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Investigation Of Heavy Metals Concentration on *Adansonia Digitata* Leaves Consumed in Onda, Nasarawa Local Government Area, Nasarawa State – Nigeria

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Abstract
This work presents an assessment on the concentration of heavy metals in Adansonia digitata leaves consumed in Onda village of Nasarawa Local Government Area, in North central Nigeria. The concentration levels were measured using Atomic Absorption Spectrometer. The results obtained showed that the level of concentration of arsenic, chromium, mercury and lead ranged from 0.33 to 2.48 mg/Kg, 1.88 to 6.25 mg/Kg, 2.52 to 4.19 mg/Kg, and 1.99 to 4.02 mg/Kg respectively. The arsenic, chromium, mercury and lead concentration levels were found to be above the WHO and FAO maximum permissible limits (2016), that is 1.00 mg/Kg, 2.30 mg/Kg, 0.01 mg/Kg and 10.00 mg/Kg respectively, except in zone A and B where the arsenic concentration values were found to be below the WHO and FAO maximum permissible limits with values 0.33 mg/Kg and 0.71 mg/Kg. It is therefore, obvious that the consumption of the Adansonia digitata leaves from the studied area subjects the consumers to health risk resulting from accumulation of all the studied metals which appeared to be above WHO and FAO standards in almost all the zones, in a long run.

Introduction

Adansonia digitata, that is Baobab (commonly identified as Kuka in Northern, Nigeria) is a deciduous tree belonging to the Malvaceae family and is aboriginal in arid central African (Brener *et al.*, 2003). It is widely found in most of Sub-Sahara Africa's, semi-arid and sub-humid regions as well as in the western Madagascar. Because of its outstanding antioxidant and anti-inflammatory properties, various parts of the tree are used for the treatment of different ailments such as Malaria, Diarrhea, DNA damage and microbial infections (Barcelo, *et al.*, 2001; Gebauer, *et al.*, 2002) and also eaten as food, that is to say no part is waste. World Health Organization (WHO) maintained that nearly 70 – 80 % of the world population still largely relies on non – conventional medications, mostly derived from herbal plants. WHO guidelines for the quality assessment of herbal medicines shows the relevance of quality and safety assessment of medicinal plants and their products for the wellbeing of expected users (WHO, 1993), since most of these medicinal plants have heavy metals collected in/on them.

The term heavy metals refer to the natural metallic elements with density greater than 5 g/cm^3 (Jarup, 2003; Diffus, 2002) and are natural components of the earth's crust (Keil *et al.*, 2011). There are many heavy metals among which these four: Lead (Pb), cadmium (Cd), mercury (Hg), and arsenic (As), are of particular concern to health (Jarup, 2003). According to United State Agency for Toxic Substances and Disease Registry (ATSDR), these four heavy metals are the top of the six causative agents of hazards in toxic waste sites. They are highly toxic and can cause damaging effects even at very low concentrations. They tend to accumulate in the food chain and in the body (they are collected into soft tissues (e.g., kidney) and hard tissues (e.g., bone) leading to serious health issues. Therefore, it is imperative that their concentrations and effect be checked or controlled. They are easily spread around because as metals, they have the ability of forming complexes, since they often exist in a positively charged form and can bind on to negatively charge organic molecules. Hence, serious contamination can arise from several sources such as industrial wastes disposal and human activities such as mining, automobile, vehicle emissions, lead-acid batteries, paints, treated woods and aging water supply infrastructure, use of pesticides, fertilizers and fungicides containing heavy metals in agricultural activities, as well as natural source like heavy metal emission from volcanic eruptions, sea-salts, forest fires, rock weathering, biogenic sources and wind-borne soil particles (Masindi & Meudi, 2018; Paul, 2017).

The presence of heavy metals in plants is a unique way by which trace elements in the surrounding environment are transferred to humans through devise activities such as industrial wastes, mining etc. (Masindi & Muedi, 2018). The most essential natural heavy metals (trace elements) are mercury (Hg), chromium (Cr), lead (Pb), copper (Cu), cadmium (Cd), arsenic (Ar), zinc (Zn) (Danuta, *et al.*, 2021). Dissolved elements in plants emit particles which gradually expose living tissues to danger upon accumulation (Alani, 1996; Guber, *et al.*, 2017), resulting in problems like anemia, reproductive and nervous systems complications (Jarup, 2003; Mergler, *et al.*, 2007; Herberg, *et al.*, 2018). Therefore, deliberate measurement and analysis of the concentration of heavy metals in the foods we eat becomes necessary for good health and environmental safety in affirmation to Ajayi and Owalobi, 2018, and to hold on to the suggestion of WHO that herbs and herbal products should not be used without qualitative and quantities analysis of their heavy metal contents (WHO, 2007).

MATERIALS AND METHOD

The materials used for this research include Atomic Absorption Spectrometer (AAS), electronic balance, mortar and pestle, beaker, funnel, volumetric flask, conical flask. Others are measuring cylinder, pipette, water bath, hot plate, plastic containers and oven. Also, analytical reagent (AnalaR) grade chemicals and distilled water were used throughout the study. All glassware and plastic containers used in this work were first washed with detergent solution followed by 20 % (v/v) nitric acid and then rinsed with tap water and finally with distilled water. *Adansonia digitata* leaves were collected from Onda village which lies within the geographical coordinates are $8^0$29'2" N and $7^0$49'37'E (Chukwujama, 2021). It is a village in Nasarawa Local Government Area of Nasarawa State. The samples were plucked from the trees in the respective mapped out zones, then wrapped in black polythene and labeled based on the zones. They were taken to the laboratory where each sample was washed with tap water and thereafter with distilled water and then dried in an oven at 80°C (Sabia, 2015). At the end of the drying, the oven was turned off and left overnight to enable the sample cool to room temperature. Each sample was grounded into a fine powder, sieved and finally stored in a 250 cm^3 screw capped plastic jar appropriately labeled for experimental work.

