Journal of Advanced Veterinary and Animal Research
ISSN 2311-7710 (Electronic)
http://doi.org/10.5455/javar.2017.d215
A periodical of the Network for the Veterinarians of Bangladesh (BDvetNET)

September 2017
Vol 4 No 3, Pages 227-233.

Original Article

Occurrence of *Salmonella* in ruminants and camel meat in Maiduguri, Nigeria and their antibiotic resistant pattern

Zakaria Musa[1], Samson Amali Onyilokwu[2], Solomon Jauro[2,#], Comfort Yakubu[1] and Jasini Athanda Musa[2]

• **Received:** March 15, 2017 • **Revised:** May 26, 2017 • **Accepted:** May 27, 2017 • **Published Online:** July 27, 2017

AFFILIATIONS

[1]*Department of Veterinary Anatomy, Faculty of veterinary Anatomy, University of Maiduguri, PMB 1069, Maiduguri, Borno State, Nigeria.*

[2]*Department of Veterinary Microbiology, Faculty of Veterinary Medicine, University of Maiduguri, PMB 1069, Maiduguri, Borno State, Nigeria.*

CORRESPONDENCE:

[#]Solomon Jauro,
Department of Veterinary Microbiology, Faculty of Veterinary Medicine, University of Maiduguri, PMB 1069, Maiduguri, Borno State, Nigeria.
E-mail: sjauro@unimaid.edu.ng

ABSTRACT

Objective: This study was conducted to determine the occurrence of *Salmonella* in various meat products (beef from cattle, chevon from goats, mutton from sheep and jaziir from camel), by screening the various selling points which includes; meat retailers in abattoir, markets and shops in Maiduguri and its environs.
Materials and methods: A total of 120 samples of fresh meat from cattle, sheep, goats and camels sampled from ten meat retailers in abattoir, markets and shops in the Maiduguri metropolis, using simple random sampling technique. All samples were processed and examined according to standard bacteriological protocols.
Results: Percentage occurrence of *Salmonella* species had the highest value of 15 (50.1%) from the market, found in sheep, while the lowest occurrence of *Salmonella* species was associated with 3(10.0%) in goats sampled from shop meat.. Antibiotic susceptibility pattern of *Salmonella* species from cattle meat revealed high resistant to Erythromycin (52%). In sheep, the higher percentage of resistance occurred against Ampicillin (33.3%) and less resistant to Amoxicillin (4%) was obtained. The isolates from camel meat recorded 25% resistant against Ampicillin, Gentamycin and 12.5% to Streptomycin. A total of 28.4% of the isolates were resistant to Ampicillin, Gentamycin and 23.1% to Ofloxacin.
Conclusion: The study has shown that *Salmonella* species are present in fresh meat sold in abattoir, retail markets and shops. We recommend strict hygienic measures in places where fresh meat are sold in Maiduguri metropolis, Nigeria to ensure consumers right to have safe food.

KEYWORDS

Antibiotics; Fresh meat; Resistance; Ruminants; *Salmonella*

How to cite: Musa Z, Onyilokwu SA, Jauro S, Yakubu C, Musa JA. Occurrence of *Salmonella* in ruminants and camel meat in Maiduguri, Nigeria and their antibiotic resistant pattern. Journal of Advanced Veterinary and Animal Research, 2017; 4(3):227-233.

