ISSN 1023-1072

Pak. J. Agri., Agril. Engg., Vet. Sci., 2016, 32 (2): 191-201

NUTRITIONAL ASSESSMENT OF UNDERUTILIZED NON-TRADITIONAL LEAFY VEGETABLE LAMBS QUARTER OF LOWER SINDH, PAKISTAN

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ABSTRACT

Nontraditional vegetables play a vital role in the diet of the people throughout the world. Among the non-traditional leafy vegetables of Sindh Pakistan, the edible portion (leaves) of lambs quarter was analyzed for their proximate, mineral and phytochemical composition. The results from nutritional analysis showed that lambs quarter had a low content of crude fat and high content of moisture, ash, crude protein, crude fiber, carbohydrates and energy. The vegetable was also rich in major minerals like K^+, Ca^{2+} and Mg^{2+} and sufficient in essential trace elements (Fe^{2+}, Cu^{2+} and Zn^{2+}). The phytochemicals including alkaloids, saponins, flavonoids, total phenols and tannins were found in larger quantities in fresh samples. Taking into account the amount of available mineral elements, phytochemical contents and other nutrients in lambs quarter, this non-traditional vegetable could be valuable and important contributor to the diets of the people in Sindh, Pakistan.

Keywords: non-traditional vegetable, lambs quarter, proximate composition, phytochemicals, mineral elements.

INTRODUCTION

Non-traditional plants are useful dietary source and can be used as an alternative source of vegetables for human consumption (Shah, 2016). These wildly grown vegetables are mostly free of agricultural contaminants; however, their effects on the health of human beings is still unknown (Luczaj, 2010). These plants are possible sources of nutrients needed by human beings. The nutrients are required for maintaining physiology and metabolism of the body (Uraku *et al*., 2016). However, many of these economical nutritive plants have not been assessed for their nutritional values or are yet to be adequately studied and utilized by human (Uraku *et al*., 2015). The use of culinary herbs and wild

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vegetables are widely spread in some regions of the world, where these species are perceived as chief healthy food (Afolayan and Jimoh, 2009). Khomdram *et al*. (2014) reported the benefits of wild vegetables as a source of numerous nutrients which in turn can be helpful in reducing the health related diseases like aging, neurodegenerative ailment, coronary heart disease, cancer and diabetes. Wild vegetables are rich in phytochemicals such as n-6 and n-3 essential fatty acids, vitamins E and C and polyphenols, therefore their inclusion in the daily diet is crucial in the prevention of age-related diseases and cancer (Nishino *et al*., 2005). These vegetables represent a useful dietary source and can be used as an alternative source of vegetables for human consumption (Shah, 2016).

Chenopodium album is also known as pigweed or lambs quarter or fat hen, belongs to the family of Chenopodiaceae. It has been found growing as a weed in wheat fields around Tando Jam and Mirpurkhas Sindh, Pakistan (Kazi *et al*., 2007). *Chenopodium* species have been used in folk medicine worldwide for treatment of different ailments, improves the appetite, kills intestinal parasites from immemorial time and acts as anthelmintic, laxative, diuretic and tonic (Yadav *et al*., 2007). They further reported that the plant is also used as carminative, diaphoretic and treats emmenagogue, cough, pulmonary obstruction, amenorrhea, catarrh and humoral asthma and is a good substitute for *C. ambrosioides*.

Chenopodium album is a rich source of important dietary elements (Afolayan and Jimoh, 2009; Hussain *et al*., 2009) such as protein (Bhargava *et al*., 2006), Vitamin A and iron (Singh *et al*., 2007) and known to be resistant to pests, diseases and thrives best in poor nutritive soils (Gesinki and Nowak, 2011). The local inhabitants use wild vegetables since very long time, but to our knowledge, no systematic research has been done so far to estimate the nutritient content in these vegetables. The present study was, therefore, designed to assess the nutritional value of commonly consumed wild vegetable lambs quarter.

MATERIALS AND METHODS

Procurement and processing of vegetable materials

The lambs quarter vegetable was collected from Mirpurkhas district of lower Sindh in 2014. About ten kilograms of lambs quarter vegetable was collected and packed in polythene bags, labelled and retained in an ice-chest box (to reduce the enzymatic activities of vegetable) for transportation to the laboratory of the Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam. The leaves (edible portion) were separated from the stalks and washed to remove dirt. The vegetable was processed for further analysis as given in Figure 1. The fresh, boiled and cooked samples were packed with proper labelling and stored in a freezer at -20°C, whereas the dried samples were ground in a pestle mortar and sieved through 2.0 mm mesh, packed, labelled and placed at room temperature for further analysis.

