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A STUDY OF WILD VEGETABLES: PROXIMATE AND MINERAL ANALYSIS OF SELECTED WILD EDIBLE VEGETABLES OF PARACHINAR, DISTRICT KURRAM KP, PAKISTAN

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Abstract

Wild vegetables have a crucial role in human life in connection with diet, medicine or other domestic uses. The five wild vegetables, i.e., *Bistorta amplexicaulis, Chenopodium album, Nasturtium officinale, Citrullus colocynthis* and *Polygonum plebejum*, were collected from the District Kurram of Khyber Pakhtunkhwa, Pakistan, to estimate the mineral and nutritional composition of these plants. For the analysis of the nutritional composition, Association of Official Analytical Chemists (AOAC) methods and for minerals, atomic spectrometric methods were used. *Chenopodium* album showed the highest content of both moisture and nitrogen-free extract (15.12% and 72.97% respectively), while the ash content was highest in *Nasturtium officinale* (21%). In *Polygonum plebejum,* crude fiber content was the highest (12.74%), and the crude fat and protein content was the highest in *Nasturtium officinale* and *Bistorta amplexicaulis* (8.49% and 12.25%). The highest amount among all the minerals shown is Ca (102.7 mg/L) followed by K, Mg and Fe, (77.15, 17.26 and 2.964 mg/L). Among all proximate analysis and minerals content, only minor variations were observed. Agreement was found when the results were compared to other studies with slight differences, which might be due to climatic and regional conditions.

Key words: Wild vegetables, Mineral composition, Nutritional value, Proximate analysis.

Introduction

The word vegetable means a plant or any part of a plant used as food. Wild vegetables are non-cultivated and self-growing vegetables that are obtained from their natural habitats or forest (Abbas *et al*., 2020). Wild vegetables are the major source of food and medicine (Narzary *et al*., 2015). Humans have used plants abundantly from the beginning of time in their daily lives. Both humans and their animals use plants for nutrition (Tuncturk *et al*., 2015). Plants have a great socio-economic significance because of their food and medicinal value. Vegetables are the edible parts of plants that are consumed wholly or partially, either cooked or not cooked as parts of major dishes or salad (Abbas *et al*., 2020). Vegetables are a good source of vitamins, protein, carbohydrates, minerals and oil, which may not be obtainable from other food sources. These are the nutrients which are important for the maintenance of life and for the caloric requirements of the body (Peironi & Soukand, 2019). Wild edible vegetables are also a good source of income for many poor communities in rural areas. In many agrarian countries, people conventionally harvest bundles of leafy vegetables, roots, tubers and fruits from the wild only for their culinary use. Edible wild plants are found in different countries of the world which have rather different climates (Brahma *et al*., 2014). Essential minerals are divided into two main groups, macro minerals (Mg, K, and Ca,) which are required in greater amounts and represent 1% or less of body weight, and micro-minerals.

All the others are considered micro-mineral (Mn, F, Cr P, S and Si) and trace elements (Na, Cl) that are required in and represent less than 0.01% body weight (Saika & Deka, 2013).

Malnutrition is of serious and major concern for many developing countries due to the deficiency of micronutrients; approximately two billion people suffer worldwide resulting in poor health, low work opportunities and high death ratio. For instance, iron deficiency anemia affects nearly thirty percent of the world's population. Vegetables are an important source of beta-carotene, vitamins and minerals whose importance in human health is indisputable. An acceptable intake of essential minerals is important to remain healthy as they are involved in numerous biochemical processes (Hardission *et al*., 2001; Arivalagan *et al*., 2012). Some scientists have already appreciated this need and they have started exploring the value of wild vegetables. Guerrero *et al*., (1998) compiled a comprehensive nutrients report of wild vegetables consumed by the first European farmers and nearly all the species indicated a significant amount of several micronutrients. Magnesium and potassium content in wild vegetables was higher than those of cultivated species such as spinach, lettuce and cabbage. In both these kinds of vegetables, the concentrations of zinc, manganese, copper and iron were similar (Turan *et al*., 2003). Wild vegetables are the chief source of food and minerals (Booth *et al*., 1992; Freyra *et al*., 2000). All results show that wild vegetables are important components of many diets, especially in periods of seasonal food shortage (Muchuweti *et al*., 2008).

The common and tribal people of District Kurram commonly use many wild vegetables in their customary dishes. They eat these wild vegetables boiled, fried or uncooked as salad. Various vegetables, of course, are consumed following various processes of cooking. It varies according to the communities and tribes who use the items. In some plant species, leaves and flowers are fried after cutting and are used as food. In some cases, rhizomes, stolon, leaf petioles, corm or even the whole plants are consumed. Though these plants are used as vegetables but some medicinal as well as nutrient properties are also found (Nath, 2015).

