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PRESENCE AND CONCENTRATION OF LEAD AND CADMIUM IN READY-TO-EAT MEAT SAMPLES SOLD IN OPEN MARKETS IN UMUDIKE, NIGERIA

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ABSTRACT

Ready to eat meat samples sold by road side meat vendors were analyzed for the presence of lead and cadmium using Atomic Absorption Spectrometry. Samples selected included beef, fish, pork and chicken which were processed by different methods such as roasting, frying, boiling and smoking. This study was aimed at investigating the heavy metal contamination of ready to eat meat samples and determining which method of processing was related to contamination of the ready to eat meat samples with heavy metals. It was found that all pork samples (100%) were contaminated with lead with a mean concentration of 0.233 ± 0.043 mgkg^{-1} while some of the fish samples (33.3%) had cadmium concentrations of 0.065 ± 0.049 mgkg^{-1}. The study also revealed that samples processed by frying and smoking had mean cadmium concentration of 0.031 ± 0.016 and 0.031 ± 0.016 respectively. Lead was recorded only in samples that were boiled before smoking (0.233 ± 0.043mgkg^{-1}). The level of lead in the pork meat and fish sampled exceeded the maximum permissible level given by World Health Organization. Boiled and smoked meat had lead levels above the maximum permissible level while fried meat had cadmium levels above the maximum permissible level. Lead levels in meats were positively and significantly correlated to the methods of processing.

Keywords:Concentration, lead, cadmium, meat, Umudike

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INTRODUCTION

Most ready to eat meat products such as *Suya*, Chicken barbeque, Fish and Bush meat are made outside restaurants and prepared using aluminum utensils. These meat are considered the most common and easy to get sources of protein usually sold by street vendors and fast food restaurants [1]. Such meat products can be contaminated with heavy metals including lead, mercury, chromium, arsenic and cadmium, which are present in the environment due to human activities such as burning of coals, incineration of cadmium waste, metals smelting, chemical and pesticide production, vehicle exhaust emissions, paints. Such meat products may be contaminated during the various stages and processes of production like smoking,

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roasting, grilling and hunting as the bullets are lead loaded [2,3,4,]. The continuous consumption of ready to eat meat products contaminated with these heavy metals exceeding the stated permissible limits may result in public health hazards through progressive irreversible accumulation in the human body [5].
In Nigeria, the incidence of high thresholds of heavy metal contamination as a result of population growth, urbanization, dumping of wastes, agricultural and industrial activities have been reported in several cities [6,7].

The risk of heavy metal contamination in meat is of great concern for both food safety and human health, because of the toxic nature of these metals at relatively minute concentrations [8]. Cadmium and lead are the elements of most concern in terms of adverse effects on human health because they are readily transferred through food chains and are not known to serve any essential biological function [9].

The persistent occurrence and accumulation of heavy metals, particularly lead (Pb) and cadmium (Cd), and the potential exposure to humans, from numerous sources such as food, water, soil and air, resulted in the Agency of Toxic Substances and Diseases Registry (ATSDR) to rank them as the most hazardous and toxic substances in the environment [10].

The present study was undertaken to determine the presence and concentration of some heavy metals (lead and cadmium) in fully processed ready to eat meat products in Umudike and environs.

MATERIAL AND METHODS

This study was undertaken in Umudike located in Ikwuano Local Government Area of Abia State, Nigeria. Umudike community in Abia State is about 10 kilometres southeast of Umuahia, the capital of Abia State within latitude 5° 55' 00" N and longitude 6° 28' 00" E and a Military Grid reference system coordinate of 32NKM1950554632 [11].

Fully processed samples of ready to eat meat such as beef, chicken pork and fish were collected on the basis of availability and willingness or cooperation of the vendors. The selection of samples based on processing methods such as frying, roasting, smoking etc was done based on availability. During each visit, the processing methods and environment was observed and recorded with still photographs taken where necessary.

The samples were rinsed using distilled water. Then drained and oven dried for 4 hours at 105°C or until dried and homogenized to powder using pestle and mortar. One gram of each sample was digested according to the methods the Association of Official Analytical Chemists [12,13]. The digested samples were then analyzed using Atomic Absorption Spectrometer (AAS).

The data on different variables (the concentrations of cadmium and lead in different types of meat samples used and the different processing methods used) obtained from the study were statistically analyzed using SPSS. Analysis of variance and post Hoc test were used to determine statistical differences among various parameters at $P \leq 0.05$ while correlation analysis was used to determine relationship among the various variables [14].

RESULTS

In the various ready to eat meat samples, the mean concentration of Pb was higher and above the minimum permissible level (MPL) in pork samples, while Cd was higher and above the MPL in fish samples (Table 1).

Considering the various methods used in processing of the meat samples, lead was higher and above the MPL in samples processed by boiling and smoking, while the mean concentration of Cadmium was higher and above the MPL in meat samples processed by frying (Table 2).

The concentration of cadmium was significantly ($P< 0.05$) higher in fish while lead was higher ($P< 0.05$) in chicken (Table 3).

