Indian Journal of Weed Science **44**(4): 247–250, 2012

Presence of heavy metals in medicinal weed species grown at contaminated sites

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Received: 14 September 2012; Revised: 19 November 2012

ABSTRACT

Concentration of heavy metals like Cd, Pb, Ni, Co, Zn, Mn and Fe were tested in medicinal weeds growing at heavy metal contaminated site around Jabalpur during winter season of 2008. Except *Vicia sativa*, higher concentration of Cd was observed in weeds like *Sonchus arvensis* (3.07 µg/g), *Alternanthera viridis* (1.56 µg/g), *Anagalis arvensis* (1.5 µg/g), *Melilotus indica* (1.30 µg/g), *Eclipta alba* (1.14 µg/g), *Chenopodium album* (1.15 µg/g), *Cichorium intybus* (1.05 µg/g), *Lathyrus sativa* (0.77 µg/g). Copper concentrations in plant was higher than prescribed standard limit, *viz. Amaranthus viridis* (*46* µg/g), *Ageratum conyzoides* (22 µg/g), *Polygonum persicaria* (37 µg/g), *Commelina communis* (30 µg/g), *Alternanthera sessilis* (22 µg/g), *Solanum nigrum* (22 µg/g) and *Ipomoea aquatica* (21 µg/g) . Ni and Zn contents exceeded the permissible limit in shoots of *Polygonum persicaria* (19,265 µg/g), *Commelina communis* (17,192 µg/g), *Alternanthera sessilis* (14,216 µg/g), *Amaranthus viridis* (17,488 µg/g), *Ipomoea aquatic* (15,238 µg/g), *Heliotropicum indicum* (16,89 µg/g), *Ageratum conyzoides* (15,127 µg/g), *Blumea lacera* (3,218 µg/g), *Solanum nigrum* (16, 191 µg/g), *Convolvulus arvensis* (15,125 µg/g) and *Cyperus iria* (15,177 µg/g) respectively. *Calotropis procera* (21 µg/g) exhibited higher Pb concentration exceeding prescribed standard limit. Conversely, Co content was found within prescribed limit in *Melilotus indica, Lathyrus sativa, Heliotropicum indicum, Cyperus iria, Convolvulus arvensis, Blumea lacera,* Pb below standard limit in *Hyptis suaveolens, Cichorium intybus, Lantana camara and Datura stramonium*, and no Pb was detected in *Alternanthera sessilis, Abutilon indicum, Xanthium strumarium, Anagalis arvensis.*

Key words: Contamination, Heavy metals, Standard limit, Weed species

Herbal medicines are in great demand in both developed and developing countries in primary health care because of their great efficacy having little or no side effects. The weeds prevailing abundantly in nature have been used since time immemorial as an indispensable basic raw material in the ayurvedic medicines. *Datura stramonium* is commonly used for the preparation of 'Kanaka taila' by many industries indigenously and for skeletal muscle relaxant in the western system of medicine respectively. This plant has contributed various pharmacological activities in Indian system of medicine like analgesic and antiasthmatic activities (Soni *et al.* 2012). However, indiscriminate collection of such weeds from the contaminated sites has deteriorated the quality of medicines. Saper (2004) reported that one out of five ayurvedic formulations from South Asian countries contains heavy metals. A single dose of 0.1-0.2 mg Cu/kg body weight can cause gastrointestinal disturbances in sensitive persons (Bosshard and Zimmerli 1994). Ingestion of Zn in large amount cause vomiting and diarrhea and neurological damages.

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World Health Organization (WHO) recommended that medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals. WHO prescribed maximum permissible limits of toxic metals like Ar, Cd and Pb, which amount to be1.0, 0.3 and 10 ppm, respectively WHO (1998). Weeds species having medicinal value are indiscriminately grown at contaminated sites pose risk in the herbal products of theuraptic use. Their use 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.

An investigation was made to study the status of heavy metals (Ni, Co, Pb and Zn) in weedy plants grown in drains carrying waste water and along the roads in Jabalpur and adjoining areas.

