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Full Length Research Paper

Heavy Metal Concentration in Meat Samples from Markets in Oil Producing Communities in Delta State (A Case Study of Owhelogbo, Oleh, Ozoro Market

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ABSTRACT: Humans are primarily exposed to heavy metals and trace elements through their diet. The purpose of this study was to determine the concentration (mg/kg) of heavy metals (copper, lead, cadmium, chromium, and nickel) in beef samples from three main towns in Delta state (Ozoro, Oleh, and Owhelogbo). A total of 27 samples were collected from local markets in each location and analyzed for heavy mineral concentration using an Atomic Absorption Spectrophotometer. ANOVA was used to analyze the data, and the average mean concentrations of heavy metals in samples were separated using the Duncan Multiple Range test. The study's results showed that the amount of toxic elements in samples bought from Owhelogbo was generally low (0.001mg/kg) and within the WHO-approved limit. Also, samples from Oleh had the highest amount of cadmium (0.07 mg/kg) and it was significantly different (p0.005) from other toxic metals. In this study, the meat samples from Ozoro had the highest concentration of copper (0.723mg/kg). Nickel and chromium concentrations in the samples were less than 0.001mg/kg. When the amount of heavy metals in samples from each town was compared, it was found that the most toxic metals were in samples from Ozoro. When all of the information from this study is looked at together, it shows that the amount of toxic metals in the meat from the sample locations is generally low. However, the concentrations of these metals need to be constantly checked to prevent an outbreak of toxic metal poisoning in the future.

Keywords: Heavy metals concentration, meat, different markets

INTRODUCTION

Meat is the flesh of an animal that is eaten as food, and humans have been hunting and killing animals for meat since prehistoric times. Domestication of animals such as chickens, lambs, rabbits, pigs, and cattle became possible with the emergence of civilization. This subsequently led to their usage in industrial-scale meat production with the assistance of slaughterhouses. Meat is mostly made up of water, protein, and fat. It is edible uncooked, but is more commonly consumed after being cooked, seasoned, or prepared in a variety of nutritional ways (Dave and Ghaly, 2011). Meat is vital in the economy and culture, despite the fact that its mass production and consumption have been shown to be hazardous to human health and the environment. Many religions have regulations concerning what meat can and cannot be consumed. Vegetarians and vegans may abstain from eating meat due to environmental concerns about livestock production or nutritional concerns about consumption. Meat is vital for growth and health maintenance since it contains carbohydrates, fat, protein, water, vitamins, and minerals (Ahmad et al., 2018). Heavy metals emitted by man-made pollution are constantly released into aquatic and terrestrial ecosystems. Heavy metal contamination is a severe threat because of its toxicity, bioaccumulation, and biomagnification in the food chain (Ali et al., 2014). In recent years, much attention has been focused on the concentrations of heavy metals in meat and other foods in order to check for those hazardous to human health (Mansour and Sidkey, 2002; Moiseenko and Kudryautseva, 2001). Minerals and heavy metal contents of retail meat and meat products were also determined (Tamate, 1987) Metals such as iron, copper, zinc and manganese are essential metals since they play important role in biological systems, whereas mercury, lead and cadmium are toxic, even in trace amounts (Amani et al., 2012).

The essential metals can also produce a toxic effect at high concentrations. Only a few metals with proven hazardous nature are to be completely excluded in food for human consumption. The main threats to human health are contamination with heavy metals, especially lead, calcium and mercury (Sivaperumal et al., 2007). Heavy metals become toxic when they are not metabolized by the body accumulated in tissues (WHO, 2011) heavy metals are dangerous because they tend to accumulate in living organisms. During food processing, some heavy metals are deposited as residues. (WHO, 2000).

The main objective of this study was to determine the concentration of heavy metals in meat samples from three (3) Abattoirs in Delta State and compare the concentration of the heavy metals among the selected Abattoirs.

MATERIALS AND METHODS

Sample collection

A number of meat samples (27) was purchased from popular markets in three towns in Delta State, (Ozoro, Oleh, Owhelogbo). At the point of collection, the sample was covered with aluminum foil to prevent contamination, and placed in a cooler before being transported to the laboratory for analysis. All samples were stored in the freezer at -20 ^{0}C before analysis.

Metal analysis

In a blender, the oven dried meat samples were crushed. The pulverized samples were weighed and then digested with Nitricperchloric acid. The process involved digesting the pulverized sample with strong acids for 10 minutes in a fume closet at 95 ±5^{0}C. The digested samples were filtered and mixed with distilled water in a volumetric flask to make 40ml. Using an atomic absorption spectrophotometer, the digested extracts were analyzed for Cu, Cd, Pb, Cr, and Ni.

Data analysis

The study's data was statistically examined using the Analysis of Variance (Anova). Using SAS techniques, Duncan's Multiple Range was performed to determine the difference in the means of the various meat samples at a 5% level of probability SAS (2000).

RESULTS AND DISCUSSION

The data presented in (Tables 1-3) reveals the heavy metal concentration of Ni, Cr, Cd, Cu, and Pb determined in beef obtained from Owhelogbo, Oleh and Ozoro respectively. The Ni, Cr, Cd, Cu, and Pb contents were compared to the recommended limits published by the FAO/WHO in 1999 to assess food contamination levels and determined to be within acceptable limits. The result of Cd in meat samples ranged from 0.001-0.072 mg/kg which is below the guideline of 1.0 mg Cd/kg (EC, 2001). In a previous study, there were higher levels of Cd in chicken meat, turkey meat, and gizzards consumed in Southern Nigeria than in this study, ranging from 0.01 to 4.60 mg/kg (Iwegbue et al., 2008). According to Gonzalez-Weller et al. (2006), mean levels of 1.68, 5.49, 1.90 and 1.22 µg/kg of Cd were reported in chicken meat, pork, beef and lamb meat respectively. According to EFSA a revised tolerable weekly intake (TWI) for cadmium is 2.5 µg/kg bodyweight (equivalent to 0.36 µg/kg body weight/ day) (Rose et al., 2010).

