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Short Communication

Analysis of Some Heavy Metals in Cow Skin (Ponmo) Sold at Major Markets in Ado-Odo/Ota LGA, Ogun State, Nigeria

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ABSTRACT

Many of the food markets in Nigeria are open markets where foodstuffs are usually sold on open flat trays, wooden materials and baskets. Foods on sale in the open marketplace are at high risk of being contaminated by heavy metals. This study aimed at determining the occurrence of heavy metals in cow skin (ponmo) sold at the major markets in Ado-Odo/Ota Local Government Area of Ogun State. The wet and dried forms of ponmo were sampled from three major markets, Lusada, Atan and Ota. Thirty samples of the food items were analysed for lead (Pb), cadmium (Cd), nickel (Ni), manganese (Mn) and zinc (Zn) using the Atomic Absorption Spectroscopy (AAS). The results obtained were subjected to one-way analysis of variance (ANOVA). Most of the toxic heavy metals were detected (Ni, 25.62±1.55-70.45±2.44; Pb, 1.02±0.56-1.99±0.86) in both ponmo forms. However, Cd was detected only in the dried ponmo and in only one of the markets. These non-essential metals were detected in very high concentrations above maximum allowable limits by international regulatory agencies (USDA). Where detected, Mn (46.84±1.54-83.11±2.04) was also higher than the limits that are allowed in food in the two ponmo forms only in Ota and Atan markets. Zinc (8.86±0.81-11.70±0.96) was the only metal that was generally below the regulatory limits in the ponmo forms across the three markets. The present study shows that the cow skin on sale around the study area is not entirely free from heavy metal contamination and this may have health consequences.

***Keywords*:** Atan, Lusada, Ota, Pomo, Heavy metal.

Introduction

Nigeria, with an average population of about 200 million people remains the highest populous nation country in Africa.[1] Cow hides are widely consumed as food in Nigeria.[2, 3] Cow hide serves as a local delicacy. Prior to consumption, it is processed into an edible form like beef which provide a substitution for beef in meals.[3] Cow hides processed effectively as a source of food is very significant to secure its savoury. This can be accomplished in various ways. Boiling and burning (singeing /roasting).[3,4] Elimination of the hair from the hides is conventionally carried out by softening the hides in boiling water, accompanied by trimming with a sharp blade or knife.[5] The substances employed in the burning of hides contain toxic contaminants which can impact the hides and make them unhealthy for humans' consumption. The distinction in the end product derived from the two techniques are the colour, and the chemical composition.[6, 3] The distinction in colour noted by Funke[6] was due to the processing techniques utilized. It was reported that the boiling technique results in the white coloured "pomo" while the burning technique led to the burnt/brown coloured type of "pomo". The substances employed in the burning of hides contain toxic contaminants which can impact the hides and make them unhealthy for humans' consumption. Hides scorched with firewood blended with automobile engine fluids may contain certain toxic substances like dioxins, benzene, furans, lead and Polycyclic aromatic hydrocarbons (PAHs).[7]

Therefore, constant and excessive consumption of such probable contaminated hides may pose a great danger to the consumer.[8]

Ota, Atan and Lusada towns are characterized by a high population density, industrial activities, high activity of automobiles, most especially during the peak hours and also during intensive industrial processes. In the three towns, there are major markets where hundreds of consumers go to on a daily basis, patronizing these markets to meet their different daily food needs. Some of these places where foodstuffs are sold can be described as "open markets", the food items are sold close to the public roads where the traffic density is usually extremely high. This study outlines the levels of heavy metals in dried and fresh cowhides (ponmo) on sale in Ado/Odo Local Government area of Ogun state, Nigeria.

Materials and Methods

Study area

The sampling locations for this study were three major markets, Lusada, Atan and Ota markets all in Ogun State (Figure 1)

Collection of samples

Two forms of ponmo, wet and dried were collected from the three markets in March 2018. Five (5) samples of each form of cow hide (ponmo) were collected from five different sellers at each market making a total of thirty (30) samples.

Digestion and analysis of samples

Pieces of the ponmo samples were put in oven and made to dry at 100°C until a constant weight is achieved. A protocol for wet digestion of the samples was followed. All glass wares were allowed a minimum time of 24 h to soak in dilute nitric acid and thereafter rinsed in distilled water before use. One (1) gram of the sample was added onto nitric acid and sulfuric acid in the ratio 3:1 in a beaker of 50 mL volume.

