# TOXIC AND ESSENTIAL METAL CONCENTRATIONS IN ROASTED PLANTAIN AND FISH COMMONLY CONSUMED BY PORT HARCOURT INHABITANTS, RIVERS STATE, NIGERIA

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**ABTRACTS**

*Of recent, the consumption of roasted Plantain and fish popularly known as Bole during lunch hours in Port Harcourt has been on the increase. Considering the open nature by which this meal is prepared along roadside and the industrial concentrations of the Port Harcourt metropolis, most inhabitants of the city believed that these food items may have been polluted by metals. Hence, this study was necessitated to actually ascertain the levels of some toxic and essential metals in roasted plantain and fish in the city. Food samples were collected from eight locations based on high population of the area, high vehicular movements and presence of industries. The collected food samples were prepared, digested and subjected to heavy metals analyses using the atomic absorption spectroscopy. The results of the detectable concentrations (mg/kg) of the metals in the roasted plantain were: Cd (0.062±0.1289) mg/kg, Pb (0.135±0.1207) mg/kg, Zn (21.33±13.203) mg/kg, Fe (58.19±14.73) mg/kg, Cr (0.054±0.3002) mg/kg, Mn (0.026±0.0273) mg/kg, Ag (0.036±0.0197) mg/kg and As (0.038±0.0243) mg/kg. In the roasted fish the mean concentrations with standard deviation were: Cd (0.007±0327) mg/kg, Pb (0.07±0.066) mg/kg, Zn (29.6±27.34)mg/kg, Fe (44.103±19.838)mg/kg, Cr (0.64±0.289)mg/kg, Mn(0.03±0.0192) mg/kg, Ag(0.0215±0.0174) mg/kg and As(0.0145±0.0141)mg/kg. These results showed that the mean concentration of all the essential metals in roasted plantain and fish were within the recommended limit set by WHO/FAO. For the heavy metals, the mean concentrations were within the recommended limits in the plantain and fish except in few locations where the concentrations of Pb, Cd, Ag and As were slightly elevated. Based on the findings, roasted plantain and fish may be considered fit for consumption. The slight increase in concentration at some locations however calls for caution considering the non-biodegradable nature and accumulative properties of heavy metals.*

***Keywords****: Toxic, essential, concentration, roasted, plantain, fish, Port Harcourt, metal consumed etc.*

## INTRODUCTION

In Port Harcourt, Rivers State, Nigeria, roasted plantain and fish commonly known as Bole is a very popular meal for lunch and one of the streets vend foods or road side foods. As one of the major oil producing area in the country there has been immense growth in population as well as advancement in technology which has led to high level of industrialization and urbanization. Also due to high mobility status of the people in the course of work, demand and supply of street vend food is continually on the increase, however there is little or no regulation governing this street vend food supplies (DFID, Undated) which has resulted in declining safety and quality of such foods. The exposure of this food to the environment may have resulted to its contamination with some metals such as mercury (Hg), Zinc (Zn), Cobalt (Co) Lead (Pb), Iron (Fe), Copper (Cu), Chromium (Cr), Cadmium (Cd) etc due to industrial wastes and vehicular emission. Heavy metals contamination in the environment is of critical concern due to their toxic effect on human life. Although as trace element, some heavy metals like copper (Cu), Zinc (Zn) and Iron (Fe) are required to maintain the metabolism of the body. Many urban dwellers obtain significant portion of their diet from street food which has increased the demand of food in major cities (Pikuda & Ilelaboye, 2009). Also Street food vending is a large source of employment in many cities of developing countries (Choudbery et al., 2011). It has also contributed significantly to house hold incomes (Biswas et al., 2010; Oladipo, 2010; Feglo & Sakyi, 2012). However, most handlers of street vend food in the developing countries are ignorant of basic food safety measures. It has been noted that street foods are commonly exposed to various contaminants at different stages of handling (Rane, 2011). Consequently, this has resulted into a situation where food sanitary measures and proper handling have been transferred from individual and families to the food vendors who rarely enforce such practice (Musa & Akande, 2012). The threat of toxic heavy metals in the environment is more serious than those other pollutants due to their non-biodegradable nature, accumulative properties and long biological half lives. It is difficult to remove them completely from the environment once they enter it (Aderinola et al., 2009). In a study carried out by Nwineewii and Nna (2016) to investigate the impact of Eleme Petrochemical on the level of some heavy metals in shrimps, it was observed that the concentrations (mg/kg) of the various metals were: Cd (0.0107$\pm$0.006), Cr (7.825$\pm$2.313), Pb (0.066$\pm$0.022), Fe (233.8$\pm$61.98), Zn (18.89$\pm$3.094), Ni (8.42$\pm$1.681), Mn (57.91$\pm$9.187), Cu (7.104$\pm$1.491). In another study conducted by Iweala etal (2014) on metal contamination of food and drinks consumed in Ota, Nigeria, it was discovered that the metal concentrations (mg/kg) in roasted plantain were: Zn(0.25±0.07), Ni(2.58±3.19), Pb(0.004±0.01), Mn(0.37±0.12), Cu(0.38±0.18), Cd(0.02±0.01) and Hg(0.04±1.23) while in fish the metal concentrations were as follows: Zn(0.81±0.21), Pb(0.12±0.13), Mn(0.04±0.05), Cu(0.19±0.08) and Cd(0.02±0.01). It has been reported that industrialization has also resulted in concentration of many chemicals in the atmosphere from where it enters into the body fluids and different environmental media of soil, water, air, food, amongst others (Ajayi & Kamson, 1983; Onianwa & Egunyomi, 1983; Ogunsola et al., 1994). Also vehicular emission is a major source

