Scientific Publishing House

Trends in Ecological and Indoor Environmental Engineering

Nosa Omoregbe Obayagbona & Olusegun Oguntoke *TEIEE 4(1) 2026*

RESEARCH ARTICLE **OPEN ACCESS**
https://doi.org/10.62622/TEIEE.026.4.1.11-21 **ISSN 2956-9761**

EVALUATION OF HYGIENE MANAGEMENT PRACTICES IN NIGERIAN RETAIL BEEF OUTLETS BASED ON A SURVEY OF KEY PRINCIPLES

Nosa Omoregbe Obayagbona[1*], Olusegun Oguntoke[2]
[1]Department of Environmental Management and Toxicology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria
[2]Department of Environmental Management and Toxicology, College of Environmental Resources Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
*Corresponding email: Omoregbe.obayagbona@uniben.edu

Received: 14.12.2026; ***Accepted:*** 17.01.2026; ***Available online:*** 22.01.2026; ***Published:*** 30.03.2026

Cite this article: Obayagbona, N. O., & Oguntoke, O. (2026). Evaluation of Hygiene Management Practices in Nigerian Retail Beef Outlets Based on a Survey of Key Principles. *Trends in Ecological and Indoor Environmental Engineering*, 4(1), 11–21.

Background: Retail beef sales represent a critical interface between meat production systems and consumers in Nigeria, where retail handling conditions strongly influence food safety outcomes. In many urban markets, beef is displayed at ambient temperatures within retail environments constrained by limited cold chain infrastructure, irregular electricity supply, inadequate water access, and poor waste management systems. These infrastructural limitations increase the risk of microbial contamination, with direct implications for SDG 3 (Good Health and Well-being) through heightened exposure to foodborne diseases. At the same time, inefficient storage and handling practices contribute to meat spoilage and avoidable losses, undermining progress towards SDG 12 (Responsible Consumption and Production). There is a lack of research in Nigeria to integrated assessments linking retail infrastructure, hygiene practices, and food safety within sustainable food system frameworks. **Objectives:** This study aimed to assess the hygiene status of 104 consenting retail beef outlets in three urban areas of Edo State, Benin City, Ekpoma, and Auchi – using an observational hygiene checklist and a structured questionnaire. By identifying critical gaps in personal hygiene and infrastructural provisions, this study seeks to provide evidence-based insights to inform targeted interventions and organizational actions aimed at improving hygiene management practices in beef retail establishments by enhancing meat safety to reduce public health risks. **Methods:** The observational checklist evaluated parameters including the availability of potable water for hand washing, use of aprons, use of head covers, and protective screening to prevent contamination from insects. The questionnaire assessed retailers' knowledge and practices regarding meat hygiene. Responses were analysed using descriptive statistics, cross-tabulations, and binary logistic regression to examine associations between predictor variables (age, years of experience) and outcome variables (e.g., hand washing). **Results:** The majority of retail meat sellers in Benin City (76.9%) were female, whereas those in Auchi and Ekpoma were exclusively male (13.5% and 9.6%, respectively). Hand washing prior to meat handling was reported by 98.1% of participants. No significant associations were observed between age or years of experience and hand-washing practices; years of experience was a non-significant negative predictor of hand washing (OR 0.700; 95% CI 1.109 – 4.487; p = 0.706). Aggregate hygiene risk scores for all outlets were classified as low. **Conclusion:** Although overall hygiene risk scores were low, survey findings revealed critical gaps in personal hygiene and infrastructure that could compromise food safety. Interventions by Local Government Authorities, such as the provision of point-of-use water stations and subsidized screening kits to protect meat from insect contamination, are recommended to strengthen retail hygiene practices.

Keywords: retail meat; food safety; hygiene; microbial contamination risk; foodborne diseases; SDG 3; SDG 12; reduced food waste; West Africa.

INTRODUCTION

Retail beef sales represent a critical stage in the beef value chain in Nigeria, serving as the primary interface between meat production systems and final consumers. Across both urban and rural markets, retail meat sellers play a central role in ensuring the availability of beef cuts to a rapidly growing population. However, the conditions under which beef is handled, displayed, and sold at the retail level remain a major determinant of meat quality and food safety outcomes.

Inadequate hygiene practices, limited access to cold chain infrastructure, and weak regulatory enforcement at the retail stage significantly increase the risk of microbial contamination and foodborne diseases. These challenges have direct implications for SDG 3 (Good Health and Well-being), as unsafe beef products contribute to the burden of foodborne illnesses, disproportionately affecting vulnerable populations such as children, pregnant women, and low-income households. Improving food safety practices in retail beef markets is therefore essential to reducing preventable health risks and strengthening public health outcomes.

At the same time, retail beef handling practices are closely linked to SDG 12 (Responsible Consumption and Production). Inefficient storage, spoilage, and inadequate waste management at the retail level contribute to avoidable meat losses, undermining the sustainability of the beef value chain. Promoting compliance with food safety standards, encouraging responsible retail practices, and improving traceability and hygiene not only enhance consumer protection but also support more efficient resource use and reduced food waste. Strengthening the retail segment of the beef value chain, thus represents a key entry point for aligning food safety improvements with broader goals of sustainable production, responsible consumption, and resilient food systems in Nigeria.

In many Nigerian urban markets, beef cuts are commonly displayed at ambient temperatures on open surfaces within market stalls or rented sheds. These retail environments are frequently characterized by infrastructural limitations, including irregular electricity supply, limited access to potable water, and inadequate waste disposal systems. Such constraints can compromise basic hygienic practices and increase the risk of microbial contamination of raw beef prior to purchase. Given the highly perishable nature of fresh beef, even short-term exposure to suboptimal sanitary conditions at the point of sale may adversely affect product safety and shelf life (Ntanga et al., 2014; Christiana Cudjoe et al., 2022; Manyi-Loh et al., 2023).

Consumer perception of beef quality is strongly influenced by visual attributes such as colour and surface appearance, which are often used as proxies for freshness at the retail stage (O'Grady et al., 2000; Liu et al., 2022; Mao et al., 2024). Consequently, retailers tend to prioritize product display practices that enhance visual appeal, sometimes at the expense of appropriate temperature control and hygienic handling. Prolonged display durations under ambient conditions may therefore exacerbate hygiene-related risks (Rani et al., 2017),

particularly in settings where protective infrastructure such as chilled display units and insect-proof enclosures is lacking.

Although beef is typically subjected to thorough cooking prior to consumption in Nigeria – a practice that can substantially reduce microbial loads – the safety of cooked meat remains indirectly dependent on the hygienic status of raw meat at the point of purchase. Poor sanitary practices during retail handling may increase the likelihood of cross-contamination (Wang et al., 2022; Vatin et al., 2023; Garcia et al., 2025), elevate initial microbial loads, and pose risks to consumers through improper handling during transportation and preparation at the household level. Thus, evaluating hygiene practices at the retail stage remains essential, irrespective of downstream cooking behaviours.

