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Original Research Paper

Evaluation of heavy metals in orange, pineapple, avocado pear and pawpaw from a farm in Kaani, Bori, Rivers State Nigeria

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Eight heavy metals, Cd, Cu, Zn, Fe, Pb, Ni, Mn and Co were determined in four fruits namely: avocado pear, orange, pawpaw and pineapple using Atomic Absorption Spectroscopy (AAS) after wet digestion. The results obtained showed high levels of Cd (0.08-0.22 mg/kg), Cu (0.23-5.29 mg/kg), Fe (19.0-29.6 mg/kg), Pb (1.69-5.80 mg/kg), Ni (1.16-5.87 mg/kg), Mn (1.03-12.6 mg/kg), and Co (1.43-3.56 mg/kg) in all the four fruits studied. The concentration of Cu in avocado, pawpaw and pineapple exceeded the permissible limit of 0.05-0.5 mg/kg. Concentrations of Zn in all the four fruits were below the permissible limit of 99.40 mg/kg. The concentrations of Fe, Pb, Ni and Mn in all the four fruits exceeded the permissible limits, of 0.8 mg/kg, 0.20 mg/kg (0.l mg/kg for orange), 0.14 mg/kg and 0,30 mg/kg respectively, while Co concentrations were within the acceptable limits except in pawpaw which exceeded the permissible limit of 2.00 mg/kg. The order of concentration of heavy metals is: Fe>Zn>Pb>Ni>Cu>Co>Mn>Cd. The levels of concentrations recorded for Pb, Ni and Cd in these fruits are not acceptable as these heavy metals have been categorized as carcinogens.

Key words: farm, Kaani, carcinogens, diseases

INTRODUCTION

Fruits are widely used for culinary and dietary purposes. They are made up of chiefly cellulose, hemi-cellulose and pectin substances that give them their texture and firmness. Fresh fruits and vegetables are of great importance in the diet because of the presence of vitamins and mineral salts. In addition, they contain water, calcium, iron, sulphur and potash (Sobukola et al., 2007). They are very important protective foods and quite useful for the maintenance of health and the prevention and treatment of various diseases (D'Mello, 2003). Regular consumption of fruit is associated with reduced risk of cancer, cardiovascular diseases (especially coronary heart disease), stroke, Alzheimer disease, cataracts, and some of the functional declines associated with aging (Liu, 2003).

However, the health benefits of consuming fruits can be diminished by heavy metals contamination. These metals are extremely persistent in the environment. They are nonbiodegradable and themostable and these readily accumulate and thus readily accumulate to toxic levels (Sharma et al., 2007). Dietary exposure to heavy metals, namely Cd, Pb, Zn, Cu has been identified as a risk to human health through the consumption of vegetable crops (Katchenko and Singh, 2006). At higher concentrations, they may be toxic to the biota and could disturb the biochemical process and cause hazards (Anju et al., 2011). Many metals such as arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni) and their compounds may be mutagenic (Valko et al., 2005) at levels above the maximum permissible limits. Mutagens are capable of causing mutations in the DNA of an organism above the natural background level. These mutations cause cancer. Some metals such as As, Cd and Pb can volatilize during high temperature processing. These metals will convert to oxides and condense as fine particulates (Smith et al., 1995).

