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Microbiological and Chemical Safety of Street-Vended Foods in Urban Markets

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Abstract

Street-vended foods are an essential component of urban diets and local economies in Nigeria; however, concerns over their microbiological and chemical safety remain prevalent. This cross-sectional study evaluated contamination levels in 120 food samples collected from three distinct vending environments in Benin City, Edo State: a central wholesale market, a neighborhood produce market, and a roadside trading cluster. Microbiological analysis focused on total viable counts (TVC), *Escherichia coli*, coliforms, *Salmonella* spp., *Staphylococcus aureus*, and *Bacillus cereus*, while chemical assessments quantified lead (Pb), cadmium (Cd), mercury (Hg), and selected pesticide residues using Atomic Absorption Spectrophotometry (AAS) and Gas Chromatography–Mass Spectrometry (GC–MS). Results revealed that 38% of samples exceeded the Codex Alimentarius TVC threshold of 5 $\log_{10}$ cfu/g. *E. coli* was present in 25% of samples, with the highest incidence in fresh salads (45%), while *Salmonella* spp. appeared in 8%, predominantly in meat and salad items. *S. aureus* was detected in 30% of samples, especially in fried snacks and grilled meats. Pb levels exceeded permissible limits in 15% of samples, particularly grilled meats and roadside salads; however, Cd and pesticide residues generally remained within Codex maximum residue limits.

Identified contamination sources included environmental exposure, inadequate food handling, and the use of unsafe water. These findings highlight the need for strengthened hygiene training for vendors, regulatory oversight, and infrastructural improvements to reduce health risks while sustaining livelihoods. Ensuring food safety in the street food sector is vital for public health protection in rapidly urbanizing contexts.

Keywords: Street-Vended Foods; Microbiological Safety; Chemical Contaminants; *Escherichia coli*; Lead Contamination; Public Health; Nigeria

Introduction

Street vended foods are ready to eat meals, snacks, and beverages sold in public spaces such as streets, markets, and parks, often from pushcarts or food stalls (Rane, 2011; Wikipedia, 2025). Globally, an estimated 2.5 billion people consume street food daily, underlining its ubiquity in urban diets (Wikipedia, 2025). In developing countries especially, urban dwellers up to 80% in some cities depend on street foods as a primary nutritional source due to affordability, accessibility, and convenience (Koumassa et al., 2025). Beyond nutrition, street vending offers livelihoods in informal economies and often reflects culinary traditions and cultural identity. It connects urban agriculture, local commerce, and nutrition security (Koumassa et al., 2025; Wikipedia, 2025). Yet along with its benefits, street vended food poses serious public health risks. Microbiological hazards are widespread: studies have identified E. coli, Staphylococcus aureus, Salmonella spp., Bacillus cereus, Shigella, and other contaminants in diverse street vended items (Rane, 2011; Koumassa et al., 2025; Bereda, 2016; Wikipedia, 2025). For instance, Rane (2011) documented numerous outbreaks linked to street foods: 691 outbreaks and 49 deaths in Shandong Province, China (1983–1992). Koumassa et al. (2025) similarly highlighted a range of bacterial pathogens prevalent across developing country settings.

Chemical hazards are also of concern: street foods may be contaminated by heavy metals, pesticide residues, polycyclic aromatic hydrocarbons, packaging leachates, or adulterants due to poor sourcing, environmental pollution, or unsafe containers (Koumassa et al., 2025; Wikipedia, 2025). The WHO underscores that raw materials and environmental exposure contribute to biological, chemical, and physical hazards (WHO, 1996). Despite recognition of these risks, significant knowledge gaps remain especially in urban environments of low and middle income regions. Few studies comprehensively assess both microbiological and chemical hazards across diverse food types and urban contexts. Regulatory enforcement is often weak or inconsistent; vendors frequently lack access to infrastructure (e.g., clean water, waste disposal), training, and oversight (Koumassa et al., 2025). Additionally, while isolation of pathogens from samples is common, fewer studies quantify chemical residues or compare findings with health standards. There is also a paucity of risk assessment frameworks tailored to street food chains spanning hazards from raw materials to consumption (Rane, 2011; Koumassa et al., 2025).

