**EFFECT OF SLAUGHTERHOUSE HYGIENIC PRACTICES AND RISK FACTORS OF BACTERIAL CONTAMINATION OF MEAT FROM SELECTED ABATTOIRS IN OWERRI NORTH L.G.A., IMO STATE.**

**ABSTRACT**

This study was to evaluate the level of compliance with good hygiene practices in slaughterhouses, to assess the microbiological quality and investigate the risk factors in some selected abattoirs in Owerri North L.G.A., Imo State. Standard microbiological techniques were adopted and surface swab samples were collected from hands, butcher’s tables, knives, transport media, water samples, slaughterhouse floor, lairage, cold room, tripe room and the processing section in the two abattoirs, Egbu and Naze. A total of 204 samples (104 contact surfaces and 100 abattoir section) were collected from the abattoirs. Egbu abattoir revealed bacterial load before and after sanitation and 2.6×105, 3.6×105, 2.4×105,1.8×105, 2.9×105, 2.1×105,2.4×105,3.4×105and 1.7×105and 8.9×105,3.5×105,5.6×105,9.5×105, 6.3×105, 9.4×105, 8.9×105, 6.1×105and 8.7×105(cfu/cm2) respectively. While in Naze abattoir recorded 1.3×105, 3.5×105, 3.3×105, 1.2×105, 2.5×105, 1.7×105, 1.3×105, 2.4×105and 1.2×105and 4.6×105, 6.9×105, 9.8×105, 9.7×105, 5.9×105, 9.7×105, 8.0×105, 4.6×105and 8.6×105(cfu/cm2) for bacterial load before and after sanitation respectively. The average values were 20.65×105cfu/cm2and 67.4×105cfu/cm2respectively. The bacteria identified were *Escherichia coli, Salmonella enteritidis, Staphylococcus aureus, Shigella dysenteriae*and *Klebsiella pneumoniae* on 55, 45, 50, 40 and 14 surfaces respectively. Poor hygiene, inadequate sanitation, and cross-contamination led to widespread bacterial presence on surfaces, tools, and workers’ hands. Post-sanitation bacterial loads were alarmingly higher than pre-sanitation levels, exceeding WHO standards. This was linked to unwashed hands, lack of protective gear, contaminated equipment, and non-potable water. Pathogens like *E. coli*, *Salmonella*, *S. aureus*, *Shigella*, and *K. pneumoniae* were identified, posing serious health risks. The findings highlighted the urgent need for strict hygiene enforcement and training of meat handlers.

**Keywords:** Meat, Abattoir,Hygiene, BacterialandContamination

**1.0. Introduction**

Foodborne illnesses stems from a wide range of microbial sources and pose serious challenges for both consumers and the food industry. Most of these diseases are caused by bacteria originating from animals, humans, or the surrounding environment (Manyi-Loh *et al.,* 2023). One of the primary contributors to foodborne illness is contaminated raw beef, which can be tainted by environmental factors, human handling, or the animal itself (Pigott, 2008). During the slaughtering and processing stages, contamination can occur through exposure to faeces, hides, water, intestinal contents, lymph nodes, equipment, and personnel, all of which can introduce harmful microbes to meat and carcasses (Morshdy*et al.,* 2023).

Abattoir workers who fail to follow proper hygiene practices contribute to the spread of zoonotic diseases among themselves and increase the risk of meat contamination intended for public consumption. Research shows that the microbial load of meat from abattoirs and butcher shops in Sub-Saharan Africa, including Nigeria, often exceeds the limits recommended by the World Health Organization (WHO) (Iroha *et al.,* 2011; Haileselassie *et al.,* 2013). There have also been reported cases of zoonotic infections in both abattoir workers and cattle in various Nigerian facilities (Allwin *et al.,* 2015; Fasanmi*et al.,* 2017). Further studies from Nigeria highlight issues such as inadequate infrastructure, unhygienic conditions, and poor sanitary practices in many abattoirs and slaughterhouses (Adesokan *et al.,* 2014; Azuamah *et al.,* 2019), despite the fact that maintaining abattoir hygiene is a critical aspect of Nigeria's National Environmental Sanitation Policy (FME, 2005).