Refining process and gas flaring also releases streams of

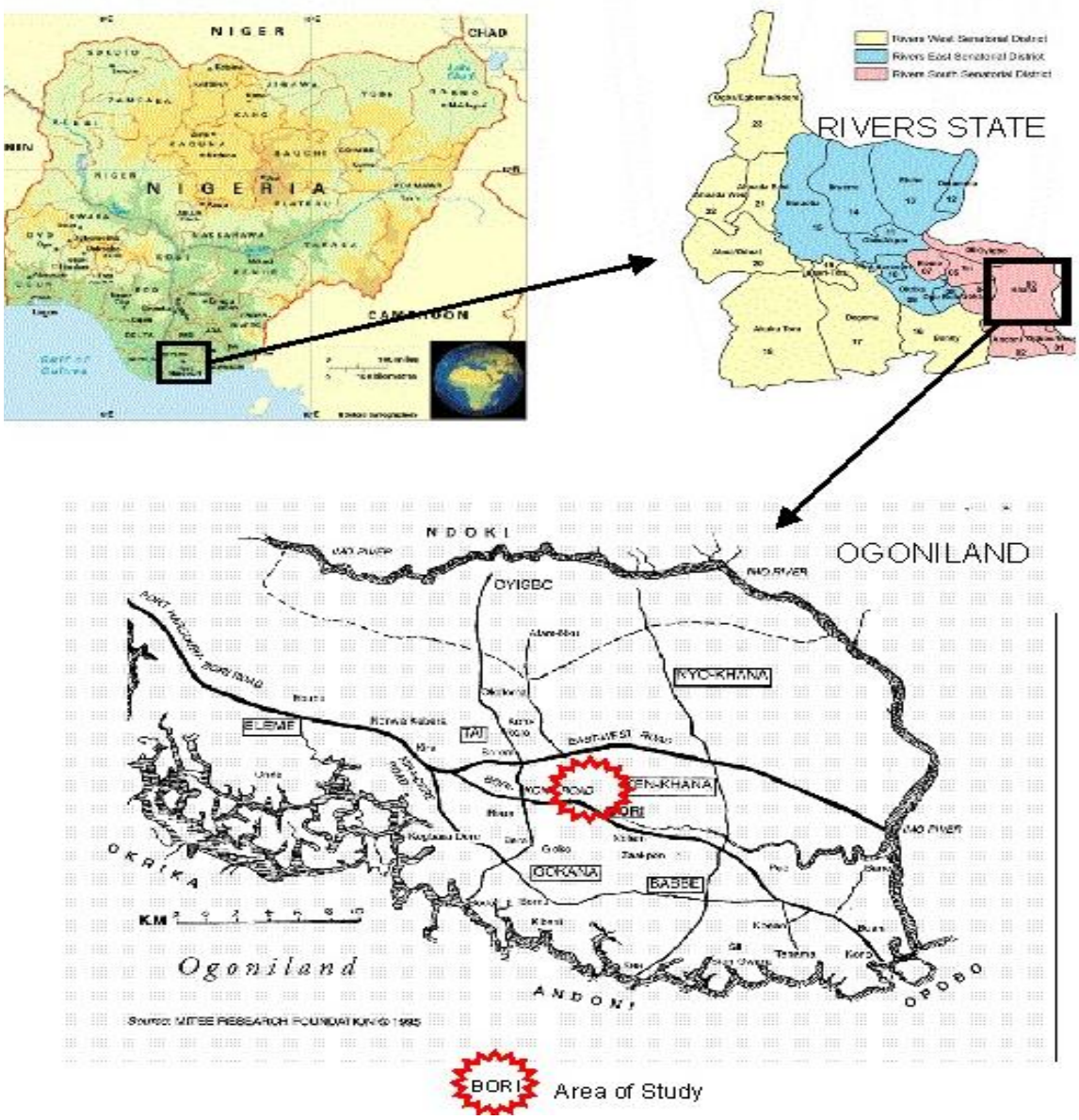

Figure 1: Map showing Nigeria, River State and Ogoniland

vapours, gases, harmful effluents and emissions. Stack emissions can be distributed over a wide area by natural air currents until dry and /or wet precipitation mechanisms remove them from the gas stream (Wuana and Okieimen, 2011)

Research studies have been carried out on the levels of heavy metals in a variety of fruits cultivated in other parts of Southern Nigeria (Orisakwe et al, (2012), Sobukola et al, (2010), Rapheal et al (2011), but not in Kaani which is one of the communities in Ogoniland. It has been under tremendous effect of environmental pollution since oil was discovered within and around the community. It is located on 4.67 latitude and 7.37 longitudes, a distance of 30.15km from the Port Harcourt refinery in Alesa, Eleme where gas flaring is still ongoing. Due to the high level of environmental pollution in the area, this study was carried out as a first step evaluation of heavy metals contamination in these fruits and is a prelude for further studies into soil-to-plant metal transfer in fruits and vegetables in Kaani. (Figure 1)

MATERIALS AND METHODS

Sample collection

A total of four fresh fruit samples were collected from a farm in Kaani, Bori, Rivers State. The fruit samples include

Table 1: Concentrations of heavy metals in the fruits juices (mg/kg)

Heavy Metals	Fruits				Average Concentration (mg/kg)	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	WHO/FAO Acceptable Limit (mg/kg)
	Avocado pear	Orange	Pawpaw	Pineapple				
Cadmium (Cd)	0.15	0.10	0.22	0.08	0.13	0.08	0.22	0.10
Copper (Cu)	3.10	0.23	5.29	0.64	2.31	0.23	5.29	0.05 – 0.5
Zinc (Zn)	8.87	7.22	7.31	6.78	7.54	6.78	8.87	99.40
Iron (Fe)	28.60	19.0	29.60	25.70	25.70	19.00	29.60	0.80
Lead (Pb)	1.69	5.80	5.57	5.01	4.52	1.69	5.80	0.20 (0.1 for orange)
Nickel (Ni)	3.34	2.99	5.87	1.16	3.34	1.16	5.87	0.14
Manganese (Mn)	1.31	1.09	1.03	2.60	1.50	1.03	2.60	0.30
Cobalt (Co)	1.62	1.67	3.56	1.43	2.07	1.43	3.56	2.00

pineapple, pawpaw, avocado and orange. Four fruits each were picked from four different trees for each type of fruit. The samples were placed in polythene bags and stored in refrigerator (<4°C) until analyzed.

