Evaluation of mineral, proximate compositions and anti-oxidant activities of some wild edible vegetables of District Kurram Khyber Pakhtunkhwa, Pakistan

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Abstract
This study was conducted to determine the mineral contents and some nutritional properties of five local wild vegetable; Allium griffithianum Boiss, Buglossoides arvensis (L.) I.M.Johnst., Caralluma tuberculata (N.E.Br.), Chaerophyllum reflexum Aitch, and Stellaria media (L.) Vill., from district Kurram KP, Pakistan which are associated with folk knowledge in the region. This research is the first scientific report on the nutritional composition of the above mentioned species. Among five wild species, the Buglossoides arvensis had the highest carbohydrates content (71.99 ± 0.5%) and high lipid contents (4.8 ± 0.2%). Besides that, it has the highest total energy (349.024 kcal/100 g). Stellaria media was found to have the maximum ash (22.77 ± 0.1%) and lipids (4.87 ± 0.06%). Chaerophyllum reflexum showed the highest protein content (10.5 ± 0.4%) and high total energy (332.68 ± 0.3 kcal/100 g). Mineral analysis showed that the local wild vegetables contained considerable amount of minerals; Calcium (2.20 ± 0.5-1506 ± 0.06 µg/g), Potassium (3.018 ± 1.7-1272.06 ± 0.005 µg/g), Phosphorous (2.98 ± 0.01-180.01 ± 0.1 µg/g), Chromium (0.98 ± 0.6-42.9 ± 0.5 µg/g), Cobalt (0.18 ± 0.005-7.7 ± 0.2 µg/g), Sodium (0.78 ± 0.5-205.53 ± 0.4 µg/g) and Copper (5.5 ± 0.4-35.06 ± 0.7 µg/g). These data suggest that wild plants from district Kurram could be useful for nutrition or other applications. For instance, Caralluma tuberculata contains the highest number of mineral elements, which has been traditionally used as an anti-diabetic, blood purifier and for weight loss.

Keywords
Proximate analysis, Antioxidants, Wild vegetables, District-Kurram.

Introduction
All living creatures need food for survival. Increasing global population, the people have been suffering from malnutrition due to the unavailability of a balanced diet (1). So, wild vegetables could be a cheap and good source of energy for human beings, particularly in rural areas of the world (2, 3). Balanced food mainly depends upon the relative concentration of food supplements i.e. minerals, carbohydrates and vitamins in the diet (4). The vegetable food consumers are more than 85 - 90 % based mainly on staple food. Still, it is a fact that in many parts of the world, wild edible plants have been a greater contribution to the daily intake of food (5-8). It is estimated that more than 3,50,000 various plant species have been identified, but a limited number, around 80,000 are considered as safe for human consumption (2,
Vegetables are the edible part of plants that are used up entirely or in part either cooked as a central part of a dish or salad. Vegetables are a good and primary source of food supplements such as carbohydrates, oil, vitamins and minerals, which may or may not be obtainable in other food sources. Vegetables constitute a more significant part of daily food intake and play a prominent role in a balanced diet, which keeps a person healthy (10).

Wild edible plants can grow in natural or semi-natural environments and can exist without dependence, and autonomously of direct human action (11-13). Around the world, one billion people harvest land crops and around 3,000 species of wild plants, which have been used as wild vegetables across the globe (14-16). According to modern nutritional studies, the utilization of wild or cultivated leafy vegetables provide many health benefits, because they contain different valuable contents which are essential to human diet and in the treatment of disease as they contain vitamins, significant amount of fibers, amino acids, fatty acids and minerals (15). Wild vegetables contain different valuable contents, which is essential to the human diet and in the treatment of disease as they contain vitamins, a crucial amount of fibers, amino acids and minerals (17, 18).

According to the World Health Organization (19), minerals and essential protein deficiencies are linked to a wide variety of diseases (i.e. cardiovascular disease, diabetes, hypertensive pregnancy disorders and anaemia, premature delivery of a child, delayed sexual maturation and behavioural changes); particularly in developing and under-developed countries (15). In low-income countries, diets are dominated by a single staple food item and shared with small amounts of other food products, resulting in a monotonous diet and high risk of inadequate intake of macronutrients and micronutrients (15, 20).

