Usang et al. *Afr. J. Clin. Exper. Microbiol.* 2026; 27 (3): 402 - 405 https://www.afrjcem.org

African Journal of Clinical and Experimental Microbiology. ISSN 1595-689X Jul 2026; Vol.27 No.3
AJCEM/2498. https://www.ajol.info/index.php/ajcem

Short Communication **Open Access**

Prevalence and identification of microbial contaminants of reusable plastic containers from informal food vending sites in Calabar, Nigeria

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Abstract

Background: Reusable plastic containers are widely used in informal food vending sites in developing countries like Nigeria, posing potential risks for microbial contamination and foodborne illnesses. This study determined the prevalence and identify microbial contaminants in 350 reusable plastic containers sampled from selected sites (markets, schools, roadside sellers, hawkers, and motor parks) in Calabar, Nigeria.
Methodology: The study applied standard swab and culture method to collect and analyze samples, which involved sampling 350 different containers from the 5 randomly selected sampling sites in Calabar. Chi-square test was used to assess the differences in contamination rates of containers between the sampling sites with $p<0.05$ considered as statistical significance level.
Results: Overall, 288 (82.3%) containers were contaminated, predominantly with bacteria (81.7%, n=286), which includes *Escherichia coli* (56.6%, n=163), *Staphylococcus aureus* (37.4%, n=108), *Enterococcus faecalis* (4.2%, n=12), and *Pseudomonas aeruginosa* (1.1%, n=3). Fungal contaminants were minimal (0.6%, n=2), with no parasites detected. Contamination rates varied by sites but showed no significant differences between sampling sites ($\chi^2=7.40$, $p=0.116$).
Conclusion: These findings highlight significant public health risks, comparable to high contamination levels in other African contexts but exceeding those in developed nations. Interventions focusing on hygiene education and regulation are recommended to mitigate foodborne disease burdens in Nigeria.

Keywords: Microbial contamination, reusable plastic containers, food vending, pathogens, Nigeria

Received Feb 14, 2026; Revised Apr 30, 2026; Accepted May 1, 2026

Prévalence et identification des contaminants microbiens des contenants en plastique réutilisables provenant de points de vente alimentaires informels à Calabar, au Nigéria

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Résumé:

Contexte: Les contenants en plastique réutilisables sont largement utilisés dans les points de vente alimentaires informels des pays en développement comme le Nigéria, ce qui représente un risque potentiel de contamination microbienne et de maladies d'origine alimentaire. Cette étude a déterminé la prévalence et identifié les contaminants microbiens présents dans 350 contenants en plastique réutilisables prélevés dans différents sites (marchés, écoles,

vendeurs ambulants, colporteurs et gares routières) à Calabar, au Nigéria.
Méthodologie: L'étude a utilisé la méthode standard de prélèvement et de culture pour collecter et analyser les échantillons. L'échantillonnage a porté sur 350 récipients différents provenant de 5 sites sélectionnés aléatoirement à Calabar. Le test du χ^2 a été utilisé pour évaluer les différences de taux de contamination des récipients entre les sites d'échantillonnage, le seuil de signification statistique étant fixé à $p<0,05$.
Résultats: Au total, 288 récipients (82,3%) étaient contaminés, principalement par des bactéries (81,7%, n=286), notamment *Escherichia coli* (56,6%, n=163), *Staphylococcus aureus* (37,4%, n=108), *Enterococcus faecalis* (4,2%, n=12) et *Pseudomonas aeruginosa* (1,1%, n=3). La contamination fongique était minime (0,6%, n=2) et aucun parasite n'a été détecté. Les taux de contamination variaient selon les sites, mais aucune différence significative n'a été observée entre les sites d'échantillonnage ($\chi^2=7,40$, $p=0,116$).
Conclusion: Ces résultats mettent en évidence des risques importants pour la santé publique, comparables aux niveaux de contamination élevés observés dans d'autres contextes africains, mais supérieurs à ceux des pays développés. Des interventions axées sur l'éducation et la réglementation en matière d'hygiène sont recommandées afin de réduire la charge des maladies d'origine alimentaire au Nigéria.

Mots-clés: Contamination microbienne, contenants en plastique réutilisables, vente ambulante d'aliments, agents pathogènes, Nigéria

Introduction:

Food safety remains a critical public health challenge in developing countries, where informal food vending contributes significantly to dietary intake but often lacks stringent hygiene standards (1). In Nigeria, street-vended foods are a staple for urban populations, yet they are frequently associated with microbial contamination due to poor handling practices, inadequate sanitation, and reuse of containers without proper cleaning (2). Reusable plastic containers, common in informal settings, can harbor pathogenic bacteria such as *Escherichia coli* and *Staphylococcus aureus*, leading to foodborne illnesses that account for over 200,000 deaths annually in Nigeria (3).

Globally, the World Health Organization estimates 600 million cases of foodborne diseases yearly, with sub-Saharan Africa bearing a disproportionate burden (4). In Calabar, a bustling city in southern Nigeria, informal vending sites like markets and motor parks serve as hubs for food distribution, exacerbating contamination risks through environmental exposure and cross-contamination (5). Previous studies in Nigeria have reported high bacterial loads in food contact surfaces, but data specific to reusable containers in Calabar is limited (6).

The objectives of this study are to determine the prevalence of microbial contaminants, identify bacterial and fungi isolates, and assess variations across vending sites, with the aim of providing insights for targeted interventions.

