Comparative study of heavy metals in some selected medicinal plants

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Abstract

Essential and nonessential heavy metals like Pb, Co, Fe, Zn, Cu, Cd, Cr, Ca, Mg, and Mn were analyzed in four selected medicinal plants such *Asam paya*, *Okoubaka aubrevellei*, *Clove* and *Vitex doniana* leaves by atomic absorption spectrophotometer (AAS). The results showed differences in metal concentrations in the investigated medicinal plants. The concentration of Pb ranged from 0.05-0.29mg/kg on dry wet basis, where as that of Co ranged from 0.04-0.05mg/kg. Fe concentration ranged from 0.11-0.52mg/kg, Zn from 0.03-0.48mg/kg, Cu from 0.32-0.98mg/kg, Cd from 0.30-0.46mg/kg, Cr from 0.02-0.09mg/kg, Ca from 0.21-0.81mg/kg, Mg from 0.12-1.40mg/kg, while Mn from 0.02-0.95 mg/kg respectively. The results indicated that all the investigated heavy metals were below the WHO permissible limit except in *Okoubaka* sample which showed higher concentration of Mg that is above permissible limit of WHO.

Keywords

Atomic Absorption Spectrophotometer (AAS); Heavy metals; Herbs

Introduction

There has been increasing challenges with the use of synthetic drugs, partially because

microorganisms continue to exhibit resistance against these drugs and also the cost of most effective synthesized drugs in the third generation antibiotics are not within the reach of the poor population. All these have led to the gradual shift from these synthetics drugs to plants products of medicinal value [1]. In spite of the importance of medicinal plants, there is need for toxicological test to determine the safety. However, most of the concoctions of the medicinal plant products are not screened for their safety consumption and therefore, worsen the ailment by the overdose intake which is a common phenomenon [2]. In some developing countries, there are insufficient medical setup in its remote areas, thus people from these areas depends on peruse medicines prepared from different medicinal plants for treatments of various diseases like diarrhea, Malaria, Skin infections, diabetes, respiratory problems, bacterial and fungal [3]. Meanwhile, some medicinal plants contribute immensely to the sustenance of human existence in various ways such as food for nutritional purposes, medicine for treatment of infections, and constituent of cosmetics for maintenance of healthy skin. Also, these plants has significant role in the regulation of various body systems. However, the nutritious value as well as the toxicity of the medicinal plants is due to the chemical compositions, trace and heavy metals in them [4]. The aim of this study is to quantify the trace and heavy metals concentration in some selected medicinal plants .Trace metals composition of medicinal plant is of interest because of their essential or toxic nature [5]. Heavy metals have bio-importance as trace element but, the bio-active effects of many of them in human Biochemistry are of great concern [6]. They are natural components of the Earth's crust which cannot be degraded or destroyed. They enter our bodies via food, drinking water and air [7]. Among the known heavy metals are: lead. Mercury, Arsenic, Nickel, Cadmium and Mercury are linked to human poisoning at certain levels. Other heavy metal such as Cobalt and Chromium are required by the body in small amount but can be toxic in larger doses [8, 9].Other sources of heavy metals in the environment include air emissions from automobile exhaust, pesticides leaching into water bodies and processing of wastes from mining industries [10, 11]. Heavy metals are generally present in agricultural soils at low levels due to their cumulative behaviour and toxicity. Furthermore, heavy metals have a potential hazardous effect not only on plants but also on human health [12].

The aim of this study was to identify and quantify the trace and heavy metals concentrations in the four selected medicinal plants.

Material and method

Chemicals and reagents

All chemicals used, namely Concentrated Perchloric acid ($HClO_4$) and Nitric acid (HNO_3), 2 molar solution of HNO_3 and deionized water, were of analytical grade made of BDH and JHD chemicals Ltd Poool England.