In the developing world to take a balanced diet in daily routine is not easy; due to low-income, high population and living expenses. To overcome minerals and protein deficiencies in our bodies, we could easily include wild vegetables in daily consumption. The wild plants could naturally and easily be available, which are rich in carbohydrates, protein, enzymes, fibers, pigment, minerals and vitamins such as A, C, B1, B2, B6, niacin, iodine, potassium, iron, magnesium, manganese and calcium (21, 22). This is why wild plants are now consumed around the world for their nutritional value. These plants could offer an alternative ingredient compared to other foodstuffs (23). The nutritional components of wild vegetables depend upon the plant families, geography, season and climatic situation of habitat (24, 25). The aim of this research was to investigate the mineral contents and some nutritional properties of 5 uninvestigated wild plants (Stellaria media, Buglossoides arvensis, Caralluma tuberculata, Chaerophyllum reflexum and Allium griffithianum), which have been consumed as vegetables by local communities of the district of Kurram.

Materials and Methods

The determination of different nutritional parameters such as moisture content, ash%, crude fibers%, crude protein%, crude lipid%, carbohydrates%, and total energy was carried out using the methods of Association of Official Analytical Chemists method (AOAC) (26). While minerals analysis was carried out using Atomic Absorption Spectrometry (AAS): calcium, magnesium, iron, manganese, zinc, chromium, cobalt and copper were analyzed using AAS, while Sodium and potassium were analyzed by flame photometry and phosphorous was analyzed by colorimetric method.

Selected geographical region of the study

The district of Kurram is 115 km long and has a total area of 3380 sq. km, which has a unique geographical location attached by the province of Paktia, Nangarhar in the West and North, Orakzai, Khyber districts in the East and Hangu district in the South East. It is attached to North Waziristan in the south (27). The climate of the Kurram valley remains pleasant for most of the summer, but in winter, the minimum temperature drops below freezing 0 (28, 29). These climate and weather uniqueness of Kurram profoundly affects the nutritional components of the wild vegetables. The river Kurram highly promotes bountiful growth of wild plants (30, 31). However, in this district of Khyber Pakhtunkhwa, Pakistan, due to its complex geographical nature wild plants had not been widely explored for the medicinal and nutritional benefits.

Plant collection

Five wild green vegetables Allium griffithianum Boiss., Buglossoides arvensis (L.) I.M.Johnst., Caralluma tuberculata (N.E.Br.), Chaerophyllum reflexum Aitch. and Stellaria media (L.) Vill., were collected during the period of their consumption from different areas of Kurram. The plants were identified and submitted in the Department of Botany, GPGC (Government Postgraduate College) Parachinar district, Kurram.

Local consumers helped a lot in the collection of these wild vegetables investigated during fieldwork. During the specimen collection, vegetative parts were gathered for the exploration. We put all these plants in zippered bags immediately after its collection. Every specimen was recorded and labelled with a comprehensive note in a specimen collection notebook to maintain proper information labelled during the collection and processing period. Some of the selected wild vegetables for mineral and proximate compositions are shown in Fig. 1.

Sampling and Proximate analysis

Plants were washed three to four times with tap water to clean the adhering materials and placed in the shade for drying. After drying, the samples were ground into powders then packed in plastic bags. Proximate analysis was carried out according to the Association of Official Analytical Chemist method (AOAC, 2000).

Moisture content

Moisture content was determined according to the standard procedure (32). Two g of each dried sample was placed in an electric oven (Precision Thelco no 17) at 105°C for 4-6
hrs. Then transferred the samples into a desiccator and cooled it down for 20 min. Again, weighed and calculated the % moisture by the following formula,

\[
Moisture (\%) = \frac{W_{m1} - W_{m2}}{\text{Weight of sample}} \times 100,
\]

where \( W_{m1} \) is the initial weight of the sample taken for moisture measurement and \( W_{m2} \) is the weight of the sample after drying it in the oven.

