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Research Article

Level of Heavy Metals in *Cassia Occidentalis, Leptadenia Hastata* and *Guiera Senegalensis* Used As Medicinal Plants in Kano, Northern Nigeria

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Abstract: Traditional medicine is one of the oldest and effective means of managing many diseases. However, it was ignored in many places due to lack of proper hygiene and knowledge about the exact composition of the plants (herbs). The aim of this research was to determine the levels of some heavy metals in three plants; *Cassia occidentalis, Leptadenia hastata* and *Guiera senegalensis* used as medicinal plants. The concentrations of Pb, Ni, Mn, Zn, Cu, Fe, and Co were determined in the three plants using atomic absorption spectrophotometer. The concentration of the heavy metals ranges from 0.34 $mgkg^{-1}$ as observed in Pb to 40.00 $mgkg^{-1}$ as observed in Zn. The relative abundance of the metals ($mgkg^{-1}$) is Pb (0.39) < Fe (15.85) < Mn (17.67) < Cu (18.06) < Co (19.56) < Ni (21.10) < Zn (35.00). The concentrations of the heavy metals are within the recommended values by Food and Agriculture Organization and World Health Organization (FAO/WHO). The results of the study showed the levels of heavy metals were all below toxic levels set up by FAO/WHO.

Keywords: Medicinal plants, *Cassia occidentalis, Leptadenia hastata* and *Guiera senegalensis* heavy metals, Kano.

1. INTRODUCTION

Plants parts and their different sections have been used for many centuries for medicinal as well as other domestic purposes. It has been claimed that almost every plant has a potential medicinal capability (Aline, P.C. *et al.*, 2013). In various part of the world, different plants have been recognized as cure for many human diseases (Tomas, J. *et al.*, 2012). Extracts of plant leaves, roots and stem have been used in treatment of Diabetes, Sickle cell anemia, cancer etc (Shad, A.K. *et al.*, 2011). Various scientific studies have associated phytochemicals with active processes of curing and management of diseases (Opaluwa, O. *et al.*, 2012). In western part of Africa, most treatment of injuries, burns and associated disease are conducted using plant-derived substances (Das. K.K. *et al.*, 2008). This has made these plants to be significant part of various domestic activities of African life. *Cassia occidentalis* is a major medicinal plant that grows widely in western part of Africa. It belongs to the *Caesalpiniaceae* family and grows majorly in Tropical areas (Nuhu, A., & Aliyu, R. 2008). Leaves of *C. occidentalis* are widely used for various medicinal purposes including Typhoid fever, malaria, liver and heart diseases, diabetes and arthritis (Ibrahim, H.A. *et al.*, 2012). In rural areas and other parts of Kano, Katsina and Zaria in Northern part of Nigeria, it is known as *Rai-Rai* and believed to be a cure for any infections (Nuhu, A., & Aliyu, R. 2008). Similarly, *Leptadenia hastata* is also a tropical plant widely seen in Northern part of Nigeria, Ghana, Senegal and Niger (Togola, A. *et al.*, 2008). Leaf and root extracts of this plant are widely used by people in this area for treatment of skin diseases, hypertension and lactation. Senegalese healers also use *L. hastata* for prostate and rheumatism complains (Ibrahim, H.A. *et al.*, 2012). Guiera senegalensis is also another major medicinal plant used widely in Western part of Africa (Kamal, N. *et al.*, 2016). In Nigeria, it is known as *Saabara* in Hausa language andis widely used for treatment of gastroenteritis, diabetes, malaria and stomach aches (Dénou, A. *et al.*, 2016). Heavy metal toxicity of plants is rather a major threat in use of

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medicinal plants (Kiyawa, S. A. 2015). Lead (Bayero, A. S. *et al.*, 2019; Malik, R.N. *et al.*, 2010), mercury and other heavy metal poisoning have been reported to be a major cause of death in various part of Africa particularly Northern Nigeria due to major mining activities (Nuhu, A., & Aliyu, R. 2008). This study is aimed at determining levels of heavy metals in these 3 medicinal plants; *Cassia occidentalis*, *Leptadenia hastata* and *Guiera senegalensis*. The determined levels of the heavy metals Pb, Ni, Mn, Co, Fe, Zn and Cu are analyzed and compared with standardized levels set up by World health organization (WHO).