Recipe used in cooking of wild lambs quarter

Initially the fresh leaves were chopped into small pieces and boiled for about five minutes. Later the water used for boiling was discarded and the boiled leaves were used for cooking as per recipe used in cooking of nontraditional lambs quarter given in Table 1. The pan was placed on medium flame and cooking oil

was added. The sliced onions were fried till golden brown color appeared. The chopped garlic and tomatoes with all other ingredients added and stirred for 30 seconds. The boiled leaves were then added, stirred for 5 minutes and then left till water evaporated under low flame. The vegetable was stirred again and then taken out into prewashed bowl (Figure 2).

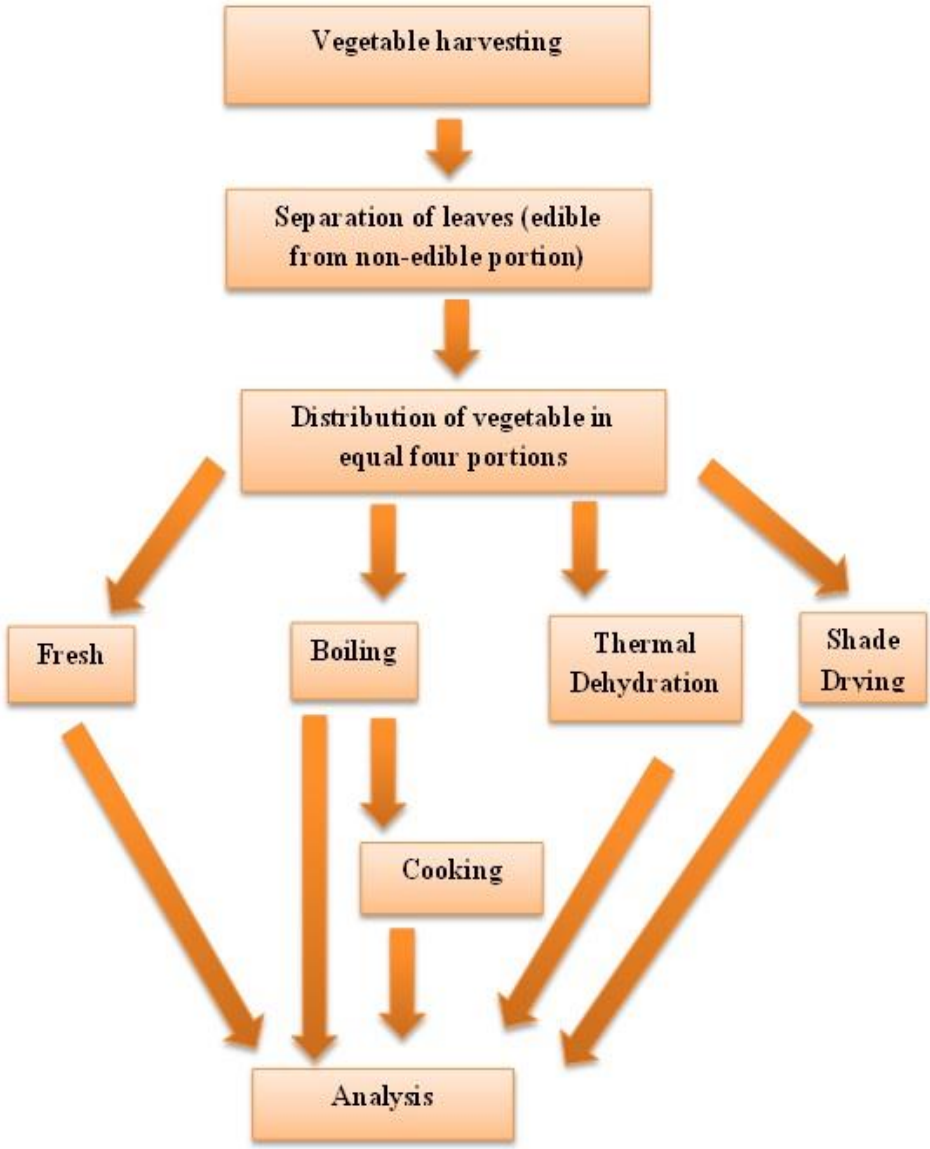

Figure 1. Flow diagram of lambs quarter processing

a. Lambs quarter

b. Chopped lambs quarter

c. Boiled lambs quarter

d. Cooking curry of lambs quarter

Figure 2. Processing and cooking of lambs quarter

Table 1. Recipe used in cooking of wild lambs quarter

Ingredients	Weight (g)
Total vegetable	500
Salt	2
Red chili powder	2
Turmeric powder	0.5
Onion (chopped)	10
Tomato	20
Garlic	5
Chilli green	10
Oil	30 ml
Final Product (Curry)	519
Number of servings	4 persons

Bio-chemical analysis

All the chemicals used in the research were of analytical grade. The analysis was repeated in triplicate to make sure the adequacy of the results. Crude proteins, crude fibers, fats, fatty acids, carbohydrates, nitrogen free extract, ash, total solids, moisture and pH, were determined by the procedures of AOAC (2005). The difference method was applied to calculate the carbohydrate content (AOAC, 1990). The percentage Nitrogen Free Extract (NFE) was obtained by the

procedure of Owolabi *et al*. (2012). The energy value in the form of kcal 100 g^{-1} of a given sample was obtained by the formula of Asibey-Berko and Taiye (1999). Total fatty acids were determined by methods of Akinyeye *et al*. (2010) and Greenfield and Southgate (2003). The total solids of given sample were calculated by subtracting its moisture percentage from hundred (James, 1995). Minerals were estimated using perchloric-acid digestion (Allen, 1974). Phyto-chemicals viz. alkaloids, tanins, saponins, flavonoid, sponins, total phenols and tanins were determined by the methods of Harborne (1993); Boham and Kocipai (1994); Obadoni and Ochuko (2001); Humadi and Istudor (2008) and Ebrahimzadeh *et al*. (2008), respectively.

Statistical analysis

