Analysis of Heavy Metals in Goat and Cow Hides Singed with Scrap Tyre In Tudun Wada Zango Abattoir, Kaduna State, Nigeria

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ABSTRACT: Singeing of goat and cow hides is the major process by which fur on the skin of slaughtered animals is burnt in open fire using materials like firewood and charcoal because it preserves the animal's hide for consumption. Tyres have been reported to contain heavy metals that could pose health threats to hides consumers. This study was done to determine the concentration of heavy metals in goat and cow hides singed with scrap tyre in Tudun Wada Zango Abattoir, Kaduna. 42 goat and cow hides samples were analysed. Samples were collected before singeing, after singeing and when singed hides were washed. Furthermore, scraped soot from singed hides were collected and determination of heavy metals. Samples were prepared according to the method of Association of Official Analytical Chemists and concentration of Lead, Cadmium, Zinc and Iron were determined using Atomic Absorption Spectrophotometer. The concentration of Lead and Cadmium in tyre singed goat and cow hide have exceeded maximum permissible limit (MPL) of European Commission Regulation (ECR) while that of Zinc and Iron were below MPL. Washing reduced the concentration of heavy metals in both hides but levels of Lead and Cadmium were still above MPL. This makes goat and cow hides singed with scrap tyre unsafe for consumption. The scraped soot obtained from the singed hides had high concentrations of lead and Cadmium and can contaminate nearby water bodies and soil. Therefore, proper laws should be enacted to stop butchers from using scrap tyre as source of fuel to singe hides.

Keywords: Hides, Fur, Singeing, Scraped Soot

1. Introduction

In Nigeria and other parts of Africa, in addition to the regular consumption of red meat, the habit of eating singed goat and cow hide is a common practice (Okiei et al., 2009). This practice poses a threat not only to the health of its consumers, it also threatens the leather industry that use this hide as a raw material. This is the reason why Government and non Governmental organisations have been enlightening individuals against the consumption of goat and cow hides (Leita et al., 2009). The methods of hide removal in slaughtered animals and the process of singeing hide for human consumption are done mostly according to different cultures (Dada et al., 2017). Ruminant animals like goat and cow, after hide removal, are normally singed to get rid of the fur. Singeing in an open fire is the major process by which fur of the skin of slaughtered goat and cow is removed (Omojola et al., 2010). In African countries, singeing is largely preferred in several ways because it preserves the animal's hide for consumption and evokes taste in it that are strongly desirable and acceptable by the local population (FAO, 2005).

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Processed goat and cattle hides are popularly known as “ponmo” in South-Western Nigeria and “Ganda” in the Northern part of the country and they are served as food delicacy in several homes (Okiei et al., 2009; Obiri-Danso et al., 2008). Singeing is mainly done by the use of firewood as fuel, but the relative scarcity of firewood in recent times has resulted in local butchers using plastics, scrap car tyres and charcoal (Obiri-Danso et al., 2008). Tyre derived fuel‟ (TDF) carry several heavy metals like lead (Pb), zinc (Zn), copper (Cu) that could be carcinogenic if consistently exposed over a long period by consumers. Furthermore, high level of heavy metals were detected in goat and cowhide as a result of singeing with scrap automobile tyre and this make it dangerous for human consumption (Obiri-Danso et al., 2008). Singeing of hides with hazardous substances could contaminate the environment, meat products and can also have adverse health implications (Okiei et al., 2009). Water bodies located near the abattoir often get contaminated with these hazardous substances through runoffs and other improper management of abattoir waste (Adelegan, 2002).

Heavy metals are essentially metallic chemical elements that have a relatively high density and are toxic at high concentration, Examples include: arsenic, lead, copper, iron, zinc, nickel. Metals such as copper, iron, zinc and nickel are essential metals since they play important roles in biological systems, whereas cadmium and lead are non-essential metals and they are harmful even in small concentaration (Fernandes et al., 2008). Heavy metals are bio-accumulative and therefore require close monitoring (Bhattacharya et al., 2008). The aim of the research is to analyse the concentration of heavy metals in goat and cow hide singed with scrap tyre in Tudun Wada Zango abatoir, Kaduna State. The study will also analyse the concentration of these metals in scraped tyre soot obtained from the singed hides and the water used in washing the hides after singeing.

2. Materials And Method

2.1 Sudy Area

The study was conducted in Tudun wada Zango abattoir Kaduna which lies within latitudes 10°30ˈ104" N, and longitude 7°24ˈ452" E. The abattoir is located in Tudun Wada, Kaduna South Local Governement Area of Kaduna State, Nigeria. This is the largest abattoir supplying both live animals and meat products to nearby and far away markets.

