Kohat. The details of each plant species, in respect of their local names, part used and collection areas are elaborated in Table 1.

Sample preparation: The samples were washed under running water and blotted dry. The moisture content of the leaf samples was determined at 60ºC (Anon., 1990; Hussain *et al*., 2009a). The dried matter obtained was ground to a fine powder and stored at 5°C in air-tight containers prior to further analysis.

Proximate analysis: The proximate analyses (moisture, ash, fibers, crude fats, proteins and carbohydrates) of all the samples were determined. The moisture and ash were determined using weight difference method. The nitrogen value, which is the precursor for protein of a substance, was determined by micro Kjeldahl method described by Pearson (1976), involving digestions, distillation and finally titration of the sample. The nitrogen value was converted to protein by multiplying a factor of 6.25. Carbohydrate was determined by difference method. All the proximate values are reported in percentage (Anon., 1990a,b; Hussain *et al*., 2009a, d).

Macro and micronutrient analysis: The macro and micronutrients contents, namely Cu, Ni, Zn, Pb, Co, Cd, Fe, Na, Ca and Cr of the eight selected vegetable species was done using atomic absorption spectrometer mineral (Perkin Elmer AA Analyst 700). The results were obtained while using a working standard of 1000 ppm for each of the species (Hussain *et al*., 2009a,d).

Table 1. Vegetables collected for the study and pattern of local use.

Species name	Family name	Local name	Parts used	Status
Solanum melongena	Solanaceae	Bengan	Fruit	Cultivated
Trianthema portulacastrum	Aizoaceae	Warkharee	Leaves	Wild
Abelmoschus esculentus	Malvaceae	Bhindi	Fruit	Cultivated
Spinacia oleracea	Chenopodiaceae	Saag	Leaves	Cultivated
Praecitrullus fistulosus	Cucurbitaceae	Tenda	Fruit	Cultivated
Luffa acutangula	Cucurbitaceae	Thoriy	Fruit	Cultivated
Cucurbita moschata	Cucurbitaceae	Mita Kado	Fruit	Gardening
Cucumis sativus	Cucurbitaceae	Khira	Fruit	Gardening

Statistical analysis: Each experiment was repeated three times. The results are presented with their means, standard deviation and standard error using Microsoft Office Excel 2007.

Results and Discussion

Proximate analysis: Edible vegetables are a vital component of human diet comprising essential biochemicals important for human metabolism (Aliyu, 2006). The result of proximate analysis showed variation in concentration/proportions of biochemicals (carbohydrate, fats and protein) and other contents (ash, fiber, moisture).

Looking at the results of carbohydrate composition of selected vegetables, it was found highest in *Cucurbita moschata* followed by *Luffa acutangula*, *Cucumis sativus,* and *Solanum melongena* while other vegetable species had insignificant carbohydrate composition (Table 2). The estimated available carbohydrate content in these species were found 20% lower than in *Senna obtusfolia* leaves (Faruq *et al*., 2002) and 23.7% in *Amaranthus incurvatus* leaves (Asibey-Berko & Tayie, 1999). On the other hand, it also contain less available carbohydrate compared to *Corchorus tridens* (75.0%) and sweet potatoes leaves (82.8%) (Asibey-Berko & Tayie, 1999).

Roger *et al*., (2005) reported that protein level of green leafy vegetables range from 20.48-41.66%. In case of protein content, *Spinacia oleracea* and *Trianthema portulacastrum* had higher amount compared to *Abelmoschus esculentus, Praecitrullus fistulosus, Solanum melongena, Luffa acutangula, Cucurbita moschata* and *Cucumis sativus* (Table 2). It has been reported that protein-calories malnutrition deficiencies is a major factor responsible in nutritional pathology (Roger *et al*., 2005). According to Pearson (1976), plant food that provide more than 12% of its calorific value from protein are considered good source of protein. Furthermore, adults, pregnant and lactating mothers required 34-56 g, 13-19 g and 71 g of protein daily respectively (Anon., 2002). The results of this work showed that adequate amount of protein are present in these vegetables.

Similarly *Trianthema portulacastrum* had highest percentage of fat contents followed by *Spinacia oleracea* and *Solanum melongena* while in *Abelmoschus esculentus*, *Praecitrullus fistulosus, Luffa acutangula*, *Cucurbita moschata* and *Cucumis sativus* lower amounts of fats were found (Table 2). The fat contents of these species were found in the range compared with reported values (8.3-27.0% DW) in some vegetables consumed in Nigeria and Republic of Niger (Ifon & Bassir, 1980). The results indicated that these species are good sources of lipids.