Each year, approximately 1.9 million people globally die from foodborne infections, which remain a leading cause of illness in developing countries (Abebe et al., 2020). The widespread occurrence of diarrheal diseases in these regions highlights serious food safety concerns (WHO, 2022). In recent times, bacterial foodborne illnesses—particularly those involving pathogens like *Enterobacteria*, *Staphylococcus aureus*, and *Salmonella* species—have emerged as significant public health challenges across many African nations (Smith et al., 2022). These infections are closely linked to poor hygiene and improper food handling practices.

The objective of this work was to evaluate the level of compliance with good hygiene practices in slaughterhouses, to assess the microbiological quality and investigate the risk factors in some selected abattoirs in Owerri North L.G.A., Imo State.

**2.0. Methodology**

**2.1 Study Design**

This research design was an experimental study involving laboratory tests/analysis to assess the bacteriological qualities of meat contact surfaces in selected abattoirs in Owerri North Imo State.

**2.2 Study****Area**

This research was conducted in Owerri North Local Government Area (LGA) of Imo State, which is characterized by a semi-urban environment comprising districts such as Uratta, Naze, Egbu, Emekeobibi, Umunahu, Emii, Ogada, Oha, Umuayalu, and Ihite. The administrative headquarters is located in OrieUratta. Owerri North spans an area of 198 square kilometers and experiences an average temperature of 27°C. Geographically, it lies at a latitude of 5.46°N and a longitude of 7.11°E, with an elevation of 102 meters (335 feet) above sea level. Six major roads from the municipal area traverse the communities within Owerri North. To the north, Orlu Road connects to Amakaohia and Akwakuma; to the east, Okigwe Road links to Orji; to the west, MCC Road via Wetheral leads to ObibiUratta and Ihitaoha; to the south, Mbaise Road serves Egbu and Emekuku, while Aba Road extends to Naze, Agbala, and Ulakwo. The area also functions as a commercial hub for agricultural products such as palm produce, maize, yams, and cassava. Based on the 2006 national population census, the LGA had an estimated population of 175,395 (Tiebet-*et al.,* 2019).

**2.3. Study Population**

The study population included all the major abattoir in Owerri North which are two (2) major abattoirs under study (Egbu and Naze).

**2.4. Sample Size and Sampling Methods**

**2.4.1. Sample Size**

A total of two hundred and four (204) samples was used for this study. Table 1, below shows that the visits to the abattoirs (Egbu and Naze) were made once a week for a period of 2 weeks. During each visit to these selected abattoirs, forty swab samples of meat contact surfaces of the hands, tables, knives, transport media and 12 water samples were aseptically collected. A total of 104 samples were transported to the laboratory in ice boxes and peptone water for bacteriological analysis. 50 swab samples of abattoir sections (Lairage, slaughterhouse floor, coldroom, triperoom, processing section) were also aseptically collected in an ice packed flask. A total of 100 samples of abattoir sections from the two abattoirs were collected during 2 visits.

**Table 1: Breakdown of sample collection and size**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | | | | |
|  | **No of samples on each visit** | **No of visits** | **Egbu** | **Naze** | **Total samples collected** |
| **Meat contact surfaces** |  |  |  |  |  |
| **Hand** | 5 | 2 | 10 | 10 | 20 |
| **Table** | 5 | 2 | 10 | 10 | 20 |
| **Knife** | 5 | 2 | 10 | 10 | 20 |
| **Transport media** | 5 | 2 | 10 | 10 | 20 |
| **Water samples**  **(borehole water)** | 6 | 2 | 12 | 12 | 24 |
| **Total** | 26 | 10 | 52 | 52 | 104 |
| **Abattoir section** |  |  |  |  |  |
| **Slaughterhouse floor** | 5 | 2 | 10 | 10 | 20 |
| **Lairage** | 5 | 2 | 10 | 10 | 20 |
| **Cold room** | 5 | 2 | 10 | 10 | 20 |
| **Tripe room** | 5 | 2 | 10 | 10 | 20 |
| **Processing section** | 5 | 2 | 10 | 10 | 20 |
| **Total** | 25 | 10 | 50 | 50 | **100** |

**2.5. Sampling Method**

A simple random sampling using balloting was used for the selection of two (2) out of the three (3) functional abattoirs in Owerri North for the study. 80 swab samples and 24 water samples from contact surfaces (hands-palms, table, knife, transport media and water samples) were used for this study; 10 swabs from each of the contact surface, hence, a total of 40 swab samples of contact surfaces from each abattoir. Since two abattoirs were involved in this study, a sum total of 80 swabs from the contact surfaces and 24 water samples were aseptically collected. However, a total of 100 swab samples were collected with 10 swab samples aseptically from each section of the abattoir (slaughterhouse floor, lairage, cold room, tripe room and cutting/processing section). All the samples were transported to the laboratory in a cooler box stocked with ice packs, and processed within 3- 8 hours on reaching the laboratory (Jaja *et al.,* 2018).