The objectives of the current study;

- To correlate the traditional folk knowledge with their chemical composition.
- To explore the role of the phytochemicals on human health.
- To promote the local uses of wild vegetables.

Material and Methods

Study area: Kurram is a newly-formed tribal district of Khyber Pakhtunkhwa, Pakistan. Before 2018, the district Kurram was the part of the Federally Administered Tribal Area (FATA), but after 2018 it was moved to Khyber Pakhtunkhwa which is now called district Kurram (Abbas *et al*., 2020). The name Kurram comes from the river Kurram, which flows along the valley. Parachinar is the headquarters of district Kurram (Hussain *et al*., 2020; Abbas *et al*., 2020). The district Kurram is located between 33°20`to 34°10`north latitude and 69°50`to 70°50` east longitude. The district Kurram is bounded on the north and west by Ningrahar and Puktia, the province of Afghanistan, on the east by Orakzai and Khyber district, on the southeast by Hangu and on the south by North Waziristan (Hussain *et al*., 2018; Hussain *et al*., 2019; Anwar *et al*., 2022). The district Kurram is 115 km long and encompasses a total area of 338 Square Kilometers. The people of district Kurram are poor, mostly farmers and pastoralists (Ali *et al*., 2019; Abbas *et al*., 2020). The climate of Kurram remains pleasant for most of the summer. However, in winter, minimum temperatures usually remain below freezing, occasionally hitting -10 degrees Celsius. The annual rainfall is 1239.9 mm. Humidity is higher in the morning than in the evening (Hussain *et al*., 2020; Hussain *et al*., 2021; Hussain *et al.,* 2022).

Collection of wild vegetables: *Bistorta amplexicaulis Chenopodium album, Nasturtium officinale*, *Polygonum plebejum* and *Citrullus colocynthis*, were collected randomly from various areas of Parachinar District Kurram (Fig. 1).

Preparation of sample: The five samples of wild vegetables were washed and then air dried under shade. After air drying, samples were crushed into powder using a grinder and stored in glass bottles for further chemical analysis.

Proximate analysis: The proximate analysis was carried out in the laboratory of applied chemistry Agricultural University of Khyber Pakhtunkhwa, Pakistan. Following the methodology of the Association of Official Analytical Chemists (2000).

Determination of moisture content: According to Anon., (2000), the content of moisture was carried out at 105°C overnight by drying samples in an oven. A two-gram (2g) sample was taken and weighed in a clean, dry petri dish (W1). After cooling it was weigh again (W2) (Begum *et al*., 2018; Anwar *et al*., 2022). The following formula was used to determine percent moisture.

$$\text{Moisture \%} = \frac{\text{W1} - \text{W2}}{\text{Weight of samples}} \times 100$$

W1 = Weight of petri dish + Weight of sample before drying
W2 = Weight of petri dish + Sample after drying