**Crude fiber**

Acid and alkali digestion was used to determine the crude fiber (34). In acid digestion, 200 ml of hydrochloride (HCl) with two grams of each sample boiled on a water/steam bath at 90-95°C for half an hr. The filtrate was collected and washed with hot water until it became acid-free, using a muslin cloth. The acid-free filtrate was treated with 200 ml of 2.5% Sodium hydroxide (NaOH) (alkali digestion) and again kept on steam/water bath at the same temperature for half an hr and filtered the residue; washed thoroughly with hot water. The washed residue was transferred to the crucible to remove moisture in an oven at 105°C for 4 hrs and then cooled in a desiccator. After cooling, it was weighed (\( W_{f1} \)) and then placed in a furnace for four hours at 550-600°C until it became grey-whitish ash. Desiccator was used to cool and weight again. Following formula was used to calculate the crude fiber.

\[
\text{Crude fiber (\%)} = \frac{W_{f1} - W_{f2}}{W_{f}} \times 100
\]

where, \( W_{f} \) is the weight of the sample taken for calculating crude fiber percentage, \( W_{f1} \) is the weight of oven-dried residue and \( W_{f2} \) is the weight of residue after the furnace.

**Crude protein**

We followed the Kjeldahl method to discover crude protein.

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**Fig. 1.** Selected wild vegetables (a) Allium griffithianum Boiss (b) Buglossoides arvensis (L.) I.M.Johnst (c) Caralluma tuberculata N.E Br (d) Chaerophyllum reflexum Aitch (e) Stellaria media (L.) Vill (f) experimental laboratory.
in terms of nitrogen content (34, 35). One g of the sample, digestion mixture Potassium sulphate: Copper sulphate (K₂SO₄: CuSO₄) 7:1 of 8 g and concentrated Sulfuric acid (H₂SO₄ 12 ml) was digested on digester heater under a fume hood until the sample became clear and transparent (blue-green color). Distilled water was added to digest to make 100 ml volume.

The Kjeldahl apparatus was used to carry out the distillation of the digested sample. In this process, 10 ml of the digest sample, along with 10 ml of Sodium hydroxide (NaOH 40%), were appended. NH₃ produced in receiving flask, collected as Ammonium hydroxide (NH₄OH). Four percent (4%) Boric acid (H₃BO₃) solution of 20 ml and a meagre amount of methyl red indicator was added to the flask. As a result, the pink color of NH₄OH changed into yellowish during distillation (17).

When the pink color becomes visible, the distillate was titrated against standard zero of N (normality) HCl. A blank was also run. Crude protein was calculated as follows

\[ \text{Crude lipids} \, \% = 6.25 \times \left( \frac{S - N}{{V} \times W} \right) \times D \times 100 \]  

(Eqn. 4)

where value 6.25 represents protein conversion factor for plants; S is the sample titration reading; N is the normality of HCl; D is the dilution of the sample after digestion; V is the volume distillation.

**Crude lipids**

For the determination of crude lipids, we used Soxhlet’s apparatus. Moisture free biomass (1g) was placed in a cellulose flask in 'Soxhlet’s apparatus. One hundred ml of petroleum ether were used to carry on the extraction for 6 hrs at the 40-60 °C (2, 36). The solvents were evaporated on a rotary evaporator to remove the solvent and obtain the crude lipids. The flask was kept to cool, to weight it correctly. The contrast among in weights was expressed as % crude lipids using following formula.

\[ \text{Crude lipids} \, \% = \frac{W_{11} - W_{12}}{\text{weight of sample}} \times 100 \]  

(Eqn. 5)

where \( W_{11} \) = weight of flask with fat and \( W_{12} \) = weight of empty flask.

**Carbohydrate content (%)**

The total available carbohydrates of each sample were calculated as nitrogen-free extraction. The carbohydrates contents were found out by deducting the total amount of moisture, ash, fat, protein and fiber from 100 (AOAC) (2, 33, 34).

All the samples were run in triplicate. And all of the above contents were expressed on a dry matter basis.

\[ \text{Carbohydrates(%) } = 100 - (\% \text{ crude protein} + \% \text{ crude fat} + \% \text{ crude fiber} + \% \text{ ash content}) \]  

(Eqn. 6)

**Total energy content**

The total energy value or calorific value of the selected plants in kcal/100 g was calculated by the following formula reference by (33, 37).

\[ \text{Total energy (kcal per100g)} = (\% \text{ protein } \times 4.1) + (\% \text{ lipids } \times 9.3) + (\% \text{ carbohydrates } \times 4.1) \]  

(Eqn. 7)

As one g of protein contributes 4.1 kcal of energy, 1 g of lipids contributes 9.3 kcal energy and 1 g of carbohydrates contributes 4.1 kcal energy.