**2.6. Materials needed**

**2.6.1. Instrument for Data Collection:** The instrument used for data collection of the bacteriological qualities of meat contact surfaces were laboratory equipment which included; sterile sampling swabs stick, sterile sampling containers, sterile sampling gloves, transport coolers, labels and permanent markers and an observational checklist.

**2.6.2. Personal Protective Equipment, Laboratory Equipment and Materials for the Bacteriological Assessment:** These included; hand gloves, face mask and laboratory coat. While glass wares included; test tubes, pipettes, conical flasks, glass spreaders, glass slides, cover slips, bijou bottles and volumetric flasks.

**2.6.3. Media and Diluents:** These included distilled water, peptone water, grams reagents, mannitol salt agar, *Salmonella Shigella* Agar, Eosin Methylene Blue Agar, MacConkey Agar, Nutrient Agar, Campylobacter and Blood Free Agar

**2.6.4. Equipment for Laboratory analysis:** These includedcolony counter, microscope and autoclave.

**2.6.5. Other materials included;-**wire loop, mounting needle/inoculating needle and cold box.

**2.7. Method of Data Collection/ Preparation and Analysis**

**2.7.1. Collection of Samples**

Swap samples were collected from the hands (Palms, back of the hand, fingers, and between fingers), tables, knife, transport vehicles, water and Abattoir Section (slaughtering area, cutting and processing area, cold room, tripe room and packaging area)

**2.7. 2 Preparation of Media and Diluents**

All bacteriological media was prepared according to manufacturer’s specification. Nutrient agar was used in the isolation of heterotrophic bacteria, MacConkey Agar for faecal coliform bacteria, Eosin Methylene Blue Agar for *Escherichia coli*, *Campylobacter* Agar for *Campylobacter* species, Mannitol Salt Agar strictly for *Staphylococcus aureus* and *Salmonella Shigella* Agar for the isolation of *Salmonella* and *Shigella* species). Physiological saline used as diluents was prepared by dissolving 9.8 g of sodium chloride in 1000ml of distilled water and dispensed in 90 ml and 9ml portions. Both diluents and media were sterilized in an autoclave at 121°C for 15 minutes.

**2.7.3 Sample Analysis and Tests: Preparation of Samples and Inoculation**

Test tubes containing swabs from the contact surfaces and the different abattoir sections were shaken on a vortex mixer for 30 seconds for uniform distribution of bacteria. Ten-fold serial dilution of all samples was prepared using sterile normal saline solution (NSS). 0.1ml of each sample was pipetted into agar plate and incubated at 37°C for 42-48 hours for total plate bacteria count. For Total Plate Count, 0.1ml of each sample was pipetted and spread on Nutrient agar. Inoculated plate was incubated at 32°C for 18-24 hours to determine the total plate counts. For *Enterobacteriaceae* Count, 0.1ml of each sample was pipetted and spread on MacConkey agar supplemented with glucose. Inoculated plate was incubated at 35°C for 24 hours. All reddish purple/pink colonies were counted as members of the *Enterobacteriaceae*.

**2.7.4 Determination of Total Plate Count**

Serial dilutions were made from 1ml of the contact sample and 9 ml of the normal saline solution. Appropriate dilutions were surface plated on plate count agar for enumeration of total aerobic viable counts and plates incubated at 37°C for 24-48 hours. The number of distinct colonies on each plate was enumerated using a colony counter, Colony Forming Units (CFU) per ml or cm2 of sample were calculated, using the dilution factor of each and converted to log10 CFU/ cm2 or ml values. Mean values of total aerobic viable counts were determined and reported before and after processing.

