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Research Article

Nutritional, phytochemical and content variation of essential trace element in selected folk medicinal plants around Lahore, Pakistan

Fouzia Noreen[1*], Ashif Sajjad[2], Muhammad Tahseen Aslam[1], Saima Nazir[3], Khalil Ur Rehman[3] and Inam ul Haq[4]

1. Pakistan Council of Scientific and Industrial Research Laboratories, Islamabad, Pakistan
2. Institute of Biochemistry, University of Balochistan, Sariab Road Quetta, Pakistan
3. Pakistan Council of Scientific and Industrial Research Laboratories Complex, Ferozpur Road Lahore, Pakistan
4. Agriculture Research Institute, Sariab Road Quetta, Balochistan, Pakistan

**Corresponding author's email: fnoreen28@yahoo.com*

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Abstract

The aim of the present study was to determine the nutritional, phytochemical and trace element contents in fourteen medicinal plants used in Lahore (Pakistan) to cure a wide range of ailments. Microwave acid digestion method and flame atomic absorption spectrometry has been used to estimate the levels of four essential trace elements (iron, chromium, nickel and zinc) while muffle furnace and Kjeldahl methods were used for nutritional and phytochemical characteristics (ash, moisture, carbohydrate, crude protein, crude fats, alkaloid, flavonoid and saponin). The levels of trace elements in studied plants has shown a trend as Fe>Zn>Cr>Ni. The ash and moisture content were found to be highest in *Bambusa arundinaceae* (29.0 ± 0.03%) and *Adiantum capillus* (9.03 ± 0.41%) respectively, whereas the highest levels of carbohydrate, crude protein and crude fat were observed in *Punica granatum* (82.08±0.59%), *Pistacia lentiscus* (8.35 ± 0.01%) and *Pongamia pinnata* (2.73 ± 0.06%). In case of alkaloids, flavonoid and saponin the highest values were found in *Abroma agusta* (0.77 ± 0.01 %), *Quereus infectoria* (0.78 ± 0.02%) and *Tinospora cordifolia* (2.48 ± 0.02%) respectively followed by other plants. The present study provides baseline data on levels of essential trace elements, nutritional and phytochemical contents in medicinal plants commonly used for treating different ailments.

Keywords: Atomic absorption spectrophotometry; Medicinal plants; Microwave digestion; Nutritional values; Proximate analysis; Trace elements

Introduction

Humans depend on plants for everyday necessities like shelter, food, fiber, and medicinal uses. A number of versatile animal and human ailments are cured by using plants having therapeutic properties. Vital dietary components like fat, protein and carbohydrates significant for metabolic, morphological and physiological activities are obtained from medicinal plants **[1]**. The use of conventional medication was reduced due to the advancement in medical sciences,

discovering and developing chemically synthesized drugs with desired and instantaneous therapeutic effects [2, 3]. After understanding the therapeutic and adverse properties of synthetic drugs the people are now returning to nature i.e. to remedies related to medicinal plants. Due to presence of diverse physiological components like phytochemicals and minerals, various medicines are derived either directly or indirectly from plants. Herbal medicines are preferably used in rural regions to cure different ailments as plants are excellent source of medicines. There is an increased interest in herbal medicines in rural areas [4, 5]. Around 80 % of world's population uses its local medicinal plants to treat illnesses as observed in surveys conducted by World Health Organization.

In countries like Pakistan where medical services are inadequate in rural regions, there is a use of medicinal plants to treat diseases like malaria, diarrhea, respiratory problems diabetes and bacterial skin and fungal infections [6, 7]. The mankind uses different medicinal plants in many respects, as a food for nutritional purpose, medicine for treatment of infections, and constituent of cosmetics for maintenance of healthy skin. These plants have significant role in the regulation of various body systems. The nutritious value as well as the toxicity of the medicinal plants is due to their chemical composition [8]. All over the world interest has been increased in medicinal plant as they are confirmed source of essential bioactive compounds that cure different ailments with supreme efficacy and lower adverse effects [9-11]. The drugs derived from plants have a basic advantage that these are normally lower costs, safer and substantial healing properties [12]. Trace elements although present in reduced amount in human body, play vital roles in keeping the metabolism normal and their deficiencies cans cause long lasting harmful effects on health [13].

