Sahel Journal of Life Sciences FUDMA (SAJOLS)
September 2025 Vol. 3(3): 315-319
ISSN: 3027-0456 (Print)
ISSN: 1595-5915 (Online)
DOI: https://doi.org/10.33003/sajols-2025-0303-40

Research Article

Assessment of *E. coli and E. coli O157:H7* Contamination in Cattle Carcasses, Workers, Equipment and Contact Surfaces of Unguwa-uku Abattoir, Kano State, Nigeria

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ABSTRACT

Unguwa-Uku abattoir is one of the major meat suppliers in Kano city and environs. Despite its capacity and importance in meat production and processing, most of the procedures are conducted under poor hygienic conditions, which may render the environment a potential source of pathogenic microorganisms. This study investigated the prevalence and distribution of *Escherichia coli* and *E. coli* O157:H7 in slaughtered cattle and environmental samples at the Unguwa-Uku abattoir, Kano State, Nigeria. A total of 80 samples, including carcass swabs, caecal contents, and contact surfaces, were collected and analysed using standard microbiological and biochemical methods, such as Indole, methyl red, Voges Proskauer and citrate tests. Results showed that 25% of the samples were positive for *E. coli*, while *E. coli* O157:H7 was detected in 8.75% of samples. The highest contamination was observed in caecal contents and cutting boards. Although *E. coli* O157:H7 was detected across multiple sample types, the association between sample type and prevalence was not statistically significant (P = 0.482). These findings highlighted potential hygiene risks in the abattoir environment and underscore the need for improved slaughterhouse sanitation and food safety practices.

Keywords: Abattoir hygiene; Carcass contamination; *E. coli; E. coli* O157:H7; Food safety

Citation: Sulaiman, T., Adamu, M.T., Garba, L., Tawfiq, U.A., Bukar, A., Namadina, M.M., Aminu, M.A., & Sani, H. (2025). Assessment of *E. coli and E. coli O157:H7* Contamination in Cattle Carcasses, Workers, Equipment and Contact Surfaces of Unguwa-uku Abattoir, Kano State, Nigeria. *Sahel Journal of Life Sciences FUDMA*, 3(3): 315-319. DOI: https://doi.org/10.33003/sajols-2025-0303-40

INTRODUCTION

Escherichia coli O157:H7 is a significant zoonotic pathogen and one of the most virulent strains of Shiga toxin-producing *E. coli* (STEC), responsible for a wide range of clinical manifestations in humans. These range from mild, self-limiting diarrhea to severe complications such as haemorrhagic colitis and the potentially fatal haemolytic uremic syndrome (HUS) (Al-Zogibi *et al*., 2023; CDC, 2022). The global remainf *E. coli O157:H7* infections remain a pressing public health concern, affecting both developed and developing countries due to increasing food trade, urbanization, and inconsistent hygiene practices (Taye *et al*., 2023; WHO, 2023).

Numerous outbreaks of *E. coli O157:H7* have been linked to the consumption of contaminated food, particularly undercooked or raw ground beef, unpasteurized milk, and other dairy products (Gomez-Aldapa *et al*., 2024). In addition to foodborne sources, water contaminated with faecal matter and cross-contamination during food handling, especially via unclean utensils and surfaces, are major transmission

routes (EFSA, 2022). The pathogen's low infectious dose, estimated at just 10–100 organisms, increase its risk to public health (Teunis *et al*., 2022).

In developing regions, particularly across sub-Saharan Africa, slaughtering and meat processing are often conducted in unhygienic environments, contributing significantly to the microbiological contamination of meat (Eze *et al*., 2022). Cattle are known to be asymptomatic carriers of *E. coli O157:H7*, and faecal shedding during slaughter increases the chances of carcass contamination (Zhao *et al*., 2023). In fact, studies have shown that ground beef accounts for over 70% of *E. coli O157:H7* outbreaks globally due to contamination during processing stages such as milking, slaughtering, and grinding (Aboi *et al*., 2023; U.S. FDA, 2022).

