ejpmr, 2025, 12(8), 353-358

SJIF Impact Factor 7.065

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN (O): 2394-3211

ISSN (P): 3051-2573

ASSESSMENT OF COLIFORM BACTERIA CONTAMINATION ON GRILLED BEEF(SUYA) CONSUMED BY THE INHABITANTS OF BAMENDA II and III

Lukong Jude Thaddeus Veranso[1], Dr. Lukong Hubert Shalanyuy[2,3]*, Nchiambi Pretty Fube[4], Chah Peter Nges[2], Dine Mariclaire Leinyuy[1] and Gewun Braindaline[3]

[1]The Cameroon Baptist Convention (CBC) Health Services, Cameroon.
[2]National Polytechnic University Institute Bamenda, Cameroon.
[3]Essential Health Higher Institute – Foumbot Cameroon.
[4]Florence Nightingale Higher Institute of Health and Biomedical Sciences.

***Corresponding Author: Dr. Lukong Hubert Shalanyuy**

National Polytechnic University Institute Bamenda, Cameroon.

Article Received on 14/06/2025 **Article Revised on 03/07/2025** **Article Accepted on 24/07/2025**

ABSTRACT

Background: Meat is a vital source of protein in the human diet but is highly perishable and prone to microbial contamination, especially when processed as street foods like *suya*. Suya, a popular grilled meat delicacy in Cameroon and Nigeria, is often prepared and sold under unhygienic conditions that favor bacterial growth, particularly coliforms. Contamination may arise from poor slaughtering practices, use of untreated water, and proximity to refuse sites. Coliforms, though mostly non-pathogenic, indicate fecal contamination and can include harmful strains like *E. coli* O157:H7. In Bamenda, challenges such as water scarcity and overcrowding increase the risk, necessitating microbial analysis of suya to ensure food safety and protect public health. This study aimed to determine the occurrence of coliform bacteria on grilled beef (suya) collected from different sources and the associated risk factors that contribute to coliform bacteria contamination on grilled beef in Bamenda II and III. **Methods:** This study was a community based cross sectional study, which focused on suya vendors in Bamenda II & III, with a calculated minimum sample size of 50 using standard formulae. Convenience sampling was employed, and only willing vendors were included. Suya samples were collected in sterile cups, preserved on sterile ice bags, and analysed at FLENHIHBS laboratory. Serial dilutions and EMB agar (Eosin Methylene Blue agar) were used to detect and quantify coliform bacteria. The Sorbitol MacConkey Agar (SMAC) test was also used to identify *E. coli*. Gram staining differentiated gram-negative bacteria under a microscope. Socio demographic data was collected via questionnaires and laboratory analysis of samples was done following all sterile protocol measures. Data was analysed using SPSS version 23, with inferential statistics done using the Chi square analysis. Statistical significance was considered when P value was less than equal to 0.05. Ethical clearance was obtained from the Regional Delegation of Public health for the North West Region. **Results:** The study showed that most suya vendors were aged 26–30 (34%), with the least in the 41–50 age range (4%). Primary education was most common (52%), with no vendors having tertiary education. Half of the vendors sourced meat from slaughterhouses, while 42% used sales points and 8% practiced self-slaughter. Vending sites were mainly on the streets (40%), followed by bars (28%), markets (22%), and restaurants (10%). Tap water was the most used for washing meat (36%), followed by borehole (34%) and well water (28%). The occurrence of coliform contamination in suya was 4%, with all positive samples from street vendors. Chi-square analysis identified only suya exposure as a significant risk factor ($\chi^2 = 13.235$, $p = 0.001$). Other factors like water source ($p = 0.747$), meat source ($p = 0.237$), vending site ($p = 0.663$), packaging method ($p = 0.776$), and proximity to dumpsites ($p = 0.229$) showed no significant association. **Conclusion:** This study concludes that suya exposure was the only significant risk factor associated with coliform contamination, highlighting street vending as a key public health concern.

KEYWORDS: Occurrence, coliform bacteria, grilled beef (suya), risk factors, Bamenda II and III.