With the growing interest of the common people to use herbal medicines as dietary supplement, cosmetics, pharmaceuticals and health-improving items there is a dire need to quantify the mineral and micronutrient of medicinal plants. The medicinal plants are meticulously used by the general community so it is the extreme requirement of the time. Keeping in view the importance of medicinal plants researchers is paying attention to explore the chemical compositions of these plants so their impact can be known on public health. Mineral composition and nutrition value of medicinal plants used in different areas of India were also estimated [14]. Neutron activation was used for elemental characterization of medicinal plants of Romania [15]. The concentrations of macro, micro elements, phytochemicals and amino acids of medicinal plants of particular areas were determined by various scientists [16-18]. So keeping in view the importance of trace elements and phytochemical in medicinal plants the following study was designed. The aim of current study was to assess trace metal and phytochemical levels of fourteen most commonly used medicinal plant. The medicinal plants chosen for the study have been conventionally used by the local people of Lahore (Pakistan) to cure various ailments having diverse range. Such study is need of the day because the studied plants are possible source of trace elements like Zn, Fe, Cr, Ni and phytochemicals which also proven to be anti-oxidant elements. Owing to their beneficial contribution, the medicinal plants could be an excellent source of essential components based on their use to treat diverse illnesses.

Materials and Methods

Sampling

The plant material for fourteen medicinal herbs were collected from local herbal market present in Lahore Pakistan. The plants with their local, botanical names parts and the ailments for which they used are described in

(Table 1). Grinding machine was used to crush plant material and powdered samples were onward treated. Methods of Association of Official Analytical Chemists [19] were followed to process the powdered sample (3.0 g each) for the determination of studied parameters.

Table 1: Medicinal plants representing their local and botanical names and parts used

S. No.	Botanical name	Local name	Family	Parts used
1	*Nelumbo nucifera*	Kanwal	Nelumbonaceae	Seeds
2	*Acacia nilotica*	Kikar	Fabaceae	Bark
3	*Quereus infectoria*	Mezophali	Fagaceae	Bark
4	*Adiantum capillus*	Hansraj	Pteridaceae	Leaves
5	*Punica granatum*	Anar	Punicaceae	Seeds
6	*Tinospora cordifolia*	Giloo	Menispermaceae	Stem
7	*Pongamia pinnata*	sukh chane	Fabaceae	Leaves
8	*Bambusa arundinaceae*	Tabasheer	Poaceae	Gum
9	*Abroma agusta*	Olat kamble	Malvaceae	Leaves
10	*Cassia sophera*	Kasunbah	Fabaceae	Leaves
11	*Pistacia lentiscus*	Kundar	Anacardiaceae	Gum
12	*Albizzia lebbeck*	safed siris	Fabaceae	Leaves
13	*Lactuca sativa*	Kahu	Asteraceae	Leaves
14	*Juniperus communis*	Abhal	Cupressaceae	Berries

Elemental analysis

Digestion of plant materials was achieved by a domestic micro-wave oven (Dawlance, Pakistan) having a power of 900 W and can be programmed for time [20]. Flam atomic absorption spectrophotometer (Perkin Elmer model Aanalyst 800) was used to analyze the trace elements. Certified standard solutions (1000 ppm, Sigma – Aldrich, Germany) were used to prepare standard solution of respective elements. Diluted nitric acid was used to prepare working standard solutions which then stored at 4 ^{o}C in polypropylene bottles prior to analysis.

Proximate analysis

Association of Official Analytical Chemists methods were used to determine ash, moisture, carbohydrates, proteins and fats content in all plant samples. The method of Weight difference was used to determine ash and moisture. Kjeldahl method was used to determine the nitrogen value, which is then converted into protein by multiplying with a factor of 6.25. The crude lipid contents of plant samples were measured by solvent extraction (Soxhlet extraction) method. Petroleum ether (boiling range 40 - 60°C) was used as a solvent for extraction purpose. Carbohydrates in medicinal plants were determined by difference method [100 - (ash+ moisture +Protein +Fats)]. The values of proximate parameters were described in Percentage [19].