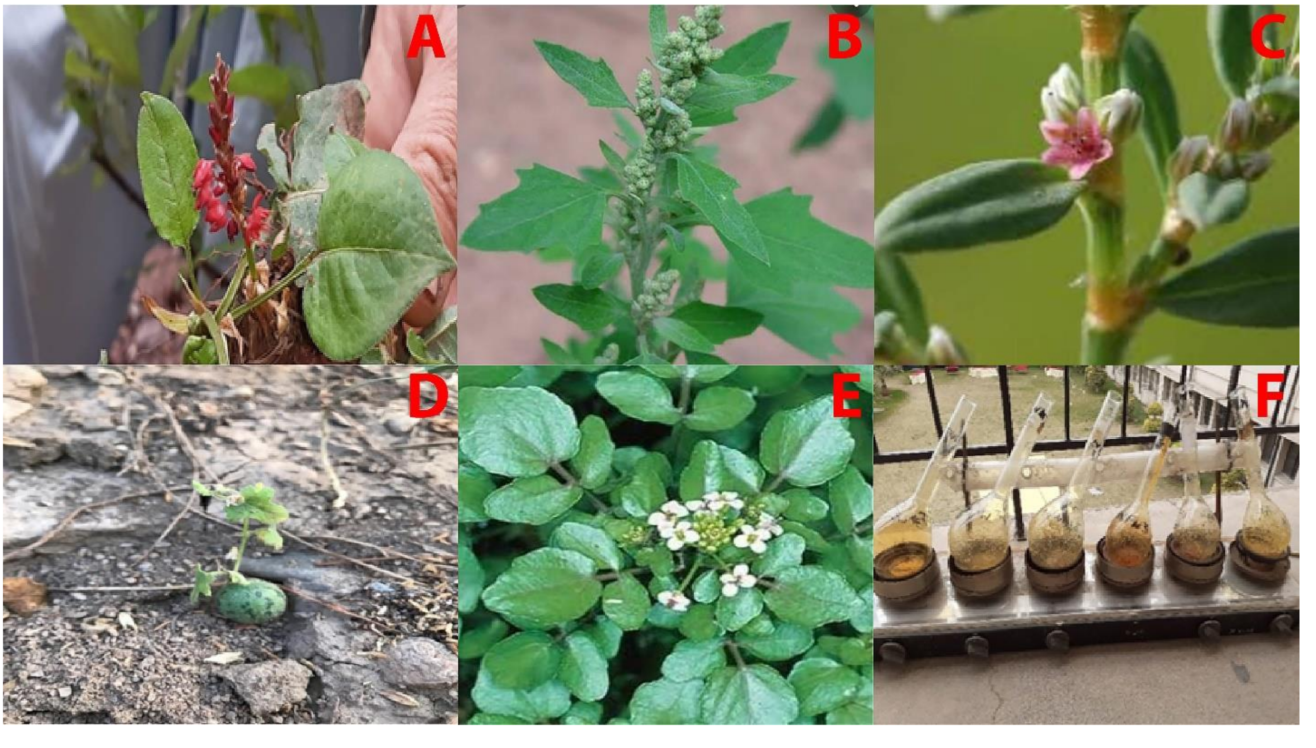

Fig. 1. (A, B, C, D, E, F) Shows the collection of plants during field work and (e) during experimental work: (A) *Bistorta amplexicaulis* (B) *Chenopodium album* (C) *Polygonum plebejum* (D) *Citrullus colocynthis* (E) *Nasturtium officinale* (F) *Experimental work in laboratory*.

Determinations of ash content: Association of Official Analytical Chemists 2000, method was adopted for the determination of ash in which an empty oven-dried crucible was used and cooled in a desiccator, followed by measuring its weight. The sample of 1g sample was taken in the crucible, weighed and labeled as initial weight (W1). The sample was charred over the burner with a low flame. After charring, the crucible was then placed in a muffle furnace. The furnace temperature was set to reach 550°C to 660°C slowly. The samples were allowed to completely combust in the furnace for six hours until they showed the grey whitish color. The sample was removed from the furnace after the completion of the burning period and was cooled in a desiccator. Again, the weight was measured and labeled as final weight (W2) (Salamat *et al*., 2017; Anwar *et al*., 2022).

$$\text{Ash (\%)} = \frac{\text{weight of Ash (W3} - \text{W1)}}{\text{Weight of samples}} \times 100$$

Determination of crude protein content: The crude protein of wild vegetables was determined using a Kjeldahl apparatus (Okunlolo *et al*., 2019; Anwar *et al*., 2022). For digestion, a one-gram (1g) sample was weighed and transferred to a digestion flask. To the sample, digestion mixture (K_2SO_4; $CuSO_4$) 7 of 8g and concentrated H_2SO_4 were added to the digestion flask. The content was mixed thoroughly by spinning the flask so that no crystal formation occurred. It was then placed on a heater under a fume hood to start the digestion which continued till the mixture become clear (blue green color). After digestion, the heater was turned off and the flask was cooled. Distillation of the digested sample was carried out on a Kjeldahl apparatus. The distillation tube was filled with 10ml of the digested sample and 10 ml of of sodium hydroxide (NaOH 40%) was added. NH_3 was produced in the receiving flask and collected as ammonium hydroxide (NH_4OH). To the flask, 20ml solution of 4% boric acid (H_3BO_4) and some drops of methyl red indicator were added. Because of NH_4OH, the pink color was slowly transformed into yellowish. During distillation when the pink color appeared, the distillate was titrated against the standard 0.05 N HCl. Following the above-mentioned steps, a blank was also run. The following formula was used for protein determination:

Crude protein (%) = 6.25* × % N
(*factor for vegetables)

$$\% \text{ N} = \frac{(\text{S} - \text{B}) \times 0.01 \times 0.014 \times 100}{\text{Weight of sample x V}} \text{x100}$$

S = Sample titration, B = Blank titration reading, N = Normality of HCl, D = Sample dilution after digestion, V = Volume taken for distillation, 0.014 = Milliequivalent weight of nitrogen, 6.25 = Protein conversion factor for plants (vegetables).

Determination of crude lipid content: The crude lipid content was determined using Soxhlet's apparatus. Moisture-free biomass (1g) was placed in a cellulose cartridge in Soxhlet's apparatus. 100 mg of petroleum spirits were used to carry out the extraction for six hours at 40-60°C. The solvents were evaporated on a rotary evaporator to remove the solvent and obtain the crude lipids. The flask was allowed to cool to obtain the correct weight. The contrast in weights was expressed as % crude lipids using the following formula (Satter *et al*., 2016; Anwar *et al*., 2022).