Chromium at low concentrations is an essential element but when consumed in excess becomes carcinogenic. For adults, an adequate intake of chromium is believed to be above 25 µg/day and for children and adolescents between 0.1 and 1.0 µg/ kg body weight /day respectively (Department of Health 1991). The data on Cr presented in this study were all within permissible levels and pose no threat to consumers. The values of Cr in this study were lower than concentrations reported by Demirezen and Uruc (2006) for fish and meat products in Turkey. Similarly, Iwegbue et al. (2008) found Cr values in poultry meat to be within the range of 0.01–3.43 mg/kg. The results for Ni content in meat samples presented in this study were all within permissible limits. Nickel is carcinogenic and can cause respiratory difficulties; the upper tolerated nickel consumption levels for children (1-3 years old) and adults (19-70 years old) are 7 and 40 mg d-1, respectively (Institute of Medicine, 2003).

Table 1: Heavy metals concentration in meat sample from Owhelogbo.

Parameters	Muscle 1 Mg/kg	Muscle 2 Mg/kg	Muscle 3 Mg/kg	Average Mg/kg
Nickel (Ni)	<0.001	<0.001	<0.001	<0.001[a]
Chromium (Cr)	<0.001	<0.001	<0.001	<0.001[a]
Cadmium (Cd)	<0.001	<0.001	<0.001	<0.001[a]
Copper (Cu)	<0.001	<0.001	<0.001	<0.001[a]
Lead (Pb)	<0.001	<0.001	<0.001	<0.001[a]

Results represent the mean of three independent determination and letters with different superscript along columns are significantly different p<0.05

Table 2: Heavy metals concentration in meat sample from Oleh.

Parameters	Muscle 1 Mg/kg	Muscle 2 Mg/kg	Muscle 3 Mg/kg	Average Mg/kg
Nickel (Ni)	<0.001	<0.001	<0.001	<0.001[D]
Chromium (Cr)	<0.001	<0.001	<0.001	<0.001[D]
Cadmium (Cd)	0.072	0.070	0.070	0.071±0.001[a]
Copper (Cu)	<0.001	<0.001	<0.001	<0.001[D]
Lead (Pb)	<0.001	<0.001	<0.001	<0.001[D]

Results represent the mean of three independent determination and letters with different superscript along columns are significantly different p<0.05

Table 3: Heavy metals concentration in meat sample from Ozoro.

Parameters	Muscle 1 Mg/kg	Muscle 2 Mg/kg	Muscle 3 Mg/kg	Average Mg/kg
Nickel (Ni)	<0.001	<0.001	<0.001	<0.001[c]
Chromium (Cr)	<0.001	<0.001	<0.001	<0.001[c]
Cadmium (Cd)	0.040	0.040	0.039	0.039 ± 0.005[b]
Copper (Cu)	0.720	0.730	0.720	0.723± 0.006[a]
Lead (Pb)	<0.001	<0.001	<0.001	<0.001[c]

Results represent the mean of three independent determination and letters with different superscript along columns are significantly different p<0.05

According to Rose at al. (2010), Ni content in poultry and fish products was below the limit of detection, while Ni levels in beef were 0.07 mg/kg in the UK.

Pb has been linked to decreased cognitive development in children, as well as higher blood pressure and cardiovascular illness in adults (Alturiqi and Albedair, 2012). The average content of Pb in meat samples in this study was 0.001mg/kg. Mariam et al. (2004) analyzed Pb concentrations in beef, mutton, and poultry in Pakistan and reported mean values of 2.18, 4.25 and 3.15 mg/kg respectively. Similarly, much higher values of Pb content in samples of liver and kidney were also reported by Aranha (1994) and Danev et al. (1996).

Copper contributes to the formation of bone and skeletal mineralization, and it maintains connective tissue integrity (Mariam et al., 2004). The data of Cu levels in meat samples showed that while concentrations of Cu in meat samples from Ozoro were 0.723mg/kg, those in Owhelogbo and Oleh were 0.001mg/kg. It is unclear why Ozoro has a higher Cu content than the other towns, but it may be due to higher industrial activity. In a previous study, Mukhacheva and Bezel (1995) found higher levels of copper in the livers and kidneys of mutton and beef. Iwegbue et al. (2008) also reported Cu levels that ranged from between 0.01–5.15 mg/kg in meat and poultry samples. Although Cu is an essential element, it is toxic and the maximum limit intake is set from 1 to 10 mg/day (WHO, 1996).

Conclusion

Metal concentrations in meat from Owhelogbo, Oleh, and Ozoro were determined. The results revealed that there were minor variances in the concentration of trace elements in the meat samples, but they were all within tolerable levels. As a result of the investigation, the concentration of harmful metals in meat samples from the three sites is minimal and safe to consume. Basic food hygiene training (Hygiene Processing) is recommended to ensure that slaughterhouses and abattoirs follow the required rules for proper hygiene and sanitation of food handlers on a regular basis as is the establishment of a code of practice for the street food industry.

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