MATERIALS AND METHODS

Out of 20 weed species of medicinal value, 11 from drains and 9 from the road sites were selected for the heavy metal uptake study in their shoot part. The weed samples were collected from the various drains including

Omati, Urdhana, Panagar, Pariyet and Karonda and road sites of National highway (Nagpur bypass), Adhartal, Khamaria, Mandla and Mazoli in Jabalpur city and its adjoining area during the winter season of 2008. Plants were washed in fresh running water to eliminate dust, dirt and possible parasites and then treated with deionized water and were dried in shade at 25-30°C. During sample preparation for analysis, necessary measures were taken in order to avoid any loss or contamination of heavy metals. For each species, 10-15 plants were collected randomly at maturity stage. The plant samples were thoroughly washed and dried at 70^0C for 48 h, ground and mixed thoroughly for metal analysis. Weed samples (1 g) were digested in concentrated nitric and perchloric acid (5:1) till a clear solution was obtained. The solution was filtered, reconstituted to the desired volume and analysed with atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Medicinal weeds observed in heavy metal contaminated soils along drains and roads were; *Vicia sativa, Chenopodium album, Melilotus indica, Lathyrus sativa, Anagallis arvensis, Alternanthera viridis, Sonchus arvensis, Eclipta alba, Cichorium intybus, Calotropis procera, Hyptis suaveolens, Cichorium intybus, Lantana camara, Alternanthera sessilis, Abutilon indicum, Xanthium strumarium, Anagalis arvensis, Datura stramonium*. Aquatic weeds including *Polygonum persicaria, Commelina communis, Alternanthera sessilis, Amaranthus viridis, Ipomoea aquatica, Heliotropicum indicum, Ageratum conyzoides, Blumea lacera, Solanum nigrum, Convolvulus arvensis and Cyperus iria* were observed in the waste water carrying drains in Jabalpur and adjoining areas.

The concentration of Cu, Ni, Zn, Mn, Cd and Pb in selected medicinal unmetals plants are depicted (Table 1 and 2). Higher concentration of Co (Table 1 and 2) was found in *Amaranthus viridis* (46 µg/g) followed by *Polygonum persicaria* (37 µg/g), *Ageratum conyzoide* (37 µg/g), *Commelina communis* (30 µg/g), *Alternanthera sessilis* (22 µg/g), *Solanum nigrum* (22 µg/g) and *Ipomoea aguatica* (21µg/g) grown in waste water carrying drain whereas *Vicia sativa* (78.4 µg/g), *Chenopodium album*, (31.8 µg/g) *Anagalis arvensis*, (20.5 µg/g), *Alternanthera viridis*, (22.6 µg/g) *Sonchus arvensis*, (41.4 µg/g) *Eclipta alba*, (48.9 µg/g), *Cichorium intybus* (28.2 µg/g) grown in contaminated field soil irrigated with waste water which was beyond the prescribed limit (20 µg/ g) as suggested by European Union. Conversely, the Co content was found within prescribed limit in weeds growing along the drain including *Heliotropicum indicum, Cyperus iria, Convolvulus arvensis, Blumea lacera* and in weeds growing in field including *Melilotus indica, Lathyrus sativa* respectively. High levels Cu may cause metal fumes fever with flue like symptoms, hair and skin decoloration, dermatitis, irritation of the upper respiratory tract, metallic taste in the mouth and nausea. FDA 1993 has recommended the lower limit of the acceptable range of Cu as 20 IJg/mg body weight per day (FDA 1993). Co deficiency results in anemia and congenital inability to excrete resulting in Wilson's disease (Bull and Cox *1994*).

