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Nutritional quality and safety aspects of wild vegetables consume in Bangladesh

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ABSTRACT

Objective: To evaluate the nutritional composition, including major minerals, essential trace elements and toxic heavy metals of five different wild vegetables Dhekishak (*Dryopteris filix-mas*), Helencha (*Enhydra fluctuans*), Kalmishak (*Ipomoea aquatica*), Patshak (*Corchorus capsularis*) and Shapla stem (*Nymphaea stellata*) and their safety aspects.

Methods: Proximate parameters moisture, ash, fat, fiber, protein, carbohydrate and energy; major minerals Na, K, Ca and Mg; trace elements Fe, Zn and Cu; and toxic heavy metals Pb, Cd, Cr, Ni and Hg were evaluated in the selected wild vegetables using the standard food analysis techniques.

Results: The results from nutritional analysis showed that all the wild vegetables used in this study had a low content of crude fat and high content of moisture, ash, crude protein, crude fiber, carbohydrate and energy having the recommended dietary allowances. The vegetables were also rich in major minerals Na, K, Ca and Mg, sufficient in essential trace elements Fe, Cu and Zn while the heavy metals Pb, Cr and Ni were detected higher in amount in all the vegetables except Patshak than the limits recommended by Food and Agriculture Organization/World Health Organization. The heavy metals Cd and Hg were not detected in any vegetable.

Conclusions: The outcome of this study suggests that the wild vegetables have very good nutritional potential to meet the recommended dietary allowances, but special awareness should be taken for public health concern about the high level of Pb, Cr and Ni which exceed the Food and Agriculture Organization/World Health Organization recommended limits for the metals in vegetables.

1. Introduction

Vegetables are the fresh and edible parts of herbaceous plants. It may include roots, stems, leaves, fruits or seeds of the plants that can be eaten as raw and/or cooked form. Vegetables are a major part of daily food intake by human with their main dishes all over the world. It is the cheapest and most readily available source of foods that can contribute significantly to human nutrition and health. It is well known for their essential biochemicals and nutritional importance as they contained good amounts of proteins, fats, carbohydrates, vitamins and minerals [1,2]. Besides these, moisture, fiber, ash and energy provided by individual vegetable are important for good health and prevention of diseases. It plays an important role in the balanced diet and advised to intake more that may reduce the risk of diseases like cancer, coronary heart attack, diabetes, *etc.* [3,4]. The traditional wild vegetables have also some medicinal value like antibacterial and anticancer activity, which makes it a valuable addition to the diet [5].

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The nutritional status of Bangladesh is quite alarming with a great number of populations suffering from malnutrition. The household consumption survey showed that the average per capita consumption of vegetable in Bangladesh is about 166 g, well below the minimum level of 200 g [6]. The extent of micronutrient deficiency in Bangladesh is far greater than energy malnutrition. About 60% of the total populations suffer from various micronutrient deficiencies, which is increasingly recognized as the cause of serious health problems. Vegetables are the major part of daily food intake by human population all over the world that play an important role in the diet and make it balanced. Green leafy vegetables are excellent sources of micronutrients, so the consumption of these may contribute to meet the nutritional requirement and to overcome the micronutrient deficiency at minimum cost [2,7]. However, these vegetables contain both essential and toxic metals over a wide range of concentration, and have several toxicological effects on the human body [8].

In recent decades, a resurgence of interest has focused on wild edible plants for their nutritional and medicinal values to broaden the diversity of the human diet [9,10]. In many developing countries, rural or tribal people traditionally harvesting a wide number of wild vegetables without any cultivation due to cultural uses, taste habits or food shortage [11]. Nowadays wild vegetables have become a commercial crop with increasing market potential due to their nutritional importance, absence of residues from pesticides or fertilizers [12]. A lot of work has been done on the nutritional composition, functional properties, and toxic heavy metal contents of various types of edible vegetables [13–16]. Many wild vegetables are also traditionally using with staple food in both urban and rural areas of Bangladesh. The wild vegetables traditionally used as food that enhance the taste and color of the diets but scientific data on the nutrients and chemical composition of those wild vegetables still unknown in our country, and people do not have adequate knowledge on whether those are beneficial or not and have any toxic effect or not. Food safety is a major public concern nowadays. Considering the potential toxicity, persistent nature and cumulative behavior of heavy metals, frequent consumption of wild vegetables, safety aspect of foods and the awareness of the people, much research work is still needed to be done on wild vegetables grown in Bangladesh. Thus the study was designed to analyze the nutritional composition, minerals content and toxic heavy metals of the traditionally used wild vegetables available in the city markets of Bangladesh that is a public health concern about the safety aspects.

