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Full Length Research Paper

Investigation of macro and micro-nutrients in selected medicinal plants

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Heavy metals contents including Fe, Zn, Ni, Cr, Pb, Cu, Cd and Ag and inorganic constituents like HCO_3^- CO_3^{-2}, Ca^{+2}, Mg^{+2}, Cl^- Na^+, K^+, SO_4^{-2}, NO_3^-, Fe^{+2} and F^- are quantitatively determined in *Citrolus colocynthis, Opuntia monocantha, Gallium apparine, Foeniculum vulgare, Equisetum arvensis, Hypericum perforatum, Carthamus lanatus* and *Cichorium intybus* collected from Khyber Pakhtunkhwa are of Pakistan using Atomic Absorption Spectrophotometer techniques. The study showed that the level of Fe was found very high as compared to Zn and Ag. In case of the inorganic constituents, the level of the components was found high except florid and potassium with very low concentration. All the parameters were found below the maximum permissible level. These results obtained from the current study are of particular importance by providing a scientific data base which will be very helpful for pharmaceutical consumption and for the local practitioners using these herbs for different types of ailments.

Key words: Medicinal plants, inorganic constituents, heavy metals, atomic absorption spectrophotometer.

INTRODUCTION

Medicinal plants have been used as herbs or traditional medicines for various types of diseases since ancient times. Recently, the use of phytotherapics is considered to be safer and congenial to the human body. Medicinal plants are used for the preparation of various modern drugs or used as the principle sources of raw materials. Phytochemical progresses have been aided enormously by the development of rapid and accurate methods of screening medicinal plants for particular chemicals. The medicinal values of these plants lie in bioactive phytochemical constituents that produce specific physiological action on the human body (Akinmoladun et al., 2007). It has been reported that out of 110 known elements, 81 are present in living organism which were then biologically classified (Qureshi, 1991-1992). The active constituents, especially inorganic elements present in plants are variable in quantity, if grown under favorable or unfavorable conditions and different type of varieties used for cultivation (Kanwal, 2002). It has been reported that whatever is taken as food could cause metabolic disturbance subject to the allowed upper and lower limits of trace metals (Prasad, 1976).

Both the deficiency and excess of essential micronutrients and trace of toxic metals may cause serious effects on human health (Underwood, 1997). WHO recommends that medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals, further it regulates maximum permissible limits of toxic metals like arsenic, cadmium and lead, which amount to 1.0, 0.3 and 10 ppm, respectively (WHO, 1989). Plants may absorb heavy metals from soil, water or air. Medicinal herbs may be

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easily contaminated during growing and processing. The ability of plants to selectively accumulate essential elements is different for different species and is subjected to certain geochemical characteristics depending on the type of soil (Bin et al., 2001).

Usually soil is subjected to contamination through atmospheric deposition of heavy metals from point sources including metalliferous mining, smelting and different industrial activities. Some other sources of soil contamination involve use of fertilizers, pesticides, sewage sludge and organic manures (Singh et al., 1997). Plants readily assimilate such elements through the roots. Metallic ions get dissolved in water and are retained.

Additional sources of these elements for plants are rainfall, atmospheric dusts and plant protection agents, which could be absorbed through the leaf blades. An important source of contamination, in vegetable crops, is considered to be the foliar uptake of atmospheric heavy metals emissions by the soil (Alim et al., 1993). In continuation to our previous studies (Iqbal et al., 2011), the present study is therefore an initiative towards the contribution for establishing scientific data base which will help humans in providing information about the concentration level of these constituents which are playing a vital role in the human body.

MATERIALS AND METHODS

Materials and reagents

The following materials, chemicals and deionized double distilled water were used throughout this work: Distilled water, closed bottles, powdered plant materials, crucibles, furnace and desiccators, plastic bottles, Whattmann filter paper 42, and HNO_3 (65%, extra pure) from Rd H Laborchemikalien, GmbH & Co., Germany.

Instrumentation

A Perkin Elmer Atomic Absorption Spectroscopy (AAS) (Model 3100) was used for measurement under standard operation condition.

Sampling area

All eight plants, *Citrolus colocynthis, Opuntia monocantha, Gallium apparine, Foeniculum vulgare, Equisetum arvensis, Hypericum perforatum, Carthamus lanatus* and *Cichorium intybus* were collected from different areas of KPK. After collecting the plant samples, they were first washed with tap water and then distilled water to remove the dust. They were dried in shade, crushed and stored for further processing.

Determination of heavy metals

1 g of the each sample was taken and after charring, the samples were kept in the furnace for 4 h at 600°C. After cooling, 2.5 ml of 6 M HNO_3 was added to each sample (Boham and Kocipai, 1994).

