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Occurrence of high levels of Cadmium, Mercury and Lead in Medicinal Plants of India

Vasudevan Deepa T[1*], Dinesh Kavitha R[2], Gopalakrishnan S[3]

1. Asst. Prof. Amrita School Of Pharmacy, Amrita Vishwavidyapeetham University, Health care Campus, Kochi, Kerala, India.
2. Prof. Amrita School Of Medicine, Dept. of Microbiology, Amrita Vishwavidyapeetham University, Health care Campus, Kochi, Kerala, India. Email: kavitharadhakrishnan@aims.amrita.edu
3. Prof. Sree Ramakrishna Institute Of Paramedical Science and Research center, Dept. of Pharmaceutics, Coimbatore, Tamilnadu, India.

E-Mail: *deepaaims@yahoo.co.in rosearoma1234@gmail.com*

ABSTRACT

In the present study selected medicinal plant samples used in the preparation of Indian herbal medicinal products were analysed, after nitric acid digestion, for the content of cadmium, mercury and lead, by atomic absorption spectrophotometry. The samples are procured by three method.1.Self collected from medicinal plant garden with the help of experts.2.Purchased from local drug collectors.3. Purchased from raw material stores. Result shows that 33% of sample analysed were contain toxic levels of cadmium, 40% were contain toxic levels of lead and no sample posses arsenic above the limit. (limit of cadmium, mercury and lead were 0.3,0.5 and 10 µg/g, respectively)

PRACTICAL APPLICATIONS

Plants can contain heavy metals from their presence in the soil, water or air. High levels of toxic metals can occur when the plants are grown in polluted areas, such as near roadways or metal mining and smelting operations. In addition, high levels can be found when agricultural expedients are used, including Cadmium containing fertilizers, organic mercury or lead based pesticides, and contaminated irrigation water. Quality has to be built into the whole process beginning from the selection of starting material to the final product reaching the consumer. In the present study were carried out, to evaluate the quality and safety of crude drug. The result shows that Indian herbal drug industry needs to ensure procurement of standardized authentic raw material free from toxic contaminants. Such approaches remain important in global promotion of medicinal plants & herbal medicinal products from India.

KEYWORDS: *Atomic absorption spectrophotometry, Cadmium, Lead, Mercury, Quality, Toxic metals.*

INTRODUCTION

The use of medicinal plants in therapeutics or as dietary supplements goes back beyond recorded history, but has increased substantially in the last decades (1,2,3). Global acceptance of herbal formulation from India is gearing up and in the same time there has been a decline in the demand for medicinal plants from India. Global Herbal Drug sale is about $100 billion, Developed countries share is 50% and Indian share is only 2.3% (3). Contamination and adulteration of market samples remains a major problem in domestic and export markets of Indian herbal products. Heavy metals such as mercury, arsenic and lead contamination have also become a critical problem (4). Market botanicals are stored under undesirable conditions may have contamination or adulteration of other materials, which thereby adversely affect the efficacy and sometimes even add to toxicity. The safety of their use has been questioned due to the reports of illness and fatalities (4; 5). Poisonings associated with the presence of toxic metals in medicinal plants were reported in Asia, Europe and the United States (6,7,8,9). Plants can contain heavy metals from their presence in the soil (including contamination of the plant material with soil), water or air (10). High levels of toxic metals can occur when the plants are grown in polluted areas, such as near roadways or metal mining and smelting operations (11). In addition, high levels can be found when agricultural expedients are used, including Cadmium containing fertilizers (eg. Rajphose), organic mercury or lead based pesticides, and contaminated irrigation water (12). Chronic exposure to cadmium can cause nephrotoxicity in humans, mainly due to abnormalities of tubular re-absorption (13). Lead and mercury can cause adverse effects on the renal and nervous systems and can cross the placental barrier, with potential toxic effects on the fetus (14,15).