of pollution of most street vended food (Adekunle & Akinyenui, 2004; Opeolu, 2010). Essential heavy metals (trace elements) such as zinc becomes toxic when the nutritional supply exceeds tolerance level that is, the trace metals become toxic when the concentration level exceeds the required amount from nutritional response. Alka, (2000) states that a group of heavy metals like Iron, Cobalt, Copper, Manganese, Molybdenum and Zinc are required by humans but excessive levels can be damaging to the organism. According to Charles & Linder, (1999), heavy metals such as mercury and lead have no known vital or beneficial effect on the organism and their accumulation overtime in the bodies of the organisms can cause serious illness. Also a group of heavy metals are classified as non-essential because they have no biological, chemical and physiological importance in man e.g. cadmium, mercury and lead (Ikem & Egiebor, 2005)

## MATERIALS AND METHODS

### Study Area

The study covers Port Harcourt metropolis in Port Harcourt City Local Government Area of Rivers State. Eight different locations were chosen based on high population of the area, high vehicular movements and presence of industries. The various locations were Rumuokwuta, Rumuolumeni, Rumuokoro, Rumuola, Lagos Bus Stop, Leventis, Mile 1 and Oil mill. These locations are separated from each by at least a distance of one kilometre apart.

### Sample Collection

Roasted fish mostly Atlantic Mackerel (Scomber, Scombus) are known to be prepared by thawed, scaled and cut into pieces, washed in water, steeped into palm oil mixed with dried pepper, salt and flavour (such as monosodium glutamate). These are then arranged on wire gauze placed over an open charcoal fire. Also roasted plantain is prepared by firstly washing ripe or unripe plantain in water and peeled. The raw pulps are placed on wire gauze that was placed over an open charcoal fire to roast until they are slightly brown. This food sample is mostly served as lunch within Port Harcourt and as such the collection was done by 2pm daily in the month of April, 2016. The food samples (Bole) were purchased from eight different street food vendors by the roadsides. Food Samples were randomly purchased, stored in well labelled sterile polyethylene bags and transported to the laboratory. The collected samples were stored properly until they were ready for preparation.

### Sample Preparation/Digestion

The collected samples were separately mashed first in the laboratory with ceramics mortar and pestle immediately after collection, air dried for 3-days to remove the remaining water particles and crushed into fine powdered form. 5g of each of the ground samples were measured into separate conical flasks. In each of the conical flasks, concentrated perchloric acid and concentrated nitric acid were added in the ratio 1:3. The mixture was heated on a hot plate in a fume cupboard until white fumes were observed which signified that digestion is completed. The

digest was allowed to cool, after which 50ml of distil water was added and later filtered. The digested samples (filtrate) were taken to the laboratory to analyse for the concentrations of the following metals: Lead (Pb), Cadmium (Cd), Zinc (Zn), Chromium(Cr), Iron (Fe), Manganese(Mn), Silver (Ag) and Arsenic(As) using flame solar atomic Absorption Spectrophotometer (AAS) model S4 – 71706.