**Mineral analysis**

Before analysis, plants were oven-dried at 65 °C for a period of 72 hrs. Clean and clear polythene bags were used to store the powdered plant material. One g of each dried sample was put in the flask and digested by 12 ml of concentrated Nitric acid and left overnight. To this solution, 5 ml of per-chloric acid was added, and heated on hot plates for 20 min until the solution seems to be transparent. The sample was cooled and then filtered through filter paper No. 42. On the completion of the filtration, the filtrate was then poured into a 100 ml volumetric flask. Five samples solution were investigated for Ca, Mg, Fe, Mn, Cu, Zn, Cr, Na, K and Co elements by Atomic Absorption Spectrometers (Shimadzu AA-670). As the atom absorbed light energy of a specific wavelength, it entered from the ground state to the excited state. Quantitative determination of the amount of analyte can be made when the numbers of atoms in the light path are absorbed. Atomic absorption spectroscopy with an air acetylene flame, laminar flow burner and hollow cathode lamps are used to determine above mentioned elements using the absorption of optical radiation by free atoms in the gaseous state (37). The acid digest was sucked by means of a capillary tube into the flame. The device was set for analysis of each element by setting a light source of the desired element. The instrument calibration was performed, introducing standard and digest samples into the device (38). On-screen, the absorbance readings appeared were noted and used to calculate the concentration of each element as follows,

\[ \frac{\text{Instrumental reading} \times \text{ Dilution factor}}{\text{weight of sample}} \]

(Eqn. 8)

For phosphorus determination, the mixed reagent was made from “ammonium molybdate (6g/125 ml distilled water), sulfuric acid and antimony potassium tartrate (146/500 ml of 5N sulfuric acid)”. For the color reagent, 370 mg of ascorbic acid was dissolved in the mixed reagent. Using a spectrophotometer (Spectronic SP3000 Japan) on the basis of molecular absorption spectrophotometry (26), a standard solution was prepared from phosphorous salt. Potassium dihydrogen phosphate (KH₂PO₄), 439 mg was solvated in distilled water. The mixture was equivalent to a concentration of 100 mg/l i.e.100 ppm by a dilution formula.
We diluted the solution to 2, 4, 6 and 8 ppm and transferred 1 ml of each to 25 ml of the volumetric flask. Then, color reagent of 4 ml was added to it and by adjusting the volume with distilled water up to the mark. It was lifted until the bluish color was developed. The absorption of these solutions against the blank was determined by the spectrophotometer. These are used in the preparation of the standard curve.

The amount of phosphorous was calculated by the following formula

\[
\text{Amount of } P = \frac{\text{Graphical reading} \times \text{Dilution Factor}}{\text{weight of sample}}
\]

(Eqn. 9)

Antioxidant assays

Determination of % free radical scavenging activity (% FRSA)

The free radical scavenging activity (FRSA) of wild vegetables was assessed by monitoring their ability to extinguish stable 2, 2-diphenyl 1-picrylhydrazyl (DPPH) free radicals. A DPPH solution was prepared by dissolving 3.2 mg DPPH in 100 ml of 82% methanol. Then, 2800 μl of DPPH solution was added to glass vials followed by the addition of 200 μl of Crude methanolic extracts (CME) solution in methanol, leading to the final concentrations of 100 μg/ml, 50 μg/ml, 25 μg/ml, 10 μg/ml, 5 μg/ml, 2 μg/ml and 1 μg/ml. The mixtures were shaken and kept in the dark at a controlled room temperature (25 °C–28 °C) for one hour. Absorbance was measured at 517 nm by using a spectrophotometer (DAD 8453, Agilent). Methanol (82%) was used as a blank, while a mixture of 200 μl of methanol and 2800 μl of DPPH solution was taken as a negative control. Ascorbic acid was used as a positive control. Each test was performed in triplicate and the inhibition % was measured according to the formula given below:

\[
\% \text{FRSA} = \frac{1 - Ab/Ab_m \times 100}{Ab}
\]

Where, \( Ab \) absorbs the test sample, while \( Ab_m \) absorbs the negative control containing DPPH and methanol instead of the sample.

