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Evaluation of heavy metals in herbal plants growing in Singrauli Region of Madhya Pradesh

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Abstract
Popularity of herbal drugs is increasing all over the world because of lesser side effects as compared to synthetic drugs. Besides, it costs less and easily available to poor people particularly in developing countries. But quality assurance of herbal drugs is very necessary prior to its use. Because in today polluted environment, even herbal drugs are not safe. The quality and safety of herbal drugs is becoming a major concern worldwide particularly due to contamination by heavy metals. The amount of heavy metals in the plants was analyzed to show the potential threat of their effects to the animals and human beings who consume them as such or their derived products. The work is much more beneficial as the actual nutrient content of the medicinal plants in terms of the essential trace elements could also be identified. The concentration levels (mg/kg) of the selected trace metals (Pb, Cd, Cu, Cr, Fe, Ni and Zn) were estimated in some of the important herbal plants of the Singrauli region. The atomic absorption spectrophotometer was employed for the estimation of heavy metals of three different plant species that were collected from different locations within Singrauli region. The plants selected for the analysis were *Zingiber officinale* (Ginger), *Amorphophallus paeoniifolius* (Suran) and *Cuminum Cyminum* (Cumin). The metal contents in the samples were determined and were found that there is no cadmium, chromium, lead and nickel in plant samples. The results show that *Zingiber officinale* has the level of metals in the range of Fe>Zn>Cu, *Amorphophallus paeoniifolius* Fe>Zn>Cu and *Cuminum Cyminum* Fe>Zn>Cu. Plants absorb heavy metals from the environment and can therefore be used as an indicator of environmental pollution.

Keywords: Heavy metals, *Zingiber officinale*, *Amorphophallus paeoniifolius*, *Cuminum Cyminum*, atomic absorption spectrophotometer, herbal drugs

Introduction
The quality and safety of herbal medicines are major concerns worldwide due to increasing heavy metal contamination resulting from anthropogenic activity. Adverse effects of herbal medicines contaminated with heavy metals are well documented [1, 3]. In India and others country cases of metal poisoning associated with the use of traditional medicines are common, with arsenic (As), chromium (Cr) and magnesium (Mg), the most frequently implicated metals resulting in poisoning, morbidity and mortality [4]. Thus, the screening of traditional medicines for potentially harmful components has been recommended to protect consumers [5]. Some medicinal plants have the ability to accumulate heavy metals when grown in contaminated soils. The addition of heavy metals in herbal medicinal products through deceitful practices such as adulteration for alleged increase in therapeutic properties is also well documented [1, 6, 7]. Thus stringent legislation on the production and processing of herbal medicine as well as detailed information on herbal products is of paramount importance to protect consumers. One of the most common practices in India and others country is the collection of medicinal plants from wild populations [8]. This not only threatens the ecological balance but also leads to safety concerns as a result of heavy metal contamination arising from industrial encroachment. The source and quality of raw materials as described in good agricultural and collection practices (GACP) and good manufacturing processes (GMP) are essential steps for quality control of herbal medicine. Thesewill play a pivotal role in guaranteeing the quality and stability of herbal products [18]. According to WHO 2007 [10], the concentration of trace elements must be controlled in medicinal plants in order to meet and improve quality assurance and safety. Heavy metal contaminations in medicinal plants affect the phytochemical composition as well as the biological activities and thus influence the efficacy of medicinal plant products [11].

Zahid *et al*. 2011 [12] reported that the presence of heavy metals in the medicinal plant *Marsilea minuta* reduced antimicrobial activity by two possible mechanisms either by changing the amounts of bioactive compounds in the plants or by deactivating the bioactive compounds through chelation of metal ions. There is insufficient information linking the quality, safety concerns and efficacy measures with regard to heavy metals in Indian medicinal plants. The aim of this study were estimated the concentration levels (mg/kg) of the selected trace metals (Pb, Cd, Cu, Cr, Fe, Ni and Zn) in some of the important herbal plants of the Singrauli region. The atomic absorption spectrophotometer was employed for the estimation of heavy metals of three different plant species that were collected from different locations within Singrauli region.

Materials and Methods

Collection of samples

The plant samples *Zingiber officinale*, *Amorphophallus paeoniifolius* and *Cuminum Cyminum* is the widely cultivated in numerous private home-gardens and farms within different area of Singrauli. The rhizomes of *Zingiber officinale*, *Amorphophallus paeoniifolius* and seeds of *Cuminum Cyminum* were carefully collected, labeled and stored accordingly.

Washing and Grinding of samples

After collection, the samples were brought to the laboratory and processed for further analysis. Samples of plants were properly separated and washed to remove dust particles. Samples were then chopped into small pieces using a knife. Plant sample were air-dried and then dried in an oven at 35 °C. Dried samples were grinded into a fine powder (80 mesh) using a mechanical electrical blender and stored in sterilized poly bags, until used for acid digestion with labeling.