Sample preparation and digestion

The fruit samples were washed thoroughly under running tap water and peeled. The juice was extracted using a domestic blender and filtered using a sieve. 2g of the sample juice was weighed out on a weighing balance and put in a beaker and 10mL of a mixture of nitric acid and perchloric acid in the ratio (4:1) was added to each sample and heated on a hot plate in a fume chamber until all the fumes were given off. Then the digested samples were allowed to cool and acidified with 10mL of 1:1 mixture of HCl: H_2O. This was transferred to a 50mL volumetric flask and made up to mark with deionized water (AOAC, 2000). The digested samples were transferred into plastic bottles and taken for analysis.

Analysis

The analytes were quantified using AAS (Atomic Absorption Spectroscopy), GBC Avanta model.

RESULTS AND DISCUSSION

Table 1 shows the concentrations of heavy metals investigated in fruits consumed in Kaani, Bori, and the maximum permissible limits by WHO and FAO. The plots of the metal concentrations in these fruits are presented in Figures 2 to 9.

Cadmium (Cd) is a non-essential element in food and natural waters and it accumulates principally in the kidneys and liver. From this study, its concentration is high in avocado pear (0.15 mg/kg) and pawpaw (0.22 mg/kg) compared to other published results on these fruits by Orisakwe et al, (2012) and Sobukola et al, (2010) the maximum permissible limit of 0.1 mg/kg by WHO and FAO. These high values may be attributable to the prevailing environmental pollution from the refinery and gas flaring. Its concentration in orange was found to be 0.10 mg/kg which is within the permissible limit and 0.08 mg/kg for pineapple which is below the permissible limit. This is presented in Figure 2.

Copper (Cu) is an essential trace element required for proper health in an appropriate limit. Its high uptake in fruits can be harmful for human health and in the same way; lower uptake in human consumption can cause a number of symptoms like growth retardation, skin ailments, gastrointestinal disorders, etc. From this study, its concentration ranged between 0.23 mg/kg for orange to 5.29 mg/kg for pawpaw. Avocado pear was found to be 3.10 mg/kg and pineapple was 0.64 mg/kg. The results obtained from this study and presented in Figure 3, were observed to be 10 times higher than the maximum permissible limit of 0.05 - 0.5 mg/kg by WHO and FAO, except for orange. Sobukola et al, (2010) have reported 0.015 mg/kg, 0.002 mg/kg, 0.003 mg/kg and 0.009 mg/kg for pineapple, orange, pawpaw and banana respectively.

Zinc (Zn) is an important component of many vital enzymes. Some of the symptoms of any acute oral intake include vomiting, tachycardia, nausea, vascular shock and pancreatic disorder. The concentrations of Zn from this study were found to be about 10 times lower in all the tested samples compared to the maximum permissible limit of 99.40 mg/kg by WHO and FAO and are presented in Figure 4. The highest concentration of zinc was found in avocado pear (8.87 mg/kg), while the lowest, was found in pineapple (6.78 mg/kg). Its concentration in pawpaw was 7.31 mg/kg and 7.22 mg/kg in orange. These values were observed to be very high compared to results from similar analysis by Sobukola et al., 2010.

Iron (Fe) is an essential element in man and plays a vital role in the formation of haemoglobin, oxygen and electron transport in human body. The concentrations of iron from this study which are presented in Figure 5 were found to be 28.6 mg/kg for avocado pear, 19.00 mg/kg for orange, 29.60 mg/kg for pawpaw and 25.70 mg/kg for pineapple. These values are about 30 times higher than the