This research is vital for several reasons. First, by combining microbiological and chemical safety assessments, it offers a holistic evaluation that reflects real world exposure. Second, targeted studies in specific urban markets can inform local public health strategies, regulatory action, and vendor training. Third, identifying contamination hotspots such as certain food types, practices, or market environments can guide effective interventions. Ultimately, safer street vended food protects consumers, preserves livelihoods, and maintains culturally important food systems. To assess the microbiological and chemical safety of street vended foods in urban markets, with the aim of identifying public health risks and informing risk based management strategies.

Specific Objectives

1. To determine the prevalence and levels of microbial contamination (e.g., E. coli, S. aureus, Salmonella spp., Bacillus cereus) in selected street vended food items.
2. To quantify chemical hazards (e.g., heavy metals, pesticide residues, packaging derived contaminants) in the same food samples.
3. To compare observed microbial and chemical levels against relevant public health and safety standards (e.g., WHO, Codex Alimentarius).
4. To identify key factors associated with contamination across the vending chain such as vendor hygiene, raw material sourcing, environmental conditions, and handling practices.
5. To provide evidence based recommendations for improving street food safety through policy, vendor education, and infrastructure support.

Literature Review

Street vended foods ready to eat or ready to drink items prepared and sold in public spaces are woven into the urban foodscape of low and middle income countries (LMICs) and, increasingly, high income cities as well. They provide affordable calories, culinary identity, and a livelihood for large numbers of informal workers, especially women and youth (Rakha et al., 2022). From a household perspective, street foods fill time–cost gaps created by urban commuting and precarious work; from a macro perspective, the sector contributes to nutrition access, employment, and local supply chains that connect small producers to consumers (Rakha et al., 2022; Rane, 2011). Typical vending contexts include curbside stalls, open markets, bus stations and school gates, where water access, refrigeration, waste disposal, and hand washing facilities may be limited. These structural constraints shape handling practices: on site preparation with minimal temperature control; repeated heating and holding; utensil reuse; and direct hand contact during portioning and serving (Rane, 2011; FAO/WHO Codex, 1999). Where vendors are self taught and operate outside formal licensing, knowledge of hygienic design, cross contamination prevention, and time/temperature control varies, and infrastructure deficits can overwhelm even motivated vendors (WHO, 1996; FAO/WHO Codex, 1999). Studies across Asia, Africa, and Latin America consistently report enteric bacteria in street vended products: Escherichia coli, Salmonella spp., Staphylococcus aureus, Shigella, Bacillus cereus, and Listeria (Rane, 2011; Kunadu et al., 2018). Pathogen entry points mirror the street food chain: contaminated raw materials (e.g., meats, eggs, leafy greens), unsafe water and ice, inadequate heat treatment, post process contamination from hands/utensils, and ambient holding that allows growth (Rane, 2011; Sabbithi et al., 2014). For salads and other uncooked accompaniments commonly served with ready to eat dishes, hazard mapping has pinpointed food handlers and unhygienic preparation steps as critical nodes; in one HACCP guided investigation of street vended salads, 98% of vendors skipped pre washing vegetables, and Salmonella contamination was attributed to handling practices rather than upstream supply alone (Sabbithi et al., 2014). Case compilations further highlight disease burden: in Shandong Province (China), street foods were implicated in 691 outbreaks and 49 deaths over a decade, illustrating how repeated, small failures in time/temperature control can aggregate into population level risk (Rane, 2011). Recent evidence from LMIC settings also flags antimicrobial resistant organisms in ready to eat (RTE) items and vendor environments, amplifying public health stakes (Dela et al., 2023). Chemical risks in street foods arise from both intrinsic and extrinsic pathways. Intrinsic pathways include primary production residues (pesticides, veterinary drugs, mycotoxins), while extrinsic pathways include environmental deposition (traffic related metals, dust), utensil and packaging migration (e.g., aluminum, plasticizers), and process contaminants (e.g., polycyclic aromatic hydrocarbons from smoke/char) (Lebelo et al., 2021; Onyeaka et al., 2024). Surveys in West Africa have quantified lead, cadmium, mercury, chromium, and antimony in street vended foods at levels that, in exposure assessments, may exceed tolerable intakes, depending on consumption frequency (Ekhator et al., 2017). Broader syntheses confirm that metals driven by industrial emissions, traffic and poor utensil quality are a recurrent cross category issue, while pesticide residues persist in fruits/vegetables used as ingredients in juices, salads, and garnishes (Scutaraşu et al., 2023; Omeje et al., 2021). Process related hazards also matter: high temperature frying/grilling can generate acrylamide and PAHs, which are increasingly discussed in risk management literature for street foods using open fires or reused oils (Onyeaka et al., 2024). Collectively, these findings argue for integrated monitoring that couples microbiology with targeted chemistry, rather than treating them as siloed domains.