Materials and method:

Study design, sampling sites and collection:

A cross-sectional study was conducted in Calabar, Nigeria, from January to June 2025. A total of 350 reusable plastic containers were randomly sampled from five informal food vending sites; markets (n=126), schools (n=74), roadside sellers (n=84), hawkers (n=52), and motor parks/garages (n=14). Containers were selected based on active use for food storage or serving.

Sterile swabs moistened with buffered peptone water were used to sample inner surfaces, following standard protocols (ISO 18593: 2018). Swabs were transported in cool boxes to the laboratory within 2 hours for analysis.

Microbial culture, isolation and identification:

Swabs were inoculated into enrichment broth (tryptic soy broth) and incubated at 37°C for 24 hours. For bacterial isolation, serial dilutions were plated on selective media; MacConkey agar for *E. coli*, mannitol salt agar for *S. aureus*, *Pseudomonas* cetrimide agar for *P. aeruginosa*, and bile esculin azide agar for *Enterococcus* (7).

Colonies were enumerated as colony-forming units (CFU/ml) and identified by Gram stain reaction and biochemical tests (API 20E systems) (8). Fungal isolation involved culture on Sabouraud dextrose agar (with chloramphenicol), incubation at 25°C for 5-7 days, followed by microscopic identification. Parasites were identified in urine samples by wet mounts and concentration techniques (9).

Statistical analysis:

Data obtained from the laboratory culture, isolation and identification were analyzed using SPSS version 26.0. Contamination rates were expressed as percentages. Chi-square test was used to determine associations between sites and contamination rates, with $p<0.05$ considered statistical significance.

Results

Of the 350 containers sampled, 288 (82.3%) were contaminated with microbial pathogens (Table 1). There is no significant diffe-

rence in contamination rates between the five different sampling sites (χ^2=7.40, df=4, p= 0.116) (Table 2).

Bacterial contamination predominated, in 286 containers (81.7%), fungal in 2 (0.6%), with 2 overlaps (0.6%), but no parasite was detected in any container (Table 3). Bacterial isolates included *E. coli* (56.6%, n=163), *S. aureus* (37.4%, n=108), *E. faecalis* (4.2%, n=12), and *P. aeruginosa* (1.1%, n=3) (Table 4).

Table 1: Contamination rate of food vending plastic containers in Calabar, Nigeria

Parameter	Number	Percentage (%)
No of containers sampled	350	-
No of containers contaminated	288	82.3
No of containers uncontaminated	62	17.7

Table 4: Contamination by sites

Site	No sampled	No contaminated	%
Markets	126	105	83.3
Schools	74	64	86.5
Roadside sellers	84	67	79.8
Hawkers	52	38	73.1
Motor parks	14	14	100.0
Total	350	288	82.3

No significant site differences (χ^2=7.40, df=4, p=0.116)

Table 3: Contamination of containers by microbial types in Calabar, Nigeria

Type	Number	Percentage (%)
Bacterial	286	81.7
Fungal	2	0.6
Parasitic	0	0
Bacterial + Fungal	2	0.6

Table 3: Frequency of bacterial isolates contaminating food vending plastic containers in Calabar, Nigeria

Species	Number of isolates	Percentage (%)
Escherichia coli	163	56.6
Staphylococcus aureus	108	37.4
Enterococcus faecalis	12	4.19
Pseudomonas aeruginosa	3	1.05
Total	**286**	**100.0**

Discussion:

The high contamination rate (82.3%) observed underscores the vulnerability of reusable plastic containers in informal vending, aligning with studies in Nigeria reporting 70%-90% bacterial loads in similar surfaces (6,9). This high contamination rate can be attributed to poor quality water used in these informal food vending areas (10,11). *Escherichia coli* and *S. aureus* dominance reflects fecal and human skin sources, common in unhygienic handling (2), contrary to the study reporting *S. aureus* as the most prevalent bacteria isolated (12).

In Africa, comparable rates include 54.3% *E. coli* in Ethiopian street foods (13) and 37.6% in raw foods across the continent (14). Motor parks showed 100% contamination, likely due to high traffic and poor sanitation, similar to Mozambican vendors (15). Globally, developed countries report lower rates (e.g. <20% in U.S. food surfaces) due to strict regulations and advanced cleaning (7). In contrast, developing nations face higher burdens from inadequate infrastructure (1).

Microbial contamination in reusable food containers leads to economic losses through three main effects, which include creating unnecessary food waste and harming street vendor businesses and raising medical expenses and control expenses (16). This study's findings imply potential for outbreaks, contributing to Nigeria's $3.6 billion annual foodborne illness costs (3). Compared to Africa with 91 million cases/year, figures are lower in Europe/Asia due to better surveillance (4). Recommendations include vendor training, as in Ghanaian interventions reducing contamination by 40% (5). Limitation of this study include lack of molecular typing. Future research should incorporate AMR profiling.

Conclusion:

This study showed that reusable plastic containers used by informal food vendors showed high contamination rate of 82.3% probably due to unsatisfactory hygiene standards and unsafe water sources. The presence of the bacteria contaminants such as *E. coli* signifies fecal contamination from human excretions which poses high risk of foodborne diseases to people who live in high-density regions such as motor parks. The contamination of the containers sampled presents significant threats to public health that call for urgent measures to improve hygiene practices, vendor education programmes and effective food safety regulations.

Contributions of authors:

AU conceived the study and participated in the laboratory analysis; EVO edited, proof read and participated in the laboratory analysis; OBA analyzed the data collected. All authors approved the manuscript submitted for publication.

Source of funding:

No funding was received for the study

Conflict of interests:

Authors declare that they have no competing interests, financial or otherwise, that could have influenced the work reported in this manuscript

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