



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Assessment of the sanitary quality of meat sold in Kozah(Togo)

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Volume 8, Issue 9, September 2026

Received: 15 June 2026

Accepted: 27 August 2026

Published: 15 September 2026

[doi:10.48047/AFJBS.8.9.2026.24-41](https://doi.org/10.48047/AFJBS.8.9.2026.24-41)

Abstract

Several studies have addressed food safety in school canteens and street vendors but none on meat in Togo. This study assessed the food safety knowledge, attitude and practices among butchers of Kozah through cross-sectional survey and microbiological analyses. Pork, beef, sheep, goat and donkey were the meats mostly sold. Most respondents are male and aged between 30 and 50 years. 15.12% received hygiene training, and 3.49% showed good knowledge of practices. Veterinary inspections occur before and after slaughtering. Most butchers adopt good practices when handling meat. Few of them regularly check their health status. The sanitation facilities are limited. Most of butchers wash hands after handling meat. Beef meat is colonized by total mesophilic aerobic flora, Enterobacteriaceae, fungi, and coagulase-positive *Staphylococcus aureus* at average values of 9.21 ± 2.19 , 6.35 ± 1.55 , 3.93 ± 0.70 and $5.30 \pm 0.41 \log \text{CFU/cm}^2$ respectively; which exceed the threshold values set by the Republic of Togo and the European Union for beef carcasses. The findings show that the meat samples analyzed are heavily contaminated with various microbes. KAP score is directly linked to butchers' knowledge, attitude and practice. Butchers' of Kozah poor food handling practices risk customers' health, highlighting the need for training programs centred on knowledge, attitude and practice on food safety procedures.

Keywords: Butcher, Kozah, Enterobacteriaceae, Meat, *S. aureus*.

1- Introduction

Hygienic food safety is crucial for public health, as inadequate hygiene procedures can expose consumers to infections and severe health complications(Ahad et al., 2025). Animal-based foods, such as beef, are high-risk commodities due to their high nutritional value(Mallhi et al., 2019). Meat is the most perishable food, and its sources of pathogens include unhealthy animals, personal hygiene, unsanitary food preparation, unsafe transportation, storage, processing, working conditions, and polluted water(Bersisa et al., 2019). Meat hygiene involves specific standards, codes of practice, and regulatory action to ensure meat safety for consumers. It includes production, processing, transportation, handlers, equipment, and the environment.

Numerous studies have demonstrated high levels of bacterial contamination associated with bad hygiene practices along the production chain. According to Koech et al. (2024) and Ousman et al. (2025), the microbiological quality of meat and meat products across Africa is a significant public health concern. Furthermore, the situation is worsened by poor or poorly implemented regulatory frameworks, especially in West Africa where meat consumption is increasing steadily(Sissoko et al., 2025).

In developing countries like Togo, poor food handling practices, unsanitary work environments, lack of medical checkups, poor personal hygiene, and unsafe water contribute to foodborne diseases.

Several studies have been conducted in Togo on the safety of food served in school canteens and sold on the streets(Mizéhoun-Adissoda et al., 2022), few have focused on the chicken meat(Akakpo et al., 2022) but none on safety of meat sold in butcher shops and the level of knowledge and application of hygiene rules by butchers in their shops. Food as meat safety is a critical public health issue worldwide as reported by Ashuro et al. (2023). However, there is limited information on meat safety risks in the prefecture of Kozah in Togo. This study had two objectives: to assess butchers' knowledge, attitudes, and practices regarding food safety, and to evaluate the microbiological quality of beef meat sold in the Kozah.

2- Methodology

Study design and sites: The current study was conducted among butchers of Kozah prefecture (Figure 1) in Togo. The Kozah Prefecture is located in the Kara region in northern Togo. It covers an area of 1,074 km² and has an estimated population of approximately 283,738 inhabitants in 2022. The prefecture's capital is the city of Kara. Geographically, it is bordered to the north by the prefecture of Doufelgou, to the south by the prefecture of Assoli, to the east by the prefecture of Binah, and to the west by the prefecture of Bassar. The prefecture has 15 cantons and is divided into four municipalities, namely Kozah1, Kozah2, Kozah3, and Kozah4. The municipality of Kozah1 is made up of four cantons (Lassa, Lama, Soumdina and Landa), Kozah2 of seven cantons (Bohou, Yadè, Tchitcho, Sara-Kawa, Pya, Tcharé and Kouméa), Kozah3 comprises two cantons (Awandjélo and Kpènzidè); and finally, Kozah4 comprises two cantons (Atchangbadè and Djamdè).