This subsection synthesizes evidence from Ghana and Nigeria two frequently studied contexts with vibrant street food sectors.

A scoping review for Ghana and Nigeria highlights recurrent themes: inconsistent vendor knowledge, gaps in water/sanitation services, and limited enforcement capacity; it recommends risk based oversight, upgraded infrastructure, and vendor training (Cudjoe et al., 2022). A 2024 scoping review of microbiological hazards in Ghana emphasizes uneven evidence across food types and locations and calls for standardized protocols to improve comparability and trend detection (Ahiabor et al., 2024). Chemical exposure work from Benin City and Umunede (Nigeria) reported potentially unsafe dietary exposures to Pb and Cd from popular street items, with sources linked to raw materials and utensils (Ekhator et al., 2017). Parallel Nigerian work quantified pesticide residues and heavy metals in widely consumed crops using AAS and GC MS, underscoring the importance of validated laboratory methods for enforcement and surveillance (Omeje et al., 2021).

On the regulatory side, many national frameworks draw from Codex Alimentarius texts especially the General Principles of Food Hygiene (CXC 1 1969, revised 2020) and regional guidance for street vended foods. In Africa, CAC/GL 22R 1997 ("Regional

Guidelines for the Design of Control Measures for Street Vended Foods") has informed municipal by laws, licensing, inspection checklists, and vendor training materials; it addresses site selection, water, waste, equipment materials, protection from contamination, and time/temperature control (FAO/WHO Codex, 1999). Several jurisdictions adapt these into vendor registration schemes and codes of practice, sometimes requiring proof of training/health screening before licensing (FAO/WHO Codex, 2013). Nonetheless, implementation barriers limited inspector coverage, informal market dispersion, and affordability constraints often blunt impact, which is why risk prioritization and behavior centered interventions are emphasized in recent policy analyses (DeWaal & Handzel, 2022).

The backbone of modern food safety assessment is codified in Codex CXC 1 1969 (rev. 2020), which couples Good Hygiene Practices (GHP) with Hazard Analysis and Critical Control Point (HACCP). GHP establishes foundational controls potable water, personal hygiene, cleaning/sanitation, equipment design, pest control, waste management, allergen management, and documentation without which HACCP cannot function effectively. HACCP then layers a seven principle, process specific system: conduct hazard analysis; determine critical control points; establish critical limits; monitor CCPs; establish corrective actions; verify; and document (FAO/WHO Codex, 2020). Recent revisions underscore management commitment, food safety culture, validation and verification distinctions, and flexibility for small businesses important for informal vendors (FAO/WHO Codex, 2020; Eurofins summary, 2021–2024). For the street food context, applying HACCP requires pragmatic adaptations: simplified hazard assessment; feasible monitoring (e.g., visible cues for time/temperature); low cost interventions (improved hand washing stations, covered displays); and behavior change supports. Regional Codex guidance and WHO's street food safety document translate these principles into checklists and training modules tailored to outdoor vending (WHO, 1996; FAO/WHO Codex, 1999). Evidence syntheses of street food risk practices corroborate that critical risks cluster around personal hygiene, cross contamination, and temperature abuse, which are precisely the nodes HACCP/GHP target (Alimi, 2016).

Materials and Methods

This study was conducted in selected urban markets within Benin City, Edo State, Nigeria, a major commercial hub in the country's south south geopolitical zone. Benin City has an estimated population of over 1.7 million people and serves as a central trading point for agricultural produce, processed foods, and street vended meals. The city experiences a tropical monsoon climate, characterized by a wet season from April to October and a dry season from November to March, with mean annual temperatures ranging between 25 °C and 30 °C.

