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Determination of Heavy Metals (Lead, Zinc, Nickel and Cadmium) in Medicinal Plants (Scent Leaf and Pawpaw) in Bayelsa State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study investigated the level of zinc, nickel, lead and cadmium in selected medicinal plants - Scent Leaf (*Ocimum gratissimum*) and Pawpaw (*Carica papaya*) that are traditionally used in alternative medicine in Amassoma community, Bayelsa State, Nigeria.
Study Design: Scent leaf (*Ocimum gratissimum*) and Pawpaw *(Carica papaya)* from where these plants are grown were randomly collected for heavy metal analysis from within Amassoma community in Southern Ijaw Local Government Area of Bayelsa State, Nigeria
Place and Duration of Study: This study was carried out in Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Amassoma, Bayelsa State between March 2019 to September 2019
Methodology: Scent leaf (*Ocimum gratissimum*) and Pawpaw *(Carica papaya)* were digested and analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS, model S471096). The method used was wet-ashing method for the analysis.

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Results: The result showed that the concentration of Lead in the pawpaw fruit with 5.99mg/kg and pawpaw seed with 3.72mg/kg, were above the WHO permissible limit. While the concentration of Cadmium in the pawpaw fruit, pawpaw leaf, pawpaw seed and scent leaf with 1.32mg/kg, 0.96mg/kg, 0.21mg/kg, and 0.59mg/kg, were all above the permissible limits. Again, Zinc in the pawpaw fruit, pawpaw leaf, pawpaw seed and scent leaf were 2.52mg/kg, 2.53mg/kg, 5.30mg/kg, and 0.79mg/kg respectively, and these are also above the permissible limit. While that of the concentration of Nickel in the pawpaw fruit, pawpaw leaf, pawpaw seed and scent leaf were observed to be within permissible limit.

Conclusion: It is therefore recommended that caution should be taken when such plants are to be used as alternative to conventional medicine as excess of it could pose the risk of bioaccumulation and possible health effects in humans.

Keywords: Carica papaya; heavy metals; Ocimum gratissimum; pawpaw; permissible limit; scent leaf.

1. INTRODUCTION

Heavy metals are hazardous contaminants in food and the environment and they are non biodegradable having long biological half-lives [1]. The implications associated with heavy metals contamination are of great concern, particularly in agricultural production systems [2,3] due to their increasing trends in human foods and environment. Food safety has been a general concern in recent years [4,5]. The Nigerian contemporary society is characterized by the use of traditional medicine in treating various illnesses, as the uses of scientific medications have proven nearly impossible because of poverty. As defined by the World Health Organization [6], a medicinal plant is any plant which in one or more of its organs contains substances that can be used for the therapeutic purposes or which are precursors for the synthesis of useful drugs. Schmelzer & Gurib-Fakin [7] pointed out that they contribute significantly to rural livelihoods of the people and social equilibrium in Africa. Man's life and survival would be impossible without 'symbiosis' with, and extensive use of plants and plant products. The World Health Organization [8] redefined traditional medicine (TM) as comprising therapeutic practices that have been in existence, often for medicine and are still in use today. These practices vary widely in relation to the social and cultural heritage of different countries. According to Sofowora [9], the practitioners of traditional medicine could serve as additional sources of health manpower in developing countries such as Nigeria. Traditional plant uses can be inventoried for present day use, adaptation, or for future survival. Most times, traditional medicines are gotten from plants which over the years have been proven to solve various health issues. Even though these medicinal plants did not go through the scientific rigor to ascertain the real implications of the substances contained in them, they have been believed to be the cure for many illnesses. This is evident as the World Health Organization (WHO) estimates, that nearly 70–80% of the world population still primarily relies on nonconventional medications, mostly derived from plants [10;11]. It has gone to the point where such plants are deliberately planted basically for medical use. For instance, the scent leaf plant is a plant eaten by the Amassoma indigenes as vegetable and it is nutritionally important as a seasoning partly because of its aromatic flavor. It is also reported that they also use it in the care of a baby's umbilical cord because of its sterile action on the umbilical wound surface. Phytochemical evaluation of this plant has revealed its rich contents to include alkaloids, flavonoids, tannin, phytates and oligosaccharides. This could be the reason that they are seen as a cure of various ailments, [12]. It is also observed that in Amassoma, the scent leaf is used as antimalaria, mosquito repellent and anticonvulsant. The juice of this plant is used as anticonvulsant, smooth muscle relaxant, anti-catarrh and against headache. Oil produced from the plant has been proven to posses' antibacterial, antifungal and antiseptic, antibacterial activities. Milky latex may cause dermatitis; Hypoglycemic activity has been shown experimentally. The inner bark of Samoa Amebicide - latex and seeds are used in Central America to kill *Entamoeba histolytica* which causes dysentery and liver abcesses, Cosmetics - pawpaw fruit pulp is the basic component of many facial creams, salves, and shampoos.

