*South Asian Journal of Research in Microbiology*

***Volume 18, Issue 7, Page 76-83, 2024; Article no.SAJRM.118621***
***ISSN: 2582-1989***

# Antibiogram and Bacteriological Assessment of Raw Meat Sold in Owerri, Southeast Nigeria

**Bede Chinedu Azudialu [a*], Ohalete Chinyere Ngozi [b], Ogunnaya Frances [c], Benjamin Iheanyichukwu Nkem [d] and Calistus Muodebe Nwokeji [e]**

*[a] Department of Family Medicine, Federal University Teaching Hospital Owerri, Nigeria.*
*[b] Department of Microbiology, Imo State University Owerri, Nigeria.*
*[c] Department of Internal Medicine, Newark Beth Israel Medical center, Newark NJ, USA.*
*[d] Research Unit, Federal University Teaching Hospital, Owerri, Nigeria.*
*[e] Department of Medical Microbiology and Parasitology, College of Medicine, Imo State University, Owerri, Nigeria.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: https://doi.org/10.9734/sajrm/2024/v18i7374

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118621

***Original Research Article***

***Received: 14/04/2024***
***Accepted: 18/06/2024***
***Published: 01/07/2024***

## ABSTRACT

This study assessed the antibiogram and bacteriological assessment of raw meat sold in Owerri. Samples of fresh beef were taken from beef vendors from three (3) markets; Relief market, Ekeonuwa market and Amakohia market in Owerri, Imo State. Three samples each weighing 100g were aseptically collected in sterile polythene pouches, sealed and transported in ice to the Imo State University Microbiological Laboratory for microbiologic alanalysis within some few hours of

**Corresponding author: Email: chinedu.azudialu@npmcn.edu.ng;*

***Cite as:*** *Azudialu, Bede Chinedu, Ohalete Chinyere Ngozi, Ogunnaya Frances, Benjamin Iheanyichukwu Nkem, and Calistus Muodebe Nwokeji. 2024. "Antibiogram and Bacteriological Assessment of Raw Meat Sold in Owerri, Southeast Nigeria". South Asian Journal of Research in Microbiology 18 (7):76-83. https://doi.org/10.9734/sajrm/2024/v18i7374.*

collection. The results of this study showed that the total heterotropic bacteria counts of ranged from 3.72× $10^5$cfu/g - 4.2 × $10^5$cfu/g , the coliform bacterial counts ranged from 1.9 × $10^5$cfu/g - 2.7 × $10^5$cfu/g while the total salmonella shigella count ranged from 0cfu/g -4.12x$10^3$cfu/g. Bacteria isolated were *Escherichia coli, Salmonella spp., Streptococcus spp., Bacillus spp.* and *Staphylococcus aureus.* Of the 50 bacterial isolates obtained, *E. coli* [15 (27.7)] and *Staphylococcus spp* [15 (27.7)] were the prevalent isolates. Other bacterial pathogens incriminated in this study were *Salmonella spp* [9(18.0)], *Bacillus spp* [7(14.0), and *Streptococus spp* [4 (8.0)].Most of the Gram-positive bacteria were highly susceptible to ceftizoxime and the Gram-negative to gentamicin and cefotaxime. *E. coli*, was susceptible to ampicillin/sulbactam (71% susceptibility), cefotaxime (71%), ciprofloxacin (94%), chloramphenicol (94%), ceftizoxime (100%), ofloxacin (82%), and amikacin (100%). *S. aureus* was susceptible to ampicillin/sulbactam (75%), cephalexin (75%), cefotaxime (100%), roxithromycin (75%), lincomycin (75%), and gentamicin (100%). Bacterial quality of fresh beef sold in Owerri has shown that beef sold in Owerri is contaminated with *Staphylococcus spp., Escherichia coli* and *Salmonella spp*. but the prevalence of *Salmonella spp*. was low.This findings shall guide clinicians in the management of food poisoning/enteritis from possible meat consumption. Effective supervision and health education of meat sellers and their abbatoirs is highly recommended.

