Determination of Lead and Cadmium level in cattle offals, water and feed in Omdurman locality –Sudan

Sahar Mohammedan Joda1,2, Hind A. Elnasri2*
1) Animal Resources Research Corporation, Animal Production Research Centre, Khartoum, Sudan.
2) University of Bahri, College of Veterinary Medicine, Khartoum, Sudan.

*) Corresponding Author: hindnasri2017@gmail.com

Received: 29 January 2023; Revised: 06 June 2023; Accepted: 19 June 2023
DOI: https://doi.org/10.46676/ijfanres.v4i2.153

Abstract-- This study was carried out to determine the level of Cadmiium (Cd) and Lead (Pb) in cattle meat, offals, water and feed samples. The samples were obtained from Al Muwalih area (Omdurman locality - Sudan). Laboratory analysis was carried out using Atomic Absorption Spectroscopy. Usually, animals are transported from the Western region of Sudan to the capital city Khartoum, were after few months will be slaughtered for consumption. The highest concentration of Cd and Pb was observed in kidney and liver with a mean of 0.0302 ±0.003mg/g and 0.259± 0.008mg/g respectively. High levels of Cd and Pb were also detected in water and feed samples. It is thus important to supply safe feed for animals to safeguard animal health and reduce the risk of exposure of consumers to heavy metals.

Keywords-- Heavy metals, Meat, cattle, Food analysis, Sudan

I. INTRODUCTION

Heavy metals in food is becoming one of the major current health problems especially because of their ability to be transferred through the food chain. Thus, food contamination with heavy metals, especially lead (Pb), cadmium(Cd) and mercury (Hg), that are not usually metabolized by the body can have toxic effects due to their bio accumulation within the body tissues.[1-2]

Meat is a rich and convenient source of nutrients such as proteins and other micronutrients [3-4]. Offal are the eatable parts of an animal and is very popular in the Middle Eastern countries due to its unique flavor, texture, aroma, in addition to high content of vitamins , and minerals like phosphorus, iron, copper, magnesium, iodine, calcium, potassium, sodium, selenium, zinc and manganese needed by the human body [5-6-7].

Several factors may affect the concentration of heavy metals in animal tissues or products such as animal species, the breeding system, the type of feed, slaughter and transportation conditions, seasonality and free grazing [8, 59]. In addition pollution of water, or environment, use of animal drugs, pesticides, and other agricultural or industrial chemicals may also affect the level of heavy metals in the tissues [9-10-11].

Cd and Pb are known to be highly toxic heavy metals [12, 57]. Chronic exposure to Cd can lead to damage in the kidneys, liver, various body systems such as immune, reproductive, cardiovascular, nervous and gastrointestinal track [13]. Bone demineralization is also affected by Cd toxicity directly and indirectly as a result of renal dysfunction [14]. Pb toxicity can lead to reproductive dysfunctions, nephropathies, damage to the central as well as the peripheral nervous system and interference with the body enzymatic systems [15]. It can also cause carcinogenesis, mutagenesis and teratogenesis [16]. In Sudan, cattle are mainly grazed in the natural pasture during the rainy seasons then transported to big cities, kept for some time until slaughterering. During this period, animals may be exposed to various sources of metal contamination originating from water used for drinking, the roughage used for feeding or from the environment.

This study is among the first studies carried out locally to measure the level of Cd and Pb in cattle meat and offal. The study also aims to compare the level of these metals with the International acceptable limits and determine the possible sources of contamination.

II. MATERIALS AND METHODS

A. Study Area

In the current study samples were obtained from Omdurman locality which has one of the largest cattle markets (Al - Muwalih) for receiving livestock from all parts of the Sudan. The animals are usually kept for some time till slaughter. The area also contains a large number of slaughter houses which are the main source for providing meat for local consumption.

B. Data Collection

The data was obtained in two parts:

(i) Questionnaire: a pre structured questionnaire was filled out to obtain data regarding the origin of the animal, age, type of feed, source of water.
(ii) Sample collection: a total of 30 fresh samples (10 muscle, 10 liver and 10 kidney) were collected randomly immediately after slaughtering. The samples were collected in clean bags and sent to the laboratory for analysis (Veterinary Research Laboratory—Soba). In addition 10 samples of feed and water were collected from the rearing area (Omdurman locality).