However, human industrial activities such as the practice disposal of industrial wastes, automobiles exhaust, refuse burning and use of pesticides in agriculture, have contaminated the agricultural soils with heavy toxic metals such as zinc (Zn), iron (Fe), lead (Pb), cadmium (Cd) and chromium (Cu), which can potentially lead to the uptake and accumulation of these metals in the medicinal plants parts. These are a source of possible health risk factors to the health of plants and animal. Research has shown that plants are crucial in humans getting contaminated by heavy metals via the soil because these heavy metals have the capacity to form concentrates in the normal ecological food chain. The low excretory capability of the kidneys with respect to heavy metals which has consequent deleterious health effects is the reason the WHO has recommended allowable limits of commonly used heavy metals on plants which when taken will have no or minimal effect on human health. Even though certain metals such as zinc, copper, iron, manganese, and chromium are essential nutrients, increase in their intake above certain permissible limits can become toxic [13;14]. In general, health problems have been related with large dietary uptake of heavy metals.

These include a decrease in immunological defenses, cardiac dysfunction, fatal malformation, impaired psychosocial and neurological behaviors, gastrointestinal cancer, and many others [15;16]. This study focuses on investigating the level of concentration of some selected heavy metals found mostly in medicinal plants and in the associated soils in Amassoma, Bayelsa State and also compare the concentrations with the permissible limits recommended by the WHO.

2. MATERIALS AND METHODS

2.1 Sample Area

Amassoma community in Southern Ijaw LGA, Bayelsa State of Nigeria was selected for sampling. Sampling was done at random from three different locations within Amassoma metropolis. These locations were selected at random to centralize the sample stations within the community (Sample location) as shown in Figure 1. Geographically, sample area has land mass of 2,682km^2 and a population of 319413 at the 2006 census. The people are predominant farmers, fishermen, business men and civil servants.

