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(RESEARCH ARTICLE)

# Effect of different dehairing methods on the concentrations of some heavy metals in cow tail sold in Minna Abattoir

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## Abstract

Heavy metals are a group of heterogeneous elements that bioacumulate in tissues causing hazardous effects on livestock and human health. In the present study, effect of different dehairing methods on the concentration of some heavy metals in cow tail sold in Minna abattoir were evaluated. Three fresh cow tails were obtained Bosso abattoir in Minna, Niger state Nigeria. Each cow tail was divided into three portions and was dehaired using fire wood, scrap tyres and scalding method respectively. Each of the processed cow tail were separated into the skin, meat, and bones and analysed for heavy metals (arsenic, lead, cadmium, mercury and chromium) using atomic absorption spectrophotometer. Heavy metals analysed in all the samples were above the permissible limit. Furthermore, mercury was significantly ($p<0.05$) higher in bones than in meat and skin of cow tail under the three processing methods. The concentration of chromium was higher in skin of cow tail processed with fire wood. The lead concentration was significantly ($p<0.05$) higher in meat and skin of cow tail processed with scrap tyre. There were no significant differences ($p>0.05$) in arsenic and cadmium concentration in all cow tail parts among the three dehairing method employed. Cow-tail de-hairing methods enhanced the heavy metal accumulations in the skin, meat and bone contents of cow tail. Continuous consumption of these cow tail pats could become a serious human health threat.

**Keywords:** Arsenic; Bioaccumulation; Cadmium; Cow tail; Dehairing methods; Heavy Metals

## 1. Introduction

Heavy metals are a group of heterogeneous elements which vary widely in their chemical properties and biological functions. These metals have specific weights more than 5 $gcm^{-3}$ [1]. They enter the environment by natural means as well as via human activities. These metals may get into the human body via the skin, respiratory tract, and gastrointestinal tract; they are distributed into the liver, kidney, bone, tissues and nervous tissues [2]. The metals of particular concern in relation to harmful effects on health are mercury, lead, cadmium, tin, and arsenic [3]. These metals can cause hazardous effects on livestock and human health and because they cannot be easily degraded they tend to accumulate in biological tissues in a process known as bioaccumulation [4]. This process begins to occur in all living organisms as a result of exposure to metals in food and the environment, including food animals such as fish and cattle [3]

Meats are important for human diet in many parts of the world because they contribute to solve the global food problem and provide the well-known proteins, minerals and vitamins and trace element [5]. Animal proteins have a high biological value, and the presence of essential amino acids in them makes them complete protein for this reason, they are mostly the preferred choice of protein for most individuals. Sources are mainly from cow, pork, sheep, and goat. When these animals feed on plants, they take up nutrients from the soil and unfortunately they also absorb some

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hazardous chemicals that are introduced into the environment [6]. A study by Sabir *et al.,* [7] showed that higher levels of metals have been indicated in mutton and beef, as cattle graze on contaminated soil. These heavy metals could also get into the meat of animals via the processing method used in slaughter houses and abattoirs. These methods range from the method of dehairing to the method of butchering.

The act of burning off fur from animal carcass with open flame is practiced in most African countries. In Nigeria, firewood is mainly used as fuel for singeing, but the cost of firewood in current times has mandated local butchers in abattoirs to use scrap tyres in its place [8]. This preferred choice, according to the local butchers is affordable and more efficient, produces more flame with less heat, and is also able to selectively burn off the fur from the animal carcass [9]. Although in Minna, Niger state, this practice has also been observed but some processing points still prefer the old practice of singeing with fire wood which they presume to be safe. Unfortunately, when these materials (firewood and scrap tyre) are used for singeing, they may have the potency to contaminate the hides as well as the meat of the animal with heavy metals rendering it toxic for human consumption. Since these heavy metals are not biodegradable, they bioaccumulate in biological tissues and may become cancinogenic, nephro and neuro toxic and eventually result to death when consumed over a long period of time. [10].

## 2. Material and methods

### 2.1. Sample collection and processing

Three fresh cow tails were purchased at an abattoir in Bosso, Niger state. Each cow tail was divided into three portions. A portion of the tail was dehaired by meat processors in the abattoir using old car tyre and spent engine oil as is practiced in most abattoirs. The tyre was first burnt to start the flame; then the cow tail was placed in the burning flame to singe off the hair. Spent engine oil was also added in order to prevent the flame from going off. The cow tail portion was then scraped with a knife to remove ash and then washed in water.

The second portion was processed using firewood which was obtained from local vendors for the fire wood processing method. In this method, the flame is ignited with dried woods after which a portion of the cow tail was placed on wire gauze which was then placed on the burning wood to allow the hair to be singed off. The process was then followed by scrapping the cow tail with a knife to remove ash and singed hair and then washed in well water.

The last portion was processed using the scalding method. Water was obtained from a well and was allowed to boil after which the portion of the cow tail was dipped into it. The cow tail was left in the hot boiled water to allow softening of the hair for ten (10) minutes after which it was removed. The hair was then scrap off from then skin using a new razor blade [8].

