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Nutritional prospects of some wild edible medicinal plants of District Harnai Balochistan, Pakistan

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Abstract

The aim of this research work was to evaluate the nutritional worth of some wild edible medicinal plants of District Harnai, Balochistan. Five wild edible medicinal plants (WEMPs) *viz.*, *Ficus carica* L., *Morus alba* L., *M. nigra* L., *Olea ferruginea* Royle and *Pistacia khinjuk* Stocks were collected from study area. Proximate and mineral composition of leaf and fruit samples were quantified. Proximate composition revealed that leaf samples contained significant amount of dry matter, ash and protein content in *O. ferruginea* and fat content and Crude fiber in *F.carica*, Total carbohydrates and Organic matter in *P. khinjuk* comparatively. Further data highlighted fruit samples as rich source of organic matter, fat content and total carbohydrate (*F.carica*), Dry matter (*P. khinjuk*), Ash and protein content (*M. alba*) and Crude fiber (*M. nigra*). Similarly, mineral composition revealed a wide variability of macro and micronutrients in leave and fruit samples of selected WEMPs. The overall results obtained in this study have showed that *F. carica and M. alba*. may serve as good source of many important macro-nutrients *viz.*, N, Ca, K, Mg, S and P. Whereas, *M. alba* followed by *M. nigra* may be considered as an excellent source of essential micro nutrients including Al, B, Cr, Fe, Mn, Ni, Sr and Zn. Each selected wild plant manifested variable levels of mineral and proximate compositions representing that all the investigated WEMPs are rich source of nutrients that can fulfil the needs of nutrition while *M. alba, M. nigra* and *F. carica* are rich and easily available sources of essential nutrients for human diet.

Keywords: wild edible medicinal plants; proximate analysis; elemental analysis; macronutrient; micronutrient.

Practical Application: *M. alba, M. nigra* and *F. carica* may be used as a direct organic source of supplements to accomplish nutrient deficiencies.

1 Introduction

Plants have been used from primitive time for medication of various diseases. An annual report of World Market has revealed that 43 billion dollar has been earned from medicines which have been derived from medicinal plants reported by Elisabetsky & Castilhos (1990). Moreover, traditional medicines fulfil the requirements of 75% population of Pakistan (Hocking, 1958; Qureshi et al., 2007). Therefore, growing necessity for sustainable diet needs alternative ways. The famous saying "Let food be thy medicine and medicine be thy food" by Hippocrates is gathering immense value in today's world full of diet-related health issues. These alarming health related problems calls for scientific communities across the globe to focus on natural resources and explore more opportunities in the field of food and medicine (Abdul Aziz et al., 2021). Wild edible medicinal plants (WEMPs) are one of those natural sources of food and medicine especially for rural communities that may help to provide nutritional prospects in this era of food scarcity. In this scenario, exploring nutritional composition of these wild food plants is crucial as excessive consumption of highly processed foods has deteriorated human health with over and under-nutrition indicating an urgent need to opt for more sustainable and healthier nutritional sources. Wild edible plants with their diversity thus, may be considered as one of those healthier sources to fulfil nutritional prospects (Motti, 2022). Local communities and herbal practitioners use these WEMPs in their daily routine while adapting diverse modes of utilization. Despite of their ethnobotanical value in traditional systems, their use is still restricted to some local areas. Although, these wild plants may serve as an excellent and healthy alternative source to processed and imported food (Borelli et al., 2022), their availability to global market is still limited. With their remote habitat in less disturbed area, accessibility is one major hurdle to promote these wild plants. In Pakistan, rural areas are deprived in many ways including proper educational facilities and thus, lack of knowledge regarding their own natural assets such as these wild plants is another obstacle leading to their poor marketing. Pakistan has God gifted and distinctive edaphic as well as climatic environment which has huge potential to support wild edible medicinal plants. As per reports around 600 out of 6000 species of plants are being used for medicinal purposes

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(Shinwari, 2010; Shinwari & Qaiser, 2011). About 3,000 species have been used as agricultural crops and only 150 plant species have been cultivated on commercial bases (Heywood & Skoula, 1999). Moreover, the aerial parts of wild plants are considered significant because of their uses in folk medicines. In past the pharmaceutical plants were utilized as therapies for numerous ailments. At present, researchers have been attentive to use these plants in pharmaceutical industries for drugs preparation either from individual species or mixture of plants are used to treat chronic diseases (Mohanta et al., 2003). Apart from their therapeutic properties, these wild plants may have other vital contents of diet including water, carbohydrates, minerals, fats, vitamins, proteins and essential minerals. The metabolic products of these WEMPs, if explored for their nutritional worth may serve as an equally essential food product as cultivated plants. It was further demonstrated that minerals elements present in metabolites of these wild species show active role in metabolic processes inside human body. These wild edible medicinal plants (WEMPs) thus, provide us with pharmaceutical, nutritional as well as trace elements if consumed. Therefore, may be considered as a basic nutraceutical in food and medicine industries. Each and every WEMPs plays a significant role owing to their unique chemical and elemental composition. Their deficiency therefore, may cause some abnormal developments in body (Zafar et al., 2010). Few essential elements extracted from aerial parts of these plants are used to improve elemental deficiency aiding to treat symptoms in diverse diseases. Apart from their beneficial uses, the trace elements present in wild plants may also interfere with normal body functions and may cause harmful impact on body tissues under excessive intake (Obiajunwa et al., 2002). Therefore, in order to ensure the beneficial properties of wild plants it is essential to quantify their elemental composition along with other phytochemical and nutritional analysis. The present study thus was designed to carry out proximate and elemental analyses of five ethnomedicinal plants growing wild in local area of District Harnai, Balochistan. These WEMPs were easily available in the study sites and were consumed on daily basis by local inhabitants of study area. The attempt, thus; was made to highlight nutritional availability of different primary metabolites and minerals to cope with malnutrition without further supplementation.

2 Materials and methods

2.1 Study area

The study area is Harnai District which was before Tehsil of Sibi District in Balochistan, Pakistan. The study area is located 1923,545 m above the sea level in the province of Balochistan (Tareen et al., 2016). It is encircled by mountainous ranges which include Zarghoon and Khilafat. Hanai District has an area 12,637 square km. The area has fertile land and plenty of rainfall during the monsoon season (Tareen et al., 2019). In the west of the district, Thore Shore has Juniper forests and in the North of the district, there are wild Olives which is extended from Chapper Rift to Spintangy which make a healthy ecosystem. The rangeland of Harnai, consists of bushes, grasses and shrubs, provide great opportunity for local grazers and seasonal travelers which play crucial role in local economy. The Afghan migrants and Marries from the adjacent area i.e., Spintangy, Baber Kach, Kutmandai and Kohlu graze their animals in these rangelands (Anon, 2011).