Senegalese healers also use the *L. hastata* for prostate and rheumatism complaints (Thomas, S.D. 2012). *Guiera senegalensis* is also another medicinal plant widely used in various treatments in West Africa. *Guiera senegalensis* belongs to the *Combretaceae* family and is one of the most important West African medicinal plants, often used to treat a variety of microbial infections (Dénou, A. *et al.*, 2016). In Africa, *Guiera senegalensis* is widely distributed in Northeast Tropical Africa, Sudan, West Tropical Africa and Burkina faso (Kamal, N. *et al.*, 2016). It is referred in the savannah regions of West Africa comprising of Northwestern part of Nigeria and Niger, as "Saabarah" (Dénou, A. *et al.*, 2016). The plant leaves and roots used in treatment of acute stomach pain, Gastroenteritis, peptic ulcer and wound healing**.** Similarly, plant leaf extract is used in treatment of microbial and metabolic diseases such as malaria, dysentery, diabetes and hypertension (Koh, H.L., & Woo, S.O. 2000). Plant leaves and vegetables have been reported to be nutritious due to their mineral element contents (Tomáš, J. *et al.*, 2012).

The study is aimed at studying levels of the heavy metals; Pb, Ni, Mn, Zn, Cu, Fe, and Co in leaf samples of three medicinal plants *Guiera senegalensis*, *C. occidentalis* and *L. hastata* and comparing these levels with standard levels given by the Food and Agriculture Organization of the United Nations (FAO) and or the World Health Organization (WHO).

2.0 MATERIALS AND METHODS

2.1 Sample collection and Preparation

The plant leaves were obtained from Panshekara area of Kano state in Nigeria. The plants were authenticated and identified at Biological Science Department of Bayero University Kano (BUK). The leaves of the plant sample were air-dried, grinded and sieved. The samples were then transferred into to labeled sample bottles which were then subjected to ashing and digestion. The levels of metals were determined using Atomic Absorption Spectrometer (Buck model 210VGP) after ashing and digestion of the three powdered samples (AOAC. 1990).

2.2 METHOD OF ASHING AND DIGESTION

0.5g of each of the plant samples were taken into clean 125 ml Erlenmeyer flask. 4 ml of perchloric acid, 25 ml of HNO_3 and 2 ml of H_2SO_4 were added to the samples in the flask under fume hood. The mixture was gently heated at low to medium hating on a hot plate under perchloric acid fume hood. Dense white fumes appeared after continued heating. Later, the mixture was heated vigorously for a minute and the greyish white ash was obtained. The mixture was then cooled for 5 minutes. After cooling, the mixture was re-boiled for half a minute on the same plate at medium heat. The mixture was then cooled and filtered with a wash bottle into 100 ml pyrex volumetric flask which was made up to the mark with distilled water. Two small sample bottles were used for each heavy metal.

2.3 Measuring Absorbance

The absorbance of all elements was determined at 400 nm

2.4 Statistical Analysis

The concentrations of the heavy metals (Mean ± SD) were statistically analyzed using GraphPad version 3.10 32-bit for Windows and Microsoft Excel 2016. Depending on experiment, the statistical significance was determined using the unpaired Student's t-test with $P < 0.05$ considered significant.

3.0 Results and Discussion

3.1 Result

Table 1 shows the concentrations ($mgkg^{-1}$) of the Pb, Ni, Mn, Zn, Cu, Fe, and Co in the leaves of the three plants. Zn (35.00 ± 3.55) has highest concentration in the plants while Pb (0.39 ± 0.16) has the least concentration. Among the plants studied, *Guiera senegalensis* leaves have highest concentration of Pb (1.02), Mn (22.00), Cu (21.20) and Fe (19.00). On other hand, *Cassia occidentalis* the lowest concentration of Pb (0.34), Mn (9.00), Cu (13.37), Zn (31.67), and Fe (13.01).

The mean concentrations of the metals examined in *Cassia occidentalis*, *Leptadenia hastata* and *Guiera senegalensis* was found to be in the order Pb < Fe < Mn < Cu < Co < Ni < Zn.

Table 2, shows the mean and range of concentrations of the respective metals in the plants as well as the recommended values of the respective metals by FAO/WHO.

Table 1: Mean ± Standard deviation (mgkg^{-1}) for the heavy metals in leaves of *Cassia occidentalis, Leptadenia hastata* and *Guiera senegalensis*

Heavy Metal	*Cassia occidentalis*	*Leptadenia hastata*	*Guiera senegalensis*	Mean ± SD
Pb	0.34 ± 0.30	0.98 ± 0.09	1.02 ± 0.09	0.39 ± 0.16
Ni	23.30 ± 7.64	20.00 ± 4.00	20.00 ± 2.00	21.10 ± 4.55
Mn	9.00 ± 3.61	22.00 ± 6.00	22.00 ± 0.00	17.67 ± 3.20
Cu	13.37 ± 1.73	19.62 ± 1.75	21.20 ± 0.73	18.06 ± 1.40
Zn	31.67 ± 5.77	40.00 ± 2.00	33.33 ± 2.89	35.00 ± 3.55
Co	23.00 ± 2.00	15.67 ± 3.06	20.00 ± 0.00	19.56 ± 1.69
Fe	13.01 ± 0.96	15.53 ± 1.60	19.00 ± 0.92	15.85 ± 1.16