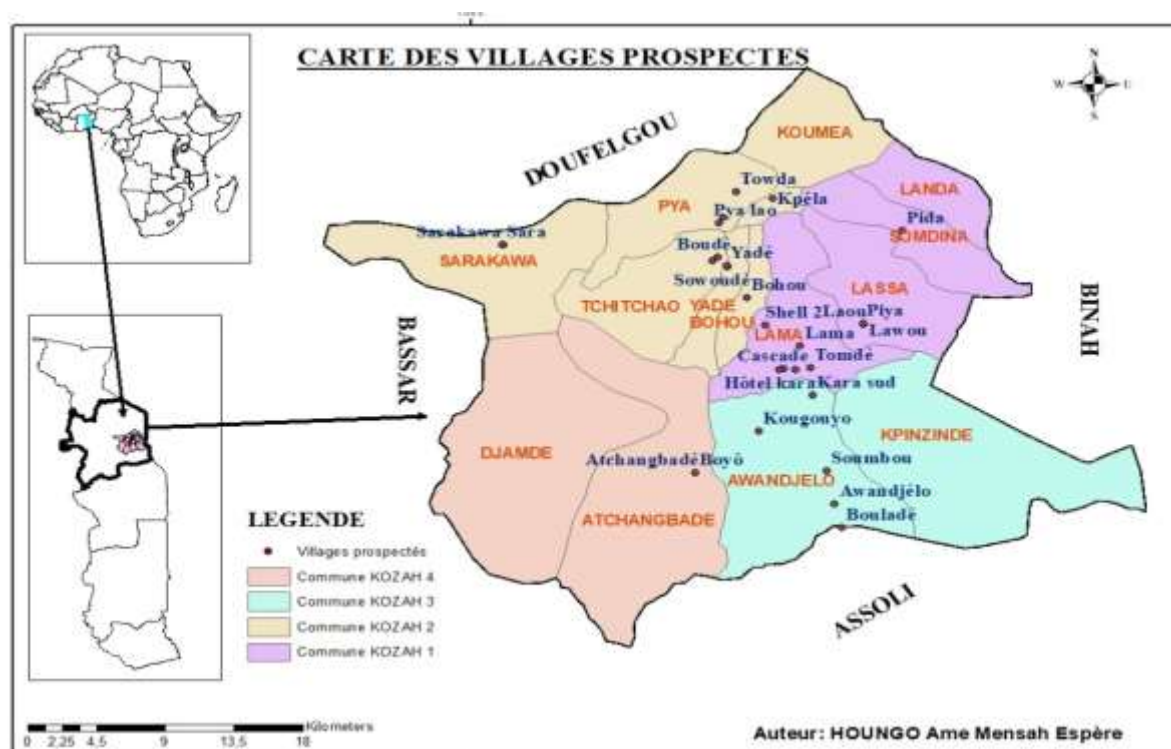


Figure 1: Sampling map

This figure shows the study area. Interviewed butchers are located in the areas marked in blue on the map.

Questionnaire preparation: The questionnaire for study was design to align with the socio-demographic characteristics and cultural contexts of people of Kozah. The administrated questionnaire included 163 questions divided into 17 sections: approval of the respondent, location, civil status of the butcher, acquisition of raw materials (animals), health status of butchers, personal hygiene of butchers, general knowledge of butchers regarding hygiene rules, application of hygiene by butchers or meat handlers in butcher shops, knowledge of butchers regarding food contamination, knowledge of food safety regulations, butcher shop and its environment, the cold chain, butchery hygiene, meat processing area, processing equipment, butchery waste management, and pest and antimicrobial control.

Piloting and data collection: A cross-sectional survey was undertaken with butchers in Kozah prefecture. Semi-structured, pretested questionnaire was used to obtain data on butchers' knowledge, attitudes, practices toward food safety and Pest and microbial control methods. A total of 86 butchers were surveyed. The surveys were delivered through face-to-face interviews with the butchers.

Inclusion criterion: Each participant was required to give their consent before the interview began.

Survey authorization: A survey authorization to collect data from butchers in Kozah was issued by the Department of Livestock and Fisheries.

Microbiological analyses: A microbiological analysis was conducted on fifteen randomly selected beef samples. Samples ($n = 15$) were analyzed for total mesophilic aerobic flora(ISO4833-1, 2014),

Enterobacteriaceae(ISO21528-2, 2004), *Staphylococcus aureus*(ISO6888-1, 2021), yeast and mould(ISO21527-2, 2008) using culture-based methods. The results were then interpreted in accordance with the microbiological standards of the Republic of Togo and the European Union to identify any critical exceedances. Each value was validated by triplicate analyses to ensure reliability.

Statistical analysis: The collected data were systematically analyzed using R (version 4.5.1) to align with the study's research objectives. The collected data was subjected to rigorous analysis, employing rigorous statistical methods to ensure the validity of the results. The study utilized descriptive analyses to investigate the demographic attributes, training, knowledge, attitudes, and practices of butchers related to food safety.