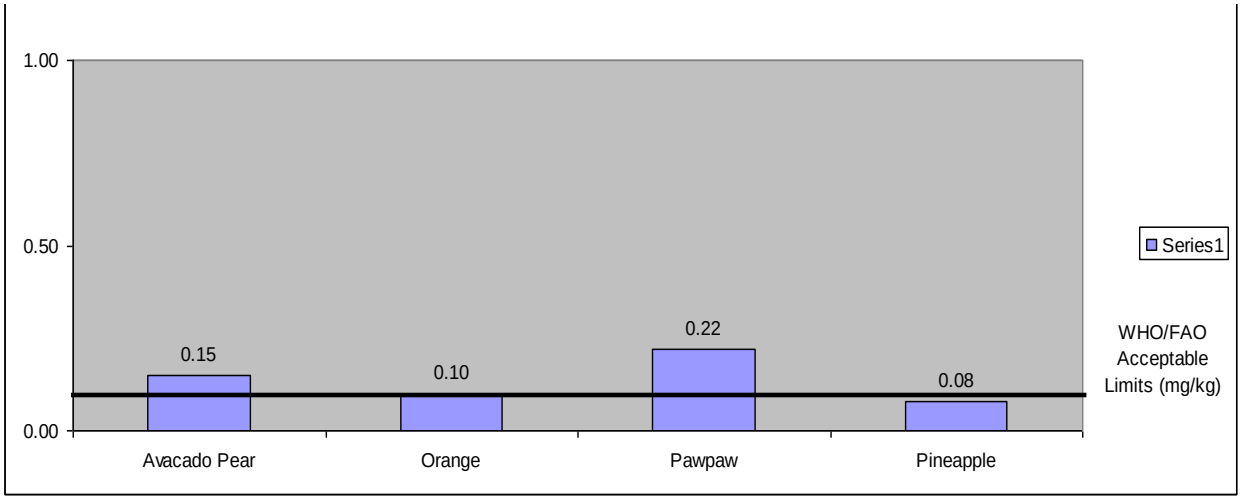

Figure 2: Concentration (mg/kg) of Cd for the fruits

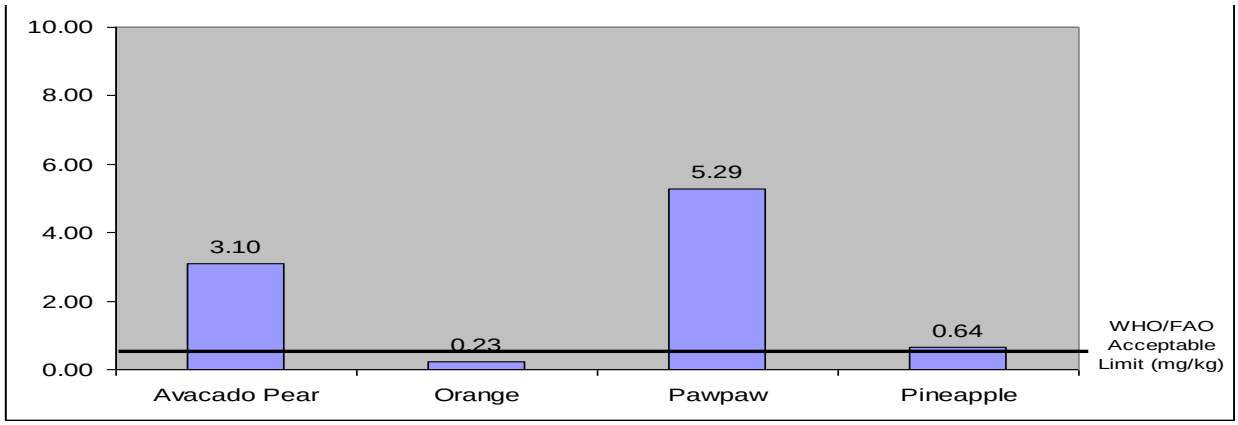

Figure 3:Concentration (mg/kg) of Cu for the fruits

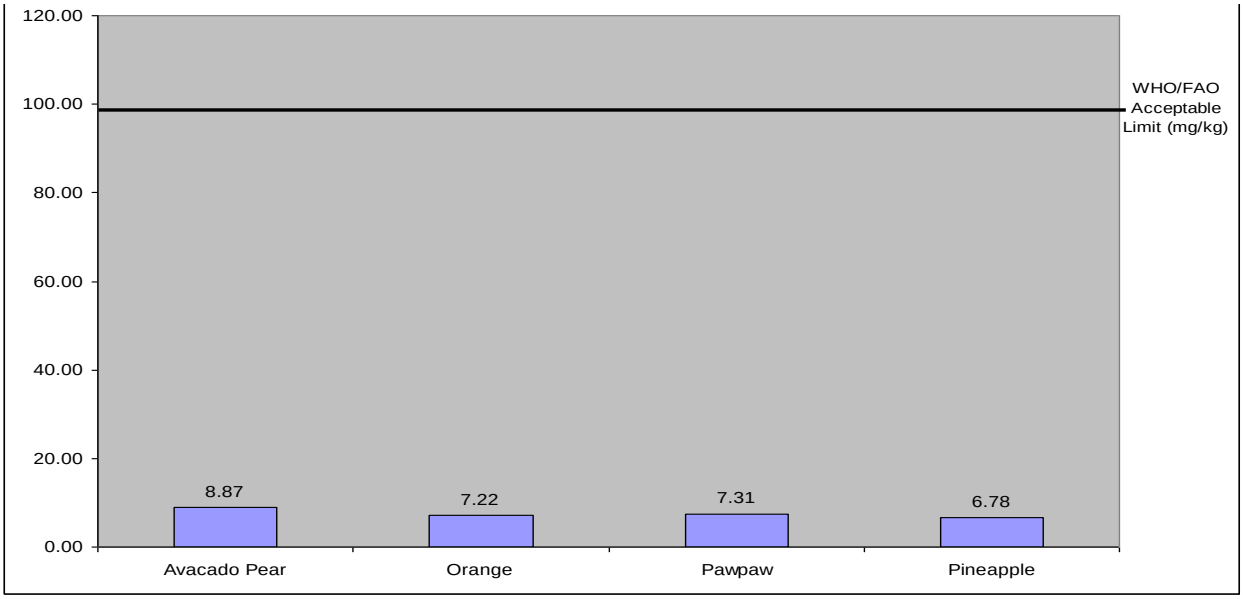

Figure 4:Concentration (mg/kg) of Zn for the fruits

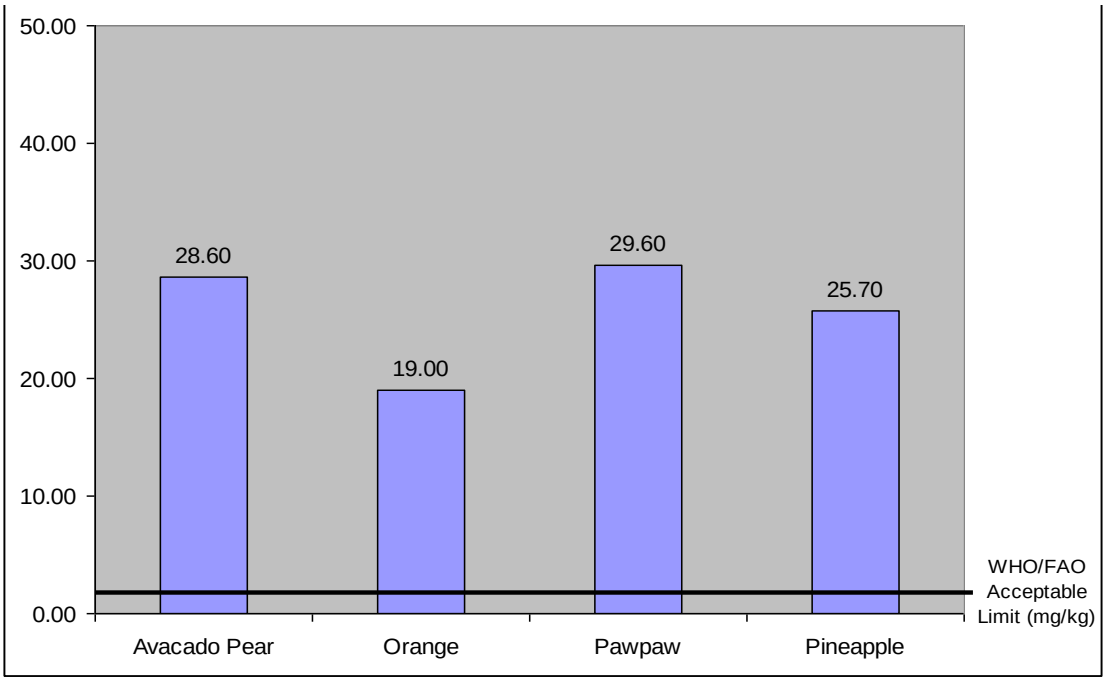

Figure 5:Concentration (mg/kg) of Fe for the fruits

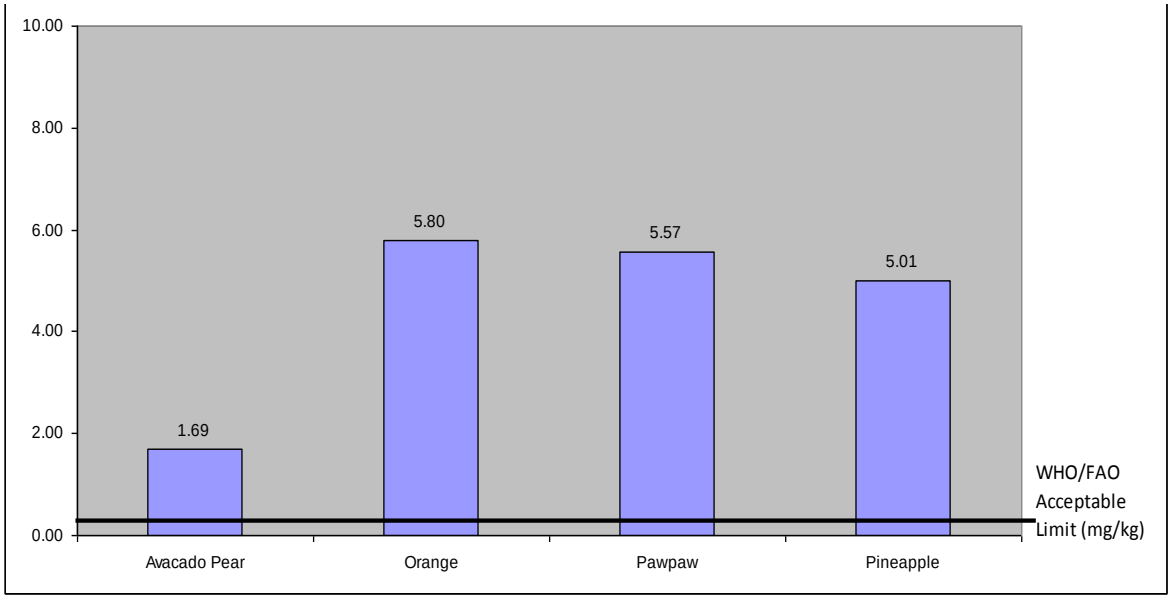

Figure 6:Concentration (mg/kg) of Pb for the fruits

maximum permissible limit of 0.80 mg/kg by WHO and FAO.

The results from this study showed that the concentrations of lead (Pb) in all the-samples ranged between 1.69 mg/kg in avocado pear and 5.80 mg/kg in orange. Its concentration in pawpaw was 5.57 mg/kg and in pineapple wa s 0.01 mg/kg. These values exceeded the maximum permissible limit of 0.1 mg/kg for orange and 0.2 mg/kg for the other fruits by WHO and FAO and are presented in Figure 6. Lead (Pb) accumulates in the brain leading to plumbism. In children it leads to lower IQ, short attention span, hyperactivity and mental deterioration. Loss of memory and weakness of joints have been reported in adults.