**RESULTS AND DISCUSSION**

The concentrations of some toxic and essential metals in roasted plantain from different parts of Port Harcourt are presented in Table 1. The concentrations of the toxic and essential metals vary from location to location. Cadmium concentrations range from 0.002 to 0.364mg/kg with the lowest concentration of 0.002mg/kg at Rumuolumeni location while the highest of 0.364mg/kg was at Leventis. The mean concentration of this metal was 0.062±0.128mg/kg and is found to be lower than the recommended 0.2mg/kg maximum limit by FAO/WHO (2001) for food indicating that Cadmium level in the roasted plantain was still within limit as the observed mean concentration was 0.062mg/kg. However, it is observed that the leventis location recorded slightly elevated concentration of 0.364/kg. The elevated concentration recorded at Leventis could be attributed to dense population of the area resulting in massive dumping of wastes along the roadside. Iweala etal (2014) obtained 0.021mg/kg as the mean concentration for cadmium in roasted plantain in their study on the metal contamination of food and drinks consumed in Ota, Nigeria. Lead concentration of 0.005mg/kg from Leventis was the lowest obtained in the study while the highest concentration of 0.289mg/kg was obtained from Rumuolumeni. The mean concentration of Lead obtained in the study was 0.135±0120mg/kg. Iweala etal (2014) obtained 0.12mg/kg as the mean concentration for lead in roasted plantain in their study on the metal contamination of food and drinks consumed in Ota, Nigeria. Nwineeewii and Nna (2016) obtained 0.066mg/kg as the mean concentration of Lead in Shrimp while studying the impact of Eleme Petrochemical on the level of some heavy metals in shrimp from Eleme Creeks. The FAO/WHO (2001) recommended limit for Lead in food is 0.3mg/mg. The elevated concentration of Lead recorded from Rumuolumeni Location may be attributed to fumes from numerous industries within the area. The mean concentration of Lead obtained in this study is within recommended limit by FAO/WHO (2001) and other authors. Zinc is an essential metal which is required in certain amount for the proper upkeep of the body. The highest concentration of Zinc obtained in the study was 46.25mg/kg from Lagos Bus Stop location while the lowest concentration of 7.359mg/kg was from Rumuokwuta and the mean concentration was 21.333±13.203mg/kg. The FAO/WHO (2001) recommended that the level ofZinc required in food is 99.4mg/kg. The mile 1 location recorded the highest concentration of 74.43mg/kg of Iron while the Lagos Bus Stop Location recorded the lowest concentration of 32.66mg/kg. The mean concentration of Zinc recorded in the study was 58.19±14.73mg/kg. Iron is one of the essential metals necessary for the proper balance of the body but it may becomes toxic when it exceed the maximum limit.

The FAO/WHO (2001) recommended 425.5mg/kg of Iron for the body system. The concentration of Iron obtained in this study is still within the recommended limit.

***Table 1.*** *Concentrations of some Metals (Mg/kg) in roasted Plantain from different parts of Port Harcourt*

| Metals | Rumuokwuta | Rumuolumeni | Rumuokoro | Rumuola | Lagos Bus | Leventis | Mile 1 | Oil Mill | $\bar{X}$ + SD | | | FAO/ WHO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cadmium | <0.001 | 0.002 | 0.093 | 0.041 | 0.23 | 0.364 | 0.062 | 0.058 | *0.062* | ± | *0.128921* | 0.2 |
| Lead | 0.245 | 0.296 | 0.06 | 0.102 | 0.006 | 0.296 | 0.005 | 0.169 | *0.1355* | ± | *0.120765* | 0.3 |
| Zinc | 7.359 | 9.306 | 16.106 | 26.56 | 46.25 | 32.96 | 15.06 | 28.09 | *21.333* | ± | *13.20399* | 99.4 |
| Iron | 49.06 | 42.33 | 56.09 | 60.29 | 32.66 | 72.64 | 74.43 | 66.46 | *58.19* | ± | *14.73444* | 425.5 |
| Chromium | 0.167 | 0.892 | 0.02 | 0.082 | 0.065 | 0.043 | 0.008 | 0.006 | *0.054* | ± | *0.300259* | 2.3 |
| Manganese | 0.003 | 0.008 | 0.02 | 0.09 | 0.032 | 0.04 | 0.02 | 0.043 | *0.026* | ± | *0.027397* | 0.05 |
| Silver | 0.02 | 0.007 | 0.04 | 0.02 | 0.067 | 0.056 | 0.034 | 0.038 | *0.036* | ± | *0.019761* | 0.05 |
| Arsenic | 0.03 | 0.004 | 0.066 | 0.08 | 0.044 | 0.022 | 0.032 | 0.049 | *0.038* | ± | *0.024351* | 0.05 |

