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RESEARCH PAPER

Evaluation of Microbiological Quality and Safety Practices of Street Food Vending in Urban Areas

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ABSTRACT

Street food vendors (SFV) are essential in providing jobs and reasonably priced meal alternatives, especially for those from poor socioeconomic backgrounds. However, due to the possibility of contamination, there is a significant risk to public health from the microbiological safety of foods sold on the street. The purpose of the research was to evaluate the safety and microbiological quality of meals sold on the streets in cities. Socioeconomic data were collected through structured questionnaires, while microbial analysis was conducted on 320 ready-to-eat (RTE) food samples from multiple vending sites. Data were analyzed using SPSS version 26. While inferential statistics, such as One-Way Analysis of Variance (ANOVA), were utilized to compare microbial counts across various food categories, descriptive statistics were utilized to characterize vendor characteristics and microbiological counts. The association between vendor practices (such as hand hygiene and using clean water) and microbiological contamination was investigated using chi-square testing. The findings showed that microbial counts showed the presence of aerobic mesophilic bacteria (5.2 ± 0.6), lactic acid bacteria (4.3 ± 0.5), *Enterobacteriaceae* (4.1 ± 0.7), *Staphylococcus* spp. (5.16±1.3), *Escherichia coli* (3.9 ± 0.5), *Salmonella* spp. (3.6 ± 0.4), and *Pseudomonas* spp. (2.8 ± 0.3). These findings demonstrate the low microbiological quality of street food and the need for enhanced safety protocols and public health campaigns in urban street food vending.

Keywords: Street Food Vending, Microbiological Quality, Food Safety, Antibiotic Resistance, Urban Public Health, Contamination, Vendor Practices

The quality of food meant for human consumption is a constant problem. Recent years have seen a rise in the occurrence of food-borne illnesses, which have a bigger negative influence on the health and economies of developing nations (Compaore *et al.* 2022). Because the street foods associated with urban lifestyles are typically marketed in places where people congregate frequently or infrequently. Even though customers are aware that there are some restrictions on the facilities where ready-to-eat (RTE) street food is made, they occasionally pick these dishes because of their accessibility, affordability, distinctive flavour, variety, and quick service (Barreira *et al.* 2024). Because urban residents, particularly those in the middle- and lower-income categories, choose products that are affordable, useful, and readily available on the sidewalk (Alelign *et al.* 2023). Food is categorized as drinks, and snacks made in homes, small companies, marketplaces, and on the street food safety. For those with limited incomes, particularly younger generations, street food is their main source of nutrition (Ay & Doğan, 2025). In particular, view this culinary choice as a vibrant embodiment of their

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social customs and traditions. In practically every city's street food is a significant feature of the street and road layout. Recent research found that street food sellers have significantly risen in the capital cities, as a result of variables related to tourism and rising local demand (Paloma & Israel, 2025). RTE food is a crucial reliance for urban and periurban areas worldwide due to its affordability, accessibility, and nutritional value. It creates jobs and attracts tourists, but it also spreads foodborne pathogens, highlighting the need for improved hygiene in street food vending (Dominguez-Gonzalez *et al.* 2022).

Carbon monoxide, greenhouse gases, volatile organic chemicals, heterocyclic amines, polycyclic aromatic hydrocarbons, dangerous trace metals, and particulate matter are some examples of this toxicant (Ali *et al.* 2023). However, the quantity of charcoal used for grilling increases its concentration, particulate matter is observed in excess (Kebede & Getu, 2023). Street food vendors (SFVs) are unofficial businesses in public areas that provide quickly, reasonably priced, and ready-to-eat meals from either fixed or movable locations throughout the globe (Al Banna *et al.* 2022). Public health is at risk when evaluating the microbiological quality of SFV due to issues, such as uneven hygiene standards, tainted raw materials, inadequate training, poor temperature control, cross-contamination, environmental factors, restricted testing access, regulatory gaps, and inconsistent vendor practices (Andrade *et al.* 2023). This research evaluated microbiological safety and quality in urban street food vending by analyzing 320 RTE food samples, examining hygiene practices, and providing baseline data for improving public health initiatives.

Section 2 of the research outlines related work, Section 3 and 4 explains methods and discusses the findings and it includes discussion, and Section 5 wraps up the work.