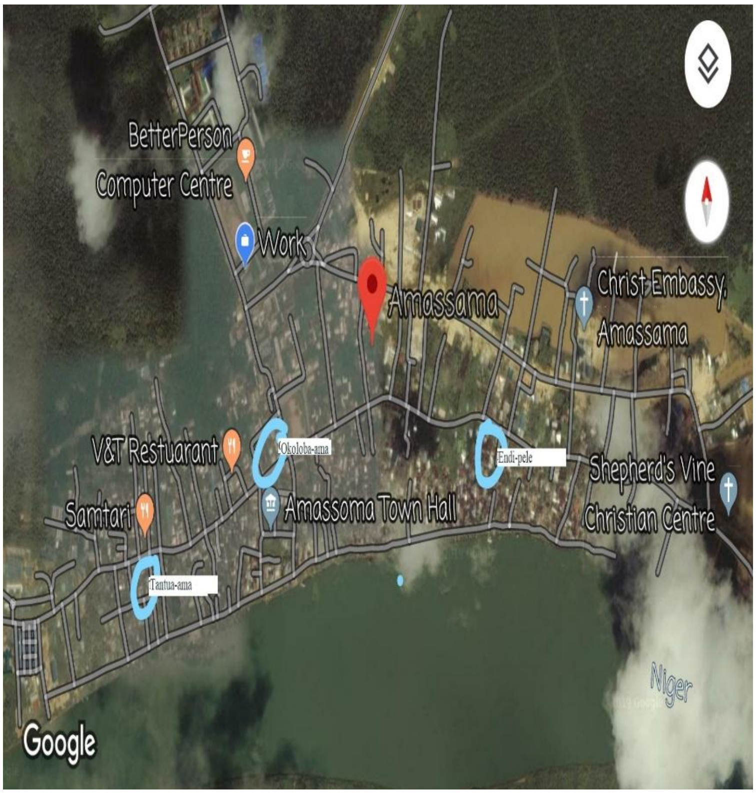

Fig. 1. Study Area Map (Amassoma Community), Showing sampling sites

2.2 Plant Sample Collection and Preparation

Samples used for this study were Scent leaf (*Ocimumgratissimum*) and pawpaw (*Carica papaya*).

pawpaw (*Carica papaya*)

Scent leaf (*Ocimumgratissimum*)

These samples were obtained at random from three different sample locations in Amassoma community. The pawpaw fruit and leaf were plucked from Pawpaw tree with a stick and scent leaf was cut with a knife. The used plants were selected because of their frequent use for nutrition and medicinal purpose by the people in the sample area. The most commonly used parts of each plant were considered as experimental target. All plant samples were washed clean using distilled water and dried under shade for accuracy of results and to avoid sample contamination. All reusable laboratory wares were washed thoroughly and rinsed with distilled water.

2.3 Plant Parts Studied

Pb, Cd, Ni, and Zn were determined from the leaves, seeds and fruits of pawpaw, and scent leaf, and the soil. These parts where collected for sampling because of their ability to bioaccumulate or biomagnified heavy metals. That is, they serve as pockets for heavy metal storage. To achieve this, freshly collected plant samples were stored in separate polythene bags and then transported to the laboratory for processing.

2.4 Sample Analysis

Beakers and flasks, Solar thermo elemental atomic absorption spectrophotometer (Flame AAS), Burner, Hollow cathode lamps, Graphical display and recorder, Pipette (micro liter with disposal tips), Pressure reducing valves, Glassware, Volumetric flask of suitable precision and accuracy.

Air, Acetylene, Metal free water, Stock metal solution, Potassium chloride solution, Aluminium nitrate solution, Hydrogen tetraoxosulphate (vi) acid (H_2SO_4), Trioxonitrate (v) acid (HNO_3), Perchloric acid ($HCLO_4$).

A total volume of 100ml of H_2SO_4, HNO_3, and HCIO in the ratio of 40%: 40%: 20% was mixed together. A portion (1g) of the sample was weighed into a conical flask; 2ml of the mixed acid was taken to each of the sample in the conical flask. It was digested in a fume cupboard with hot plate until white fumes appeared. After that, it cooled and was filtered into 100ml volumetric flask and made up to mark with distilled water [17].

This technique operates on Beer-Lambert's law which states that Absorbance is directly proportional to concentration. Hence, absorption spectrometry is used to evaluate the concentrations of analyte in a sample; it requires standards with known analyte concentrations. The light source is a lamp with a cathode of the same element being determined since each element has a characteristic wavelength that is readily absorbed. An AAS consists of an atomizer burner to convert the element in the solution to free atoms in an acetylene flame, a monochromatic to disperse and isolate emitted and a photomultiplier to detect and amplify the light transitory through the monochromatic into its component wavelength. The photomultiplier then receives only the isolated resonance wavelength and absorption of its light by the sample. After proper lamp for the test element has been inserted, the intensity of the light is measured by passing through the unrestricted flame. Then the sample is introduced into the flame and the concentration of the elements in the sample is determined by the increase in light intensity.

2.5 Statistical Analysis

The samples of this study were analysed using the Statistical Programme for Social Sciences

(SPSS). A t test was used to determine the significant difference between the means of the various sample, using P < 0.05 level of significance.

3. RESULTS AND DISCUSSION

The results obtained revealed that the concentrations of Lead, Cadmium and Zinc in plants are above the WHO permissible limits but that of Nickel are within the allowable limit. The heavy metals concentrations in pawpaw and scent leaf soil were within the allowable safety limits as recommended by WHO.

