Analysis of heavy metals in ethnic food plants using by tribals of kumaon region in Uttarakhand.

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ABSTRACT

Ethnic food plants and medicinal plants used by tribals were analyzed for their content of toxic metals like Arsenic, Cadmium, Mercury, Lead, Selenium, Zinc, Iron, Nickel, Copper and Chromium. were quantified in ethnic food plants including *Piper longum*, *Argemone mexicana,Terminalia chebula, Dioscorea bulbifera, Phyllanthus officinalis, Eleusine coracana, Rubus biflorus*, *Dolichos biflorus*, *Berberis aristata*, *Ocimum sanctum* and *Sapindus mukurossi* by using Inductively Coupled Plasma Mass Spectrometer (ICP-MS).The main purpose of this study was to document evidence of essential and non-essential toxic metals in herbs, which are extensively use for curing diseases by tribals. Some metals are also essential nutrient (Zinc, Iron, Copper, Chromium and Selenium) and only become toxic at high concentration, while others (Arsenic, Cadmium, Mercury and Lead) have no known beneficial properties and are exclusively toxic. The essentiality of trace elements as well as their biochemical and pathological significance to human and animal are well known.

Key words: Tribals, Plant species, Heavy metals, ICP-MS.

INTRODUCTION

The contribution of medicinal plants in the traditional system of medicine for curing diseases has been documented. Nowadays increased scientific interest and consumer demand have promoted the development of herbal products as dietary supplements. In view of renewed interest, oriental herbal medicines have a prominent role to play in the pharmaceutical and health markets of the 21st century (Kleinschmidt & Johnson, 1977). 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 & Reilly, 1980).

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, 1998). Medicinal herbs are easily contaminated during growth, development and processing. After collection and transformation into dosage form the heavy metals confined in plants finally enter the human body and may disturb the normal functions of central nervous system, liver, lungs, heart, kidney and brain, leading to hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancers .

Material and methods

In Uttarakhand, there are five major tribal communities, namely Bhotiya, Jaunsari, Raji and Tharu. Kumaon region is inhabited by tribes like Buksa. Buksa, Raji, Tharu and Bhotiya. Geographically the kumaon region is located between 28˚ 44" and 30˚ 49"northern latitude and between 78˚ 45" and 81˚eastern latitude. In the east, the river kali demo its border with Nepal and in the north lies the region of Kailash mansarovar in Tibet-china. To the west are the Chamoli and Pauri districts of Garhwal Division add in the south lie the Bareilly, Pilibhit, Rampur, Moradabad and Bijnor district of Uttar pradesh. The altitude of the region roughly varies between 250 meter and 7816 meter above sea level. Gomati, Saryu, Kosi, Eastern and Western Ramgangas, Kali, Gori and Dhauli are the major river of the region. The headquarters of its 6 administrative districts are Almora, Nainital, Bageshwar, Pithoragarh, Champawat and Rudrapur (Udham Singh Nagar).

Tribal communities' uses ethnic food plants in the various diseases as Meduwa or Ragi (*Eleusine coracana*) Chapaties for anemia and diabetes. Gahat (*Dolichos biflorus)* ki dal for stone treatment, Timur (*Xanthoxylum alatum*) branches are used as tooth brush and its fruits are used in gastric trouble and root of Hisalu (*Rubus biflorus*) are used in constipation.

Some plants material like *Agaves spp, Asparagus fillicinus, Bauhinia vahlii, Dioscorea bulbifera*, *Eleusine coracana*, *Malva sylvestris, Sapindus mukurossi* and *Sesamum indicum* etc. are used for washing and bathing. Different species of *Agave* are mostly used as a substitute of detergent because young shoots produce rich lather for washing. Use of Bhimal (*Grewia optiva)* as a substitute of soap is very common as the quality of its lather is very good for softening the hairs.

Collection and post harvest treatment of plant material

Experiments were carried out at Delhi Test House laboratory, Delhi. Plants were collected from natural habitat of Kumaon region. Plant parts, especially root were washed in fresh running water to eliminate dust and possible parasites and then treated with de-ionized water and were dried in shade at 25-30C. During this sample processing, necessary measures were taken in order to avoid any loss or contamination of heavy metals.