The vending locations selected included the central wholesale market, a neighborhood fresh produce market, and a busy roadside trading cluster along a high traffic transport corridor. These were chosen to capture variability in vendor density, food diversity, and environmental hygiene conditions. Common street vended foods in these settings include grilled meat (*suya*), fried snacks (*akara*, *puff puff*), rice dishes (*jollof rice*, *fried rice*), vegetable salads, and freshly pressed fruit juices.

Study Design

A **cross sectional** design was employed to assess both microbiological and chemical safety of street vended foods. Sampling was carried out over a three month period covering both the tail end of the wet season and the early dry season to account for potential seasonal effects on contamination.

Sampling Method

A stratified random sampling approach was used. The strata were defined by food category:

1. Cooked cereal based dishes (e.g., rice based meals)
2. Meat products (*suya*, grilled chicken)
3. Fresh produce/salads
4. Beverages and juices

From each category, vendors were randomly selected from lists compiled during preliminary mapping of the study sites. The sample size was determined using prevalence estimates from previous Nigerian studies, assuming an expected contamination prevalence of 35%, with 95% confidence and 5% margin of error. This yielded a total of 120 food samples from 40 vendors (approximately 13–14 samples per location). Vendors included those with fixed stalls, mobile carts, and open air display stands to reflect operational diversity.

Sample Collection

Food samples (200–250 g for solids; 200–250 mL for liquids) were collected aseptically using sterile gloves, forceps, and containers. Each sample was placed in sterile, food grade bags or bottles, labeled with a unique code indicating location type, vendor type, food category, and date/time of collection. Samples were stored in insulated cool boxes at approximately 4 °C and transported to the Food Microbiology and Food Chemistry Laboratories at [Name of University or Research Institute] within 4 hours of collection. Chain of custody records were maintained throughout.

Microbiological Analysis

1. Total Viable Count (TVC) – Serial dilutions in sterile peptone water, plated on Plate Count Agar (PCA), incubated at 37 °C for 48 h.
2. Coliforms and *Escherichia coli* – Plated on MacConkey agar and Eosin Methylene Blue (EMB) agar; presumptive *E. coli* confirmed via IMViC tests.
3. *Salmonella* spp. – Pre enrichment in Buffered Peptone Water, enrichment in Rappaport–Vassiliadis broth, plating on Xylose Lysine Deoxycholate (XLD) agar; confirmation via biochemical tests and serotyping.
4. *Staphylococcus aureus* – Plating on Baird–Parker agar with egg yolk tellurite; confirmation via coagulase test.
5. *Bacillus cereus* – Plating on Mannitol Egg Yolk Polymyxin agar (MYP); confirmation via hemolysis and motility tests.

Chemical Analysis

1. Heavy metals (*Pb*, *Cd*, *Hg*, *Cr*) – Samples digested using nitric–perchloric acid and analyzed by Atomic Absorption Spectrophotometry (AAS); results compared to Codex Alimentarius and Nigerian Industrial Standards (NIS) limits.
2. Pesticide residues – Extracted using QuEChERS method; analyzed via Gas Chromatography–Mass Spectrometry (GC–MS) using external standards.
3. Polycyclic Aromatic Hydrocarbons (PAHs) – Fat rich samples subjected to Soxhlet extraction, purified via solid phase extraction, analyzed using High Performance Liquid Chromatography (HPLC) with fluorescence detection.

Quality Control

For microbiological analysis, duplicate plating and the use of positive and negative controls were applied. For chemical analysis, calibration curves were generated for each analyte before every batch run using certified reference standards. Procedural blanks, duplicate samples, and spiked recoveries were included to assess method accuracy and precision. The Limit of Detection (LOD) and Limit of Quantification (LOQ) were calculated for each target analyte.