2. Materials and methods

2.1. Collection of wild vegetables

Certain commonly consumed wild vegetables were collected from different locations of the city markets, Bangladesh. The unedible portions of the vegetables were removed prior to analysis and a composite sample was prepared. The details of the wild vegetable species, local names and parts of vegetables used for analysis were shown in Table 1.

2.2. Sample preparation

The freshly collected raw vegetables were washed up with tap water thoroughly to remove the attached dust particles, soil, unicellular algae, *etc*. Then they were washed with distilled water and finally with deionized water. The washed vegetables were dried with blotting paper followed by filter paper at room temperature to remove surface water. The vegetables were immediately kept in desiccators to avoid further evaporation of moisture from the materials. After that the vegetables were chopped into small pieces they were oven dried at (55 ± 1) °C. Then the vegetables were crushed into fine powder using a porcelain mortar and pestle. The resulting powder was kept in air tight polythene packet at room temperature until further analysis.

2.3. Nutritional analysis of wild vegetables

The nutritional composition of the powdered vegetable sample was analyzed as follows in our laboratory following the standard food analysis methods described in the Association of Official Analytical Chemists (AOAC) [17].

2.3.1. Determination of moisture content

Moisture content was determined by oven-dry method as the loss in weight due to evaporation from sample at a temperature of (100 ± 2) °C. The weight loss in each case represented the amount of moisture present in the sample.

$$\text{Moisture}(\%) = [(\text{Weight of original sample} - \text{Weight of dried sample}) / \text{Weight of original sample}] \times 100$$

2.3.2. Determination of crude protein

The crude protein content was determined following the micro Kjeldahl method [17]. Percentage of nitrogen (N) was calculated using the following equation.

$$\text{Nitrogen}\ (\%) = [(S - B) \times N \times 0.014 \times D \times 100] / (\text{Weight of sample} \times V)$$

where, D is Dilution factor, T is Titration value = (S–B), W is weight of sample, 0.014 is the constant value. Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus crude protein (%) = % of N × 6.25.

2.3.3. Determination of crude fat

Crude fat was determined by the Soxhlet extraction technique followed by AOAC [17]. The fat content of the dried samples can easily extract into organic solvent

Table 1

Edible wild vegetable used in the study.

Local name	Botanical name	Family	Parts used
Dhekishak	*Dryopteris filix-mas*	Polypodiaceae	Stems and leaves
Helencha	*Enhydra fluctuans*	Compositeae	Leaves, young plant parts
Kalmishak	*Ipomoea aquatica*	Malvaceae	Leaves and tender stems
Patshak	*Corchorus capsularis*	Convolvulaceae	Leaves and tender stems
Shapla	*Nymphaea stellata*	Nymphaceae	Stems

(petroleum ether) at 40–60 °C and followed to reflux for 6 h. Percentage of fat content was calculated using the following formula.

$$\text{Crude fat }(\%) = \text{Weight of fat in sample} \times 100/\text{Weight of dry sample.}$$

2.3.4. Determination of ash content

Ash content was determined by combusting the samples in a muffle furnace at 600 °C for 8 h according to the method of AOAC [17].

$$\text{Ash content }(\%) = \text{Weight of ash} \times 100/\text{Weight of sample}$$

2.3.5. Determination of crude fiber

The bulk of roughage in food is referred to as the fiber and is called crude fiber. Milled sample was dried, defatted with ethanol acetone mixture and then the experiment was carried out using the standard method as described in AOAC [17].

$$\text{Crude fiber }(\%) = (\text{Weight of residue} - \text{Weight of ash}) \times 100/\text{Weight of the sample.}$$