Total antioxidant capacity (TAC)

Phosphomolybdic acid-based chlometric assay was performed to determine the total antioxidant potential and was expressed according to the microgram equivalent of microgram acid per mg of dry plant weight (g aAE / mg DW). Each test extract contains 0.1 ml (4 mg / ml DMSO) and positive control (ascorbic acid, 4 mg / ml DMSO) to 0.9 ml reagent (0.6 M sulfuric acid, 28 mm sodium phosphate) and was mixed with (4 mm) ammonium (molybdate solution in H2O). The blank contained 0.9 ml of reagent solution and 0.1 ml of DMSO without any liqueur. All tubes were placed in a water bath for 90 min at 95 °C and then cooled to room temperature from where 200 μl of each sample was thoroughly transferred to the 96 well plates. The gravity was measured at 630 nm using a microplate reader (Biotech USA, Microplate Reader Alex 800). A calibration curve of ascorbic acid (\( y = 0.0212x + 0.0926 \), \( R^2 = 0.9913 \)) with a final number of 100, 50, 25, 12.5, 6.25, 3.12 / g / ml was prepared and the experiment was performed in a repetitive form.

Analysis and evaluation

Proper exposition of nutrient examination results cannot be achieved unless appropriate sampling methods have been used. The plant age can have a notable effect on various nutrients amount. Plant’s growth continually influences nutrient levels until it reaches its critical point. We collected the samples from a wild vegetable at its middle age before they reach their critical point of growth age. All the determination was carried out in triplicate and the results of the samples were subjected to standard error and means statistically in Microsoft software excels.
Minerals are inorganic mass found almost in every tissue of the body. Their presence is required to keep body chemicals and physical functions normal. The minerals may be macro, micro and trace. The trace minerals are needed for the body in less than a few mg per day in quantity.

Macro minerals

Calcium content

The results of the Calcium (Ca) of selected wild vegetables are shown in Table 2. They ranged from (2.195 µg/g) in Stellaria media up to (1506 µg/g) in Caralluma tuberculata which was followed by Buglossoides arvensis (459.34 µg/g), and then Allium griffithianum (405.16 µg/g), and the content of calcium in Chaerophyllum reflexum showed (19.13 µg/g).

Magnesium content

The result showed that Magnesium (Mg) ranged from (0.635 µg/g) to (368.03 µg/g) in selected samples. The maximum Mg content was reported in Buglossoides arvensis (368.03 µg/g). The remaining plants, i.e. Caralluma tuberculata show (176.45 µg/g), Allium griffithianum show (405.16 µg/g) and Chaerophyllum reflexum have (16.103 µg/g) content of Mg. The lowest Mg content was reported in Stellaria media (0.635 µg/g) as displayed in Table 2.

Phosphorous content

Phosphorous (P) is required for different functions and development in the body. From Table 2 it is clear that Caralluma tuberculata has the highest amount of phosphorous (180.01 µg/g) as compared to all others. Allium griffithianum has second-highest phosphorous content (61.26 µg/g), Buglossoides arvensis has the third (41.43 µg/g) while are the fourth-highest content followed by Stellaria media and Chaerophyllum reflexum with (2.98 µg/g).

Potassium content

The highest level (1272.06 µg/g) of Potassium (K) was in Caralluma tuberculata. The results were followed by Allium griffithianum (426.061 µg/g), Buglossoides arvensis (87.90 µg/g), Stellaria media (5.775 µg/g) while the lowest K content was found in (3.018 µg/g) in Chaerophyllum reflexum as showed in Table 2.

Micro minerals

Iron content

The highest (1050.5 µg/g) amount of Iron was recorded in Buglossoides arvensis which was followed by Allium griffithianum with (1002.021 µg/g), Stellaria media with (901.76 µg/g).
The copper content was found to be lowest in Chaerophyllum reflexum (2.10 µg/g), while the highest value contained by Caralluma tuberculata (45.88 µg/g) as shown in Table 2.

Zinc content

The result of Zinc (Zn) contents is shown in Table 2. The content of zinc ranged from (7.7 µg/g) to (0.18 µg/g). Highest zinc content (7.70 µg/g) was found in Stellaria media, while the lowest activity shown in the wild vegetables was in Caralluma tuberculata (1.28 µg/g). The DPPH radical is a stable free radical due to the presence of a delocalized reserve electron over the entire molecule which provides a characteristic absorption band at 517 nm. Highest free radical scavenging activity was shown by ethanol extract of Allium griffithianum with (45.88 µg/g) and then, Buglossoides arvensis which had (15.87 µg/g) content. Stellaria media showed (0.335 µg/g) of Cu.