Determination of in organic constituents

1 g of the each sample was taken and after charring, the samples were kept in furnace for 4 h at 600°C. After cooling, the samples were filtered through Whattmann filter paper No 42 and diluted to 120 ml with distilled water. The samples were then analyzed for inorganic constituents using standard procedures. The samples were filtered and diluted each to 20 ml with distilled water. The samples were analyzed for heavy metals using Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Table 1 shows the concentration level of heavy metal in the selected medicinal plants including *C. colocynthis, O. monocantha, G. apparine, F. vulgare, E. arvensis, H. perforatum, C. lanatus* and *C. intybus.* The plants were collected from different regions of Khyber Pakhtunkhwa.

Iron

A relatively high concentration 34.85 mg kg^{-1} of iron was found in *C. lanatus* followed by *C. colocynthis* 29.55 mg kg^{-1}, while in remaining samples iron was found in the decreasing order is *F. vulgara* > *H. peraforatum* > *G. apperine* > *O. monocantha* > *C. intybus* > *E. arvensis* at 15.35, 14.35, 12.4, 8.2, 7.95, 4.7 mg kg^{-1}, respectively.

Zinc

The concentration 2.2 mg kg^{-1} of zinc was found in *C. colocynthis* followed by the *C. lanatus* 1.65 mg kg^{-1}, and *H. perforatum* 1.5 mg kg^{-1}. The remaining samples showed variable amount of 1.2 to 0.55 mg kg^{-1} in *F. vulgar, G. apparine, C. intybus, E. arvesis* and *O. monocantha*, respectively.

Nickel

In most of the samples, Ni was not detected or found below detection level. It was found only in *C. intybus* 1.7 mg kg^{-1}.

Chromium

F. vulgare gave 2.25 mg kg^{-1} of chromium while in other studied samples, the level of the Cr was below the detection limit.

Lead

The level of Pb found in the *O. monocantha* was 2.15 mg kg^{-1}, followed by *H. perforatum* 2.05 mg kg^{-1}. A similar concentration of 1.95 mg kg^{-1} was detected in *C. intybus* (Table 1).

Table 1. Concentration of the heavy metals (mg/kg).

Plant code	Fe	Zn	Ni	Cr	Pb	Cu	Cd	Ag
C. colocynthis	29.55	2.2	nd	nd	nd	0.3	nd	0.6
O. monocantha	7.95	0.55	nd	nd	2.15	nd	nd	0.55
G. apparine	12.4	1.1	nd	nd	nd	0.05	nd	0.55
F. vulgare	15.35	1.2	nd	2.25	nd	nd	nd	0.5
E. arvensis	4.7	0.75	nd	nd	nd	nd	nd	0.6
H. perforatum	14.35	1.5	nd	nd	2.05	nd	nd	0.55
C. lanatus	34.85	1.65	nd	nd	nd	nd	nd	0.6
C. intybus	7.95	0.9	1.7	nd	1.95	0.6	0.2	0.55

Nd: Not detected.

Table 2. Concentration (mg/kg) of inorganic constituents in selected medicinal plants.

Plant code	HCO_3	Ca	Mg	Hard	Cl	Na	K	SO_4	NO_3	F	TDS
C. colocynthis	190	53	18.83	210	9.9	23	1	19.2	5.8	0.07	265
O. monocantha	120	28	2.43	80	10.6	31	1	6.4	0.82	0.49	155
G. apparine	210	58	23.09	240	20	38	2	31.2	7.2	0.21	330
F. vulgare	240	70	34.99	319	23.1	26	1	21.4	16.3	0.1	393
E. arvensis	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
H. perforatum	90	20	9.72	90	14.2	9	1	6	0.604	0.18	117
C. lanatus	200	62	23.81	253	16.5	26	0	19.8	13.4	0.1	327
C. intybus	240	68	36.4	320	24	26	1	32	14.2	0.1	394

Nd: Not detected.

Copper

The concentration level of copper was not detected in most of the samples, however *C. intybus* has 0.6 mg kg^{-1}, *C. colocynthis* 0.3 mg kg^{-1}, and 0.05 g kg^{-1} was found in *G. apparine.*

Cadmium

In case of cadmium, in most of the samples, it was found below detection limit. However, it was found only in *C. intybus* 0.2 mg kg^{-1}. Table 2 shows the quantitative determination of inorganic constituents of *C. colocynthis, O. monocantha, G. apparine, F. vulgare, E. arvensis, H. perforatum, C. lanatus* and *C. intybus*. The analyzed inorganic constituents include HCO_3^-, CO_3^{-2}, Ca^{+2}, Mg^{+2}, Cl^-, Na^+, K^+, $SO4^{-2}$, NO_3^- and F^-. All inorganic constituents play a vital role both in plants and animals. Some initiates growth while the others activate enzymes. Calcium strengthens the bones while potassium activates some enzymes.