There was a positive and significant correlation (r = 0.734; $P< 0.05$) between lead concentration in RTEM and method of processing, but the relationship between cadmium concentration and method of processing was negative and not significant (r = -0.302; $P> 0.05$) (Table 4).

Table 1. Mean concentration of lead (Pb) and cadmium (Cd) in the ready to eat meat samples.

Ready to eat meat samples	Heavy metal concentrations	
	Lead (Pb)	Cadmium (Cd)
Beef	0.043 ± 0.029	0.016 ± 0.003
Fish	0.066 ± 0.007	0.065 ± 0.049*
Pork	0.233 ± 0.043*	0.022 ± 0.004
Chicken	0.026 ± 0.012	0.016 ± 0.010

*Heavy metal concentrations above the maximum permissible levels of 0.1 and 0.05 $mgkg^{-1}$ respectivelyfor lead and cadmium.

Table 2. Mean concentration of lead (Pb) and cadmium (Cd) in ready to eat meat samples prepared by different processing methods.

Processing method	Heavy metal concentrations	
	Lead	Cadmium
Roasted	0.029 ± 0.013	0.014 ± 0.004
Fried	0.052 ± 0.030	0.053 ± 0.051*
Smoked only	0.064 ± 0.009	0.031 ± 0.016
Boiled and smoked	0.233 ± 0.043*	0.022 ± 0.004

*Heavy metal concentrations above the maximum permissible levels of 0.1 and 0.05 $mgkg^{-1}$ respectivelyfor lead and cadmium.

Table 3: Mean concentration (mg/kg) of heavy metal in ready to meat samples.

Heavy metal	Beef (M+SD) (mg/kg)	Fish (M+SD) (mg/kg)	Pork (M+SD) (mg/kg)	Chicken(M+SD) (mg/kg)
Lead	$0.043+0.029^{a}$	$0.066+0.007^{a}$	$0.233+0.042^{b}$	$0.026+0.012^{a}$
Cadmium	$0.016+0.003^{a}$	$0.065+0.049^{b}$	$0.022+0.003^{a}$	$0.016+0.009^{a}$

[ab]Mean concentrations of heavy metals within rows with different superscripts are significantly different (post Hoc test: $P< 0.05$).

DISCUSSION

The results from this study showed that ready to eat meat samples sold by road side meat vendors in Umudike contained varying levels of lead and cadmium. The concentration of lead and cadmium in most meat products have also been described by researchers in other countries [8,15,16,17].

The varying concentration of heavy metals recorded in the meat samples may be attributed to any or a combination of the following factors; presence of heavy metals in feed, free range grazing in cattle, extensive system of piggery management, drinking water from polluted streams and drains and exposure

of ready to eat meat to atmospheric depositions especially automobile fumes, open burning of solid waste and heavy metal leaching in vegetations [18,19,20].

Table 4: Correlation between heavy metals, mode of processing and type of meat sample.

	MOP	RTEM	Lead	Cadmium
MOP	1			
RTEM	0.543*	1		
Lead	0.734	0.603	1	
Cadmium	-0.302	-0.008	0.019	1

*correlation is significant at the 0.05 level; RTEM = Ready to eat meat;
MOP = Method of processing.

The fact that the concentration of lead was high in samples processed by boiling and smoking, shows that lead pollution is multidimensional and that the possible sources may include food processing techniques, traffic pollution and other factors [21,22]. Similarly, Joyce *et al* [23] reported that boiling can impact heavy metals on food. The contamination of fried samples with cadmium agrees with previous reports [24,25].

The strong positive correlation between lead concentration and method of processing suggests that processing impacts lead on samples. This agrees with the various reports that suggested that processing methods can contaminate food with heavy metals [5,26]. The concentration of lead in the different types of RTEM sample processed was also positively correlated indicating that the concentration of heavy metals especially lead depends on the type of meat being processed.

The negative correlation between both the RTEM sample and its method of processing with the concentration of cadmium in the RTEM samples implies that the cadmium in RTEM samples was from sources other than processing methods. These other sources could possibly be the environment in which they were processed or sold since, according to Smirjakova *et al.* [27], the environment is laden with all forms of heavy metals ranging from Lead, Cadmium, Arsenic, Chromium and Iron and that the exposure of meat and meat products to the open air or by the wayside further predisposes them to contamination due to the numerous environmental activities.

CONCLUSION

This study revealed the presence of heavy metal in the ready to eat meat samples sold in Umudike and environs. It also revealed that the method of processing the meat can influence the eventual concentration of heavy metals found in the processed meat. Apart from the processing methods, the environment may also be a source of heavy metal contaminant for meat; suggesting that the longer these meats are exposed to the atmosphere, the higher the concentration of heavy metals they accumulate.

RECOMMENDATIONS

On the basis of the results of this study, there is need for public education on the health benefits of safe and proper handling of ready to eat meat products including better and hygienic processing and display methods as well as control of dietary habits and rate of consumption of these meat products. There is also need for a national standard of permissible levels of heavy metals in our indigenous meat and meat products as well as proper enforcement of extant laws or the enactment of such laws where they do not exist in Nigeria.