2.2 Sample Collection

A total of forty-two samples of hides (This consists of 21 hides samples from goat and 21 cow respectively) were taken from seven different goats and cattle carcass from the slaughter sites between the months of January to December, 2020. Approximately 5g portions of hides were carefully cut from each animal. In each case, hides were cut before singeing, after singeing with scrap tyre and when singed carcass were washed.

The samples were put in air tight bags (sandwich sealers), placed in coolers containing some quantity of ice and transported to the laboratory for chemical analysis.

2.3 Hides Sample Preparation And Digestion

Each sample was scraped to remove ash and rinsed using distilled water. The samples were then drained and oven dried at 105°C for 4 hours or until dried and homogenized using pestle and mortar until powdered. The powdered sample (1 g) was used for the wet digestion. This was put in a 50 ml volumetric flask. Five liters of concentrated acid mixture (HNO3 and HCIO4) was added to the

volumetric flask containing 1g of powdered hide and shaken slightly to ensure proper mixture after which 5 ml of H2SO4 was also added and mixed gently. This mixture was then heated in a fume chamber for 30 min or until a clear solution was gotten. For samples in which solutions were not clear after digestion, acid solutions were added again and reheated. The flask was then left to cool and 20 ml of distilled water added to it. This mixture was shaken to ensure proper mixing. The volumetric flask was then filled to the 50 ml mark using distilled water. This was then analyzed using Atomic Absorption Spectrophotometer (AAS). The determinations were carried out in triplicates. Methods of wet digestion were adopted from Association of Official Analytical Chemist (1979) and Levinson (1968).

2.4 Water Sampling

Sample containers were thoroughly washed with detergent, rinsed with water followed by distilled water and allowed to air dry. Samples of water were collected before washing of goat and cattle hides and analyzed to determine if the type of water used in washing hides during processing contributed to heavy metal contamination. Disposable gloves were worn and water samples were collected into well rinsed 500ml plastic bottles. Samples were transported to the laboratory in a cool box of ice to keep the metal ions in their dissolved state, as well as to prevent microbial activities for analysis (APHA, 2005).

The samples were digested according to Standard methods for the examination of water and wastewater, American Public Health Association (APHA, 2005). Each sample was thoroughly mixed, 20ml was transferred into a conical flask, 10ml concentrated nitric acid was added and brought to slow boiling before evaporating on a hot plate to lowest volume (5 – 10ml). Concentrated nitric acid was added as necessary until digestion was complete as shown by light colour clear solution. The digest was filtered into 50ml volumetric flask and made up to the mark. The digest was then used for the heavy metal analysis

2.5 Scraped Charcoal Ash And Tyre Soot Preparation And Digestion

5g of charcoal ash and 5g of scraped tyre soots were collected from singed hides before washing. Scraped soot samples were air dried and grinded with a mortar and pestle, then sieved and preserved in plastic bottles for chemical analysis. Method of wet digestion were adopted from Association of Official Analytical Chemist (1984). 1g of sieved soot sample was weighed into a digestion flask. Concentrated perchloric acid and nitric acid (20ml each) were added and the mixture was heated using hot plate. After heating, it was allowed to cool and 30 ml of distilled water was added and filtered with Whatman filter paper and a digest was obtained. The digest was made up to 50 ml with distilled water and kept for analysis.

2.6 Analysis of Samples

The digests were used for determination of heavy metals (Pb, Cd, Zn and Fe) using the atomic absorption spectrophotometer (AAS) model AA 220. Each digest were determined in triplicates. Standards for AAS calibration were prepared using commercial stock metal standards of each metal.

2.7 Data Analysis

Concentrations of heavy metals obtained from the analysis were expressed as mean ± SEM (standard error of mean) using SPSS 17.0. One way ANOVA was used to compare means among treatments and differences resulting in $p < 0.05$ were considered significant