INTRODUCTION

Salmonellosis is a disease of intestines caused by a bacterium called *Salmonella* (Mohammed, 2013). *Salmonella* is a Gram negative, non-spore forming bacilli of the genus belonging to a family *Enterobacteriaceae*. Several species of this important group are pathogenic producing infections in many animal hosts and man. A considerable percentage of normal animals may harbour *Salmonella* in their intestinal tracts (Jajere et al., 2014). They are common contaminants of wide range of foods, vegetables, water, milk, eggs, meat and meat products and are therefore seriously regarded as most common causes of food borne infection worldwide (Scallan et al., 2011; Jajere et al., 2014). It has been observed that microbial contamination can occur as a result of poor handling, some authors have reported on the microbial quality of retail meat products in Nigeria such as Suya, Tsire and Kilishi (Negbenebor et al., 1990) and Badau et al. (1999). However, information on the *Salmonella* contamination of fresh meat sold in the abattoir, various shop and markets in Maiduguri is lacking. Such information will assist in a planned quality control programme of serious *Salmonella* outbreak which at present is non-existent. Evaluation of the relative contributions of quantitative risk assessment to different meat categories linked to *Salmonella* infections in humans associated with food-borne, the occurrence of the pathogen in the food chain, food production flows, food preparation as well as consumption habits was studied by EFSA (2008).

Microbial growth is considered as one of the principal factors for fresh meat spoilage, particularly in developing countries where refrigerated storage facilities are in fall or inadequate (Mendonca et al., 1989). This now has become a major concern to meat industries due to consistent microbial contamination of fresh meat.

Meat and its products are more susceptible to microbial spoilage when compared with other food commodities as reported by Badau et al. (1999). Major proportion of all food borne infections is due to meat and meat products. Bacterial food poisoning results from consumption of meat products that have been contaminated by large number of living bacterial cells or their toxins. It has been reported that some *Escherichia coli*, *Staphylococcus aureus*, *Clostridium perfringens* and *Salmonella spp.,* have the potential to undergo rapid proliferation resulting in generation of toxins which could yield varied types of food borne diseases (Badau et al., 1999).

It was reported that meat in Maiduguri abattoir and fresh meat market, are left on the tables uncovered after they are delivered at the points of sales. In the same vein, the fresh meat products from abattoir are distributed to various market and shops in an open trucks and wheel barrows, left uncovered on the tables and thereafter, unrefrigerated which render the meats vulnerable to air pollution and microbial contamination (Badau et al., 1999).

Occurrence of *Salmonella* in food have great public health significance. Due to lack of proper information on this subject matter, it was considered of paramount importance to determine the level of meat contamination by *Salmonella spp.* in abattoirs, shops and markets in Maiduguri and its environs.

MATERIALS AND METHODS

Ethical approval: The samples collected for the study were fresh meat which includes; beef from cattle, chevon from goats, mutton from sheep and jaziir from camel, standard sample collection for microbiological procedures was observed.

Sample collection: A total of 120 samples of fresh meat; beef from cattle, chevon from goats, mutton from sheep and jaziir from camel were selected using simple random sampling technique. They were separately collected from ten meat retailers in abattoir, markets and shops over a period of five months (May to September, 2014). Four samples each was collected from 40 retailers of beef, chevon, mutton, and jaziir. Samples were taken in the morning from 8.30 am-10.0 am, afternoon period 1.30 pm-2.30 pm and in the evening from 4.00 pm-6.00 pm within the Maiduguri metropolis. All the samples were collected in sterile polythene bags and kept in Coleman® box containing ice blocks at 4^0C and were transported immediately to the Veterinary Microbiology Laboratory, Faculty of Veterinary Medicine, University of Maiduguri. The ambient temperature and humidity of the markets were recorded to be 32-45% and 20-60% respectively during sampling.

Processing of samples and bacterial isolation: The samples were processed according to the method described by Fawole and Oso (2001), using reagents, chemicals and media obtained from Oxoid® and Sigma® Co. Ltd., England. Five grams of each sample was comminuted in a sterile blender containing 95 mL of sterile distilled water to give a dilution of 10^1. For each of the pulverized meat sample in solution, 1 ml was aseptically aspirated and added to 2 mL of sterile Selenite 'F' broth in a sterile McCartney bottles and incubated aerobically at 37^0C for 24-48 h immediately following sampling. After enrichment, cultures were inoculated onto modified *Salmonella Shigella* agar (SSA),

Desoxycholate citrate agar (DCA), McConkey agar (MCA) and Brilliant green agar (BGA). Discrete colonies were further subcultured onto modified Xylose lysine desoxycholate (XLD) agar to purify the isolates, which were then incubated aerobically at 37^{0}C for 24-48 h. Typical colonies of *Salmonella* isolates which yielded pink colonies with or without dark centres were presumptively identified on the XLD agar media.