*Keywords: Raw meat; bacterial infection; salmonellosis; food poisoning; Nigeria.*

## 1. INTRODUCTION

One excellent source of protein in human diet is meat [1]. It has long been known for its high nutritional content, hence, consumed by many people worldwide. The protein profile of meat has been described as excellent due to the presence of all the essential amino acids required by the body [2]. The protein and vitamin especially vitamin A and B12 in meat is not available in plant sources. Majority of the world population depend on meat as a source of food [2,3,4,5]. There is considerably high food related infections such as diarrhea, typhoid fever and cholera recorded in hospitals and clinics worldwide. In the past people have expressed worry about the role of meat and meat products in food poisoning but available records show that more than 74% of cases of food poisoning worldwide are due to meat dishes [6]. Meat is highly prone to microbial contamination due to itsrich source of nutrients which provide a suitable environment for growth of microbes (Steinkraus, 2014).

Dirty environment and unhygienic food handling influence wide spread of bacterial food poisoning [7-11]. Major bacterial pathogens found in meat include *Bacillus cereus, Clostridium botulinum, Clostridium perfringens, Salmonella, Escherichia coli* and *Staphylococcus aureus* [6,12-15]. Contamination could come from unhygienic slaughtering, handling and processing conditions or from inherent microflora in normal tissues of animals, air and environment [16].

The family *Enterobacteriaceae* is a large, heterogeneous group of gram-negative rods whose natural habitat is the intestinal tract of humans and animals. They are also found in soil and plant from where they can contaminate the food chain and cause food-borne gastroenteritis.The genera in the family include *Escherichia, Shigella, Salmonella, Yersinia, Enterobacter, Klebsiella, Serratia, Proteus* and others [17-26].

Common organisms implicated in meat poisoning include *Escherichia coli,* which becomes pathogenic only when they reach tissues outside of their normal intestinal or other less common normal flora sites. Raw beef can be an important vehicle in the transmission of E. coli during slaughtering, processing or from cross-contamination as a result of unsanitary food handling practices. Its presence in meat is usually a result of faecal contamination or when the intestinal tract is punctured [27-32].

For long *Staphylococcus aureus* has been known as one of the most important bacteria that causes disease in humans. It is responsible for many skin and soft tissue infections such as abscesses (boils), furuncles, and cellulitis [33]. An estimated 185,000 cases of foodborne illnesses associated with Staphylococcal food intoxication occurs annually in United States [34]. Therefore any food which requires handling in preparation may easily become contaminated. Staphylococcus aureus also commonly occurs on the skin and hides of animals, and may thus

contaminate foods from these animals as a result of cross-contamination during slaughter [35].

S***almonella species*****:** Salmonella are nonspore-forming, rod-shaped, Gram-negative and predominantly motile enterobacteria with flagella distributed all around the cell body. They are widely spread in nature and are responsible for illnesses such as typhoid fever, paratyphoid fever and food poisoning [36]. Salmonellosis is a type of food poisoning caused by Salmonella enteric bacteria. For over 100 years, the most severely affected people are the elderly, infants, and those with impaired immune systems [37]. Salmonellosis continues to be an important cause of food borne disease in human worldwide although total number of cases has remained fairly constant between 1996 and 2002 (CDC, 2012).

The aim of this study was to determine the antibiogram and bacteriological assessment of raw meat sold in Owerri.

## 2. METHODOLOGY

This study was conducted in Owerri, capital of Imo state in Nigeria.

Samples of fresh beef were taken from beef vendors from three (3) markets; Relief market, Ekeonuwa market and Amakohia market in Owerri, Imo State. Three samples each weighing 100g were aseptically collected in sterile polythene pouches, sealed and transported in ice to the Imo State University Microbiological Laboratory for microbiological analysis within some few hours of collection.

All the media used were prepared according to the manufacturer's guide. Nutrient agar, MacConkey agar, Salmonella-shigella agar and Muller hinton agar were used for the isolation of bacteria. Muller Hinton agar was used for antimicrobial sensitivity testing.Identification of pure colonies using morphological characteristics were based on morphological differences, colonies were isolated from their axenic culture. Slides were equally prepared for Gram staining. Samples were also subjected to biochemical tests using Indole test, Methylred test, Voges-Proskauer Test, Oxidase test, Catalase Test, Coagulate Test, Citrate Utilization Test.

