The Proximate Composition, Heavy Metals and Microbial Load of Cow, Goat and Sheep Offals Sold in University of Maiduguri

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Abstract: This study was designed to determine the proximate composition, total plate count and heavy metal composition of offal (kidney, liver and intestine) from cow, goat and sheep sold within University of Maiduguri Campus. The result of proximate analysis of offal showed that moisture ranged from 15.96 to 38.95%, ash ranged from 0.81 to 1.76%, protein ranged from 10.43 to 20.38% and fat ranged from 38.81 to 65.82%. Also total plate count ranged from $1.7 \times 10^1$ to $10.3 \times 10^1$ CFU/g. Lead ranged from 0.06 to 0.12 mg/kg, cadmium ranged from 0.01 to 0.3 mg/kg, chromium ranged from 0.10 to 1.10 mg/kg and copper ranged from 0.18 to 1.18 mg/kg. Lead was not detected in other samples. The result of the heavy metals and total plate counts did not exceed the recommended levels except lead content of cow’s kidney. This study indicated that offal (kidney, liver, intestine) of goat and sheep, as well as offal (liver, intestine) of cow sold within university of Maiduguri have significant nutritional value and also pose no health risk to its consumers. Follow up studies are recommended to determine the lead content of kidney of cows in order to safeguard consumers from possible exposure to health hazards. Therefore, it is advisable when cooking offal; one should cut the tissue into smaller sizes, and then boiled and washed thoroughly in order to reduce the concentration level of these heavy metals.

Keywords: Metals, Meat, Hazards, Disease, Animals, Muscle and Organs

1. INTRODUCTION

The word offal originated from the Norman Conquest from 1150 to 1470 century which means refuse from a processed animal meat product (Simpons, 2017). Literary, according to the encarta dictionary, offal are edible internal organs of animals which include the heart, liver, brain and tongue. In this context, it is defined as those part of an animal which are used as food but which are not skeletal muscles (Mwirigi and Wawefu, 2011). As such, offal could be referred to as all the edible internal organs and entrails (including the heart, liver, lungs, intestine, kidney, head and feet), excluding the muscle and bone of a butchered animal (Marriam et al., 2011).

Offal are used as food stuff in many parts of the world such as in Argentina, Bolivia, Nigeria, China, Germany, Italy, Mexico, Pakistan and Russia. In other word, it serves as a delicacy. This part of animals (organs) are consumed as food by many and similarly rejected by others as well. This diversity in ideology is due to health, cultural and religious preferences. Similarly, this has an implication that is why it was stated that “one man’s offal is another man’s meat” (Gordon and Quastel, 1948; Allina et al., 2012).

Certain organs such as liver, bone marrow and intestines of the animal recently achieved more widespread acceptance among professional cookers. These animal parts is commonly incorporates into their menu (Sietsema, 2015). In the U.S, for example, most consumers prefer only the basic muscle tissue of an animal, especially the smallest part (most – tender, lightest – coloured and mildest flavoured) muscles. Offal is either sold at reduced prices to customers or used for other purposes than human consumption (Gordon and Quastel, 1948). On the contrary, others that do not eat offal is due to the implications that offal such as liver for example is not good for consumption because of the storage of livers substances including toxins. Eating liver is equally like eating toxins in the slaughtered animal’s body. This mis-information has lead people to believe toxins from foods and other substance absorbed into our bodies simply accumulate in the liver and are never expelled (Josh, 2017).
Offal comprises of numerous components. They tend to contain significant amounts of essential nutrients including high quality protein, vitamin A, all the B vitamins, iron, folic acid, trace elements such as copper, zinc, chromium and coenzymes (Christiana and Boyes, 2015).

Offal has benefits for human consumption. Based on its advantages, offal is an excellent source of high – quality protein. Also they contain an unidentified anti-fatigue factor. Besides these, offal serves as a good source of purines, nitrogen – containing compounds that serve as precursors for DNA and RNA (Christiana and Boyes, 2015).

Heavy metals are unique group of naturally occurring substances found in the environment, which may be released into the environment by anthropogenic process. The World Health Organization has reported heavy metals like cadmium (Cd), lead (Pb), copper (Cu), and mercury (Hg) as the major contaminants of public health concern (WHO, 2003). Heavy metals are components of earth’s crust and are essential nutrients for plants and animals but at trace levels. However, all metals can be harmful at high concentrations and prolong exposure. Via ingestion heavy metal could be a potential cause of lung, kidney, liver, digest tract and pancreas cancers. Also heavy metals could cause oxidative cellular stress, respiratory problems, cardiovascular disease, nervous system toxicity and kidney damage via inhalation (Krishnamurti, 1987).