Herbal drug preparations are supposed to be produced with high Quality. Quality encompasses all the properties of the final product which makes it optimal suitable for it's intended use. Reproducible quality is a goal, which is, among others, achieved by the process of standardization. The quality requirements for orthodox drug preparations are stringent in terms of content of active principles and toxic materials. As herbal medicinal products are complex mixtures which originate from biological sources, great efforts are necessary to guarantee a constant and adequate quality. By carefully selecting the plant material and a standardized manufacturing process, the pattern and concentration of constituents of herbal medicinal products should be kept as constant as possible as this is a prerequisite for reproducible therapeutic results. Quality has to be built into the whole process beginning from the selection of starting material to the final product reaching the consumer. Good Agricultural Policies (GAPs) offer standard operating procedures for use of fertilizers, irrigation systems and disease management allied with insects and pest prevention and cure. GAPs also establish standards for noxious and harmful contaminants like heavy metals, pesticide residues and microbes in plants. In the present study were carried out, to evaluate the heavy metal contaminants on five medicinal plants.

MATERIALS AND METHODS

Selection of medicinal plants for this study

Five medicinal plants including *Allium sativum, Azadiracta indica, Cassia fistula, Curcuma longa, Wrightia tinctoria* were utilized in the study. The products were chosen on the basis of commercial availability and popularity of use and were procured by three method. 1. Self collected from medicinal plant garden with the help of experts. 2. Purchased from local drug collectors. 3. Purchased from raw material stores in south India. Table 1(herbal drugs analyzed). All the specimens were identified, voucher specimens were prepared and stored for future use.

Chemicals and instrumentation

HNO_3 65% (max. 0.0000005% Hg); standard solutions of mercury ($Hg(NO_3)_2$, 1000 mg/l, in 0.5M HNO_3), lead (1.000g of $Pb(NO_3)2$ in H_2O) and cadmium (1.000 g of $CdCl_2$ in H_20); and $NaBH_4$ for reduction (>96% purity). Distilled-deionized water was used for all analytical work. All glassware was washed with 2% Extran solution, soaked in 3N HCl for 24 h, and rinsed with distilled-deionized water before use. The atomic absorption spectrophotometer (AAS) AA7000 BC, coupled with

Table 1: Plants used

Sample code	Comman name	Botanical name	Parts of plant used
Crude drug Azadirachta indica leafs(CRDAL$_1$)	NEEM	Azadirachta indica A. Juss	Leaf
Crude drug Azadirachta indica leafs(CRDAL$_2$	NEEM	Azadirachta indica A. Juss	Leaf
Crude drug Azadirachta indica leafs(CRDAL$_3$)	NEEM	Azadirachta indica A. Juss	Leaf
Crude drug Allium sativum Bulb(CRDAB$_1$)	GARLIC	Allium sativum Linn	Bulb
Crude drug Allium sativum Bulb(CRDAB$_2$)	GARLIC	Allium sativum Linn	Bulb
Crude drug Allium sativum Bulb(CRDAB$_3$)	GARLIC	Allium sativum Linn	Bulb
Crude drug Curcuma longa Rhizome(CRDCR$_1$)	TURMERIC	Curcuma longa Linn.	Rhizome
Crude drug Curcuma longa Rhizome(CRDCR$_2$)	TURMERIC	Curcuma longa Linn.	Rhizome
Crude drug Curcuma longa Rhizome(CRDCR$_3$)	TURMERIC	Curcuma longa Linn.	Rhizome
Crude drugWrightia tinctoria (CRDWL$_1$)	DANTAPPALA	Wrightia tinctoria Roxb.	Leaf
Crude drugWrightia tinctoria (CRDWL$_2$)	DANTAPPALA	Wrightia tinctoria Roxb.	Leaf
Crude drugWrightia tinctoria (CRDWL$_3$)	DANTAPPALA	Wrightia tinctoria Roxb.	Leaf
Crude drug Cassia fistula Leaf(CRDCL$_1$)	KANIKONNA	Cassia fistula Linn.	Leaf
Crude drug Cassia fistula Leaf(CRDCL$_2$)	KANIKONNA	Cassia fistula Linn.	Leaf
Crude drug Cassia fistula Leaf(CRDCL$_3$)	KANIKONNA	Cassia fistula Linn.	Leaf

