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Investigation of Heavy Metals Contents in Malawian *Vernonia glabra* (Steetz) *Vatke* Leaves, *Trichodesma zeylanicum* Roots and *Securidaca longepedunculata* (Fresen) Roots

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ABSTRACT

Medicinal plants are a source of chemical substances that have different biological activities including treatment of diseases. *Trichodesma zeylanicumm, Securidaca longepedunculata* and *Vernonia glabra* are some of the medicinal plants used in Malawi to treat wound infections and other diseases. Therefore, the objective of this study was to determine the essential and non essential heavy metals present in the three medicinal plants. The samples were digested by dry digestion method and analysed using microwave plasma – atomic emission spectrometer system. It was observed that the highest levels of metal concentration was recorded for iron (42.47 ppm) found in *S. longepedunculata*, followed by Magnesium (21.03 ppm) in *T. zeylanicum* and also iron (13.89 ppm) in *V. glabra*. The results shows that the levels of heavy metals in the three medicinal plants are within the WHO permissible range except for *S. longepedunculata* which have higher levels of toxic element, chromium, 2.76 ppm.

Keywords: *Trichodesma zeylanicumm, Securidaca longepedunculata, Vernonia glabra,* Dry digestion method, Microwave plasma–atomic emission spectrometer system.

INTRODUCTION

Contamination with heavy metal of herbs may happen during the growing in the field, processing and handling[1] and it is important to have quality medicinal herbs in order to protect the 80 % of the developing world population which depends on them for their primary health care needs. Some of heavy metals are essential in very small concentrations; however, exposure to trace and heavy metals above the permissible

range affects human health and may result in illnesses to human[2]. This problem is more serious in Malawi, where medicinal plants products are neither controlled nor properly regulated by quality assurance parameters.

Trichodesma zeylanicumm belongs to the family Boraginaceae, and it is a densely bristly-hairy annual herbal plant that can grow up to 1 metre. Leaves are narrowly elliptic, while flowers becomes nodding, in terminal 1-sided bracteates inflorescences. Sepals are bristly hairy enlarging in fruit. Corrolla (7-9 mm), are scarcely exserted from the sepals, lobes pale blue to lilac or pinkish[3]. According to Gurib-Fakim et al 1997, *T. zeylanicumm* powdered roots are applied externally on wounds[4] and skin as analgesic. And in 1984, Msonthi isolated squalene and other known phytosterols compounds from the leaves and recommended the plant as a good source of steroidal hormone precursors because of the high yield. The plant has also been reported to contain the low toxic alkaloids supinine[5].

Securidaca longepedunculata belongs to the family of polygalaceae widely distributed in Western and Southern Africa and almost all the parts of the plant are reported to be used in disease management[6]. The plant is a savanna shrub with twisted bole or slender erect branches and grows up to 30 ft high and in Malawi, the leaves and roots are used to treat wounds, coughs, venereal diseases, diarrhoea[7], snake bites, bilharzias and other ailments[8].

Vernonia glabra belongs to the family of asteraceae and is herbaceous perennial plant with flowers grouped in dense clusters at the tip of the stem and grows up to 4-5 ft high. It is widely used in Malawi for treatment of pneumonia and stomach ailments[9]. The leaf ash or crushed leaves rubbed into scarification around the snake bite is used as antidote[10].

Therefore, the objective of this study was to determine the essential and non essential heavy metals present in medicinal plants; *Trichodesma zeylanicumm, Vernonia glabra and S. longepedunculata* commonly used in Malawi to treat wound infections using microwave plasma – atomic emission spectrometer system.

MATERIAL AND METHODS

Collection of plant

The medicinal plants *Trichodesma zeylanicumm, Vernonia glabra and* S. Longepedunculata were collected from Zomba and Machinga districts and identified by Mr. I.H. Patel at Malawi Herbarium and Botanical Gardens with voucher specimen numbers 18930, 34810 (Masiye, Zomba 15˚19′S 35˚18′E) and 887 (EJ Tawakali and I.H. Patel, Machinga 15˚07′S 35˚27′E) respectively. The roots and leaves were separately shade dried, finely powdered using a blender and kept in airtight polyethylene bags at room temperature in the dark until used.

Determination of toxic metals

The standard procedure for determination of toxic metals described in Association of Official Analytical Chemists (2000) was used for the preparation of samples for the analysis. Accurately weighted (2 g) sample was transferred into a silica crucible and kept in a furnace for ashing at 450 °C for 3 hours and then 5 mL HCl was added to the crucible. Care was taken to ensure that all the acid was in contact with the ash. Further, the crucible containing acid solution was kept on a hot plate and digested to obtain a clean solution. The final residue was dissolved in 0.1M HNO_3 solution and made up to 50 ml. Working standard solutions were prepared by diluting the stock solution (prepared solution), with 0.1M nitric acid in order to check the linearity.