While analyzing the fiber contents of vegetable species, *Cucurbita moschata* had highest fiber composition compared to other vegetable species. The other species *Trianthema portulacastrum, Spinacia oleracea, Abelmoschus esculentus*, *Praecitrullus fistulosus, Luffa acutangula* and *Cucumis sativus* had nominal percentage values (Table 2). In the present study, the crude fiber contents in *Cucurbita moschata* are very high compared to 8.5-20.9% in some Nigerian vegetables (Ifon & Bassir, 1980). The major drawbacks to the use of vegetables in human nutrition is their high fiber content which invariability causes intestinal irritation and lower nutrient bioavailability, hence large quantities of plant vegetables have to be consumed to provide adequate levels of nutrients (Aletor & Adeogun, 1995). On the other hand, intake of dietary fibers can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Ishida *et al*., 2000). The RDA of fibers for children, adults, pregnant and lactating mothers are 19-25%, 21-38%, 28% and 29% respectively. Thus *Cucurbita moschata* could be valuable sources of dietary fibre in human nutrition.

Table 2. Proximate Analysis of various vegetables from Kohat region.

Plant species	Ash (%)	Moisture (D) (%)	Moisture (W) (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)	Energy values (%)
Solanum melongena	10.15± 0.6	9.136±0.27	92.60±0.61	14.34±0.13	2.82±0.016	12.85±0.25	63.87±0.10	336.97±0.17
Trianthema portulacastrum	30.22±0.027	5.33±0.13	93.32±0.06	19.63±0.9	3.81±0.20	8.66±0.22	40.99±0.36	276.85±0.63
Abelmoschus esculentus	13.58± 0.22	6.93±0.20	85.74±0.11	16.17±0.26	2.07±0.23	11.65±0.27	60.90±0.16	326.93±0.47
Spinacia oleracea	21.34±0.06	5.68±0.25	86.49±0.17	20.82±0.07	3.32±0.26	4.92±0.27	48.82±0.54	308.49±0.86
Praecitrullus fistulosus	11.67±0.08	31.50±0.8	92.33±0.31	15.34±0.30	2.52±0.15	9.57±0.55	38.96±0.19	239.85±0.11
Luffa acutangula	5.55±0.017	7.31±0.11	90.53±0.9	13.47±0.05	2.095±0.18	12.55±0.19	71.54±0.38	358.94±0.10
Cucurbita moschata	6.63±0.030	6.28±0.14	91.25±0.2	10.77±0.23	2.175±0.22	46.11±0.22	74.13±0.24	359.18±0.24
Cucumis sativus	10.5±0.020	11.73±0.29	94.42±0.6	10.57±0.23	2.52±0.15	8.21±0.13	64.62±0.67	323.46±0.16

D = dry weight basis; W = wet weight basis

According to the results obtained, *Cucurbita moschata* and *Luffa acutangula* had highest and significant level of energy values (Table 2). The calorific value of *Cucurbita moschata* and *Luffa acutangula* are estimated to be high compared to 248.8-307.1 kcal/100g reported in some Nigerian leafy vegetables (Isong *et al*., 1999). Asibey-Berko & Tayie (1999) also reported high energy content in some Ghanaian green leafy vegetables such as *Corchorus tridens* (283.1 kcal/100g) and sweet potato leaves (288.3 kcal/100g).

The ash content, which is an index of mineral contents in biota, was high in *Trianthema portulacastrum* compared to the values reported in leaves of *Ipomea batatas*, *Corchones tridens* and *Amaranthus incarvatus* grown in Ghana (Asibey-Berko & Tayie, 1999). Lockeett *et al*., (2000) had also reported high ash content in some greens use by the lactating mother such as bitter leaves, *Veronia colorate* (15.86% DW) and *Moringa oleifera* (15.09% DW). This indicates *Trianthema portulacastrum* could be good sources of mineral elements (Table 2).

Comparing the moisture content in dry and fresh vegetable species, the results showed that *Praecitrullus fistulosus* had higher moisture in dry form while in fresh form *Cucumis sativus, Solanum melongena* and *Praecitrullus fistulosus* had significant level of moisture compared to other species. In comparative assessment of the various species, the results showed that *Cucurbita moschata* is most significant species having higher concentrations of carbohydrate, fiber and energy values compared to the other species (Table 2). While analyzing the field observations and the cultivation pattern, the use of *Cucurbita moschata* is very minimum among the local community as food item.

Looking at the correlation analysis of the selected parameters, it was found that similar parameter has highly significant correlation while among parameters the correlation is either non-significant or less significant or moderate relation (Table 3). Ash and moisture, ash and fat, ash and fiber showing negative or insignificant correlation and similar pattern for other parameter as well (Table 3). However, moisture (D) and fats and protein and fats have shown significant correlation (Table 3).

Nutrients composition and analysis: The nutrients analysis shows that *Trianthema portulacastrum* had the highest concentration of Cu, Ni, Zn, Pb, Co, Cd, Fe, Na, Ca and Cr compared to other species (Table 4; Table 5). It has been reported that for many plant species Cr proved to be toxic at 5 mg/l. In this regard, all the studied plants have very lesser concentration of Cr as compared to the recommended level for toxicity in plants (Adriano, 1986; Khanzada *et al*., 2008; Hussain *et al*., 2009a & b).