Biochemical tests on *Salmonella* isolates: The isolates were later confirmed as *Salmonella spp.* by using biochemical tests; Voges-Proskauer (VP), Methyl red (MR), Citrate utilization, Triple Sugar Iron Agar (TSI), Urease, Oxidase and Hydrogen Sulfide (HS). Others include various sugar utilization tests using standard microbiological techniques according to the procedures described by Cheesbrough (2003) and Raufu et al. (2009).

Antibiotic susceptibility testing: Antibiotic susceptibility pattern of *Salmonella spp.* was carried out on twelve commonly used antibiotics on Muller Hinton agar (Oxoid) sing Kirby-Buaer disk diffusion method, as recommended by Cheesbrough (2003). The susceptibility of all the isolates were determined to the following antibiotics (Oxoid England): Trimethoprim (25 µg), Streptomycin (10 µg), Chloramphenicol (30 µg), Oxfloxacin (5 µg), Amoxicillin-Clavulanic Acid (5 µg), Ampicillin (30 µg), Vancomycin (30 µg), Erythromycin (15 µg), Ciprofloxacin (10 µg), Neomycin (25 µg), Tetracycline (30 µg) and Gentamycin (30 µg).

Data analyses: The results of the total *Salmonella* isolates from the fresh meat samples were statistically evaluated using descriptive statistics and Chi-square test at $P<0.5$ was considered as significant.

RESULTS

The occurrence of *Salmonella spp.* in fresh meat of cattle, sheep, goats and camels collected from Maiduguri municipal abattoir is presented on **Table 1**. Among the samples collected from different types of meat, only 1(3.3%) occurrence of *Salmonella spp.* during the morning period occurred in sheep, while for other animals none was detected. During the afternoon period, the highest incidence of *Salmonella spp.* 4(13.3%), was recorded in sheep, followed by 3(10.0%) both for cattle and goats and 2(6.7%) for camels. Six (20.0%) was reported for sheep, followed by 4(13.3%) for camel and goats and 5(16.7%) for cattle during the evening period. Of the total percentage obtained, the highest value of 11(36.6%) occurred in sheep, while the lowest was 6(20.0%) in camels.

Table 2 shows the comparative occurrences of *Salmonella spp.* of fresh meat of cattle, sheep, goats and camels obtained from market and meat shops in Maiduguri metropolis. Camels and sheep meat from market, both presented 2(6.7%) as compared to 1(3.3%) from cattle meat sold at the market during morning period. No *Salmonella spp.* were isolated from meat of cattle and sheep sampled from shops. For goats' meat in both locations; market and shops, 0.0% was recorded for the presence of *Salmonella* species. Higher percentages were found during the afternoon period with 5(16.7%) in sheep meat as the highest value from the market. In the evening, there was an increase in all the meat collected from different locations. A total of 15(50.1%) was found in sheep meat, followed by 11(36.9%) from cattle meat sold in the market, while the lowest occurrence of *Salmonella spp.* was associated with 3(10.0%) in goats sampled from shop meat.

The occurrence of *Salmonella spp.* in fresh meat from market, abattoir and shops in Maiduguri Municipal is presented in **Figure 1**. Beef sampled from all the collection centres recorded the highest incidence of 44% in samples from market, followed by 33% in samples collected from abattoir and 24% from shops. Samples collected in all the locations; 37.5% was recorded in samples of jaziir obtained from the market and shops. Mutton sampled from all locations revealed 41.7% in market samples, followed by 30.8% from abattoir and 27.8% from shops. The chevons samples showed the following percentages of occurrence; 41.2% in samples from market and abattoir and 17.6% in from shops been the lowest value recorded from all locations.