Calibration of equipment

For the elements under investigation, the following are calibration parameter: Fe (259.94 nm), 0 and 0.55 ppm; Mn (403.076 nm), 0 and 0.55 ppm; Cd (228.802 nm), 0 and 1.10 ppm; Mg (285.213 nm), 0 and 0.451 ppm; Cu (324.754 nm), 0 and 0.55 ppm); Zn (213.857nm), 0 and 0.55 ppm; Cr (425.433 nm), 0 and 0.66 ppm; Pb (405.781nm) 0 and 0.66 ppm.

Preparation of blank solution

The blank solutions were treated the same digestion procedure as that of the sample.

Preparation of standards solution

The stock solution for Pb, Cd, Mn, Zn, Cr, Cu, Fe and Mg were procured from Merck and solutions of varying concentrations were prepared for all the metals by diluting the standards.

Procedure for herbal sample analysis

The sample were analysed using the Agilent 4100 Microwave Plasma-Atomic Emission Spectrometer System (MP-AES) for heavy metals; Pb, Cd, Mn, Zn, Cr, Cu, Fe and Mg. All necessary precautions were followed to avoid any possible contamination of samples as per AOAC guidelines.

Data Collection

The levels of heavy metals present in the extract were expressed as mean of heavy metal concentration (ppm) ±S.D of three replicates. Calibration functions for each element was determined. Concentration of each metal in the medicinal plants was calculated from the calibration functions.

Data Analysis

The null hypothesis being tested in the study is that there is no significant heavy metal present in the selected medicinal plant. The mean and the S.D of each herbal plant extract were used and calculated values of the heavy metal concentrations of the herbal extract computed.

RESULTS

Table 1 and Figure 1 shows analysis results of the levels of heavy metal concentration of Pb, Cd, Mn, Zn, Cr, Cu, Fe and Mg present in the *Securidaca longepedunculata, Vernonia glabra* and *Trichodesma zeylanicum* plants.

Lead

The results obtained indicate that the high concentration of lead was found in Vernonia glabra 0.15 ppm compared to Securidaca longepedunculata 0.11 ppm and Trichodesma zeylanicum 0.03 ppm. The WHO prescribed limit for lead content in herbal medicine is 10 ppm. Lead is a non-essential trace elements having function neither in human body nor in plant. They induce various toxic effects in humans at low dose with such symptoms of lead poisoning as follows; colic, anemia, headache, convulsions and chronic nephritis of the kidney, brain damage and central nervous disorder[11].

Cadmium

The results obtained show that there were no traces of cadmium found in Vernonia glabra while 0.11 ppm was found in Trichodesma zeylanicum and 0.19 ppm in Securidaca longepedunculata. The permissible limit for cadmium set by WHO is 0.3 ppm. Cadmium intoxication can lead to kidney, bone and pulmonary damage[12].

Manganese

The results obtained show that manganese content was higher in Trichodesma zeylanicum at 14.80 ppm compared to 4.70 ppm found in Vernonia glabra and 10.15 ppm in Securidaca

longepedunculata. However, WHO has not yet established the limit of manganese in medicinal plants.

Zinc

The results obtained indicate that high concentration of zinc was found in Securidaca longepedunculata 0.71 ppm compared to 0.57 ppm in Vernonia glabra and 0.45 ppm found in Trichodesma zeylanicum. Zinc is an essential trace element and plays an important role in various cell processes including bone formation and wound healing.

Chromium

The results obtained show that high concentration of chromium was found in Securidaca longepedunculata 2.76 ppm compared to 0.60 ppm in Trichodesma zeylanicum and 0.11 ppm in Vernonia glabra. WHO limit for chromium has not been established, however, permissible limit for chromium in Canada is 2 ppm for raw medicinal plant material. It can be observed that Securidaca longepedunculata contains high levels of chromium above the permissible limits of 2 ppm. Chromium chronic exposure may results in liver, kidney and lung damage and toxic intake causes skin rash, nose irritations, bleeds, upset stomach, kidney and liver damage, nasal itch and lungs cancer[11].