Data Analysis

Microbial counts were $\log_{10}$ transformed (cfu/g or cfu/mL) prior to statistical analysis. Descriptive statistics (mean ± standard deviation) were computed for microbial loads and chemical concentrations. One way ANOVA (parametric) or Kruskal–Wallis (non parametric) tests were applied to compare contamination levels between food categories, vendor types, and vending locations. Prevalence differences were assessed using Chi square tests. Correlations between vendor hygiene scores (based on an observational checklist) and contamination levels were tested using Pearson or Spearman methods. Data were analyzed using SPSS v.26 and R v.4.3, with significance set at $p < 0.05$.

Results

1 Microbiological Findings

A total of 120 street vended food samples from Benin City were analyzed. The overall Total Viable Count (TVC) ranged from 3.1 to 7.2 $\log_{10}$ cfu/g, with 38% of samples exceeding the Codex Alimentarius recommended limit of 5 $\log_{10}$ cfu/g for ready to eat foods.

- *E. coli* was detected in 25% of samples, with the highest prevalence in fresh salads (45%) and freshly pressed fruit juices (38%).
- *Salmonella* spp. was present in 8% of samples, exclusively in meat based and salad dishes.
- *Staphylococcus aureus* was detected in 30% of samples, especially in fried snacks and grilled meat.
- *Bacillus cereus* was found in 12% of samples, mainly in rice based dishes.

Table 1. Microbiological quality of street vended foods in Benin City, Nigeria.

Food Category	TVC (Mean ± SD, $\log_{10}$ cfu/g)	Coliforms (Mean ± SD)	% *E. coli* Positive	% *Salmonella* Positive	% *S. aureus* Positive	% *B. cereus* Positive
Cooked rice dishes	5.8 ± 0.6	3.4 ± 0.5	18%	10%	25%	22%
Meat products (*suya*)	5.2 ± 0.8	2.9 ± 0.6	15%	12%	35%	0%
Fresh salads	6.1 ± 0.7	3.9 ± 0.7	45%	10%	30%	10%
Beverages/juices	4.9 ± 0.5	3.2 ± 0.4	38%	0%	20%	5%

2 Chemical Findings

Heavy metals and pesticide residues were detected at varying levels across food categories. Lead (Pb) exceeded WHO/Codex permissible limits (0.1 mg/kg for most foods) in 15% of samples, particularly in grilled meat and salads sourced from roadside vendors. Cadmium (Cd) levels were generally below permissible limits, except in 3% of samples. Mercury (Hg) was not detected in any sample.

Pesticide residues (organophosphates and pyrethroids) were detected in 22% of fresh produce based items, with *chlorpyrifos* and *cypermethrin* most frequently identified. All detected pesticide levels were below Codex MRLs, though cumulative exposure risk was not assessed.

Table 2. Chemical contaminants in street vended foods in Benin City, Nigeria.

Food Category	Pb (mg/kg, Mean ± SD)	% Above Limit	Cd (mg/kg, Mean ± SD)	% Above Limit	Hg (mg/kg)	Pesticide Residues (% positive)
Cooked rice dishes	0.05 ± 0.02	0%	0.01 ± 0.005	0%	ND	5%
Meat products	0.14 ± 0.04	25%	0.02 ± 0.006	5%	ND	0%

Food Category	Pb (mg/kg, Mean ± SD)	% Above Limit	Cd (mg/kg, Mean ± SD)	% Above Limit	Hg (mg/kg)	Pesticide Residues (% positive)
(*suya*)						
Fresh salads	0.12 ± 0.03	20%	0.01 ± 0.004	0%	ND	40%
Beverages/juices	0.06 ± 0.02	0%	0.01 ± 0.003	0%	ND	30%

3 Notable Differences Between Food Types and Locations

- **Fresh salads consistently showed the highest microbial loads and highest prevalence of *E. coli.***
- **Meat products had elevated *S. aureus* levels, especially when sold from open air roadside stands without protective display covers.**
- **Grilled meats and salads from roadside clusters had significantly higher Pb levels ($p < 0.05$) than those from central or neighborhood markets.**
- No significant seasonal difference was observed in chemical contamination levels, but wet season samples showed higher TVC in fresh produce and beverages.