The concentrationof Ni in different plants was higher in weed species, *Polygonum persicaria* (19 µg/g), *Commelina communis* (17 µg/g), *Alternanthera sessilis* (14 µg/g), *Amaranthus viridis* (17 µg/g), *Ipomoea aquatica* (15 µg/g), *Heliotropicum indicum* (16 µg/g), *Ageratum conyzoides* (15 µg/g), *Blumea lacera* (3 µg/g), *Solanum nigrum* (16 µg/ g), *Convolvulus arvensis* (15µg/g) and *Cyperus iria* (15 µg/g). The most common ailment arising from Ni is an allergic dermatitis known as Ni itch, which usually occurs when skin is moist. Further 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 and Pendias 1992). EPA has recommended daily intake of Ni below be <1 mg beyond which it is toxic (McGrath and Smith 1990).

High concentration of Zn was found in *Amaranthus viridis* (488 µg/g) followed by *Polygonum persicaria* (265 µg/g. *Ipomoea aquatica* (238 µg/g), *Blumea lacera* (218 µg/g), *Alternanthera sessilis*, (216 µg/g). *Commelina communis* (192 µg/g), *Solanum nigrum* (191 ppm), *Cyperus iria* (177 ppm) and *Ageratum conyzoides* (127 ppm), *Convolvulus* arvensis (125 µg/g) and *Heliotropicum indicum* (89 µg/g) (Table 1). Zn is an essential trace element for plant growth and also plays an important role in various cell processes including normal growth, brain development, behavioural response, bone formation and wound healing. Zn deficient patients fail to improve their power of perception and also causes loss of sense of touch and smell (Hunt 1994). The dietary limit of Zn is 100 µg/g.

Maximum concentration of Mn was found in *Alternanthera sessilis* (124 ppm), *Hyptis suaveolens* (93.9 ppm), *Calotropis procera* (76.6 µg/g), *Lantana camara* (74.5µg/g), *Cichorium intybus* (68.8 µg/g) , *Datura stramonium* (65.4 µg/g), *Abutilon indicum*, (27.8 µg/g) which

Table 1. Heavy metal uptake by weed species grown in contaminated soils in Jabalpur

Medicinal weeds grown in contaminated soils along drains	Heavy metals (µg/g dry weight)			Medicinal weeds grown at contaminted soils along roads	Heavy metals (µg/g dry weight)	
	Cu	Cd	Fe		Pb	Mn
Vicia sativa	78.4	ND*	3485	*Calotropis procera*	21.0	76.6
Chenopodium album	31.8	1.11	547.5	*Hyptis suaveolens*	6.25	93.9
Melilotus indica	Nd	1.30	ND	*Cichorium intybus*	3.00	68.8
Lathyrus sativa	Nd	0.77	ND	*Lantana camara*	5.5	74.5
Anagalis arvensis	20.5	1.55	1060	*Alternanthera sessilis*	ND	124
Alternanthera viridis	22.6	1.56	621	*Abutilon indicum*	ND	27.8
Sonchus arvensis	41.4	3.07	923	*Xanthium strumarium*	ND	ND
Eclipta alba	48.9	1.14	962	*Anagalis arvensis*	ND	ND
Cichorium intybus	28.2	1.05	646	*Datura stramonium*	2.15	65.4
EU[1], PFA[2] limit, critical concentration of Mn[3]	<20[1]/30[2]	0.2[1]/1.5[2]	-	WHO[3] Limit	10[3]	300-500[3]

ND - Not detected

Table 2. Heavy metals concentrations in aquatic weeds grown in drains carrying waste water

Weed species grown in drains	Heavy metals (µg/g dry weight)			
	Co	Ni	Zn	Fe
Amaranthus viridis	46	17	488	420
Commelina communis	30	17	192	1257
Alternanthera sessilis	22	14	216	345
Ipomoea auatica	21	15	238	510
Heliotropicum indicum	9	16	89	550
Polygonum persicaria	37	19	265	1240
Ageratum conyzoides	37	15	127	818
Blumea lacera	17	3	218	574
Solanum nigrum	22	16	191	400
Convolvulus arvensis	13	15	125	1900
Cyperus iria	7	15	177	513
Range	7-46	3-19	89-488	345-1900
EU[1], PFA[2] limit	<20[1]	<1.5[1]	< 50[2]	-

was within normal background level (300-500 µg/g), whereas no Mn was detected in *Xanthium strumarium* and *Anagallis arvensis*. Mn deficiency in plants causes chlorosis. The estimated safe and adequate daily dietary intake in adults is 11 mg/day (Pendias and Pendias 1992). Deficiency of Mn in beings human causes myocardial infarction and other cardiovascular diseases, also disorder of bony cartilaginous growth in infants and children (Smith 1990, Barceloux 1999).