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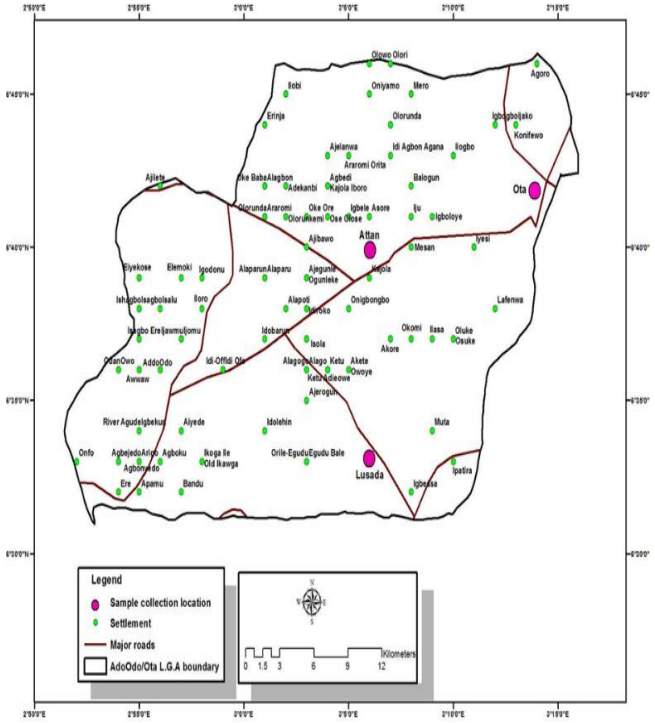

Figure 1: Map of Ado-Odo/Ota Local Government Area showing the Sampling Locations

After the tissue had reacted sufficiently with the acids, the beaker was heated for another 30 mins at 60°C on a hot plate. The beaker was allowed time to cool, 5ml nitric acid was added and the beaker was not heated further on observing colour change in the samples. The sample was sieved until it was very clear, enabling any impurities to be removed in the process. The content of the beaker was transferred into a 50 ml volumetric flask and made up to mark with ultra-pure water.

Analytical measurement

Concentrations of nickel, cadmium, lead, manganese and zinc were then analyzed using a graphite furnace Atomic Absorption Spectrometer with high-purity argon. Results were converted to mg/kg dried sample.

Statistical analysis

The results obtained were subjected to statistical analysis using the GraphPad Prism Software. Means and standard deviation were generated; the means were compared for significance by Analysis of Variance (ANOVA). Duncan's multiple range test was used to test the level of significance of the means at $p < 0.05$.

Results and Discussion

The concentration of heavy metals was significantly high in all the ponmo samples from each of the three markets, with the exception of zinc which recorded a highest and lowest values of 11.70 mg/kg and 8.86 mg/kg respectively. The concentration of nickel in ponmo was highest in Atan market with a value of 70.45 ± 2.44 mg/kg (fresh ponmo), followed closely by Lusada market with a value of 54.02 ± 2.06mg/kg (fresh ponmo), and lastly Ota market with a value of 48.99 ± 2.41 mg/kg (fresh ponmo). The dried ponmo samples recorded lower concentrations of nickel compared to the fresh ponmo with both Ota and Lusada markets having the same values of 25.62 ± 1.05 mg/kg and 25.62 ± 1.55 mg/kg while Atan market recorded 39.59 ± 1.68 mg/kg. Cadmium was detected in dried ponmo at low concentration in just Lusada market with a value of 19.94 ± 1.22 mg/kg, and remained undetected in the other markets at both fresh and dried forms (Table 1).

Furthermore, the concentration of zinc present in the ponmo was highest in Atan market with a value of 11.70 ± 0.96 mg/kg (fresh ponmo), followed closely by Ota market with 10.82 ± 1.12 mg/kg (fresh ponmo) and 10.19 ± 1.01 mg/kg (dried ponmo), with Lusada market having values of 9.85 ± 0.92 mg/kg (fresh) and 9.80 ± 1.02 mg/kg (dried), and lastly, Atan recorded the lowest concentration of Zinc with value of 8.86 ± 0.81 mg/kg. The levels of manganese were highest in Atan market, with values of 83.11 ± 2.04 mg/kg (dried ponmo), and 76.63 ± 1.85 mg/kg followed by Ota market with values of 49.09 ± 1.98 mg/kg (fresh ponmo) and 46.84 ± 1.54 mg/kg (dried ponmo). Manganese was not detected in Lusada market.

With the exception of Zn, the concentration of other metals analysed in the ponmo samples were far above the maximum permissible levels (0.1 mg/kg; 0.5 mg/kg; 0.3 mg/kg) in meats. The highest concentration of nickel, Ni was found in Atan market with a value of 70.45 mg/kg for fresh ponmo, while the lowest concentration of Ni was recorded in both Ota and Lusada markets for dried ponmo recording the same values of 25.62 mg/kg. The values of Ni in all the three markets for both fresh and dried ponmo, was found to be far above the permissible limits of 0.300 mg/kg.[9] Nickel is a metal that can be found in the earth's crust either in elemental form or combined with other elements as compounds of nickel.[10] It has some unique features such as resistance to heat and corrosion, in addition to being strong and hard. Because of this, it has enjoyed a very wide usage especially in industries.[11] Therefore, through industrial processes by human activities, natural processes like volcanic eruptions and movement of dust by wind, nickel and its compounds easily gets into the atmosphere.[12] Additionally, humans and other organisms can also be exposed to low concentrations of nickel via tobacco smoke, food, water and air. Nickel-plated materials such as jewellery, coins, and cooking utensils may also be a source of nickel exposure to the general public. Evidently, Ni has a low toxicity in man. Adverse effects can range from airways irritation to increased risks of nasal and airway cancer.[11] Chronic exposures can lead to reduction in body weight, liver and kidney damage and skin irritation.[13]