3- Results and Discussion

3.1. Socio-demographic characteristic's

The study examines the socio-demographic factors affecting butchers' operational practices, focusing on factors like sex, age, marital status, education, religion and profession. The socio-demographic profile of butchers in the Kozah are shown in Table 1. A total of 86 butchers were surveyed in 12 cantons of the Kozah prefecture which are Atchangbadè, Awandjélou, Bohou, Lama, Landa, Lassa, Pya, Sarakawa, Soumdinah, Tcharè, Tchitchao, and Yadè.

Only 4.65% of those surveyed were women, and female butchers are present in the cantons of Awandjélou, Bohou, Lama, and Lassa. These results show the predominance of men in this sector of activity as reported by Alimi et al. (2022) and Ahad et al. (2025) when studying socio-demographic characteristics of meat handlers at Nigeria and Ethiopia.

Most respondents are aged between 30 and 50 years. Findings align with ages 21-40 identified by Anachinaba et al. (2022) in Ghana. Butchers in Kozah are older than those in the Somali region of Ethiopia, according to Ahad et al. (2025), who found ages between 18 and 30 years. A significant majority of respondents are married (94.19%). Religious affiliation shows that 47.67% of respondents are Christians. Twelve point seventy-nine percent (12.79%) of butchers never attended school.

Table 1: Socio-demographic profile of butchers of Kozah

Items	Number	Percent	Mean	Range
Sex				
Female	4	4.65%	NA	
Male	82	95.35%		
Age				
[20 - 30[	8	9.30%	17.2	[30 - 40[
[30 - 40[	34	39.53%		
[40 - 50[	34	39.53%		

[50 - 60[	8	9.30%		
[60 - 70[	2	2.33%		
Marital status				
Married	81	94.19%	NA	
Single	5	5.81%		
Education				
High school	8	9.30%	NA	
Middle school	39	45.35%		
Never attended school	11	12.79%		
Primary	22	25.58%		
University	6	6.98%		
Religion				
Christian	41	47.67%	NA	
Muslim	18	20.93%		
Traditional religion	27	31.40%		
Profession				
Sheep butcher	12	13.95%	NA	
Goat butcher	12	13.95%		
Pork butcher	44	51.16%		
Donkey butcher	6	6.98%		
Beef butcher	23	26.74%		

NA: Not Applicable. The data shows gender, age, marital status, education level, religion, and type of meat sell by butchers in Kozah.

Pork (51.16%), beef (26.74%), sheep (13.95%), goat (13.95%) and donkey (6.98%) were the various type of meat sold in Kozah. These animals are imported from Kozah (Awandjélou, Bohou, Djamdè, Kara Livestock Market, Landa, Lassa, Sarakawa, Soumdinah, and Tcharé), and other localities in Togo (Gando, Kanté, Kadjala, Kéméri, Kéto, Mango, Namon, Niamtougou, Pagouda, Sanda Kagbanda, Dapaong, Srika, and Cinkansé); as well as from the Republics of Benin and Ghana.

3.2. Knowledge

To assess the level of knowledge of the butchers in Kozah, a series of questions were administered to them. The correct and incorrect answers are reported in table 2. An analysis of the correct answers shows that half of those surveyed know that meat requires special handling because it contains bacteria or germs. None of the butchers don't know how long raw meat should be left out before being stored, or the types of foodborne illnesses, and microorganisms that cause foodborne illnesses. However, 37 butchers know that it's illegal to slaughter an animal without supervision or inspection. Only 13 out of 86 butchers received Hygiene training.

Table 2 : Kozah butchers' knowledge

Knowledge questions	Correct answer	Incorrect answer
Meat requires special handling because it contains bacteria or germs.	43(50%)	43(50%)
Do you know how long raw meat should be left out before being stored?	0(0%)	86(100%)

Do you know the term “foodborne illnesses”?	2(2.33%)	84(97.67%)
Do you know the symptoms of foodborne illnesses?	2(2.33%)	84(97.67%)
Do you know the types of foodborne illnesses?	0(0%)	86(100%)
Do you know any microorganisms that cause foodborne illnesses?	0(0%)	86(100%)
Do you know the food laws of Togo?	6(6.98%)	80(93.02%)
Have you seen anyone prosecuted for violating food laws in Togo?	16(18.60%)	70(81.40%)
Is slaughtering an animal in unsanitary conditions a crime?	26(30.23%)	60(69.77%)
Is it illegal to slaughter an animal without supervision or inspection?	37(43.02%)	49(56.98%)
Did you know that it is illegal to transport food in a manner that does not comply with standards?	15(17.44%)	71(82.56%)
Hygiene training	13(15.12%)	73(84.88%)
Average knowledge estimate	4.58 ± 1.75	

The data contained in this table provides a general overview of butchers' level of knowledge regarding food hygiene and safety.

