International Journal of Research Studies in Agricultural Sciences (IJRSAS)
Volume 4, Issue 11, 2018, PP 10-17
ISSN No. (Online) 2454–6224
DOI: http://dx.doi.org/10.20431/2454-6224. 0411002
www.arcjournals.org

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

Charles Bristone*, Hauwa Sa'ad Abubakar, Mamudu H. Badau

Department of Food Science and Technology, Faculty of Engineering, University of Maiduguri, P. M. B.1069, Maiduguri, Nigeria

Corresponding Author:** ***Charles Bristone, *Department of Food Science and Technology, Faculty of Engineering, University of Maiduguri, P. M. B.1069, Maiduguri, Nigeria*

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 x 10^1 to 10.3 x 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 contains 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 cadmuim (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 $32^{o}C$ 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 was introduced into petri dish, about 15 ml of the prepared plate count ager 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 HNO_3 and 3 ml of $HClO_4$ (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.

Table1. *Proximate composition of offal*

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

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 x 10^1 CFU/g to10.3 x 10^1 CFU/g. The total plate count in dried cow's offal is ranged from 5.5 x 10^1 CFU/g to 8.0 x 10^1 CFU/g. The total plate count in dried goat's offal is ranged from 1.7 x 10^1 CFU/g to 4.8 x 10^1 CFU/g. The total plate count in dried sheep's offal is ranged from 2.3 x 10^1 CFU/g to 10.3 x 10^1 CFU/g. It was observed that the total plate count of sheep's intestine 10.3 x 10^1 CFU/g was the highest, followed by sheep's liver 9.4 x 10^1 CFU/g, cow's kidney 8.0 x 10^1 CFU/g, cow's liver 6.7 x 10^1 CFU/g, cow's intestine 5.5 x 10^1 CFU/g, goat's liver and goat's intestine 4.8 x 10^1 CFU/g, sheep's kidney 2.3 x 10^1 CFU/g and goat's kidney 2.3 x 10^1 CFU/g, respectively.

Table2. *Total plate count of offal of cow, goat and sheep sold within University of Maiduguri*

Offal	Total plate count (CFU/g)
Cow liver	6.7 x 10^1
Cow kidney	8.0 x 10^1
Cow intestine	5.5 x 10^1
Goat liver	4.8 x 10^1
Goat kidney	1.7 x 10^1
Goat intestine	4.8 x 10^1
Sheep liver	9.4 x 10^1
Sheep kidney	2.3 x 10^1
Sheep intestine	10.3 x 10^1

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 x 10^6 CFU/g to 2.78 x 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 x 10^4 CFU/g. However, the result of this study showed that the total plate count ranged from 1.7 x 10^1 to 10.3 x 10^1 CFU/g which did not exceed the recommended limit of 1.0 x 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 chromium detected ranged from 0.10 to 1.10 mg/kg. The copper detected ranged from 0.14 to 1.18 mg/kg. It was observed that cow's kidney (0.12 mg/kg) had the highest lead content while sheep's kidney (0.06 mg/kg) had the least lead content. 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).

Table3. *Heavy metal composition of offal of cow, goat and sheep sold within University of Maiduguri*

	Heavy Metal (mg/Kg)			
Offal	**Pb**	**Cd**	**Cr**	**Cu**
Cow liver	ND	0.02	0.70	0.14
Cow kidney	0.12	0.03	1.10	1.18
Cow intestine	ND	0.01	1.00	0.31
Goat liver	ND	0.03	0.10	0.30
Goat kidney	ND	0.01	0.10	0.93

Goat intestine	ND	0.03	0.20	0.18
Sheep liver	0.10	0.01	0.40	0.60
Sheep kidney	0.06	0.02	0.10	0.66
Sheep intestine	ND	0.01	0.20	0.46

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).

PlateA. *Goat Offal*

PlateB. *Sheep Offal*

PlateC. *Cattle 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.

ACKNOWLEDGEMENTS

We thank the National Agency for Food and Drug Administration and Control (NAFDAC) in Maiduguri for technical support.