Despite the recognized importance of retail hygiene in ensuring food safety, empirical data on compliance with core hygiene principles among retail beef sellers in southern Nigeria remain limited. Existing studies have often focused either on abattoir-level practices or on microbiological assessments of meat products, with comparatively fewer investigations integrating seller knowledge, self-reported practices, and on-site observational assessments at the retail level. In particular, there is a paucity of survey-based studies that systematically evaluate hygiene-related risk factors within urban retail beef outlets under real market conditions. This observation would necessitate the current integrated assessment in Edo State markets to ascertain critical gaps and inform targeted interventions.

Against this backdrop, the present study aimed to assess compliance with five core hygiene principles among retail beef outlets in selected urban markets of Edo State, Nigeria. Using a structured questionnaire administered to retail meat sellers alongside an observational hygiene checklist, the study sought to (i) evaluate prevailing sanitary conditions at the point of sale and (ii) assess the level of knowledge of retailers regarding hygienic meat handling practices. By identifying critical gaps in personal hygiene and infrastructural provisions, this study seeks to provide evidence-based insights to inform targeted interventions and organizational actions aimed at improving hygiene management practices in beef retail establishments by enhancing meat safety to reduce public health risks.

MATERIALS AND METHODS

Study areas

The study was conducted in three urban municipalities of Edo State, southern Nigeria: Benin City, Ekpoma, and Auchi (Figure 1). These municipalities represent the principal urban centres of the state's three geopolitical zones – Edo South, Edo Central, and Edo North – and are among the most densely populated areas within their respective zones (Magnus & Eseigbe, 2012).

A total of 35 municipal markets across the three municipalities were visited during a two-month field survey (August – September 2023) (Figure 2, 3). Seven markets were excluded due to the absence of retail beef outlets, resulting in a final sample of 28 markets. Within each market, retail sections where beef sellers were domiciled were inspected, and a systematic sampling approach was employed following Okike et al. (2011), selecting every available beef shop positioned third in each row of outlets.

Across the 28 markets, 221 retail meat sellers were approached, of whom 104 consented to participate in both the questionnaire survey and the observational hygiene assessment.

Questionnaire administration

A structured questionnaire, adapted from Okike et al. (2011), Ntanga (2013), was used to collect data on sociodemographic characteristics, educational background, and knowledge, attitudes, and practices related to meat hygiene. The questionnaire also included items addressing specific sanitary conditions and potential risk factors for microbial contamination at the retail outlets.

The questionnaire was pretested informally, following the method described by Nanda et al. (2013), to identify ambiguities and improve clarity. Open-ended questions were revised to include relevant closed-ended options where appropriate, and additional explanations were provided in Pidgin English to ensure comprehension.

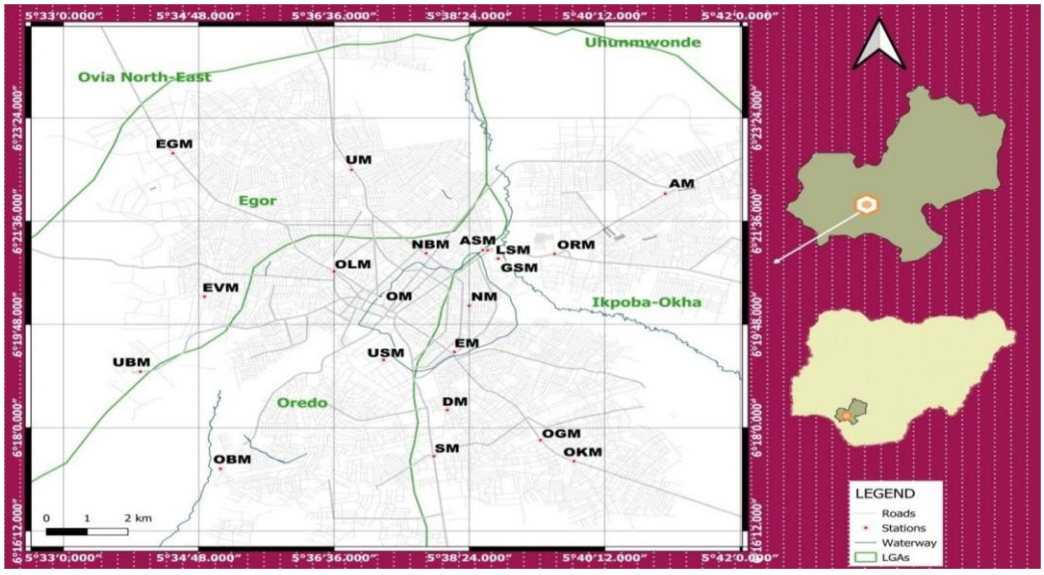

Figure 1. Locational map indicating the geographical position of the markets visited in Benin city: OBM – Ogba market; SM – Santana market; OKM – Okha market; OGM – Omoregie market; DM – Dumez market; USM – Upper St Saviour market; EM – Ekiosa market; OM – Oba market; NM – New market; OLM – Oliha market; GSM – Government abattoir meat market; LSM – Lawal & Sons abattoir meat market; ASM – Afro abattoir meat market; NBM – New Benin market; ORM – Oregbeni market; AM – Aduwawa market; EVM – Evuotobu market; UM – Uselu market; EGM – Egor market; UBM – Ugbiyokho market

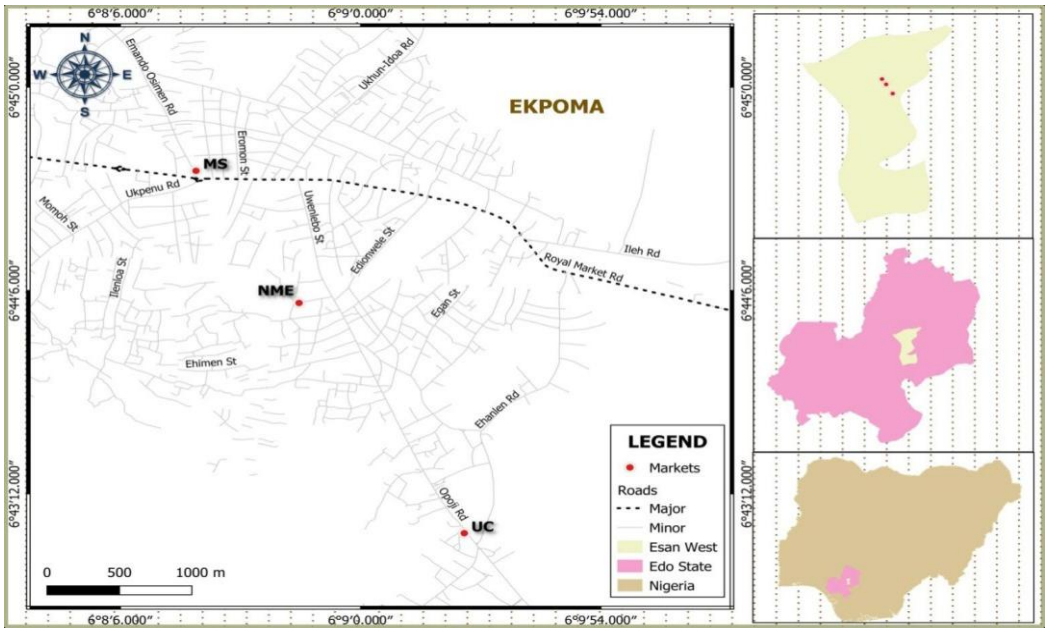

Figure 2. Locational map indicating the geographical position of the markets visited in Ekpoma – MS – Market Square; NME – New market Ekpoma; UC – Uhiele cattle market