2.2 Plant sampling and processing

A total of five most common and medicinally important wild edible medicinal plants (WEMPs) *viz., Ficus carica* L., *Morus alba* L., *M. nigra* L., *Olea ferruginea* Royle. and *Pistacia khinjuk* Stocks were collected from the study area (Table 1). **The samples were collected by simple random sampling technique.** Leaves and fruits were collected, washed and then mixed separately to make a representative sample for each selected plant. Each representative sample was then immediately oven dried at 60 °C for 48 hours for moisture removal. In order to avoid any metal contamination, dried samples were manually crushed in to fine powder in a ceramic pestle and mortar, and stored in clean polyethylene containers.

Table 1. Medicinal uses wild edible plants used by local communities living in the study.

S.	Plant Name	Family Name	Local Name	Plant Part	Medicinal Uses
1	*Ficus carica* L.	Moraceae	Inzar	Leaves	The leaves are used in raw form for treatment of Anti hemorrhoid by local community
				Fruit	Fruit is eaten raw; used for improving the eye vision and latex is applied on pimples and eruptions, blood purifier, miswak and skin problems.
2	*Morus alba* L.	Moraceae	Tooth	Leaves	The leaves are used for curing of Digestion and anti-fever.
				Fruit	Dried and fresh fruit is used as food and used for stomach problem, antifertility and cough.
3	*Morus nigra* L.	Moraceae	Shahtooth	Leaves	Used for Throat ache Internal inflammation
				Fruit	The fruit is used as food, mixed in Ghee and for curing various diseases like cough, fever
4	*Olea ferruginea* Royle	Oleaceaea	Shawan	Leaves	Its leaves are used medicinally for treatment of Liver pain, flue and cough. Leaves paste is useful for mouth gums and toothache.
				Fruit	The fruit is used for Liver pain, cough and flue
5	*Pistacia khinjuk* Stocks	Anacardiaceae	Shna	Leaves	The leaves are used for Digestion and Diarrhea
				Fruit	The fruit is used for Digestion and Diarhhea

2.3 Chemical analysis

Dry and powdered leaf and fruit samples of all five selected WEMPs were subjected to various standard protocols described by, in order to evaluate their nutritional proficiency. Dry matter percentage was determined by drying leaf and fruit samples of all selected plants at 65 °C for 72 hours to obtain the dry matter for each sample. Ash was determined by incineration in a furnace at 550 °C until constant weight. Organic matter percentage was calculated by subtraction method. Protein was determined by the micro-Kjeldahl method using copper sulphate and selenium as catalysts of mineralization and boric acid as the receiver solution in the distillation of ammonia. The extraction of crude fiber was obtained by using fat free material (after digestion with the petroleum ether) or organic residue. Extraction was done by H_2SO_4 and 1.25% Na_2SO_4. The carbohydrates percentage were calculated by calculating the difference, using the Equation 1:

$$Carbohydrates\left(\%\right) = 100 - moisture\% - \left(Ash\% + Crude\ Protein\% + Ether\ Extract\%\right) \tag{1}$$

2.3 Elemental analysis

Elemental analysis was performed at the Laboratory of Pakistan Institute of Nuclear Science and Technology (PINSTECH), Islamabad. Carbon (C), Hydrogen (H) and Nitrogen (N) were quantified by organic elemental analyzer (CHNS-O) Flash 2000 Thermo-Scientific. Helium (99.99%) was used as a carrier gas and oxygen (99.99%) were used to perform oxidation. For the analysis of other elements *viz.,* Couple plasma – Optical Emission Spectrometers (ICP- OES) was adopted. All the reagents was used in the procedure were of analytical grade Hydrogenperoxide ($H_2O_2$35%; Sigma–Aldric, Germany), nitricacid (HNO_3 69%; BDH, England) and hydrochloric acid, (HCl 37%; Sigma –Aldrich,Germany). All the apparatus was washed with distilled water and 10% HNO_3. For the calibration for every element, standard elements (1000 mg/L) were used in diluted stock solution.

2.4 Statistical analysis

Analyses were carried out in triplicate. All results were expressed as means ± standard deviation. The statistical significance between plant samples was calculated by analysis of variance (ANOVA) followed by Least Significance Difference (LSD) at $P \leq 0.05$.

3 Result and discussion

Wild Edible Medicinal Plants (WEMPs) may help to provide an amazing amount of nutrition to the surrounding local communities and at very low cost due to their availability and accessibility. WEMPs provide plentiful energy as well as essential nutrients not only to human being but also may serve as a good source of nutrition to livestock (Penafiel et al., 2011; Powell et al., 2015).

3.1 Proximate analysis

The results of analysis of Proximate composition of all leaf and fruit samples are presented in Table 2 (Figure 1). In present study, the highest dry matter content in leaf samples of investigated WEMPs was determined in *Olea ferruginea* (43.61%) and significantly ($p > 0.05$) lower amounts were detected in *Pistacia khinjuk* (27.39%). On the other hand, a significant variation from 45.93% (*P. khinjuk*) to 19.36% (*O. ferruginea*) in the fruit samples. The dry matter content of plants reveals the actual quantities of various nutrients available for animal consumption (Seal et al., 2020). Investigating other wild edible medicinal plants of Balochistan, higher percentages of dry matter was reported by other researchers (Anjum et al., 2019). The ash content represents the total quantity of mineral present in a sample. It is related to the pharmacological properties present in a plant sample. That's the reason, medicinal plants always show higher ash content (Keta et al., 2018). Among investigated WEMPs, the highest level of ash content was detected in leaves of *O. ferruginea* (27.3%) and the lower was measured in *P. khinjuk* (20.4%). The ash content ranged between 33.4% to 16.4% in *M. alba* and *F. carica* respectively in fruit samples. The statistical analysis showed a significant difference (p 0.05) between highest and lowest ash level in leaves and fruits of WEMPs. The data of ash content corroborates the data for wild edible plants reported by Ullah et al. (2017) and lower than the wild edibles plants commonly consumed in other areas (Shad et al., 2013; Hussain et al., 2009). Food in daily routine providing 1-2% of its caloric energy as lipid is said to be sufficient to human body, as excess lipid consumption may cause cardiovascular disorders (Kris-Etherton et al., 2002). The lipid content in present study was reported in a range of 0.44% (*F. carica*) to 0.14% (*O. ferruginea*) in leaf samples. In the fruit samples, the lipid content of WEMPs exhibited a higher level (0.54%) in *F. carica* and lower (0.12%) in *M. alba*. Mean values in present study showed a significant variation ($p \leq 0.05$) among leaf and fruits samples of all studied WEMPs. These values reported here in this study were lower than that reported. Carbohydrates are considered as one of the most abundant compounds in living plants.

Table 2. Proximate composition of selected wild edible medicinal plants collected from Harnai, Balochistan.