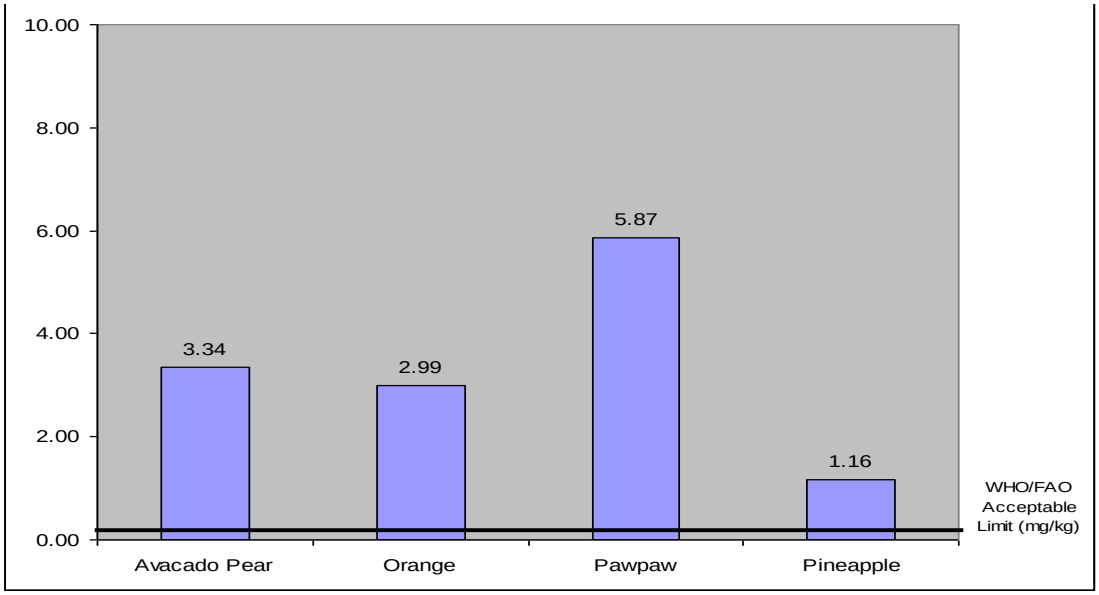

Figure 7:Concentration (mg/kg) of Ni for the fruits

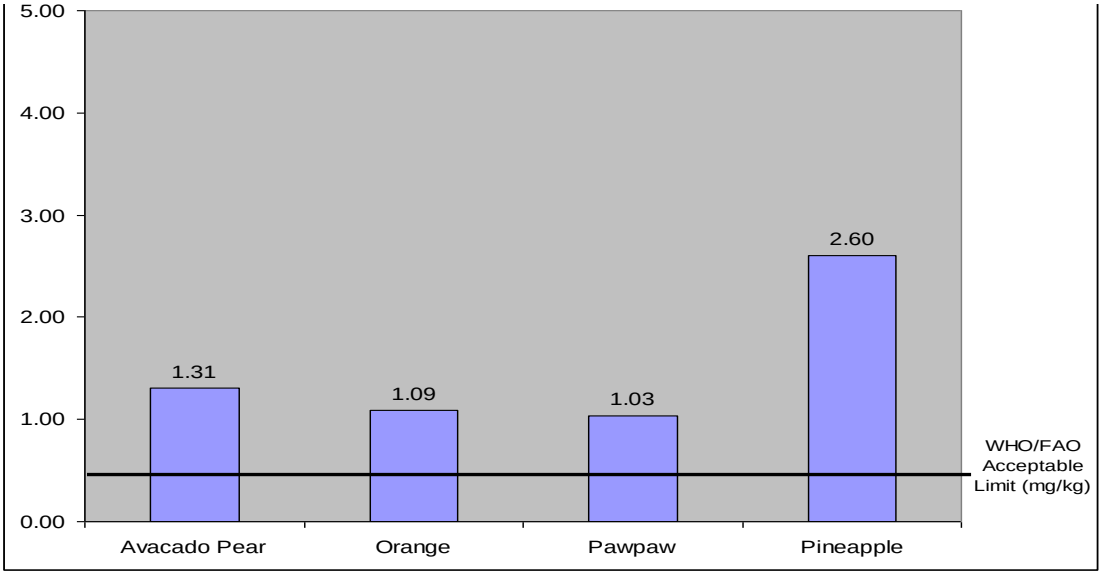

Figure 8:Concentration (mg/kg) of Mn for the fruits

Nickel (Ni), is an element that occurs in the environment only at very low levels and is essential in small doses, but it can be dangerous when the maximum tolerable amounts are exceeded. This can cause various kinds of cancer on different sites of the body, its concentration in the samples tested varied between 1.16 mg/kg for pineapple, which is comparable to the result obtained by Orisakwe et al, (2012) for pineapple (1.76 mg/kg). Other values reported by Orisakwe et al, (2012) are 0.08 mg/kg, 0.26 mg/kg and 0.72 mg/kg for orange, pawpaw and avocado respectively. However, concentration values of 0.134 mg/kg, 0.129 mg/kg and 