Heavy metals often have direct physiologically toxic effects and are often deposited in living tissues (Baykov et al., 1996). A study carried out by John and Jeanne (1994) from other sources showed that levels of cadmium, mercury, copper and lead were found to be very high and generally above the permissible level. Similarly, the distribution and localization of some heavy metals in the tissues of some calf organs were detected. The most affected organs, which showed higher levels of trace metals, were livers, kidneys and intestines (Horky et al., 1974). Heavy metal such as lead is a metabolic poison and a neurotoxin that binds to essential enzymes and several other cellular components and inactivates them (Cunningham and Saigo, 1997). Toxic effects of lead are often seen on haemopoietic, nervous, gastro intestinal and renal systems (Baykov et al., 1996). Food is one of the principle environmental sources of cadmium (Baykov et al., 1996). As cadmium moves through the food chain it becomes more and more concentrated as it reaches the carnivores where its concentration increases in by a factor of approximately 50 to 60 times (Daniel and Edward, 1995). Toxic effects of cadmium are: kidney dysfunction, hypertension, hepatic injury and lung damage (John and Jeanne, 1994). Cadmium chloride at teratogenic dose induced significant alterations in the detoxification enzymes in the liver and the kidney (Reddy and Yellamma, 1996). Animals vary in their arsenic accumulation depending upon the type of food they consume (John and Jeanne, 1994). Acute arsenic exposure can give symptoms with rapid onset of headache, nausea and severe gastrointestinal irritation (Allen, 1995). Similarly, increase in levels of copper was reported to cause liver, kidney and brain damage which may follow haemolytic crisis (Judith et al., 1994).

It was observed that in most developing countries people that consume offal (kidney, liver, intestine) from animals such as cow, goat and sheep do it without knowing the health implication on the body system. Therefore it is important to investigate the potential implication of offal within the University of Maiduguri, since there are rampant reported cases of kidney, liver and some disease infections within the region.

2. MATERIALS AND METHODS

Nine (9) different types of offal namely: kidney, liver and intestine from cattle, goat and sheep were procured from University of Maiduguri Campus. Each of these was obtained from different sources.

Samples collected from the study area were transported to Food Science laboratory in the Department of Food Science and Technology, University of Maiduguri inside polyethylene bags. The nine samples were diced using sterile stainless steel cutting scissors on the cutting board. The samples were taken to the solar tent drier which dried the offal in 4 days at 32°C and were then milled into powder (Igwebge et al., 1992; Igwebge, 2014). The prepared powdered offal was analyzed for proximate composition, total plate counts and heavy metal.

2.1. Determination of Proximate Composition of Offal

Proximate composition of offal was determined using methods as described by AOAC (1990).
2.2. Determination of Total Plate Count of Offal

The medium was prepared by weighing 28 g of nutrient agar using a weighing balance and it was introduced into a conical flask. Distilled water was added (1000 ml) and the solution was stirred to dissolve completely. This was then sterilized in an autoclave at the temperature of 121°C for 15 minutes (Oranusi et al., 2012). One gram of each sample was taken and it was introduced into bijour bottle containing 9 ml of sterile distilled water. It was shaken and allowed to stand for few minutes. Then 1 ml of the diluents was pipette and it was introduced into petri dish, about 15 ml of the prepared plate count agar was poured and stirred to mixed, this was allow to solidify (gel) in the dish which was then incubated for 24 hours at 37°C. The colonies were finally observed after 24 hours of incubation with the aid of colony counter as described by Oranusi et al. (2012).

2.3. Determination of Heavy Metals of Offal

Two gram of offal was placed in crucible and ash at 500°C for 4 hours. The ash was removed from the muffle furnace and cooled in desiccators. The ash was placed in beaker. Then, 10 ml of 0.25 M HNO₃ and 3 ml of HCLO₄ (70% v/v) were added and it was digested by heating on hot plate. This was diluted with distilled water 100 ml (Akan et al., 2010). Blank was also prepared as described by Akan et al. (2010). The heavy metals were determined using atomic absorption spectrophotometer (AAS Model: 6405UV/VIS, Jenway, UK).