Butchers' knowledge of food safety is essential to ensure meat hygiene, but our findings show that only 15.12% butchers had received hygiene training (mean score: 4.58 ± 1.75). This very low percentage is worrying in terms of knowledge on meat hygiene. Respectively 3.49% and 1.16% of butchers show a good and excellent knowledge (Figure 2). The results show that meat handlers in the Kozah have unsatisfactory knowledge on meat safety and hygiene including proper meat handling, zoonotic disease transmission, and the importance of slaughterhouse inspections by vets. Several studies on butchers' knowledge of hygiene have revealed significant variability in their understanding of food safety principles. Otupiri et al. (2000) and Abera et al. (2025) have reported an insufficient training among butcher's and butcher shop workers in Kumasi and Ethiopia which limited their understanding of zoonotic disease and their prevention. Butchers in Togo, particularly those in Kozah, undoubtedly face similar challenges, mainly due to the lack of food safety training programmes resulting from insufficient funding for food safety training programmes. Tailored actions, carried out by local butchers' associations or public health initiatives, or even by grassroots development committees with members in neighbourhoods, could fill these gaps.

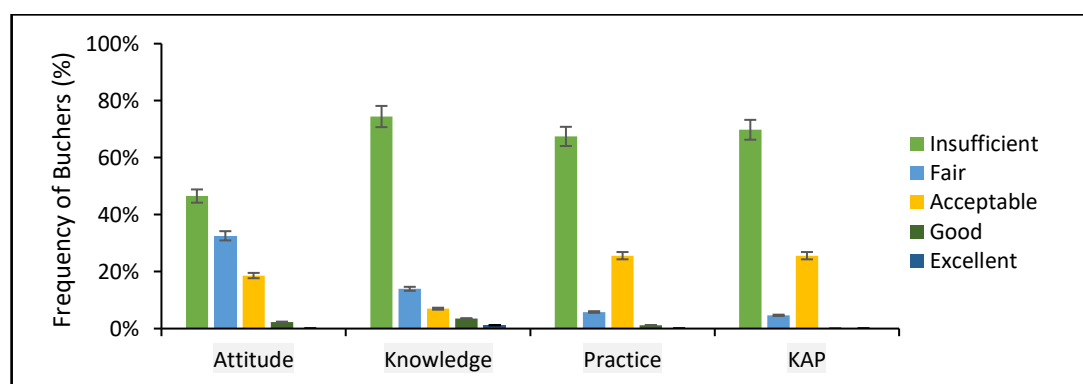


Figure 2 : Level of knowledge, attitude, practice and KAP score

The KAP insufficient score is directly linked to butchers' knowledge, attitude and practice.

3.3. Attitudes

The various attitudes taken by butchers in the Kozah in the performance of their duties are summarized in Table 3. The results showed that 26,74% of respondent's check their health status and 4,65% have been diagnosed with tuberculosis, typhoid fever, skin disease, cold or cough. None butcher present open wounds during the survey. Most of butchers (91,86%) are aware that hair, nose, mouth, and ears should not be touched when handling meat. Also 98,84% know that they must wear clean aprons and hairnets during their service. Respectively 84,88% and 38,37% butchers from Kozah know that they must wear boots or a pair of clean shoes and should not touch money when handling meat. Butchers know also that they must protect meat displayed for sale from parasites or germs, insects, and dust, monitor meat storage time and temperature and must fight microbes and parasites. The mean score of 8.56 ± 1.39 is obtained. Respectively 46.51% and 2.33% of survey butchers have insufficient and Good attitude towards handling meat (Figure 2).

Table 3 : Kozah butchers Attitude

Attitude questions	Correct answer	Incorrect answer
Are suppliers inspected?	17(19.77%)	69(80.23%)
Animals inspected before slaughter	15(17.44%)	71(82.56%)
Animals inspected after slaughter	81(94.19%)	5(5.81%)
Animals inspected during slaughter	3(3.49%)	83(96.51%)
Animals are inspected by a veterinary officer before slaughter	17(19.77%)	69(80.23%)
Animals are inspected by a veterinary officer after slaughter	71(82.56%)	15(17.44%)
Health check	23(26.74%)	63(73.26%)
Diagnosed with tuberculosis / typhoid fever	4(4.65%)	82(95.35%)
Diagnosed with skin disease / cold / cough	4(4.65%)	82(95.35%)
Presents open wounds	0(0.00%)	86(100%)
Hair. nose. mouth. and ears should not be touched when handling meat	79(91.86%)	7(8.14%)
Butchers must wear clean aprons and hairnets	85(98.84%)	1(1.16%)
Butchers must wear boots or a pair of clean shoes	73(84.88%)	13(15.12%)
Butchers should not touch money when handling meat	33(38.37%)	53(61.63%)
Do you protect meat displayed for sale from parasites or germs, insects, and dust?	71(82,56%)	15(17.44%)
Monitoring meat storage time and temperature	74(86.05%)	12(13.95%)
Fighting microbes and parasites	26(30.23%)	60(69.77%)
Average attitude estimate	8.56 ± 1.39	

Most butchers adopt good practices when handling meat. Few of them regularly check their health status.