High Fe concentration was recorded in *Convolvulus arvensis* (1900 µg/g dry weight) followed by *Commelina communis* (1257 µg/g), *Polygonum persicaria* (1240 µg/g), *Ageratum conyzoide* (818 µg/g), *Blumea lacera* (574 µg/g), *Heliotropicum indicum* (550 µg/g), *Ipomoea auatica* (510 µg/g), *Cyperus iria* (513 µg/g), *Amaranthus viridis* (420 µg/g), *Solanum nigrum* (400 µg/g) and *Alternanthera sessilis* (345 µg/g) grown along the drain and *Vicia sativa* (3485 µg/g), *Anagallis arvensis* (1060 µg/g), *Eclipta alba* (962 µg/g), *Sonchus arvensis* (923 µg/g), *Cichorium intybus* (646 µg/g), *Alternanthera viridis* (621µg/g) and *Chenopodium album* (547.5 µg/g), was beyond the prescribed limit (20 µg/g) as suggested by EU. Conversely, no Fe content was found in weeds *viz.*, *Melilotus indica* and *Lathyrus sativa*. The dietary limit of Fe in the food is 10-60 mg/day (Kaplan *et al.* 1993). Low Fe content causes gastrointestinal infection, nose bleeding and myocardial infarction (Hunt 1994).

Cd accumulates in human body and damages mainly kidneys and liver. Except *Vicia sativa*, Cd contents were observed in field weeds like *Sonchus arvensis* (3.07 µg/g), *Alternanthera viridis* (1.56 µg/g), *Anagallis arvensis* (1.55 µg/g), *Melilotus indica* (1.30 µg/g), *Eclipta alba* (1.14 µg/g), *Chenopodium album* (1.11 µg/g), *Cichorium intybus* (1.05 µg/g) and *Lathyrus sativa* (0.77 µg/g). The maximum acceptable concentration of Cd for food stuff is around 0.2 ppm (EU limit), 1 ppm (Neil 1993). *Calotropis procera* (21 ppm) accumulated higher concentration of Pb which exceeded the prescribed standard limit (Table 2), whereas *Hyptis suaveolens* (6.25 µg/g), *Cichorium intybus* (3.00 µg/g), *Lantana camara* (5.5 µg/g) and *Datura stramonium* (2.15 µg/g) absorbed Pb below the prescribed standard limit. However, no Pb was detected in *Alternanthera sessilis*, *Abutilon indicum*, *Xanthium*

strumarium, Anagallis arvensis grown in soils along roads. The typical symptoms of Pb poisoning are colic, anemia, headache, convulsions and chronic nephritis of the kidneys, brain damage and central nervous system disorders. WHO (1998) prescribed limit for Pb contents in herbal medicine is 10 ppm.

Indiscriminate use of medicinal weeds grown in waste water carrying drain or soils irrigated with untreated waste water and soils contaminated along the roads roses great risk of metal entry into food chain. Heavy metal contents in most of the weeds with medicinal values exceeded the prescribed stringent EU limit as well as the PFA Indian limit. Higher concentration of Co (78.4 µg/g) in *Vicia sativa*, Pb (22 µg/g) in *Calotropis procera*, cadmium (3.07 ppm) in *Sonchus arvensis*, Ni (19 ppm) in *Polygonum persicaria*, Zn (488 µg/g) in *Amaranthus viridis*, Mn (232 µg/g) in *Alternanthera sessilis*, Fe (1900 µg/g) in *Convolvulus arvensis* were above the detection limits. These findings may be taken into consideration while using herbs for human consumption. Medicinal plants used for human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat.

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