Workers in abattoirs and meat processing facilities are particularly vulnerable due to their close and frequent contact with live animals and raw meat, often without proper protective gear or training on hygienic practices (Alegbeleye & Singleton, 2024). Key risk factors include the use of contaminated water for washing carcasses, airborne particles in processing rooms, and poor sanitation of cutting surfaces and equipment (Adedayo *et al*., 2023). These factors underscore the need for comprehensive preharvest and postharvest interventions to minimize contamination risk along the meat production chain. Controlling *E. coli O157:H7* at the source particularly in cattle is crucial to reducing transmission risks. Research highlights that implementing good agricultural and hygienic practices, improving sanitation in abattoirs, and raising awareness among meat handlers can significantly mitigate the pathogen's spread (Dong *et al*., 2024; Taddese *et al*., 2023). Despite these insights, knowledge gaps and poor public health communications persist, especially in local abattoirs such as Unguwa-uku Abattoir in Kano, Nigeria, where awareness about the zoonotic nature and transmission routes of *E. coli O157:H7* remains low.

Consequently, this study aimed to assess the of *E. coli O157:H7* contamination in cattle carcasses, workers and contact surfaces within Unguwa-Uku Abattoir, Kano State, Nigeria. This research seeks to provide data that may inform targeted interventions to improve meat safety and public health outcomes in the region.

MATERIALS AND METHODS

Sample Collection and Processing

Swab samples were collected aseptically from slaughtered cattle carcass body surface, caecal contents, butchers' hands, knives, cutting boards, and wastewater within the abattoir using a systematic random sampling technique, as reported by (Bekele, Yeshitila, & Lemma, 2023; Sebsibe & Asfaw, 2020). Swabbing was performed first in a horizontal motion, followed by vertical strokes to ensure sufficient microbial recovery from each area. After sampling, the swab shafts were broken inside sterile test tubes, leaving the cotton tips for subsequent laboratory analysis. All collected samples were immediately placed in an ice-cooled box and transported to the Microbiology Laboratory at Bayero University, Kano. Upon arrival, samples were stored at 4°C 24 hours before processing for bacterial isolation and identification, following the protocol recommended by Tizeta *et al*. (2014) and and Demissie (2022).

Isolation and Identification

Swab samples collected from slaughtered cattle, workers, and contact surfaces were first homogenized in nutrient broth and incubated at 37°C for 24 hours to allow bacterial enrichment, following CDC (2023) and WHO (2023) guidelines. After enrichment, the broth cultures were streaked onto Eosin Methylene Blue (EMB) agar and incubated at 37°C for another 24 hours. Colonies showing the characteristic green metallic sheen typical of *Escherichia coli* were selected. These isolates were further identified using standard biochemical tests; indole, methyl red, Voges-Proskauer, and citrate utilization (IMViC tests) according to established diagnostic protocols (Gomez-Aldapa *et al.,* 2024). Pure cultures were obtained through subculturing and preserved on nutrient agar slants at 4°C for further analysis. To detect *E. coli* O157:H7, suspected isolates were plated on Sorbitol MacConkey Agar (SMAC) containing 0.05 mg/L Cefixime and 2.5 mg/L potassium tellurite (Oxoid Ltd., Hampshire, UK) and incubated at 37°C for 24 hours. On this medium, *E. coli* O157:H7 appeared as pale or colourless colonies (non-sorbitol fermenters), while other *E. coli* strains formed pink colonies (sorbitol fermenters) (Taddese, Belachew, & Diriba, 2023). Between three and five non-sorbitol-fermenting colonies with round, pale morphology was selected as presumptive *E. coli* O157:H7 isolates. Final confirmation was done through cultural, morphological, and biochemical characterization, along with 16S rRNA gene sequencing as described by Aboi, Ahmed, and Alhassan (2023).

Molecular Identification of the Isolates

The bacterial isolates were cultured in nutrient broth and incubated at 37°C for 24 hours to promote active cell growth. After incubation, the bacterial cells were harvested by centrifugation at 10,000 × g for 5 minutes, and the resulting cell pellet was used for DNA amplification. The 16S rRNA gene of each isolate was

amplified using a 2× Taq Master Mix with universal primers 27F (forward: 5′-AGAGTTTGATCCTGGCTCAG-3′) and 1492R (reverse: 5′-GGTTACCTTGTTACGACTT-3′). The Polymerase Chain Reaction (PCR) was performed under the following conditions: initial denaturation at 95°C for 5 minutes; followed by 30 cycles of denaturation at 95°C for 30 seconds, annealing at 59°C for 30 seconds, and extension at 72°C for 30 seconds. A final extension step was carried out at 72°C for 7 minutes, followed by a hold at 4°C. Amplified PCR products were analysed using **agarose gel electrophoresis** to verify the presence and expected size of the DNA fragments. A 1.5% agarose gel stained with ethidium bromide (or an equivalent non-toxic dye) was prepared, and electrophoresis was conducted at 100 V for approximately 45 minutes. The resulting DNA bands were visualized under ultraviolet (UV) light using a gel documentation system (Sambrook & Russell, 2001). Confirmed PCR products showing clear and distinct bands were **purified and sequenced**. The obtained 16S rRNA gene sequences were compared with known bacterial sequences in the **NCBI GenBank database** using the Basic Local Alignment Search Tool (BLAST) to determine the species identity based on sequence similarity (NCBI, 2024).