REFERENCES

[1] A.O. A. C. (1990). Official method of Analysis Association of Analytical Chemist, 13th edition: Washington D.C, USA. pp 6-10.

[2] Akan, J.C ,Abdulrahman ,F.I, Sodipo, O.A., Ochanya, A.E. and Askira, Y.K. (2010). Heavy metals in sediments from River Ngada, Maiduguri Metropolis, Borno State, Nigeria. *Journal of Environmental Chemistry and Ecotoxicology*. 2 (9): 131-140.

[3] Akan J.C., F.I. Abdulrahman, O.A. Sodipo and Y.A. Chiroma (2010). Distribution of heavy metals in the liver, kidney and meat of beef, mutton, caprine and chicken from Kasuwan Shanu Market in Maiduguri Metropolis, Borno Stat e, Nigeria. *Research Journal of Applied Sciences, Engineering and Technology 2 (8)*: 743- 748

[4] Allen, P. (1995). Chronic accumulation of cadmium in the edible tissue of Orechromis Aureus (Steindache) , modification by mercury and lead. Arch. Environmental Contamination Toxicology. 29: 8-14.

[5] Allina M, Azrina A, Moh'd Yunus , A.S , Moh'd Zakuddin S, Moh'd Izuan Effandi H, Muhammad Rizal R.. (2012). Heavy metals (mercury, arsenic, cadmium , plumbum) in selected marine fish and shell fish along the straits of Mallaca. *International Food Research Journal*. 9 (1) : 135-140.

[6] ATSDR, (2004). Agency for toxic substances and diseases registry, division of toxicology, clifton road, NE Atlanta C.A retrieved from http://www.atsdr.cde.goo/toxprotiles

[7] Baykov, B. D, Stoyanov, M. P., and Guyova, M. L. (1996). Cadium and lead bioaccumulation in male chicken for high food concentration. Toxicology and Environmental Chemistry. 54 : pp 155-159.

[8] Chafik, A., Eddoha, R., Bagri, A., Nasser, B. and Essamadi, A. K. (2014)). Distribution of trace elements and heavy metals in liver, lung, meat, heart and kidney of cattle, sheep, camel and equine slaughtered in Casablanca city-Morocco. International Journal of Scientific & Engineering Research. 50 (5):214-295

[9] Christiana, S and Boyes, T (2015). Why eat offal? The hidden health benefit of organ meats. Retrieved from www.wisechoicemarket.com/blog 5th, Feb.2018.

[10] Cunningham, W. P and Saigo B. W (1997). Environmental science a global concern, 4th edition, WMC Bron publisher, New York pp: 389.

[11] Daniel, B and Edward, A. K, (1995). Environmental science, earth as a ling planet. John wiley and sons, inc. New York, pp: 278-279.

[12] EOS (2010) . Egyptian Organization for the Standardization and Quality Control of Maximum Level of Contaminant in Food stuffs. Retrieved on 4th july,2018 from http:www.eos.org.gs.

[13] Joshua, E. L. and Vijay, I. (2015). WTO Notified – Microbiological Standards for Meat and Meat Products. Retrieved from the Website: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/WTO%20Notified%20%E2%80%93%20Microbiological%20Standards%20for%20Meat%20and%20Meat%20Products_New%20Delhi_India_9-21-2015.pdf 0n 27th November, 2019

[14] Gordon, J. J, and Quastel, G. H (1948). Effect of organic arsenicals on enzyme system. *African Journal of Biochemistry* .42: 337-350.

[15] Horky, D.J , Illeiek and A. Pechowa (1974). Distribution of heavy metals in calf organs. Veternary Medicine 43: 331-342.

[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.

[17] Igwebge A. O, Belhaj, H. M, Hassan, T. B and Hibali, A. S (1992). Effect of high waste traffic on the level of lead and cadmium in fruit and vegetable grown along the road sides, *Journal of Food Safety*. 13: 7-18.