2.3.6. Determination of carbohydrate

The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100% according to AOAC [17].

$$\text{Carbohydrate }(\%) = 100 - [\text{Moisture }(\%) + \text{Fat}(\%) + \text{Protein }(\%) + \text{Ash }(\%)]$$

2.3.7. Determination of total energy

The total energy value of the food formulation was calculated according to the method of [18] using the formula as shown in equation:

$$\text{Total energy}(\text{kcal}/100\text{ g}) = (\%\text{ Available carbohydrates} \times 4.1) + (\%\text{ Protein} \times 4.1) + (\%\text{ Fat} \times 9.3)$$

2.3.8. Determination of minerals and heavy metals in wild vegetables

Minerals and heavy metal content of the samples were determined by atomic absorption spectrophotometer, flame emission spectrophotometer (JENWAY, PFP7) and UV spectrophotometer (Analytikjena, SPECORD 205). The ash residue of each vegetable sample was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and the contents were filtered through Whatman filter paper 42. Each sample solution was made up to a final volume of 25 mL with deionized water. The aliquot was used separately to determine the mineral contents using an atomic absorption spectrophotometer (Spectra AA 220, USA Varian).

2.4. Statistical analyses

Collected data obtained from various parameters of processed vegetable samples were subjected to statistical analysis using SPSS (version 12.00) computer programmed to compute ANOVA techniques.

3. Results

3.1. Nutritional composition of wild vegetables

The young fresh leaves and stems of the wild vegetables were used for the analysis of nutritional composition. Nutritional analysis except moisture of fresh vegetables was carried out on dry basis and has shown in Table 2. The moisture content of the fresh vegetables was found highest (94.36%) in Shapla stem and lowest (86.81%) in Patshak. The other wild leafy vegetables Dhekishak, Helencha and Kalmishak contained the moisture of 90.37%, 87.60% and 90.12%, respectively. The vegetables were then dried, packed in poly bags and kept for the analysis of other nutritional composition. Similarly, on dry basis the moisture content was analyzed and found highest (8.98%) in Shalpa stem and lowest (6.03%) in Dhekishak. The ash content of the vegetables was found highest (13.26%) in Dhekishak and lowest (8.68%) in Shapla stem. The wild vegetables such as Helencha, Kalmishak and Patshak contained 12.46%, 9.11% and 13.06% of ash, respectively. The wild vegetables Dhekishak, Helencha, Kalmishak, Patshak and Shapla stem (Table 2) contained 2.27%, 2.66%, 3.34%, 4.76% and 1.45% of crude fat respectively. The crude protein content of the reported wild vegetables Dhekishak, Helencha, Kalmishak, Patshak and Shapla stem was found 20.76%, 16.69%, 21.45%, 21.98%, and 4.55%, respectively (Table 2). The crude fiber content of the wild vegetables represented in Table 2 was found between 9.26% and 17.70%, which was lowest in Kalmishak and highest in Dhekishak. The carbohydrate content of Dhekishak, Helencha, Kalmishak, Patshak and Shapla stem (Table 2) was found 57.69%, 61.61%, 52.78%, 60.21% and 76.34%, respectively. The results obtained from the caloric value, Patshak had the highest and significantly

Table 2
Nutritional composition of the wild vegetables. %.

Nutrients	Dhekishak	Helencha	Kalmishak	Patshak	Shapla stem
Moisture	90.37 ± 0.45	87.60 ± 0.57	90.12 ± 0.72	86.81 ± 1.05	94.36 ± 0.97
Ash (Total mineral)	13.26 ± 0.43	12.46 ± 0.55	9.11 ± 0.13	13.06 ± 0.13	8.68 ± 0.49
Protein	20.76 ± 0.59	16.69 ± 0.36	21.45 ± 0.32	21.98 ± 0.45	4.55 ± 0.29
Fat	2.27 ± 0.13	2.66 ± 0.20	3.34 ± 0.19	4.76 ± 0.31	1.45 ± 0.13
Carbohydrate	57.69 ± 1.11	61.61 ± 1.10	52.78 ± 0.82	60.21 ± 0.87	76.34 ± 0.30
Crude fiber	17.70 ± 0.49	11.95 ± 0.18	9.26 ± 0.15	10.06 ± 0.13	15.55 ± 0.12
Energy (kcal/100 g)	343.65 ± 1.70	345.72 ± 1.57	326.98 ± 0.78	371.60 ± 1.16	345.12 ± 2.11

All data were expressed as mean ± SD of triplicate experiment (n = 3).

energy (371.60 kcal/100 g) compared to the other wild vegetables (Table 2).