S. NO.	Parameters (%)	Plants									
		O. ferruginea		*P. khinjuk*		*M. alba*		*M. nigra*		*F. carica*	
		A	B	A	B	A	B	A	B	A	B
1.	**Dry Matter**	43 ± 7.46[a]	19.36 ± 2.05[e]	27.39 ± 3.68[d]	44.93 ± 9.60[a]	33.62 ± 5.08[c]	45.93 ± 5.36[a]	39.14 ± 6.05[b]	22.93 ± 3.67[e]	34.95 ± 4.61[bc]	19.43 ± 2.08[e]
2.	**Ash Content**	27.3 ± 4.08[c]	18.2 ± 2.08f[g]	20.4 ± 3.09[e]	31.2 ± 3.03[b]	24.5 ± 4.06[d]	33.4 ± 5.11[a]	24.87 ± 4.10[d]	19.32 ± 2.05[ef]	20.11 ± 2.03[e]	16.42.74[g]
3.	**Ether Extract**	0.14 ± 0.12[g]	0.28 ± 0.05[d]	0.36 ± 0.075[c]	0.17 ± 0.03[f]	0.18 ± 0.03[f]	0.12 ± 0.03[g]	0.22 ± 0.036[e]	0.34 ± 0.046[c]	0.44 ± 0.05[b]	0.54 ± 0.046[a]
4.	**Total Carbohydrates**	27.33 ± 3.07[g]	61.73 ± 4.63[a]	51.06 ± 3.62[c]	21.34 ± 3.07[h]	40.65 ± 3.06[e]	18.14 ± 4.01[i]	34.46 ± 3.03[f]	56.8 ± 5.36[b]	43.54 ± 5.05[c]	63.28 ± 3.64[a]
5.	**Organic Matter**	38.5 ± 2.9[h]	64.5 ± 3.1[b]	56 ± 3.6[d]	43 ± 3.6[g]	51.5 ± 3.9[e]	35 ± 3.0[i]	51 ± 3.6[e]	61.5 ± 3.9[c]	45 ± 3.0[f]	71 ± 3.6[a]
6.	**Crude Fiber**	30.77 ± 5.05[cd]	48.84 ± 4.05[abd]	50.77 ± 5.02[abc]	27.27 ± 3.04[d]	41.67 ± 3.04[abc]	38.3 ± 3.63[bcd]	40.79 ± 3.66[abc]	48.91 ± 3.05[ab]	56.36 ± 3.03[a]	41.67 ± 3.05[abc]
7.	**Crude Protein**	2.63 ± 1.025[a]	0.44 ± 0.103[c]	0.79 ± 0.005[bc]	2.36 ± 1.006[a]	1.05 ± 0.004[bc]	2.80 ± 0.088[a]	1.313 ± 0.103[b]	0.610.004[bc]	0.96 ± 0.004[bc]	0.35 ± 0.004[c]

(A) Leaf samples (B) Fruit samples, Mean ± Standard Deviation, N = 3. Different alphabets/letters on data represent statistically significant interaction ($p < 0.05$) according to LSD (least significant difference) test.

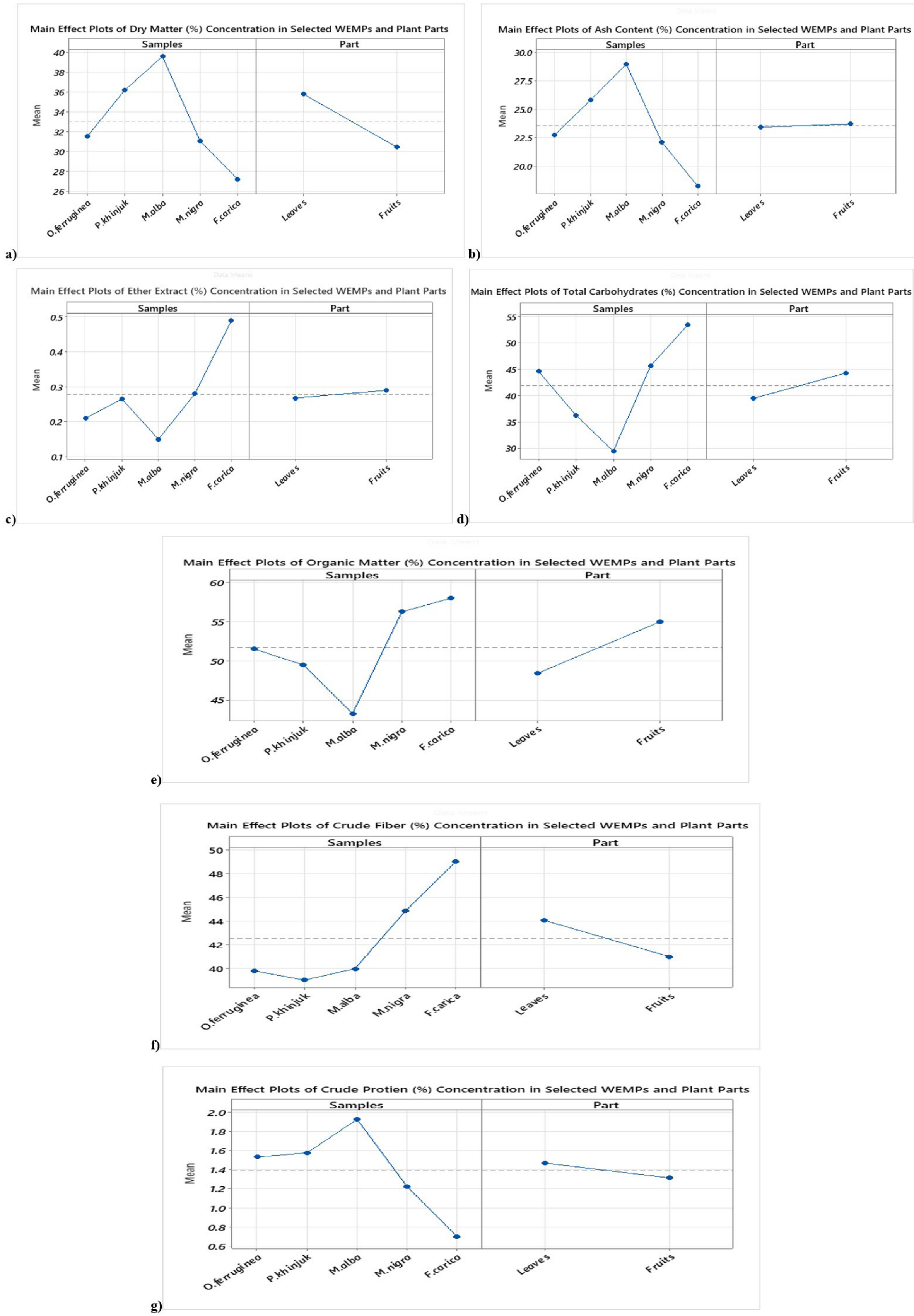

Figure 1. Main effect plots showing variation in plant samples (*O. ferruginea, P. khinjuk, M. nigra, M. alba* and *F. carica*) and parts used (Leaves, Fruits) for a) Dry matter content, b) Ash content, c) Ether extract (Crude fat), d) Total carbohydrates, e) Organic matter, f) Crude fiber, g) Crude protein.