Chromium content

Among the selected wild vegetables, Chromium (Cr) was present in the highest amount in Caralluma tuberculata (42.9 µg/g), then the higher value contained by Stellaria media (38.27 µg/g), which is followed by Allium griffithianum (27.604 µg/g), while Buglossoides arvensis with (6.20 µg/g) and the Chaerophyllum reflexum with (0.98 µg/g).

Cobalt content

The result showed that the Cobalt (Co) amount of these selected wild vegetables ranged from (7.7 µg/g) to (0.18 µg/g) in the selected wild vegetables. From the result, it was concluded that the highest content (7.7 µg/g) of Cobalt is present in Caralluma tuberculata while others in descending order as Allium griffithianum (3.69 µg/g), Stellaria media (2.10 µg/g), and Chaerophyllum reflexum (1.28 µg/g). The lowest content (0.18 µg/g) was observed in Buglossoides arvensis.

Manganese content

The current results showed that Manganese (Mn) concentration ranged from (10.68 µg/g) to (130.95 µg/g) in five selected wild vegetables. The highest level (130.95 µg/g) was found in Stellaria media followed by Caralluma tuberculata with (113.85 µg/g), Allium griffithianum with (96.054 µg/g) and Chaerophyllum reflexum with (17.06 µg/g). At the same time, the lowest Mn content was evident in Buglossoides arvensis (10.68 µg/g).

Copper content

It is an essential trace having fundamental importance in the establishment of red blood cells, maintaining nerve cells, and the immune system. From the result of five selected wild vegetables, the copper content was found to be highest in Caralluma tuberculata (35.06 µg/g) which was followed by Allium griffithianum (19.012 µg/g), Chaerophyllum reflexum (13.0 µg/g), Stellaria media (9.32 µg/g) and lowest in Buglossoides arvensis with (5.5 µg/g) as shown in Table 2.

Trace mineral

The Sodium (Na) contents of wild vegetables are presented in Table 2, which shows it ranged from (0.78 µg/g) in Chaerophyllum reflexum to (205.53 µg/g) in Caralluma tuberculata followed by Allium griffithianum with (45.88 µg/g) and then, Buglossoides arvensis which had (15.87 µg/g) content. Stellaria media showed (0.335 µg/g) of Na.

Antioxidant assays

Determination of % Free radical scavenging activity (% FRSA)

The percentage of free radical scavenging activity (% FRSA) of the selected wild vegetables samples, calculated by measuring the discoloration of the DPPH solution is shown in Fig. 2. The test protocol is based on the conversion of the stable purple colored DPPH radical into its diphenylpicryl yellow colored hydrazine molecule accepting electrons or hydrogen radicals from the donor antioxidant. The DPPH molecule is considered as a stable free radical due to the presence of a delocalized reserve electron over the entire molecule which provides a characteristic absorption band at 517 nm. Highest free radical scavenging activity was shown by ethanol extract of Allium griffithianum which was 44%, followed by Stellaria media 24%, Caralluma tuberculata 22%, while the lowest activity shown in the wild vegetables of Chaerophyllum reflexum 12% followed by and Buglossoides arvensis which is 18%.

![Fig. 2. Showing the %FRSA activity in selected wild vegetables.](image)
mated according to the standard methods (54, 55). In these wild vegetables all showed a significant difference among each other in the total antioxidant capacity. Among these five wild vegetables the wild vegetables *Chaerophyllum reflexum* showed the highest value that is 1.49 mg/ml followed by *Caralluma tuberculata* and then *Buglossoides arvensis* as shown in Fig 3. While the wild fruit *Allium griffithianum* showed the lowest value (0.74 mg/ml) among all five fruits followed by wild vegetable *Stellaria media*.

![Fig. 3. Showing the total antioxidant activity in selected wild vegetables.](https://plantsciencetoday.online)

### Statistical Analysis

The standard error declares the scatteredness in the proximate composition of the five selected wild vegetables. This study found the highest scatteredness in the *Caralluma tuberculata*. However, the vibration in the moisture and ash is negligible for all the 5 wild vegetables.