The results displayed by figure 3-A show a multiple coefficient of determination (R) of 0.942, indicating a very strong and positive correlation between knowledge and attitude. The coefficient of determination $R^2 = 0.888$

indicates that nearly 88.8% of the variation in knowledge level is explained by the variation in attitude level. Residual analysis shows a relatively homogeneous distribution, with normalized residuals varying mainly between -2 and +2, indicating the absence of major anomalies and good model validity.

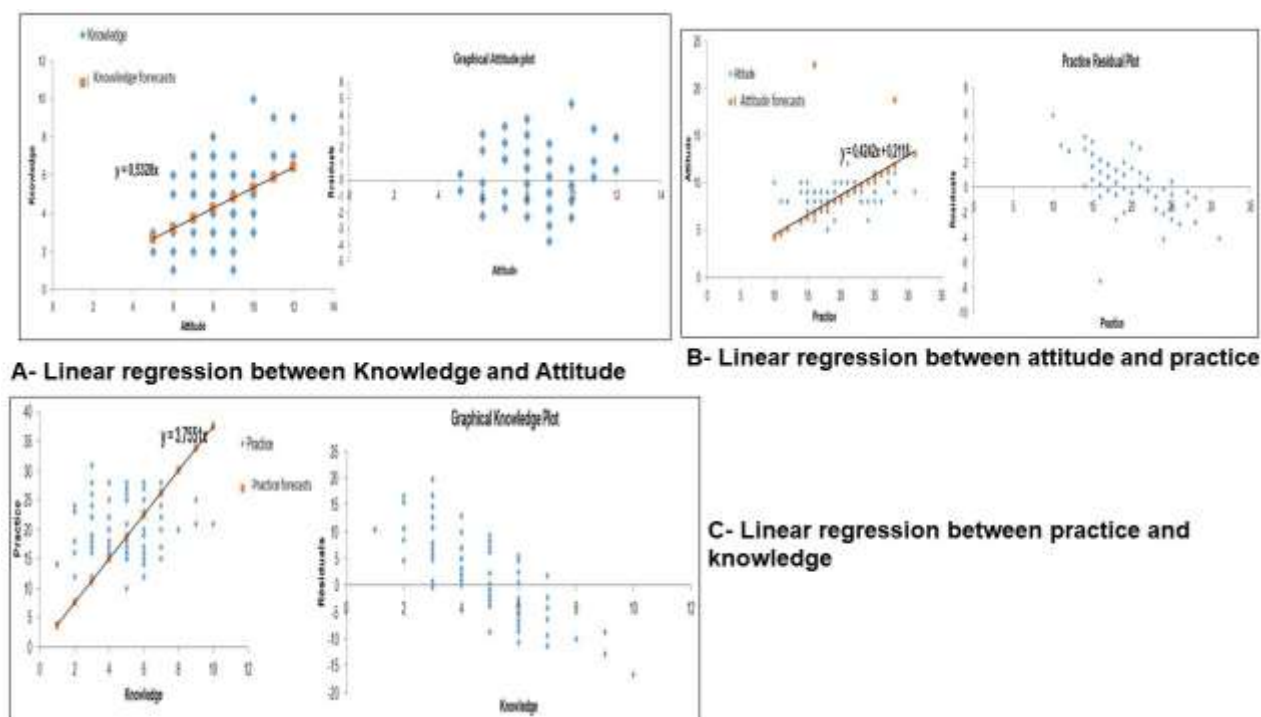


Figure 3: Linear regression between: A- Knowledge and Attitude, B- attitude and practice, C- practice and knowledge

A uniform distribution and strong model validity are revealed by residual analysis. With correct residuals, the linear regression analysis reveals a significant positive correlation between attitude and practice, accounting for 94.6% of attitude variation. The practice score increases by 3.7551 units for every unit rise in the knowledge score.

Many butchers agree on the importance of basic hygiene practices, such as wearing clean protective equipment (Adesiyun et al., 2025), proper handwashing, and the necessity of meat inspections. Hand hygiene is crucial for reducing pathogen transmission during meat handling due to direct contact with raw meat and contaminated surfaces which can be the source of microbe's contamination (da Silva et al., 2016).

Butchers must wear sanitary protective gear such gloves, aprons, masks, hairnets, and boots during their service in order to reduce cross-contamination (Abera et al., 2025; Akuriba et al., 2026; Zewude et al., 2025) and targeting consumer health (Azumamah et al., 2018; Wambui et al., 2017).