Carbohydrates helps in energy production in the body and their deficiency may cause tissue damage inside our body (Berto et al., 2015). Leaves and fruits were also evaluated for total carbohydrate content and showed a significant difference ($p \leq 0.05$) between samples. In the plant sample of WEMPs collected from study area, the total carbohydrates ranged between 51.0% (*P. khinjuk*) to 27.33% (*O. ferruginea*) in leaf samples whereas in fruits of selected plant samples, the highest value of total carbohydrates were observed in *F. carica* (63.28%) and lowest in *M. alba* (18.14%). The higher total carbohydrate content was documented by other researchers and lower concentrations were reported by Srivastava et al., (2006). Organic matter content was measured in range between 56 and 45% in leaf samples while 71 and 35% in fruit samples of *P. khinjuk, F. carica* and *M. alba* respectively. In the current study, the mean values for organic matter content showed a significant difference ($p \leq 0.05$) between the leaves and fruits in all samples of WEMPs except for *M. alba* and *M. nigra leaf* samples. Results obtained were lower when compared with other reported wild edible plants. Fiber plays a key role in our diet for optimal health (Lattimer & Haub, 2010). According to Ishida et al. (2000), foods with high fiber content are good for diabetics, reducing blood cholesterol and obesity The maximum concentrations of crude fiber were observed in leaves of *F. carica* (56.36%) whereas the minimum value was found in *O. ferruginea* (30.77%). In the fruits of studied WEMPs, the concentrations of crude fiber were ranged from 48.01% to 27.27% in *M. nigra* and *P. khinjuk* respectively. The lower values of crude fiber were detected in previous literature (Ullah et al., 2017; Shad et al., 2013). The protein content vitally serves as building material for bones, muscles, skin, and other tissues in the body. As per reports, almost 20% of human body is protein and essentially 12% of its caloric value is provided by plants as a food source (Satter et al., 2016). In the present study, the protein content of the studied WEMPs varied from 2.63% (*O. ferruginea*) to 0.79% (0.79%) in leaf samples. The protein content in fruit samples was comparable, whereas *Morus alba* contained relatively higher amounts of protein content in their fruits (2.801%) while *F. carica* showed the lowest content (0.35%). But higher than values were reported in other wild edible plants (Shad et al., 2013). The overall proximate composition exhibited significance variation ($p \leq 0.05$) among all parameter indicating different plant species or even parts of plant may serve us with variety of nutritional contents. The difference in composition could be attributed to origin, plant species, age, ecological and climatic factors, or it can be correlated to the physiological status of the plant itself and nutrients available in the soil (Elshamy et al., 2019; Assaeed et al., 2020; Hassan et al., 2020)

3.2 Elemental analysis

Earth is a reservoir of almost 92 elements, of those 82 were documented to be used by plants during their metabolic activities (Reimann et al., 2001). In the present study, 18 elements were quantified from leaves and fruits of selected plant samples (Tables 3 and 4; Figure 2 and 3). The elements under investigation were classified into macro and micro nutrients.

Table 3. Elemental composition of selected wild edible medicinal plants collected from Harnai, Balochistan, by CHNS-O analyzer.

S.NO.	Elements	Plants									
		O. ferruginea		P. khinjuk		M. alba		M. nigra		F. carica	
		A	B	A	B	A	B	A	B	A	B
1.	**C%**	45.48 ± 0.03^{c}	52.26 ± 0.036^{b}	47.87 ± 0.05^{bc}	63.33 ± 0.05^{a}	42 ± 5.57^{c}	43.97 ± 10.01^{c}	35.9 ± 0.04^{d}	43.97 ± 0.02^{c}	32.74 ± 0.065^{d}	43.51 ± 0.04^{c}
2.	**H%**	9.05 ± 0.04^{c}	9.99 ± 0.06^{b}	6.71 ± 0.03^{h}	12.11 ± 0.02^{a}	7.15 ± 0.03^{g}	8.24 ± 0.03^{e}	6.19 ± 0.03^{i}	8.28 ± 0.036^{d}	5.44 ± 0.055^{j}	7.63 ± 0.046^{f}
3.	**N%**	1.29 ± 0.04^{e}	0.49 ± 0.072^{g}	1.25 ± 0.04^{e}	1.64 ± 0.08^{d}	6.550.1^{a}	2.42 ± 0.056^{c}	2.68 ± 0.095^{b}	1.55 ± 0.1^{d}	1.38 ± 0.07^{e}	1.14 ± 0.06^{f}

(A) Leaf samples (B) Fruit samples, Mean ± Standard Deviation, N = 3. Different alphabets/letters on data represent statistically significant interaction ($p < 0.05$) according to LSD (least significant difference) test.

Table 4. Elemental composition of selected wild edible medicinal plants collected from Harnai, Balochistan, by CHNS-O analyzer and ICP-OES.