Table 1 below shows the mean concentration, standard deviation and the differences between the concentration mean and the recommended permissible limit by WHO of Lead (Pb) in pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf in mg/kg. The table shows that the average amounts of Pb in pawpaw fruit, pawpaw leaf, papaw seeds and scent leaf was 5.99mg/kg, 1.09 mg/kg, 3.72 mg/kg, and 1.0967 mg/kg, respectively, with observed standard deviations of 4.5210, 0.10536, 4.69751, and 0.05508, respectively.

Also, the table compared the average value of Pb in pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf with the allowable permissible limit of Pb recommended by WHO. The table shows that the mean difference for pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf were 3.99, -0.91, 1.72, and -0.90, respectively, when compared with the allowable limit of 2 mg/kg recommended for Pb by WHO.

The pawpaw fruit sample shows that P= 0.266 at P<0.05. This shows that the sample's mean was not significantly different. The pawpaw leaf sample shows that P= 0.004 at P<0.05. This shows that the mean of the sample was significantly different. The pawpaw seed sample shows that P= 0.591 at P<0.05. This shows that the mean of the sample was not significantly different. The scent leaf sample shows that P= 0.001 at P<0.05. This shows that the mean of the sample is significantly different.

Table 2 shows the mean concentration, standard deviation and the differences between the concentration mean and the recommended permissible limit by WHO of Cadmium (Cd) in pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf in mg/kg.

The Table 2 shows that Cd average amount in pawpaw fruit, pawpaw leaf, papaw seeds and scent leaf were 1.32 mg/kg, 0.96mg/kg, 0.21mg/kg, and 0.59mg/kg respectively, with observed standard deviations of 0.99, 1.24, 0.05, and 0.56, respectively.

Table 2 shows that the mean difference for pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf are 1.20, 0.94, 0.19, and 0.57, respectively, when compared with the allowed permissible limit of 0.02 mg/kg recommended by WHO. The pawpaw fruit sample shows that P= 0.151 at P<0.05. This show that the sample's mean was not significantly different. The pawpaw leaf sample shows that P= 0.320 at P< 0.05. This shows that the sample's mean was not significantly different. The pawpaw seed sample shows that P= 0.019 at P<0.05. This shows that the sample's mean was significantly different. The scent leaf sample shows that P= 0.22 at P<0.05. This shows that the sample's mean was not significantly different.

Table 1. Descriptive statistics on the concentration of lead in theplant samples with the permissible limit recommended by WHO

Treatment	WHO permissible limit = 2					
	T	**df**	**Sig. (2-tailed)**	**Mean**	**Mean Difference**	**Std. Deviation**
Pawpaw Fruit	1.529	2	0.266	5.990	3.99000	4.52103
Pawpaw Leaf	-14.960	2	0.004	1.090	-.91000	0.10536
Pawpaw Seed	0.633	2	0.591	3.716	1.71667	4.69751
Scent Leaf	-28.409	2	0.001	1.097	-.90333	0.05508

Table 2. Descriptive Statistics on the Concentration of Cadmium in thePlant Samples with the Permissible Limit Recommended by WHO

Treatment	WHO permissible limit= 0.02					
	T	df	Sig. (2-tailed)	Mean	Mean Difference	Std. Deviation
Pawpaw Fruit	2.272	2	0.151	1.3167	1.29667	0.98855
Pawpaw Leaf	1.313	2	0.320	0.9633	0.94333	1.24420
Pawpaw Seed	7.086	2	0.019	0.2133	0.19333	0.04726
Scent Leaf	1.762	2	0.220	0.5867	0.56667	0.55717

Table 3. Descriptive Statistics on the Concentration of Nickel in the Plant Samples with the Permissible Limit Recommended by WHO

Treatment	WHO permissible limit = 10					
	T	df	Sig. (2-tailed)	Mean	Mean Difference	Std. Deviation
Pawpaw Fruit	-3.731	2	0.065	3.7633	-6.23667	2.89517
Pawpaw Leaf	-2.340	2	0.144	3.4700	-6.53000	4.83243
Pawpaw Seed	-2.322	2	0.146	4.7667	-5.23333	3.90396
Scent Leaf	-3.224	2	0.084	2.8100	-7.19000	3.86268