Bicarbonates

The concentration of bicarbonates was found high in *F. vulgare* and *C. intybus* 240 mg kg^{-1}, followed by *G. apparine* 210 mg kg^{-1}. In the rest of samples, the concentration level was 200, 190, 120, 113 and 90 mg kg^{-1} in *C. lanatus, C. colocynthis, O. monocantha E. arvensis, H. perforatum*, respectively.

Calcium

As can be seen from Table 2, a relatively high concentration of calcium was found in *F. vulgare* 70 mg kg^{-1} followed by *C. intybus* 68 mg kg^{-1}, *C. lanatus* 62 mg kg^{-1}, *G. aparine* 58 mg kg^{-1}, *Ccolocynatus* 53 mg kg^{-1} and *O. monocantha* 28 mg kg^{-1}, while *H. perforatum* has the lowest concentration 20 mg kg^{-1}.

Magnesium

The concentration of magnesium 36.45 mg/kg was found in *C. intybus* followed by *F. vulgare* 34 mg kg^{-1}, while *G. aparine* and *C. lanatus* have equal concentration of 23.81 mg kg^{-1}, and the rest of the plants samples have been found to contain variable amount of inorganic constitutents. The lowest concentration was found in *O. monocantha* 2.43 mg kg^{-1}.

Chlorine

The concentration level of chlorine 23.1 mg kg^{-1} was found in *F. vulgare*, followed by *G. aparine* 20 mg kg^{-1}. The rest of the samples have different amounts of Cl. The lowest amount of Cl was recorded in *C. colocynthis* 9.9 mg kg^{-1}.

Sodium

Relatively high concentration of sodium was found in *G. aparine* 38 mg kg^{-1}, followed by *O. monocantha* 31 mg kg^{-1}. *F. vulgare, E. arvensis*, *C. lanatus* and *C. intybus*, have equal concentration of 26 mg kg^{-1}. The lowest concentration of Na was found in *H. perforatum* 9 mg kg^{-1}. High concentration of Na is associated with the common disease of blood pressure while in some cases, is associated heart failure.

Potassium

Concentration of 2 mg kg^{-1} of K was found in *G. aparine* which is found to be higher among recorded samples (Table 1). The rest of the plants samples have equal concentration of 1 mg kg^{-1}. K was not detected in *C. lanatus.*

Sulphates

Relatively high concentration of sulphates was found in the *C. intybus* 32 mg kg^{-1}, followed by *G. apparine* 31.2 mg kg^{-1}*. F. vulgare, C. lanatus*, *C. colocynthis* and *O. monocantha* had concentrations of 21.4, 19.8, 19.2 and 6.4 mg kg^{-1}, respectively. *E. arvesis* and *H. parforatum* showed lowest sulphate contents 6 mg kg^{-1}.

Nitrates

Nitrates concentration was high in *F. vulgare* 16.3 mg kg^{-1}. The decreasing order of concentration level in the remaining samples were *C. intybus* > *C. lanatus* > *G. apparine* > *C. colocynthis* > *O. monocantha* > *E. arvensis* were 14.2, 13.4, 7.2, 5.8, 0.82 and 0.74 mg kg^{-1}, respectively. The lowest nitrate level was found in *H. perforatum* 0.604 mg kg^{-1}.

Fluorine

The concentration 0.49 mg kg^{-1} of fluorine was found in *O. monocantha*, followed by *G. apparine* 0.21 mg kg^{-1} and *H. parforatum* 0.18 mg kg^{-1}. The concentration of fluorine was lower in *C. colocynthis* 0.07 mg kg^{-1}.

TDS

The total dissolved solids were found high 394 mg kg^{-1} in *O. monocantha* and *F. vulgare* 393 mg kg^{-1}, while *H. perforatum* has the lowest concentration 117 mg $kg^{-1}$of TDS (Table 2).

Conclusion

From the present study, the level of heavy metal and inorganic constituents was investigated in selected plants samples, and it was found that level of most of the constituents is below the maximum permissible limit. Beside this, it is also of particular importance that scientific data for the herbal utilizers, pharmaceutical industries and local practioners can be obtained. Thus from this study, it is concluded that these herbal plants can be utilized for deficiencies of different essential macro and micro-nutrients.

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