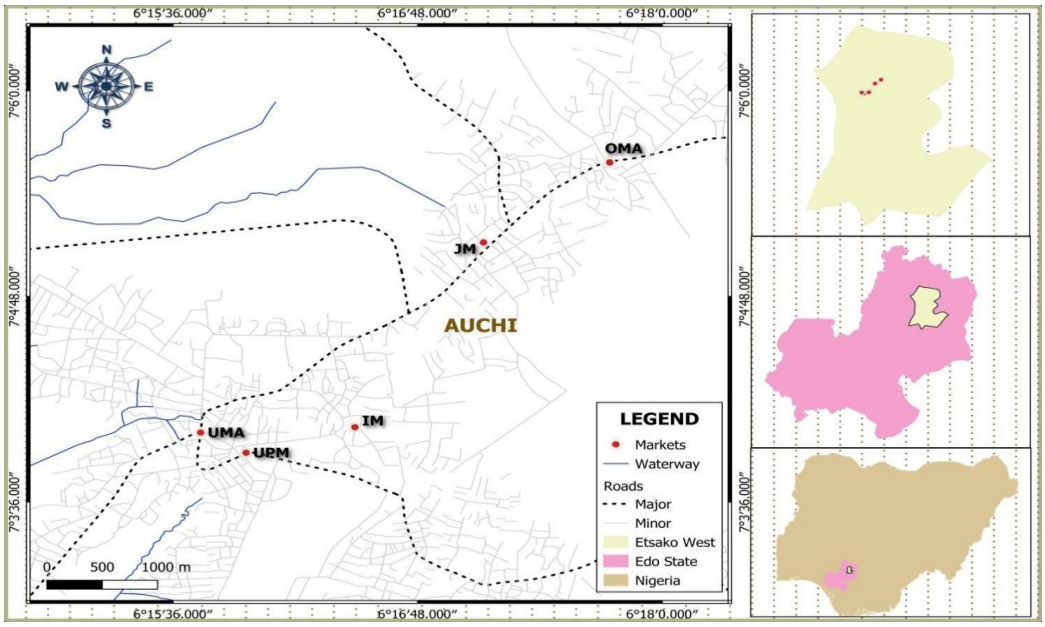

Figure 3. Locational map indicating the geographical position of the markets visited at Auchi: UPM – Up market; IM – Igbe market; OMA – Okuoto market; JM – Jattu market; UMA – Uhiele market Auchi

Assessment of hygiene conditions

An observational hygiene checklist was used to evaluate the sanitary conditions of each participating retail beef outlet. The checklist, adapted from Okike et al. (2011) included seven key parameters:

1. Availability of potable water for hand washing;
2. Use of aprons;
3. Use of head covers;
4. Use of nets or screens to protect displayed meat from insects;
5. Availability of clean hand towels for hand drying;
6. Meat transportation practices;
7. Overall display hygiene.

Responses were scored as follows: "Yes" = 1, indicating compliance, and "No" = 3, indicating non-compliance. Aggregate hygiene risk scores were calculated for each outlet, with risk interpretation as: Low risk – 25 – 30 points; Moderate – 36 – 42; High – 43 – 60; Very high – 61 – 85.

Data analysis

Questionnaire and observational data were entered into Microsoft Excel 2015 and analysed using SPSS version 21.0. Descriptive statistics (frequencies and percentages) were computed, and associations between predictor variables (age, years of experience) and outcome variables (hand washing, apron use) were assessed using cross-tabulations and two-way χ-square tests. Binary logistic regression was performed to determine the predictive effects of age and experience on hygiene-related practices. Statistical significance was set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Socio-demographic and occupational characteristics of retail meat sellers

The percentage retrieval of completed survey forms was less than half (47%) for the approached participants. This trend could be indicative of the general mistrust or suspicion, harboured by some of the participants who initially gave their full consent to the first author, even as the first author repeatedly reassured each of willing respondents, of the pure research purpose of the survey. It is very difficult to trace or explain the reason for this mistrust or suspicion of some of the meat sellers to individuals working for the different Government tiers such as the Federal Government (in the case of the first author) but this is a likely reason why majority of the collected survey forms were deliberately not returned back to the first author during the field survey.

The socio-demographic profile of the 104 retail meat sellers interviewed is presented in Table 1. Females constituted the majority (72.1%), whereas males accounted for 27.9%. Notably, all participants from Benin City (76.9%) were female, while all respondents from Auchi (13.5%) and Ekpoma (9.6%) were male. This gender pattern likely reflects socio-cultural perceptions in Benin City, where meat retail is viewed as a predominantly feminine activity, a perception absent in Auchi and Ekpoma.

The exclusive participation of females in retail meat sales in Benin City may be attributed to prevailing socio-cultural norms within the municipality. According to respondents' perceptions, the retail sale of meat – particularly beef – is commonly regarded as a feminine occupation. In contrast, this perception was not reported by respondents in Ekpoma and Auchi, where no gender-based occupational attribution was identified.

The predominance of female meat sellers observed in the present study contrasts with findings reported by Okike et al. (2011), who documented a male-dominated retail meat sector in Kaduna, Ibadan, Enugu, and Abuja. Similarly, Al Banna et al. (2021) reported an exclusively male workforce (100%) among retail meat sellers surveyed in butcher shops across several locations in Bangladesh. These discrepancies highlight the influence of regional and cultural contexts on gender participation in the retail meat trade.

Most respondents (74.0%) completed secondary education, while 11.5% had only primary education, 7.7% had post-secondary qualifications, and 3.8% held tertiary degrees. Age distribution revealed that 45.2% were 40 – 60 years old, 29.8% were 31 – 40 years, 18.3% were 18 – 30 years, and 6.7% were over 60 years. The majority of respondents (31.7% each) had 5 – 10 or 11 – 20 years of experience in meat retail, while 22.1% had more than 20 years, indicating a workforce dominated by middle-aged, moderately experienced sellers.