3. RESULTS AND DISCUSSION

3.1. Proximate Composition of Offal

Table 1 indicates proximate composition of offal (liver, kidney and intestine) of cow, goat and sheep sold within University of Maiduguri. The moisture content of offal ranged from 15.96% to 38.95%, while protein ranged from 10.43% to 20.81%, ash ranged 0.81% to 1.76%, fat ranged from 2.13% to 9.65% and carbohydrate ranged from 38.81% to 65.82%. It was observed that cow’s kidney had the highest moisture content, while sheep’s kidney had the lowest moisture content. For ash, it was observed the cow’s kidney had the highest value (1.76%) and the least was cow’s intestine (0.81%). Also, the cow’s liver recorded highest protein content of 20.81%, followed by goat’s kidney (20.28%) and sheep’s intestine (17.50%). The fat content of the goat’s intestine was the highest (9.09%) followed by cow’s intestine (9.05%) and the least recorded fat content was observed in sheep’s intestine (2.13%). The carbohydrate content of sheep’s kidney was the highest (65.82%) followed by cow’s intestine (61.61%), sheep’s liver (60.65%), sheep’s intestine (57.92%), goat’s kidney (54.25%), cow’s liver (53.19%), goat’s intestine (51.69%), goat’s liver (49.14%) and cow’s kidney (38.81%), respectively.

Table 1. Proximate composition of offal

<table>
<thead>
<tr>
<th>Offal</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow liver</td>
<td>20.69</td>
<td>1.71</td>
<td>20.81</td>
<td>3.60</td>
<td>53.19</td>
</tr>
<tr>
<td>Cow kidney</td>
<td>38.95</td>
<td>1.76</td>
<td>17.33</td>
<td>3.15</td>
<td>38.81</td>
</tr>
<tr>
<td>Cow intestine</td>
<td>18.10</td>
<td>0.81</td>
<td>10.43</td>
<td>9.05</td>
<td>61.61</td>
</tr>
<tr>
<td>Goat liver</td>
<td>27.56</td>
<td>1.43</td>
<td>18.54</td>
<td>3.34</td>
<td>49.14</td>
</tr>
<tr>
<td>Goat kidney</td>
<td>21.71</td>
<td>1.51</td>
<td>20.38</td>
<td>2.16</td>
<td>54.24</td>
</tr>
<tr>
<td>Goat intestine</td>
<td>27.26</td>
<td>0.99</td>
<td>10.98</td>
<td>9.09</td>
<td>51.69</td>
</tr>
<tr>
<td>Sheep liver</td>
<td>16.78</td>
<td>1.28</td>
<td>18.19</td>
<td>3.10</td>
<td>60.65</td>
</tr>
<tr>
<td>Sheep kidney</td>
<td>15.96</td>
<td>1.04</td>
<td>15.05</td>
<td>2.13</td>
<td>65.82</td>
</tr>
<tr>
<td>Sheep intestine</td>
<td>20.09</td>
<td>1.16</td>
<td>17.50</td>
<td>3.33</td>
<td>57.92</td>
</tr>
</tbody>
</table>

Each value is a mean of triplicate determination

Recent study shows slightly similar distribution pattern. The study found moisture composition of cow’s liver to be 74.90 ± 1.68%, the protein was 18.90 ± 0.53%, fat was 3.80 ± 0.11% and ash was 1.80 ± 0.05% (Kakimov et al., 2018). Salomina and Liesl work on South African C2 cow’s offal in 2014 also shows slightly similar findings; with cow’s liver moisture being 55.7%, protein 26.7% and fat 8.0% (Salomina and Liesl, 2014).
3.2. Total Plate Count of Offal

Table 2 indicates total plate count in dried offal (liver, kidney and intestine) of cow, goat and sheep sold within University of Maiduguri. The total plate count in dried offal ranged from $1.7 \times 10^1$ CFU/g to $10.3 \times 10^1$ CFU/g. The total plate count in dried cow’s offal is ranged from $5.5 \times 10^1$ CFU/g to $8.0 \times 10^1$ CFU/g. The total plate count in dried sheep’s offal is ranged from $2.3 \times 10^1$ CFU/g to $10.3 \times 10^1$ CFU/g. It was observed that the total plate count of sheep’s intestine $10.3 \times 10^1$ CFU/g was the highest, followed by sheep’s liver $9.4 \times 10^1$ CFU/g, cow’s kidney $8.0 \times 10^1$ CFU/g, cow’s liver $6.7 \times 10^1$ CFU/g, cow’s intestine $5.5 \times 10^1$ CFU/g, goat’s liver and goat’s intestine $4.8 \times 10^1$ CFU/g, sheep’s kidney $2.3 \times 10^1$ CFU/g and goat’s kidney $2.3 \times 10^1$ CFU/g, respectively.