Antibiotic susceptibility pattern of *Salmonella spp.* isolated from fresh meat of cattle, camels, sheep and goats sampled from different selling points in Maiduguri is shown on **Table 3**. The result obtained from cattle meat revealed that the isolates were not resistant to ciprofloxacin and vancomycin, but were highly resistant to erythromycin (52%) and minimally resistant to amoxicillin (4%). The isolates from jaziir recorded 25% resistant against ampicillin and gentamycin and 12.5% to streptomycin but were susceptible to the rest of the antibiotics tested. The *Salmonella spp.* isolated from sheep meat were not resistant to neomycin, ciprofloxacin, streptomycin, erythromycin, vancomycin, chloramphenicol and amoxicillin but revealed highest resistant to ampicillin (33.3%) with the lowest resistance observed with tetracycline (11.1%). The solates from chevon presented 0% resistant to all the antibiotics used in this study. A total of 28.4% of the isolates were resistant to ampicillin and gentamycin followed by ofloxacin (23.1%),

Table 1: Occurrence of *Salmonella spp.* in fresh meat of cattle, sheep, goats and camels From Maiduguri municipal abattoir

Period	Cattle (n=30; %)	Camels (n=30; %)	Sheep (n=30; %)	Goats (n=30; %)
Morning	ND	ND	1 (3.3)	ND
Afternoon	3 (10.0)	2 (6.7)	4 (13.3)	3 (10.0)
Evening	5 (16.7)	4 (13.3)	6 (20.0)	4 (13.3)
Total incidence	8 (26.7)	6 (20.0)	11 (36.6)	7 (23.3)

ND = Not determined

Table 2: Comparative occurrence of *Salmonella spp.* of fresh meat of cattle, sheep, goats and camel obtained from market and meat shops in Maiduguri metropolis

	Cattle n=20		Camels n=30		Sheep n=30		Goat n=30	
Period	MK (%)	Shops (%)	MK (%)	Shops (%)	MK (%)	Shops(%)	MK (%)	Shops(%)
Morning	1 (3.3)	0 (0.0)	2 (6.7)	1 (3.3)	2 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)
Afternoon	3 (10.0)	2 (6.7)	2 (6.7)	3 (10.0)	5 (16.7)	4 (13.3)	3 (10.0)	1 (3.3)
Evening	7 (23.3)	4 (13.3)	5 (16.7)	5 (16.7)	8 (26.7)	6 (20.0)	4 (13.3)	2 (6.7)
Total	11(36.9)	6 (20.0)	9 (30.1)	9 (30.0)	15 (50.1)	10 (33.3)	7 (23.3)	3 (10.0)

MK= Market

Table 3: Antibiotic resistant pattern of *Salmonella spp.* from fresh meat at abattoir, markets and shops in Maiduguri metropolis

Antibiotic (µg)	Number of resistant isolates (%)				Total Number of Resistant (%)
	Cattle	Camels	Sheep	Goats	
Neomycin (25)	6 (24.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (7.8)
Ampicillin (30)	12 (48.0)	6 (25.0)	12 (33.3)	0 (0.0)	22 (28.2)
Ciprofloxacin (10)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Streptomycin (10)	7 (28.0)	3 (12.5)	0 (0.0)	0 (0.0)	10 (12.8)
Erythromycin (15)	13 (52.0)	0 (0.0)	0 (0.0)	0 (0.0)	13 (16.7)
Tetracycline (30)	9 (36.0)	0 (0.0)	4 (11.1)	0 (0.0)	13 (16.7)
Ofloxacin (5)	11 (44.0)	0 (0.0)	7 (19.4)	0 (0.0)	18 (23.1)
Vancomycin (30)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamycin (30)	5 (20.0)	6 (25.0)	11 (30.6)	0 (0.0)	22 (28.2)
Chloramphenicol (30)	2 (8.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.6)
Amoxicillin (5)	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)