$$\text{Crude lipid \%} = \frac{\text{W1-W2}}{\text{Weight of samples}}$$

W1 = Flask weight with fat

W2 = Weight of empty flask

Determination of crude fiber: The crude fiber content was determined using the acid and alkali digestion method (Gafar *et al*., 2011; Anwar *et al*., 2022). Exactly 200ml of 2% HCl was placed in a beaker and then 2g of sample were added to it. It was stirred constantly and boiled for 30 minutes on a steam bath and then filtered with muslin cloth. The residue was then treated with 2% NaOH solution following the same procedure. The crucible was weighed and residue was added to it. The crucible was then kept in the desiccator for the procedure. After cooling, the crucible was weighed and then placed in a furnace for 4 hours at 550°C. The crucible was cooled in the desiccator and weighed again. Percentage of crude fiber was determined as;

$$\text{Crude fiber (\%)} = \frac{\text{Weight of dried residue} - \text{Weight after oven}}{\text{Weight of samples}} \times 100$$

Determination of carbohydrates: Total available carbohydrate was calculated as nitrogen-free extract. Carbohydrate content in the wild vegetables was determined using the subtraction method (Anwar *et al.,* 2022). This is by subtracting the percentage sum of food nutrients: % crude protein, % crude fiber, % crude lipids and % ash from 100%, using the equation below:

% Crude NFE = 100 - (% crude proteins + % crude lipids + % crude fiber + % ash)

Mineral evaluation: *B. amplexicaulis, C. album, P. plebejum, N. officinale* and *C. colocynthis* were selected for mineral evaluation too. We took a one-gram (1g) sample of selected wild vegetables in the flask and then added 12 ml Nitric acid to the sample in order to get digestion and let it sit overnight. We then poured 5ml perchloric acid in solution and heated the solution on hot plates as the solution became transparent. After that, the samples were allowed to cool and filtered using Whatman filter paper No (42). The filtrate was poured into the volumetric flask. Results were analyzed for diverse factors using an Atoms Adsorption spectrometer (Shimadzu AA/670) with suitable hole cathode lamps.

The measurement of different factors was determined using the corresponding general calibration curves obtained using general AR-grade solutions of the factors K+, Mg++, Ca++, Na+, Fe++, Co++, Mn+2, Cu+3, Cr+++, and Zn++ (Ullah *et al*., 2017).

Results

During the current study *Bistorta amplexicaulis Chenopodium album, Nasturtium officinale*, *Polygonum plebejum* and *Citrullus colocynthis* were collected through available literature (Shad *et al*., 2013; Shah *et al*., 2015; Tareen *et al*., 2016; Ahmad *et al*., 2019; Abbas *et al*., 2020) in the different parts of the study area from their natural habitats. Those wild vegetables were commonly used by the people of the local area for the treatment of various human disorders as well as for cooking. Those wild green leafy vegetables have been recognized by common villagers as the cheapest and most abundant source of nutrients in the areas of District Kurram. These wild vegetables (*B. amplexicaulis C. album*, *P. plebejum*, *N. officinale* and *C. colocynthis*) were collected from the natural habitat during April to August 2019 at their consumable stages. The wild vegetables were shade dried and powered in a grinder. The samples of wild vegetables in powder form were stored in glass bottles and analyzed for proximate analysis and mineral composition. The parameters analyzed were moisture content, ash content, crude fats, crude fibers, crude protein and nitrogen-free extract. The data was as follows:

Moisture content: The moisture content of the plants studied ranged from 6.4 to 15.2%. The highest moisture content (15.2%) was found in *C. album*, followed by *N. officinale* (10.8%), *B. amplexicaulis* (8.21%), and *P. plebejum* (6.40%) while the lowest moisture content was found in *C. colocynthis* (6.4%) as shown in Fig. 2. The moisture content varied significantly in the selected wild vegetables; the variation might be due to the type of wild vegetables. High moisture content in food is important for human health because water plays a vital role in excretion through urine, which carries wastes from the body. When these wild vegetables are in fresh form, they contain enough moisture and no extra water is needed for cooking.

Ash content: Ash content of wild vegetables ranged from 10.83% to 21.0%. The ash content in *N. officinale* was the highest with a value of 21.0%, *C. colocynthis* and *C. album* showed 17% and 16.1% respectively. *P. plebejum* has 12.43% while the lowest ash content was found in *B. amplexicaulis* (10.83%) as given in Table 1. Ash content represents mineral matter of the vegetables. The maximum ash content indicates a higher number of minerals, which might be macro or micro. Minerals play a crucial role in the life of plants and are essential for consumers.

Crude fiber content: The crude fiber in selected wild vegetables ranged from 4% to 12.74%. The maximum fiber content of food was found in *P. plebejum* (12.74%), followed by *B. amplexicaulis* (8.9%), *C. album* (7.38%) and *C. colocynthis* (8.0%), while the minimum crude fiber was found in *N. officinale* (4.0%) as presented in Table 1. Crude fiber provides necessary bulk to the diet. Lack of fiber can lead to many diseases, including cancer.