Related work

Research on the impact of microwave sterilization on plantain chips and roasted groundnuts in Nigerian street-vendor snacks revealed a reduction in microbial density with increasing heat treatment time as described (Aba *et al.* 2023). However, the fungal load was not linear. The research suggested that plantain chips contain some microorganisms that survive heat treatment, potentially affecting public health. To emphasize the need for education on sanitary protocols for food producers (Atilola, 2022). The findings indicated that although the vendors' expertise was "fairly good," there was a significant association between their marital status and knowledge, attitudes, and practices (KAP) ratings. Although the samples did not meet Philippine criteria, they were determined to be appropriate for microbial growth. To enhance KAP and guarantee product safety, appropriate food safety guidelines were required. In underdeveloped nations, eating street food is common, but improper handling and unhygienic circumstances raise safety issues. According to research conducted in the Bolgatanga Municipality of Ghana, 42.4% of food samples examined (Aovare *et al.* 2022) contained Escherichia coli and *Staphylococcus aureus*. Groundnut soup, rice balls, and tomato sauce had the greatest levels of contamination. According to the report, to guarantee food safety, sellers should get training on good personal hygiene and how to keep their hands away from food. The research examined the antibiotic resistance and bacteriological quality of Dhaka City's Street food (Ahmed *et al.* 2022). Tests of antibiotic susceptibility showed widespread resistance, especially to Penicillin G. The results emphasized the necessity of better vendor education and food safety procedures.

The research also found that 60% of RTE foods had unsatisfactory microbial quality, with salads being the most contaminated (Pandey *et al.* 2024). Both food and water tests have coliforms and common enteropathogens, which suggested that the microbiological quality is degraded. Ethiopia has seen a sharp rise in edible oil production, particularly in Gondar, which has led to poor quality control and potential microbial contamination (Yohannes *et al.* 2024). To ensure food safety and quality, stricter rules, regulations, and contemporary production technology were required. All street food vendors

should have enough training on food safety, according to a study conducted in Mekelle City, Northern Ethiopia, where 85% of them had sound knowledge, 81.1% had a positive attitude, and 58.9% had good practices (Mnilu, 2024). According to research conducted in Bangladesh, Staphylococcus aureus, a significant foodborne pathogen, was discovered in 23.81% of food samples and human hand swabs (Werkneh *et al.* 2023). The biofilm formation ability of *S. aureus* was determined using a combination of culturing, staining, biochemical, and Polymerase Chain Reaction (PCR) tests. According to research conducted in Bangladesh, hospital food service employees had good attitudes and behaviors about food safety but a modest understanding of it (Al Banna *et al.* 2022). Higher expertise was linked to factors like men, private hospitals, and those with dietitians and food service managers. To decrease foodborne illnesses and outbreaks, hospital administration should take these aspects into account while improving food handlers' understanding and providing more training on food safety procedures. The research (Meher *et al.* 2022) assessed food safety knowledge among 650 Bangladeshi SFV consumers. Results showed moderate knowledge, with male, non-formal, and secondary education consumers being less knowledgeable. Table 1 demonstrates the overall performance of previous work.

MATERIALS AND METHODS

The research was conducted at urban street vendor sites, collecting 320 RTE food samples from 10 vendors. The five common foods sampled were collected. Data on socio-economic status were collected using questionnaires and samples were microbiologically analyzed and used to assess the level of contamination and food safety practices. Fig. 1 shows the overall work flow.

Vendors details

The research involved 10 vendors with different ages (27–45 years) and 3–12 years of experience. Most vendors performed regular/irregular hand hygiene, were often using well or tap water or borehole, and were not always wearing gloves. These details are shown in Table 2.