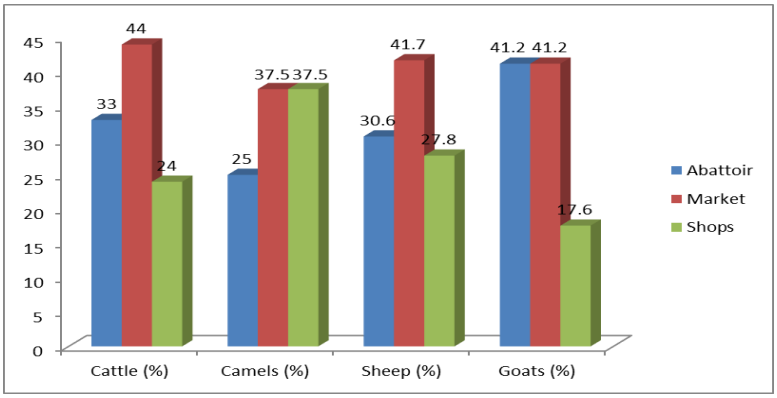

Figure 1: Occurrence of *Salmonella spp.* in fresh meat from markets, abattoir and shops in Maiduguri Metropolis

whereas the lowest resistant was shown against amoxicillin (1.3%).

DISCUSSION

Salmonellosis is one of the major cause of human bacterial enteritis in many countries of the world. *Salmonella* frequently colonize the gastrointestinal track of animals without producing any clinical signs. Animals, therefore can be contaminated with *Salmonella* during the time of slaughter. In this study the occurrence of *Salmonella* in ruminant and camel meat was studied along with their antibiogram study.

The overall percentage of occurrence of *Salmonella spp.* isolated in fresh meat analyzed was 26.7%. This finding agreed with the work of Mohammed (2013) who reported a prevalence of 26.0%. Similarly, Little et al.

(1999) found a prevalence of 28.0% which was slightly higher than the one found in this study. Essa et al. (2009) reported 23.3% and Torlak et al. (2012), 23.0%, while 16.7% prevalence was published by Kusumaningrum et al. (2012). Additionally, 5.7% was reported by Sjölund-Karlsson et al. (2013) and 15% by Alemu and Zawde (2012). Ukut et al. (2010) found 11.1%, whereas, Mboto et al. (2012) and Kegode et al. (2008) reported as 2.9% and 10.0%, respectively, as differed with our findings.

Higher percentages of *Salmonella spp.* were generally found among the meat sold on the table in the open market particularly towards evening period with an average of 10.5 (35.0%). This report is in agreement with the findings of Okonko et al. (2010). The possible reason may be associated with the condition of the market and the hygienic practices employed by meat sellers and butchers. Similarly, this concur with the work of Mohammed (2013) who attributed the higher rate to be largely due to cutting boards, surfaces used for preparation of meat and equipment such as meat grinder, mincers, blenders which are considered as important source for meat contamination by *Salmonella spp.* The contamination was attributed to trucks, lairages, slaughter line, quartering, knives used and surface of table of meat and meat products as opined by Mohammed (2013). Water used to clean equipment and cutting/slicing machines leading to cross-contamination especially with raw meat have also been reported to play a role in meat contamination. Handlers' not practicing proper hygiene and lack of proper monitoring devices can lead to *Salmonella* infection through the consumption of meat and meat products by humans.

The presence of *Salmonella* on meat could also be due to the fact that meat contains an abundance of all nutrients required for the bacteria in adequate quantity (Ukut et al., 2010). The high percentage of *Salmonella spp.* isolated from sample in the market can be attributed to the condition of the slaughter slap and source of water used in the market and the hygienic practice employed by meat sellers and butchers.

The presence of *Salmonella spp.* recorded in fresh meat from abattoir indicates the deplorable state of poor hygienic and sanitary practices employed in the slaughtering, processing and packaging of fresh meats. This is in agreement with the previous report of Clarence et al. (2009) who reported the presence *Salmonella spp.* and other bacteria including *S. enterobacter*, *S. aureus, E. coli, Proteus* spp*, Klebsiella* spp. and *Pseudomononas* spp. in a study on sea food products. In actual sense, the detectable presence of *Salmonella spp.* in meat and meat product is considered as an indicator of adulteration (Yousuf et al., 2008).