In terms of occupational experience, 14.4% of the respondents had less than 1 – 4 years of experience in retail meat selling. Equal proportions (31.7% each) reported having 5 – 10 years and 11 – 20 years of experience, while 22.1% had been engaged in the trade for more than 20 years. This distribution differs from the findings of Ntanga (2013), who reported that a higher proportion (37.5%) of retail meat sellers in Morogoro Municipality, Tanzania, had accumulated only 1 – 4 years of experience, suggesting possible differences in workforce stability and entry dynamics across study locations.

Table 1. Demographic and occupational characteristics of retail meat sellers (n = 104)

Characteristic		Frequency	Percentage, %
Age group in years	18 – 30 years	19	18.3
	31 – 40 years	31	29.8
	40 – 60 years	47	45.2
	above 60 years	7	6.7
Municipality of residence	Benin City	80	76.9
	Ekpoma	10	9.6
	Auchi	14	13.5
Gender	Male	29	27.9
	Female	75	72.1
Educational level	Informal Education	3	2.9
	Primary Education	12	11.5
	Secondary Education	77	74.0
	Post-secondary education (University Diploma, Diploma certificate; OND, HND and NCE)	8	7.7
	Tertiary Education (University degree)	4	3.8
Time period, the seller has been engaged in retail meat sales	less than 1 – 4 years	15	14.4
	5 – 10 years	33	31.7
	11 – 20 years	33	31.7
	above 20 years	23	22.1

Hygiene practices and sanitary conditions of retail meat sellers

The hygiene practices and sanitary conditions of the retail meat sellers are presented in Table 2. All respondents (100%) reported the absence of hand-washing sinks either within their shops or in the immediate vicinity of the market premises.

Despite the lack of designated hand-washing facilities, the majority of participants (98.1%) indicated that they washed their hands before handling meat, while 1.9% reported that they did not engage in hand washing prior to meat handling. Among respondents who practiced hand washing, 70.2% reported the use of soap, whereas 29.8% washed their hands with water only.

Hand washing represents a critical component of personal hygiene, particularly in situations where sterile hand gloves are not used, as was observed among all respondents in this study. In such contexts, effective hand hygiene is essential for minimizing microbial cross-contamination of meat by resident skin microflora, which are typically present in higher loads on unwashed hands. The failure of some respondents to wash their hands prior to meat handling therefore constitutes a significant lapse in hygienic practice. Notably, all respondents were observed to handle naira currency notes during sales transactions and subsequently use the same hands to touch and display meat products. Currency notes have been reported to harbour diverse microbial contaminants, including *Staphylococcus spp.* and *Escherichia coli* (Ofoedu et al., 2021). Furthermore, higher microbial loads have been associated with higher-denomination notes (₦500 and ₦100) compared with lower-denomination notes (₦50 and ₦20) (₦ – Nigerian Naira, at the time of the study). Similar risks of cross-contamination arising from the handling of non-sterile currency during meat sales have been documented among retail meat sellers in Mekelle City and Bishoftu, Ethiopia (Haileselassie et al., 2013; Bersisa et al., 2019).

With respect to water sources, the majority of respondents (96.2%) relied on commercially packaged sachet water, while a small proportion (1.0%) used stored groundwater kept in plastic buckets within the shop area. The heavy dependence on sachet water can be attributed to the absence of functional pipe-borne water supplies in all surveyed markets. Respondents who utilized stored water were primarily meat sellers operating within markets located on abattoir premises, where water was routinely sourced from nearby slaughter halls. This finding contrasts with that of Okike et al. (2011), who reported that most retail meat sellers in selected Nigerian municipalities accessed water from taps and water tankers.

All respondents (100%) reported the use of wooden chopping boards for the preparation of beef cuts. Observational assessment revealed that the majority of these chopping boards (72.1%) were in fair hygienic condition, while 26.9% and 1.0% were categorized as good and poor, respectively. In addition, most respondents (87.5%) reported wearing aprons during meat sales, whereas 12.5% did not use any form of protective clothing.

The absence of hygiene-enhancing clothing among some respondents represents an undesirable practice, as the use of protective garments such as aprons can reduce both the risk of product contamination and the likelihood of work-related injuries during meat processing. The proportion of apron use observed in this study is comparable to that reported by Haileselassie et al. (2013), who found that 88.7% of retail meat sellers in Mekelle City wore aprons, while 11.3% did not. None of the respondents in the present study utilized headgear during meat sales. Among those who wore aprons, the hygienic condition was predominantly assessed as fair (59.6%), while a small proportion (1.9%) were observed to be in poor condition.

Associations between hygiene practices and occupational/demographic characteristics

The relationships between years of experience, age group, and hand-washing practices among retail meat sellers are presented in Figures 4a – 4d. Overall, no statistically significant associations were observed between years of experience and hand-washing behaviour across the different age categories.

Table 2. Hand washing practices (n = 104)

Characteristic		Frequency	Percentage, %
Availability of sink for hand washing	No	104	100.0
Hand washing prior to touching meat	Yes	102	98.1
	No	2	1.9
Washing of hands with soap prior to touching meat	Yes	73	70.2
	No	31	29.8
Source of water	Water stored in bucket	4	3.8
	Sachet water	100	96.2
Usage of wood chopping block for cutting meat	Yes	104	100.0
Hygienic condition of wood chopping block used for cutting meat	Good	28	26.9
	Fair	75	72.1
	Poor	1	1.0
Usage of apron/white coat while selling meat	Yes	91	87.5
	No	13	12.5
Hygienic condition of apron/white coat and or head cover	Good	27	26.0
	Fair	62	59.6
	Poor	2	1.9
	Not applicable	13	12.5