<table>
<thead>
<tr>
<th>Offal</th>
<th>Total plate count (CFU/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow liver</td>
<td>$6.7 \times 10^1$</td>
</tr>
<tr>
<td>Cow kidney</td>
<td>$8.0 \times 10^1$</td>
</tr>
<tr>
<td>Cow intestine</td>
<td>$5.5 \times 10^1$</td>
</tr>
<tr>
<td>Goat liver</td>
<td>$4.8 \times 10^1$</td>
</tr>
<tr>
<td>Goat kidney</td>
<td>$1.7 \times 10^1$</td>
</tr>
<tr>
<td>Goat intestine</td>
<td>$4.8 \times 10^1$</td>
</tr>
<tr>
<td>Sheep liver</td>
<td>$9.4 \times 10^1$</td>
</tr>
<tr>
<td>Sheep kidney</td>
<td>$2.3 \times 10^1$</td>
</tr>
<tr>
<td>Sheep intestine</td>
<td>$10.3 \times 10^1$</td>
</tr>
</tbody>
</table>

Each value is a mean of triplicate determination.

The total plate counts in this study were lower than the ones obtained from Bauchi State, where their study indicated total plate count ranged from $2.05 \times 10^6$ CFU/g to $2.78 \times 10^6$ CFU/g (Moshood et al., 2012). Some studies conducted around the world describe offal as potential primary exposure pathway for bacterial infection (Mullner et al., 2009; Paulin, 2010). According to Joshua and Vijay (2015), the recommended limit of total viable count is $1.0 \times 10^4$ CFU/g. However, the result of this study showed that the total plate count ranged from $1.7 \times 10^1$ to $10.3 \times 10^1$ CFU/g which did not exceed the recommended limit of $1.0 \times 10^4$ CFU/g of total plate count set by Joshua and Vijay (2015).

3.3. Heavy Metal Composition of Offal

Table 3 indicated heavy metal composition of offal (liver, kidney and intestine) of cow, goat and sheep sold within University of Maiduguri. The lead was only detected in cow’s kidney (0.12 mg/kg), sheep’s liver (0.10 mg/kg) and sheep’s kidney (0.06 mg/kg). The cadmium detected in the offal ranged from 0.01 mg/kg to 0.03 mg/kg. The copper detected ranged from 0.14 to 1.18 mg/kg. The chromium detected ranged from 0.10 to 1.10 mg/kg. As for the cadmium composition of offal, cow’s kidney (0.03 mg/kg), goat’s liver (0.03 mg/kg) and goat’s intestine (0.03 mg/kg) had the highest value followed by cow’s liver, sheep’s kidney (0.02 mg/kg) and then cow’s intestine, goat’s kidney, sheep’s liver and sheep’s intestine (0.01 mg/kg). The chromium content of cow’s kidney (1.10 mg/kg) was observed to be highest followed by cow’s intestine (1.00 mg/kg), cow’s liver (0.70 mg/kg), sheep’s liver (0.40 mg/kg), then goat’s intestine and sheep’s intestine (0.20 mg/kg), and lastly followed by goat’s liver, goat’s kidney and sheep’s kidney (0.10 mg/kg). As for the copper content of offal, it was cow’s kidney (1.18 mg/kg) had the highest value and the least was goat’s liver (0.30 mg/kg).

<table>
<thead>
<tr>
<th>Offal</th>
<th>Pb (mg/kg)</th>
<th>Cd (mg/kg)</th>
<th>Cr (mg/kg)</th>
<th>Cu (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow liver</td>
<td>ND</td>
<td>0.02</td>
<td>0.70</td>
<td>0.14</td>
</tr>
<tr>
<td>Cow kidney</td>
<td>0.12</td>
<td>0.03</td>
<td>1.10</td>
<td>1.18</td>
</tr>
<tr>
<td>Cow intestine</td>
<td>ND</td>
<td>0.01</td>
<td>1.00</td>
<td>0.31</td>
</tr>
<tr>
<td>Goat liver</td>
<td>ND</td>
<td>0.03</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td>Goat kidney</td>
<td>ND</td>
<td>0.01</td>
<td>0.10</td>
<td>0.93</td>
</tr>
</tbody>
</table>
The Proximate Composition, Heavy Metals and Microbial Load of Cow, Goat and Sheep Offals Sold in University of Maiduguri