Determination of phytochemicals

Alkaloids

The plant sample in powered form was weighed (5.0 g) and mixed with 10 percent acetic acid/ethanol mixture (200 mL) and left for four hours. After filtration, water bath was used to concentrate the filtrate to which NH_4OH (concentrated) was added to complete precipitation process. The solution was then washed with dilute NH_4OH and filtered. The alkaloid content was determined by collecting, drying and weighing the residue [21].

Alkaloid (%) = (Weight of precipitate/ Weight of original sample) × 100

Flavonoid

The plant sample in powered form was weighed (10.0 g) and repeatedly extracted with 80% methanol (aqueous) for three days (100 mL/day). The filtrate was obtained after filtering the solution and transferred to a crucible for evaporation to dryness using a water bath. The flavonoid contents were estimated from the constant weight of the extracted plant material [22].

Flavonoid (%) = (Weight of dried sample /Weight of original sample × 1) × 100

Saponin

The plant material in powder form (5.0 g) was shaken with 50 mL of ethanol (20%) for thirty minutes and then heated for four hours at 55^0 C using a water bath. After filtering the mixture, the extraction process was repeated with collected residue using another 200 mL of aq. Ethanol (20%). The filtrates were concentrated to 40 mL at a temperature of 90^0 C using water bath and transferred to separating funnel, then shaking with diethyl ether, lower layer was retained while discarding the upper ether layer. The aqueous layer was shaken with 60 mL of n-butanol in using separating funnel and the extracted upper butanol layer was retained while discarding the lower layer. 10 mL of aqueous sodium chloride (5%) was used twice to wash butanol layer. The collected solution was heated and dried in an oven at a temperature of 40◦ C to get constant weight [21].

Saponin (%) = (Weight of residue /Weight of original sample) × 100 (10)

Results and Discussion

Atomic absorption spectrophotometry has been successfully used for the analysis of iron, chromium, nickel and zinc in fourteen medicinal plants and it was indicated that these four essential trace metals are commonly present in all samples and responsible for the treatment of various ailments [23-36]. Essential trace element levels along with their standard deviations are given in (Table 2). Results indicated the presence of variable levels of essential elements in these medicinal plant samples (Fig. 1). In general, the levels of essential metals in analyzed Pakistani medicinal plants has shown a trend like: Iron > Zinc >Chromium > Nickle. A significant quantity of Fe was detected in all plant samples and ranged from 35.2 mg/kg in *Juniperus communis* to 77.5 mg/kg in *Nelumbo nucifera* (Table 2). The Fe levels were comparatively variable and statistically diverse ($P < 0.001$). Iron is part of hemoglobin as well numerous human enzymes. It is a recognized essential element. High levels of Iron are present in tissues and red blood cells and anaemia is caused by its deficiency. An overdose of iron was reported to affect liver functioning [37, 38]. Based on the results portrayed in (Table 2), the lowest concentration of Cr was observed in *Lactuca sativa* (0.83 ± 0.1 mg/kg) while highest level was detected in *Adiantum capillus* (5.0 ± 0.4 mg/kg). Significant difference in the Cr levels was observed among the plants except *Adiantum capillus* and *Bambusa arundinaceae*. With various active sites and vigorous biological action Cr is a well- recognized essential trace element [39]. It acts by regulating glucose homeostasis and stimulating insulin metabolism. Diabetes is caused by Cr deficiency [40]. Analysis of Ni level shown that this element is present in extremely low quantity in all the plants investigated in current study. The range of Ni was from 0.1 up to 0.33 mg/kg (Table 2) and the highest level (0.33 ± 0.08) of this essential element was found in *Acacia nilotica*. The statistically significant Ni values were not exhibited by the investigated plants. As body requires Ni in small quantity and it generally present in pancreas. Nickel is needed for insulin production, red blood cells formation and lipid content regulation. Liver disorder is caused by Ni deficiency [41].