### 2.2. Sample preparation

The cow tail was separated into the skin, meat, and bones. Each separated part of the processed cow tail was placed in an oven set at 105 oC for two days to allow total drying. After drying to a constant weight, the samples were then grinded to fine powder and then stored in a sample bottle until required for further analysis [11].

### 2.3. Sample Digestion and heavy metals analysis

From each dried powdered sample, 0.2 g was weighed into a digestion tube, and 5 ml of digestion mixture (concentrated HNO3, concentrated $H_2SO_4$, and 60-62 % Perchloric acid) in the ration (5:1:2) was added to the tubes, swirled gently, and then placed in a fume cupboard. The mixture was left to digest for 2 hours at 250 $^0$C using a Gerhardt digester. The mixture was allowed to cool and then 30ml distilled water was added. The mixture was filtered and mixed vigorously using a vortex mixer, then made up to 100 ml with 70 ml distilled water. Trace metals (As, Cd, Hg, Cr, and Pb) were then determined using Atomic Absorption Spectrophotometer at the following wavelengths (Hg: 298.4 nm, Pb: 288.3 nm, Cd: 326.1 nm, As: 197.2 nm, and Cr: 359.4 nm). Method of wet digestion was adopted from Association of Official Analytical Chemist [12] and Levinson [13].

### 2.4. Statistical Analysis

Statistical analysis was done using SPSS, 24 and Analysis of Variance (one way Anova) was used to test the level of significance. Levels of Hg, As, Cd, Cr, and Pb in each digest were determined in triplicates and values presented as Mean $\pm$ Standard deviation.

## 3. Results

Effect of the different dehairing methods on the concentration of arsenic (As) in various parts of cow tail is presented in table 1. The arsenic (Table 1), lead (Table 2), cadmium (Table 3), mercury (Table 4) and chromium (Table 5) contents in skin, meat and bone of cow tail processed with fire wood, scalding and scrap tyre where all above the permissible limit. Concentration of chromium in skin of cow tail dehaired with fire wood was significantly higher than the chromium contents in skin. Meat and bone processed with scrap tyre and scalding. Concentration of lead (Pb) in meat and skin of cow tail dehaired with scrap tyre were significantly higher than lead contents in skin. Meat and bone processed with firewood and scalding. There were no significant differences ($p>0.05$) in arsenic and cadmium concentration in skin, meat and bone of cow tail among the three dehairing method employed. Mercury were significantly ($p<0.05$) higher in bones of cow tail under the three processing methods employed when compared with the contents in skin and meat of the cow tail.

**Table 1** Effect of the different dehairing methods on arsenic concentration (mg/kg) in dehaired cow tail

| | **Scrap tyre (Mg/kg)** | **Fire wood (Mg/kg)** | **Scalding (Mg/kg)** |
|---|---|---|---|
| Skin | $0.366 \pm 0.002^{a}$ | $0.369 \pm 0.002^{a}$ | $0.371 \pm 0.001^{a}$ |
| Meat | $0.367 \pm 0.001^{a}$ | $0.371 \pm 0.002^{a}$ | $0.373 \pm 0.001^{a}$ |
| Bone | $0.370 \pm 0.002^{a}$ | $0.373 \pm 0.003^{a}$ | $0.372 \pm 0.002^{a}$ |

Data are Mean $\pm$ SEM of triplicate determination. Value followed by different superscript alphabet are significantly ($p<0.05$) differences

**Table 2** Effect of the different dehairing methods on lead concentration (mg/kg) in dehaired cow tail

| | **Scrap tyre (Mg/kg)** | **Fire wood (Mg/kg)** | **Scalding (Mg/kg)** |
|---|---|---|---|
| Skin | $0.866 \pm 0.004^{b}$ | $0.767 \pm 0.021^{a}$ | $0.763 \pm 0.009^{a}$ |
| Meat | $0.875 \pm 0.007^{b}$ | $0.768 \pm 0.007^{a}$ | $0.754 \pm 0.005^{a}$ |
| Bone | $0.769 \pm 0.003^{a}$ | $0.767 \pm 0.003^{a}$ | $0.748 \pm 0.002^{a}$ |

Data are Mean $\pm$ SEM of triplicate determination. Value followed by different superscript alphabet are significantly ($p<0.05$) differences

**Table 3** Effect of the different dehairing methods on cadmiun concentration (mg/kg) in dehaired cow tail

| | **Scrap tyre (Mg/kg)** | **Fire wood (Mg/kg)** | **Scalding (Mg/kg)** |
|---|---|---|---|
| Skin | $3.652 \pm 0.013^{a}$ | $3.686 \pm 0.016^{a}$ | $3.720 \pm 0.022^{a}$ |
| Meat | $3.635 \pm 0.027^{a}$ | $3.658 \pm 0.039^{a}$ | $3.711 \pm 0.017^{a}$ |
| Bone | $3.679 \pm 0.030^{a}$ | $3.700 \pm 0.030^{a}$ | $3.730 \pm 0.015^{a}$ |

Data are Mean $\pm$ SEM of triplicate determination. Value followed by different superscript alphabet are significantly ($p<0.05$) differences