The presence of 26.7% *Salmonella spp.* in fresh meat samples is an indication of feacal contamination of the meat which might be due to possible contamination of fresh meat possibly during sales or unhygienic handling of the meat from the slaughtering, butchering and processing. Contamination may likely be associated with the skin, mouth, or nose of the handlers that can be introduced directly into food through the process line workers (Sobukola et al., 2009).

In recent time, there has been increased reports on the spreading of multidrug-resistant phenotypes among *Salmonella* serovars worldwide (Zhao et al., 2003; Ponce et al., 2008). The development of resistance is attributed to the manner in which the antimicrobial agents are use in veterinary medicine, animal husbandry, agriculture, aquaculture and human medicine practices (Zhao et al., 2003). These routine practices are important factors in the emergence of antibiotic-resistant bacteria that subsequently can be transferred to humans through the food chain. *Salmonella* have serious public health significance and concern (Okonko et al., 2009). The isolation of several antibiotic resistant *Salmonella* in this study is of practical impact. *Salmonella* infections have continued to be a major public health concern in several counties. They are zoonotic and the infections are generally food borne (Helms et al., 2005). The main reservoir of zoonotic *Salmonella* is food animals, which in industrialized counties, serves as the main sources of infections derived from animal products majorly fresh meat products and eggs (Helms et al., 2005). *Salmonella spp.* such as *Salmonella typhi* is a bacterium that causes typhoid fever (enteric fever), an acute life-threatening febrile illness (CDC, 2008). The disease is a cause for concern and a major public health problem in developing countries especially in Nigeria due to poor sanitary conditions and lack of or inadequate portable water (Ibekwe et al., 2008). It is mainly transmitted through food, drinking water contaminated with urine or faeces of infected people or a chronic carrier (CDC, 2008; Okonko et al., 2010).

It is not surprising therefore that fresh meats sold to the public in open markets are grossly contaminated with *Salmonella*. The results of this study therefore revealed that fresh meat sold at abattoir, markets and shops in Maiduguri, Nigeria are contaminated with pathogenic bacteria, and the possible source of these contaminants may be due to the unhygienic manner of meat handling, from the slaughter house to the markets and shops. This implies also that these meats could serve as viable source of various diseases and could spread or pose serious health problems in a society.

In Maiduguri, it was observed during the study that some of the condemned carcasses were found in the same vicinity with non-condemned ones which may result in contamination of the non-condemned carcasses. Uncontrolled disposal of slaughter house effluent is frequently shown to be heavily contaminated with these organisms which are potentially hazardous. Another source of contamination could be attributed to the nature of the market and the attitude of the customers who would like to touch the meat with bare unwashed hands. These people may be carriers of *Salmonella* organisms. Attention should be made for the improvement of personal hygiene, abattoir hygiene and public awareness may reduce the occurrence of *Salmonella* in the meat sold in the stud area stud areas to ensure consumers health.

CONCLUSION

In conclusion, potential hazard posed by *Salmonellosis* to humans and animals can be drastically reduced by an effective control over slaughter of infected animals, regular enlightenment of the customers on the dangers of touching the meat with bare hands before buying. Butchers also should be taught how to clean and disinfect their utensils after use. The presence of *Salmonella* in meat should be given particular attention as it indicates public health hazard and give warning signal for the possible occurrence of food borne intoxication. It is therefore advisable to suggest that fresh meat processors and sellers should be enlightened on the adverse effect of contamination. More so, it is of paramount importance that processors, handlers and sellers observe strict hygienic measures so that they may not serve as source of chance inoculation of microorganisms and faecal contamination of fresh meat and other meat products.

ACKNOWLEDGEMENT

We thank the Department of Veterinary Microbiology, University of Maiduguri for providing us with laboratory facilities used in this study.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTION

MZ and JAM designed the study. SJ and CY collected the samples. The laboratory works were conducted by SAO and SJ. All the authors contributed in writing and reviewing the manuscript, and approved finally.