The concentration of Zn in the medicinal plants ranged from 12.9 mg/kg in *Cassia*

sophera to 43.4 mg/kg in *Nelumbo nucifera* (Table 2). Significant differences ($P < 0.01$) in Zn levels were investigated among the medicinal plants. Zinc has been considered to involve in cholesterol lowering and glucose metabolism. It also stimulates homeostatic control. **[42, 43].** Deficiency of zinc severely affect the central nervous, epidermal, immune, reproductive, skeletal and gastrointestinal systems. It is known that its deficiency causes impairment of tissues due to zinc-stimulated metabolic processes. So zinc is not only essential for optimum health but for life itself **[44]**.

Table 2: Concentration (mg/kg) of four essential elements in fourteen medicinal plants (n=3, mean ± SD)

S. No.	Local name	Botanical name	Essential elements (mg/kg)			
			Fe Mean±SD	Cr Mean±SD	Ni Mean±SD	Zn Mean±SD
1	Kanwal	*Nelumbo nucifera*	77.5±0.4	1.9±0.1	0.13±0.1	43.4±0.09
2	Kikar	*Acacia nilotica*	34.3.±0.3	4.5±0.2	0.33±0.08	19.2±0.1
3	Mezophali	*Quereus infectoria*	41.0±0.2	2.3±0.3	0.1±0.01	14.5±0.01
4	Hansraj	*Adiantum capillus*	56.4±0.4	5.0±0.4	0.24±0.03	27.3±0.03
5	Anar	*Punica granatum*	44±0.04	1.2±0.04	0.18±0.06	22.7±0.02
6	Giloo	*Tinospora cordifolia*	39.4±0.6	3.2±0.4	0.15±0.02	18.3±0.3
7	Sukh chane	*Pongamia pinnata*	73.1±0.7	0.96±0.02	0.12±0.01	31.6±0.04
8	Tabasheer	*Bambusa arundinaceae*	51.4±0.9	4.9±0.5	0.17±0.04	16.7±0.03
9	Olat kamble	*Abroma agusta*	43.4±0.8	1.8±0.03	0.18±0.01	31.4±0.02
10	Kasunbah	*Cassia sophera*	38.3±0.2	1.4±0.1	0.12±0.03	12.9±0.01
11	Kundar	*Pistacia lentiscus*	52.5±0.7	1.5±0.03	0.14±0.03	35.8±0.02
12	safed siris	*Albizzia lebbeck*	63.3±0.3	1.1±0.1	0.16±0.01	30.5±0.02
13	Kahu	*Lactuca sativa*	*49.0*±0.8	*0.83*±0.1	*0.14*±0.01	*23.4*±0.1
14	Abhal	*Juniperus communis*	35.2±0.08	1.1±0.02	0.04±0.01	26.7±0.01

GRAPHICAL ABSTRACT

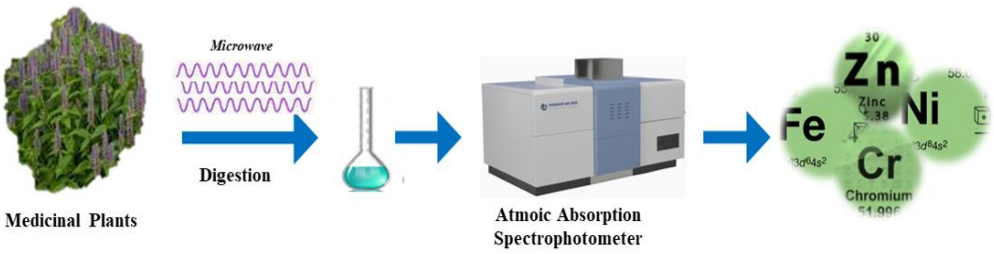

Figure 1: Showing graphical representation of elemental analysis

A comparison was made between the results obtained in present study and the values reported by other researchers. A current study in India have determined the levels of macro and micro elements [1] and their values show a similar trend for micro elements Fe (182.02- 322.38 µg/g) >Zn (18.03- 58.71 µg/g) >Cr (2.0-6.0 µg/g) as our present study. Another study in China conducted on heat relieving herbal medicines determined trace elements [13]. A similar trend was shown by that study and highest concentration of iron (87.85–1951.86 µg/g) was investigated in all herbs as determined in our study. It was demonstrated through these results that similar tendency in essential elements levels was shown by medicinal plants having diverse origins.