The data were subjected to ANOVA to compare the mean value using SPSS 16.0. Differences between means were assessed for significance at $P< 0.05$ using Least Significant Difference (LSD) (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

The results of nutritional composition of lambs quarter (Table 2) showed that the leaves have high moisture content in boiled samples (85.46%) as compared to the fresh, dried and cooked samples. These values support the previously reported findings of Satter *et al*. (2016), who reported the moisture contents of the wild vegetables Dhekishak, Helencha, Kalmishak, Patshak and Shapla stem were 90.37, 87.60, 90.12, 86.81 and 94.36%, respectively. These results were very close to the moisture contents of some wild edible and commonly used vegetables in Pakistan (Hussain *et al*., 2011; Koca *et al*., 2015). Protein was found highest in curry samples (5.30%) as compared with fresh, boiled and dried samples (Table 2). Therefore, the leaf contains ideal protein diet for children, adults and infants (Mendoza, 2002). This is in agreement with the study of Hassan and Umar (2006), who reported the highest values of protein content in *Momordica foecide* (4.6%) leaves and dried plant extracts of *B*. *pilosa* (19.1%) consumed in Swaziland and Nigeria. Similarly, Akindahunsi and Salawu (2005) also reported the greater value of protein in dried plants of *T. triangulare* (31.00%), *Amaranthus candatus* (20.5%), *Piper guineeses* (29.78%) and *I. batatas* (24.85%). In general, it is also recommended that plant food providing more than 12% of its caloric value from protein is a good source of protein. So, the data (Table 2) showed that the lambs quarter is rich source of protein, which encourages their use in human diets and might be helpful for protein energy malnutrition. The fat content of the lambs quarter in dried samples (2.75% in thermally dehydrated samples and 2.4% in shade dried samples) was recorded similar to the fat content (2.00- 3.01%) of some wild vegetables in Nigeria and Pakistan (Khan *et al*. 2013). The curry sample of the lambs quarter was observed high in fat content (6.85%) as compared to other treatments due to addition of extra cooking oil. Carbohydrates are the principal source of energy. The highest carbohydrate content of *Chenopodium album* was recorded in thermally dried powder samples (69.06%). The results of the present study were considerably higher than the reported values when compared to some wild edible plants (3%) of Pakistan and commonly consumed vegetables (29.40- 32.80%) in Nigeria (Khan *et al*. 2013).