**2.7.5 Biochemical Characterization of Bacteria Isolates**

Microorganisms that were not identified by the colonial and microscopic characteristics were further subjected to few biochemical tests to determine the Gram-positive and Gram-negative bacterial pathogens from table surfaces for Oxidase Test, IMViC Test and Citrate Utilization Test described by Cheesbrough (2000).

**2.7.6 Characterization and Identification of Microbial Isolates**

After incubation of the various inoculated plates, the predominant bacterial colonies were picked randomly from countable plates and inoculated into test tubes containing about 5 ml nutrient broth. The bacterial culture was purified by repeated streak plating and characterization. The predominant bacterial isolates were characterized based on cultural (colonial), microscopic and biochemical methods with reference to standard manuals. The identities of the isolates were cross-matched with reference to standard manuals for the identification of bacteria from meat contact surfaces and different abattoir sections (Cheesbrough, 2000).

**2.7.8 Microscopic Characterization**

The Gram staining technique was used for the bacterial isolates/spread from transport vehicles while motility test was done-as described by Cheesbrough (2000).

**2.7.9 Isolation of Bacteria from Meat Contact Surfaces and Abattoir Section**

The isolation of bacteria from meat contact surfaces and abattoir section were considered based on the following; *Staphylococcus aureus* (Fawole and Oso, 2001; Okonkwo *et al*., 2010), *Escherichia* coli and Salmonella (Cheesbrough, 2000).

**2.8. Data Analysis:** Using IBM-SPSS statistical package version 25, statistical tools such as standard deviation and regression analysis was carried out to determine the relationship between the variables. One-way ANOVA and the independent sample T-test was used to test the hypotheses at 95% confidence interval and acceptable value of p≤-0.05 was considered to be statistically significant.

**2.9. Ethical Consideration/Informed Consent**

The approval was obtained from the Department of Public Health, Federal University of Technology Owerri Imo State Nigeria and the Chairmen of the Abattoirs in Owerri North.

**3.0. Results and Discussion**

A total of two hundred and four (204) samples from two Abattoirs in Owerri North, Nigeria was taken to the laboratory for analysis.Bacterial contamination levels were recorded before and after sanitation, in colony-forming units per square centimeter (cfu/cm²). A percentage reduction was calculated to indicate the effectiveness of sanitation.

The "sanitation" practices are ineffective, often worsening bacterial contamination. There was a clear lack of hygiene, such as: butchers handling food and money/phones simultaneously, use of non-potable water and lack of gloves, proper cleaning tools, and protective gear. These poor practices create a high risk of contamination across nearly all meat contact surfaces.

**Table 2: The Evaluation of the Current Sanitation Practices/Personal Hygiene in Reducing Bacteria contamination on Meat contact surfaces in the Abattoirs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Abattoirs** | **Contact Surfaces  Sampled** | **Bacterial Load Before Sanitation(cfu/cm2)** | **Bacterial load after  sanitation (cfu/cm2)** | **% Reducton** | **Observation on Sanitation Practices/ Personal Hygiene** |
|
| Egbu | Hands | 2.6×105 | 8.9×105 | 342.31 | Butchers handles phones while selling |
| Butcher's Tables | 3.6×105 | 3.5×105 | 97.22 | Toilet location can cause contamination |
| Knives | 2.4×105 | 5.6×105 | 233.33 | Butcher's knives are exposed to flies |
| Borehole Water | 1.8×105 | 9.5×105 | 527.78 | Some butchers wore jewelries and big rings on their hands and fingers |
| Slaughterhouse Floor | 2.9×105 | 6.3×105 | 217.24 | Some butchers had visible skin rashes |
| Lairage | 2.1×105 | 9.4×105 | 452.38 | Worktables and work surfaces are not cleaned and sanitized between operations |
| Cold Room | 2.4×105 | 8.9×105 | 370.83 | Inadequate wash -hand basins with soap and running water are not available |
| Tripe Room | 3.4×105 | 6.1×105 | 179.41 | Mops are not washed after use and are stored head down |
| Processing Section | 1.7×105 | 8.7×105 | 511.76 |  |
| Naze | Hands | 1.3×105 | 4.6×105 | 353.85 | Butchers handles money while selling |
| Butcher's Tables | 3.5×105 | 6.9×105 | 197.14 | Some butchers had visible skin rashes |
| Knives | 3.3×105 | 9.8×105 | 296.97 | Butchers do not cover their mouth while coughing |
| Borehole Water | 1.2×105 | 9.7×105 | 808.33 | Some butchers had long nails |
| Slaughterhouse Floor | 2.5×105 | 5.9×105 | 236 | Butcher's knives are exposed to flies |
| Lairage | 1.7×105 | 9.7×105 | 570.59 | inadequate ventilation |
| Cold Room | 1.3×105 | 8.0×105 | 615.38 | Poor scheduled deep cleaning |
| Tripe Room | 2.4×105 | 4.6×105 | 191.67 | Non-potable water |
| Processing Section | 1.2×105 | 8.6×105 | 716.67 | High accumulation of waste materials |
| Average |  | 20.65×105 | 67.4×105 |  |  |