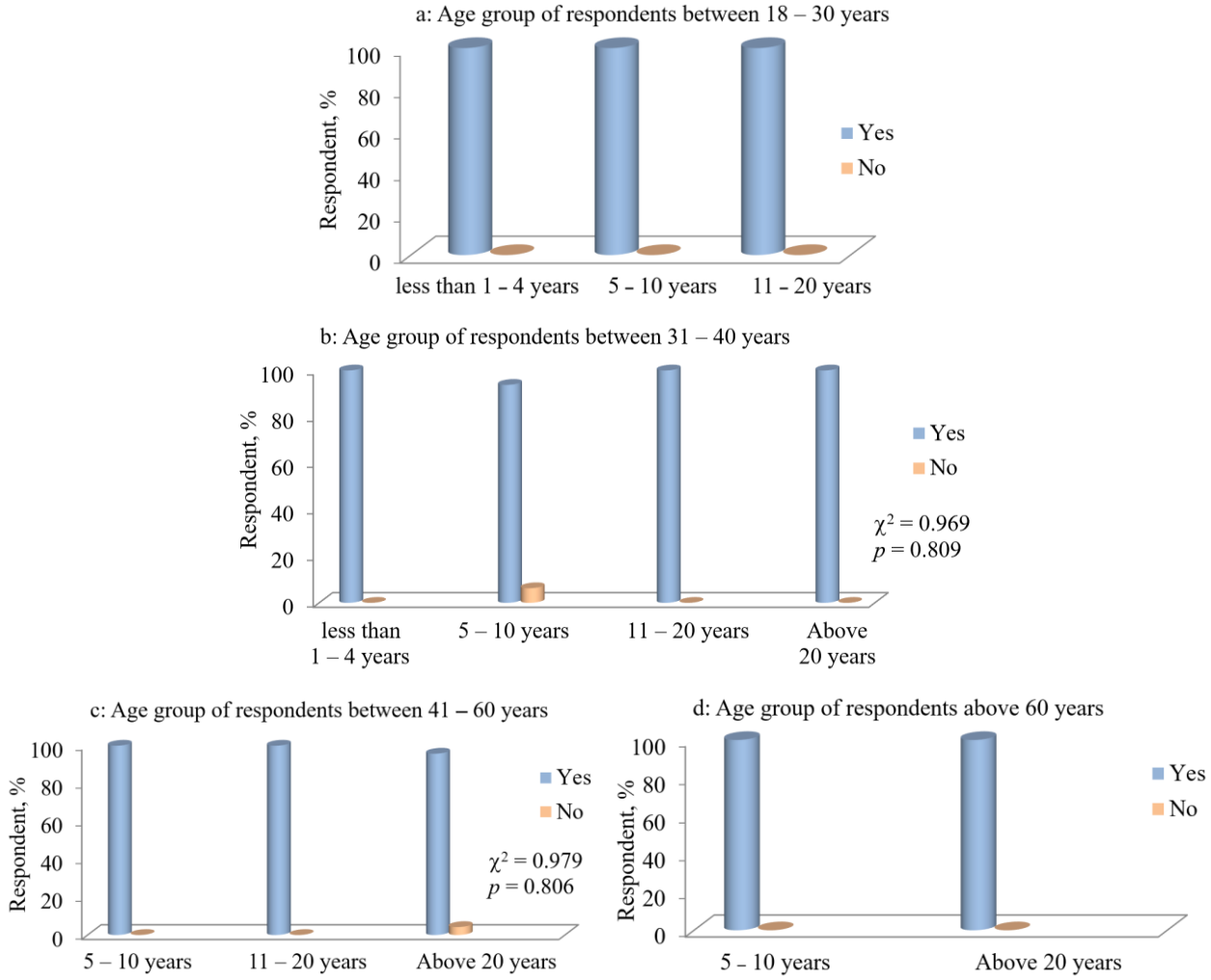

Figure 4. Relationship between hygiene practices and age groups of meat sellers (hand washing before handling meat)

For respondents aged 18 – 30 years, the two-way chi-square test did not yield a statistically interpretable association between years of experience and hand-washing practices (Figure 4a). Similarly, among participants aged 31 – 40 years, the association between years of experience and hand washing was not significant (χ^2 = 0.969, p = 0.809) (Figure 4b). No significant associations were observed for respondents aged 41 – 60 years (χ^2 = 0.979, p = 0.806) (Figure 4c), nor for those older than 60 years, for whom the chi-square analysis also failed to demonstrate a statistically meaningful relationship (Figure 4d).

Despite the lack of statistical significance, a consistent descriptive trend was observed across all age groups. Participants with fewer years of experience (<1 – 4 years or 5 – 10 years) universally reported washing their hands prior to touching displayed meat cuts (Figures 4a – 4d). In contrast, a lower proportion of hand washing was evident among respondents aged 41 – 60 years with the greatest length of experience (Figure 4c). This pattern suggests that prolonged occupational exposure may be associated with reduced adherence to recommended hand-washing practices, although this association did not reach statistical significance.

Figures 4a – 4d. Distribution of hand-washing practices among meat sellers stratified by age group and years of experience.

Association between apron usage, age, and years of experience

The association between years of experience, age group, and the use of protective clothing (aprons or white coats) is illustrated in Figures 5a – 5d. Across all age categories, no statistically significant associations were detected between years of experience and apron usage.

Among respondents aged 18 – 30 years, the relationship between years of experience and the choice to wear or not wear an apron was not significant (χ^2 = 1.380, p = 0.502) (Figure 5a). Similar nonsignificant results were observed for participants aged 31 – 40 years (χ^2 = 0.227, p = 0.973) (Figure 5b), 41 – 60 years (χ^2 = 1.980, p = 0.577) (Figure 5c), and those above 60 years of age (χ^2 = 0.194, p = 0.659) (Figure 5d).

Notwithstanding the absence of statistically significant associations, descriptive analysis revealed that all respondents with the longest duration of experience (11 – 20 years or more than 20 years) within the younger age groups (18 – 30 and 31 – 40 years) consistently wore aprons during meat sales (Figures 5a, 5b). This observation suggests that increased experience among younger sellers may be associated with a greater appreciation of the importance of protective clothing during meat handling.

Figures 5a – 5d. Distribution of apron usage among meat sellers stratified by age group and years of experience.

Independent predictors of hand washing and apron usage

Independent predictors of hand-washing practices and apron usage were assessed using logistic regression analysis, with results expressed as odds ratios (ORs). The independent variables included age group and years of experience in retail meat selling.