Education and training programmes have been identified as a pivotal factor in enhancing attitudes among meat handlers. A substantial corpus of research has demonstrated that training focused on hygiene, food safety, foodborne pathogen control, handling procedures and ethical practices engenders significant positive change (Abera et al., 2025; Akuriba et al., 2026).

The results showed that animals are inspected by a veterinary officer before (19,77%) and after (82,56%) slaughter. Meat inspections are crucial for ensuring the safety of meat products by identifying contamination and ensuring compliance with hygiene standards. This could reduce foodborne outbreaks and promote Good Hygiene

Practices (GHP). Inspections include routine checks, facility certification, and workforce training. Enhancing inspection infrastructure and imposing penalties for non-compliance are vital for maintaining meat safety standards in the prefecture of Kozah.

Many understand hygiene's importance but often overlook risks from unsafe practices, leading to more contaminants as reported by Zegene et al. (2025). Inadequate training causes food safety problems.

Butchers can achieve practice improvements and risk reduction by participating in educational programmes. Attitudes also significantly influence practices by mediating between knowledge and behaviour. Having a positive attitude towards food safety and hygiene is essential for effectively implementing safe practices.

3.4. Practice

Thirty butchers were suit worn (30/ 34.88%), this number is less than 29.05% reported in Nigeria by Alimi et al. (2022) (Table 4).

More than half of butchers (68.60%) wash their hands after handling meat. This value is less than 93% and 91.60% found in Ethiopia by Ahad et al. (2025) and Yenealem et al. (2020). Indeed, according to Kahraman et al. (2010) hands are a major source of microorganism’s contamination especially pathogens ones because they are present under the fingernails of the food handler. That’s why Assefa et al. (2015) recommend to food handlers to wash their hand as a part of a good hygiene practice. Also, appropriate and clean clothing help reduce the risk of food contamination.

Toilets and washbasin are available and equipped with water and 73.26% use drinking water which is stored in a container (77.91%).

Butchers transport the meat from the slaughterhouse to the butcher's shop by himself (79.07%) and 91.86% cover their meat during transportation. The butcher's shop is located in close proximity to a sewer, while the immediate surroundings are characterised by the presence of urinals and a rubbish tip. The area is further characterised by an abundance of weeds. We notice the presence of flies, insects and signs of rodent activity including droppings and chewed bags in butchers’ shop. None of the butchers used insecticides in pest control. In Kozah, 95.35% of butcher shops and butchers work closely with a veterinary officer and cutting equipment is cleaned efficiently. Moreover, the cutting board is kept clean, and waste is disposed of by dumping near the slaughterhouse or incineration (Table 4).

Table 4: Application of hygiene rules by Kozah butchers in their workplaces

Practice questions	Correct answer	Incorrect answer
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Wearing an apron	30(34.88%)	56(65.12%)
Hair covered	12(13.95%)	74(86.05%)
Toilets available	28(32.56%)	58(67.44%)
Presence of washbasin	17(19.77%)	69(80.23%)
The washbasin is equipped with water	6(6.98%)	80(93.02%)
Transporting meat from the slaughterhouse to the butcher's shop yourself	68(79.07%)	18(20.93%)
The meat is covered during transport from the slaughterhouse to the butcher's shop	79(91.86%)	7(8.14%)
The Butchery is located near a sewer	20(23.26%)	66(76.74%)
Urinal located nearby	33(38.37%)	53(61.63%)
Presence of a landfill site nearby	27(31.40%)	59(68.60%)
Presence of weeds next to the butcher's shop	30(34.88%)	56(65.12%)
Does the location of the butcher's shop prevent cross-contamination?	2(2.33%)	84(97.67%)
Does the butcher shop have a place to store meat that has not been sold during the day?	18(20.93%)	68(79.07%)
Presence of a thermometer	14(16.28%)	72(83.72%)
Is the water used drinkable?	63(73.26%)	23(26.74%)
The water used is stored in a container	67(77.91%)	19(22.09%)
The floor of the butcher's shop is clean	70(81.40%)	16(18.60%)
Cleaning the premises before work	81(94.19%)	5(5.81%)
Presence of flies	52(60.47%)	34(39.53%)
Presence of insects	6(6.98%)	80(93.02%)
Use of insecticides	0(0.00%)	86(100.00%)
The walls can be cleaned up to about 1.5m from the floor	11(12.79%)	75(87.21%)
The work carried out in this butchery is supervised by a veterinary agent	82(95.35%)	4(4.65%)
Cutting equipment is positioned in such a way as to facilitate their cleaning.	12(13.95%)	74(86.05%)
The cutting board is clean	53(61.63%)	33(38.37%)
Disposal of waste by dumping it near the slaughterhouse	79(91.86%)	7(8.14%)
Waste disposal by incineration	0(0.00%)	86(100.00%)
Presence of signs of rodent activity such as droppings and chewed bags	49(56.98%)	37(43.02%)
Washing hands after handling meat	59(68.60%)	27(31.40%)
Average practice estimate	19.45 ± 4.69	

The sanitation facilities are limited. Most of butchers wash hands after handling meat and only 12 cover their hair. Seventy butcher shops are clean, but pests are present, no insecticides are used, and waste disposal is near the slaughterhouse, while cutting equipment and boards are clean.