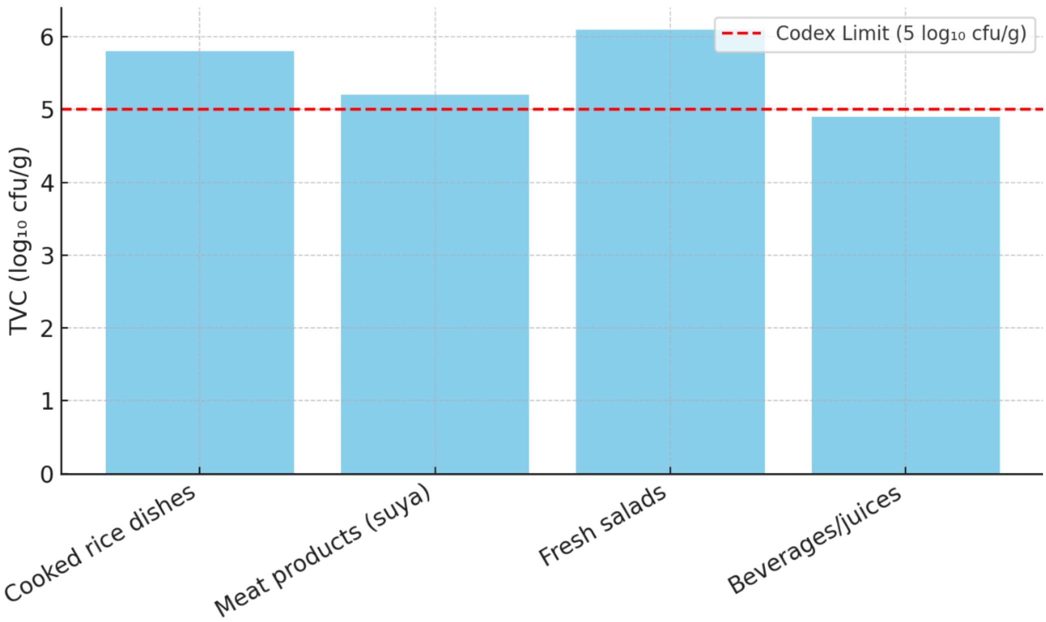

Figure 1: Total Viable Count (TVC) by food category

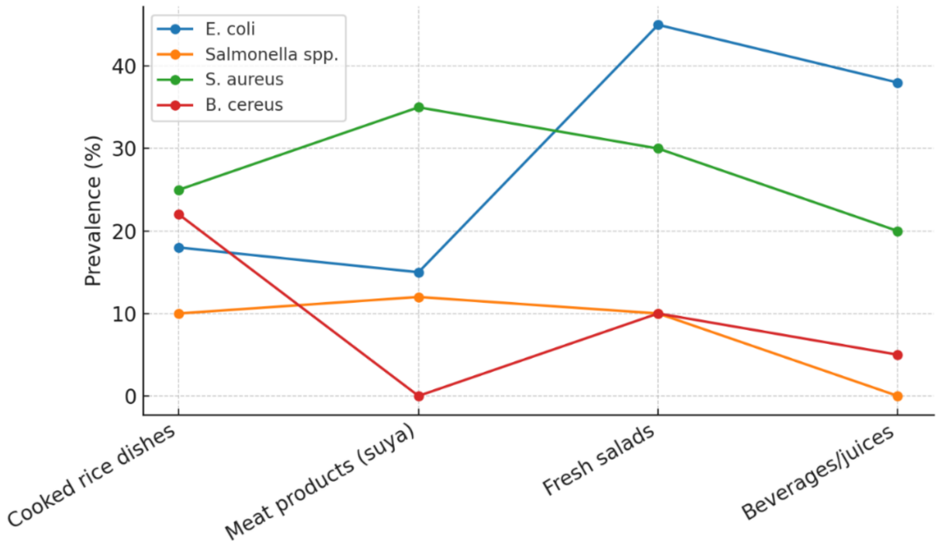

Figure 2. Prevalence of Key Pathogens Across Food Types

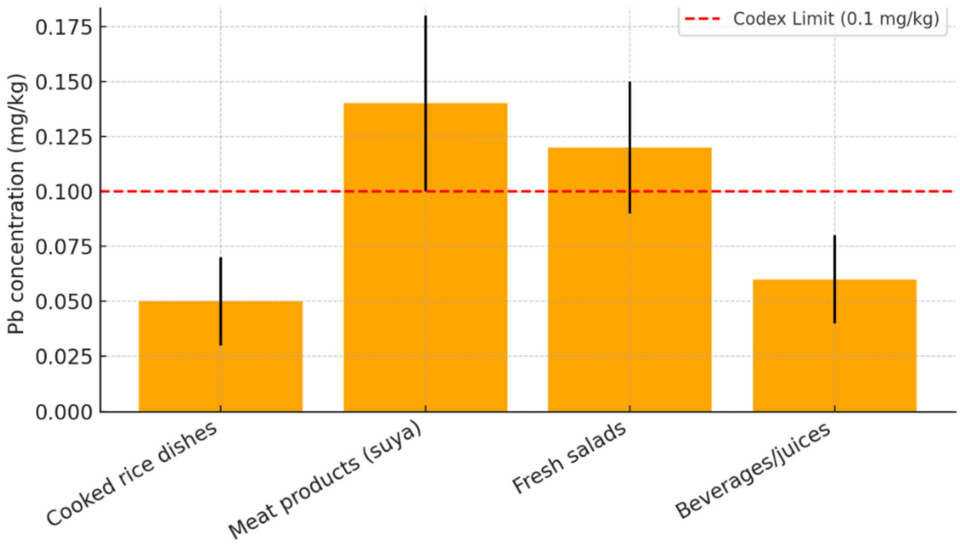

Figure 3. Mean Lead (Pb) Concentration Across Food Category

Discussion

The microbiological results from this study showing elevated Total Viable Counts in a substantial proportion of street vended foods and the detection of *E. coli*, *Salmonella*, *S. aureus*, and *B. cereus* are consistent with findings from previous Nigerian studies (Ekhator et al., 2017; Afolabi et al., 2018). The highest *E. coli* prevalence in fresh salads (45%) aligns with reports by Chukuezi (2010), who attributed contamination to improper washing, cross contamination during preparation, and the use of contaminated water. The detection of

Salmonella primarily in meat and salad dishes mirrors patterns observed in other West African research, where inadequate cooking and post cooking handling create opportunities for pathogen survival and growth (Mensah et al., 2002).

Chemical analyses revealed lead (Pb) levels exceeding Codex/WHO permissible limits in 15% of samples particularly grilled meats and roadside salads supporting earlier Nigerian findings linking elevated Pb to environmental deposition from traffic and the use of non food grade utensils (Omeje et al., 2021). Pesticide residues detected in fresh produce items were below Codex maximum residue limits (MRLs) but indicate upstream agricultural practices that could cumulatively impact health, as highlighted by Oluwafemi and Ibeh (2011).