Equipment

Atomic Absorption Spectrophotometer (AAS) model VGP, 210 was used for analyzing the heavy metals. All glass wares used were made up of Pyrex and were all soaked with 2M HNO_3 for the whole night, washed with deionized water, and was rinsed twice with deionized water to reduce the chances of interference. Morter and pestle, Mammonlex super blender mill greater model no (4 A0 0018 Type JW 1001), Ohause digital weighing balance model Gallenhamp Deionizer model no (274) and Staurt Scientific Hot-plate model no (S 000100505).

Sample collection and pre-treatment

Samples of aforementioned medicinal plants (*Clove* leave, *Okoubaka aubrevillei* leave, *Vitex Doniana* leave, and *Asam Paya* leave) were sourced from local markets within South East and South West geo-political zones of Nigeria in November 2016. The samples were identified by a taxonomist of the Botany department of Nnamdi Azikiwe University P.M.B. 5025 Awka, Anambra State of Nigeria. Two per each of the four samples were collected. Furthermore, three among the four samples were sourced from one market while one sample was sourced from another market. Also, about 500g twice per each of the four samples were collected. These plants have curative effects in various capacities.

Samples were washed properly with tap water and distilled water to remove dust and other contaminated agents. Furthermore, the samples were dried in a shade at room temperature 22-26°C. The dried sample was ground using Mammonlex super mill greater and was homogenized with morter and pestle. The powdered samples were kept in polyethylene sampling bags separately and ready for digestion.

Digestion algorithm

0.5g of each of the samples was weighed separately into 100ml beakers. 25ml of homogenous solution of HNO_3 and $HCLO_4$ in ratio of 7:3 was added into each of samples. The mixture was heated on a hot plate for digestion at temperature of 95-100°C until dissolution of the sample is completed in the solution. It was allowed to cool and the digest was transferred into 250ml volumetric flask and made up with distilled water to the mark.

All the digested sample solutions were analyzed by AAS which uses acetylene flame and this generate high temperature at the ignition chamber and enhanced reducing settings for the atomization of the respective heavy metals. Each sample solution was aspirated by nebulizer, converted into an aerosol, mixed with gases and conditioned into atomic form. Only a small portion, about 5% of the total sample was allowed to aspirate which significantly controlled interfaces. All the sample solutions were analyzed for the quantification of the following elements: Ca, Mg, Mn, Pb, Fe, Zn, Cu, Co, Cd, and Cr.

Results and discussion

The Table 1 displayed the various concentrations of metals in the samples which include Pb, Co, Fe, Zn, Cu, Cd, Cr, Ca, Mg, and Mn.

Table 1. Concentrations of investigated heavy metals expressed in mg/kg in the leaves of the investigated medicinal plant

	Vitex Doniana	***Okoubaka Aubrevellei***	***Clove***	***Asam Paya Leave***	**WHO Std. in mg/kg**
Pb	0.29	0.20	0.19	0.05	0.05
Co	0.05	0.04	0.04	0.04	
Fe	0.24	0.11	0.44	0.52	50.00
Zn	0.03	0.48	0.39	0.11	50.00
Cu	0.40	0.98	0.87	0.32	10.00
Cd	0.30	0.32	0.40	0.46	1.30
Cr	0.02	0.03	0.05	0.09	1.50
Ca	0.21	0.81	0.60	0.58	0.1-1.5
Mg	0.98	1.40	0.12	0.26	0.1-1.0
Mn	0.07	0.02	0.95	0.24	50.00

Calcium (Ca) is very pertinent to the body because of its various functions in the body such as, strong teeth, strong bone and skeletal building and they are needed in higher percentage and its deficiency could lead to joint pains. *Okoubaka aubrevellei* showed the