0.114 mg/kg were reported for pineapple, orange and pawpaw respectively by Sobukola et al, (2010). From our study and the results presented in Figure 7, the concentration of Ni in pawpaw (5.87 mg/kg) was the highest. Orange was found to be 2.99 mg/kg and avocado pear was 3.34 mg/kg. These values are observed to be higher than the maximum permissible limit of 0.14 mg/kg as prescribed by WHO and FAO.

Manganese (Mn) concentrations from this study are presented in Figure 8 and ranged between 1.03 mg/kg for pawpaw and 12.60 mg/kg for pineapple. Its concentration

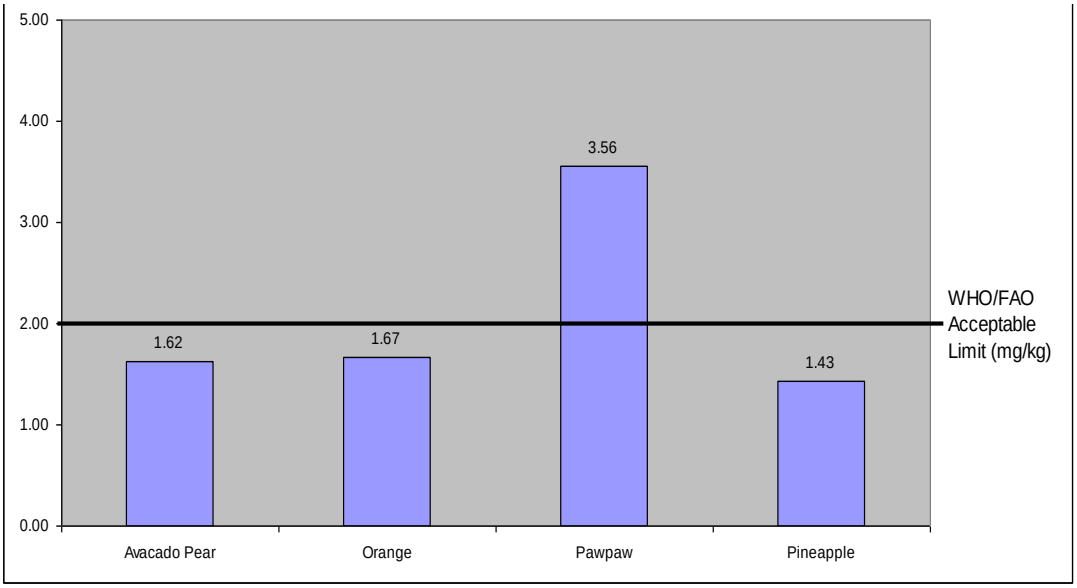

Figure 9:Concentration (mg/kg) of Co for the fruits

in orange was found to be 1.09 mg/kg and 1.3 mg/kg in avocado pear. These values are also higher than the maximum permissible limit of 0.30 mg/kg by WHO and FAO.