Preparation Standard and Sample solution

Prepare stock solution of 1 ppm from Certripure standard in 2% HNO3 and make the final dilutions to concentrations of 0, 1, 5, 10, 20, 50, 100 ppb to achieve a linearity of minimum of 5 points. Accurately weighed 0.500gm of crushed sample in vessels. Add 5ml HNO_3+3ml water and 2ml of 30%H_2O_2. Run the programme for 30 min. in microwave digestion system. After completed cycle the liquid sample take in 100ml volumetric flask and make up to the mark with de-ionized water.

Table-1: Heavy metal concentration in plant material collected from area under study

Plant Species	Metal Concentration(in mg/kg)									
	As	Cd	Hg	Pb	Zn	Fe	Ni	Cu	Cr	Se
Argemone Mexicana	0.117	N.D.	N.D.	0.577	86.1	168	0.292	2.41	0.324	0.4
Terminalia chebula	0.126	N.D.	N.D.	0.315	83.1	152	0.486	1.42	0.372	0.162

Dioscorea bulbifera	0.131	N.D.	N.D.	0.244	114	379	0.5	1.058	0.193	0.161
Phyllanthus officinalis	0.113	N.D.	N.D.	0.53	127	272	0.226	3.45	0.318	0.377
Piper longum	0.109	N.D.	N.D.	0.295	49.3	194	0.473	4.13	0.141	0.827
Ocimum sanctum	0.279	N.D.	0.144	0.651	126	325	0.289	6.39	0.13	1.42
Sapindus mukurossi	0.024	ND.	0.141	0.437	228	152	0.361	0.602	0.678	1.32
Eleusine coracana	0.036	N.D.	N.D.	0.184	166	378	0.085	4.5	0.032	10.82
Rubus biflorus	0.136	N.D.	N.D.	0.168	68.6	200	0.249	1.13	0.2	0.21
Dolichos biflorus	0.136	N.D.	N.D	0.268	53.1	220	0.33	0.562	0.413	0.163
Berberis aristata	0.142	N.D.	N.D	0.265	218	352	0.321	2.02	0.216	0.217

Result and Discussion

The chemical constituents in plants, including metal ions, are partially responsible for their medicinal and nutritional properties as well as the toxic ones. As trace elements they are important metabolic products for the plants cells and also play an important role in the plant metabolism and biosynthesis as cofactors for enzymes. Plants can accumulate metals in both the root and the above ground organs and transfer heavy metals pollutants from soils into the food chain. This accumulation is one of the most serious environment concerns of the present day, not only because of the phytotoxicity of many of these metals, but also because of the potential harmful effects that toxic metals could have on animals and human health. In protecting the public from hazards of these metals, the monitoring of heavy metals in medicinal and edible plants is therefore of great importance. Some metals are also essential nutrient (Zinc, Iron, Copper, Chromium and Selenium) and only become toxic at high concentration, while others (Arsenic, Cadmium, Mercury and Lead) have no known beneficial properties and are exclusively toxic. The essentiality of trace elements as well as their biochemical and pathological significance to human and animal are well known.

These plants available in kumaon region were analyzed for their content of the heavy metals, Arsenic (as As), Cadmium (as Cd), Mercury (as Hg), Lead (as Pb), Chromium (as Cr), Nickel (Ni), Zinc (as Zn), Copper (as Cu) and Iron (as Fe). The main purpose of this study was to document evidence of essential and non-essential heavy metals in herbs, which are extensively used for curing diseases by tribal people in Kumaon region.

The concentration of As, Cd, Hg, Pb, Zn, Fe, Ni, Cu, Se and Cr in used medicinal are appended (Table 1). As evident from this table, maximum concentration of Fe was found in *Dioscorea bulbifera 379ppm, Eleusine coracana 378ppm, Berberis aristata 352ppm, Ocimum sanctum 325ppm, Emblica officinalis 272ppm, Dolichos biflorus 220ppm, Rubus biflorus 200ppm, Argemone maxicana 168ppm, Sapindus mukurossi 152ppm*. Iron concentration is high in all plants. Iron is an essential element for human beings and animals and is an essential component of hemoglobin. It facilitates the oxidation of carbohydrates, protein and fat to control body weight, which is very important factor in diabetes. Results in table 1 reveal that maximum concentration of Iron was found in *Dioscorea bulbifera 379ppm.*

The results suggest that high amount of Fe in plants may also be due to absorption from the surroundings. Low contents causes' gastrointestinal infection, nose bleeding and myocardial infarction (Hunt, 1994).