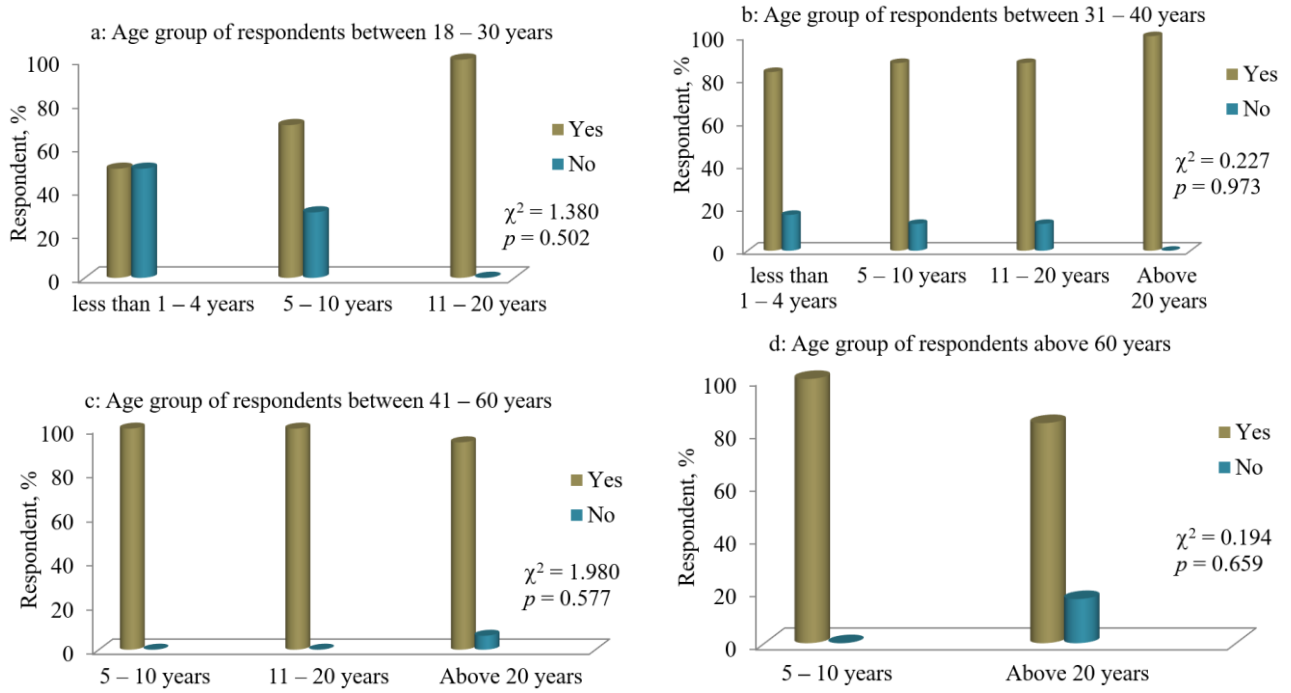

Figure 5. Relationship between apron use and respondents' age (wearing an apron while selling meat)

Age was positively associated with hand-washing behaviour, indicating an increased likelihood of engaging in hand washing across age categories (OR = 1.507; 95% CI: 1.171 – 13.296; p = 0.712). This finding suggests a one-fold increase in the probability of hand washing prior to handling beef cuts with increasing age (Table 3). However, years of experience did not increase the likelihood of hand washing. On the contrary, experience was associated with a reduced probability of hand washing (OR = 0.700; 95% CI: 1.109 – 4.487; p = 0.706), as reflected by an odds ratio below unity.

With respect to apron usage, neither age (OR = 0.358; 95% CI: 0.133 – 0.966; p = 0.142) nor years of experience (OR = 0.822; 95% CI: 0.338 – 1.997; p = 0.664) significantly increased the probability of wearing protective clothing during meat sales.

These findings suggest that, as retail meat sellers gain experience, they may become less attentive to routine hygiene practices such as hand washing prior to meat handling. Qualitative responses obtained during the survey further supported this interpretation. Several respondents expressed the view that hand washing was unnecessary because beef cuts would ultimately be cooked by consumers. Others attributed their noncompliance to structural limitations, particularly the lack of access to pipe-borne water within market premises, a constraint that was consistently observed across all surveyed markets.

Table 3. Logistic regression analysis of hand washing and apron usage determinants for meat sellers

Factor	Independent variables[c]			Independent variables[d]		
	Odds ratio (OR)	95% Cl	p-value	Odds ratio (OR)	95% Cl	p-value
Age of participant	1.507	0.171 – 13.296	0.712	0.358	0.133 – 0.966	0.142
Time period, the respondent has been engaged in meat sales	0.700	0.109 – 4.487	0.706	0.822	0.338 – 1.997	0.664

Note: "c" – this indicates a dependence on the variable: hand washing; "d" – this indicates a dependence on the variable: wearing of an apron

Patronized beef sources and sanitary conditions of vehicles used for meat transportation to different markets

As presented in Table 4, 16.3%, 11.5% and 10.6% of the respondents sourced their beef cuts from the Edo State Government, Afro, and Lawal and Sons abattoirs, respectively. This distribution was expected, given that substantial numbers of cattle are routinely slaughtered at these facilities. In contrast, only a small proportion of respondents (2.9% and 1.9%) obtained beef from slaughter tables such as Sarikin and Eyaen, both located near the Aduwawa market, as well as Iyanomo and Upper Uwa slaughter tables, which are situated in close proximity to the Santana, Okha, and Upper St. Saviour markets.

Proximity of the meat processing facility (abattoir or slaughter table) to the market emerged as the principal determinant influencing the choice of beef source among meat sellers. This factor also influenced the time at which vendors commenced daily sales. However, proximity was less relevant for retail meat sellers operating within markets located inside abattoir premises, such as those at the Afro abattoir. Additional factors affecting the choice of meat source included established personal relationships between wholesale butchers and retail sellers, as well as the overall accessibility of the processing facilities.

With respect to transportation hygiene, the majority of respondents (76.0%) rated the sanitary condition of vehicles used for transporting beef as fair (Table 4). Notably, 17.3% of the respondents did not rely on vehicular transportation, as they operated within market sheds located inside abattoir premises. These respondents typically used wheelbarrows to convey beef cuts from slaughter halls to their shops.

Table 4. Disease incidences (2014 – 2023)

Characteristic	Abattoir or slaughter table	Frequency	Percentage, %
Source of purchased meat sold by the meat handler	Government Abattoir, Benin City	17	16.3
	Bob Izua Abattoir	7	6.7
	Afro Abattoir	12	11.5
	Madam Sarah abattoir	1	1.0
	Holy Ghost abattoir	9	8.7
	Lawal and Sons	11	10.6
	Osaigbovo and Sons	1	1.0
	Obazee slaughter-house	7	6.7
	Iyanomo slaughter table	2	1.9
	Upper Uwa slaughter table	2	1.9
	Mama Queen Abattoir	1	1.0
	Eyaen slaughter table	2	1.9
	Sarikin slaughter table	3	2.9
	Goody Goody Abattoir	1	1.0
	Central Abattoir Ekpoma	6	5.8
	Irrua cattle market and slaughter table	1	1.0
	Uhiele slaughter table Ekpoma	2	1.9
	Ewu slaughter table	1	1.0
	Auchi slaughter-house	8	7.7
	Iyuku slaughter-house	4	3.8
	Uhiele slaughter table, Jattu	2	1.9
	Holy Ghost abattoir B	4	3.8
Assessment of the hygienic condition of vehicle used for meat transportation	Good	7	6.7
	Fair	79	76.0
	Not applicable	18	17.3
Type of meat sold by the meat handler	Cattle	104	100.0
Are the flies present inside of the shop?	Yes	104	100.0
The utilization of a routine method or tool for controlling the flies present within the shop/stand by the meat seller	Yes	104	100.0

All respondents (100%) reported that they both purchased and sold beef cuts at their respective retail outlets. House flies were reported to be commonly present in all shops, and respondents indicated that routine measures were employed to prevent flies from accessing displayed meat. However, none of the respondents used protective net screens to cover the meat products (Table 4). The methods adopted for controlling fly activity included the use of knives (53.8%), swatting sticks (26.0%), hand movements (7.7%), and brooming (5.8%), as shown in Table 5.