[18] John, H. H and I. R Jeanne, (1994). Food additives contaminants and natural toxins in Maurice E. S, A. O James, S. L, Moshe and Fesiger, (Eds), modern nutrition in health and disease. 8th edition part II, pp 1597-1598.

[19] Josh, A. (2017). Offal are organ meat healthy to eat? https://draxe.com/offal/ Accessed on, 29/01/2018.

[20] Judith, R. T, Maurice, E. S, A. O. James, S. L.O she and Feiger, (1994). Modern nutrition in health and disease, 8th edition, part I, pp 237-240.

[21] Kakimov, A., Anuarbek, S., Aleksandr, T., Nurlan, M., Nadir, I., Nazirve, K., Gulmira, M. and Zhanibek, Y. (2018). Nutritive and biological value of liver and blood of various slaughtered animals. Journal of Pharmaceutical Research International 22 (3): 1-5.

[22] Krishnamurti, C. R., (1987). The cycling of arsenic, cadmium, lead and mercury in India: lead, mercury, cadmium and arsenic in the environmental (Eds:C. Hutchinson and K. M. Meema). SCOPE 31, John Wooley and sons, chichester, pp 315-333.

[23] Marriam, I., Igbal, S. and Nagra S. A (2011). Distribution of some trace and macro minerals in beef, mutton and poultry. *International Journal of Agriculture Biotechnology* .6: 816-820

[24] Milam , C., Dimas,B. J., Jang, A. L. and Eneche, J. E. (2015) . Determination of some heavy metals in vital organs of cows and bulls at Jimeta Abattoir, Yola Adamawa State, Nigeria . *American Chemical Science Journal*. 8 (4): 1-7.

[25] Mullner, P., Geoff , J., Alasdair, N., Simon, S., Steve, H. (2009). Source Attribution of Food-borne Zonoses in New Zealand: A Modified Hald Model. An International Journal 29 (7): 948-970.

[26] Mwiringi, L. M and Wawefu, J. (2011). Knowledge attitudes and practices study of offal consumption among Somali population. August 2011.

[27] Moshood, A. Y., Tengku, H. A. , Tengku, A. H., and Ibrahim, H. (2012). Isolation and identification of bacteria associated with balangu (Roasted Meat Product) Sold in Bauchi State, Nigeria. IOSR Journal of Pharmacy. 2 (6): 38-48.

[28] Oranusi, S. U., Braide, W. and Nezianye, H. O, (2012). Microbiological and chemical quality assessment of some commercial packed fruit juices sold in Nigeria . *Greener Journal of Biological Science* 2 (1): 001-006.

[29] Paulin, L., Petri, A., Martin, R., Pasi, P. and Jenni, H. (2010). Bacterial diversity at different stages of the compository process. BMC Microbiology.10 (1): 94.

[30] Reddy, A.T.V and K. Yellemma (1996). Cadmium chloride induced alteration in the detoxification enzymes of rat liver and kidney pollution. Res, 15: 371-373.

[31] Salomina, M., Van Heerden, Liesl Morey (2014). Nutrient Content of South African C2 Beef Offal. *Journal of Food Measurement and Characterization.* 8 (3): 249-258.

[32] Seitsema, R. (2005). The Offal-eaters Handbook, untangling the myths of organ meat's www.eaters. Come/20115/16/16/878663/jun 16, 2015

[33] Simpson, J. (2017). Oxford dictionary, oxford University press.(Accessed on 29thjanury, 2018) available from. http://www.oxfordictionaries.com/det/eng/:/offel

[34] WHO (2003). World Health Organization. Cadmium Environmental Health Criteria vol. 134 WHO .Geneva

Citation: *Charles Bristone.et.al,(2018). "The Proximate Composition, Heavy Metals and Microbial Load of Cow, Goat and Sheep Offals Sold in University of Maiduguri" International Journal of Research Studies in Agricultural Sciences (IJRSAS), 4(11), pp.10-17, http://dx.doi.org/10.20431/2454-6224.04011002*