Crude fat content: The crude fat content of the selected wild vegetables ranges from 0.97% to 8.49%. The crude fat content was highest in *N. officinale* (8.49%) and lowest in *C. album* (0.97%). The remaining plants such as *P. plebejum* have 6.79%, *C. colocynthis* showed 5.60% and *B. amplexicaulis* possesses 4.85% as displayed in Table 1. The crude fat in wild vegetables may be beneficial for health.

Crude Protein content: The crude protein content of selected wild vegetables was 2.62% in *C. album* and 12.25% in *B. amplexicaulis.* The protein content in *C. colocynthis*, *P. plebejum* and *N. officinale* is 10.06%, 8.75% and 5.25% respectively as shown in Table 1. Protein is the major component of body tissue next to water. Proteins catalyze all biochemical reactions in the form of enzymes. It also transports oxygen to all parts of the body in the form of hemoglobin. The selected plant species contain sufficient crude protein to meet the protein needs of animals and humans in rural areas.

Carbohydrate content: The carbohydrate content ranged from 59.29% to 72.97%. The level of nitrogen-free extract contents was found to be highest in *C. album* (72.97%), followed by *B. amplexicaulis* (63.97%), *N. officinale* (61.51%) and 59.34% in *C. colocynthis*, while the lowest nitrogen-free extract content was present in *P. plebejum* (59.29%) as shown in Table 1. Carbohydrates are important constituents in many foods and are considered a significant energy source. The reported plant species contain a high enough carbohydrate content to meet the needs of humans and animals.

Table 1. Proximate composition of the selected wild vegetables (% dry matter).

Plant name	Family	Local name	Consumed part	Moisture (%)	Ash (%)	Crude fiber (%)	Crude protein (%)	Crude lipids (%)	Carbohyd rates (%)
Bistorta ampeixicaulis	Polygonacaea	Sarka	Leaves	8.21 ± 0.1	10.83 ± 0.1	8.9 ± 0.03	12.25 ± 0. 1	4.85 ± 0.1	63.17± 0.1
Chenepodium album	Amaranthaceae	Sormi	Leaves	15.12 ± 0.01	16.1 ± 0.1	7.38± 0.06	2.62 ± 0.1	4.85 ± 0.1	72.97 ± 0.02
Polygonum plebeium	Polygonaceae	Bandoki	Stem	6.46 ± 0.1	12.43 ± 0.04	12.74 ± 0.1	8.75 ± 0.1	6.79 ± 0.1	59.29 ± 0.05
Citrulus colocynthis	Cucurbitacea	Pirpandyan	Whole plant	6.4± 0.1	17 ± 0.6	8 ± 0.05	10.06± 0.01	5.60 ± 0.01	59.34 ± 0.06
Nasturtium officinale	Brassicaceae	Shiree	Young stem and leaves	10.8 ± 0.1	21 ± 0.4	4 ± 0.3	5.25 ± 0.1	8.49 ± 0.1	61.51 ± 0.1

Note: All the data expressed as means ± SD of the triplicate experiments. All of the above contents (i.e., Ash, Crude fiber, crude protein, crude lipids, and Carbohydrates) are expressed on a dry matter basis

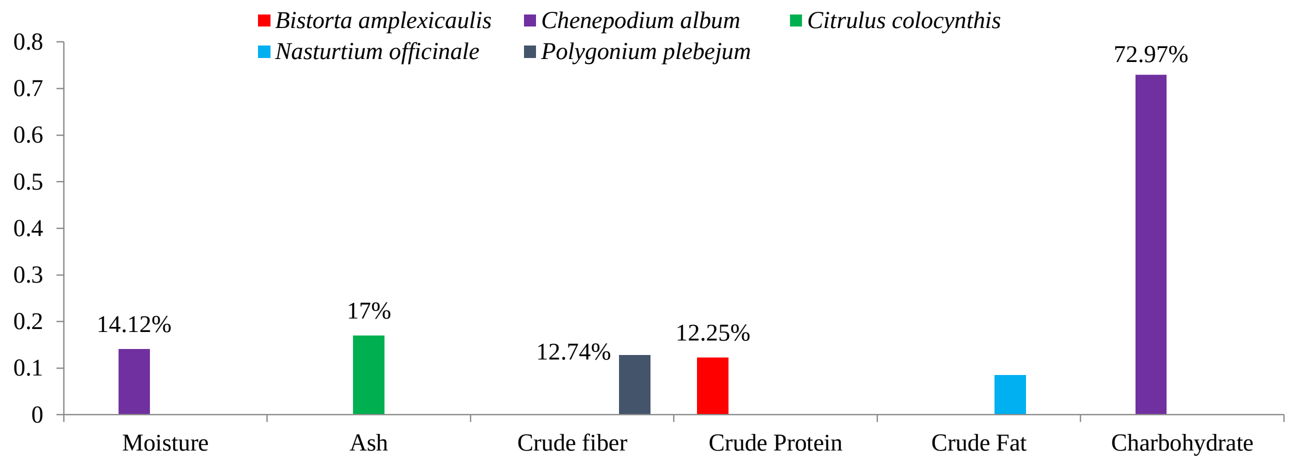

Fig. 2. Showing chemical composition of selected wild edible vegetables.