BACKGROUND

Meat has played a central role in human nutrition throughout history, providing a rich source of essential nutrients including protein, vitamins, and minerals.[1] As the global population increases, the demand for protein-rich foods such as meat also rises. However, meat is highly perishable due to its favorable composition for microbial growth, especially spoilage bacteria.[2] Suya, a popular form of processed meat in West Africa, is traditionally made by roasting seasoned meat over open flames and is widely consumed due to its affordability and taste.[3] Despite its popularity, the safety of suya is

questionable because of its preparation under often unhygienic conditions.[4]

Processed meat like suya is nutritionally valuable, offering essential proteins for body repair and growth.[5] It serves as a convenient street food in many parts of Africa and provides income opportunities for numerous vendors.[3] However, due to poor hygiene during preparation and sales, suya is vulnerable to contamination by microorganisms, especially coliforms, which are indicators of possible fecal contamination.[6] Coliforms, although not always pathogenic, include dangerous strains like *E. coli* O157:H7, which are associated with serious illnesses such as bloody diarrhea and hemolytic uremic syndrome.[7–9]

Coliforms are classified as environmental or fecal types, with fecal coliforms being more reliable indicators of contamination and poor hygiene.[10] Their presence in food products like suya may indicate exposure to unsafe water, dirty utensils, or proximity to refuse sites.[11] The U.S. Environmental Protection Agency recommends methods such as the multiple tube fermentation technique for detecting coliforms, but these methods can be limited by poor specificity and incubation delays.[12] Suya's high pH and the unsanitary handling practices contribute further to microbial growth, especially when the meat is exposed post-cooking at points of sale.[13]

In Bamenda, several local challenges such as water scarcity, overcrowding, and low education among vendors compound the risk of suya contamination. Many vendors resort to untreated water sources like wells and boreholes due to the lack of pipe-borne water, especially in the dry season.[14] Additionally, vending sites near dumpsites increase exposure to flies and pathogens, while the high demand for suya, especially at night, raises the chances of cross-contamination during serving. Vulnerable populations such as children and the elderly are particularly at risk of severe foodborne illnesses.[15] Although research has been done on suya microbial quality, none has focused specifically on Bamenda. This study aims to fill that gap by investigating the occurrence of coliforms in suya sold in Bamenda and its associated risk factors.[3]

METHODS

Sample collection was conducted in Bamenda II and III subdivisions, located in the North West Region of Cameroon, known for high suya consumption, especially in street settings. Laboratory analysis was carried out at the Florence Nightingale Higher Institute of Health and Biomedical Sciences (FLENHIHBS) Laboratory, Allahlie. This was a cross-sectional study conducted over a one-month period in 2025 involving 50 suya vendors in Bamenda II and III who freely consented to participate in the study. The dependent variable in this study was the presence of coliform bacteria in suya meat, while the independent variables were the source of meat, water used, vending site location, and hygienic practices. Suya samples were collected using sterile cups from consenting vendors and transported on sterile ice flasks to the FLENHIHBS laboratory. 1g of suya was homogenized in sterile saline, serially diluted, and cultured on EMB agar using the pour plate method. After incubation, colonies were counted, Gram-stained, and identified microscopically as coliforms. Identification of faecal coliform *E.* coli was done using the Sorbitol MacConkey Agar test. Data was analysed using SPSS version 23. Chi-square test was used to identify statistically significant associations between risk factors and occurrence of coliforms. Statistical significance was considered when p value was less than 0.05.

RESULTS

General Characteristics of Study Participants

Characteristics of the Participants

Table 1 below shows that most study participants where in the age group 26-30 (34%). The list age group was 41-45 and 46-50. With respect to educational level, majority of those who participated in this study had attended primary education (52%), 24(48%) had attended secondary education and none (0%) attended tertiary level. Concerning the source of meat. The result of this study indicates that most suya vendors source their meat from the slaughter house (50%). 42% source their meat from the sales point while 8% practice self-killing of animals. Finally, with regards to the location of the vending site, 28% of suya vending sites are located in front of bars, 20% are located at the markets, 40% are found on street sites and 5% are found in restaurants.

Table 1: The characteristics of the participants.

Variable	Frequency	Percentages
Age		
20-25	16	32
26-30	17	34
31-35	9	18
36-40	4	12
41-45	2	4
46-50	2	4
Educational level		
Primary	26	52
Secondary	24	48
Tertiary	0	0
Sources of raw meat		

Slaughter house	25	50
Sales point	21	42
Self-killing of animals	4	8
Location of vending sites		
Bar	14	28
Market	11	22
Street	20	40
Restaurants	5	10

Source of water

The figure below shows that majority (36%) of the suya vendors used tap water to wash their meat. 34% of the participant used borehole, 28% of the participant used well water while 2% used streams.