The scatteredness in the *Stellaria media* triplicates is higher for Co, Cr, Zn and Ca. However, the lower standard error (0.002 and 0.003 for Na and P respectively) in *Stellaria media*, reveal that all the triplicates of *Stellaria media* have almost same composition of Na and P. The three copies of *Buglossoides arvensis* show higher standard values for all the elements, other than Co, which disclose a clear difference in the composition of above mentioned elements. In the triplicates of *Caralluma tuberculata*, the composition of Mg, Fe, Cr, Na, Mn and Cu show the great difference as the standard value for these elements is high. However, the composition of K and Ca remains the same for all the triplicates as the standard error for them is lower. The standard error of elements composition in the triplicates of *Chaerophyllum reflexum* shows a higher difference in Fe and Mg. However, the composition is almost similar to all the other elements as their standard errors are negligible. For *Allium griffithianum*, the compositions of the elements in the triplicates are highly different as the standard error of Ca, Mg, K, Cr and Na are higher.

### Discussion

The current study was carried out to correlate the chemical constituents of selected wild vegetables with their beneficial uses. The selection of the wild vegetables was carried out through available literature (22, 25, 29, 33, 38 – 41). The result obtained from the proximate analysis showed that the highest moisture content was found in *Allium griffithianum* (11.85%) on a dry basis. Moisture is regarded as an important source of water. It is needed that 20% of the total consumption of water must be from food moisture (33). The moisture content observed in this study was higher than the moisture content of (22). Like moisture, the ash content is also essential biochemically. Among the selected wild vegetables, the ash content was observed high 22.77% in *Stellaria media*. The ash content of these wild vegetables was also higher than the results reported by (2, 17). The fiber content of *Caralluma tuberculata* was high at (27.36%). It plays a vital role in preventing heart attacks, obesity, intestinal cancer, serum cholesterol and hypertension (2). Traditionally *Caralluma tuberculata* was reported for the cure of diabetes, high blood pressure, intestinal cleaner and anti-rheumatic (42). The values reported during the current results were standard as compare to the reported values from different parts of Pakistan and the world, while few studies were not in line with existing results (34, 43). Agriculture is the primary source of food and income for the people of Kurram. Among the population of Kurram, 70-80% depends on wild vegetables and farm-grown crops for daily bread/income and fodder for their domestic animals. Among the tested wild vegetables, the highest crude protein was found in *Chaerophyllum reflexum* (10.5%); this result revealed that these are a good source of energy-rich compounds i.e. Protein. Leafy vegetables with high crude protein content can be used as a source of inexpensive protein (44). Protein is vital for growth, resistance to infections, replacement of used up blood and one g of protein provides about 4 kcal energy to the body (45). The data of the present work is supported by (31), who reported the protein content of the wild vegetables consumed in the Lebilem Highlands south-western Cameroon. Fat content in the diet is regarded as a major source of energy, as vegetables with fat are recommended for obesity. The higher crude fat content was reported in *Stellaria media* (4.87%), and ethnically *Stellaria media* is used as food in the rural area of the understudy. By reviewing the literature, it has been confirmed that present results are in line with (34). The present study revealed that nitrogen-free extract (NFE) was found as the main constituent of the proximate analysis of the selected wild vegetables. Due to the higher nitrogen-free extract in these species, they are considered a good source of food. The maximum carbohydrates (71.99%) were observed in *Buglossoides arvensis*. It has a specific cultural interest to present during a special religious and cultural festival of EID-e-NOWROZ and also has medicinal value as used for the cure of anaemia (29). The present results are in line with (17), whose reported carbohydrate content in wild vegetables was in the range of 52.78 to 76.34%. Higher energy values propose that these plants may be used in the formulation of various dietary supplements. The maximum amount of energy was recorded in *Buglossoides arvensis* vs. 349.024 kcal/100 g. These results are in line with (31) reported by whose results ranged from 109.78 kcal/100 g to 364.98 kcal/100 g. The standard deviation shows the scatteredness in the proximate composition of wild vegetables. The study analysis the highest deviation in the energy content and carbohydrates; however, the variation in the moisture content and ash is negligible for all the 5 wild vegetables.