Table 3 identifies types of bacteria, how many surfaces were contaminated, associated health risks, and observed causes

**Table 3: The Potential Health Risks Associated with the Bacterial Contamination of Meat Contact Surfaces in the selected Abattoirs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Types of bacteria  identified** | **Number of contaminated  surfaces** | **Potential health risks** | **Relevant observations** |
| *Escherichia coli* | 55 | Gastrointestinal illness, sepsis | Butcher's hands are not washed routinely with soap and potable water |
| *Salmonella enteritidis* | 45 | Severe diarrhea, and dehydration | Butchers do not wear hand gloves |
| *Staphylococcus aureus* | 50 | Skin and soft tissue infections, respiratory infections | Meat handlers are not free from skin illness |
| *Shigella dysenteriae* | 40 | Neurological complications (seizures, headache) | Some butchers do not wear aprons |
| *Klebsiella pneumoniae* | 14 | Pneumonia, urinary tract infections | Butchers do not wear hand gloves and also, they do not wash their hands with soap and potable water |
|  |  |  |  |

**3.2. Discussions**

The results from the study indicated a varied percentage of bacterial occurrences across the sampled surfaces, reflecting the hygiene practices and the level of contamination in these abattoirs.

The identification and classification of the specific types of bacteria found in meat contact surfaces in the selected abattoirs showed that one Gram-positive bacteria (*Staphylococcus aureus*) and four Gram-negative bacteria (*Escherichia coli, Klebsiella pneumonia, Shigella dysenteriae* and *Salmonella enteritidis*) were isolated from the meat contact surfaces and confirmed their different biochemical/carbohydrate characteristics. Sandle (2004) isolated the same bacterial species through Gram staining techniques and Hemraj *et al.,* (2013) reviewed the commonly used biochemical test for bacteria.Generally, they are mostly present in rich protein food, such as fish and meat (Silas *et al.,* 2024).

Although *Escherichia coli* are unavoidable meat contaminants, the numbers are usually low when good hygiene is practiced (Adegunloye, 2013). Uzoigwe-*et al.*, (2021), in a similar study identified *E. coli* bacteria isolates found in the abattoir. This report was also confirmed by Gurmu and Gebretinsaen (2012). The high rate of *Pseudomonas spp*. contamination of meat indicated the deplorable state of the abattoir and poor sanitary practices employed in the slaughterhouse.

The presence of *Staphylococcus* spp., *Escherichia coli*, *Klebsiella* spp., *Shigella* spp., and *Salmonella* spp. in meat processing environments was associated with poor hygiene, cross-contamination, and inadequate sanitation. Butchers’ hands, tables, and knives became contaminated due to improper handwashing, handling of raw meat, and inadequate sterilization. Transport media, water sources, and slaughterhouse floors harboured bacteria due to infrequent cleaning and exposure to faecal matter. Lairage areas, cold rooms, and tripe rooms facilitated bacterial survival due to animal waste, moisture, and inefficient washing. Processing sections further spread bacteria through contaminated tools and poor food handling.

The evaluation of sanitation practices and personal hygiene in the Egbu and Naze abattoirs revealed alarming levels of bacterial contamination, with post-sanitation bacterial loads significantly higher than pre-sanitation levels on all tested surfaces. This finding is contrary to the expected outcome of sanitation procedures and underscores serious lapses in hygiene protocols within these facilities.