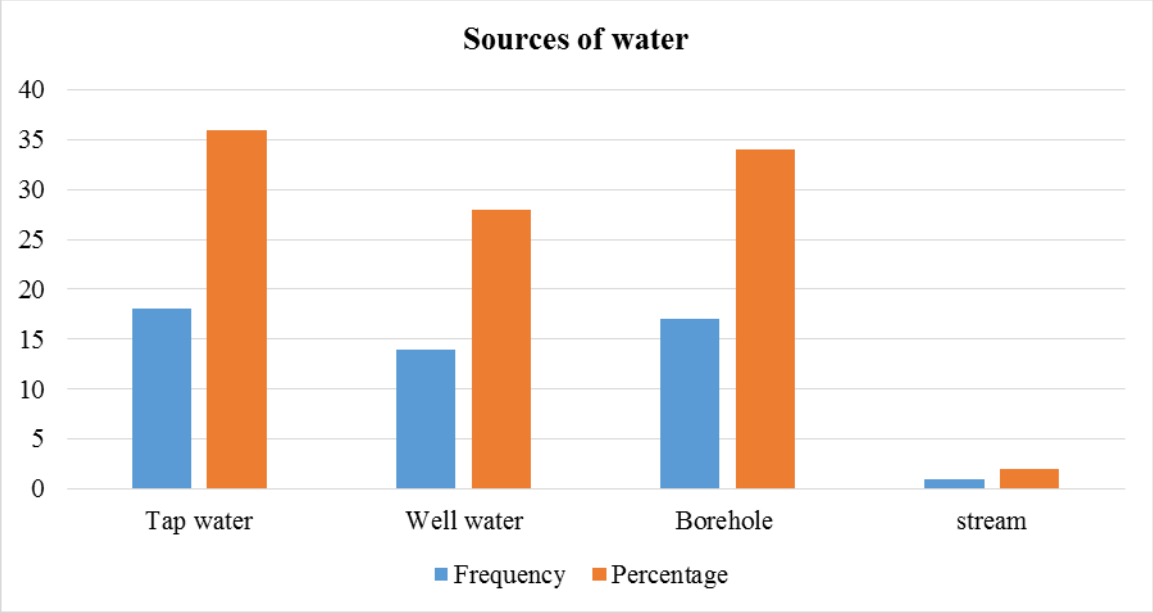

Figure 1: Sources of Water Use in Washing raw Meat and Equipment.

The prevalence of coliform

The result from this study indicates that the prevalence of coliform in suya sold in Bamenda II and III is 4% as shown in fig (4) below. The 4% positive was sourced from the street.

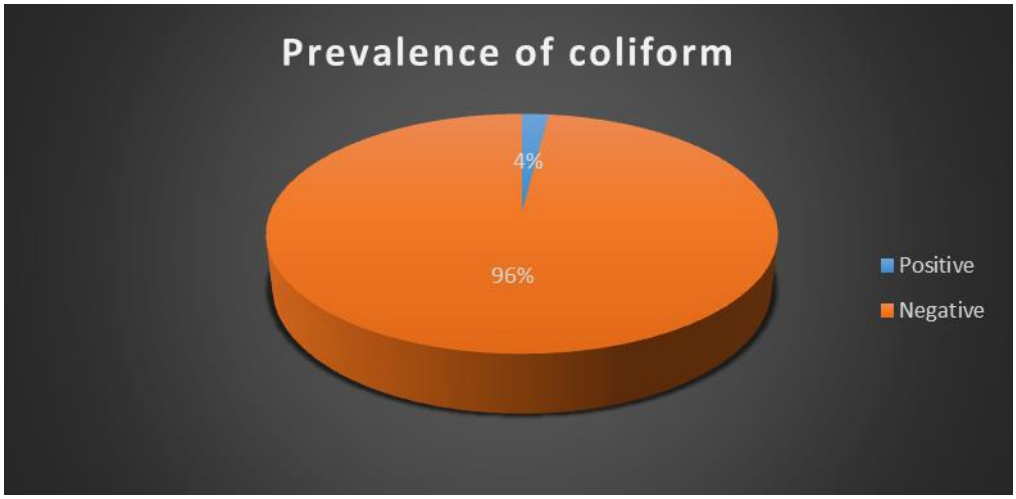

Figure 2: Prevalence of Coliform in Suya.

