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Heavy Metals Contamination Levels In Suya Meat Marketed In Selected Towns In Delta State, Nigeria

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Abstract: *Heavy metals are considered as a major pollutant causing environmental cytotoxic, mutagenic and carcinogenic effects in animals and aquatic organisms. The study aims to analyze the presence of lead, cadmium and mercury on selected suya samples from Warri, Ughelli and Ozoro in Delta State, Nigeria. Quantitative analysis confirmed the presence of lead, cadmium and mercury in all suya samples analysed using Flame Atomic Absorption Spectrophotometer. The mean concentration of lead, cadmium and mercury were 0.125±0.007, 0.140±0.006 and 0.150±0.040 for Warri respectively; 0.060±0.000, 0.075±0.003 and 0.120±0.009 for Ughelli respectively and 0.085±0.003, 0.110±0.050 and 0.090±0.010 for Ozoro suya respectively. The mean concentration of lead, cadmium and mercury in the suya samples were within the standard limits set by WHO, JECFA and EOSQC.A continuous monitoring program is recommended for suya processing outfits in order to preserve the 'health' of suya consumers.This study would be useful for the creation of guidelines to protect the public from the harmful effects of the heavy metal toxicants present in suya generally consumed by the public.*
Keywords: *Suya, heavy metal, lead, cadmium, mercury.*

I. Introduction

Among the pollutants generated by industry and urbanization, heavy metals and various pathogenic bacteria are the most dangerous, because they can cause serious health problems to human population. As a consequence of natural and anthropogenic activities, heavy metals are present in the environment, so that people come into contact with them especially through the consumption of foods [1].The main sources of heavy metal contamination are growing and are represented, especially, by pesticides, fertilizers, industrial processes and exhaust gases from automobiles [2].

The main threats to human health are contamination with heavy metals, especially lead, cadmium and mercury. Heavy metals become toxic when they are not metabolized by the body and accumulate in tissues [3]. Heavy metals are dangerous because they tend to accumulate in living organisms. Some heavy metals are deposited as residues in food, during processing [4].

During the last decades the use of lead (Pb) in industrial activities for manufacturing of batteries, bearing metals, cable covering, gasoline additives, explosives and ammunition, antifouling paints and analytical reagents has caused wide spread environmental contamination [5]**.** Overexposure to lead affects the neurological, reproductive, renal, haematological system more susceptible to its adverse effects. Studies showed that children are more prone to lead toxicity compared to adults. Therefore, exposure to lead during childhood must be monitored. This led many researchers to study the relationship between lead exposure and low intelligent quotient of children [6].

Cadmium is one of the most toxic heavy metals for living beings. Its environmental ubiquity and persistence, its accumulation in organisms and biomagnifications along the trophic chain imply a continuous exposure to low doses. Cadmium is primarily toxic to the kidney, especially to proximal tubular cells. Bone demineralization is affected by cadmium toxicity directly by bone damage and indirectly as results of renal dysfunction. Industrial workers exposed to airborne cadmium have higher risk in developing lung impairment and lung cancer [7].

Pollution by heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain [8]. The pollutants often have direct physiological toxic effect because they are stored or incorporated in tissues and sometimes permanently [9].

The continuous consumption of suya contaminated with these heavy metals exceeding the safe permissible limits may result in a public health hazards through progressive irreversible accumulation in human body. If residual levels exceed the prescribed standards, due to the cumulative effect in the human body as a result of repetitive and persistent ingestion, they will induce negative effects on human health; hence the duty of all farmers and meat processors is to minimize the possibilities and probabilities of contaminations.

In order to prevent the harmful exposure to these heavy metals, awareness of the sources and uses, modes of entry in the body, toxic effects and safe limits must be established [10]. This study will serve as an instrument of change to help the public to become more aware of the possible harmful health effects they may be exposed to in the consumption of suya meat. It will also help the government, agencies and policy makers in the creation of laws and guidelines that would control the rise of heavy metals arising from different suya processors in the country. And lastly, this study will benefit other researchers that aim to protect the environment from destructive contaminants like the heavy metals.

II. Materials And Methods

A. Research Design

Descriptive-quantitative research design was used in the study. Samples were prepared through acid digestion and analysed for the presence of lead, cadmium and mercury by the used of Flame Atomic Absorption Spectroscopy.

B. Suya Sample Collection

Three (3) suya samples were collected from three locations namely Ughelli, Warri and Ozoro in Delta State, Nigeria.

C. SuyaSample Acid Digestion and Preparation

Five (5) grams of each suya samples were separated into three different parts and were digested in 10ml concentrated nitric acid in an open glass container for 24 hours, at room temperature. The following day the pre-digested samples were heated at 80°C for 5 hours. Samples were then cooled to room temperature, and the volume was adjusted to 50ml with distilled water. Diluted samples were stored in polyethylene (PET) bottles and were analysed using flame atomic absorption spectrophotometer.