Respectively 67.44%, 5.81%, 25.58%, 1.16% and 0.00% have insufficient, fair, acceptable, good and excellent score in practice (Figure 3-B). Moreover, the linear regression between attitude and practice as displayed by Figure 3-B show a multiple correlation coefficient (R) = 0.973, indicating a very strong and positive correlation between the two variables. The coefficient of determination $R^2 = 0.946$ shows that 94.6% of the variation in attitude level is explained by variations in practice level. Residual analysis indicates a homogeneous distribution centred around zero, with normalised residuals mostly between -2 and +2. This demonstrates the model's validity, with no systematic bias or significant outliers.

The most significant deviations (residuals > 2) are rare, which reinforces the model's predictive quality. Furthermore, the linear between practice and knowledge (Figure 3-C), revealed a very strong and positive correlation between knowledge and hygiene practices ($R = 0.92$; $R^2 = 0.85$). The model is statistically significant ($F = 468.88$; $p < 0.001$), indicating that knowledge explains 84.7% of the variation observed in practices. The regression coefficient ($\beta = 3.755$; $p < 0.001$) shows that a one-unit increase in the knowledge score leads to an average improvement of 3.76 units in the practice score. This result confirms that strengthening butchers' knowledge is an essential way to improve their food hygiene and safety practices. The residuals fluctuate around zero, with no particular trend (homoscedasticity respected).

3.5. KAP scores

Studies on the Knowledge, Attitude, and Practice (KAP) scores of butchers show a trend of insufficient (69.77%) level. The results from the KAP analysis shows that butchers have different levels of knowledge and hold different attitudes (Figure 2). The KAP scores show globally higher score of Insufficient in Attitude, Knowledge and Practice by the butchers. Adesiyan et al. (2025) and Akuriba et al. (2026) demonstrated that butchers of Ghana and Nigeria exhibited differing levels of food safety knowledge, highlighting significant gaps in their understanding of hygiene practices implementation. As reported by Ashuro et al. (2023), formal education enhances meat hygiene knowledge, with higher education linked to better understanding of foodborne pathogens, temperature control, and sanitation, crucial for preventing contamination. Likewise, research in Libya indicated that butchers possessed moderate knowledge of meat safety but were less aware of zoonotic diseases and their positive attitude did not consistently translate into proper implementation (Eljamay et al., 2022). As reported by Khan et al. (2024) and Soltan-Alinejad et al. (2025), the Knowledge, Attitude, and Practice (KAP) framework is frequently employed to assess understanding, beliefs, and behaviors among specific occupational groups, such as butchers, particularly concerning food safety, hygiene, and disease prevention.

Some practical recommendations to improve the KAP scores of Kozah butchers: firstly, organize training workshops and awareness sessions for them on hygiene standards and their implementation as well as waste

management. Secondly, that the competent authorities ensure the strict enforcement of the existing regulations by conducting periodic inspections and applying penalties for non-compliance with safety measures to any offender. Finally, promote hygiene as a community norm in order to change attitudes and encourage better practices on a larger scale.

3.6. Microbiological aspect of meat sold

The various microorganisms colonising beef meat in Kozah include total flora, enterobacteria, yeasts, moulds and staphylococci. Their enumeration yielded average values of 9.21 ± 2.19 , 6.35 ± 1.55 , 3.93 ± 0.70 and 5.30 ± 0.41 logCFU/cm² for total mesophilic aerobic flora, enterobacteria, yeasts and moulds, and *Staphylococcus aureus* respectively. The results showed high microbiological contamination of the samples analysed exceeding the thresholds set by the Togolese Republic for acceptable microbial load in bovine carcasses in Togo and that of the European Union (Table 5).

Table 5: Microbes counts in beef samples

Microorganisms	Count (logCFU/cm ²)	Criterion (logCFU/cm ²)	Conclusion	References
Total mesophilic aerobic flora (TMAF)	9.21 ± 2.19	5	Poor quality	(RT-MAEP, 2008)
Enterobacteria	6.35 ± 1.55	2.5		(EC, 2005)
Yeasts and molds	3.93 ± 0.70	3		
<i>Staphylococcus aureus</i>	5.30 ± 0.41	3		

This table shows that the meat samples analyzed are heavily contaminated with various microbes.