S. NO.	Elements	Plants									
		O. ferruginea		*P. khinjuck*		*M. alba*		*M.nigra*		*F.carica*	
		A	B	A	B	A	B	A	B	A	B
1.	**Al** (µg/g)	75.22 ± 0.04^{d}	13.92 ± 0.09^{g}	92.6 ± 0.02^{d}	39.32 ± 0.09^{e}	204 ± 1^{a}	95.95 ± 1.04^{c}	171 ± 10.15^{b}	79.34 ± 8.11^{d}	174 ± 9^{b}	25.72 ± 0.14^{f}
2.	**B** (µg/g)	29.52 ± 0.12^{e}	11.18 ± 0.05^{g}	50.82 ± 2.101^{d}	0.94 ± 0.09^{e}	108 ± 2^{d}	10.48 ± 0.04^{g}	200 ± 7.21^{a}	8.64 ± 0.10^{g}	142 ± 4^{b}	24.34 ± 0.06^{f}
3.	**Ca** (µg/g)	6089 ± 8^{f}	1741 ± 7^{j}	9895 ± 5.3^{d}	1983 ± 9.53^{i}	13472 ± 6.6^{c}	3227 ± 4.58^{h}	20541 ± 5.56^{b}	3601 ± 100^{g}	25962 ± 4.4^{a}	8386 ± 9.53^{e}
4.	**Cr** (µg/g)	0.8 ± 0.04^{c}	0.08 ± 0.01^{g}	0.14 ± 0.02^{e}	0.18 ± 0.03f	0.86 ± 0.07b	0.37 ± 0.04^{e}	0.61 ± 0.6^{d}	1.13 ± 0.02^{a}	0.8 ± 0.08^{c}	0.65 ± 0.07^{d}
5.	**Cu** (µg/g)	11.1 ± 1.02^{a}	4.62 ± 0.15e	6.8 ± 0.15^{e}	7.14 ± 1.54^{bcd}	7.57 ± 0.12b	6.31 ± 0.1^{d}	7.87 ± 0.08^{b}	4.37 ± 0.10^{e}	2.78 ± 0.13^{f}	4.27 ± 0.06^{e}
6.	**Fe** (µg/g)	88.7 ± 0.15^{f}	25.36 ± 0.10^{h}	104 ± 6.24^{e}	45.390.06^{g}	290 ± 4.35^{a}	113 ± 1^{d}	191 ± 6.24^{c}	111 ± 2^{d}	234 ± 6.24^{b}	44 ± 2^{g}
7.	**K** (µg/g)	15007 ± 2^{d}	11790 ± 5.57^{g}	5383 ± 8.18^{j}	10674 ± 6.56^{h}	13550 ± 7^{e}	22840 ± 12.53^{a}	20722 ± 4.58^{b}	19027 ± 4.58^{c}	6041 ± 6.56^{i}	13527 ± 4.58^{f}
8.	**Mg** (µg/g)	1261 ± 7.54^{h}	506 ± 3^{j}	2863 ± 6.56^{e}	923 ± 4.58^{i}	3939 ± 3^{c}	2085 ± 3^{f}	4451 ± 5.57^{b}	1924 ± 4.58^{g}	8663 ± 5^{a}	3269 ± 4.36^{d}
9.	**Mn** (µg/g)	10.74 ± 0.05^{c}	4.13 ± 0.01^{d}	18.48 ± 0.05a^{b}	5.47 ± 0.09^{d}	22.08 ± 1.03^{a}	9.96 ± 0.02^{d}	18.76 ± 0.10^{c}	9.54 ± 0.10^{d}	11.55 ± 0.07^{c}	5.19 ± 0.03^{d}
10.	**Na** (µg/g)	311.48 ± 0.09^{b}	74.45 ± 0.09^{b}	84.25 ± 0.05^{b}	60.85 ± 0.11^{b}	80.2 ± 0.04^{b}	200.61 ± 0.04^{a}	55.95 ± 0.046^{b}	186.689 ± 10.15^{b}	78.58 ± 0.1^{b}	385 ± 7.55^{b}
11.	**Ni** (µg/g)	0.57 ± 0.02^{e}	0.12 ± 0.03^{f}	0.47 ± 0.06^{f}	0.37 ± 0.04^{g}	1.15 ± 0.03^{b}	0.98 ± 0.06^{c}	0.66 ± 0.09^{d}	1.35 ± 0.09^{a}	0.72 ± 0.07^{d}	0.69 ± 0.03^{d}
12.	**P** (µg/g)	858 ± 15^{e}	508 ± 3^{f}	431 ± 10^{g}	1035 ± 10.15^{d}	1537 ± 4.58^{b}	1734 ± 6.56^{a}	1151 ± 5.29^{c}	1505 ± 3.61^{b}	487 ± 9^{f}	838 ± 3.61^{e}
13.	**S** (µg/g)	821 ± 5^{bc}	248 ± 5.57^{e}	344 ± 5.57^{de}	484 ± 5.57^{c}	1346 ± 3.61^{a}	778 ± 10.54^{bc}	963 ± 7.55^{b}	593 ± 5.57^{cd}	786 ± 9.84b^{c}	839 ± 7c^{d}
14.	**Sr** (µg/g)	108.74 ± 0.1^{e}	6.19 ± 0.04^{f}	91.73 ± 0.09^{e}	14.45 ± 0.08^{f}	468 ± 9.54^{c}	122 ± 5.57^{e}	921 ± 3^{a}	100.4 ± 0.07^{e}	861 ± 4.58^{b}	352 ± 5^{d}
15.	**Zn** (µg/g)	12.8 ± 0.07^{d}	8 ± 4^{f}	8.33 ± 0.05^{f}	9.6 ± 0.05^{ef}	50.9 ± 0.06^{a}	11.8 ± 0.04^{d}	16.08 ± 0.09^{c}	17.8 ± 0.08^{b}	14.96 ± 0.02^{c}	11.4 ± 10.06^{de}

(A) Leaf samples (B) Fruit samples, Mean±Standard Deviation, N = 3. Different alphabets/letters on data represent statistically significant interaction ($p < 0.05$) according to LSD (least significant difference) test.