Microbiological tests like motility test, antibiotic culture sensitivity were carried out on the samples.

## 3. RESULTS

### 3.1 Bacteria Count of raw meat Samples

Table 1 shows the bacterial counts of each sample. The total heterotropic bacteria counts ranged from 3.72× $10^5$cfu/g - 4.2 × $10^5$cfu/g, the coliform bacterial counts ranged from 1.9 × $10^5$cfu/g - 2.7 × $10^5$cfu/g while the total salmonella and shigella count ranged from 0cfu/g -4.12x$10^3$cfu/g.

### 3.2 Morphological and Biochemical Identification of Bacteria Isolates

Results from Table 2 show the morphological appearances and biochemical properties of isolated bacteria. Bacterial isolated were *Escherichia coli, Salmonella spp., Streptococcus spp., Bacillus spp.* and *Staphylococcus aureus.*

### 3.3 Prevalence of Isolates of Bacterial Pathogens of Subjects

Table 3 shows the prevalence of isolates of bacterial pathogens from raw meat. Of the 50 bacterial isolates obtained, *E. coli* [15 (27.7)] and *Staphylococcus spp* [15 (27.7)] were the prevalent isolates. Other bacterial pathogens incriminated in this study were *Salmonella spp* [9(18.0)], *Bacillus spp* [7(14.0)], and *Streptococus spp* [4 (8.0)].

**Table 1. Bacteria counts of raw meat samples**

| Sample | Total Viable Count (CFU/g) | | |
|---|---|---|---|
| | **THBC** | **TCC** | **TSSC** |
| A | 4.2x$10^5$ | 2.7x$10^5$ | 0 |
| B | 3.7x$10^5$ | 2.7x$10^5$ | 4.12x$10^3$ |
| C | 3.8x$10^5$ | 1.9x$10^5$ | 0 |

*Keys: Sample A= Relief market; Sample B= Ekeonuwa market; Sample C= Amakohia market;THBC = Total Heterotrophic Bacteria count*

**Table 2. Morphological and Biochemical identification of bacteria isolated from raw meat**

| S/N | Morphology | Gram staining | Catalase | Citrate | Indole | Methyl red | Voges proskaeur | Oxidase | Motilityy | Suspected organism |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Yellow, Glassy, Round, Cocci in cluster | + | + | + | - | + | + | + | - | *Staphylococcus Spp.* |
| **2** | Cream, Smooth, Short rod in single | - | + | - | - | + | - | - | - | *Escherichia coli* |
| **4** | Opaque translucent straight rod colony | - | + | - | - | + | - | - | + | *Salmonella spp* |
| **4** | Creamy, Smooth, Irregular, Short rod colony | + | + | + | + | - | + | - | + | *Bacillus sp* |
| **5** | White raised grape-like colony | + | - | - | - | - | + | - | - | *Streptococcus spp* |

**Table 3. Prevalence of isolates of bacterial pathogens of subjects**

| Isolates | Frequency (%) |
|---|---|
| *Escherichia coli* | 15 (27.7) |
| *Staphylococcus spp* | 15 (27.7) |
| *Salmonella spp* | 9 (18.0) |
| *Bacillus spp* | 7 (14.0) |
| *Streptococcus spp* | 4 (8.0) |
| Total | 50 (100.0) |