3.2. Minerals composition of wild vegetables

The minerals compositions of the wild vegetables like potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn) and copper (Cu) were listed in Table 3. Among the five different vegetables examined in this study, Patshak contained the highest levels of Ca, Mg, Fe and Zn which were recorded as (909.13 ± 0.78), (315.21 ± 1.24), (73.54 ± 0.25) and (11.14 ± 0.15) mg/100 g respectively and the lowest level of Cu which was recorded (0.15 ± 0.04) mg/100 g. The Dhekishak contained the highest level of Cu which was recorded (3.25 ± 0.13) mg/100 g and the lowest levels of Ca, Na and Zn which were recorded as (279.16 ± 1.33), (94.44 ± 0.66) and (2.29 ± 0.21) mg/100 g respectively. Shapla stem contained the lowest levels of K and Fe which were recorded as (858.39 ± 0.68) and (3.59 ± 0.09) mg/100 g respectively. Kalmishak contained the highest level of K which was recorded (2 055.26 ± 1.32) mg/100 g and the wild Helencha contained the lowest level of Mg which was recorded (57.38 ± 1.16) mg/100 g.

Table 3
Mineral concentration in the wild vegetables. mg/100 g.

Minerals	PL	Dhekishak	Helencha	Kalmishak	Patshak	Shapla stem
Ca	–	279.16 ± 1.33	902.46 ± 0.85	772.14 ± 0.73	909.13 ± 0.78	379.54 ± 0.58
Na	–	94.44 ± 0.66	135.86 ± 0.27	1 092.32 ± 0.67	454.25 ± 0.52	643.58 ± 0.82
K	–	1 065.45 ± 1.13	1 253.37 ± 1.11	2 055.26 ± 1.32	1 705.32 ± 1.14	858.39 ± 0.68
Mg	–	148.50 ± 0.65	57.38 ± 1.16	193.20 ± 0.23	315.21 ± 1.24	145.48 ± 1.11
Fe	–	13.41 ± 0.66	23.34 ± 0.45	22.26 ± 0.21	73.54 ± 0.25	3.59 ± 0.09
Zn	6	2.29 ± 0.21	4.38 ± 0.20	5.16 ± 0.08	11.14 ± 0.15	3.63 ± 0.13
Cu	4	3.25 ± 0.13	1.32 ± 0.06	0.61 ± 0.04	0.15 ± 0.04	1.77 ± 0.11

All data were expressed as mean ± SD of triplicate experiment ($n = 3$); PL: World Health Organization (WHO)/Food and Agriculture Organization (FAO) permissible limit.

3.3. Heavy metals concentration of the wild vegetables

The heavy metals concentrations of lead (Pb), chromium (Cr), cadmium (Cd), nickel (Ni) and mercury (Hg) obtained from the wild vegetables were listed in Table 4. The concentration of Pb and Cr in the wild vegetables was found highest in Helencha which were recorded (0.105 ± 0.004) and (0.77 ± 0.07) mg/100 g respectively and lowest in Patshak which were recorded (0.02 ± 0.002) and (0.22 ± 0.03) mg/100 g respectively. The maximum level of Ni was found in Dhekishak which was recorded (0.43 ± 0.03) mg/100 g and the minimum level was found in Patshak which was recorded (0.09 ± 0.002) mg/100 g. The other toxic heavy metals Cd and Hg were not detected in the wild vegetables examined in our study.

Table 4
Heavy metal concentration in the wild vegetables. mg/100 g.