Plate 1: *Adansonia digitata* leaves powder

The heavy metals in powdered samples were determined at the Muhammadu Buhari TETFUND Centre for Excellence, Federal University Lafia. 2g (0.002 kg) of each of the samples were digested using the method adapted by Sobia in 2015. The digest of each sample was diluted with 20 cm^3 (0.02 liters) of distilled water and boiled for 15 minutes. This was then allowed to cool, transferred into 100 cm^3 (0.1 liters) volumetric flasks and further diluted to the mark with distilled water. The sample solution was then filtered through a filter paper into a screw capped polyethylene bottle.
An AAS machine (AA320N) that is equipped with photomultiplier tube detector and hollow cathode lamps was used for the determination of metal concentrations. Working standards were also prepared by further dilution of 1000 ppm stock solution of each of the metals concentration of the metals was measured in mg/l and converted to mg/kg.

RESULTS AND DISCUSSION

The levels of As, Cr, Hg and Pb in *Adansonia digitata* leaves samples were analyzed and the results shown all the samples as having detectable levels of all metals investigated. All analysis was performed in triplicates. Results were expressed by means of ±SD. Statistical significance was established using one-way analysis of variance (ANOVA). Means were separated according to Duncan's multiple range analysis ($p < 0.05$) using software SPSS 16.0

Table 1: The heavy metals concentration (mg/Kg) in *A. digitata* leaves.

Zones	As	Cr	Hg	Pb
A	0.330	1.880	2.520	4.020
B	0.710	3.510	4.190	2.580
C	1.970	6.250	3.750	2.130
D	2.480	3.900	3.690	1.990

2016 WHO - MPL	1	0.25	0.01	0.3

Abbreviation:
mg/Kg: Unit of concentration
WHO-MPL: World Health Organization Maximum Permissible Limit

Tests of Between-Subjects Effects

Dependent Variable: Heavy Metal Concentration

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	150.302[a]	7	21.472	14.566	.000
Zones	3.751	3	1.250	.848	.502
Metals	14.991	3	4.997	3.390	.067
Error	13.267	9	1.474		
Total	163.570	16			

a. R Squared = .919 (Adjusted R Squared = .856)

Amongst the metals assessed, Chromium (Cr) was found to be the element with the highest concentration (6.25 mg/Kg), particularly in zone C compare to the rest of the elements in all the samples.

From Table 1, it is indicative that arsenic has the lowest concentration (0.33 mg/Kg) while lead has the highest concentration (4.02 mg/Kg) in zone A. In zone B, arsenic has the lowest concentration of 0.71 mg/Kg and mercury has the highest with concentration value 4.19 mg/Kg. Also, in zone C arsenic concentration was the lowest with 1.97 mg/Kg and chromium has the highest concentration of 6.25 mg/Kg and from zone D, lead happens to be with the lowest concentration of 1.99 mg/Kg as chromium has the highest concentration to be 3.90 mg/Kg.

Overall, arsenic has the lowest concentration of 0.33 mg/Kg and chromium has the highest concentration of 6.25 mg/Kg.

In comparison with the WHO and FAO maximum permissible limit (2016), the concentration of arsenic in zone A and B stood at 0.33 mg/Kg and 0.71 mg/kg which are below or within the WHO and FAO permissible limit (1 mg/Kg). However, in zone C and D, the arsenic concentration was 1.97 mg/Kg and 2.48 mg/Kg and above the maximum permissible limit.

The concentration of Chromium across the zones ranged from 1.88 to 6.25 mg/Kg and are far above the 2016 WHO and FAO maximum permissible limit by WHO (0.25 mg/Kg). However, the concentration of mercury (Hg) ranged from 2.52 to 4.19 mg/Kg across the samples, these values are above the maximum permissible limit (0.01 mg/l) as specified by WHO and FAO (2016) showing obvious signs of environmental contamination or food poisoning. The environmental contamination by mercury could probably be from soil erosion. It could also be attributed by extensive chemical fertilizers used in the area as well as aerosols.

Lead concentration ranged from 1.99 to 4.02 mg/Kg and its lowest concentration was obtained in zone A, while the highest concentration was obtained in zone B. The values of lead in all the zones were also above the WHO and FAO acceptable limit (0.3 mg/Kg).

The statistical analysis showed that there is no significant difference amongst the concentration values of the metals in the four zones.

CONCLUSION

The overall contrast showed that all the metals in all the zones except arsenic in zone A and B have their concentrations higher than the acceptable limits of WHO and FAO of 2016. This implies that the consumers of the studied leaves whether within or outside the studied area are at the possible risk of toxic effects from accumulation of these metals. It is therefore advisable that the consumers or users should occasionally go for medical checkup. The government can as well help by identifying and putting in place measures to reduce human exposure to such risk resulting from accumulation of elements that pose danger to health.

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Appendix 1: Google Map showing the location of Onda