hydride generator GH 3000 and hole cathode lamps for Hg, Pb and Cd,

Toxic heavy metal analysis
Cadmium, mercury and lead determination

The protocol used to determine the metals in the plant material is a modification of the method proposed by Chow et al. (16). In summary, 2 g of the sample was transferred to a 100 ml Nessler tube, 15 ml of 10% HNO_3 v/v added and left in water bath at 100 ^{0}C for 3 h. For mercury analysis, the digested solution was analyzed by cold vapour AAS after reduction with $NaBH_4$. For cadmium and lead, the digested sample solutions will be treated twice under reflux with concentrated HNO_3 before determination by flame AAS. Each sample was analyzed in duplicate. The metals were quantified against standard curves prepared at the day of the analysis. The limits of quantification (LOQ) of the method were 0.01μg/g for mercury, 2μg/g for lead and 0.2μg/g for cadmium.

RESULTS

Table 2 shows the concentrations of the metals in the plants. 33% of the tested plants contain high level of cadmium. Mercury level in all tested samples were with in the limit and 40% samples analysed exceeded the maximum recommended limit of lead

DISCUSSION

For cadmium the limit of 0.3μg/g is recommended for medicinal plants (17). The report shows 33% of the tested plants contain high level of cadmium. Plants absorb cadmium from the roots (10,11). The concentrations of cadmium found in this work were similar to the ones described in other parts of the world. In Italy, 79 samples of various herbal medicines had concentrations ranging from 0.01 to 0.75 μg/g. No tested sample contains high levels of mercury. Mercury the limit of 0.5 μg Hg/g recommended in drugs, including from plants (16). Vega-Carrillo et al. (18) found mercury at similar levels (<0.01 to 0.08 μg/g) in 30 plants used in traditional medicine in Mexico. Mercury exposure for the general population occurs mainly from consumption of fish, as methyl mercury (19;20) and possibly from dental amalgam fillings (15), and it is unlikely that the exposure through medicinal herbs will affect human health. Lead was detected only in samples prepared with the leaves, fruits or barks of the plant, that agrees with the fact that lead in plants is due mainly to aerial deposition or absorption by their external parts (21,11). 40% samples analysed exceeded the maximum recommended limit of 10 μg Pb/g (17).

Table 2: Concentration of cadmium, mercury and lead in the medicinal herbs, in μg/g

Sample code	Concentration in μg/g(Mean±SD)		
	Cadmium (0.3μg/g)	Mercury (0.5μg/g)	Lead (10 μg/g)
CRDAL$_1$	0.12±0.01	0.01±0.00	6.2±0.01
CRDAL$_2$	0.10±0.00	0.005±0.02	13.1±0.02
CRDAL$_3$	0.40±0.02	0.02±0.00	11.1±0.00
CRDAB$_1$	0.01±0.00	0.02±0.01	2.0±0.02
CRDAB$_2$	0.04±0.04	0.01±0.01	4.7±0.00
CRDAB$_3$	0.05±0.04	0.08±0.02	4.2±0.01
CRDCR$_1$	0.09±0.02	0.02±0.02	3.0±0.00
CRDCR$_2$	0.10±0.00	0.04±0.00	3.2±0.02
CRDCR$_3$	0.12±0.01	0.005±0.01	12.2±0.04
CRDWL$_1$	0.10±0.01	0.01±0.01	7.2±0.04
CRDWL$_2$	0.50±0.00	0.03±0.04	12.4±0.00
CRDWL$_3$	0.40±0.01	0.02±0.03	11.5±0.01
CRDCL$_1$	0.01±0.02	0.01±0.06	7.1±0.01
CRDCL$_2$	0.40±0.02	0.01±0.00	9.1±0.01
CRDCL$_3$	0.40±0.00	0.04±0.00	11.5±0.00

CONCLUSIONS

The population growth in the developing world and the increasing interest in the industrialized nations have greatly expanded the demand for medicinal plants and their products. Approximately 80% of the world population use the medicinal plants (1). In India ,as in most countries (2), the standard quality control of these products is not always enforced, and their quality, efficacy and safety is unclear. The results of this study show the need for a systematic control of toxic heavy metals in plants used as medicines.

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