Zinc

As evident from table-1 high concentration of Zn was found in *Sapindus mukorossi, Berberis aristata, Eleusine coracana, Emblica officinalis, Ocimum sanctum, Dioscorea bulbifera, and Argemone mexicana* in following amount 228, 218, 165, 127, 125, 114, 86.1ppm respectively. Zinc is an essential trace element for plant growth and also plays an important role in various cell processes including normal growth. In human beings it is responsible for brain development, behavioral response, bone formation and wound healing. Zinc deficient diabetics fail to improve their power of perception and and also causes loss of sense of touch and smell (Hunt, 1994). The dietary limit of Zn is 100ppm (Jones, 1987)

Nickel

In case of Ni the concentration in different plants was in the order of *Dolichos biflorus* 0.562ppm, *Dioscorea bulbifera 0.500ppm, Terminalia chebula 0.486ppm, Emblica officinalis 0.473ppm,* and *Sapindus mukurossi 0.361ppm*. The higher concentration of Ni in plants may be due to its presence in soils and rocks. The most common ailment arising from Ni is an allergic dermatitis, known as nickel itch, which usually occurs when skin is moist, further more Ni has been identified as a suspected carcinogen and adversely affects lungs and nasal cavities. Although Ni is required in minute quantity for body as it is mostly present in the pancreas and hence plays an important role in the production of insulin. Its deficiency results in the disorder of liver (Pendias & Pendias, 1992). EPA has recommended daily intake of Ni should be less than 1mg beyond which it is toxic (McGrath & Smith, 1990).

Copper

Although Cu is an essential enzymatic element for plant growth and development but can be toxic at excessive levels phytotoxicity can occur if its concentration in plants is higher than 20-100ppm (dry weight). As can be seen from the data (Table-1) high concentration of Cu was found in *Ocimum sanctum 6.39ppm, Eleusine coracana 4.5ppm, Piper longum 4.13ppm, Emblica officinalis 3.45ppm, Argemone mexicana 2.41ppm,* The concentration of Cu in the selected herbs is high but it is beyond the critical level in plants (Kaplan et al.,1993). High levels Cu may cause metal fumes fever with flue like symptoms, hair and skin discoloration, dermatitis, irritation of the upper respiratory tract, metallic taste in mouth. WHO (1996) has recommended the lower limit of the acceptable range of Cu as 20ug/mg body weight per day (FDA & Waston, 1993). Copper deficiency results in anemia (Gupta, 1975).

Chromium

The concentration of Cr (Table-1) found in different plant was in the tune of *Sapindus mukurossi 0.678ppm, Dolichos biflorus 0.413ppm, Terminalia chebula 0.372ppm, Argemone mexicana 0.324ppm, Emblica officinalis 0.318ppm and Berberis aristata 0.216ppm*. The higher concentration of Cr found in *Sapindus mukurossi* but blow the critical level 5.30ppm, could be a probable cause for yields reduction with the exception of fall out of atmospheric pollutants through rain and accumulation in plant, it is probable that the metal was translocated through air dust blowing from nearby. The toxic of Cr intake rash, nose irritation bleeds, upset stomach, kidney and liver damage, nasal itch and lungs cancer, chromium deficiency is characterized disturbance in glucose lipid and protein metabolism (McGarth & Smith,1990). The daily intake of Cr 50-200μg has been recommended for adults by US National Academy & Science (Waston, 1993).

Conclusion

Arsenic, Cadmium, Mercury and Lead are non-essential trace elements having function neither in human body nor in plants. They induce various toxic affects in humans at low doses. The typical symptoms of lead poisoning are colic anemia, headache, convulsions and chronic nephritis of the kidney, brain damage and central nervous system disorders. Cadmium accumulates in human body and damages mainly the kidneys and liver. WHO (1998) prescribed limit for Pb contents in herbal medicine is 10ppm while the dietary intake limit for Pb is 3mg/week. The lowest level of Cd which can cause yield reduction is 5-30ppm, while the maximum acceptable concentration for food stuff is around 1ppm (Neil, 1993).

We found Arsenic and Lead in all samples but within limit and Mercury detected in two samples, Tulsi (*Ocimum sanctum*) collected from Buxa village Etuwa and Reetha (*Sapindus mukurossi*) collected from Raji village Kimkhola Cadmium was not detected in any species. All the heavy toxic elements were within international permissible limits (Table 1). This indicates that these toxic minerals are not in ecosystem.

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