**Table 4. Susceptibility of isolated Gram-negative and Gram-positive bacteria from raw meat**

| **Antibiotics** | **Susceptibility to anti microbial drugs** (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gram negative AS organisms** | **BA** | **CF** | **PC** | **CH** | **CP** | **CI** | **TE** | **OF** | **GM** | **AK** | **PF** | |
| *E. coli* | 71 | 6 | 71 | 41 | 94 | 94 | 100 | 24 | 82 | 71 | 100 | |
| *Slmonella spp* | 0 | 20 | 80 | 0 | 0 | 80 | 100 | 80 | 0 | 100 | 20 | |
| *Pseudomonas spp* | 50 | 100 | 100 | 100 | 0 | 50 | 0 | 0 | 50 | 100 | 0 | |
| **Gram positive organisms** | **AS** | **BA** | **PR** | **TE** | **CF** | **CP** | **PF** | **OF** | **CX** | **RF** | **LM** | **GM** |
| *Staphylococcus spp* | 75 | 0 | 75 | 0 | 100 | 13 | 0 | 0 | 50 | 75 | 75 | 100 |
| *Streptococcus spp* | 100 | 0 | 50 | 50 | 100 | 0 | 0 | 0 | 50 | 50 | 50 | 100 |
| *Bacillus spp* | 50 | 0 | 100 | 100 | 100 | 0 | 50 | 0 | 0 | 50 | 100 | 0 |

*Keys: AS = ampicillin/sulbactam (20 µg); BA = co-trimoxazole (25 µg); CF = cefotaxime (30 µg); PC = piperacillin (100 µg); CH = chloramphenicol (30 µg); CP = ciprofloxacin (5 µg); CI = ceftizoxime (30 µg); TE = tetracycline (30 µg); OF = ofloxacin (5 µg); GM = gentamicin (10 µg); AK = amikacin (30 µg); PF = pefloxacin (10 µg); PR = cephalexin (30 µg); CX = cloxacillin (1 µg), RF = roxithromycin (15 µg); LM = lincomycin (2 µg).*

### 3.4 Susceptibility of Isolated Gram-negative and Gram-positive Bacteria from Raw meat

Table 4 shows the susceptibility of isolated Gram-negative and Gram-positive bacteria from raw meat.Most of the Gram-positive bacteria were highly susceptible to ceftizoxime and the Gram-negative to gentamicin and cefotaxime. *E. coli*, was susceptible to ampicillin/sulbactam (71% susceptibility), cefotaxime (71%), ciprofloxacin (94%), chloramphenicol (94%), ceftizoxime (100%), ofloxacin (82%), and amikacin (100%). *S. aureus* was susceptible to ampicillin/sulbactam (75%), cephalexin (75%), cefotaxime (100%), roxithromycin (75%), lincomycin (75%), and gentamicin (100%).

## 4. DISCUSSION

The presence of microbial population in meat is a challenging problem to the meat industry [1]. From this study, high bacteria counts were enumerated from fresh beef samples which indicated that the beef samples were contaminated. Probable sources of contamination may include cutting knives, containers, intestinal contents, water, hides, meat handlers, vehicle for transporting carcasses and the meat processing and selling environments. The study showed that beef sold was contaminated with various genera of bacteria with *Staphylococcus* spp. and *Escherichia coli* being the most abundant. The results of this study can be compared with similar studies in Ghana, where Soyiri et al. [38] found various levels and numbers of total bacteria count, *Streptococcus spp., Staphylococcus spp., Bacillus spp.* and *Escherichia coli* in beef sold in the Ashaiman Municipality of Ghana. Adzitey et al. [39] also isolated bacteria species (*Escherichia coli, Salmonella spp., Staphylococcus spp*. and *Streptococcus spp*.) from raw beef sold in five most popular meat shops in the Tamale Metropolis of Ghana. Microbial contamination of beef samples has also been reported in other parts of the world. In Lahore Pakistan, Ahmad et al. [40] reported a high microbial load of *E. coli*, *Staphylococcus aureus* and *Salmonella* in raw meat from abattoirs and retail shops.

Nevertheless the presence of *Salmonella* and *Escherichia coli* which are known foodborne pathogens give cause for public health concern [38]. For purposes of food safety, the Nigeria Standards Board requires that there should be no pathogen in all ready to eat foods but in this study *Staphylococcus spp, Escherichia* coli and *Salmonella spp*. could not pass the test of a zero cfu/g which the Nigeria Standards Board sets for fresh beef [38].