Regarding meat storage practices, 58.7% of respondents reported using domestic refrigeration facilities, such as refrigerators or deep freezers, to preserve unsold beef at the end of the trading day, while 32.7% stored leftover meat in nearby commercial cold rooms (Table 5). A substantial majority (92.3%) stated that they did not mix leftover meat from the previous day with freshly purchased beef for the purpose of presenting it as fresh. Furthermore, all respondents indicated that stored beef was sold on weekdays and Sundays, when cattle slaughtering at licensed abattoirs within the study area was prohibited.

All participants (100%) reported that they had not received customer complaints directly related to the condition or appearance of displayed beef. Instead, consumer complaints were limited to issues concerning the size of meat portions relative to the negotiated selling price. This finding is consistent with the observations of Okike et al. (2011), who reported similar trends among meat sellers in several Nigerian cities, including Kaduna, Abuja, and Ibadan.

Hygiene ratings of the visited retail meat sales points

As indicated in Table 6, all the assessed retail meat outlets recorded low aggregate hygiene risk scores. This outcome reflects the presence of multiple unhygienic practices observed consistently across the surveyed shops. In particular, the non-use of head coverings (e.g. hair nets) by meat handlers and the absence of physical barriers, such as screens or nets, to protect displayed meat from insect contamination were common to all outlets and had a substantial negative impact on the overall hygiene ratings.

Table 5. Leftover meat storage and sales (n = 104)

Characteristic	Gadget used	Frequency	Percentage, %
Specific method or tool used to control the presence of house flies within the shop	Only hand movement	8	7.7
	Only knives	56	53.8
	Swath stick	27	26.0
	Broom	6	5.8
	Hand fan	2	1.9
	Cutlass	1	1.0
	Carton folder	2	1.9
	Both hand movement and knives	2	1.9
Storage practice utilized by the respondent with respect to left over beef at the close of daily sales	Home refrigeration	61	58.7
	Nearby cold room	34	32.7
	No meat remnant	7	6.7
	Either home refrigeration or nearby cold room depending on the meat size	2	1.9
Does the respondent engage in the mixing of fresh meat with the left-over meat from the previous day?	Yes	8	7.7
	No	96	92.3
Incidence of complaints of the condition of the displayed meat by individual customers patronizing the respondent	No	104	100.0

According to the Codex Alimentarius Code of Hygienic Practice for Meat (CAC/RCP 58-2005), food handlers involved in meat processing and retailing are required to maintain a high level of personal hygiene, including the use of appropriate protective clothing to prevent contamination from hair and other foreign matter. Similarly, the FAO/WHO General Principles of Food Hygiene (CXC 1-1969) emphasize that exposed food must be adequately protected against contamination by pests, particularly flies, which are recognized mechanical vectors of foodborne pathogens. The failure of all surveyed retail outlets to comply with these basic requirements suggests a systemic gap between recommended international hygiene standards and actual practices at the retail level.

The observed absence of insect-proofing measures is of particular concern, as house flies have been widely implicated in the transmission of enteric pathogens, including *Salmonella* spp., *Escherichia coli* and *Staphylococcus aureus*. Codex guidelines explicitly recommend the use of physical barriers, such as mesh screens, to minimize the risk of biological contamination during food display and sale. Therefore, the lack of such protective measures in the surveyed shops represents a significant public health risk and may compromise the microbiological safety of retailed beef.

The uniformly low hygiene status recorded in this study contrasts with the findings of Ntanga (2013), who reported generally poor hygienic conditions among retail meat outlets in Morogoro Municipality, Tanzania. This difference may be attributed to variations in assessment tools, enforcement of food safety regulations, levels of food safety training among meat handlers, or local regulatory oversight. Nevertheless, both studies underscore persistent challenges in achieving compliance with established hygiene standards in retail meat environments within developing-country contexts.

Overall, the findings highlight the need for strengthened regulatory enforcement, targeted hygiene training for meat sellers, and the adoption of Codex- and FAO/WHO-recommended practices at the retail level. Improving compliance with these international standards would significantly reduce contamination risks and enhance consumer protection in informal and semi-formal meat markets.

CONCLUSION

This study provides a detailed assessment of hygiene practices and sanitary conditions of retail beef outlets in Benin City, Ekpoma, and Auchi, Edo State, Nigeria. Although the aggregate hygiene risk scores of the surveyed outlets were categorized as "Low", critical gaps in personal hygiene and facility infrastructure were identified, which may compromise food safety. Notably, increased years of experience among meat sellers did not correspond with improved hygiene practices; more experienced sellers demonstrated a lower probability of performing hand-washing prior to handling meat, suggesting a potential complacency effect.

The study further identified systemic infrastructure deficiencies, including the absence of dedicated hand-washing sinks and functional pipe-borne water, resulting in a near-exclusive reliance on commercially packaged sachet water. High-risk behaviours, such as simultaneous handling of money and meat, were prevalent and represent significant vectors for microbial cross-contamination.

Table 6. Hygiene status rating of the examined retail meat sale outlets in Benin city, Ekpoma and Auchi municipalities

Market	Number of shops examined	Retail meat sales point risk score per shop	Aggregate hygiene risk score	Risk status
Benin City[a]				
Ogba market	2	11	22	Low
Santana market	3	11	22	Low
Okha market	4	11	22	Low
Omoregie market	4	11	22	Low
Dumez market	5	11	22	Low
Upper St Saviour market	3	11	22	Low
Ekiosa market	5	11	22	Low
Oba market	5	11	22	Low
New market, Benin City	4	11	22	Low
Oliha market	5	11	22	Low
Edo State Govt. abattoir meat market	4	11	22	Low
Lawal and Sons abattoir meat market	3	11	22	Low
Afro abattoir meat market	5	11	22	Low
New Benin market	4	11	22	Low
Oregbeni market	5	11	22	Low
Aduwawa market	3	17	34	Low
Evuotobu market	4	11	22	Low
Uselu market	4	11	22	Low
Egor market	4	11	22	Low
Ugbiyokho market	4	11	22	Low
Ekpoma[a]				
Market Square	4	11	22	Low
New market	4	11	22	Low
Uhiele cattle market	2	13	26	Low
Auchi[a]				
Up market	2	15	30	Low
Igbe market	3	11	22	Low
Okuoto market	3	11	22	Low
Jattu market	3	13	26	Low
Uhiele market, Auchi	3	11	22	Low

Note: "a" stands for urban areas where the markets are located

These findings underscore the need for targeted interventions. Local Government Authorities (LGAs) should prioritize the provision of "Point-of-Use" water stations within meat sections and subsidized protective "Screening Kits" to reduce mechanical transmission of pathogens by flies. Additionally, retail meat sellers should be sensitized to adopt and maintain hygiene-enhancing practices, including the routine use of protective apparel (e.g., aprons, hair nets, gloves), regular hand-washing before meat handling, and the use of screen nets to safeguard displayed meat. These interventions can be implemented and monitored by environmental health officers in collaboration with non-governmental and community-based organizations to ensure sustained improvements in food safety at retail points.