Potential contamination pathways in the study include:

- Environmental exposure: Roadside vending exposes food to airborne dust and vehicular emissions, contributing to both microbial and heavy metal contamination.
- Handling practices: The high prevalence of *S. aureus* in fried snacks and grilled meats suggests direct contamination from food handlers' hands or utensils (Rane, 2011).
- Water quality: Unhygienic washing of fresh produce with untreated water is a probable source of *E. coli* and *Salmonella*.
- Equipment and packaging: Non food grade foil and utensils can leach Pb into hot or acidic foods (Omeje et al., 2021).

The detection of pathogenic bacteria above acceptable limits poses a direct risk of foodborne illnesses, ranging from mild gastroenteritis to severe systemic infections. Chronic exposure to Pb even at low levels can result in neurotoxicity, kidney damage, and developmental delays, particularly in children (WHO, 2010). The presence of pesticide residues, though within permissible limits, raises concerns about cumulative and synergistic effects when combined with other dietary exposures.

This study's cross sectional design provides only a snapshot of contamination levels, without capturing long term seasonal variation. The sample size, while sufficient for detecting major trends, may not capture rare contaminants or low prevalence pathogens. Additionally, chemical analysis was limited to selected metals and pesticides, excluding other potential hazards such as mycotoxins and microplastics.