Minerals	PL	Dhekishak	Helencha	Kalmishak	Patshak	Shapla stem
Pb	0.030	0.097 ± 0.006	0.105 ± 0.004	0.082 ± 0.003	0.024 ± 0.002	0.074 ± 0.003
Cr	0.230	0.620 ± 0.040	0.770 ± 0.070	0.410 ± 0.040	0.220 ± 0.030	0.560 ± 0.060
Cd	0.020	bdl	bdl	bdl	bdl	bdl
Ni	0.100	0.430 ± 0.030	0.350 ± 0.020	0.38 ± 0.03	0.090 ± 0.020	0.280 ± 0.020
Hg	–	bdl	bdl	bdl	bdl	bdl

All data were expressed as mean ± SD of triplicate experiment ($n = 3$); bdl: Below detection level; PL: WHO/FAO permissible limit.

4. Discussion

Moisture of food is considered as a good source of water and 20% of total water consumption is necessary to come from food [19]. 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 (Table 2). These results were very close to the moisture contents of some wild edible and commonly used vegetables in Pakistan [20,21]. Ash content is the index of the total mineral content of any sample. The wild vegetables represented in Table 2 contained high amounts of ash that indicated the vegetables were rich in minerals and could provide a considerable amount of mineral elements in our diet. The ash content of these wild vegetables was closed to the results reported for some edible and commonly used vegetables in Pakistan [21] and lower than the commonly consumed leafy vegetables in Nigeria [1]. Fat in food is considered as a main source of energy, essential fatty acids and vitamins. The crude fat content (1.45%–3.34%, shown in Table 2) of the leafy wild vegetables was higher than the fat content (0.21%–0.45%) of some leafy vegetables in Nigeria [1] and similar to the fat content (2.00%–3.01%) of some wild vegetables in Nigeria and Pakistan [14,16]. Thus the vegetables are the poor source of fat that make the staple foods with them good for the obese people. The protein content of the reported wild vegetables (Table 2) was higher than the wild and commonly consumed leafy vegetables in Nigeria and Pakistan [1,14,21]. The report of the Bangladesh Bureau of Statistics for household income and expenditure showed that the average protein intake is 66.26 g/day in Bangladesh [6]. According to the Institute of Medicine, the recommended dietary allowance (RDA) of protein for children, men and women is 34, 56 and 46 g/day, respectively. 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 vegetables are rich sources of protein which can encourage their use in human diets and might be helpful for protein energy malnutrition. Vegetables are rich sources of fiber which is an important component in preventing overweight, constipation, diabetes, increase of serum cholesterol, risk of heart diseases, breast and colon cancer, hypertension, *etc* [22]. The crude fiber of these wild vegetables represented in Table 2 was highest in Dhekishak (17.70%) and lowest in Kalmihak (9.26%). The result was closely similar to the other wild edible plants and commonly consumed vegetables in Pakistan [21,23]. The RDA of dietary fiber for adult males and females is 38 and 25 g/day, respectively [24], a nutrient of diet that is necessary for digestion and promoting soft stools for effective elimination [25]. So, the content of fiber in the wild vegetables used in our study can encourage their use in the human diet to fulfill the RDA of fiber. Carbohydrates are the principal source of energy. The carbohydrate contents of the wild vegetables represented in Table 2 was found highest in Shapla stem (76.34%) and lowest in Kalmishak (52.78%). Imran *et al.* reported the closely related results of some wild edible leaves such as spinach, sweet potato and triden which were 54.20%, 75.00% and 82.80%, respectively [20]. On the other hand, the results 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 [1,14]. The RDA of carbohydrate for male and female is 130 g/day [24]. Due to the carbohydrate content (Table 2), the vegetables can be a good food source of carbohydrate for human consumption.