It was observed that 0.167mg/kg was the highest concentration of chromium obtained from the Rumuokwuta location while 0.02mg/kg was the lowest concentration from Rumuokoro. The mean concentration was 0.054±0.3000mg/kg. The FAO/WHO, (2001) recommended 2.3mg/kg for chromium as the maximum permissible limit. Nwineewii and Nna (2016) obtained 7.825mg/kg for chromium in their study on the impact of Eleme Petrochemicals on the levels of some heavy metal in shrimp from the Eleme Creeks. Chromium is a metal that is mostly used in coating and the level obtained in this work is relatively low because there is no known coating industry in the area where the work was carried out. Manganese is an essential element and is required for proper balance of the body and in the industry it is used for the treatment of rust and corrosion prevention. At the Rumuokwuta location, 0.003mg/kg of manganese was obtained as the lowest from the study while 0.09mg/kg was the highest and from Rumuola. The FAO/FAO, (2001) recommended 0.05mg/kg as the maximum permissible limit for manganese. The mean concentration of manganese was 0.026±0.027mg/kg. This showed that the concentration of manganese obtained in the study was within the recommended limit. The lowest concentration of silver obtained in roasted plantain was 0.007mg/kg from Rumuolumeni location while the highest concentration was 0.056mg/kg from Leventis. The mean concentration was 0.036±0.197mg/kg. The recommended limit for silver by FAO/WHO (2001) is 0.005mg/kg. Arsenic was one of the eight metals analysed for the metals concentrations. From investigation, 0.004mg/kg of arsenic was recorded at the Rumuolumeni Location which was the lowest concentration obtained in the work while 0.049mg/kg was recorded from the Oil mill location which was the highest. The mean concentration was 0.038±0.024mg/kg. It is recommended by the WHO/FAO,(2001) that the maximum allowed limit for arsenic in food is 0.05mg/kg. The pattern of the distribution of the metals from one location to another is presented in Fig. 1 below. The metal concentrations recorded in Zinc and Iron was high compared to other metals. These two metals are essential metals and they are needed in reasonable amount for the proper balancing of the body. Others as could be seen, recorded low concentrations probably because they are toxic metals and if found in high concentrations could be detrimental to the health of living organisms.