C. Laboratory Analysis

The level of Cd and Pb were measured using Atomic Absorption Spectrophotometer method [12].
Sample preparation:
(i) Muscle and Feed: two gms of muscle samples or feed were placed in a crucible then dried at 550 – 600 0C for three hours. Followed by the addition of 10 mL HCl 50% and 5 mL 33% HNO3 (Acid digestion technique), heated at 100 0C for one hour. Then the samples were filtered and the volume was completed to 100 mL using distilled water.
(ii) Liver and kidney: five gms of liver or kidney were digested in 20 mL concentrated nitric acid HON3 for 24 hours at room temperature. Then the samples were filtered and the volume was completed to 50 mL using distilled water then transferred into a plastic container for analyses.
(iii) Water: 50 mL of the water samples were weighed into a flask and 1 mL of 1% HCl was added.

D. Element Analysis of Samples

Standard solutions of the respective metals were used to establish standard curves before metal analysis. Concentrations of Cd and Pb were determined directly using Atomic Absorption Spectroscopy.

E. Statistical Analysis

Data was analyzed using SPSS version 20. The Student t-test was used for comparison of the level of the metals with standard limits.

III. RESULTS AND DISCUSSION

The questionnaire was obtained from 10 farms in Al-Muwalih market. The result of the questionnaire is shown in Table 1.

Free rearing of cattle is widely practiced in the Western parts of Sudan where large number of animals are raised in that area. This involves taking animals from one place to another in search for water and pasture especially during the rainy seasons. During this period animals can pick toxic substances (including heavy metals) from different sources such as the environment, feeding on contaminated fodder or from waste dumps, drinking polluted water from drains and streams, and intake of atmospheric depositions, especially from vehicular emission and fumes from the open burning of wastes [17]. Following that period, animals are transported to big cities for slaughter, mainly on hoof (80% of the animals) and this journey may last for two months (Table 1).

Regarding minerals level, Cd was detected in all samples studied (Fig.1). The concentration of Cd in kidney was the highest with a mean of 0.030±0.0029 mg/g, and the least concentration was detected in feed 0.0114±0.0023 mg/g. It’s concentration was significantly higher (P<0.05) than permissible limits [18] in all tissues. Previous studies also showed levels of Cd - exceeding the acceptable limits - in animal tissues such as kidney, liver and muscle [8-19-20-21]. Several studies reported a variation in Cd levels: within the permissible limit [22], below limit [23], or even not detected [24]. Regarding Pb, it was also detected in all samples (Fig.2) and the highest concentration was found in the kidney with a mean of 0.259±0.0082 mg/g and the least concentration was detected in feed (0.1142±0.00952 mg/g).

Similar to Cd, Pb concentration in all samples exceeded the permissible limits [18]. Other studies also reported Pb levels exceeding the permissible limits in animal tissues [17,25,26]. In contrast, one study reported Pb levels within the recommended limit [22], another reported levels below the limits [27] or no Pb was detected in tested meat samples [24].