The increase in bacterial counts after supposed sanitation in both abattoirs aligns with the findings of Manyi-Loh et al. (2023), who noted that contamination in meat-processing environments is often exacerbated by inadequate hygiene practices. Similarly, Pigott (2008) emphasized that contamination source-s during meat processing include equipment, personnel, and water, all of which were observed to be problematic in this study.Other studies such as Bhandare et al. (2007) and Nde et al. (2007) have also reported high microbial loads on meat contact surfaces, linking these to poor cleaning schedules, use of unclean water, and lack of proper sanitation infrastructure. These studies support the current observation where surfaces such as knives, cold rooms, and hands had bacterial increases of over 500% post-sanitation—strongly suggesting that what was termed “sanitation” may have involved the spread rather than removal of microbes.

The identification of *E. coli*, *Salmonella enteritidis*, *Staphylococcus aureus*, *Shigella dysenteriae*, and *Klebsiella pneumoniae* on meat contact surfaces in this study is consistent with reports by Abebe et al. (2020) and Smith et al. (2022), who found that foodborne pathogens are a major public health threat in sub-Saharan Africa, often due to poor food handling and inadequate hygiene.

*Escherichia coli* has been commonly detected in environments with poor hand hygiene and unclean equipment, as noted by WHO (2022). The presence of *Salmonella* and *Staphylococcus aureus* supports the findings by Hansson *et al.*, (2010), who recorded similar contaminants in informal meat markets due to lack of gloves and aprons, and exposure to environmental vectors like flies. *Shigella dysenteriae*, though less commonly reported in abattoirs, has been found in meat sold in informal markets in Nigeria and Kenya, especially where water used for cleaning is non-potable (Wolk, 2016).

The connection between poor personal hygiene and increased contamination, such as handling money or phones while working, unwashed hands, exposed wounds, and use of jewelry, supports earlier research by Fasanmi et al. (2017), which stressed the importance of training meat handlers and enforcing hygiene protocols. The presence of long nails and unwashed mops, also observed here, were considered high-risk factors for cross-contamination, as reported by Allwin et al. (2015).

The average bacterial load in this study (20.65 × 10⁵ cfu/cm² before sanitation and 67.4 × 10⁵ cfu/cm² after sanitation) was significantly higher than the WHO’s acceptable limit of <10² cfu/cm² on meat contact surfaces. This supports the conclusion of Azuamah and Amadi, 2019), who observed that in many Nigerian abattoirs, microbial loads far exceeded global safety standards due to inadequate enforcement of sanitation policies.

Table 3 highlights the significant public health risks posed by poor hygiene and sanitation in these facilities. *E. coli*was detected on 55 contaminated surfaces, which is a common indicator of faecal contamination and poor hygiene. Its association with gastrointestinal illnesses and sepsis in humans was well-documented. This aligns with findings by Manyi-Loh et al. (2023) and WHO (2017), who reported that improper handwashing and cross-contamination in meat processing significantly contributed to *E. coli* outbreaks. Butcher’s hands not being routinely washed with soap and potable water directly facilitates the spread of *E. coli*, confirming earlier studies by Fasanmi et al. (2017)on the role of poor personal hygiene.

The Identified *Salmonella* on 45 surfaces was linked with severe diarrhoea and dehydration. This was consistent with findings by Smith et al. (2022) who reported *Salmonella* as one of the most frequent contaminants in Nigerian meat, often associated with inadequate protective gear such as gloves. This was attributed to butchers not wearing hand gloves increases direct contact with contaminated surfaces, contributing to its spread—a trend also noted by Hansson et al. (2010) in East African abattoirs.

*S. aureus* was identified in 50 surfaces, which causes skin infections and respiratory illnesses, especially in immunocompromised individuals. Fasanmi et al. (2017),highlighted that its presence in meat is commonly linked to infected handlers, especially those with skin rashes or wounds. This study confirms that many meat handlers in these abattoirs suffer visible skin conditions, creating a direct contamination pathway.

The detected *Shigella* on 40 surfaces, causes neurological symptoms in addition to severe gastrointestinal illness. Though less commonly reported in abattoirs, its occurrence aligns with studies from low-resource settings where aprons and protective clothing are not used (WHO, 2022). The lack of apron use observed here mirrors unsafe practices documented in informal markets across Africa (WHO, 2017).