3. Result

The mean concentration of heavy metals in goat and cow hides singed with scrap tyre in Tudun Wada Zango Abattoir were presented in Table 1. The levels of Pb, Cd, Zn and Fe in unsinged (control) goat hides were 0.092 ±0.036, 0.031 ± 0.018, +1.082 ± 0.291 and 2.019 ± 0.516 mg/kg respectively. However, the concentration of goat hides in this study increased upon singeing to 0.229 ± 0.075, 0.068 ± 0.13, 1.251 ± 0.311 and 2.473 ± 0.417 mg/kg respectively. The level of Pb and Cd are far beyond the MPL of European Commission regulation (2006) while Fe and Zn are found in trace amount and well below MPL. After washing, the level of Pb and Cd decreased but still above MPL while Zn and Fe decreased too and found in small concentrations. Level of Pb, Cd, Zn and Fe in TSWGH were 0.160 ± 0.047, 0.043 ± 0.008, 0.940 ± 0.301 and 2.167 ± 0.499 mg/kg. In processed or ready to cook goat hide, the concentration of Pb is beyond MPL while Cd, Zn and Fe are found in trace amount. The concentration of metals recorded in USCH were 0.125 ± 0.035, 0.065 ± 0.023, 1.146 ± 0.275 and 1.734 ± 0.416 mg/kg for Pb, Cd, Zn and Fe respectively. Upon singeing with scrap tyre, the levels further increased above MPL to 0.218 ± 0.052, 0.122 ± 0.056, 1.399 ±0.328 and 2.103 ±0.381 mg/kg. TSWCH recorded a slight decrease in Pb, Cd, Zn and Fe concentration to 0.138 ± 0.034, 0.055 ± 0.014, 0.608 ± 0.211 and 1.975 ± 0.335 mg/kg respectively. The high concentration of Pb and Cd in singed hides may be related to the high concentration of Pb and Cd found in Scrap tyre soot. the concentration of heavy metals in water used for washing singed hides in Tudun Wada Zango abattoir, Kaduna in Pb, Cd, Zn and Fe were 0.116±0.085, 0.008±0.005, 0.315±0.075 and 1.060 ± 0.318 mg/l respectively (Table 3).

Table 1: Mean Concentration (Mg/Kg) of Heavy Metals in goat and cow hides singed with scrap tyre in Tudun Wada Zango Abattoir

Treatment	Pb		Cd		Zn		Fe	
USGH	0.092	±0.036^{a}	0.031	±0.018^{a}	1.082	±0.291^{a}	2.019	±0.516^{a}
TSGH	0.229	±0.075^{a,b}	0.068	±0.013^{a,b}	1.251	±0.311^{a}	2.473	±0.417^{a}
TSWGH	0.160	±0.047^{a,b}	0.043	±0.008^{a}	0.940	±0.301^{a}	2.167	±0.449^{a}
USCH	0.125	±0.035^{a}	0.065	±0.023^{a,b}	1.146	±0.275^{a}	1.734	±0.416^{a}
TSCH	0.218	±0.052^{a,b}	0.122	±0.056^{a,b}	1.399	±0.328^{a}	2.103	±0.381^{a}
TSWCH	0.138	±0.034^{a,b}	0.055	±0.014^{a,b}	0.608	±0.211^{a}	1.975	±0.335^{a}
ECR RML	0.1		0.05		50		50	

Values are mean ± Standard error. Where N=42

Value with different superscript down a column are significantly different

USGH = Unsinged Goat Hide, TSGH = Tyre Singed Goat Hide, TSWGH = Tyre Singed and Wash Goat Hide, USCH = Unsinged Cow Hide, TSCH = Tyre Singed Cow Hide, TSWCH = Tyre Singed and Wash Cow Hide

Pb = Lead, Cd = Cadmium, Zn = Zinc, Fe = Iron

ECR RML= European Commission Regulation (2006) Recommended maximum limit (RML)

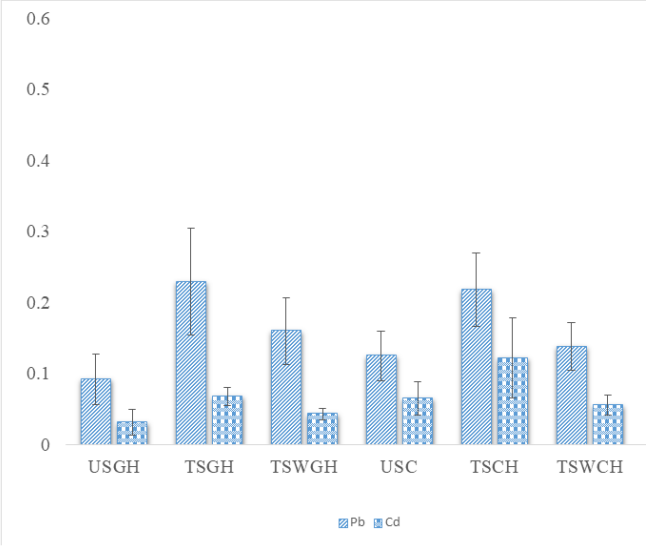

Figure 4.1: Concentration of Pb and Cd in in goat and cow hide singed with scrap tyre at Tudun Wada Zango Abattoir