## 5. CONCLUSION

This study to assess the bacterial quality of fresh beef sold in Owerri has shown that beef sold in Owerri are contaminated with *Staphylococcus spp., Escherichia coli* and *Salmonella spp*. however, the prevalence of *Salmonella spp*. is low. The general insanitary conditions at the slaughterhouse and meat shops and poor hygienic practices of the butchers were major contributors to the microbial contamination of beef. The presence of these microorganisms in raw beef though not above the permissible limit ($10^6$cfu/g) is an indication of public health hazard and gives a signal of a possible occurrence of food borne intoxication and infection if not controlled.

## 6. RECOMMENDATION

It is therefore recommended that fresh beef from the study area be thoroughly cooked before consumption to prevent food poisoning and foodborne diseases. Standard hygienic practices such as Hazard Analysis Critical Control Point system should be followed at all stages of the meat production chain. This requires training, education and supervision of meat handlers on the basic concepts of personal and general hygiene necessary to improve behavioural changes among butchers and ensuring a safe product to the consumer. Veterinary doctors should supervise the slaughtering of the animals before the meat is sold to the general public.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Komba EVG, Mkupasi EM, Mbyuzi AO, Mshamu S, Luwumbra D, Busagwe Z,

Mzula A, Sanitary practices and occurrence of zoonotic conditions in cattle at slaughter in Morogoro Municipality, Tanzania: Implications for Public Health. Tanzania Journal Health Research. 2012;14(2):2-6.
2. Collins NA, Thato S. Isolation of enteric bacterial pathogens from raw mince meat in Mafikeng, North-West Province, South Africa Life Science Journal. 2011;8(S2).
3. Okoh PI. Microbiological analysis of beef meat collected at different hours of the day in ekpoma town market. Microbiol. Res. J. Int. 2019;28(1):1-5.
Available:https://journalmrji.com/index.php/MRJI/article/view/1016
4. Bafanda RA, Khandi SA, Minhaj SU, Khateeb AM. Meat hygiene and associated health hazards awareness among consumers of Jammu district of Jammu and Kashmir. Curr. J. Appl. Sci. Technol. 2017;23(3):1-11.
Available:https://journalcjast.com/index.php/CJAST/article/view/1473
5. Azage M, Kibret M. The bacteriological quality, safety, and Antibiogram of salmonella isolates from fresh meat in retail shops of Bahir Dar City, Ethiopia. International Journal of Food Science. 2017;2017.
6. Hobbs BC, Roberts D. Food poisoning and food hygiene. 6th Ed., St. Edmundsbury Press, Burry, Bodmin, Cornwall, London, UK. 2013;216-220.
7. Burgess F, Little C, Allen G, Williamson K, Mitchelli RT. Prevalence of Campylobacter, Salmonella, and Escherichia Coli on the External Packaging of Raw Meat. Journal of Food Protection. 2015;68(3):469-75.
8. Jay JM. Modern food microbiology (5th Ed.). New York: Van Nostrand Reinhold; 2016.
9. King LK, Awumbila B, Canacoo EA, Ofosu-Amaah S. An assessment of the safety of street foods in the Ga District of Ghana; implications for the spread of zoonoses. Acta Tropical. 2010;76(1): 39-43.
10. Krebs-Smith SM. Progress in improving diet to reduce cancer risk. Cancer. 2018;83:1425–1432.
11. Lawrie RA. Lawrie"s meat science (6th Ed.). Cambridge: Woodhead Publishing Limited; 2018.
12. Aberle ED, Forrest JC, Gerrard DE, Mills EW. Principles of meat science (4th edition). USA: Kendall/Hunt Publishing Company; 2011.
13. Australia Food Regulation Standing Committee (AFRSC). Australian standard for the hygienic production and transportation of meat and meat products for human consumption. AFRSC technical report No. 3 CSIRO publishing, Australia. 2007;54-61.
14. Carrie R, Daniel, Amanda J. Cross, Corinna Koebnick, Rashmi Sinha. Trends in meat consumption in the United States. Public Health Nutrition. National Institute of Health Journal. 2011;575-583.
15. Dinh Tran Nhat Thu. Meat quality: Understanding of meat tenderness and influence of fat content on meat flavor, University of Technology, VNU-HCM. 2016;65-70.
16. Bell RG. Distribution and sources of microbial contamination on beef carcasses. Journal of Applied Microbiology. 2017;88:292-300.
17. Doyle MP. Microbial Food Spoilage – Losses and Control Strategies, (A Brief Review of the Literature), Fri Briefings; 2017.
Available:www.wisc.edu/fri/
18. FAO. Guidelines for slaughtering meat cutting and further processing; Techniques and hygiene practices in slaughtering and meat handling. Animal Production and Health Paper 91; 2011.
19. Food and Agricultural Organization of the United Nations. Animal production and Health
20. Food Standard Agency (FSA) (2008). Meat Industry Guide (MIG): Food hygiene and other regulations for the UK meat industry. Guidance to assist UK meat plant operators whose premises require approval and veterinary control under the European Union Food Hygiene Regulations. 2012;2(14):1-15.
21. Forsythe SJ. The microbiology of safe food. Oxford: Blackwell Science; 2010.
22. Hayes PR. Food microbiology and hygiene. London: Elsevier Applied Science Publishers; 2015.
23. Tomlins K. Street food in Ghana: Source of income, but not without its hazards. PH Action News, the Newsletter of the Global Post-Harvest Forum; 2012.
24. Tutenel AVD, Van Hoof J, Cornelis M, De Zutter L. Isolation and molecular characterization of *Escherichia coli* O157 isolated from cattle, pigs and chickens at