highest concentration of calcium, while *Vitex doniana* had the least concentration. *Okoubaka aubrevellei* showed the highest concentration Magnesium, while Clove had the least concentration. Magnesium (Mg) is cofactor in over 300 enzymes system that regulates diverse biochemical reactions in the body including protein synthesis, blood glucose control and blood pressure regulation and also the fourth most abundant mineral in the body, and *Okoubaka aubrevellei* showed highest concentration of it, while clove had the least concentration. Manganese (Mn) plays a vital role in the body physiological processes as a constituent of multiple of enzymes and activator of other enzymes and from the table, clove showed the highest concentration of it, while *Asam paya* showed the least concentration. Furthermore, its deficiency leads to severe skeletal and reproduction abnormalities in mammals and high concentration of Manganese causes hazardous effects on lungs and brains of humans [13]. From the table, *Vitex doniana* indicated the highest concentration of lead, while *Asam Paya* has the least concentration. However, Lead (Pb) is a non-essential heavy metal because it causes oxidative stress and contributes to the pathogenesis of Lead poisoning by disrupting the delicate antioxidant balance of the mammalian cells and also accumulation of Lead in the body causes anemia, colic, headache, brain damage and central nervous system disorder [14]. Iron (Fe) is the most essential constituent for all plants and animals. On the other hand, higher concentration of Iron causes tissues damage and some other diseases in humans. It is also responsible for anemia and neurodegenatic conditions in human being [15]. From the table, *Asam Paya* leave, showed the highest concentration of Iron, while *Okoubaka aubrevellei* has least concentration. *Okoubaka aubrevellei* showed highest concentration of Zinc, while *Vitex doniana* had the least concentration. Moreover, Zinc (Zn) is the basic component of a large number of different enzymes and plays structural, regulatory and catalytic functions. It also has very important role in DNA synthesis, normal growth, brain development, bone formation and wound healing. At higher concentration, zinc is neurotoxin [16]. Copper (Cu) being an essential trace element, it is necessary for many enzymes and also needed for normal growth and development. High concentration of Copper, causes mental fumes fever, hair and skin decolourations, dermatitis, and respiratory tract diseases. Copper (Cu) concentration was found to be highest in *Okoubaka aubrevellei* while, *Asam Paya* leave has the least concentration [17]. Cobalt (Co) was found to be highest in *Vitex doniana*, while the three other samples have the same level of concentration. Meanwhile, Cobalt (Co) is an important element which aids in the formation of Vitamin B12 or Cobalamin. It is also easily

assimilated in the body in the body and stored in the red blood cells, plasma, liver, kidney and pancreases. However, cobalt deficiency could attribute the following, the presence of helminths diseases of the gastro intestinal tract and significant blood loss while in excess. Cadmium (Cd) is a non-essential heavy metal. It is extremely toxic even at low concentration, for it causes learning disabilities and hyperactivity in children. *Asam Paya* showed the highest concentration of cadmium, while *Vitex doniana* had the least concentration. In addition, the recommended level of Cadmium in medicinal plants by WHO is 0.30mg/kg [18]. Chromium (Cr) is an important metal for it aids in the body functioning, especially in the metabolism of cholesterol, glucose and fat. It deficiency causes hyperglycemia, elevated body fat and decreased sperm count, while it is carcinogenic and toxic at higher concentration [19]. Meanwhile, the highest concentration of chromium (Cr) from the table was found in *Asam paya*, while the least concentration was observed in *Vitex doniana*. Furthermore, WHO permissible limit for Chromium in medicinal plant is 1.50mg/kg while its daily dietary intake is 0.2mg [17].

Conclusions

On the basis of the obtained results, it can be concluded that the investigated medicinal plants contained both trace and heavy metals but within the permissible limit and range of World Health Organization (WHO). However, effort should be made by the Health Ministries and Agencies in terms of public enlightenment campaign to sensitized the public especially to those living in the rural communities the dangers and toxicity of some heavy metals precisely Lead (II) and Chromium (III) especially when they are found to be in excess in medicinal plants and food substances. Hence, in this way, the heavy metal toxicity occurs in mankind as a side effect instead of treatment. Hence, in this way, the heavy metal toxicity occurs in mankind as a side effect instead of treatment. Finally, it is essentially required that every medicinal plant should be checked for contaminant load before processing it for further pharmaceutical purposes and for local human consumption.

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