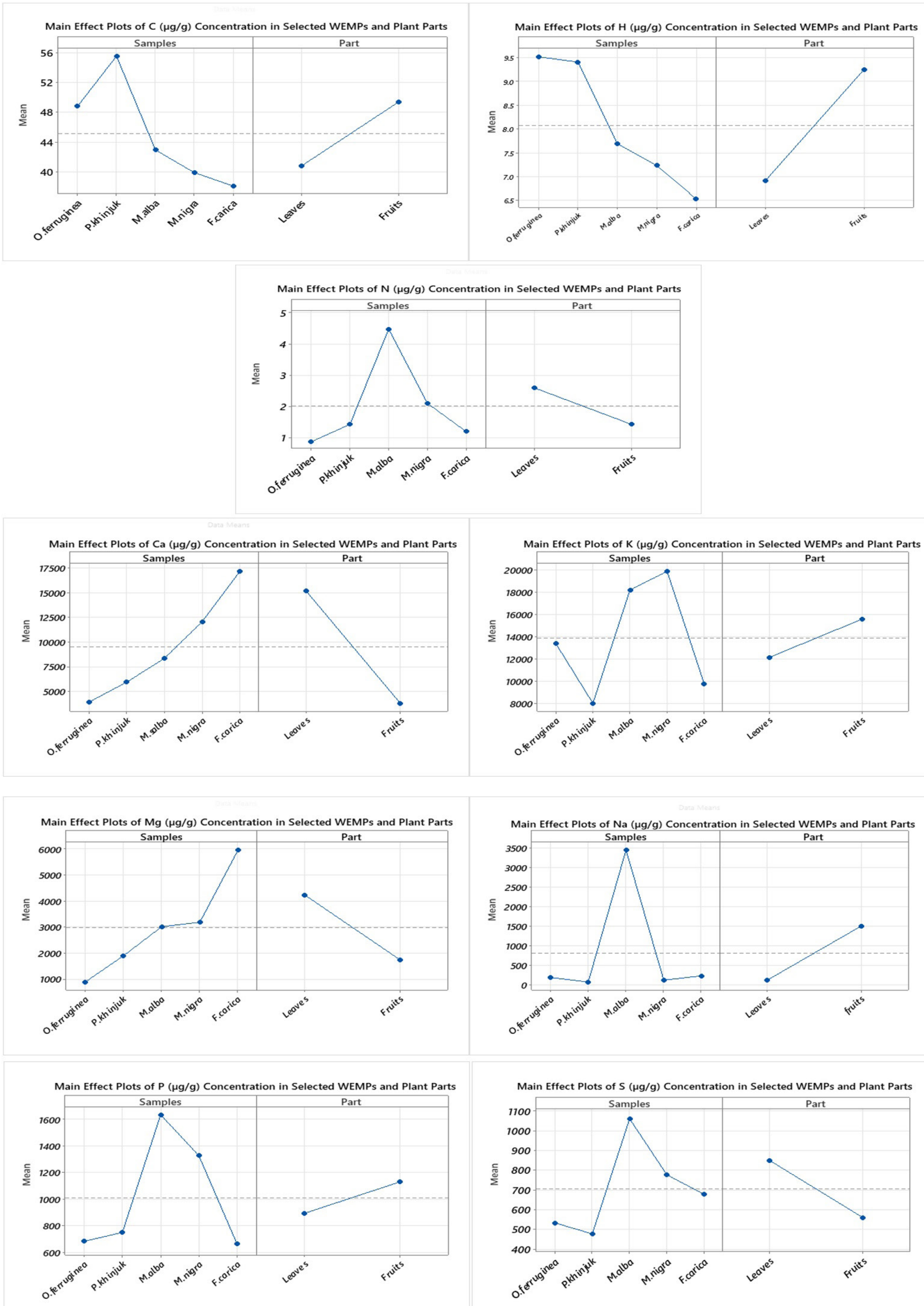

Figure 2. Main effect plots showing variation in plant samples (*O. ferruginea, P. khinjuk, M. nigra, M. alba* and *F. carica*) and parts used (Leaves, Fruits) for macro mineral *viz* Carbon (C) Hydrogen (H), Nitrogen (N), Calcium (Ca), Potassium (K), Magnesium (Mg), Sodium (Na), Phosphorous (P), Sulfur (S) analyzed by CHNS-O analyzer and ICP-OE.

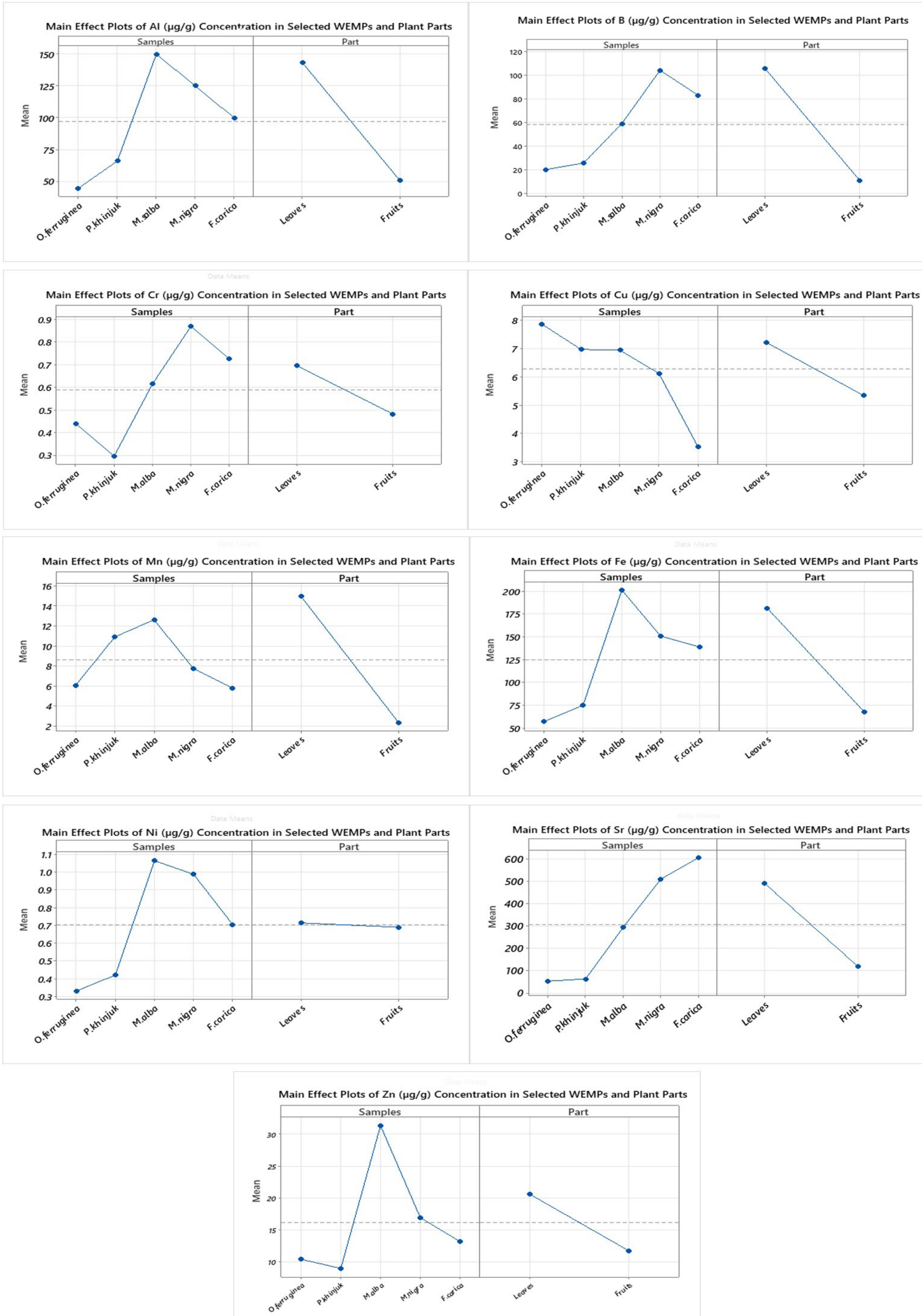

Figure 3. Main effect plots showing variation in plant samples (*O. ferruginea, P. khinjuk, M. nigra, M. alba* and *F. carica*) and parts used (Leaves, Fruits) for micro mineral *viz* Aluminum (Al), Boron (B), Chromium (Cr), Copper (Cu), Manganese (Mn), Iron (Fe), Nickle (Ni), Strontium (Sr) and Zinc (Zn) analyzed by ICP-OES.