The essential minerals K, Na, Ca, Mg and trace minerals Fe, Zn, Cu and Cr of the wild vegetables on dry weight basis are shown in Table 3. The K and Na are the most abundant minerals present in the wild vegetables, which were found (858.39 ± 0.68) to (2 055.26 ± 1.32) and (94.44 ± 0.66) to (1 092.32 ± 0.67) mg/100 g respectively. Na and K play an important role in the transport of metabolites in the human body. The ratio of Na/K in any food item is an important factor; too much Na and less K consumption contribute high prevalence of hypertension [26,27]. The Na/K ratio in our body is very important to control high blood pressure and the ratio should be less than one [28]. In our study, all the vegetables shown in Table 3 have the Na/K ration less than one, that indicate the consumption of these vegetables are helpful for human and might be able to control the high blood pressure of our body. The Ca is an important macro-nutrient for the growth and maintenance of teeth, bone, muscle and heart function [28]. The concentration of Ca in the wild vegetables (Table 3) was found highest in Patshak [(909.13 ± 0.78) mg/100 g] and lowest in Dhekishak [(279.16 ± 1.33) mg/100 g]. The results were almost similar for the wild green leafy vegetables traditionally consumed in North-East India and for the non-conventional leafy vegetables commonly consumed in Nigeria but much higher than the vegetables consumed as food in Pakistan [(9.00–181) mg/100 g] [2,16,21]. The data indicating that the wild vegetables used in this study could provide a good source of Ca to our diet. Mg is required as cofactor of many enzymes, protein synthesis and RNA and DNA synthesis of the human body. It also functions in regulating potassium fluxes and in the metabolism of Ca [29]. The Mg content of the wild vegetables analyzed in this study (Table 3) was highest in Patshak [(315.21 ± 1.24) mg/100 g] and lowest in Helencha [(57.38 ± 1.16) mg/100 g]. Saikia and Deka have reported that the Mg content was highest [(201.20 ± 10.50) mg/100 g] and lowest [(30.30 ± 2.30) mg/100 g] in the twenty one wild green leafy vegetables of North-East India [2]. It has also reported that Mg in the some wild plants *Echinops giganteus*, *Capsicum frutescens*, *Piper guineense and Piper umbellatum* of Cameroon was found 89, 254, 296 and 490 mg/100 g, respectively [30]. These reports are in agreement with the results obtained in our study. The Fe content of the wild vegetables was ranged from (3.59 ± 0.09) mg/100 g to (73.54 ± 0.25) mg/100 g which compared favorably to most of the values reported from (6.97 ± 0.43) mg/100 g to (22.73 ± 1.21) mg/100 g for some wild green leafy vegetables in North-East India and from 21.30 mg/100 g to 33.40 mg/100 g for some commonly and wildly consumed leafy vegetables in Kano, Nigeria [2,31]. Fe is important in the diet for the formation of hemoglobin, normal functioning of the central nervous system and in the metabolism of carbohydrates, proteins and fats [32,33]. The recommended average dietary intake of Fe is 400 g/day of fresh leafy vegetables that would result in an intake of about 40 g of dry vegetables per day [34]. The recommendation is an agreement with the results obtained in our study. 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 [10,35]. Zn deficiency lead to complications of pregnancy and childbirth, low birth weight, poor growth, loss of appetite and weakness are the public health problems in the developing countries [35,36]. The WHO permissible limit of Zn is 6 mg/100 g. About 20% population of the world is at Zn deficiency risk according to the food balance data of FAO. The Zn present in the wild vegetables (Table 3) was found highest in Patshak [(11.14 ± 0.15) mg/100 g] and lowest in Dhekishak [(2.29 ± 0.21) mg/100 g]. The Zn levels of these vegetables are similar to the levels reported in some wild and leafy vegetables in India and Nigeria [2,31], except the Zn level of 11.14 mg/100 g in Patshak which might be due to soil or irrigated water. Cu is an important trace mineral for health, assisting in the formation of hemoglobin and takes part in many different enzyme activities. In addition of Fe, it maintains good health, prevent anemia and interrelated with the functions of Zn and Fe of the body [37]. In some cases it may be toxic when it's concentration exceeds the safe limit [38]. The Cu levels in the wild vegetables presented in our study (Table 3) were higher than the levels reported in some wild leafy vegetables in India and lower than the levels reported in some vegetables in Nigeria [2,28]. The Cu levels in our study were observed between (0.15 ± 0.04) mg/100 g to (3.25 ± 0.13) mg/100 g which are below the WHO permissible limit (4 mg/100 g) in foods.