**Table 4** Effect of the different dehairing methods on chromium concentration (mg/kg) in dehaired cow tail

| | Scrap tyre (Mg/kg) | Fire wood (Mg/kg) | Scalding (Mg/kg) |
|---|---|---|---|
| Skin | $0.367 \pm 0.002^{a}$ | $0.469 \pm 0.001^{b}$ | $0.365 \pm 0.001^{a}$ |
| Meat | $0.368 \pm 0.002^{a}$ | $0.368 \pm 0.001^{a}$ | $0.366 \pm 0.001^{a}$ |
| Bone | $0.368 \pm 0.001^{a}$ | $0.369 \pm 0.001^{a}$ | $0.367 \pm 0.002^{a}$ |

Data are Mean $\pm$ SEM of triplicate determination. Value followed by different superscript alphabet are significantly ($p<0.05$) differences

**Table 5** Effect of the different dehairing methods on mercury concentration (mg/kg) in dehaired cow tail

| | Scrap tyre (Mg/kg) | Fire wood (Mg/kg) | Scalding (Mg/kg) |
|---|---|---|---|
| Skin | $0.364 \pm 0.001^{a}$ | $0.363 \pm 0.001^{a}$ | $0.363 \pm 0.002^{a}$ |
| Meat | $0.363 \pm 0.001^{a}$ | $0.362 \pm 0.001^{a}$ | $0.364 \pm 0.001^{a}$ |
| Bone | $0.463 \pm 0.001^{b}$ | $0.462 \pm 0.002^{b}$ | $0.466 \pm 0.002^{b}$ |

Data are Mean $\pm$ SEM of triplicate determination. Value followed by different superscript alphabet are significantly ($p<0.05$) differences

## 4. Discussion

Heavy metal analysis in foods and animal products is very crucial to the wellbeing of the consuming populace as they contribute to alleviate some heath challenges that may arise as a result of consuming foods or animal products contaminated with heavy metals. The result obtained showed a high concentration for all heavy metals analyzed when compared with the maximum permissible limits set by FAO/WHO, [14], WHO, [15] and Codex, [16]. When the comparison was done between the different dehairing methods, it was observed that there was no significant difference in the concentration of Arsenic, Cd, and Hg in the samples analyzed (Table 1). Reason could be that there was a lowering effect in the concentration of these heavy metals when heat was applied [17]. But in the bone, a significant difference ($p<0.05$) was observed for Hg content. A study by WHO, [18] stated that heavy metals are deposited in organs and bones of higher animals when exposure is done over a long period of time. This high concentration of Hg in the bone of the cow tail from the animals analyzed could be an indication of prior exposure to heavy metal rather than the effect of the processing method. Exposure to mercury could result to brain damage, mental retardation altering normal thinking and learning, poor coordination inability to speak, blindness, seizures, nervous and digestive system problems, kidney damage and could also affect the immunologic system [19].

Consumption of foods or animal products contaminated with Arsenic could lead to the development of cancers and lung disease later in life [20]. Cd when consumed from contaminated foods or animal products may induce kidney dysfunction, skeletal damage, and reproductive deficiencies [21]. Other damages that have been observed include development toxicity, hepatic, haematological and immunological effects [22].

A significantly ($p<0.05$) high concentration was recorded for Cr skin of the cow tail sample as seen with fire wood methods (figure 3). Studies have shown that plants have a way of storing heavy metals persistently in and since heavy metals are not biodegradable, they accumulate in biological tissues in a process known as bioaccumulation [4]. This could explain the reason the concentration of chromium was high when fire wood method was used. It means that there was a deposition of Cr from the woods used in singeing. Chronic exposures to chromate dust have been correlated with increased incidence of lung cancer [23].

For Pb, an increased effect was observed when the heat methods (scrap tyre and fire wood) were used for dehairing especially with the scrap tyre method. Lead is a component of automobile tyres and when these tyres are burnt for singeing, they could cause a deposition of heavy metal in the hides as well as in the meat of the cow tail [24]. This significant increase was observed to be highest in the bone of the skin and meat of the cow tail sample analyzed (figure 5). When Lead is consumed and deposited over time, it could result to various biochemical derangements as Pb

is known to be neurotoxic and nephrotoxic even in minute amount [18]. It can cause severe health problems such as reduced haemoglobin formation, thus leading to anemia [25]. Also, chronic and acute lead poisoning could result to cardiac and vascular damage with potentially lethal consequences including hypertension and cardiovascular disease [25]

## 5. Conclusion

The different concentrations of the heavy metals analyzed (Cd, Hg, Cr, As, and Pb) from different parts of the dehaired cow tail far exceeded the maximum permissible levels set by WHO. It is therefore important to note that continuous consumption of these contaminated animal parts such as cow tail could become a serious human health threat to the consuming populace and if to be consumed at all, should be with caution or moderation

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

The authors declare that they have no conflict of interests.

### *Statement of ethical approval*

The principles governing the use of experimental animals as laid out by the Federal University of Technology, Minna Committee on Ethics for Medical and Scientific Research and also existing internationally accepted principles for animal use and care as contained in the Canadian Council on Animal Care Guidelines and Protocol Review were duly observed.

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