Macro-nutrient

All life forms on earth must have to chemically balance their metabolic pathways by mediating concentration of different elements in the body for optimal growth and reproduction (Silva et al., 2015). Overall results depicted a noticeable variation in concentration of elements in selected plants species, even in studied parts of selected WEPs. Carbon (C) is devoted to perform in photosynthetic pathway and thus, considered as one crucial element in plant growth. In the current study, among selected WEMPs, *P. khinjuk* showed a higher concentration of Carbon (C) in both leaf (47.87%) and fruit (63.33%) samples whereas, in *F. carica* its concentration was found low in the leaves (32.74%) and fruits (43.51%). The obtained range in leaf samples of wild plants were in-line with the previously reported ones (Anjum et al., 2019). Further findings showed that the Hydrogen (H) content was ranged from 9.05% (*O. ferruginea*) to 5.44% (*F. caricra*) in leaf samples and were found to be significantly different ($p \leq 0.05$). Relatively lower concentration was measured in leaf samples of other wild medicinal plants of Balochistan by Anjum et al. (2019). In fruits of investigated WEMPs, it varied significantly ($p>0.05$) from 12.11% (*P. khinjuk*) to 7.63% (*F. carica*). Among macronutrients, nitrogen (N) is on major element as it is a principal constituent of almost all amino acids, proteins and co-enzymes (Mazid et al., 2011; Murchie & Niyogi, 2011). The Nitrogen (N) percentage detect in the leaves of WEMPs was 6.55% to 1.25% in *M. alba* and *P. khinjuk* respectively while in the fruits, the highest range of N was investigated in *M. alba* (2.42%) while significantly lower amounts were measure in *O. ferruginea* (0.49%). Comparatively, lower levels were found in other WEMPs (Tuğba et al., 2007). Among all selected plant species, *M. alba* showed higher concentrations of N content in leaf and fruit samples. It was evident from literature, that nitrogen may serve as a limiting nutrient for plant growth and development as, N uptake influences the uptake of other elements *viz.,* K, P, Mg, Fe, Mn and Zn (Malvi, 2011). Nonetheless, a comparable trend of interaction was observed in present study. Although, N is major element for protein formation but for plants it is merely impossible to precede the process of translation with optimum potassium (K) content, because of the fact that enzyme (nitrate reductase) which catalyzes protein formation is activated by potassium. K is also important for normal growth and muscle functioning in human as it activates several enzymes and more particularly co-enzymes during metabolic pathways (Birch & Padgham, 1994). The mean value for the Potassium (K) in the WEMPs is found higher in the leaves of *M. nigra* (20722 μg/g). The lowest concentration of K was detected in leaves of *P. khinjuk* (5383 μg/g). The K concentration was ranged between 22840 to 10674 μg/g in the fruits of *Morus alba* L. and in *P. khinjuk* respectively. The results showed a significant difference ($p \leq 0.05$) in K concentrations between leaves and fruits of all the selected WEMPs. The K concentration in WEMPs under investigation was detected lower as compare to the other already reported wild edible plants. Calcium (Ca) has great contribution in strengthening and development of healthy teeth and bones (Charles, 1992). It also has a significant role in contraction of organs, blood coagulate and various oxidative activities in human beings (Brody, 1994). The concentration of Ca was found higher in the leaves of studied WEMPs than fruits. In the leaves of the *F. carica* the highest amount of Ca was measured (25962 μg/g), while the lowest concentration was found in *O. ferruginea* (6099 μg/g). A significant difference ($p \leq 0.05$) was observed not only among the investigated WEMPs but also between their parts i.e. leaves and fruits. However, the lower mean value was also detected in other WEMPs (Renna et al., 2015). Comparatively much lower value of Ca was reported in other available literature (Ullah et al., 2017) and in the contrast to the above findings, the higher concentration of Ca was reported by Mushtaq et al. (2012). The Magnesium (Mg) contents in the leaves were ranged between 8663 μg/g in *F. carica* and 1261 μg/g in *O. ferruginea*. Similarly, in the fruits of WEMPs, the Mg concentration was detected in range of 3269 μg/g to 506 μg/g in *F. carica* and *O. ferruginea* respectively. The above results exhibit significant difference ($p \leq 0.05$) in Mg level between the leaves and fruits of investigated plants samples. The concentration was found higher when it was compared with previously reported data (Renna et al., 2015; Mushtaq et al., 2012). Contrary to that, lower Mg content was detected by Ullah et al. (2017). In the leaves of investigated WEMPs, the Sodium (Na) content was found in high concentration in *O. ferruginea* (311.48 μg/g) and in *M. nigra* (55.95 μg/g). Whereas the highest concentration was detected in the fruits of *F. carica* (385 μg/g) and the lowest level of Na was found *P. khinjuk* (60.85 μg/g). The obtained data did not exhibit a significant difference ($p \leq 0.05$) among the WEMPs except for *M. alba*. The higher values were detected by previously reported by other researchers (Mushtaq et al., 2012). Phosphorus (P) plays an essential role in the development and growth of skeletal muscles, bones, teeth, transfer of energy as well as nucleotide synthesis (Otten et al., 2006). The levels of P were detected high in the leaves of *M. alba* (1546 μg/g) whereas the lower mean value was found in *P. khinjuk* (431 μg/g). Relatively, the higher concentrations of P were ranged between 1734 μg/g to 508 μg/g in the fruits of *M. alba* and *O. ferruginea* respectively. A significant difference ($p \leq 0.05$) was detected among the WEMPs and their parts i.e. leaves and fruits. The data was in harmony with P values documented in other wild edible species. However, Koyuncu et al. (2014) also measured lower concentrations comparatively. Sulphur (S) is another very important macronutrient and a key component of amino acids including cysteine, methionine and cysteine. It is essential for the development and growth of plants (Mishra et al., 2015). The mean value for S was varied from 1346 μg/g (*M. alba*) to 344 μg/g (*P. khinjuk*) in the leaves of plant samples under investigation while in the fruits, it varied from 839 μg/g (*F. carica*) to 248 μg/g (*O. ferruginea*). The S concentrations showed a significant difference ($p \leq 0.05$) between the leaves and fruits of WEMPs. The levels of S were much lower when it is compared with other reported research work.

Micro-nutrients

Like other macro-elements, many micro elements such as Boron (B) has great role in plant metabolism. It plays vital role in plant reproduction, nitrogen fixation and development. In human body system, B plays an essential role in many biological processes ranging from antioxidant effects to anti-inflammatory activities (Khaliq et al., 2018). In this study, the concentrations of B in the leaves of WEMPs were detected higher in *M. nigra* (200 μg/g) and lower level of B was found in *O. ferruginea* (29.52 μg/g) while in the fruit samples, it ranged between 24.34 μg/g (*F. carica*) and 0.94 μg/g (*P. khinjuk*). The mean value of leaves and fruits exhibited a significant difference ($p > 0.05$). Relatively, lower levels of B were found in other WEPs (Pinedo-Espinoza et al., 2020). Copper (Cu) as an essential mineral is associated with many activities inside human tissues including cardiovascular system, neovascularization, neuroendocrine activities, lung functions, iron metabolism and optimal growth and development. Approximately, one mg of Cu is consumed by an adult in daily routine diet, of which half is absorbed by our system (Harris, 1997). In present study, Cu content ranged between 11.1 μg/g (*O. ferruginea*) to 2.78 μg/g (*F. carica*) in leaves and 7.14 μg/g (*P. khinjuk*) to 4.27 μg/g (*F. carica*) in fruit samples. The leaves and fruits samples of WEMPs showed a significant difference ($p \leq 0.05$). Comparatively, lower concentrations of Cu were reported in leaves and fruits of *M. nigra* (Koyuncu et al., 2014; Shad et al., 2013). Higher concentration ranges in wild edible plants were, also, reported (Ullah et al., 2017). Iron (Fe) is one of the important micro-nutrients which is the primary constituent of hemoglobin. It prevents anemia while its deficiency may cause several health-related problems (Kaya & Incekara, 2000). In the leaves of WEMPs, Fe concentration was found in a range of 290 μg/g (*M. alba*) to 88.7 μg/g (*P. khinjuk*). The concentration of Fe was ranged from 113 μg/g (*M. alba*) to 25.36 μg/g (*O. ferruginea*) in fruits. Relatively, higher concentration was detected in other WEMPs. However, low values for this element have been reported as well (Koyuncu et al., 2014).