USGH = Unsinged Goat Hide, TSGH = Tyre Singed Goat Hide, TSWGH = Tyre Singed and Wash Goat Hide, USC = Unsinged Cow Hide, TSCH = Tyre Singed Cow Hide, TSWCH = Tyre Singed and Wash Cow Hide

Pb = Lead, Cd = Cadmium

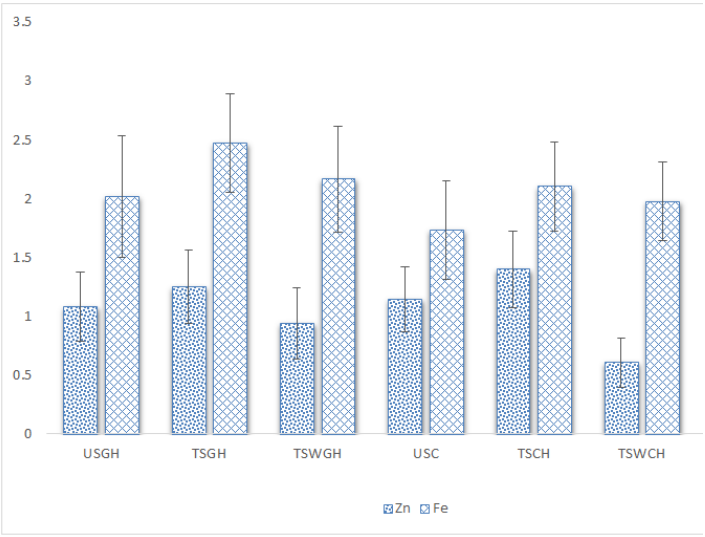

Figure 4.2: Concentration of Zn and Fe in goat and cow hide singed with scrap tyre at Tudun Wada Zango Abattoir

USGH = Unsinged Goat Hide, TSGH = Tyre Singed Goat Hide, TSWGH = Tyre Singed and Wash Goat Hide, USC = Unsinged Cow Hide, TSCH = Tyre Singed Cow Hide, TSWCH = Tyre Singed and Wash Cow Hide

Zn = Zinc, Fe = Iron.

Table 2: Mean Concentration of heavy metals (mg/kg) in scraped tyre soot obtained from Tudun Wada Zango Abattoir.

Treament	Pb	Cd	Zn	Fe
Scraped tyre soot	0.351 ±0.138	0.305 ±0.197	1.480 ±0.325	1.423 ±0.444
ECR RML	0.1	0.05	50	50

Values are mean ± Standard error. Where N=14

Pb = Lead, Cd = Cadmium, Zn = Zinc, Fe = Iron

Table 3: Mean Concentration (Mg/L) of Heavy Metals in Water used for Washing Singed goat and cow hides in Tudun Wada Zango Abattoirs

Site	Pb	Cd	Zn	Fe
Tudun Wada Zango Abattoir	0.116 ±0.085	0.008 ±0.005	0.315 ±0.075	1.060 ±0.318
WHO	0.01	0.005	1.0	1.0

Values are mean ± Standard error.

Where N= 14

Pb = Lead, Cd = Cadmium, Zn = Zinc, Fe = Iron

WHO; World Health Organization Guidelines for Drinking Water Quality (1984); Ekenma et al., (2015)

4. Discussion

The concentration of Pb and Cd in unsinged cow hide were found in substantial concentration and have exceeded MPL set by ECR (2006). The high concentration of Pb and Cd recorded in the fresh cow hide may be as a result of the local environment in which the cattle are reared. Cows are known to graze freely, they scavenge for food from different places and they drink water even from contaminated ponds and rivers, through atmospheric depositions especially from open burning of solid waste (like scrap tyres and plastics), agricultural chemicals, urban and industrial wastes, as such, they can easily come in contact with heavy metals through these processes (Obiri-Danso et al., 2008). This is in concordance with findings of Mensah et al., (2019) in Wa Municipality Ghana, who reported of high levels of Pb and Cd in unsinged cattle hide and attributed the observation to the possible exposure of the animals to heavy metals within the local environment as the free-range system of cattle rearing is a common practice in Ghana.