The highest cadmium value recorded in ponmo from the three different markets was from dried ponmo in Lusada market at 19.94 mg/kg and it remain undetected in the other markets, far above the permissible limit of 0.500 mg/kg.[9] Cadmium is found in minute quantities in the soil. It is dispersed by wind and water above land and sea, but especially in the particularly in areas of high concentrations of industrial plants and so easily taken up by many plants and aquatic organisms. The detection of cadmium in ponmo could therefore be as a result of the ponmo coming into contact with both soils and particles dispersed by wind. Cadmium exposure is toxic to the kidney. Bone demineralization is impacted by cadmium toxicity.[14] Investigations also show that cadmium may be implicated in the development of cancers of the bladder, pancrease, gall bladder and testes.[15]

Lead is known as a toxic metal that has no observed beneficial properties to organisms and its accumulation over a period of time in the tissues of animals and humans can cause grave damage.[16] The highest concentration of lead recorded was 1.99 mg/kg in fresh ponmo from Ota market, and the lowest at 1.02 mg/kg also in fresh ponmo from Lusada market. All the concentrations of lead were above the permissible limits recorded by USDA of 0.1 mg/kg.[9] Lead is capable of entering the atmosphere during smelting, manufacturing, mining and refining processes and by the utilization of products containing lead.[17] The source of Pb contamination in ponmo may be from the air and water used in their production. All the ponmo analysed contain lead in high concentrations (above permissible limits), and this could be as a result of the utilization of products containing or exposed to lead during the processing of the ponmo.[18]

The mean concentration of zinc in the ponmo samples analysed ranged from 11.70 mg/kg in fresh ponmo to 8.86 mg/kg in dried ponmo, both from Atan market respectively. The highest concentration of Zn in this study was found to be lower than the permissible limit of 50 mg/kg.[19] Although humans can handle proportionately large concentrations of zinc, excessive amounts of Zn in the human body may be hazardous and pose health challenges, such as anaemia, vomiting, stomach cramps and skin irritations. Extremely high amounts of zinc can lead to damage of the pancreas and disrupt the protein metabolism and also cause arteriosclerosis.[13]

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Table 1: Average concentrations (mg/kg) of metals in ponmo in the three markets

Heavy Metals	Ponmo Type	Ota Market	Atan Market	Lusada Market
NIckel	Fresh ponmo	48.99 ± 2.41[a]	70.45 ± 2.44[b]	54.02 ± 2.06[a]
	Dried ponmo	25.62 ± 1.05[a]	39.59 ± 1.68[b]	25.62 ± 1.55[a]
Cadmium	Fresh ponmo	ND	ND	ND
	Dried ponmo	ND	ND	19.94 ± 1.22
Lead	Fresh ponmo	1.99 ± 0.86[a]	1.34 ± 0.55[b]	1.02 ± 0.56[c]
	Dried ponmo	1.32 ± 0.42[a]	1.31 ± 0.36[a]	1.90 ± 0.10[b]
Zinc	Fresh ponmo	10.82 ± 1.12[a]	11.70 ± 0.96[a]	9.85 ± 0.92[a]
	Dried ponmo	10.19 ± 1.01[a]	8.86 ± 0.81[a]	9.80 ± 1.02[a]
Manganese	Fresh ponmo	49.09 ± 1.98[a]	76.63 ± 1.85[b]	ND
	Dried ponmo	46.84 ± 1.54[a]	83.11 ± 2.04[b]	ND

Mean ± S.E, no significant difference in values with same alphabets per row, where n = 5

Manganese concentration in all the ponmo samples analysed ranged from 83.11 mg/kg in Atan market to 46.84 mg/kg in Ata market for both dried ponmo samples exceeding the permissible limits of Mn recorded by WHO/FAO to be 0.3 mg/kg,[19] while Mn was not detected at all in Lusada market. It is widely known that manganese has the ability to disrupt calcium channels and with chronic exposure may results in CNS dopamine depletion. This imitates averagely all of the symptoms exhibited by Parkinson's disease.[13]

Conclusion

The results of this study reveals the presence of high concentrations of heavy metals in the two forms of ponmo sold in Ota, Atan and Lusada markets. Thus, this might be a source of great concern for the consumers from these three towns considering the health impacts of these metals in humans. It is necessary that effective assessments of ponmo and other food items in open markets be regularly carried out to ensure best practices and consumer safety.

Conflict of Interest Statement

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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