Copper

High concentration of copper was found in Securidaca longepedunculata 0.72 ppm compared to 0.44 ppm in Trichodesma zeylanicum and 0.39 ppm in Vernonia glabra. WHO limit for copper has not been established, however, permissible limit for copper in China is 20 ppm for raw medicinal plant material. The high levels of copper may cause metal fumes fever with flue like symptoms, hair and skin decolouration, dermatitis and irritation of the upper respiratory tract[13].

Iron

The results obtained show that high concentration of iron was found in Securidaca longepedunculata 42.47 ppm compared to 14.51 ppm in Trichodesma zeylanicum and 13.89 ppm in Vernonia glabra. Iron is essential element for human beings and animals and is essential component of haemoglobin. And also plays an important role in oxygen and electron transfer in human and animal bodies.

Magnesium

High concentration of magnesium was found in Trichodesma zeylanicum 21.03 ppm compared to 2.50 ppm in Vernonia glabra and 16.43 ppm in Securidaca longepedunculata.

CONCLUSION

The concentration (ppm) of heavy metals in the plant extracts were found to be within the WHO[14] permissible range except for *Securidaca longepedunculata* which showed higher levels of toxic element, chromium.

In terms of metal concentration, *Vernonia glabra* had least levels of toxic metals concentration; Cr* <Pb* <Cu <Zn <Mg <Mn <Fe, followed by *Trichodesma zeylanicum;* Pb* <Cd*<Cu <Zn <Cr* <Fe <Mn <Mg and *Securidaca longepedunculata;* Pb* <Cd* <Zn <Cu <Cr* <Mn <Mg <Fe.

The highest levels of metal concentration was recorded for iron (42.47 ppm) found in *Securidaca longepedunculata*, followed by Magnesium (21.03 ppm) in *Trichodesma zeylanicum* and also iron (13.89 ppm) in *Vernonia glabra*.

Therefore, it can be observed from the finding that concentrations of essential and non-essential heavy metals in medicinal plants beyond the permissible limit is a matter of great concern to public safety all over the world, hence, it is recommended that further analysis should be conducted to ascertain the

toxicological effects of the heavy metals present in the three medicinal plants, commonly used in Malawi to treat wound infections.

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Conflict of Interest

The author declares that they are no competing interest.

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Table 1. Heavy metal levels in herbal plants

Plant species	Heavy metals							
	Metal concentration (ppm). Mean ± SD							
	Pb*	Cd*	Mn	Zn	Cr*	Cu	Fe	Mg
V. glabra	0.15±0.01	-	4.70±0.06	0.57±0.03	0.11±0.02	0.39±0.00	13.89±0.76	2.50±0.17
T. zeylanicum	0.03±0.00	0.11±0.00	14.80±0.02	0.45±0.01	0.60±0.01	0.44±0.00	14.51±0.41	21.03±0.11
S. *longepedu nculata*	0.11±0.00	0.19±0.01	10.15±0.03	0.71±0.02	2.76±0.05	0.72±0.00	42.47±0.41	16.43±0.12

*represent toxic metals

Average metal contents in the 3 medicinal plants (mean ± SD)

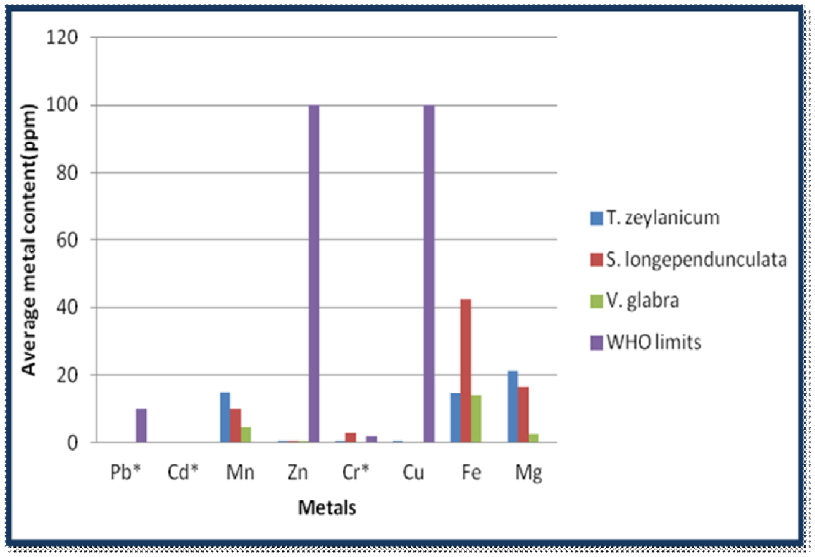

Figure 1. Average metal contents of the 3 plants in comparison to WHO permissible limits