Table 1: Summary of the related work

Ref. No	Methodology	Results/Findings	Advantages	Disadvantages
Aba *et al.* [2023]	Experimental research with heat treatments at 72°C for 10, 20, and 30 minutes.	Reduction in bacterial load with increased heat duration; fungal load showed less consistent reduction.	Effective in reducing microbial contamination; improves food safety.	Limited to specific foods; could not apply to all street foods.
Atilola, [2022]	Cross-sectional investigation assessing KAP of 148 vendors.	Moderate KAP scores; 5 out of 8 samples exceeded microbial limits.	Identifies gaps in food safety practices; provides baseline data for interventions.	Small sample size; findings may not be generalizable.
Aovare *et al.* [2022]	Microbiological analysis of 66 food samples from 150 vendors.	High contamination rates with *E. coli* and *S. aureus*; poor hygiene practices observed.	Highlights critical hygiene issues; underscores the need for vendor education.	Cross-sectional design limits causal inference; and potential observer bias.
Miraz Uddin Ahmed *et al.* [2022]	Research of 191 staff members across seven hospitals.	High attitudes and practices toward food safety; moderate knowledge	Provides insights into hospital food safety standards; identifies areas for improvement.	Limited to hospital settings; may not reflect broader food service contexts.
Pandey *et al.* [2024]	Cross-sectional research with multivariable logistic regression analysis.	High KAP scores; significant associations with age, income, education, and training.	Comprehensive data on factors influencing food safety practices; supports targeted interventions.	Cross-sectional design; potential for recall bias.

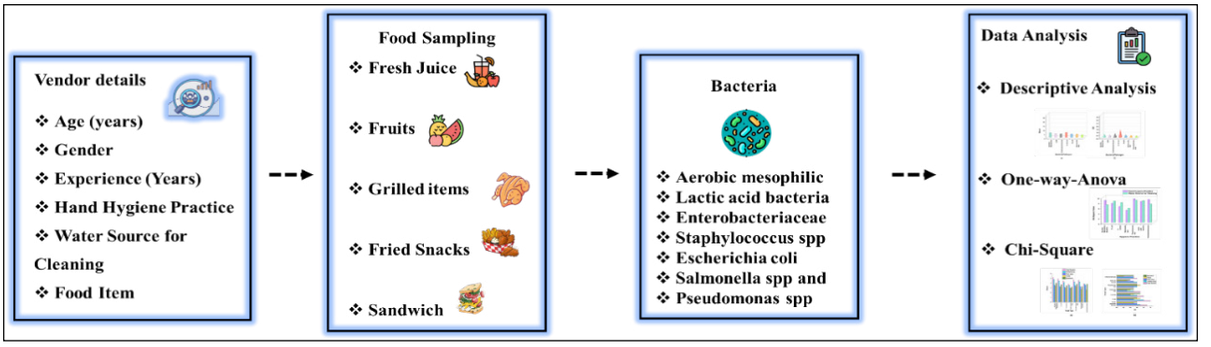


Fig. 1: Overall work flow

Table 2: Demographic Characteristics of Street Food Vendors

Vendor ID	Age (years)	Gender	Experience (Years)	Hand Hygiene Practice	Water Source for Cleaning	Food Item
V1	34	Female	6	Irregular	Well water	Fresh Juice
V2	42	Male	10	Regular	Tap water	Grilled items
V3	29	Female	4	Irregular	Borehole water	Sandwiches
V4	38	Female	8	Regular	Tap water	Fried Snacks
V5	31	Male	5	Irregular	Well water	Fruits
V6	45	Female	12	Regular	Tap water	Grilled items
V7	36	Female	7	Irregular	Borehole water	Sandwiches
V8	40	Male	9	Regular	Tap water	Fried Snacks
V9	27	Female	3	Irregular	Well water	Fresh Juice
V10	33	Female	6	Regular	Tap water	Fruits

Data collection process

Socioeconomic data were obtained via face-to-face interviews with structured questionnaires. The questionnaire included 20 simple structured/open ended questions about vendor characteristics: age, sex, education, number of years spent vending, area income daily, marital status, family/household size, type of food sold, where food is prepared, source of raw materials, hand hygiene practices, use of gloves, access to potable water, waste disposal practice, type of storage, reheating practices, knowledge of safety, training in food safety, health check-ups, and licensing. These questions are rated using 5-point Likert scale.

Food sampling and storage

The sampling of RTE foods involved collecting a total of 320 food samples from 10 vendor. The five common foods sampled were: fresh juice, fruits, grilled items, fried snacks and sandwiches, which were sampled within peak hours of culinary activity. Food samples were collected using sterile containers and placed directly into coolers with ice packs. After being collected, they were transferred to the lab for microbiological investigation in less than four hours. SFV samples were tested for microorganisms and contained various pathogens. These samples were tested for potential pathogens using selective media, including PCA, MRS, MacConkey, and Salmonella_ shigella agar. Pathogens detected included aerobic mesophilic bacteria, lactic acid bacteria, *E. coli*, *Salmonella*, and *S. aureus*. Suspected isolates were tested for antibiotic resistance, as shown in Table 3.