Aluminium (Al) is associated in approximately 300 different chemical reactions in body. It also plays an important role in protein formation, energy metabolism and cardiac and nervous system activities (Insel et al., 2011). The concentration of Al in the leaf samples varied from 204 μg/g to 75.22 μg/g in *M. alba* to *O. ferruginea* respectively. Similarly, in fruit samples, the mean value of Al was found in higher concentration in *M. alba* (95.95 μg/g) whereas in *O. ferruginea* (13.92 μg/g) was measured in comparatively lower amounts. Chromium (Cr) is known as an essential element in several body function including fat and carbohydrate breakdown as its associated to glycide and lipid metabolism (Racek, 2003). Current study, documented the level of Cr in the leaves of WEMPs at a range of 0.86 μg/g (*P. khinjuk*) to 0.41 μg/g (*M. alba*). Whereas, in fruit samples of WEMPs, concentration of Cr was found in high concentration in *M. nigra* and it was detected in low concentration in *O. ferruginea* (0.08 μg/g). A significant difference ($p \leq 0.05$) was observed in the leaves and fruits of selected WEMPs. Comparing our results with those already reported, Cr concentration was lower in available literature (Hussain et al., 2009). In our daily life, Manganese (Mn) is another important micronutrient. Several physical activities and reactions need Mn as catalyst. It is an essential element for production of energy and synthesis of hemoglobin. It also improves the immunity (Indrayan et al., 2005). The data obtained from the leaves of investigated plants, showed the maximum mean value in *M. alba* (22.08 μg/g) and minimum level of Mn was detected in *O. ferruginea* (10.74 μg/g) whereas in the fruit samples, it ranged between 9.96 μg/g (*M. alba*) to 4.13 μg/g (*O. ferruginea*). The results obtained from the present study indicated a significant difference ($p \leq 0.05$) between the fruits and leaves in all WEMPs. These results were in-agreement with the Mn concentration range previously reported (Koyuncu et al., 2014) and disagreed with other published work on wild edible medicinal plants (Mushtaq et al., 2012; Shad et al., 2013). Like other micronutrients, Nickel (Ni) also proved as an essential element for proper functioning of the human body, as it is involved in hormonal activity and lipid metabolism. This metal makes its way to the human body through respiratory tract, digestive system and skin (Zdrojewicz et al., 2016). The results obtained from the current study showed a highest level of Nickel (Ni) concentration in the leaves of *M. alba* (1.15 μg/g) and the lowest concentration of Ni was detected in the leaves of *O. ferruginea* (0.57 μg/g) among the investigated WEMPs. Similarly, in the fruits of plant samples under investigation, the Ni concentration varied from 1.35 μg/g to 0.12 μg/g in *M. nigra* and *O. ferruginea* respectively. The level of Ni was much lower than that was documented in previous literature (Hussain et al., 2009). In metabolic pathways, Strontium (Sr) serve a trace element but it can replace calcium due to their chemical similarities. It is therefore, found to play an important role in certain physiological activities, such as muscle contraction, blood clotting, and hormones balance inside animal and human organs. The daily Sr intake is about 4 mg while grains, dairy and leafy vegetable are the main source (Kołodziejska et al., 2021). The data, from the leaves of analyzed plant sample, indicated that the Sr level was in a range of 921 μg/g (*M. nigra*) to 91.73 μg/g (*P. khinjuk*). And; when the concentration was measured for fruit samples, higher Sr levels was detected in *F. carica* (352 μg/g) and lowest value in *O. ferruginea* (6.19 μg/g). The intake of Zinc (Zn) plays indispensable role in development of stunted children. It also prevents diseases like diarrhea in childhood (Osendarp et al., 2003). The results obtained showed a Zn concentration range of 50.9 (*M. nigra*) to 12.8 μg/g (*O. ferruginea*) in leaves. For fruits, the Zn concentration was found highest in *M. nigra* (17.8 μg/g) and the lowest value in *O. ferruginea* (8.00 μg/g). A significant difference ($p \leq 0.05$) was observed in the leaves and fruits in all samples of selected WEMPs. Relatively, lower concentrations of Zn were found when it was compared with other WEMPs; (Koyuncu et al., 2014; Shad et al., 2013). In a report of FAO, the Zinc deficiency is found in about 20% of world's population. The average consumption of Zn on daily bases is lower than 70 μg/day (Brown et al., 2004). Thus, in the present, it has been revealed that *M. alba, M. nigra* and *F. carica* may serve as a rich source of essential nutrients and are easily available to the nearby rural communities. These elements are essential part of human diet and may supplement various deficiencies in human body.

4 Conclusion

Wild edible medicinal plants (WEMPs) and their traditional value as medicine and food have secured enormous value globally due to their potential against various diseases and a rich organic source of nutrition respectively. Increasing commercialization of these wild plants in the name of organic industrialization poses threats to their protection and in-situ conservation. The present study, thus, intended to explore nutritional potential of these wild edible medicinal plants (WEMPs) collected from their natural habitat. These plants are used by local people living in study area in their daily routine. Therefore, current study was destined to investigate the nutritional composition of these most commonly used WEMPs. The data for leaf and fruit parts were compiled and compared for proximate and mineral composition of these plants. Comparative data highlighted diversity and worth of each selected wild species and provided an insight of variation in nutritional value in plant parts. Proximate and mineral composition significantly varied among selected wild plants species and parts of plants viz., leaves and fruits. Overall results demonstrated that these plants may serve as a good source of protein, fat, carbohydrate and essential minerals. Therefore, can be used to get dietary supplements and bio-nutrients. The study area is a part of semi-arid region and is experiencing harsh climatic conditions. Besides, other anthropogenic activities including uprooting, over-harvesting and over-grazing etc further, intensified pressure on indigenous wild flora. Therefore, it is suggested that a suitable strategic action plan must be measured in practice for the long-term preservation of these precious wild edible plant resources along with the conservation of biodiversity in their natural habitat.

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