D. Flame Atomic Absorption Spectrophotometer (FAAS)

Lead, cadmium and mercury content of the suya samples marketed in Warri, Ughelli and Ozoro, Delta state Nigeria were analysed using Flame Atomic Absorption Spectrophotometer (Shimadzu AA-6300). Prepared standard solutions with different concentrations (0.2, 0.4, 0.6, 0.8 & 1.0 mg/kg) of lead, cadmium and mercury were used to calibrate the spectrophotometer prior to analysis using distilled water as the control.

E. Statistical Analysis

The achieved data were processed statistically and presented as mean ± Standard deviation and statistical significance of the treatment effect was analysed using one way analysis of variance (ANOVA), followed by post Hoc Fisher's LSD test for multiple comparison, using the software, statistical package for social science (SPSS) version 21 windows software and significance level at p values < 0.05 was considered significant, while p values > 0.05 was considered to be statistically non-significant.

III. Results And Discussions

All suya samples were subjected to quantitative analysis using Flame Atomic Absorption Spectroscopy (FAAS). Results from the analysis confirmed the presence of lead, cadmium and mercury in all of the selected suya samples. The concentration of the heavy metals (lead, cadmium and mercury) in milligram per kilogramme (mg/kg), are presented in Table 1 and figure 1 below.

TABLE 1: Lead, Cadmium and Mercury Mean Concentrations (mg/kg) On the Suya

Suya Sample	**Lead (Pb)**	**Cadmium (Cd)**	**Mercury (Hg)**
Warri	$0.125{\pm}.007^{a}$	$0.140{\pm}.006^{a}$	$0.150{\pm}.040^{a}$
Ughelli	$0.060{\pm}.000^{b}$	$0.075{\pm}.003^{b}$	$0.120{\pm}.009^{b}$
Ozoro	$0.085{\pm}.003^{c}$	$0.110{\pm}.05^{c}$	$0.090{\pm}.010^{c}$

Result expressed as Mean±Standard deviation (M±SD) n=3ANOVA followed by LSD's multiple range tests. Values not sharing a common superscript differ significantly at P<0.05.

TABLE 2: Recommended dietary allowance of some trace elements, provisional tolerable weekly intake (PTWI) and daily intake (DI).

Elements	WHO	JECFA	EOSQC
Lead (Pb)	210 μg (DI)	-	0.05 mg (WI)-adults 0.0025mg (WI)-children
Cadmium (Cd)	60 μg (DI)	-	0.0067-0.0083 mg (WI)
Mercury (Hg)	-	1.6μg/kg (PTWI)	-

·EOSQC: Egyptian organization for standardization and quality control
(1993)/body weight.
(JECFA)Joint Expert committee on food additives (WHO/FAO)
WHO: **World Health Organization (1993)** /for 60g/adult.

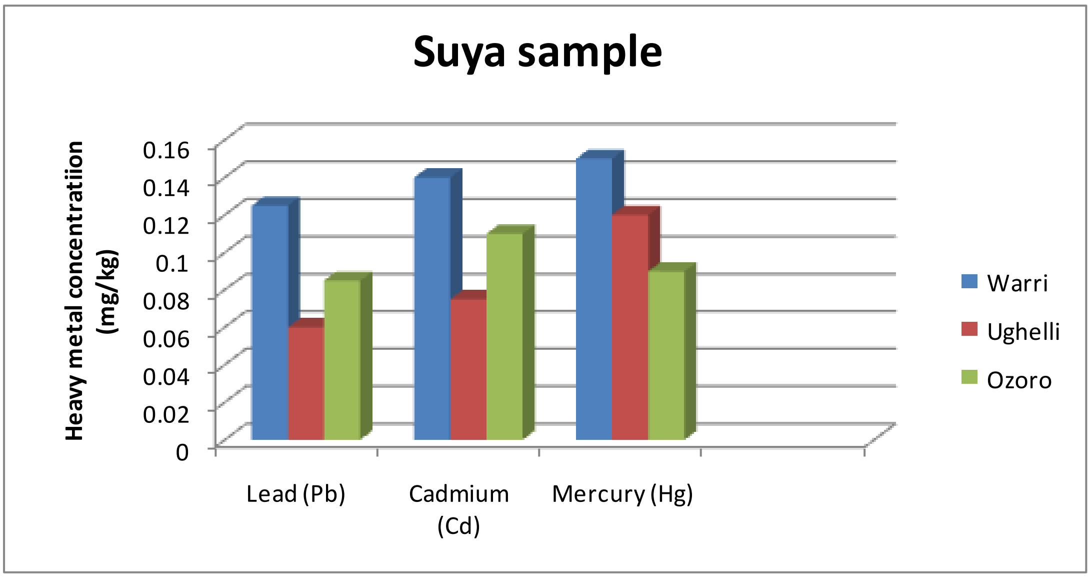

Fig. 1. Graphical representation of the heavy metals means concentrations (mg/kg) on the suya sample in Warri, Ughelli and Ozoro in Delta State, Nigeria