Table 3: Microbiological Analysis of SVF Samples

Tested Bacteria/Pathogen	Media Used	Incubation Conditions	Purpose/Indicator
Aerobic Mesophilic Bacteria	Plate Count Agar (PCA)	37°C for 24-48 hours	General microbial contamination, overall cleanliness of food handling
Lactic Acid Bacteria (LAB)	MRS Agar	Anaerobic, 37°C for 48 hours	Fermentation processes and safety indicators in foods, particularly dairy/vegetable-based foods
Enterobacteriaceae	MacConkey Agar	37°C for 24 hours	Faecal contamination indicators, differentiation of lactose-fermenting and non-fermenting species
Pseudomonas spp.	Cetrimide Agar	37°C for 24-48 hours	Spoilage organisms in RTE foods, especially in refrigerated environments
Staphylococcus aureus	Baird-Parker Agar	37°C for 24-48 hours	Pathogen-producing enterotoxins causing gastroenteritis, related to improper food handling
Escherichia coli (E. coli)	MacConkey Agar	37°C for 24 hours	Fecal contamination, undercooked or improperly handled food indicators
Salmonella spp.	Salmonella_shigella	37°C for 24-48 hours	Pathogen associated with gastrointestinal illness; differentiation based on Salmonella

Analysis Methods

Vendor demographics and microbiological contamination levels were compiled using descriptive statistics (mean, median, standard deviation) in SPSS version 26. Valid and repeatable findings were obtained by using Chi-square tests, One-Way ANOVA and descriptive to compare contamination levels across different food types.

One-Way ANOVA: A one-way relationship between food types when the same people are exposed to all levels of the independent variable. By making each person their controller, this approach reduces the unpredictability brought on by individual variances. This testing was useful to compare levels of microbial contamination among different food types (i.e., fried foods, cold drinks). In this case, it determined whether there were significant differences in contamination rates between the different food categories.

Chi-Square Test: This test was used to examine the link between vendor hygiene practices (e.g., hand-washing practices, source of water) and microbial contamination in food samples. This indicated whether certain behaviors were linked to greater levels of contamination.

Descriptive analysis: The main features of a dataset are enumerated and explained in descriptive analysis.

Typical examples of descriptive statistics. Mean $\overline{W}$ is the average value $\bar{W} - \frac{1}{m}\sum_{j-1}^{m} W_j$. Median is the midway value inside an ordered data collection. Mode is the most commonly occurring value. Standard deviation (SD) measures the dispersion of data from the mean in $SD - \sqrt{\frac{1}{m-1}\sum_{j-1}^{m}\left(W_j - \bar{W}\right)^2}$. Variance (Var) is the square of the standard deviation $Var - SD^2$. Range is the distinction between the highest and lowest values $Range - Max - Min$. Minimum and maximum is the smallest and largest values in the dataset.

RESULTS AND DISCUSSION

This research analyzed microbial contamination in 320 SFV samples, which indicated the high prevalence of pathogens. Contamination was statistically significantly correlated with inadequate food vendor

Table 4: Microbial Contamination Levels in Different Food Types

Food Type	*Aerobic Mesophilic Bacteria* (Mean ± SD)	*Lactic Acid Bacteria (LAB)*	*E. coli*	*S. aureus*	*Salmonella spp*	*Pseudomonas spp*	*Enterobacteriaceae*
Fresh Juice	$3.8 \times 10^4 \pm 1.2 \times 10^3$	$1.6 \times 10^3 \pm 3.1 \times 10^2$	Positive (42%)	Positive (36%)	Detected (10%)	Positive (25%)	Positive (38%)
Fruits	$2.3 \times 10^4 \pm 9.5 \times 10^2$	$1.9 \times 10^3 \pm 2.4 \times 10^2$	Positive (15%)	Positive (12%)	Not Detected	Positive (10%)	Positive (22%)
Grilled items	$1.5 \times 10^4 \pm 8.2 \times 10^2$	$1.1 \times 10^3 \pm 1.3 \times 10^2$	Positive (20%)	Positive (18%)	Detected (5%)	Positive (14%)	Positive (30%)
Fried Snacks	$4.2 \times 10^4 \pm 1.5 \times 10^3$	$2.0 \times 10^3 \pm 3.2 \times 10^2$	Positive (48%)	Positive (41%)	Detected (15%)	Positive (30%)	Positive (45%)
Sandwiches	$2.9 \times 10^4 \pm 1.1 \times 10^3$	$1.4 \times 10^3 \pm 2.1 \times 10^2$	Positive (25%)	Positive (20%)	Detected (8%)	Positive (20%)	Positive (34%)