slaughter. International Journal of Food Microbiology. 2013;84(1):63-9.
25. USDA. Livestock and poultry; World markets and trade; 2009.
26. Williams PG. Nutrient composition of red meat; 2017. Available:http://ro.uow.edu.au/hbspapers/8
27. Abaidoo RC, Obiri-Danso K. BIOL 503: Environmental Microbiology. KNUST, IDL (MSC Environmental Science). 2018;3.
28. McArdle J. Humans are omnivorous. Vegetarian Resource Group; 2010.
29. Meat Technology Update (MTU). Sources of contamination on beef carcasses during dressing; 2010.
30. Raloff J. Food For Thought: Global Food Trends. Science News Online; 2013.
31. Sofos JN. Challenges to meat safety in the 21st century. Meat Science. 2018;18:3-13.
32. Speedy AW. Global production and consumption of animal source foods. Journal of Nutrition. 2013;133:4048S–4053.
33. Minnesota Department of Health (MDH). Fact sheet. Causes and symptoms of Staphylococcus aureus. Revised February; 2013.
34. Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV. Food-related illness and death in the United States. Emergency Infectious Disease. 1999;5:607-625.
35. Sprenger RA. Food for thought: Approaches for steering successful meat business into the next century. Die Fleischere. 2015;1(6):7-11.
36. Fabrega A, Vila J. Salmonella enterica Serovar Typhimurium skills to succeed in the Host: Virulence and Regulation. Clinical Microbiology Reviews. 2013;26 (2):308–341.
37. Center for Disease Control and Prevention (CDC), An Atlas of Salmonella in the United States. 2014;1968-2011.
38. Soyiri IN, Agbogli HK, Dongdem JT. A pilot microbial assessment of beef sold in the Ashaiman market, a suburb of Accra, Ghana. African Journal of Food Agriculture Nutrition and Development. 2008;8(1):91-103
39. Adzitey F, Teye GA, Kutah WN, Adday S. Microbial quality of beef sold on selected markets in the Tamale Metropolis in the Northern Region of Ghana. Livestock Research for Rural Development. 2011;23.
40. Ahmad MUD, Sarwar A, Najeeb MI, Nawaz M, Anjum AA, Ali MA, Mansur N. Assessment of microbial load of raw meat at abattoirs and retail outlets. The Journal of Animal and Plant Sciences. 2013;23(3): 745-748.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*https://www.sdiarticle5.com/review-history/118621*