Risk Factors Associated with Suya Contamination by Coliform

To determine the risk factor associated with coliform contamination of suya a chi square test was conducted and suya exposure were seen to be the lone risk factor (Chi square 13.235, p-value 0.001).

Table 2: Risk Factors Associated with Suya Contamination by Coliform.

Predictors	frequency	percentages	P-value	Chi square
Sources of water				
Tap water	14	28	1.224	0.747
Well water	18	36		
Borehole	17	34		
Stream	1	2		
Sources of raw meat				
Slaughter house	25	50	2.877	0.237
Sales point	21	42		
My kill	4	8		
Vending site				
Bar	14	28	1.586	0.663
Market	11	22		
Street	20	40		
Restaurants	5	10		
Passeling method				
Cement	1	2	1.780	0.776
Plastic paper	13	26		
Notebook	11	22		
Foil paper	11	22		
Flour paper	14	28		
Closeness to sewage or refuge dump site				
Yes	9	18	1.445	0.229
No	41	82		
Suya Exposure				
Yes	42	84	13.235	0.001*
No	8	16		

***-statistically significant at 0.05 significance level**

DISCUSSION

The demographic characteristics of the participants in this study reveal that the majority of suya vendors were between the ages of 26–30 (34%), with most (52%) having only primary education and none with tertiary-level education. These findings are similar to those reported in a study by Bamidele et al. in Nigeria, where the majority of street food vendors also had low levels of formal education, primarily primary or no education at all.[16] The low educational attainment may influence hygiene practices and awareness of food safety regulations, thus impacting the microbiological quality of street-vended foods. In contrast, Ogbonna et al. reported a higher level of secondary and vocational training among food vendors in Enugu, which they associated with better compliance to hygiene protocols.[17] This difference could be due to the presence of more structured food safety education programs in urban centers compared to Bamenda.

In terms of water usage, 36% of suya vendors used tap water to wash meat and utensils, followed closely by borehole (34%) and well water (28%). Only 2% reported using stream water. Similar patterns were observed in a study conducted in Ghana where tap and borehole water were the primary water sources, but higher reliance on untreated surface water was noted in rural areas.[18] In Bamenda, seasonal water shortages and lack of reliable access to treated water likely drive vendors toward alternative sources like boreholes and wells, which may be untreated. The use of non-potable water, especially in food handling, has been strongly associated with increased contamination risks.[19]

The occurrence of coliforms in suya was found to be 4%, which is relatively low compared to studies conducted in Nigeria and Ghana. For instance, Chukuezi et al. found coliform contamination rates as high as 46% in street-vended meat in Owerri[20], and Addo et al. reported a prevalence of 28% in Accra.[21] This disparity may be due to differences in sampling methods, climatic conditions, meat handling practices, or duration of storage before testing. In our study, all coliform-positive samples were traced to street-vended suya, which aligns with previous research showing street vending sites, particularly those without sanitary infrastructure, are hotspots for contamination.[22]

Among various risk factors, only suya exposure was significantly associated with coliform contamination (p = 0.001), suggesting that environmental exposure after grilling—especially at street locations, may be the key determinant of contamination. This result is consistent with the findings of Iroha et al., who demonstrated that post-processing exposure, such as contact with unclean utensils or airborne contaminants, plays a critical role in bacterial contamination of street meat.[23] Other variables, such as water source, meat source, vending location, and proximity to dumpsites, did not show significant associations in this study. This may reflect either generally poor hygiene across sites or the effectiveness of cooking in eliminating initial contamination, making post-cooking handling the most critical point of control.

CONCLUSION

The study found out that the prevalence of coliform contamination of suya in Bamenda II and Bamenda III was 4%. Only suya exposure was found to be the risk factor of coliform contamination of suya.