The less frequently found on 14 surfaces were*K. pneumoniae*,usually associated with pneumonia and urinary tract infections. Its presence in abattoirs, as noted by Abebe et al. (2020), is often due to poor hand hygiene and lack of gloves, which were also observed in this study. It was also observed that butchers not washing hands or using gloves is a known risk factor for *Klebsiella* contamination, particularly on surfaces like knives and tables that come into direct contact with meat.

**4.0. Conclusion and Recommendations**

Meat contamination is inevitable due to microbial activity, which leads to deterioration and a reduction in its nutritional value. This occurs because microorganisms consume and grow on the nutrients present in meat. Therefore, the following are recommended;

* Proper sanitary conditions and storage methods, such as refrigeration and freezing, can help minimize microbial activity.
* Consumers must recognize that no market-sold meat is entirely free from microbial presence. Therefore, appropriate cooking techniques should be used to lower microbial levels to a safe threshold.
* The government should take responsibility by equipping municipal abattoirs with adequate storage facilities, constructing wastewater channels, and providing well-structured slaughter halls.
* Regular ante-mortem inspections of cattle should be enforced.
* Furthermore, regulations should set hygiene standards for both existing and prospective butchers while also minimizing pre-slaughter stress to preserve meat quality.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**References**

Abebe, E., Gugsa, G.and Ahmed, M. (2020). Review on major food-borne zoonotic bacterial pathogens. *Journal of tropical medicine*, *2020*.

Adegunloye, D. V. (2013) Microbial Composition of the Abattoir Environment and Its Health Implications on the Quality of Fresh Cow Meat Sold in Akure, Ondo State, Nigeria. *WIT Transactions on Ecology and the Environment*, 170, 57-65. <https://doi.org/10.2495/FENV130061>

Adesokan, H. K. and Sulaimon, M. A. (2014). Poor Slaughterhouse Waste Management: Empirical Evidences from Nigeria and Implications on Achieving Millennium Development Goals. *Int J Sci Technol*.;3(6):110–27.

Allwin, B., Kalaignan, P. A. and Senthil, N. R. (2015). Abattoir characteristics and seroprevalence of bovine brucellosis in cattle slaughtered at Bodija Municipal Abattoir, Ibadan, Nigeria. *J Vet Med Anim Heal*.;7(5):169–72

Azuamah, Y. and Amadi, A. N. (2019). Distribution of Bacterial Isolates from Contact Surfaces of Meat Handlers in Abattoirs of Southeastern, Nigeria. *Int J Res*.;06(07):109 PubMed –19.

Cheesbrough, M. (2000). *Microbiological test: District Laboratory Practice in Tropical Countries.* London: *Cambridge University Press*, pp. 1-226.

Eze, V. C., Omeh, Y. N. and Ugweje, C. D. (2013) Microbiological and Physicochemical Assessment of Soil Contaminated with Lairage Effluent in Umuahia, Abia State, Nigeria*. IOSR Journal of Pharmacy and Biological Sciences,* 8, 50-56. <https://doi.org/10.9790/3008-0825056>.

Fasanmi, O. G., Ayodeji, I. O., Oloso, N. O. and Fasina, F. O. (2017). Retrospective studies of abattoir zoonoses in Nigeria: public health implications. *CAB Rev Perspect Agric Vet SciNutr Nat Resour*.;12(January):1–14.

Fawole, M. O. and Oso B. A. (2001). Laboratory Manual of Microbiology, Revised edition spectrum books Ltd., Ibadan, p.127.

FME (Federal Ministry of Environment) (2005). Policy Guidelines on Sanitary Inspection of Premises. Abuja, Nigeria; 2005. p. 9–10.

Gurmu, E. B. and Gebretinsae, H. (2013) Assessment of Bacteriological Quality of Meat Contact Surfaces in Selected Butcher Shops of Mekelle City, Ethiopia. *Journal of Environmental and Occupational Science*, 2, 61-66. <https://doi.org/10.5455/jeos.20130416114711>

HACCP (B) HACCP in meat plants, (2015) <https://www.food.gov.uk/businessindustry/> meat/haccp/meat/plants

Haileselassie, M., Taddele, H., Adhana, K. andKalayou, K. (2013). Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle city, Ethiopia, *Asian Pac. J. Trop. Biomed.* 3 (5) (2013) 407–412.