Table 2. Proximate (%), total solids (%), total soluble solids (°Brix) and pH composition of lambs quarter

Parameters	Fresh	Thermally Dehydrated	Curry	Shade Dried	Boiled
Moisture (%)	84.08^{b}±0.72	6.00^{d} ±0.10	65.43^{c}±0.25	6.15^{d} ±0.12	85.46^{a}±0.64
Protein (%)	4.76^{b} ±0.05	4.30^{c} ±0.03	5.30^{a}±0.03	4.04^{d} ±0.03	3.16^{e} ±0.05
Fat (%)	1.25^{c} ±0.27	2.75^{b} ±0.18	6.85^{a} ±0.27	2.40^{b} ±0.25	0.75^{d} ±0.18
Carbohydrate (%)	5.51^{e}±0.61	69.06^{a}±0.19	17.12^{c}±0.28	66.35^{b}±0.63	6.98^{d} ±0.50
Crude Fiber (%)	2.17^{d} ±0.10	8.38^{b} ±0.10	3.30^{c} ±0.20	10.50^{a}±0.45	2.45^{cd}±0.99
Ash (%)	2.23^{c} ±0.06	9.49^{b} ±0.05	2.00^{d} ±0.06	10.56^{a}±0.07	1.18^{e}±0.03
pH	7.50^{b}±0.02	7.08^{c} ±0.04	5.67^{e} ±0.01	6.90^{d} ±0.04	8.91^{a} ±0.26
Total Solids (%)	15.92^{c}±0.72	94.00^{a}±0.10	34.57^{b}±0.25	93.85^{a}±0.11	14.54^{d}±0.64
Total Soluble Solids (°Brix)	1.04^{d}±0.07	1.66^{b} ±0.04	1.45^{c} ±0.02	1.72^{a} ±0.02	0.50^{e} ±0.02

Values are expressed as mean ± standard deviation (n=3)
LSD: Values with different superscripts down the row are significantly different from each other at $P< 0.05$

Table 3. Effect of different processing methods on fatty acid (%), energy (Kcal 100 g^{-1}) and nitrogen free extract (%) composition of lambs quarter

Treatments	Energy (Kcal 100g^{-1})	Fatty Acid (%)	Nitrogen free Extract (%)
Fresh	13.91^{d}±0.92	1.00^{d}±0.22	3.34^{d}±0.51
Thermally Dehydrated	93.36^{a}±0.30	2.20^{c}±0.14	60.68^{a}±0.26
Curry	43.79^{c}±0.89	5.48^{a}±0.22	13.82^{c}±0.28
Shade Dried	88.93^{b}±0.51	1.92^{c}±0.20	55.85^{b}±1.07
Boiled	12.98^{d}±0.74	4.38^{b}±0.17	4.53^{d}±1.37

Values are expressed as mean ± standard deviation (n=3)
LSD: Values with different superscripts down the column are significantly different from each other at $P< 0.05$

Table 4. Mineral content (mg 100g^{-1}) of lambs quarter

Treatments	Fresh	Thermally Dehydrated	Curry	Shade Dried	Boiled
Copper	9.86^{e} ±0.02	21.66^{a} ±0.02	12.16^{c} ± 0.04	20.86^{b} ±0.02	11.61^{d} ±0.02
Manganese	10.83^{e} ±0.02	23.07^{a}±0.004	13.64^{c} ±0.002	22.07^{b}±0.002	12.93^{d} ±0.02
Iron	62.74^{e} ±0.02	134.64^{a}±0.02	78.97^{c} ±0.002	128.14^{b} ±0.04	72.74^{d} ±0.02
Zinc	03.46^{e} ±0.03	07.86^{a} ±0.02	05.47^{c} ±0.002	07.41^{b} ±0.04	03.66^{d} ±0.02
Calcium	611.60^{d} ±0.43	1314.50^{a}±0.03	764.60^{c} ±0.04	1253.50^{b}±0.05	610.60^{e}±0.06
Magnesium	125.56^{d}±0.02	269.50^{a} ±2.00	156.12^{c} ±0.04	257.50^{b} ± 1.00	124.06^{e}±0.02
Sodium	511.60^{d} ±0.43	1214.50^{a}±0.03	754.60^{c} ±0.04	1153.50^{b}±0.05	509.60^{e}±0.06
Potassium	828.54^{d} ±0.02	1081.40^{a} 0.02	895.54^{c} ±0.02	998.40^{b} ±0.03	817.04^{e}±0.01