With regard to total mesophilic aerobic flora (TMAF), this high count could be attributed to inappropriate storage conditions following slaughter, such as a breakdown in the cold chain or frequent handling of the meat. The ambient temperatures and repeated handling promote the rapid proliferation of mesophilic flora. The presence of yeast and mould indicates that the beef has been exposed to the ambient air for a prolonged period, often without packaging or refrigeration, creating an environment conducive to fungal growth (Figure 4).

Enterobacteria are hygiene indicator microorganisms as they enable the assessment of faecal contamination. The value of 6.35 ± 1.55 logCFU/cm², which is significantly higher than the recommended value of 3 logCFU/cm², suggests potential faecal contamination, exacerbated by poor hygiene practices. These findings highlighted the link between high levels of enterobacteria and inadequate sanitary conditions, using the example of exposure to the open air at meat retail outlets showed by figure 4.

Staphylococcus aureus was found at an average of 5.30 ± 0.41 logCFU/cm², compared with a standard of 3 logCFU/cm². Other studies have also found high rates of *S. aureus* contamination in meat especially in beef meat. For example, 62.57% and 68% of the meat samples tested positive for *S. aureus* in South Africa (Madoroba et al., 2021) and Nepal (Bantawa et al., 2018) respectively. Also, 26,39% of beef samples were contaminated by *S. aureus* in Mali (Kassogu   et al., 2025). As this bacterium is often associated with human contamination (hands,

respiratory tract), its high presence indicates improper handling. In addition, significantly high levels of Enterobacteria and *Staphylococcus aureus* in the examined samples pose a serious health risk. While some species of Enterobacteria, for example *E. coli*, produce shiga toxins that can cause major problems such haemolytic uremic syndrome, *S. aureus* is known to produce a variety of potent staphylococcal enterotoxins (SEs) that are resistant to inactivation by gastrointestinal proteases. These toxins are consequently responsible for acute food poisoning (Jaja et al., 2018; Kassogu   et al., 2025). Also, improper handwashing or hand hygiene is linked to meat contamination including meat-contact surfaces, cutting boards, knives and grinders especially in the spread of Enterobacteriaceae species and coagulase-positive *S. aureus*. These surfaces are considered to be critical points for microbial growth and proliferation and have to be taken into account when studying cross-contamination risk in butcher's shops. Furthermore, the fight against microorganisms (such as Enterobacteriaceae, total flora, and *Staphylococcus aureus*) in beef relies on a strict preventive approach that combines adherence to hygiene rules, control of critical control points (HACCP), and decontamination treatments for carcasses. In order to reduce these dangers, these findings emphasise the necessity of enhancing hygienic procedures throughout the production and distribution chain as reported in table 6, which lists some steps to be taken by butchers in the Kozah region from slaughter through to sale.



Figure 4: Exposition    l'air libre de la viande de b  uf apr  s abattage (A) et dans une boucherie (B).

Table 6 : Probable causes of non-compliance and corrective actions

Most likely causes of non-compliance	Actions to take
- Contaminated materials - Failure to follow decontamination protocols - Failure to wear personal protective equipment - Faecal contamination - Inadequate cleaning and disinfection - Inadequate storage temperature, allowing growth to levels posing health risks - Inadequately disinfected materials	- Improvements in slaughter hygiene and a review of process controls and animal origin Staff Hygiene (The Most Important Factor): ➤ Handwashing: Frequent and thorough, using antibacterial soap, before starting work, after each break, and after handling raw products,

• Lack of adequate handwashing facilities (soap, hot water) • Poor hygiene and behaviour of food handlers • Poor hygiene and sanitation • Poor staff hygiene • Poor storage conditions • Prolonged storage under unsuitable conditions • Presence of skin abscesses on food handlers • Lack of training of meat handlers in good food hygiene practices. • Use of untreated water	➤ Wound Protection: Any cuts or scrapes must be covered with a waterproof bandage and gloves. ➤ Wearing of equipment: Clean work clothes (lab coat, apron) must be worn, and gloves must be changed regularly as needed. • Equipment and Facility Hygiene: ➤ Separation of food streams: Avoid any contact between raw meat and cooked or ready-to-eat products. ➤ Cleaning and disinfection: Knives, meat grinders, saws, and work surfaces must be cleaned and disinfected regularly to prevent cross-contamination.
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Conclusion

Half of the butchers in Kozah understand that meat requires special handling, but none know how long raw meat can be left out, nor do they understand foodborne illnesses. A little number had received hygiene training, leading to concerns about meat hygiene knowledge. Many butchers display unsatisfactory awareness regarding proper handling and zoonotic disease transmission.

Acknowledgments

The authors would like to thank the butchers who agreed to participate in this survey on a voluntary basis.

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