Table 2: Concentrations of heavy metals (mgkg^{-1}) in the leaves of medicinal plants and FAO/WHO recommended values in foods and Vegetables

Levels of Metals in	Pb	Ni	Mn	Cu		Zn	Co	Fe
Plants (mgkg^{-1})								
Cassia occidentalis	0.34	23.30	9.00	13.37		31.67	23.00	13.01
Leptadenia hastata	0.98	20.00	22.00	19.62		40.00	15.67	15.53
Guiera senegalensis	1.02	20.00	22.00	21.00		33.33	20.00	19.00
Mean	0.39	21.10	17.67	18.06		35.00	19.56	15.85
Range	0.34–1.02	20.00–23.30	9.00–22.00	13.37–21.00		31.67–40.00	15.67–23.00	13.01–19.00
	FAO/WHO*	5.00	67.00	500.00	73.00	100.00	50.00	425.00

FAO/WHO Source: = (Jaafar, M.H.B. 2010)
FAO/WHO Source: *= (Opaluwa, O. *et al.*, 2012)

3.0 DISCUSSION

The heavy metal concentrations in all plants were determined after the spectrophotometric analysis (Table 1). The concentrations were calculated as the mean ± standard deviation of each element in the three plants. Pb is a toxic element (Kiyawa, S. A. 2015) that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield (Yahaya, M. 2013). The mean concentration of the metals in *Cassia occidentalis* are found to be in the order: Pb < Mn < Fe < Cu < Co < Ni < Zn. This implies that the concentration of Pb was least compared to the concentration of other metals examined in *Cassia occidentalis*. The plant has reasonable concentration of biological essential heavy metals (Fe, Cu, Ni and Zn). Similarly, concentration of Pb was also least in the other plants compared to the biological essential heavy metals. The means concentration of the metals in *Leptadenia hastata* and *Guiera senegalensis* were found to be in the order: Pb < Fe < Co < Cu < Ni < Mn < Zn and Pb < Fe < Co < Ni < Cu < Mn < Zn respectively. The level of Pb was found to be higher in *Guiera senegalensis* (1.02 mgkg^{-1}) than in *Leptadenia hastata* (0.98 mgkg^{-1}) and *Cassia occidentalis* (0.39 mgkg^{-1})(Wong, M.K. *et al.*, 1993). Reported similar result with our study in which concentrations of 9 heavy metals were determined in 42 Chinese medicinal plants. According to these only a few samples contained relatively higher level of toxic metals including Pb. Similar results were reported by (Naser, H.M. *et al.*, 2010), who carried out an investigation related to heavy metal levels in herbal medicines in Singapore between 1990 and 1997. In contrast to this study, (Naser *et al.*, 2010) reported higher Pb levels than levels in this study but are within ranges set by WHO and Commission of the European Communities (CEC). Nickel (Ni) and Cobalt (Co) were found to be higher in *Leptadenia hastata* than in *Cassia occidentalis* and *Guiera senegalensis*. Zinc (Zn) levels were higher in *Leptadenia hastata* than *Cassia occidentalis* and *Guiera senegalensis*. However, Zn is a mineral element essential for normal growth and development. Although it is essentially important, higher zinc levels (above 100mg/kg) is considered toxic (Jaafar, M.H.B. 2010). Significant amount of Zn are also found in leafy vegetables (Yahaya, M. 2013). Levels of Manganese (Mn), Copper (Cu) and Iron (Fe) were found to be lower in *Leptadenia hastata* as compared with the other two medicinal plants.

4.0 CONCLUSION

The determination of low levels of heavy metals especially highly toxic metals such as Pb and Ni in medicinal plants is very important especially when the cumulative effect of heavy metals in a living organism is considered. This study indicated that heavy metals content of the medicinal plants would not pose toxicity levels. However, consistent and increase exposure of plants to industrial wastes and mining activities in a given area might have potential risk. The result obtained here indicated that the heavy metals observed in this study in the leaves of the selected medicinal plants were within the tolerated limit set by different regulatory agencies and hence is safe for human consumption.

5.0 Recommendation

The results of the study showed that heavy metals' content in the leaves of the medicinal plants used in this study were within acceptable ranges given by the regulating agencies. However continuous waste deposition and establishment of metal industries and mining plants can cause increase deposition and uptake

of these metals by the plants. It is recommended that similar and more researches should be carried out at time intervals ensuring safety of use.

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