Values are expressed as mean ± standard deviation (n=3)
LSD: Values with different superscripts down the row are significantly different from each other at $P< 0.05$

The crude fiber content of *Chenopodium album* (2.17- 10.5%) recorded in this study is in line with *T. triangulare* (6.20%), *Vernonia amygdalina* (6.5%), *Corchorus olitorius* (7.0%), *P. guineensis* (6.40%) and *Ipomea batatas* (7.20%) (Akindahunsi and Salawu, 2005).

The ash obtained for fresh, curry and boiled samples was 2.23, 2.00 and 1.18%, respectively and that of sun dried and thermally dehydrated samples were 10.56 and 9.49%, respectively. These were within the range of *Gnectum africana* (2.4% and 3.0%) and *Asystacia gangetica* (2.4% and 3.0%) reported by Taiwo *et al.* (2007).

Table 5. Phytochemical analysis (mg g^{-1}) of lambs quarter

Parameters	Fresh	Thermally Dehydrated	Curry	Shade dried	Boiled
Alkaloids	0.96^{a}±0.04	0.65^{c}±0.04	0.46^{d}±0.03	0.80^{b}±0.004	0.59^{c}±0.004
Saponins	3.51^{a} ±0.04	2.85^{c} ±0.04	2.07^{e} ±0.06	3.10^{b} ±0.002	2.51^{d}±0.004
Flavinoids	1.75^{a}±0.002	1.14^{c}±0.02	0.85^{e}±0.004	1.27^{b}±0.002	1.07^{d}±0.002
Total Phenols	5.56^{a}±0.003	3.92^{c}±0.003	3.25^{e}±0.002	5.22^{b}±0.002	3.51^{d}±0.003
Tanins	0.45^{a}±0.04	0.23^{b}±0.002	0.09^{c}±0.003	0.43^{a}±0.006	0.21^{b}±0.003

Values are expressed as mean ± standard deviation (n=3)
LSD: Values with different superscripts down the row are significantly different from each other at $P< 0.05$

The pH, total solids and total soluble solids content was recorded greater in boiled (8.91), thermally dehydrated (94.00%) and shade dried samples (1.72 ^{o}Brix) respectively as compared with other processing treatments. The pH is dependent on the maturity and stage of ripeness (Aye, 2012). The total solids content are dependent on the moisture content of the raw vegetable (James, 1995) whereas total soluble solids might be attributed to the transformation of starch into soluble sugars under the action of phosphorylase enzyme responsible for the hydrolysis of starch to soluble sugars (Zhong *et al*., 2006).

The estimated energy value, fatty acids and nitrogen free extracts of lambs quarter are depicted in Table 3. The estimated energy value for lambs quarter was recorded as 13.91, 93.36, 43.79, 88.93 and 12.98 Kcal 100 g^{-1} in fresh, thermally dehydrated, cooked, shade dried and boiled leaves (Table 3). Okon *et al*. (2015) reported the highest energy value of *L. Africana* (380.82 Kcal 100 g^{-1}), followed by *H. crinata* (377.6 Kcal 100 g^{-1}) while *P. mildbraedi* had the lowest (284.37 Kcal 100 g^{-1}). Like fats, the fatty acids were also found greater in curry sample (5.48%) than other samples due to addition of extra cooking oil. The fatty acid content is dependent on the fat content of different vegetables (Akinyeye *et al*., 2010). The nitrogen free extracts obtained after subtraction of crude fiber from carbohydrates were found higher in thermally dehydrated sample (60.68%) followed by shade dried (55.85%), curry (13.82%), boiled (4.53%) and fresh (3.34%) samples.