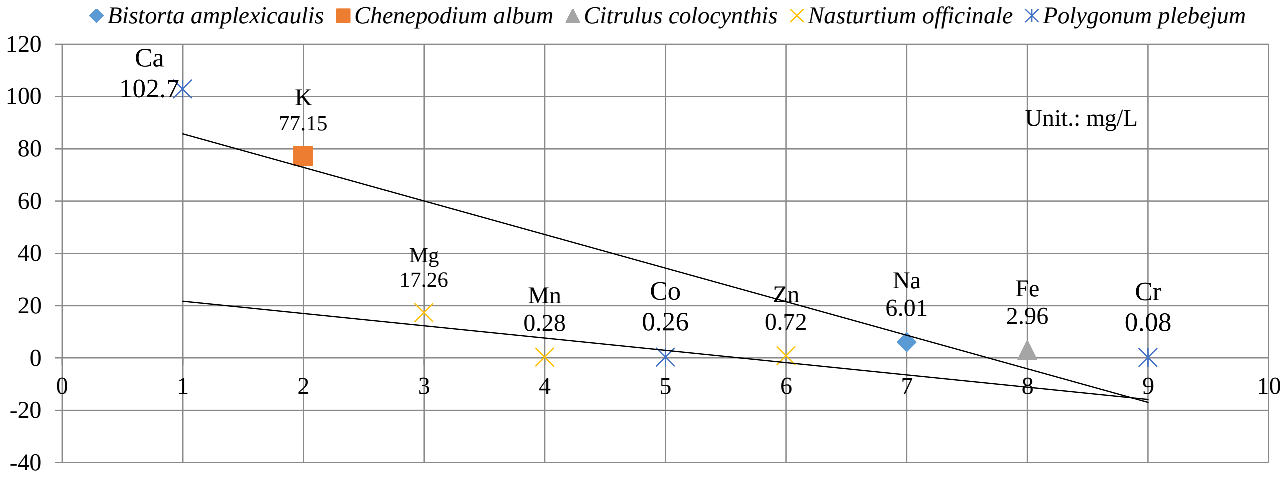

Fig. 3. Shows the mineral composition of selected wild edible vegetables.

Mineral composition

Macro elements

Calcium content: Calcium is most important mineral for the human body. It helps form and maintain healthy teeth and bones. The result showed that Ca content of selected wild edible vegetables ranged from 47.30 mg/L to 102.7 mg/L. From the result, it was concluded that the highest content (102.7 mg/L) of Ca was found in *P. plebejum*, while others in descending order as *N. officinale* (100.4 mg/L). *C. colocynthis* (88.64 mg/L), *C. album* (85.36 mg/L). The lowest content (47.30 mg/L) was observed in *B. amplexicaulis* as shown in Fig. 3.

Magnesium content: Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain the normal function of nerves and muscles, support a healthy immune system, keep the heartbeat steady, and keep bones strong. It also helps to adjust glucose level in blood. It helps in the production of energy and protein.

Current results showed that the Mg concentration ranged from 9.653 mg/L to 17.26 mg/L. The highest level (17.26 mg/L) of Mg was found in *N. officinale* followed by *C. colocynthis* with 13.72 mg/L, *C. album* with 10.29 mg/L, and *B. amplexicaulis* with 13.67 mg/L. The lowest Mg content was noticed in *P. plebejum* (9.653 mg/L) as presented in Fig. 3.

Potassium content: Potassium is one of the most important minerals in the body. It helps, regulate the balance of fluid in the body, contract and relax the muscles and carry the nerve signals. The highest level (77.15 mg/L) of K was noticed in *C. album*. The result was followed by *C. colocynthis* (76.97 mg/L), *P. plebejum* (76.71 mg/L) *N. officinale* (75.77 mg/L), while the lowest K content was found in *B. amplexicaulis* (75.42 mg/L) as given in Fig. 3.

Micro elements

Zinc content: Zinc is found in cells throughout the body. It is needed for the body's immune system to properly work. It plays a vital role in cell division, cell growth, wound healing and the breakdown of carbohydrates. Zinc is also needed for the sense of smell and taste. Among the selected wild edible vegetables, Zn was present in higher amounts in *N. officinale* (0.721 mg/L). After *N. officinale*, the highest value was contained by *B. amplexicaulis* (0.441 mg/L). *C. colocynthis*, *P. plebejum* and *C. album* contained 0.378 mg/L, 0.341 mg/L and 0.311 mg/L respectively as given in Fig. 3.