Another study recently conducted in kingdom of Saudi Arabia to investigate the essential element content of medicinal plants [45]. A similar trend of our study was observed with iron levels (193.4–1757.9 µg/g) being the highest among all the elements investigated. However, the levels of Fe reported from Saudi Arabia were comparatively higher than values determined in present study. A number of studies were also conducted in different regions of Pakistan (Haripur, Khushab, Kohat, Hattar etc.) to describe the elemental composition of medicinal plants [8, 46-49]. The levels of micro elements in all those studies followed a similar behaviour and trend (Fe> Zn>Cr Ni) being Fe the highest level element. It was reported that uptake of trace elements by plants was owed to the nutrient concentration which in turn reveal the accessibility of similar soil. The elemental absorption by plants dependent on numerous factors like chemical properties and soil composition. Furthermore, the uptake of micro and macro elements by the plants from soil is similar over the root system [50]. It can be inferred from current profile of essential trace elements that their values are within the permissible limits [51, 52].

Nutrient composition

The nutritional value of fourteen medicinal plant was investigated as these plants are multipurpose and used for a wide range of ailments. In recent study, the highest moisture contents were observed in *Adiantum capillus* (9.03 ± 0.41%) and lowest in *Bambusa arundinaceae* (4.61 ± 0.33%), whereas highest ash contents were present in *Bambusa arundinaceae* (29.13 ± 0.03%) and lowest in *Abroma agusta* (6.6 ± 0.36%). The highest moisture content in current study is in close agreement with moisture content (8.0%) reported formerly [53].

The mean value Observed for carbohydrates (82.08 ± 0.59%) was comparatively higher (Table 2) than the values reported earlier [54]. This proved that *Punica granatum* is rather a good source of carbohydrates.

Crude protein was found in the range of 4.43±0.03- 8.35± 0.01% in plant samples, which is lower as compared to other protein rich plants but in close agreement to the protein values earlier reported (54). Crude fat was observed highest in *Pongamia pinnata* (2.73 ± 0.06) followed by the other plants.

The highest alkaloid content was observed in *Abroma agusta* (0.77± 0.01%) and lowest in *Quereus infectoria* (0.45 ± 0.04%); highest flavanoid value was obtained for *Quereus infectoria* (0.78 ± 0.02%) and lowest for *Juniperus communis* (0.42 ± 0.01%) while highest saponin value was found in *Tinospora cordifolia* (2.48± 0.02 %) and lowest in *Nelumbo nucifera* (1.03 ± 0.01%) (Table 3). The values of alkaloids, flavanoids and saponin found in recent study are comparable to the values reported earlier [55].