Table 4. Descriptive Statistics on the Concentration of Zinc in thePlant Samples with the Permissible Limit Recommended By WHO

Treatment	WHO permissible limit= 0.06					
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Std. Deviation
Pawpaw fruit	1.333	2	0.314	2.5167	2.45667	3.19193
Pawpaw Leaf	1.321	2	0.318	2.5300	2.47000	3.23969
Pawpaw Seed	2.361	2	0.142	5.3033	5.24333	3.84713
Scent Leaf	25.749	2	0.002	0.7933	0.73333	0.04933

Table 3 shows that the average amounts of Ni in pawpaw fruit, pawpaw leaf, papaw seeds and scent leaf was 3.76mg/kg, 3.47mg/kg, 4.77mg/kg, and 2.81mg/kg respectively, with the observed standard deviations of 2.80, 4.83, 3.90, and 3.86 respectively. The table also compares the average value of Ni in pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf with the allowed permissible limit of Ni recommended by WHO. The table shows that the mean difference for pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf were -6.24, -6.53, -5.23, and -7.19 respectively when compared with the allowable limit of 10 mg/kg recommended by WHO. The pawpaw fruit sample shows that P= 0.065 at P<0.05. This show that the sample's mean was not significantly different. The pawpaw leaf sample shows that P= 0.144 at P< 0.05. This shows that the sample's mean was not significantly different. The pawpaw seed sample shows that P= 0.146 at P<0.05. This shows that the sample's mean was not significantly different. The scent leaf sample shows that P= 0.084 at P<0.05. This shows that the sample's mean was not significantly different.

The table shows that the average Zn in pawpaw fruit, pawpaw leaf, papaw seeds and scent leaf were 2.52mg/kg, 2.53mg/kg, 5.30mg/kg, and 0.79mg/kg respectively, having standard deviations of 3.19, 3.24, 3.84, and 0.05 respectively. The table also compares the average value of Zn in pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf with the allowable limit of Zn recommended by WHO.

The mean difference for pawpaw fruits, pawpaw leaf, pawpaw seeds and scent leaf were 2.46, 2.47, 5.24, and 0.73 respectively when compared with the allowable limit of 0.06 mg/kg recommended by WHO. The pawpaw fruit sample shows that P= 0.314 at P<0.05. This show that the sample's mean was not significantly different. The pawpaw leaf sample shows that P= 0.318 at P< 0.05. This shows that the sample's mean was not significantly different. The pawpaw seed sample shows that P= 0.142 at P<0.05. This shows that the sample's mean was not significantly different. The scent leaf sample shows that P= 0.002 at P<0.05. This shows that the sample's mean was significantly different.

4. CONCLUSION

The study above showed the presence of the selected heavy metals in the medicinal plants sampled. Furthermore, the concentration of lead (Pb) in pawpaw fruit and leaf were above the allowable limit.

Thus, it may not be appropriate for human intake because it could lead to lead poisoning. While the pawpaw seed and scent leaf were below the allowable limits of lead (Pb). Thus, it will not cause harm if taken by humans. The heavy metals in papaw fruit, pawpaw seed, pawpaw leaf and scent leaf were above the allowable limits of Cadmium (Cd). Thus, they may not be appropriate for human intake because the potentials to affect body mechanisms and risks of cancer, cardiac diseases, and osteoporosis [18].

The Nickel (Ni) contents in papaw fruit, pawpaw seed, pawpaw leaf and scent leaf were below the allowable limits. Therefore, they may be appropriate for human intake. The Zinc (Zn) contents in papaw fruit, pawpaw seed, pawpaw leaf and scent leaf were above the allowed limits. Thus, they may not be appropriate for human intake as excess intake of zinc suppresses copper and ferrous absorption [19]. Finally, the papaw soil and scent leaf soil are below the lead (Pb), Nickel (Ni), cadmium (Cd), and Zinc (Zn) permissible limits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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