Data Analysis

Data were analysed using Sigma Stat version 3.5 (Systat Software Inc., 2017). The prevalence of *Escherichia coli* O157:H7 in carcass swabs, caecal contents, and environmental samples was calculated by dividing the number of positive samples by the total number examined. To determine whether there was a statistically significant association between *E. coli O157:H7* occurrence and sample type (e.g., carcass vs. caecal content), Fisher's exact test was employed. All statistical comparisons were considered significant at $p < 0.05$, as recommended by current microbiological epidemiology standards (Gomez-Aldapa *et al*., 2024; WHO, 2023).

RESULTS AND DISCUSSIONS

A total of 80 samples were collected from different animal and environmental contact points in the Unguwa-Uku abattoir and tested for *Escherichia coli* and *E. coli* O157:H7 contamination. Out of these, 25% (20/80) were positive for *E. coli*, while 8.75% (7/80) were positive for *E. coli* O157:H7. The highest *E. coli* contamination was found in caecal contents and cutting boards (40% each), followed by body surfaces (30%), and the udder, lateral surface, knives, and wastewater (20% each). The lowest contamination level (10%) was recorded from butchers' hands. In contrast, *E. coli* O157:H7 was most frequently isolated from cutting boards, caecal contents, lateral surface, udder, butchers' hands, and wastewater (10% each). No *E. coli* O157:H7 was detected on body surfaces or evisceration knives.

Although contamination levels varied across sample types, statistical analysis (Chi-square = 13.57, P = 0.482) showed no significant relationship between sample type and the occurrence of *E. coli* O157:H7. This indicates a fairly uniform spread of the pathogen across the abattoir environment. The overall prevalence of *E. coli* O157:H7 (8.75%) is consistent with findings by Taddese *et al.* (2023), who reported 8.2% in Ethiopian abattoirs, but slightly lower than the 10–15% observed by Abebe *et al.* (2022) in abattoirs with poorer hygiene standards. The high detection rate of *E. coli* in caecal content (40%) supports reports by Gomez-Aldapa et al. (2024) and Aboi *et al*., (2023), which identified the ruminant gastrointestinal tract as a key reservoir of the bacterium. Likewise, the presence of *E. coli* O157:H7 on cutting boards, butchers' hands, and udder surfaces highlights the risk of cross-contamination during slaughtering and meat handling, particularly in resource-limited settings (Eze *et al.,* 2022; Alegbeleye & Singleton, 2024).

Interestingly, although evisceration knives had moderate *E. coli* contamination (20%), *E. coli* O157:H7 was not detected. This may be linked to differences in cleaning routines or disinfection practices, contrasting with Adedayo et al. (2023), who identified knives as major contamination sources in Nigerian abattoirs. The relatively low detection from butchers' hands (10%) suggests some compliance with hand hygiene practices. However, the presence of *E. coli* O157:H7 indicates ongoing lapses that could promote foodborne transmission (WHO, 2023). Overall, the results point to caecal contents and contact surfaces such as cutting boards as major contamination points. Strengthening hygienic slaughter procedures, enforcing regular surface disinfection, and improving personal hygiene practices among abattoir workers are essential to minimize the risk of *E. coli* O157:H7 transmission and enhance meat safety.

Table 1: Prevalence and Distribution of *E. coli and E. coli O157: H7* in Samples Collected from Unguwa-uku Abattoir

Sample Type	No. of Sample Tested	No. of Positive Sample (%)	
		E. coli	***E. coli 0157:H7***

Udder part	10	2(20)	1 (10)
Body Surface	10	3(30)	0 (0)
Lateral Surface	10	2(20)	1 (10)
Evisceration Knives	10	2 (20)	0(0)
Butchers' Hands	10	1(10)	1 (10)
Caecal Content	10	4 (40)	1 (10)
Cutting Board	10	4 (40)	1 (10)
Wastewater	10	2 (20)	2 (20)
Total	**80**	**20 (25)**	**7 (8.75)**

Contingency tables are not significantly related. **(P = 0.482); Chi-square X^2 = 13.57**