Cobalt (Co) concentrations in avocado pear (1.62 mg/kg), orange (1.67 mg/kg) and pineapple (1.43 mg/kg) were found to be lower than the maximum permissible limit of 2.00 mg/kg, except for pawpaw (3.56 mg/kg), which exceeded the permissible limit. These results are presented in Figure 9. Even lower values were reported by Sobukola et al, (2010) for pineapple (0.022 mg/kg), orange (0.027 mg/kg) and pawpaw (0.023 mg/kg). Co has similar properties to those of Fe and Ni. Excessive exposure to Co may affect the heart, thyroid, liver and kidneys.

Conclusion

The results show that the heavy metals in the various fruits analyzed exceeded the maximum permissible limit as prescribed by WHO and FAO except Zn. Pb, Ni and Cd are known carcinogens. Their presence in these fruits at high concentrations calls for concern as most of them have the characteristics of accumulation and longer half-life, which may result to acute or chronic toxicity problems. Some of these deleterious heavy metals are transmitted into fruits and other farm produces through polluted environment. Out of the four fruits studied, pawpaw has the highest concentrations for all the metals (except Zn, Pb and Mn) followed by Avocado pear and pineapple. Orange had the least concentration for all the metals except Co and recorded the highest for Pb.

The concentration of the metals is in the order of Fe > Zn > Pb > Ni > Cu > Mn > Cd. Further studies are being carried out on soil samples on the possible transfer of these heavy metals from soil to fruits.

REFERENCES

Anju D, Arun N, Sayeed A (2011). Metal analysis in *Citrus sinensis* fruit peel and psidum guajava leaf. Toxicol. Int. 18(2): 163–168.

D'Mello JPF (2003). Food safety. In Contamination and Toxins. CABI Publishing, Willingford, Oxon, UK, Cambridge pp. 480-482.

Jones LHP, Jarvis SC (1998). The fate of heavy metals. In Green DJ, Hayes MH (Eds.) The Chemistry of soil processes (pp.593-599). John Wiley and sons, New York, NY, USA.

Kachenko AG, Singh B (2006). Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. Water, Air Soil Pollu. 169: 101-123

Liu RH (2003). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. Am. Soc. Clin. Nut. 78: 517S–520S

McLaughlin MJ, Hamon RE, McLaren RG, Speir TW, Rogers SL (2000). Review: A bioavailability-based rationale for controlling agricultural land in Australia and New Zealand. Austr. J. Soil Res., 38(6): 1037-1086.

Official method of Analysis. (AOAC) 2000. J. Assoc. Off. Analy. Chem. (AOAC) Washington, D.C. 17th Edition.

Orisakwe OE, Nduka JK, Amadi CN, Dike DO, Bede O (2012). Heavy metals risk assessment for population via consumption of food crops and fruits in Owerri, South

Eastern, Nigeria. Chem. Centr. J. 6: 77–83.
Rapheal O, Adebayo KS (2011) Assessment of trace heavy metal contaminations of some selected vegetables irrigated with water from River Benue within Makurdi Metropolis, Benue State Nigeria. Adv. Appl. Sci. Res. 2(5): 590-596
Sharma RK, Agarwal M, Marshall F (2007). Heavy metals Contamination of soil & vegetable in suburban areas of Varanasi, India. Exot. Envir. Saf. 66: 258 - 266
Smith LA, Means JL, Chen A, Alleman B, Chapman CC, Tixier Jr JS, Brauning SE, Gavaskar AR, Royer MD (1995). Remedial Options for Metals-Contaminated Sites. Lewis Publishers, Boca Raton, Fla, USA.
Sobukola OP, Adeniran OM, Odedairo AA, Kajihausa OE (2010). Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria. Afr. J. Food Sci., 4(2): 389-393.
Sobukola OP, Dairo OU, Sanni LO, Odumewu AV, Fafiolu BO (2007). Thin layer drying process of some leafy Vegetable. Food Sci. Tech. Int.13(1): 35-40
Valko M, Morris H, Cronin MT (2005). Metals, toxicity and oxidative stress. Curr. Med. Chem., 12(10): 1161-1208.
WHO/FAO (2010). Summary and Conclusion, joint FAO/WHO expert committee of food additives. (JECFA/73/Sc) 73rd meeting, Geneva.
Wuana RA, Okieiman FE (2011). Heavy metals in contaminated soils: A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation. ISRN Ecology.