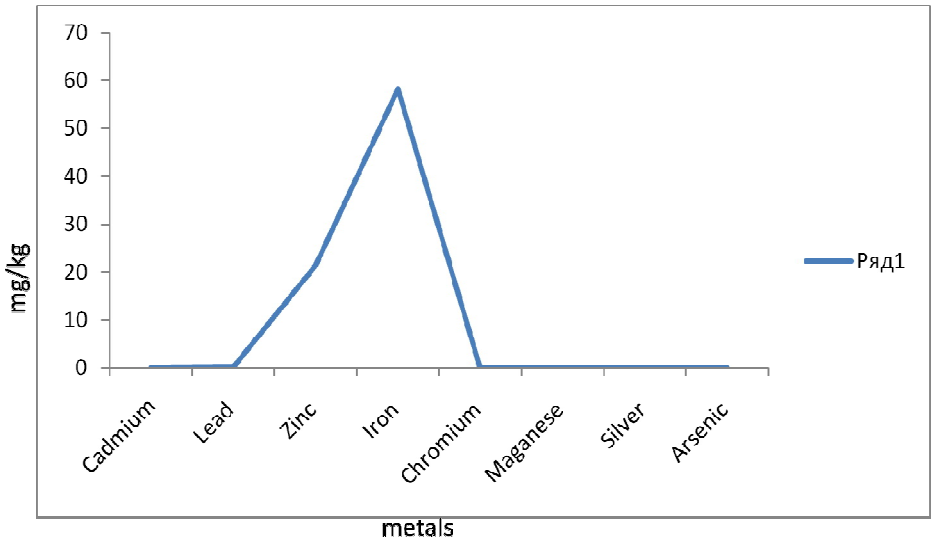


***Figure 1.*** *The distributions of the various metals in roasted plantain*

The concentrations of the investigated metals recorded in roasted fish from different parts of Port Harcourt are shown in Table 2. From Table 2 below, it can be seen that the concentrations of the metals differ from each other. It was also noticed that in some locations, the metal concentrations were below detection limit (BDL). Cadmium was detected in all the locations. However, the least concentration of 0.002mg/kg was recorded from the Rumuokwuta Location whereas the highest concentration of 0.945mg/kg was recorded from oil mill. The mean concentration obtained for Cadmium was 0.007±0.3272mg/kg. In a study carried out by Iweala etal (2014) on the metal contamination of food and drinks consumed in Ota, Nigeria, the mean concentration obtained for Cadmium in roasted fish was 0.02mg/kg. The FAO/WHO, (2001) recommended 0.2mg/kg for Cadmium as the limit. However, cadmium concentrations obtained in some locations were more than the recommended limit. Considering Lead, the concentrations at the Rumuokwuta and Lagos bus stop locations were below detection limit. The concentration obtained at the Rumuolumeni Location (0.004mg/kg) was the least while that obtained at Rumuola (0.069mg/kg) was the highest. The mean concentration obtained for Lead was 0.0745±0.0668mg/kg. The recommended limit for Lead by the FAO/WHO (2001) in food is 0.3mg/kg. Zinc was detected in all the locations where samples were collected. From the Lagos Bus stop location, the concentration of Zinc was 10.36mg/kg which was the lowest while at the Oil mill location, the concentration of Zinc was 70.29mg/kg which was the highest recorded concentration. The mean concentration for Zinc was 29.6±27.348mg/kg. In a study carried out by Iweala etal (2014) on the metal contamination of food and drinks consumed in Ota, Nigeria, the mean concentration of Zinc in roasted fish was 0.81mg/kg. The FAO/WHO (2001) recommended 99.4mg/kg as the maximum permissible limit for Zinc. Iron is an essential metal required for the healthy growth of animals. Iron was also detected in reasonable amount in all the locations. The lowest concentration of 19.28mg/kg

of Iron was recorded from the Leventis location and the highest concentration of 82.99mg/kg of iron was recorded from the Oil mill location. The mean concentration obtained for Iron was 44.103±19.838mg/kg. It is recommended by the FAO/WHO (2001) that the maximum permissible limit of iron in food is 425mg/kg.

***Table 2.*** *Concentrations of some Metals (Mg/Kg) in roasted Fish from different parts of Port Harcourt*

| Metals | Rumuokwuta | Rumuolumeni | Rumuokoro | Rumuola | Lagos Bus | Leventis | Mile 1 | Oil Mill | $\bar{X}$ + SD | | | FAO/ WHO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cadmium | 0.002 | 0.008 | 0.001 | 0.001 | 0.06 | 0.092 | 0.006 | 0.945 | *0.007* | ± | *0.327281* | 0.2 |
| Lead | <0.001 | 0.004 | 0.02 | 0.08 | <0.001 | 0.069 | 0.108 | 0.19 | *0.0745* | ± | *0.066884* | 0.3 |
| Zinc | 16.46 | 37.04 | 18.38 | 22.16 | 10.36 | 78.62 | 64.5 | 70.29 | *29.6* | ± | *27.34894* | 99.4 |
| Iron | 37.33 | 41.38 | 46.827 | 32.49 | 51.62 | 19.28 | 65.29 | 82.99 | *44.1035* | ± | *19.83874* | 425.5 |
| Chromium | <0.001 | 0.403 | 0.64 | 0.56 | 0.82 | 0.49 | 1.22 | 0.96 | *0.64* | ± | *0.289421* | 2.3 |
| Manganese | 0.02 | 0.04 | 0.009 | 0.02 | 0.043 | 0.06 | 0.046 | 0.007 | *0.03* | ± | *0.019242* | 0.05 |
| Silver | 0.003 | 0.002 | 0.04 | 0.002 | 0.02 | 0.023 | 0.041 | 0.039 | *0.0215* | ± | *0.017466* | 0.05 |
| Arsenic | 0.006 | 0.02 | 0.009 | 0.008 | 0.003 | 0.04 | 0.024 | 0.036 | *0.0145* | ± | *0.01413* | 0.05 |

Chromium was not detected at the Rumuokwuta location, and from the Rumuolumeni location, the concentration detected was 0.403mg/kg which was the lowest whereas the highest concentration of 0.96mg/kg was detected at the Oil mill location. The recorded mean concentration was 0.64±0.289mg/kg. The FAO/WHO (2001) recommended 2.3mg/kg for Chromium as the maximum permissible limit.