The heavy metals content of the wild vegetables consumed in Bangladesh has listed in Table 4. Cr is a trace element necessary for carbohydrate, fat and cholesterol metabolism and important for many hormones and enzyme activity in a certain concentration (up to 200 µg/day) but chronic exposure to Cr may damage liver and kidney. The wild vegetables analyzed in this study contained Cr between (0.22 ± 0.03) mg/100 g to (0.77 ± 0.07) mg/100 g (Table 2). The Cr content was exceeded the permissible limit in all vegetables except Patshak and found higher than the levels reported for some wild green leafy vegetables of Northern East India [2]. These high amounts of Cr might be accumulated in the vegetables due to the contamination of soil, wastewater or industrial effluents [39,40]. Pb is highly toxic heavy element that causes both acute and chronic poisoning. It has adverse effect on liver, kidney, vascular and immune system [41]. The concentration of Pb was lowest in Patshak [(0.024 ± 0.002) mg/100 g] which was below the permissible limit and highest in Helencha [(0.105 ± 0.004) mg/100 g]. The levels of Pb reported in this study were higher in some cases when compared to that reported for the aquatic plants of Tripura in India, for the wild edible plants in Pakistan and for some green leafy vegetables in Nigeria [13,14,42]. The high concentration of Pb present in some wild vegetables might be attributed to the pollutants in soil, air, water, factory wastage, *etc*. [43]. The Pb content in the wild vegetables in our study was higher except Patshak when compared to the FAO/WHO permissible limit of 0.03 mg/100 g and might concern with the people's health who are consuming these wild vegetables. Trace amount of Ni may be beneficial for healthy skin, iron metabolism and optimum growth in the human body, but it's toxicity at the higher level is prominent. The highest level of Ni was found (0.43 ± 0.03) mg/100 g in Dhekishak and the lowest level was found (0.09 ± 0.02) mg/100 g in Patshak. These Ni values were in agreement with those reported for some wild edible plants in Pakistan but observed higher than those reported for some wild green leafy vegetables in India, wild food plants in Pakistan and the WHO recommended daily intake [2,14,23]. These variations of Ni contents in various wild vegetables might be due to the pollutants in soil, air, water, factory wastages, sewerages *etc* [43,44]. The other toxic heavy metals Cd and Hg analyzed in this study were below the detection level in all wild vegetables.

The wild vegetables consumed in Bangladesh have the potential to provide essential nutrients needed to human diet for maintaining the normal body function. The results from the study showed that the wild vegetables are a very good nutritional source and in some cases, they are better than those of some green cultivated vegetables [14,21,31]. Thus, they are capable of providing energy to the consumer and sufficient to fulfill the RDA by FAO/WHO. These vegetables were also found a significantly useful source of various minerals. The minerals, particularly Na, K, Ca, Fe, Cu, Mg and Zn, were present in appreciable quantities. The toxic heavy metals Cd and Hg were not detected in these vegetables but Pb, Cr and Ni were detected higher in the vegetables than the permissible safe limit of FAO/WHO except Patshak that might be due to the industrial pollution, polluted water waste, air sewage, *etc* [39]. So the results showed that the wild vegetables are a rich source of nutrients that could make significantly contributes to the RDA of nutrients. The levels of some metals are not found within the safe limits prescribed by FAO/WHO that may directly affect the human body. Although, the wild vegetables are a good source of nutrients necessary for good health but the accumulation of some toxic metals like Pb, Cr and Ni, it would be difficult to use them in diet and should be avoided for consumption. To avoid the toxicity and enjoy the nutritional benefit it is better to cultivate the wild vegetables in a plane land with normal edible vegetables.

We must emphasize that the results obtained in this work are the first one reported in the literature for the wildly grown vegetables collected from the city markets in Bangladesh. This information can be extremely important considering that the vegetables are consumed by the peoples in the city are not safe except Patshak. However, Dhaka City dwellers are purchasing these heavy metal contaminated vegetables, which is a great concern of our health risk. So, it is strongly recommended to avoid the consumption of these vegetables.

Conflict of interest statement

We declare that we have no conflict of interest.

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