The highest concentration of Lead was found in Warri (0.125mg/kg), followed by Ozoro (0.085mg/kg) and least in Ughelli (0.060mg/kg) which had significantly lower ($p<0.05$) levels. The lead levels were significantly lower than that recommended by Food and Agricultural Organisation [11][12]. It is suggested that the spices used to make suya meat could be a possible cause for this excess and the place in which the coal was obtained might also have a contribution to the increased Lead (Pb) level. Researches carried out by [13] demonstrated that high Lead concentrations cause adverse effects to humans. A high level of Lead in adult's body can generate heart diseases, cancer and infertility. For children, the diseases caused by Lead can lead to antisocial behaviour, low intelligence or hyperactivity.

Cadmium is a toxic element to every animal species and for humans, as well. It is almost absent in the human and animal body at birth, however it accumulates with age. Statistical estimators of Cadmium concentration values in Warri, Ughelli and Ozoro samples (Table 1 and fig. 1) have defined a broad dispersion of data, related to average, with higher limits of the coefficient of variation. In the present study, the obtained results revealed that the mean Cadmium concentrations in Warri, Ughelli and Ozoro were 0.140mg/kg, 0.075mg/kg and 0.110mg/kg respectively. The highest cadmium concentration was found in Warri (0.140mg/kg) followed by Ozoro (0.110mg/kg) and least in Ughelli (0.075mg/kg). Cadmium result was below the upper allowed limit of 50 mg/kg [11]. The explanation for this is that the suya meats were highly spiced and processed. Spices could contain cadmium concentrations up to 200 ng g^{-1}. The lower level of cadmium on Ughelli suya could be as a result of the level of spices that were added during smoking or processing. The results obtained indicate that mean values of the individual products were significant ($p<0.05$). Chronic exposure to Cadmium could cause nephrotoxicity in humans, mainly due to abnormalities of tubular re-absorption [14]. The biological half life of Cadmium in the human kidney is long and has been estimated to be 10 to 30 years [15].

The obtained results revealed that the mean mercury concentrations in Warri, Ughelli and Ozoro suyas were 0.150mg/kg, 0.120mg/kg and 0.090mg/kg respectively. The highest concentration of mercury was found in Warri (0.150mg/kg) followed by Ozoro (0.120mg/kg) and least in Ughelli (0.090mg/kg). The mercury levels were significantly lower than that recommended by Expert committee on food additives (JECFA, 2003). The main concern in relation to the toxicity of mercury in the general population exposed to low levels of mercury in their diet relates to the potential neurotoxicity of organic forms of mercury, e.g. methyl mercury, in young children. Organic forms of mercury can cross the placental barrier between the mother and the unborn baby, and epidemiological studies in exposed populations of humans and toxicological studies in animals have shown that this can result in a range of neurological disturbances from impaired learning to obvious brain damage.

IV. Conclusion And Recommendations

Heavy metals are considered particularly dangerous to human health because, in the preparation or processing of food, they do not decompose. On the contrary, their concentration tends to bioaccumulate. Of the three suya samples analyzed, the highest contents of Lead, considered to be highly toxic metal, were found in samples of Warri (0.125mg/kg) and lower in Ughelli (0.060mg/kg) and Ozoro (0.085mg/kg). All the samples contain Cadmium below the maximum levels permitted by WHO. Mercury and Cadmium levels were below the limits allowed by law, in all samples.

The results of this study demonstrate the presence of the heavy metals in suya meat in Warri, Ughelli and Ozoro. Therefore, the person consuming the suya will have the same effects of the heavy metals in the different suya meat.

In conclusion, it is hereby emphasized that even though the suya samples presented a safe concentration for the three heavy metals, other heavy metals are still present and may exceed the standard limit so set. Heavy metal contaminants have a potential to bioaccumulate inside the human body. Therefore, consumption of such suya should be monitored to avoid the adverse effects brought about by lead, cadmium and mercury contamination.

It is therefore recommended that the government and global organizations involved in meats production and food nutrition should utilize this study as guidelines to protect the public from the possible adverse effects that can be brought about by the heavy metal toxicants in suya meat samples.

More future studies are required, because food contamination with heavy metals from various activities is expected to affect the health of many people.

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