Acid digestion

Heavy metals in plants samples were extracted following acid digestion procedure in which 2g of the dry weight of each sample were taken in conical flask and add 10ml of 98% nitric acid and cover the lid. The mixture was allowed to cold soak for 30 mins. Steadily raised the temperature to 120 ºC and heated for 2 hrs. Digestion was completed, with pale yellow color. A solution was makeup to 25ml with deionized water. Filtered the solution and washed the beaker with another 25 ml aliquot of water and filter. Transfer this solution to 100 ml volumetric flask and dilute to the mark. The prepared samples solution were analyzed for lead, copper, cadmium, nickel, Cr, zinc, iron, using atomic absorption spectrophotometer (ECIL AAS). A certified standard reference material was used to ensure accuracy and the analytical values were within the range of certified value. Blank and standards were run after five determinations to calibrate the instrument.

Preparation of working standards

Standard solutions of all the metals were prepared by diluting AAS standard solutions (ppm) of Pb, Cd, Cu, Cr, Fe, Ni and Zn. 0.1ml of each standard solution was taken in 100ml flask and made upto the mark with HNO_3.

Results and Discussions

The medicinal plants are destroyed and contaminated by various factors, such as environmental pollution, soil harvesting, microbial growth and introduction of toxic metals. The ingredients of plants include metal ions which are responsible for nutritional as well as medicinal usage [13]. Heavy metals like zinc, iron, copper, and nickel are essential for proper body function and become toxic when they exceed the recommended level and cause various chronic and acute effects in the living organisms [14] whereas, the metals like lead, chromium and cadmium are non-essential and are toxic in nature even in the trace amount [15]. Thus, due to the hazardous affects as well as antibiotic resistance to the synthetic drugs, researchers are trying to obtain the antimicrobial drugs from medicinal plants due to their non-toxic nature and less side effects [16]. In spite of all the progress in the field of allopathic drugs, the traditional medicines, particularly plant-based medicines, also have a key role. Many studies have shown that crude extracts of medicinal plants as well as the pure bioactive components can act as good therapeutic agents [17]. Heavy metals present in selected plant samples were analyzed. 7 elements analyzed, and the values are expressed in units of mg/kg. The results of seven different elements shown in Table 2 and indicate that there is no cadmium, chromium, lead and nickel in plant samples. The cadmium (Cd) is very toxic, non-essential and the accumulation of cadmium may damage the kidneys. According to the WHO, the recommended level of Cd is 0.02 mg/kg in plants [18]. The results show that in ginger, suran and cumin, the concentration of zinc (Zn) is below the detection limit. The ginger (rhizome) contain 22.45 mg/kg, suran (rhizome) 40.475 mg/kg, and cumin (seed) 38.55 mg/kg for the mean concentration of Zn respectively, which are below the standard recommended level. According to the WHO, the maximum permissible limit of Zinc in plants is 50 mg/kg Table 1, while its recommended level for mankind is 45 mg/day [18]. The results illustrate that the maximum amount of iron present in the cumin (seeds) 201.775 mg/kg, followed by suran (rhizome) 164.275 mg/kg, and ginger (rhizome) 94.625 mg/kg, is beyond the maximum permissible value. According to the WHO, the maximum permissible limit of iron in plants is 20 mg/kg, while its daily requirement is 10 to 28 mg/day [18]. The results further show that the high concentration of copper (Cu) was found in cumin (sseds) 13.675 mg/kg, which are beyond the maximum permissible limit as recommended by the WHO. According to the WHO, the maximum permissible limit of Cu in plant is 10 mg/kg [18]. The concentration of Cu was found in ginger (rhizomes) and suran (rhizomes) 8.025 and 7.7 mg/kg, which are below the maximum permissible level.

Table 1: Permissible limit of plant

Elements	Permissible value of plant (mg/kg)
Cd	0.02
Zn	50
Cu	10
Cr	1.30
Pb	2
Ni	10
Fe	20

Table 2: Heavy metals concentration in plant sample (mg/kg)

Heavy metals concentration in plant sample (mg/kg)								
S. No.	Sample name	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)	Copper (Cu)	Nickel (Ni)	Zinc (Zn)	Iron (Fe)
1.	Ginger	ND	ND	ND	8.025	ND	22.45	94.625
2.	Suran	ND	ND	ND	7.7	ND	40.475	164.275
3.	Cumin	ND	ND	ND	13.675	ND	38.55	201.775

Conclusion

The heavy metal stress in the plant affects the entire cycle of life due their accumulation in the biological species and further biomagnifications to the higher order levels thereby accumulating as much of metal stressors in the environment. Heavy metals cause stress to the cells in the body and hence affects the oxidation process called as the oxidative damage. The heavy metal content in the plant was beneficial only to a certain limit. The determination of heavy metal content in the plant depends on the factors such as the area of collection, sample collection procedures, preparation of the sample extract by various digestion methods, etc. The research has to be developed in the area of medicinal plants to produce both the therapeutic molecule and for the development of protective mechanism such as the metal absorption information through the field studies has to be done.

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