Author's contribution

LJTV, Study conception and design, writing of the manuscript; NPF, Data collection and critical revision of the manuscript; LHS, Study design, supervision of data collection and critical revision of manuscript; LJTV/NPF/LHS, Data analysis and critical revision of manuscript; CPN/DML, Study design, acquisition and interpretation of data, critical revision of manuscript; GB/CPN/DML, Study conception and design, supervision of data collection and critical revision of manuscript. All authors gave their consent for publication. All authors read and approved the final manuscript.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

REFERENCES

1. Lawrie RA, Ledward DA. *Lawrie's Meat Science*. 7th ed. Cambridge: Woodhead Publishing Limited, 2006.
2. Nychas GJE, Marshall DL, Sofos JN. Meat, poultry and seafood. In: Doyle MP, Beuchat LR, Montville TJ, editors. *Food Microbiology: Fundamentals and Frontiers*. 2nd ed. Washington DC: ASM Press, 2001; 453–519.
3. Ihemeje A, Ojoko EA, Njoku CN. Suya: a popular spicy grilled meat delicacy in Nigeria and Cameroon – A review. *Int J Adv Acad Res*, 2015; 1(5): 1–7.
4. Ologhobo AD. Contamination of ready-to-eat street vended suya meat in Nigeria. *Afr J Food Sci*, 2010; 4(4): 157–160.
5. Banwart GJ. *Basic Food Microbiology*. 2nd ed. New York: Chapman and Hall, 1989.
6. World Health Organization. *Protein and Amino Acid Requirements in Human Nutrition*. WHO Technical Report Series No. 935. Geneva: WHO, 2007.
7. Pennington H. Escherichia coli O157. *Lancet*, 2010; 376(9750): 1428–1435.
8. Karmali MA. Infection by Shiga toxin-producing *Escherichia coli*: An overview. *Mol Biotechnol*, 2004; 26(2): 117–122.
9. Rangel JM, Sparling PH, Crowe C, Griffin PM, Swerdlow DL. Epidemiology of *Escherichia coli* O157:H7 outbreaks, United States, 1982–2002. *Emerg Infect Dis*, 2005; 11(4): 603–609.
10. Prescott LM, Harley JP, Klein DA. *Microbiology*. 6th ed. Boston: McGraw-Hill, 2005.
11. Jay JM, Loessner MJ, Golden DA. *Modern Food Microbiology*. 7th ed. New York: Springer Science+Business Media, 2005.
12. United States Environmental Protection Agency (EPA). *Microbiological Methods for Monitoring the Environment: Water and Wastes*. EPA-600/8-78-017. Washington, DC: EPA, 1978.
13. Adams MR, Moss MO. *Food Microbiology*. 3rd ed. Cambridge: Royal Society of Chemistry, 2008.
14. Akoachere JF, Tanih NF, Ndip LM, Ndip RN. Impact of water scarcity on microbial quality of alternative water sources in urban settings: Case study in Buea, Cameroon. *Afr Health Sci*, 2015; 15(3): 875–880.
15. WHO/FAO. *Foodborne Disease Burden Epidemiology Reference Group 2007–2015*. Geneva: World Health Organization, 2015.
16. Bamidele JO, Abodunrin OL, Adebimpe WO. Hygiene behavior and sanitation practices among street food vendors in Southern Nigeria. *Int J Health Sci (Qassim)*, 2015; 9(4): 334–344.
17. Ogbonna DN. Environmental health and hygiene practices among food vendors in urban markets in Nigeria. *Pak J Nutr*, 2011; 10(11): 1002–1007.
18. Mensah P, Yeboah-Manu D, Owusu-Darko K, Ablordey A. Street foods in Accra, Ghana: How safe are they? *Bull World Health Organ*, 2002; 80(7): 546–554.
19. Tambekar DH, Jaiswal VJ, Dhanorkar DV, Gulhane PB, Dudhane MN. Microbial quality and safety of street vended fruit juices: A case study of Amravati city. *Int J Food Saf*, 2009; 11: 1–3.
20. Chukuezi CO. Food safety and hygienic practices of street food vendors in Owerri, Nigeria. *Stud Sociol Sci*, 2010; 1(1): 50–57.
21. Addo KK, Mensah GI, Bonsu C, Akyeh ML, Mensah D. Microbiological quality and antibiotic residues in ready-to-eat corned beef from retail outlets in Accra, Ghana. *Food Control*, 2007; 18(9): 1003–1008.

22. Ohiokpehai O. Nutritional aspects of street foods in Botswana. *Pak J Nutr*, 2003; 2(2): 76–81.
23. Iroha IR, Ugbo EC, Ilondu NA, Oji AE. Bacteria contamination of street-vended meat suya in Nigeria: Public health implications. *J Microbiol Biotechnol Res*, 2011; 1(2): 70–76.