Table 5: One-way ANOVA results for outcome measurements

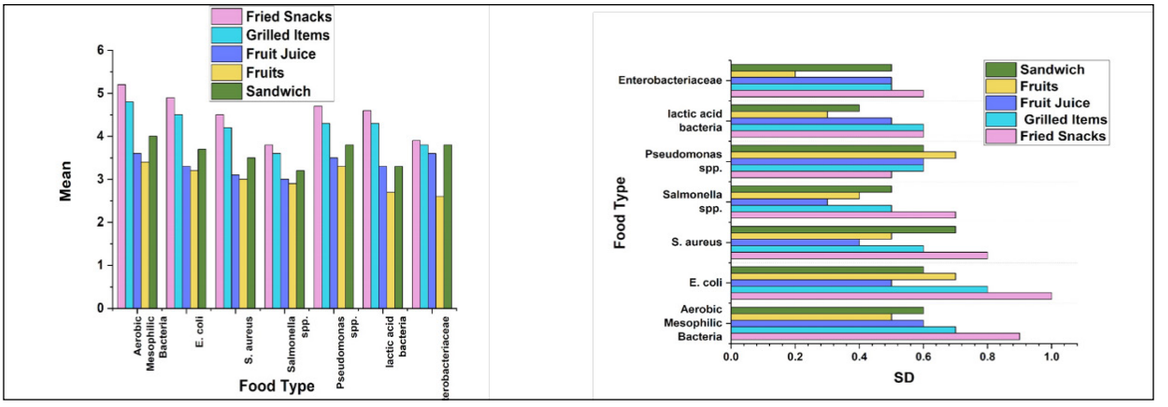
Food Type	*Aerobic Mesophilic Bacteria*		*E. coli*		*S. aureus*		*Salmonella spp.*		*Pseudomonas spp.*		*Lactic acid bacteria*		*Enterobacteriaceae*	
	Mean ± SD	**P Value**	**Mean ± SD**	**P Value**	**Mean ± SD**	**P Value**	**Mean ± SD**	**P Value**	**Mean ± SD**	**P Value**	**Mean ± SD**	**P Value**	**Mean ± SD**	**P Value**
Fried Snacks	5.2 ± 0.9	0.003	4.9 ± 1.0	0.02	4.5 ± 0.8	0.04	3.8 ± 0.7	0.05	4.7 ± 0.5	0.01	4.6 ± 0.6	**0.01**	3.9 ± 0.6	0.02
Grilled items	4.8 ± 0.7	0.004	4.5 ± 0.8	0.015	4.2 ± 0.6	0.03	3.6 ± 0.5	0.045	4.3 ± 0.6	0.008	4.3 ± 0.6	**0.01**	3.8 ± 0.5	**0.02**
Fruit Juice	3.6 ± 0.6	0.002	3.3 ± 0.5	0.01	3.1 ± 0.4	0.015	3.0 ± 0.3	0.04	3.5 ± 0.6	0.006	3.3 ± 0.5	**0.01**	3.6 ± 0.5	**0.02**
Fruits	3.4 ± 0.5	0.005	3.2 ± 0.7	0.02	3.0 ± 0.5	0.03	2.9 ± 0.4	0.048	3.3 ± 0.7	0.004	2.7 ± 0.3	**0.01**	2.6 ± 0.2	**0.02**
Sandwich	4.0 ± 0.6	0.01	3.7 ± 0.6	0.02	3.5 ± 0.7	0.03	3.2 ± 0.5	0.045	3.8 ± 0.6	0.009	2.6 ± 0.2	**0.01**	3.3 ± 0.4	**0.02**

sanitation and hygiene.

Microbial Contamination in SFV: The research of 320 samples from five street food items determined significant microbial contamination. These are usually detected using selective/enrichment methods, and the results are frequently binary (Detected / Not Detected) or expressed as a percentage of positive samples rather than colony-forming units (CFU/g). Since total plate counts (e.g., Aerobic Mesophilic Bacteria, LAB) are numerical, the mean ± SD in CFU/g is suitable (Table 4).