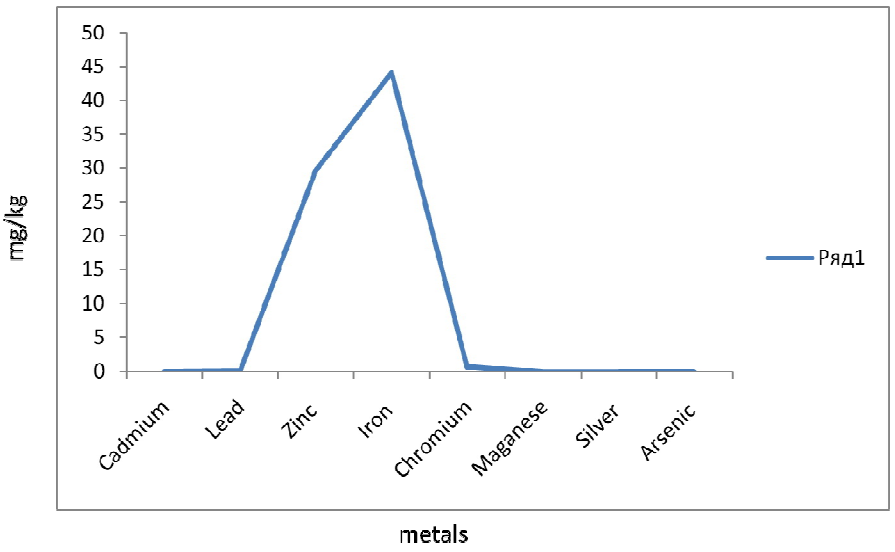


***Figure 2.*** *The distributions of the various metals in roasted fish*

The Manganese concentration obtained at Rumuolumeni location was 0.002mg/kg which was the least and the concentration obtained at Leventis was 0.06mg/kg which was the highest. The mean concentration obtained for manganese was 0.03±0.0192mg/kg. Iweala etal (2014) in their study on the metal contamination in food and drinks consumed in Ota, Nigeria obtained 0.04mg/kg as the mean concentration for Manganese in roasted fish. The FAO/WHO (2001) recommended 0.05mg/kg as the maximum permissible limit for Manganese. Silver

was detected in all the eight locations; the lowest concentration of 0.002mg/kg was obtained from the Rumuolumeni location while the highest concentration of 0.041mg/kg was obtained from the Mile 1 location. The mean concentration obtained was 0.0215±0.0174mg/kg. The maximum permissible limit for Silver in food by the FAO/WHO (2001) is 0.05mg/kg. Arsenic was detected in all the locations investigated. The lowest concentration of arsenic of 0.006mg/kg was detected at the Rumuokwuta location and the highest concentration of 0.04mg/kg was detected at the Leventis location. The mean concentration obtained for Arsenic was 0.0.145±0.0141mg/kg. The recommended level of arsenic by the FAO/WHO (2001) in food is 0.05mg/kg. The results obtained from the study indicate that arsenic found in the roasted fish in Port Harcourt is within recommended limit. Fig. 2 above shows the pattern of distributions of the metal concentrations in the roasted fish from Port Harcourt Metropolis. The graph indicates that the metal concentrations were low except for some essential metals (iron, zinc etc.) which were prominent.

## CONCLUSION

The results of the investigation on the concentrations of some metals in roasted plantain and fish (Bole) within Port Harcourt metropolis show that the mean concentrations of all the metals were within permissible limit recommended by FAO/WHO (2001) except at some locations where the metals were detected at slightly elevated concentrations. The study particularly noted that, for the roasted plantain, silver concentrations at the Lagos Bus Stop and Leventis locations were slightly higher; arsenic was also found to be higher at the Rumuokoro and the Rumuola locations. In the roasted fish, higher concentration of Lead was obtained at the Rumuola location and that of Cadmium at the Oil mill. Though, these food items may be considered safe for consumption at the moment, the slight increase in concentrations of some of the metals at few locations is of concern considering the non-biodegradable nature and accumulative properties of heavy metals.

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