The mineral composition of lambs quarter is shown in Table 4. The copper and manganese content of the lambs quarter were recorded greater in thermally dehydrated samples that is up to 21.66 and 23.07 mg 100 g^{-1}, respectively. The present results are also in line with Gupta *et al*. (2005) who reported that *Delonix elata, Centella asiatica, Boerhaavia diffusa* and *Cocculus hirsutus* had high amounts of copper. *Commelina benghalensis* and *Amaranthus tricolor* had the least copper content. Iron content of the fresh leaves of lambs quarter (62.74 mg 100 g^{-1}) compared favorably to most of the values reported from 6.97 mg 100 g^{-1} to 22.73 mg 100 g^{-1} for some wild green leafy vegetables in North-East India and

from 21.30 mg 100 g^{-1} to 33.40 mg 100 g^{-1} for some commonly and wildly grown and consumed leafy vegetables in Kano, Nigeria (Saikia and Deka, 2013). Zn is an essential mineral that plays catalytic, structural and regulatory roles as an integral part of many enzymes in human body. It is essential for normal growth, mental ability, immune system, reproduction and healthy function of the heart (Afolayan and Jimoh, 2009). The zinc content of fresh lambs quarter (3.46 mg 100 g^{-1}) compares favorably to most values for Patshak (11.14 mg 100 g^{-1}) and lowest in Dhekishak (2.29 mg 100 g^{-1}) (Satter *et al*., 2016).

The result of mineral analysis reveals that the leaves of lambs quarter contain 611.6, 1314.5, 764.6, 1253.5 and 610.6 mg 100 g^{-1} of calcium in fresh, thermally dried, cooked, shade dried and boiled samples, respectively. The results are in agreement with the Gupta *et al*. (2005) who reported that the *Digera arvensis*, *Boerhaavia diffusa*, *Cucurbita maxima* and *Amaranthus tricolor* had a high calcium content of 506, 330, 302 and 239 mg 100 g^{-1}, respectively. Magnesium is a mineral element important for circulatory diseases like ischemic heart disease and metabolism of calcium in bones (Hassan and Umar, 2006). It has also reported that Mg in some wild plants *Echinops giganteus, Capsicum frutescens, Piper guineense* and *Piper umbellatum* of Cameroon was found 89, 254, 296 and 490 mg 100 g^{-1}, respectively (Bouba *et al*., 2012). These reports are in agreement with the results obtained in our study. The sodium content was recorded 511.6 mg 100g^{-1} in fresh leaves. This could help in reducing the blood pressure. The potassium content (828.54 mg 100 g^{-1}) in fresh samples was higher than 14.55 mg 100 g^{-1} found in *Indigofera astragelina* leaves (Gafar *et al*., 2011) and also that of *Mucunasloanei*.

The chemical composition of alkaloids, saponins, flavonoids, phenols and tanins were greater in fresh samples i.e. 0.96, 3.51, 1.75, 5.56, 0.45 mg g^{-1}, respectively, for lambs quarter (Table 5). Each of these phytochemicals is known for various protective and therapeutic effects (Asaolu *et al*., 2009). Processing and preparation of vegetables, especially thermal treatment, which are applied prior to consumption may affect the phytochemicals. Their presence supports its anti-inflammatory property (Cox *et al*., 2011). Akindahunsi and Salawu (2005) reported that saponins are nontoxic in nature but can give rise to antagonistic physiological responses. They provide the body cells an anti-inflammatory and anticancer property and show tumor inhibiting activities (Akindahunsi and Salawu, 2005).

The outcome of this study shows that lambs quarter can be used as a source of dietary nutrients. Its protein and carbohydrate can contribute as building block and energy source, respectively whereas, increased fiber content may constitute to food bulk, feaces consistency and intestinal regulation (Erukainure *et al*., 2011).

CONCLUSION

It can be concluded from this study that the leaves of lambs quarter contain considerable amounts of mineral elements, calorific value, carbohydrate, fiber, fat, proteins and phytochemicals. Therefore, it is revealed that lambs quarter leaves can fulfill the nutrient requirements of human and might be used as a supplementary source of nutrients. Hence, they could be consumed to supplement the scarce or non-available sources of nutrients. It is recommended

that more information on non-traditional vegetable flowers, leaves and fruits might be gathered and enlightenment campaign may also be carried out to make the public aware about the inclusion of non-traditional vegetables into the diet could potentially address some of the challenges, such as food security in Sindh, Pakistan.

ACKNOWLEDGEMENTS

The authors are thankful to Higher Education Commission Pakistan for providing funds under project entitled “Nutritional Assessment of Selected Non-Traditional Vegetables of Sindh” and “Indigenous 5000 Ph.D Fellowship program”. The authors are also grateful to National Centre of Excellence in Analytical Chemistry for access to laboratory to conduct part of the research work.

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(Accepted August 09, 2016)