Acknowledgement

The authors wish to express their sincere appreciation to Madam E. Ihaza and Mrs. O. V. Eghomwanre for their invaluable assistance and dedicated support during the field research. Their cooperation and commitment greatly contributed to the successful completion of the study. The authors are also deeply grateful to Dr. A. F. Eghomwanre for his careful proofreading of the final version of the manuscript and for his constructive comments, which significantly improved its clarity and quality.

Author's statements

Contributions

Conceptualization: all authors; Data curation: all authors; Formal and statistical analysis: N.O.O.; Investigation: N.O.O.; Methodology: all authors; Resources: all authors; Visualization: all authors; Validation: all authors; Writing – original draft: N.O.O.; Writing – review & editing: all authors.

Declaration of conflicting interest

The authors declare no competing interests.

Financial interests

The authors declare they have no financial interests.

Funding

Not applicable.

Data availability statement

The data used in the study are available upon request from the corresponding author.

AI Disclosure

The authors declare that generative AI was not used to assist in writing this manuscript.

Ethical approval declarations

The study was conducted in accordance with the ethical standards of the Institutional Research Committee. Informed consent was obtained from all participants.

Additional information

Publisher's note

Publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

REFERENCES

Al Banna, M. H., Disu, T. R., Kundu, S., Ahinkorah, B. O., Brazendale, K., Seidu, A. A., ... & Khan, M. S. I. (2021). Factors associated with food safety knowledge and practices among meat handlers in Bangladesh: a cross-sectional study. *Environmental Health and Preventive Medicine*, 26(1), 84. https://doi.org/10.1186/s12199-021-01004-5.

Bersisa, A., Tulu, D., & Negera, C. (2019). Investigation of bacteriological quality of meat from abattoir and butcher shops in Bishoftu, Central Ethiopia. *International Journal of Microbiology*, 2019(1), 6416803. https://doi.org/10.1155/2019/6416803.

Christiana Cudjoe, D., Balali, G. I., Titus, O. O., Osafo, R., & Taufiq, M. (2022). Food safety in sub-Sahara Africa, an insight into Ghana and Nigeria. *Environmental Health Insights*, 16, 1–18. https://doi.org/10.1177/1178630222114248.

Garcia, L. N. H., da Cunha Dias, S., Costa, L. R. M., de Melo Tavares, R., da Silva Rodrigues, R., Tiba-Casas, M. R., ... & Yamatogi, R. S. (2025). Cross-contamination and antimicrobial resistance in diarrheagenic Escherichia coli and Salmonella spp. from a mixed bovine and swine slaughterhouse. *Food Control*, 176, 111406. https://doi.org/10.1016/j.foodcont.2025.111406.

Haileselassie, M., Taddele, H., Adhana, K., & Kalayou, S. (2013). Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle City, Ethiopia. *Asian Pacific Journal of Tropical Biomedicine*, 3(5), 407–412. https://doi.org/10.1016/S2221-1691(13)60085-4.

Liu, J., Li, K., Chen, Y., Ding, H., Wu, H., Gao, Y., ... & Hu, Y. (2022). Active and smart biomass film containing cinnamon oil and curcumin for meat preservation and freshness indicator. Food Hydrocolloids, 133, 107979. https://doi.org/10.1016/j.foodhyd.2022.107979.

Magnus, O. O., & Eseigbe, J. O. (2012). Categorization of urban centres in Edo State, Nigeria. *IOSR Journal of Business and Management (IOSRJBM)*, 3(6), 19–25.

Manyi-Loh, C. E., & Lues, R. (2023). A South African perspective on the microbiological and chemical quality of meat: Plausible public health implications. *Microorganisms*, 11(10), 2484. https://doi.org/10.3390/microorganisms11102484.

Mao, Y., Ma, P., Li, T., Liu, H., Zhao, X., Liu, S., ... & Hu, L. (2024). Flash heating process for efficient meat preservation. *Nature Communications*, 15(1), 3893. https://doi.org/10.1038/s41467-024-47967-1.

Nanda, T., Gupta, H., Kharub, M., & Singh, N. (2013). Diagnostics for pretesting questionnaires: a comparative analysis. *International Journal of Technology, Policy and Management*, 13(1), 67–79. https://doi.org/10.1504/IJTPM.2013.051008.

Ntanga, P. D., Mdegela, R. H., & Nonga, H. E. (2014). Assessment of beef microbial contamination at abattoir and retail meat shops in Morogoro Municipality, Tanzania. *Tanzania Veterinary Journal*, 29(2), 53–61.

Ntanga, P. D., Mdegela, R. H., & Nonga, H. E. (2014). Assessment of beef microbial contamination at abattoir and retail meat shops in Morogoro Municipality, Tanzania. *Tanzania Veterinary Journal*, 29(2), 53–61. Available: https://www.ajol.info/index.php/tvj/article/view/117815.

Ofoedu, C. E., Iwouno, J. O., Agunwah, I. M., Obodoechi, P. Z., Okpala, C. O. R., & Korzeniowska, M. (2021). Bacterial contamination of Nigerian currency notes: A comparative analysis of different denominations recovered from local food vendors. *PeerJ*, 9, e10795. https://doi.org/10.7717/peerj.10795.

O'grady, M. N., Monahan, F. J., Burke, R. M., & Allen, P. (2000). The effect of oxygen level and exogenous α-tocopherol on the oxidative stability of minced beef in modified atmosphere packs. *Meat Science*, 55(1), 39–45. https://doi.org/10.1016/S0309-1740(99)00123-0.

Okike, I., Grace, D., Mohammed, H., Dipeolu, M., Poole, J., Gachohi, J., ... & Makita, K. (2011). Assessment of risks to human health associated with meat from different value chains in Nigeria: using the example of the beef value chain. *International Livestock Research Institute (ILRI)*: Nairobi, Kenya.

Rani, Z. T., Hugo, A., Hugo, C. J., Vimiso, P., & Muchenje, V. (2017). Effect of post-slaughter handling during distribution on microbiological quality and safety of meat in the formal and informal sectors of South Africa: A review. *South African Journal of Animal Science*, 47(3), 255–267. https://doi.org/10.4314/sajas.v47i3.2.

Vatin, G., Théolier, J., Dominguez, S., & Godefroy, S. B. (2023). Fraud or cross-contamination? The case of small-scale meat processors in Quebec, Canada. *Food Control*, 150, 109763. https://doi.org/10.1016/j.foodcont.2023.109763.

Wang, R., King, D. A., & Kalchayanand, N. (2022). Evaluation of Salmonella biofilm cell transfer from common food contact surfaces to beef products. *Journal of Food Protection*, 85(4), 632–638. https://doi.org/10.4315/JFP-21-334.