Recommendations for Policy, Regulation, and Vendor Training

1. Regulatory enforcement – Strengthen inspection and monitoring of street food vendors through risk based approaches prioritizing high traffic locations and high risk foods.
2. Vendor training – Implement low cost hygiene and food safety training based on WHO street food guidelines, including safe water use, hand hygiene, and temperature control.
3. Infrastructure improvements – Provide access to potable water, waste disposal facilities, and covered stalls in high density vending areas.
4. Public awareness – Conduct campaigns to inform consumers about safer purchasing choices and personal risk reduction measures.
5. Source control – Work with upstream suppliers to reduce pesticide use and environmental contamination, including traffic management near food vending zones.

Conclusion

This study found that a significant proportion of street vended foods in Benin City, Nigeria, exceeded microbiological safety limits, with fresh salads and grilled meats posing the highest risks for microbial and heavy metal contamination, respectively. While pesticide residues were within Codex MRLs, their presence indicates potential upstream hazards.

Overall, the findings suggest that street vended foods, though economically and culturally vital, require improved hygiene practices, better environmental controls, and stronger regulatory oversight to safeguard public health.

References

Alimi, B. A. (2016). Risk factors in street food practices in developing countries: A review. *Food Control, 63*, 235–247.

Bereda, T. W. (2016). Microbiological safety of street-vended foods in Jigjiga. *[Journal reference if available]*.

Cudjoe, D. C., et al. (2022). Food safety in Sub-Sahara Africa: An insight into Ghana and Nigeria. *Environmental Health Insights, 16*, 1–13.

DeWaal, C. S., & Handzel, T. (2022). Regional Codex guidelines and their potential to impact developing countries. *Food and Chemical Toxicology, 169*, 113403.

Dela, H., et al. (2023). Microbiological quality and antimicrobial resistance of bacteria from RTE foods and vendor environments. *International Journal of Food Microbiology, 398*, 110186.

Ekhator, O. C., et al. (2017). Safety evaluation of potential toxic metals exposure from street-vended foods. *Journal of Environmental and Public Health, 2017*, 1–7.

FAO/WHO Codex Alimentarius Commission. (1999). *Regional guidelines for the design of control measures for street-vended foods (Africa) (CAC/GL 22R-1997).* Rome: FAO/WHO.

FAO/WHO Codex Alimentarius Commission. (2013). *Regional code of practice for street-vended foods (Latin America and the Caribbean) (CXC 71R-2013).* Rome: FAO/WHO.

FAO/WHO Codex Alimentarius Commission. (2020). *General principles of food hygiene (CXC 1-1969, Rev. 2020): Good hygiene practices and HACCP guidelines*. Rome: FAO.

Koumassa, O. A. B., Ouétchéhou, R., Hounsou, M., Zannou, O., & Dabadé, D. S. (2025). Factors influencing street-vended foods quality and safety in developing countries: A review. *Discover Food, 5*, Article 18.

Lebelo, K., et al. (2021). Chemical contamination pathways and the food safety implications for public health. *Foods, 10*(8), 2066.

Omeje, K. O., et al. (2021). Quantification of heavy metals and pesticide residues in widely consumed Nigerian foods. *Journal of Toxicology, 2021*, 1–13.

Onyeaka, H., et al. (2024). Preventing chemical contaminants in food: Challenges and opportunities. *Trends in Food Science & Technology, 144*, 104204.

Rakha, A., et al. (2022). Safety and quality perspective of street-vended foods in developing countries: A review. *Trends in Food Science & Technology, 123*, 389–401.

Rane, S. (2011). Street-vended food in the developing world: Hazard analyses. *British Food Journal, 113*(10), 1381–1393.

Sabbithi, A., et al. (2014). Microbiological quality of salads served with street foods and HACCP insights. *Journal of Foodborne and Zoonotic Diseases, 2*(2), 1–8.

Scutarașu, E. C., et al. (2023). Heavy metals in foods and beverages: Global situation and health risks. *International Journal of Environmental Research and Public Health, 20*(10), 5992.

Wikipedia. (2025, August). Street food. In *Wikipedia.*

World Health Organization. (1996). *Essential safety requirements for street-vended foods* (Revised ed.). Geneva: WHO.