<table>
<thead>
<tr>
<th>NO</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Geographical origin of the Animals</td>
<td>Neyala 50% Aldyeín 50%</td>
</tr>
<tr>
<td>2.</td>
<td>Animal Age</td>
<td>2-3 years 60% 3-4 years 40%</td>
</tr>
<tr>
<td>3.</td>
<td>Rearing system (at the original area)</td>
<td>free rearing (Open) 100% Close 0%</td>
</tr>
<tr>
<td>4.</td>
<td>Is the grazing area located nearby a war zone?</td>
<td>Yes 30% No 70%</td>
</tr>
<tr>
<td>5.</td>
<td>Are there any factories near the grazing area?</td>
<td>Yes 10% No 90%</td>
</tr>
<tr>
<td>6.</td>
<td>What are the type of factories</td>
<td>Seeds oil factory</td>
</tr>
<tr>
<td>7.</td>
<td>What is the source of water on original farm</td>
<td>Wells 50% Surface water 50%</td>
</tr>
<tr>
<td>8.</td>
<td>How are the animals transported to Omdurman locality?</td>
<td>on hoof 80% by vehicles 20%</td>
</tr>
<tr>
<td>9.</td>
<td>The duration of transporting livestock from west region to Omdurman locality on hoof</td>
<td>50 - 60 days 90% 60 - 70 days 10%</td>
</tr>
<tr>
<td>10.</td>
<td>How long are the animals kept in Al Muwalih before slaughtering</td>
<td>1-2 weeks 20% 2-4 weeks 60% 4-6 weeks 20%</td>
</tr>
<tr>
<td>11.</td>
<td>What is the type of roughage do the animal feed on during this period?</td>
<td>Sorghum straw</td>
</tr>
<tr>
<td>12.</td>
<td>What is the component of concentrate do the animal feed during this period</td>
<td>Ground nut cake . Cotton cake . Sunflower cake . Wheat bran sorghum cobs</td>
</tr>
<tr>
<td>13.</td>
<td>What is the main source of water</td>
<td>Well water stored in tanks 100%</td>
</tr>
<tr>
<td>14.</td>
<td>Nature of the barrels?</td>
<td>Iron barrels 70% plastic barrels 30%</td>
</tr>
</tbody>
</table>

In this study, the kidney and liver were found to have the highest concentrations of Cd and Pb (Fig.1 and Fig.2). These organs mainly function in storing and removing toxic metals from the body [4-16-28-29]. The level of heavy metal in tissues is affected by different factors such as the duration of exposure.
to the heavy metal, genetic characteristics of the animals, breed and age of the animal at slaughter time, geographical conditions, the composition of animal feed, and husbandry practices and whether animals are fattened up close to industrial areas [30-31-32].

Fig 1. Level of Cd in different samples

Fig 2. Level of Pb in different samples

In the current study, most animals were between 2-3 years old (Table 1) and were reared in the same geographical area. A previous study reported that Pb (in the muscle and liver) increase with age [33], and another study reported the highest Cd level was in 4 year old cattle [30]. Although, the age related differences in the content of different metals in deer was also confirmed, but the directions of changes were inconsistent [34].

Availing safe and clean water is very important and groundwater is one of the most valuable freshwater sources and is being used for drinking purposes throughout the world [35, 58]. Analysis of water samples collected from Al-Muwaliha area showed high concentrations of Cd (0.014±0.003 mg/g). The concentration exceeded the permissible limits [18]. As shown in Table 1, the main feed material was ground nut cake, cotton and sunflower cake, wheat bran and sorghum cobs. Plants usually absorb metal from the soil and air around which may result in accumulation of metals within different plant parts [50], and thus they may enter the body of farm animals and eventually humans get exposed to heavy metals when consuming contaminated animal products [51]. In the current study, some of the grazing areas at the western region are located near war zone (this area suffered from civil war for a long time), and the remnants of war ammunition may stay in the soil for long time in the form of various metal objects that represent a serious hazardous waste [52]. Also some farms were located near factories (Table 1), which can lead to air pollution and further deposition of metals in the soil. It has been reported that contamination of food may be affected by raising animals near contaminated areas [53]. High levels of heavy metals was found in fodder and milk of cattle raised in polluted areas as compared to animals raised in unpolluted areas [54]. Thus, mineral levels can be affected by the soil characteristics of the region, the contamination status of pasture lands and use of water with industrial wastes [55-56] which can increase the risk of transferring minerals to plants and eventually to consumers.

IV. CONCLUSION

The current study showed high levels of Cd and Pb in bovine tissues, water and feed. The highest level was detected in kidney and liver. The consumption of these tissues may pose a health hazard if consumed in large quantities due to bio accumulation of heavy metals in the body.

REFERENCES


[47] Hamidreza Farimani Raad, Alireza Pardakhti and Hamidreza Kalaretaghi . “Carcinogenic and Non-carcinogenic Health Risk Assessment of Heavy Metals in Ground Drinking Water Wells of Bandar Abbas “. School of Environment, College of Engineering, University of Tehran, page 399-400.2021