REFERENCES

1. Alemu S, Zawde BM. Prevalence and antimicrobial resistance profiles of *Salmonella* enteric serovars isolated from slaughtered cattle in Bahir Dar, Ethiopia. Tropical Animal Health and Production. 2002; 44(3):595-600. http://doi.org/10.1007/s11250-011-9941-y
2. Badau MH, Adeniran AM, Nkama I, Baba SS. Bacteriological quality of various fresh meet sold in Maiduguri Market. Nigeria. Journal of Arid Agriculture. 1999; 9:133-141. http://doi.org/10.4236/fns.2014.513137
3. CDC (Centers for Disease Control and Prevention). Health information for international travel. 2008; Available at: http://www.cdc.gov/travel/index.htm. (Accessed on June 20, 2008).
4. Cheesbrough M. Medical laboratory Manual. Tropical Health technology, Low Priced Edition Paddington, Cambridgeshire, England. 2003; p. 20-35.
5. Clarence SY, Obinna CN, Shalom NC. Assessment of bacteriological quality of ready to eat food (meat pie) in Benin City Metropolis, Nigeria. African Journal of Microbiology Research. 2009; 3(6):3390-3395.
6. EFSA (European Food Safety Authority). A quantitative microbiological risk assessment on *Salmonella* in meat: Source attribution for human *Salmonellosis* from meat. The EFSA Journal. 2008; 625:1-32. http://doi.org/10.2903/j.efsa.2008.625
7. Essa HH, Manora AM, Makar NH, Saged SM. Studies on *Salmonella* and *E. coli* in some meat product (beef burgers and luncheon) sold in Assiut city. Assiut Veterinary Medicine Journal. 2009; 55(121):211-216. Available at: http://www.aun.edu.eg/faculty_veterinary_medicine/vet/pAbstract.php?P_ID=740&J_ISS_ID=56 (Accessed on March 1, 2017)
8. Fawole MO, Oso BA. Laboratory manual of Microbiology: Revised edition spectrum books Ltd., Ibadan. 2011; p. 127.
9. Helms M, Ethelberg S, Morbak K. DT104 study group. International *Salmonella typhimurium* DT104 infections, 1992-2001. Emerging Infectious Diseases. 2005; 11(6):859-867. http://dx.doi.org/10.3201/eid1106.041017
10. Jajere SM, Onyilokwu SA, Adamu NB, Atsanda NN, Saidu AS, Adamu SG, Mustapha FB. Prevalence of *Salmonella* infection in dogs in Maiduguri, Northeastern Nigeria. International Journal of