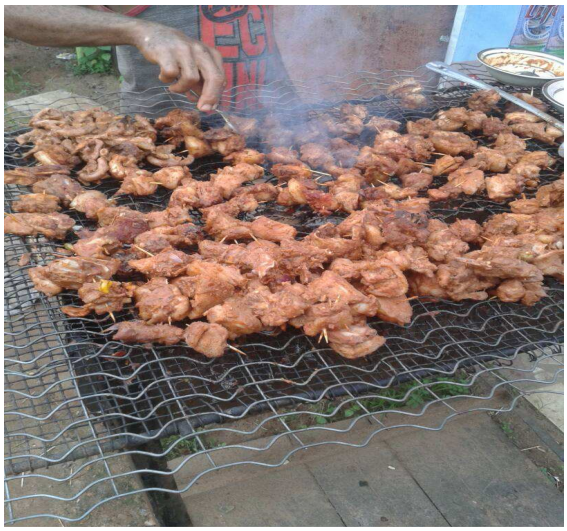

Fig 1: Pork meat processed by smoking.

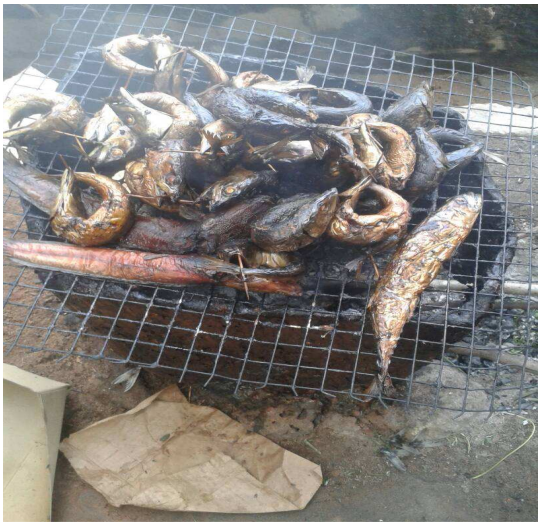

Fig 2: Fish samples undergoing smoking process.

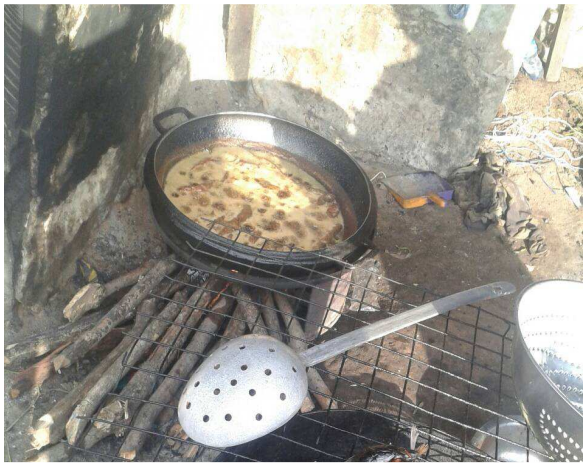

Fig 3: Fish undergoing the frying Process.

Fig 4: Beef and Chicken barbeque on display for Sale.

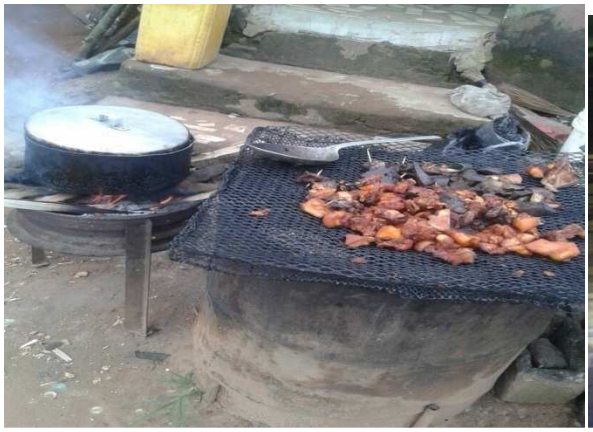

Fig 5: Pork samples that were boiled then smoked.

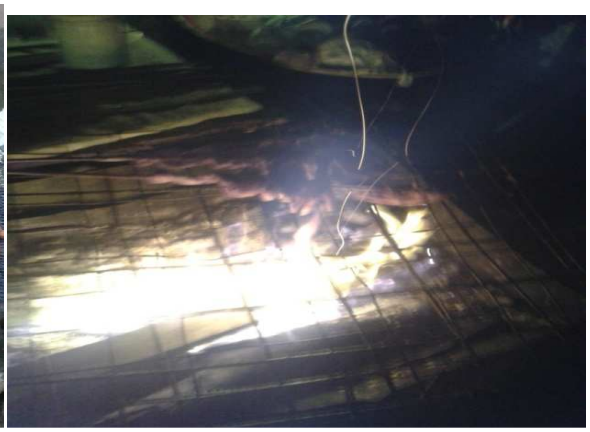

Fig 6: Beef and Chicken undergoing the roasting process.

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