In case of the Pb concentration, the suggested concentration in plant species is 2 to 6 mg/L (Broyer *et al*., 1972; Zakir *et al.*, 2006) however; the plant species under investigation carries very lesser level of Pb, which further clarifies their use as food supplement. The positive impact of zinc supplementation on the growth of some stunted children, and on the prevalence of selected childhood diseases such as diarrhoea, suggests that zinc deficiency is likely to be a significant public health problem, especially in developing countries (Osendarp *et al*., 2003; Sian *et al*., 2002; Hussain *et al*., 2009a, c). According to FAO's food balance data, it has been calculated that about 20% of the world's population could be at risk of zinc deficiency. The average daily intake is less than 70 µg per day (Holt & Brown, 2004). Thus *Trianthema portulacastrum* represent the highest amount of value (Table 4). The findings stimulate the on-farm cultivation on large scale to relieve the Zn deficiency in local community.

Table 3. Correlation matrix of proximate parameters.

	Ash	Moisture (D)	Moisture (W)	Protein	Fat	Fiber	Carbohydrate	Energy values
Ash	1							
Moisture (D)	-0.527	1						
Moisture (W)	0.166	-0.019	1					
Protein	0.209	0.473	0.354	1				
Fat	-0.660	0.851	0.150	0.694	1			
Fiber	-0.516	0.088	-0.359	-0.783	-0.282	1		
Carbohydrate	0.360	-0.279	-0.099	0.227	-0.208	-0.424	1	
Energy values	0.418	-0.001	-0.002	0.797	0.287	-0.885	0.508	1

- Shows negative correlation

Table 4. Micronutrient composition of selected vegetable plant species.

Species name	Micronutrients (ppm)							
	Cu	Ni	Zn	Pb	Co	Cd	Fe	Cr
Solanum melongena	15	<0.006	30	<0.015	<0.009	<0.0008	271	<0.003
Trianthema portulacastrum	26	7	148	<0.015	3	<0.0008	1185	<0.003
Abelmoschus esculentus	16	<0.006	51	<0.015	4	<0.0008	371	<0.003
Spinacia oleracea	11	<0.006	25	<0.015	2	<0.0008	325	<0.003
Praecitrullus fistulosus	11	<0.006	34	<0.015	<0.009	<0.0008	49	<0.003
Luffa acutangula	17	<0.006	59	<0.015	4	1	225	<0.003
Cucurbita moschata	14	<0.006	33	<0.015	<0.009	<0.0008	34	<0.003
Cucumis sativus	11	<0.006	31	<0.015	<0.009	<0.0008	90	<0.003

Table 5. Macronutrient composition of selected vegetable plant species (ppm).

Species name	Ca	Na
Solanum melongena	40	8
Trianthema portulacastrum	311	61
Abelmoschus esculentus	107	9
Spinacia oleracea	116	172
Praecitrullus fistulosus	24	4
Luffa acutangula	50	7.58
Cucurbita moschata	31	7.06
Cucumis sativus	55	12

The level of Cu is very high in *Trianthema portulacastrum* compared to acceptable range set by WHO of 2-5 mg intake per day (Anon., 1998). It has been reported that Cu consumption in excess of 3 mg/L of drinking water result in nausea and other adverse effects on the gastrointestinal tract (GIT) (Pizzaro *et al*., 1999). The presence of excess Cu can cause oxidative stress in plants and subsequently increase the antioxidant responses due to increased production of highly toxic oxygen free radicals. Accordingly, it was observed that excess Cu in plants led to oxidative stress inducing changes in the activity and content of some components of the antioxidative pathways (*i.e*., ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR) (De Vos *et al*., 1992; Luna *et al*., 1994).

Fe is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye & Otokiti, 1999). From the results, *Trianthema portulacastrum* had the highest concentration, followed by *Trianthema portulacastrum*, *Spinacia oleracea*, *Solanum melongena*, *Luffa acutangula*, *Cucumis sativus*, *Praecitrullus fistulosus* and *Cucurbita moschata* (Table 4). While the remaining nutrients like Ni, Cd and Co had negligible concentration levels in the vegetable species assayed (Table 4)

Dairy products supply 50-80% of dietary calcium in most industrialized countries, while foods of plant origin supply about 25%. The Ca concentration in *Trianthema portulacastrum* was found the highest among all the vegetable species followed by *Spinacia oleracea* (Table 5). *Spinacia oleracea* is used chiefly by the local communities of the Kohat region, however, *Trianthema portulacastrum* is a wild vegetable collected and used by the local people. *Spinacia oleracea* has the highest concentration of Na followed by *Trianthema portulacastrum*.

Conclusion

Kohat region, a semi arid region, has bestowed with ample natural wealth of plant species. Local people are depending, one way or the other on these species for food and medicine. To fulfill the nutritional needs of the local people various vegetable species are cultivated. However, the marginal communities also depend on wild vegetable species as well. The nutritional values of the eight vegetable species were analyzed using the standard AOAC methods for evaluation of nutrients and proximate parameters. Among the eight vegetable species analyzed for proximate and nutrient analysis, *Trianthema portulacastrum* (a wild vegetable species) proved to have some micro and macro nutrients while moderate level of proximate parameters. The nutritional value of *Trianthema portulacastrum* is reported for the first time here. The seven vegetable species are cultivated either at large scale or small carrying potential energy values, which proves the importance in their nutritional values.

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