Microbiology. 2014; ID392548:1-5. http://dx.doi.org/10.1155/2014/392548.
11. Kegode RB, Doetkott M, Kaitsa L, Wesley IV. Occurrence of *Campylobacter sp., Salmonella sp.* and generic *E.coli* in meat products from retail outlets in the Fargo Metropolitan area. Journal of Food Safety. 2008; 28(1):111-125. http://doi.org/10.1111/j.1745-4565.2007.00099.x
12. Kusumaningrum H, Suliantari D, Dewanti-Hariyadi R. Multidrug resistance among different serotypes of *Salmonella* isolates from fresh products in Indonesia. International Food Research Journal. 2012; 19(1):57-63.
13. Little C, Gillespie I, de Louvois J, Mitchell R. Microbiological investigation of halal butchery products and butchers premises. Communicable Diseases and Public Health. 1999; 2(2):114-118.
14. Mboto CI, Ambo BE, Ekim MA. Bacteriological study of raw meat of Calabar abattoir with public health and veterinary importance. Journal of Microbiology Biotechnology Research. 2012; 2(4):529-532. http://dx.doi.org/10.4014/jmb.1505.05021
15. Mendonca AF, Molins RA, Kraft AA, Walker HW. Microbiological, chemical, and physical changes in fresh, vacuum-packaged pork treated with organic acids and salts. Journal of Food Science. 1989; 54(1):18-21. https://doi.org/10.1111/j.1365-2621.1989.tb08557.x
16. Mohammed K. Prevalence of *Salmonella* in meat products. Global Veterinaria. 2013; 11(5):685-688. http://doi/10.5829/idosi.gv.2014.13.02.84103
17. Negbenebor CA, Igene JO, Maigoge SP, Collison EK. microbial quality of kilishi meat product. Journal of Animal Production and Research. 1990; 10(2):91.
18. Okonko IO, Donbraye E, Babatunde SOI. Microbiological quality seafood processors and water used in two different sea processing plants in Nigeria. Electronic Journal of Environmental, Agricultural & Food Chemistry. 2009; 8(8):621-629.
19. Okonko IO, Nkang AO, Fajobi EA, Mejeha OK, Udeze AO, Motayo BO, Ogun AA, Ogunnusi TA, Babalola TA. Incidence of multi-drug resistant (MDR) organisms in some poultry feeds sold in Calabar Metropolis, Nigeria. Electronic Journal of Environmental, Agricultural & Food Chemistry. 2010; 9(3):514-532.
20. Ponce E, Khan AA, Cheng C, Summage-West C, Cernigli CE. Prevalence and characterization of *Salmonella enterica* serovar Weltevreden from imported seafood. Food Microbiology. 2008; 25:29-35. https://doi.org/10.1016/j.fm.2007.09.001
21. Raufu I, Hendriksen RS, Ameh JA, Aarestrup FM. Occurrence and characterization of Salmonella Hiduddify from chickens and poultry meat in Nigeria. Food Borne Pathogens and Disease. 2009; 6:425-430. http://dx.doi/10.1089/fpd.2008.0150
22. Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson MA, Roy SL, Jones JL, Griffin PM (2011). Foodborne illness acquired in the United States-major pathogens. Emerging Infectious Diseases. 2011; 17(1):7. https://doi.org/10.3201/eid1701.P11101
23. Sjölund-Karlsson M, Howie RL, Blickenstaff K, Boerlin P, Ball T, Chalmers G, Duval B, Haro J, Rickert R, Zhao S, Fedorka-Cray PJ. Occurrence of β-lactamase genes among non-Typhi Salmonella enterica isolated from humans, food animals, and retail meats in the United States and Canada. Microbial Drug Resistance. 2013; 19(3):191-197. https://doi.org/10.1089/mdr.2012.0178
24. Sobukola OP, Awonorin OS, Idowu AM, Bamiro OF. Microbial profile and critical control points during processing of 'robo' snack from melon seed (citrullus lunatus thumb) in Abeokuta, Nigeria. African Journal of Biotechnology. 2009; 8(10):2385-2388. http://doi.org/10.5897/AJB2009.000-9298
25. Torlak EI, Akan M, Inal M. Evaluation of rapid check select for the screening of *Salmonella* in meat and meat products. Journal of Microbiological Methods. 2012; 90(3):217-219. http://doi/10.1016/j.mimet.2012.05.010
26. Ukut IO, Okonko IO, Ikpoh IS, Nkang AO, Udeze AO, Babalola TA, Majeha OK, Fajobi EA. Assessment of bacteriological quality of fresh meat sold in calabar metropolis, Nigeria. Electronic Journal of Environmental Agricultural and Food Chemistry. 2010; 9(1):89-100.
27. Yousuf AHM, Ahmed MK, Yeasmin S, Ahsan N, Rahman MM, Islam MM. Prevalence of microbial load inshrimp, penaeusmonodon and prawn, macrobrachium resenbergii from Bangladesh. World Journal of Agricultural Sciences. 2008; 4(5):852-855.
28. Zhao S, Datta AR, Ayers S, Friedman S, Walker RD, White DG. *Salmonella* serovars isolated from imported foods. International Journal of Food Microbiology. 2003; 84:87-92. https://doi.org/10.1016/S0168-1605(02)00402-6

****