Table 2. Composition of minerals in the selected wild edible vegetables (mg/L dry weight).

Mineral elements	*Bistorta ampeixicaulis*	*Chenepodium album*	*Polygonum plebeium*	*Citrulus colocynthis*	*Nasturtium officinale*
Magnesium (Mg)	13.67 ± 0.1	10.29 ± 001	9.653 ± 0.01	13.72 ± 0.1	17.26 ± 0.04
Calcium (Ca)	47.30 ± 0.1	85.36 ± 0.05	102.7 ± 0.1	88.04 ± 0.3	100.4± 0.02
Potassium (K)	75.42 ± 0.01	77.15 ± 0.04	76..71 ± 0.1	76.97 ± 0.1	75.77 ± 0.1
Zinc(Zn)	0.441 ± 0.01	0.311± 0.01	0.341 ± 0.06	0.378± 0.02	0.72 ± 0.01
Cobalt (Co)	0.230 ± 0.01	0.202 ± 0.01	0.214 ± 0.04	0.258 ± 0.01	0.244 ± 0.01
Manganese (Mn)	0.121 ± 9.0	0.0859 ± 0..01	0.164 ± 0.01	0.204 ± 0.004	0.275 ± 0.01
Chromium (Cr)	0.053 ± 0.01	0.058 ± 0.2	0.070 ± 0.02	0.069 ± 0.01	0.079 ± 0.01
Iron(Fe)	0.939 ± 0.01	0.773 ± 0.001	0.649 ± 0.04	1.716 ± 0.01	2.964 ± 0.01
Sodium (Na)	6.007 ± 0.001	2.252 ± 0.01	2.360 ± 0.02	1.479 ± 0.01	2.101 ± 0.002

Cobalt content: Cobalt is used in the body to help absorb and process vitamin B12. Cobalt also helps in the treatment of Anemia and certain other infectious diseases. Cobalt aids in the repair of myelin, which surrounds and protects nerve cells and helps in the formation of hemoglobin too. The Co content ranged from 0.202 mg/L in *C. album* up to 0.258 mg/L in *C. colocynthis* which was followed by *N. officinale* with 0.244 mg/L and then *B. amplexicaulis*, which had 0.230 mg/L. Co content of *P. plebejum* showed 0.214 mg/L. Cobalt levels are displayed in Fig. 3.

Manganese content: Manganese helps activate many enzymes in metabolism and plays a valuable role in various chemical processes in our body. The Mn concentration ranged from 0.0895 mg/L to 0.275 mg/L. The Mn level (0.275 mg/L) in *N. officinale* was found to be the highest comparative to other wild vegetables. The Mn level was recorded as 0.204mg/L 0.164 mg/L and 0.121mg/L in *C. colocynthis, P. plebejum and B. amplexicaulis* respectively. The lowest Mn content was reported in *C. album* (0.0895 mg/L) as displayed in Fig. 3.

Chromium content: Chromium is important in the breakdown of fats and carbohydrates. It stimulates the synthesis of fatty acids and cholesterol. It is important for brain function and other body processes. It also aids in insulin action and glucose breakdown. Chromium content was in the range of 0.053 mg/L to 0.079 mg/L. The highest (0.079 mg/L) was recorded in *N. officinale,* which was followed by *P. plebejum* with 0.070 mg/L, *C. colocynthis* with 0.069 mg/L, and *C. album* with 0.053 mg/L. The lowest content of Cr was recorded in *B. amplexicaulis* with 0.053 mg/L as shown in Fig. 3.

Iron content: Iron is an important component of hemoglobin, the substance in red blood cells that carries oxygen from your lungs to all other parts of the body. The result showed that Fe ranged from 0.649 mg/L to 2.964 mg/L. The maximum Fe content was reported in *N. officinale* (2.964mg/L). *C. colocynthis* showed 1.617 mg/L; *C. album* showed 0.073 mg/L and *B. amplexicaulis* showed 0.939 mg/L of Fe. The lowest Fe content was reported in *P. plebejum* (0.649 mg/L) as shown in Fig. 3.

Trace elements

Sodium content: Sodium is an essential electrolyte that helps maintain the balance of water in and around the cell. It is important for proper muscle and nerve function and helps maintain stable blood pressure levels. The sodium content is shown in Fig. 3. Content of Na ranged from 1.479 to 6.007 mg/L. The result shows that the highest content (6.007 mg/L) was found in *B. amplexicaulis*, while the lowest Na content was reported in *C. colocynthis* (1.479 mg/L). The remaining plant, *N. officinale* has 2.101 mg/L; *C. album* showed 2.252 mg/L and *P. plebejum* contains 2.360 mg/L content of Na, as given in Table 2.