One-way ANOVA table: The microbiological research showed a significant difference in contamination levels based on the type food sold by street vendors. Fried snacks showed the most *E. coli, Pseudomonas spp.* and *aerobic mesophilic bacteria*, while fruits and juices showed the lowest counts. These differences should emphasize to street vendors the need for improved hygiene and cleanliness standards, as shown in Table 5 and Fig. 2.

Chi-square table: Chi-square analysis indicated important relationships between vendor hygiene operations and microbial contamination in street foods. Hand hygiene practices were notably associated with *E. coli, S. aureus* and *Pseudomonas spp.* ($p < 0.05$) presence, also glove usage was significantly associated with *E. coli, S. aureus,* and *Pseudomonas spp.,* highlighting the importance of hygiene practices in food safety, as seen in Table 6 and Fig. 3.



(a) **(b)**

Fig. 2: Comparison of One-way ANOVA **(a)** mean, **(b)** SD

Table 6: Chi-square results for outcome measurements

Hygiene Practice	Bacteria	Chi-Square Value (X^2)	Degrees of Freedom (df)	P-Value
Hand Hygiene Practice	*Aerobic Mesophilic Bacteria*	8.62	2	0.035
	E. coli	7.48	2	0.048
	S. aureus	6.24	2	0.045
	Salmonella spp.	4.82	2	0.092
	Pseudomonas spp.	9.24	2	0.027
	Lactic acid bacteria	8.25	2	0.033
	Enterobacteriaceae	8.96	2	0.036
Water Source for Cleaning	*Aerobic Mesophilic Bacteria*	6.92	3	0.075
	E. coli	8.36	3	0.039
	S. aureus	7.81	3	0.046
	Salmonella spp.	5.56	3	0.131
	Pseudomonas spp.	8.72	3	0.035
	Lactic acid bacteria	8.52	3	0.036
	Enterobacteriaceae	7.25	3	0.037

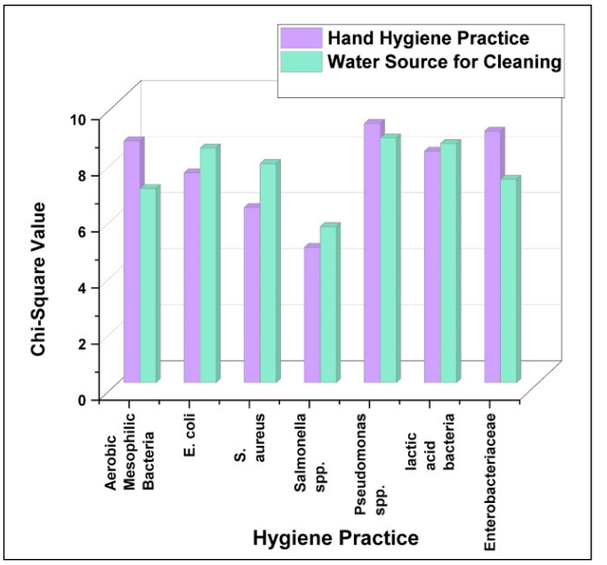


Fig. 3: Comparison of Chi-square

Descriptive analysis Table: The descriptive statistics of microbial contamination in SFV demonstrated differential effects for each pathogen as defined by the mean and standard deviation (Table 7 and Fig. 4). *S. aureus* had the highest mean contamination level (5.16 CFU/g). *Pseudomonas* spp. (mean 2.8 CFU/g)) exhibited lower and more stable levels of contamination. The range for each pathogen displays the spread of microbial contamination in the food samples.

Table 7: Descriptive analysis results for outcome measurements

Bacteria/Pathogen	Mean (CFU/g)	Standard Deviation (SD)	Minimum (CFU/g)	Maximum (CFU/g)	Range (Max-Min)
Aerobic Mesophilic Bacteria	5.2	0.6	3.8	6.8	3.0
LAB	4.3	0.5	3.1	5.4	2.3
Enterobacteriaceae	4.1	0.7	2.9	5.6	2.7
S. aureus	5.16	1.3	19.4	32.1	12.7
E. coli	3.9	0.5	3.0	4.8	1.8
Salmonella spp.	3.6	0.4	3.0	4.2	1.2
Pseudomonas spp.	2.8	0.3	2.2	3.3	1.1