Table 3: Proximate and phytochemical composition of medicinal plants

S. No.	Species Name	Moisture %	Ash %	Carbohydrate %	Crude Protein %	Crude fat %	Alkaloid %	Flavanoid %	Saponin %
1	*Nelumbo nucissfera*	7.93 ± 0.35	14.63 ± 0.04	77.28 ± 0.43	5.73 ± 0.04	2.13 ± 0.05	0.65 ± 0.04	0.64 ± 0.03	1.03 ± 0.01
2	*Acacia nilotica*	8.23 ± 0.48	23.41 ± 0.01	52.29 ± 0.92	6.44 ± 0.05	1.92 ± 0.03	0.73 ± 0.03	0.53 ± 0.01	1.58 ± 0.03
3	*Quereus infectoria*	5.32 ± 0.36	17.92 ± 0.07	42.51 ± 0.82	5.92 ± 0.05	2.33 ± 0.07	0.45 ± 0.04	0.78 ± 0.02	1.35 ± 0.02
4	*Adiantum capillus*	9.03 ± 0.41	7.4 ± 0.23	51.1 ± 0.87	7.4 ± 0.08	1.97 ± 0.04	0.63 ± 0.03	0.59 ± 0.03	1. 87± 0.03
5	*Punica granatum*	6.84 ± 0.47	21.54 ± 0.04	82.08 ± 0.59	4.43 ± 0.03	1.74 ± 0.05	0.55 ± 0.04	0.71 ± 0.01	2.24 ± 0.07
6	*Tinospora cordifolia*	5.03 ± 0.27	16.47 ± 0.34	47.31 ± 0.62	7.31 ± 0.06	2.41 ± 0.03	0.69 ± 0.02	0.67 ± 0.03	2.48 ± 0.02
7	*Pongamia pinnata*	6.83 ± 0.37	15.36± 0.26	43.74 ± 0.82	4.47 ± 0.03	2.73 ± 0.06	0.49 ± 0.04	0.59 ± 0.01	2.23 ± 0.05
8	*Bambusa arundinaceae*	4.61 ± 0.33	29.13 ± 0.03	72.32 ± 0.42	6.48 ± 0.04	1.84 ± 0.04	0.63 ± 0.03	0.68 ± 0.04	1.97 ± 0.06
9	*Abroma agusta*	5.78 ± 0.46	6.6 ± 0.36	61.83 ± 0.77	5.47 ± 0.07	1.99 ± 0.07	0.77± 0.01	0.49 ± 0.02	1.99 ± 0.08
10	*Cassia sophera*	5.3 ± 0.44	18.2 ± 0.3	73.68 ± 0.87	6.82 ± 0.09	2.11± 0.05	0.49 ± 0.03	0.65 ± 0.03	2.28 ± 0.05
11	*Pistacia lentiscus*	6.33 ± 0.07	9.4 ± 0.33	77.84 ± 0.62	8.35 ± 0.01	1.83 ± 0.03	0.61 ± 0.02	0.47 ± 0.02	1.49 ± 0.01
12	*Albizzia lebbeck*	6.81 ± 0.08	13.6 ± 0.2	63.79 ± 0.91	7.19 ± 0.02	2.16 ± 0.06	0.55 ± 0.02	0.49 ± 0.03	1.74 ± 0.02
13	*Lactuca sativa*	4.8 ± 0.01	14.6 ± 0.4	69.71 ± 0.63	6.32 ± 0.01	1.87 ± 0.01	0.71 ± 0.03	0.53 ± 0.02	2.41 ± 0.06
14	*Juniperus communis*	7.4 ± 0.04	15.5 ± 0.3	54.34 ± 0.31	5.63 ± 0.02	2.17 ± 0.07	0.59 ± 0.02	0.4 ± 0.01	1.89 ± 0.04

Conclusion

The essential trace elements profile of fourteen medicinal plants is well documented in current study. These medicinal plants are used for a range of ailments both minor as well major. So it can be concluded that all these plants contain essential trace elements which play a vital role in human body to fight against different diseases. New modern drugs can be formulated by applying different combinations of plants using data obtained in current study. As efficacy of a medicinal plant is mainly contributed both by the mineral and phytochemical compositions so detailed analysis of chemical composition of these medicinal plants is obligatory. The levels of studied elements are within the permissible limits of WHO So in terms of essential trace element Fe, Zn, Cr, and Ni these plant can also be used in food

supplement formulation and for nutritional purposes as these are good source of minerals. Preliminary information about essential trace element levels of therapeutic flora of Pakistan is provided by our baseline study. The data obtained in this study will help to understand a link between essential elements and their efficacy in local medicinal plants.

Authors' contributions

Conceived and designed the experiments: F Noreen, A Sajjad & S Nazir, Performed the experiment: F Noreen, MT Aslam, S Nazir & K Rehman, Analyzed the data: F Noreen, A Sajjad, MT Aslam & I Haq, Contributed reagents / materials / analysis: MT Aslam, S Nazir, K Rehman & I Haq, Wrote the paper: F Noreen & A Sajjad.

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