Discussion

Proximate analysis of the five wild edible vegetables was carried out to find the correlation between folk knowledge of wild vegetables and their chemical composition. Maximum moisture content (15.2%) was recorded in *C. album,* which affects the taste and shelf life of food stuffs. Therefore, high moisture content is essential to maintain the turgidity of the vegetable cells and keep them fresh. The present research was also in line with Hussain *et al*., (2010). The moisture content observed in this study was generally higher than that of the moisture value recorded in a similar study elsewhere (Martins *et al*., 2011). The five wild vegetables were generally rich in ash content with value up to 27% in *N. officinale.* Recent results show that these vegetables are a good source of minerals and a culturally important part of diet, which play a vital role in human body functioning. These study observations are supported by the earlier work of (Narzary *et al*., 2015; Anwar *et al*., 2022) who recorded 3% to 25% ash content in vegetables. The maximum crude protein content was recorded (12.25%) in *B. amplexicaulis.* The result shows that these vegetables are a rich source of protein. In most of rural and backward areas of Pakistan, wild vegetables are a good source of protein. Our results were also supported by Sundriyal and Sundriyal (2004), and Mih *et al*., (2017). The highest crude fiber content was noted (12.74%) in *P. plebejum* (Ullah *et al*., 2017). Analysis of nutrients and minerals of some wild edible plants and the results reported by them were in line with the present study. Fiber is the type of carbohydrate that cannot be digested by the body. Crude fiber has been believed to provide bulk to the diet so it is very important for normal function of the excretory system. These wild vegetables are culturally used as food and for cure of constipation. Our results are not in line of with those of Rehman & Adnan (2018) and Muchuweti *et al*., (2014), because they recorded the highest values of crude fiber as compared to the current study.

The highest crude fat content was reported in *N. officinale* (8.49%). Culturally, *N. officinale* is an important item in our daily life. Locally this vegetable is used to treat stomach disorders and as an anti-diabetic. Ifon & Bassir, (1980) and Guzelsoy *et al*., (2017), studied vegetables used as food in Nigeria and the Republic of Niger. The range of values found in their studies agreed with the present study.

In current research, the highest carbohydrate content was reported in *C. album* (72.97%). *C. album* is the most common vegetable used as food traditionally. The highest NFE concentrations were recorded in this species and it is a good source of energy. The present results were in line with Satter *et al*., (2015) and Ullah *et al*., (2017) who studied the nutritional quality and safety of wild vegetables.

The five wild vegetables are considered a good source of minerals. Mg is needed in the plasma and extracellular fluid, where it helps in maintaining osmotic equilibrium (Mohammed *et al*., 2013). The concentration of Fe in these vegetables was found to be highest in *N. officinale* with 2.964 mg/L. The results show that wild vegetables contain appreciable amounts of Fe, an essential nutrient for all living organisms, required for the hemoglobin formation and transfer of oxygen and electrons (Akunglu *et al*., 2016). Cr is important for brain function and other body processes and the highest content of Cr was reported in *N. officinale*. Study results are similar to those of Shad *et al*., (2011). The present results showed that wild vegetables were a good source of K. Zn is an essential trace element for protein synthesis of nucleic acids and normal body development (Igile *et al*., 2013). The obtained value is in line with the finding of Trichopoulou *et al*., (2000). Co is considered as essential to both plants and animals but there are no established criteria for cobalt in wild vegetables (Akunglu *et al*., 2016). Na was found highest in *B. amplexicaulis* at 6.007 mg/L and is important for human and livestock health. Sufficient intake of sodium can reduce individual risk factors for health problems (Tuncturk *et al*., 2015). The obtained value was in line with Imran *et al*., (2007).

The nutritional value of *P. plebejum* is being reported for the first time. Abbas *et al*., (2020), reported it as an edible plant and the local people used this species for food and folk medicines. *C. album* has diuretic, laxative properties, is used for urinary tract infections and its roots are effective against jaundice (Ali *et al*., 2019). *C. colocynthis* was used by local people of District Kurram for the treatment of diabetes (Hussain *et al*., 2018). Abbas *et al*., (2020), reported that *N. officinale* is locally used for urinary tract infections. The consumption of these species by the rural population may thus be considered significant for both medicines and nutrition. Results showed that most of the wild edible vegetables have considerable nutritional value and should be used in the daily diet of the rural population. These five wild vegetables have huge amounts of minerals, crude fat, crude protein, and crude fiber which are also helpful to the local people for the treatment of many diseases.

Conclusions

Proximate analysis showed that the selected five wild vegetables from the district Kurram, Pakistan have a positive nutritional and mineral value. Essential nutrients such as crude fiber and protein, as well as minerals such as Ca, Mg and K, are present in the quantity required for human dietary intake. Also, traditional wild vegetables are affordable and easily accessible to rural populations. The present study showed that wild vegetables are a valuable source of food.

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