Singeing cattle hide with scrap tyre introduced greater concentrations of Pb and Cd. The concentration of Pb and Cd in singed cattle hide have by far exceeded the MPL set by ECR (2006). Tyres were reported to contain some heavy metals like Pb, Cu, Cd and Fe, when these tyres are used for singeing hides, they can be accumulated in the hides, while others are released into the atmosphere and environment in form of soot. In a similar report by Mensah et al., (2019), the authors revealed that there was an increase in Pb and Cd concentration in cattle hide singed with scrap tyre and identify the tyre as the source of these heavy metals in the hide. This observation contradicts the findings of Eremong et al., (2011), who reported of decreasing level of heavy metal residues in singed cattle hides. This was said to be due to losses through the scrapings (Okiei et al., 2009). In Nsukka, Enugu State of Nigeria, Ekenma et al., (2015), reported that scrapping can also reduce the level of heavy metal in tyre singed hides but the scrapped soot can end up polluting soil and water in the abattoir. However, in this study, there was a decrease in Pb and Cd conc. After washing the hide but they are still above acceptable limit. As such, it is unwholesome for consumption. In Ghana, Adam et al., (2013), reported that washing of singed goat hide slightly reduce the heavy metal concentrations, but the heavy metal residues were still higher than the maximum permissible level (MPL), signifying that washing cannot render it wholesome for consumption especially when the heavy metal concentration in singed hides are very high before washing. Pb and Cd are non-essential elements and they are carcinogenic, they can be hazardous to the health in a trace amount. According to Chang (2016), ingestion of materials containing at least 30g of Pb by a child can affect a child's IQ to drop by 10 points. It causes bone marrow deficiencies and stunted growth, it can also cause insomnia, nausea, weight loss, malfunctioning of kidney, headache, constipation and destroys central nervous systems (Ekenma et al., 2015). Lead toxicity damages the nervous system, heart, blood and pose greater risk to infants, young children and pregnant women. It has been reported to affect fetal development, cause learning difficulties and behavioral defects (Adam et al., 2013). Cd have been reported to be very toxic even at low concentration and has no known biological or physiological importance (Young, 2005).

However, Zn and Fe in unsinged cow hide were found in trace amount. Upon singeing, the concentration slightly increased but were still below MPL. This in agreement with the findings of Ekenma et al., (2015), who reported some slight increase in Zn and Fe concentration in cattle hide singed with scrap tyre but the concentration recorded have not exceeded the MPL set by ECR (2006). The concentration of Zn and Fe in singed washed hide were below the MPL of ECR (2006). Zn and Fe are essential elements and are needed for biological functioning of the body but can be very toxic at high concentration. Zinc is essential for normal functioning of cells which comprises of carbohydrate metabolism, protein synthesis, cell division and cell growth (Okiei et al., 2009). Zn is an important micro-nutrient in the body, but high dosage in the body can depress the Immune system, cause anemia and cause a type of dermatitis known as "Zinc Pox". It can also cause irritation of the digestive tract leading to nausea and vomiting (WHO, 1996).

The concentration of Pb, Cd and Fe in water used for washing singed hides in Tudun Wada Zango Abattoir were found to be above MPL while that of Zn was found below the standard set by WHO. The high level of these metals recorded in water can be as a result of the tyre ash that was not properly managed and drained into water body during rainfall, contamination from sewage runoff from agrochemicals and fertilizers from nearby farms.

The concentration of heavy metals of Pb and Cd in scrap tyre soot were high while that of Zn and Fe were low. Scrapped tyre soot are often washed into drains and in case of rainfall, they are transported into different water bodies around the abattoir. It might be one of the sources of heavy metals in air,

water and soil and sometimes even plants. Heavy metals have the ability to easily dissolve in water and thereby be absorbed by plants during photosynthesis. Animals are known to graze on plants and drink water from streams and rivers, these heavy metals can be gradually taken by these animals through this medium over a period of time and accumulate in their tissues and skin (Obiri- Danso et al., 2008). Aya and Nwite, (2016), reported on a high level of Pb, Zn and Fe in tyre soot from Ebonyi abattoir in the Southern part of Nigeria.

5. Conclusion and Recommendations

From this study, it can be concluded that hides of goat and cattle can accumulate variety of heavy metals. High concentration of Pb and Cd that were recorded in unsinged hides may be as a result of exposure of the animals to the local environment through rearing or scavenging for fodder and drinking contaminated water. An increase in concentration of this metals were recorded after the hides were singed with scrap tyre. This shows that scrap tyres contain heavy metals that can be readily absorbed in hides when they are used to singe hides. Washing the hides did not reduce the concentration of these metals below acceptable limit, as such, consumption of hides singed with scrap tyre poses a great health challenge to consumers. High concentration of these metals above permissible limits were also recorded in water used in washing the hides and this may be related to high concentration of metals found in soot scraped from the hides before washing. Soot that were scraped from the hides after singeing were mostly poorly managed and are taken off to nearby water bodies through sewage run off thereby causing water contamination. Therefore, necessary measures should be taken by Environmental Protection Agencies to ban the use of scrap tyres to singe hides because it is harmful not only to consumers but also to aquatic animals and the air quality.

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