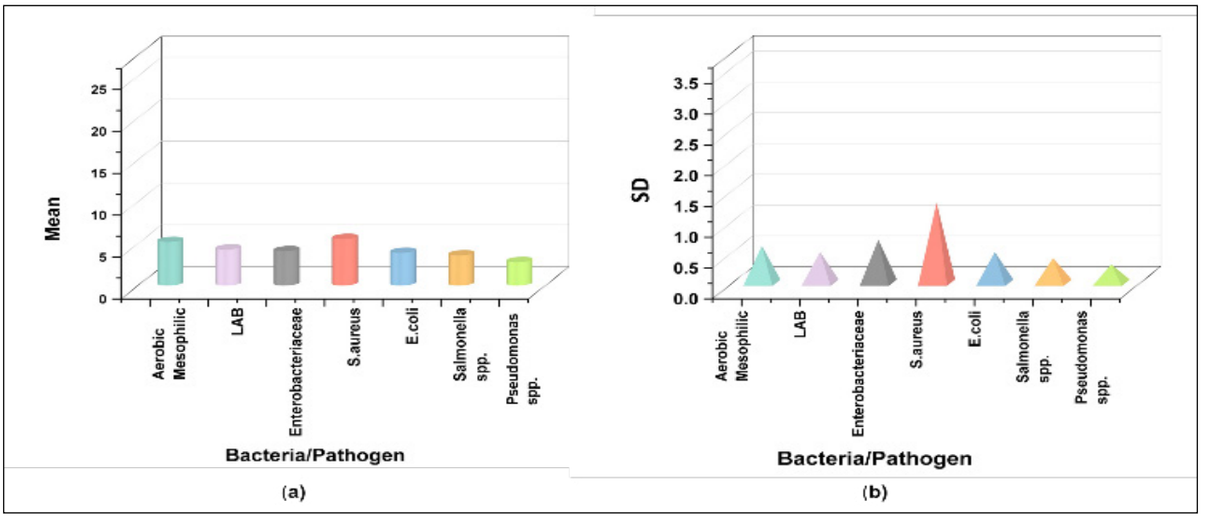


Fig. 4: Comparison of descriptive statistics **(a)** mean, **(b)** SD

This research underscores the important role of hygiene behaviors by vendors in food safety in street vending, to the observations reported from Maputo, Mozambique where a great deal of street food vendors were female, often for socio-economics and culturally accepted reasons (Bukhari *et al.* 2021). Similarly, in, food surface contamination was evident from *E. coli* and *S. aureus* as cleaning techniques and food storage possibilities were poor (Salamandane *et al.* 2021). Findings show that food vendors practice poor hygiene behaviors by handling food with bare hands and having contaminated water sources that expose food handlers and consumers to more risk for microbial contamination. Accordingly, practices must improve with suitable hygiene systems, such as proper hand washing when using clean water sources and using human protection items like gloves to minimize the risk of foodborne illness from SFV. Regular monitoring of vendors on a modular basis and re-training of vendors may potentially lead to improved food standards.

CONCLUSION

Research focused on examining the microbiological quality and safety of SFV in urban locations, as well as evaluating the role of vendor hygiene practices in contributing to microbial contamination. A total of 320 samples of RTE food products from different vending outlets were analyzed for pathogenic organisms described as *aerobic mesophilic bacteria, lactic*

acid bacteria, Enterobacteriaceae, Staphylococcus spp. Escherichia coli, Salmonella spp. and *Pseudomonas spp*. Information was collected on vendor characteristics, including hand hygiene, the type of water used for cleaning, and whether gloves were worn. The research used descriptive and inferential statistical analysis (One-Way ANOVA, Chi-square tests). The results indicate significant microbial contamination throughout different types of street foods, with the highest levels in fried snacks. Poor hygiene practices, especially with respect to hand hygiene and glove use, were strongly correlated with contamination. Efforts to enhance hygiene standards, water cleanliness, and/or regular monitoring of vendors can ultimately reduce the risk of food-borne illness while ensuring the safety of street-vended foods. Several isolates were found to be antibiotic-resistant. The findings highlight the importance of improving hygiene in street food vending to reduce microbial contamination. Limitations included a limited sample and reliance on vendor-reported hygiene practices. Future studies should be conducted with larger samples, implementations to educate vendors on hygiene, and more investigation of antimicrobial resistance in SVF.

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