Hemraj, V., Diksha, S. and Avneet, G. (2013). A review on commonly used biochemical test for bacteria. *Innovare. J. Life. Sci,* 1 (1): 1-7. 11.

Iroha, I. R., Ugbo, E. C., Ilang, D. C., Oji, A. E. and Ayogu, T. E. (2011). Bacteria contamination of raw meat sold in Abakaliki, Ebonyi State Nigeria. *J Public Heal Epidemiol*.; 3(2):49–53.

Jaja, I., Green, E. and Muchenje, V. (2018). Aerobic Mesophilic coliform, Escherichia coli, Staphylococcus aureus counts from the formal and informal meat sectors in south Africa. *International Journal of Environmental Research and Public Health,* 15(9),819.

Manyi-loh, C. E., Okoh, A. I. and Lues, R. (2023). Occurrence and multidrug resistance in strains of Listeria monocytogenes recovered from the anaerobic co-digestion sludge contained in a single stage steel biodigester: Implications for antimicrobial stewardship. *Microorganisms*, 11(3): 725. https://doi.org/10.3390/microorganisms11030725

Morshdy, A. E. M., Mehrez, S. M., Tharwat, A. E., Abdallah, K. M. and Darwish, W. (2023). A review on the microbial surface contaminants of the animal carcasses. *Journal of Advanced Veterinary Research*, 13(6): 1248 – 1251.

Okonkwo, I. O., Ukut, I. O. E., Ikpoh, I. S., Nkang, A. O., Udeze, A. O., Babalola, T. A., Mejeha, O. K. and Fajobi, E. A. (2010). Assessment of bacteriological quality of fresh meats sold in Calabar metropolis, Nigeria. EJEAFChe; 9:89-100.

Pigott, D. C. (2008). Foodborne illness. *Emergency Medicine Clinics of North America*, 26(2): 475 – 497.

Sandle, T. (2004). Gram`s Stain: History and Explaination of the Fundamental Techniques of Determinative Bacteriology*. IST Science and Technology Journal,* 54 (1) ,3 – 4.

Silas, I. I., Essien, E. A., Anietie H. N., Inyang, S. X. and Akpan, A. E. (2024). Comparative study on the prevalence of gastrointestinal parasite between wild and pond raised African Sharptooth Catfish *Clariasgariepinus* in Akwa Ibom State. *South Asian Journal of Parasitology(SAJP),* 7(2):133-140.

Smith, M. A., Olimpo, J. T., Santillan, K. A. and McLaughlin, J. S. (2022). Addressing Foodborne Illness in Côte d’Ivoire: Connecting the Classroom to the Community through a Nonmajors Course-Based Undergraduate Research Experience. *Journal of Microbiology & Biology Education*, *23*(1), e00212-21.

Tiebet, P., Ibe, S., Nwoke, E., Nworoh, B. and Iwuoha, G. (2019). Factors Influencing Contraceptive Use among Women of Reproductive Age in Owerri North, Imo State, Nigeria. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS);* 18 (11):30-38.

Ukut, I. O., Okonko, I. O., Ikpoh, I. S., Nkang, A. O., Udeze, A. O., and Babalola, T. A. (2010). Assessment of bacteriological quality of fresh meats sold in Calabar metropolis, Nigeria. *Electronic J. of Environ., Agric. and Food chem., 9:89-100.*

Uzoigwe, N. E., Nwufo, C. R., Nwankwo, C. S., Ibe, S. N., Amadi, C. O. and Udujih, O. G. (2021) Assessment of Bacterial Contamination of Beef in Slaughterhouses in Owerri Zone, Imo State, Nigeria. *Scientific African,* 12, e00769. <https://doi.org/10.1016/j.sciaf.2021.e00769>.

WHO (World Health Organization) (2017) WHO Publishes List of Bacteria for Which New Antibiotics Are Urgently Needed. <https://www.who.int/news/item/27-02-2017-who-publishes-list-of-bacteria-for-which-new-antibiotics-are-urgently-needed>.

WHO (World Health Organizaton) (2022). Food safety and food borne illness. Factsheets of the Programmes and Projects of WHO.2022.[https://www.who.int/news-room/fact-sheets/detail/food-safety] Accessed on 13/10/2022

Wolk, A. (2016). Potential health hazards of eating red meat. *J. of Inter. Med*., 12:79- *85*.