The mineral composition was analyzed to find the correlations between traditional knowledge of wild vegeta-
ables and their mineral composition such as calcium, magnesium, phosphorous, potassium, iron, zinc chromium manganese, sodium and copper. The calcium concentration was found highest in *Caralluma tuberculata* (1506 µg/g). Our results are very co-related to some of the wild vegetables consumed in Nigeria and North-eastern part (a hilly and rainy area like Kurram) of the India but much higher than the vegetables consumed as food in some other part of Pakistan (36, 46, 47). Similarly, magnesium concentration was recorded maximum in *Buglossoides arvensis*, i.e. (378.03 µg/g). In the comparison of some leafy vegetables as referenced in (46), the content of magnesium in wild vegetables of Kurram was much higher. The maximum amount of phosphorous was found in *Caralluma tuberculata* (180.01 µg/g). Phosphorus is an important element that plays a role in various normal physiological functions of the body. A study from Turkey (48) reported similar phosphorus results for the same wild edible vegetables grown there. The average amount of potassium and sodium was reported in selected wild vegetable species. Both potassium and sodium ratio helps in preventing high blood pressure in the human body (49). The concentration of iron in these vegetables was found to be highest in *Buglossoides arvensis* (1050 µg/g), in the formation of hemoglobin, Iron is considered as an essential trace element. It transports oxygen to different parts of the body and guarantees a healthy immune system (50). Our results indeed agree with folk knowledge reported (29) that the *Buglossoides arvensis* is locally used in the remedy for the treatment of anaemia. The zinc content in *Caralluma tuberculata* was recorded at (49.26 µg/g). "It plays a vital role in diabetes as a cofactor for insulin but at an optimum concentration" (43), which is in line with the findings (29) that *Caralluma tuberculata* is used for diabetes in the district of Kurram. The highest amount of Cr was reported, i.e. (42.9 µg/g) in *Caralluma tuberculata*. The highest amount of the Co was also found in *Caralluma tuberculata* 7.7 µg/g. "It is an essential trace element for the human body, which is an integral part of vitamin B12 and plays a vital role in the formation of many amino acids" (51). The maximum concentration of manganese content was observed, i.e. (130 µg/g) in *Stellaria media* and it is another essential microelement for human nutrition. The highest amount of sodium was reported in *Caralluma tuberculata* (205.53 µg/g). Sodium regulates blood pressure and movement of fluid in and out of body cells. Sodium is also involved in the regulation of acid-base balance, the transport of metabolites, nerve and muscle contraction" (52). The highest content of copper was reported in *Caralluma tuberculata* (35.06 µg/g). The primary function of Cu is that it is an important component of an enzyme, which helps in the incorporation of Fe in red blood cells and prevent anaemia (53). The total antioxidant capacity record highest in the *Chaerophyllum reflexum* followed by *Caralluma tuberculata*, while *Stellaria media* showed the lowest value of antioxidant among all the 5 wild vegetables. The highest DPPH values showed by *Allium graffithianum*, while the *Chaerophyllum reflexum* showed the lowest values. The highest antioxidant activity in the wild vegetables help in the reducing oxidative stress that’s why they mostly used for the treatments of several human diseases such as diabe-

tes mellitus, chronic inflammation, atherosclerosis (54-56). The standard deviation for the mineral composition shows that there is a wide scatteredness in the composition of iron, magnesium, sodium and phosphorous in selected wild vegetables. However, the level of cobalt and copper can be considered as equal in all the wild vegetables due to the lesser deviation in the composition. This is the ever first study recording the proximate analysis as well as minerals compositions of vs. *Allium graffithianum*, *Chaerophyllum reflexum* and *Buglossoides arvensis* in Pakistan and all over the world.

**Conclusion**

The results of the current study publicize that the chosen wild vegetables, which were traditionally used for various medicinal purposes and sources of food for centuries, are a good source of food (vital nutrients and minerals) regarding human health. In the conclusion of the current study, we can say that there was a strong connection between folk knowledge and phytochemicals of the selected wild species. The current study is a basis for evidence that folk knowledge makes a significant contribution to the balance of food consumption in the district of Kurram. To meet food needs, these wild vegetables are commonly used in daily eating and need to grow them widely. These wild vegetables can ensure a balanced diet by its various species and can prevent mineral deficiencies and malnutrition. From the result, it was concluded that most of the wild edible vegetables have considerable amounts of nutritional values and commonly used in the daily diet among the rural population. These 5 wild vegetables have massive amount of minerals, crude fat, crude protein and crude fiber which are also helpful for the local people to the treatment of many diseases.

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**Authors contributions**

SA, ZM carried out the field and laboratory work and wrote the initial draft. WH supervised and designed the research project. AA and JH helped in analysis of data. NA helped in experimental work. DH helped in structured and finalized the contents of the manuscript; improved the manuscript by editing and reviewing. All authors have read and agreed to the published version of the manuscript.

**Compliance with ethical standards**

**Conflict of interest:** The authors declare that they have no conflict of interest.

**Ethical issues:** None.
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