<table>
<thead>
<tr>
<th></th>
<th>Goat intestine</th>
<th>ND</th>
<th>0.03</th>
<th>0.20</th>
<th>0.18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep liver</td>
<td>0.10</td>
<td>0.01</td>
<td>0.40</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>Sheep kidney</td>
<td>0.06</td>
<td>0.02</td>
<td>0.10</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Sheep intestine</td>
<td>ND</td>
<td>0.01</td>
<td>0.20</td>
<td>0.46</td>
<td></td>
</tr>
</tbody>
</table>

Each value is a mean of triplicate determination

**Keys:** Pb = Lead, Cd = Cadmium, Cr = Chromium and Cu = Copper; ND = Not Detected.

These values correspond slightly with the ones obtained eight years ago in Maiduguri Metropolis (Akan et al., 2010), where they found low chromium level (0.43 ± 0.10 mg/kg) in cow’s liver but higher levels in sheep’s liver (0.76 ± 0.03 mg/kg) and goat’s liver (1.22 ± 0.21 mg/kg). They also found lower chromium level in cow’s kidney (0.32 ± 0.05 mg/kg) but higher levels in sheep’s kidney (0.65 ± 0.02 mg/kg) and goat’s kidney (0.85 ± 0.01 mg/kg). As for the copper content, it was detected highest in cow’s kidney (1.18 mg/kg) and it was least detected in goat’s liver (0.30 mg/kg). The heavy metals content of offal obtained in this study mostly fall within ranges obtained in Jimeta, Adamawa State (Milam et al., 2015). The copper distribution they obtained was; cow’s intestine (0.45 ± 0.82 mg/kg) cow’s kidney (0.40 ± 0.50 mg/kg) and cow’s liver (1.98 ± 2.47 mg/kg). The lead distribution they obtained was; cow’s intestine (0.15 ± 0.03 mg/kg) cow’s kidney (0.17 ± 0.02 mg/kg) and cow’s liver (0.15 ± 0.02 mg/kg) while the cadmium distribution they obtained was; cow’s intestine (0.03 ± 0.12 mg/kg) cow’s kidney (0.30 ± 0.34 mg/kg) and cow’s liver (0.03 ± 0.01 mg/kg). In a study in Morocco, higher heavy metals content was obtained from similar samples (Chafik et al., 2014).

Plate A. Goat Offal

Plate B. Sheep Offal
The concentrations of various metals in meat are critical because these contaminants have deleterious effects on consumers. Many illness and disease such as cancer and hypertension have been associated with increased concentration of cadmium, chromium, copper and lead in meat (ATSDR, 2004).

In this study, it was observed that cadmium; chromium and copper are within the recommended safe range set by Egyptian Organization for Standardization and Quality Control, except cow’s kidney which had slightly higher level of lead than the recommended limit (EOS, 2010).

4. CONCLUSION

This study investigated the proximate composition, total plate count and heavy metals in offal of cow, sheep and goat sold in the University of Maiduguri campus. The result showed that cow’s kidney had the highest moisture content while sheep’s kidney had the lowest moisture content. For ash, cow’s kidney had the highest value and the least was cow’s intestine. The study also shows that the levels of protein and fat in liver, kidney and intestine from cow, goat and sheep were low compared to protein content of red meat from cow, goat and sheep. The carbohydrate content of sheep’s kidney had the highest value while cow’s kidney had the lowest value. Total plate count did not exceed the permissible limit. The highest total plate count was found in sheep’s intestine and the least in goat’s kidney. The levels of the heavy metals observed in the offal investigated in this study are much lower than the maximum recommended level except cow’s kidney. It is advisable when cooking offal, one should cut the tissue into smaller sizes and then it should be boiled and washed thoroughly in order to reduce the concentration levels of these metals. Follow up studies are recommended to safeguard consumers from possible exposure to health hazard. Proximate composition, heavy metals composition and microbiological count study of processed meat products such as tsire, balangu, kilishi, dambu should be investigated since people often consume them.

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REFERENCES


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[16] Igwebge, A.O. (2014). Effect of location seasoning and processing on heavy metal content in selected locally harvested fresh fish species from Borno State,Nigeria. A Ph. D. Thesis, Department of Food Science and Technology, Faculty of Engineering, University of Maiduguri, Nigeria.


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