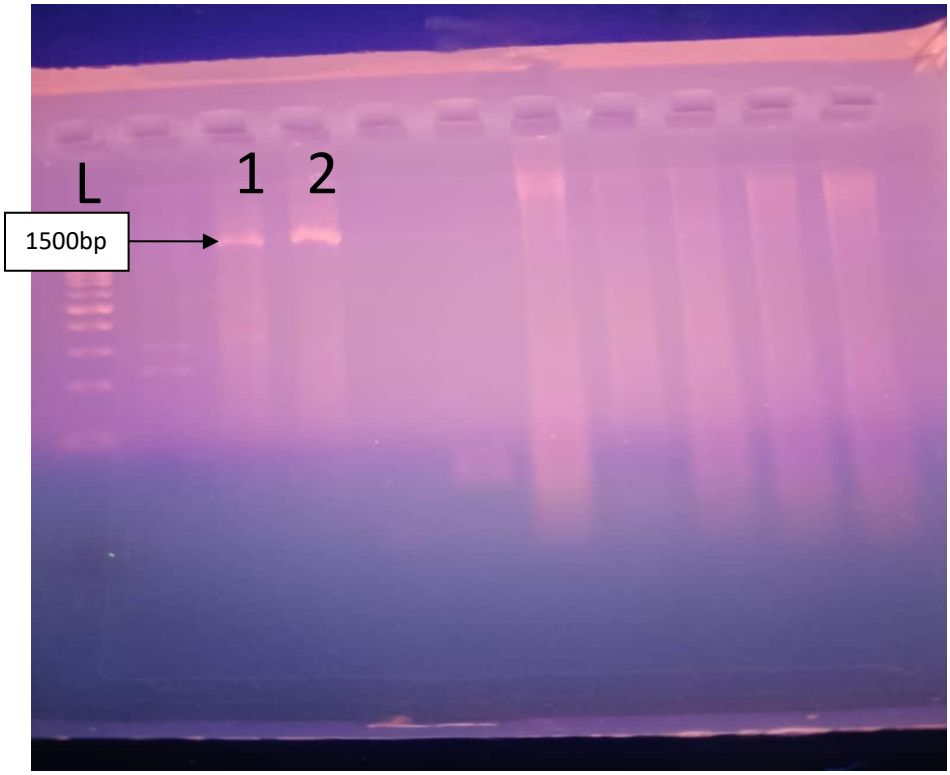

Figure 1: Gel Electrophoresis of the amplified 16s rRNA genes

Figure 1 displays the gel electrophoresis results for the PCR products obtained from the 16S rRNA gene amplification. The lanes labelled 1, & 2 represent the bacterial isolates. The presence of DNA band in the lanes confirms the success of the PCR amplification. The ladder lane (lane L) on the left serves as a size reference.

CONCLUSION

The findings of this research have therefore established the prevalence of *E. coli* (25%) and a moderate presence of *E. coli* O157:H7 (8.75%) across both animal and environmental samples, with the highest contamination observed in caecal contents and cutting boards. *Although E. coli O157:H7* was distributed across multiple sampling points, no statistically significant association was found between sample type and pathogen presence (P = 0.482). These results emphasize the potential public health risk posed by inadequate hygiene practices within the abattoir and underscore the need for targeted interventions to improve slaughter hygiene, equipment sanitation, and worker education to mitigate cross-contamination and the spread of foodborne pathogens.

Enhanced hygiene protocols should be enforced throughout the slaughtering process, especially during evisceration and carcass handling, to reduce contamination from faecal matter and gastrointestinal contents. Cutting boards, knives, and worktables identified as high-risk surfaces should be disinfected regularly using approved sanitizers to minimize cross-contamination between carcasses and the environment. Structured training programs on the risks of *E. coli O157:H7* and the importance of proper handwashing, glove use, and handling practices should be conducted for all abattoir workers. Routine testing of

meat products, carcasses, and environmental samples should be instituted to monitor the presence of *E. coli* and other pathogens, enabling early detection and response. The abattoir layout should clearly demarcate areas for slaughtering, carcass dressing, and meat handling to prevent cross-contamination between clean and contaminated sections. Proper drainage and treatment of wastewater are essential to prevent environmental contamination and reduce the risk of spreading pathogenic organisms like *E. coli O157:H7*. Government and public health authorities should intensify supervision, inspection, and enforcement of food safety standards within municipal abattoirs to ensure compliance with hygiene regulations. Educational campaigns targeting consumers, butchers, and meat handlers should be developed to raise awareness about foodborne pathogens and the importance of safe meat consumption practices.

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