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Bacteriological quality and food hygiene: A descriptive cross-sectional study of street restaurants on the University of Kinshasa campus, Democratic Republic of the Congo

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ABSTRACT

Introduction

Eating is a fundamental human need essential for survival, development, and wellbeing. Consumers have the right to safe food that does not pose a health risk.

Purpose

To assess the bacteriological quality and food hygiene of meals sold in restaurants on the University of Kinshasa campus.

Methods

We conducted a cross-sectional descriptive study between July and November 2024. A two-stage sampling strategy was applied to select campus restaurants. Food samples were subjected to bacteriological analysis and restaurant hygiene practices were evaluated. Bacteriological quality was compared with international standards. Continuous variables were summarised as medians and interquartile ranges, while categorical variables were presented as frequencies and percentages.

Results

Most respondents (93.7%) were women; 87.5% had no formal training in food hygiene; 87.5% did not wear personal protective equipment; and 68.8% washed their hands only 1–2 times per day. Over half (56.3%) used buckets as waste bins. Of 32 food samples analysed, 81.2% were contaminated with *Escherichia coli*, 78% with total coliforms, 34.3% with mesophilic aerobes, and 9.4% with enterococci. At least one food item from restaurants in Zones A and C contained all the microorganisms tested.

Conclusion

Bacteriological quality and food hygiene in University of Kinshasa campus restaurants are unsatisfactory, exposing consumers to potentially severe foodborne diseases that could negatively impact their academic performance. Capacity building for food handlers and regular inspections are urgently needed.

INTRODUCTION

Food safety encompasses the handling, preparation, and storage of food to prevent foodborne illness (Batu et al., 2021). Everyone is responsible for ensuring that food remains safe and uncontaminated from production to consumption (Codex Alimentarius Commission, 2022). The World Health Organization estimates that unsafe food causes over 200 diseases globally, affecting about 600 million people annually and resulting in 420,000 deaths, including 125,000 among children (WHO, 2024).

A preventive approach is essential to safeguard food safety and reduce the risk of contamination (Codex Alimentarius Commission, 2022). Foodborne diseases in academic settings underline the urgency of improving prevention and quality control (Liu et al., 2023). In many low-resource countries, campus restaurants and informal food outlets often lack adequate hygiene measures (Faye et al., 2025).

Since the closure of the university canteen at the University of Kinshasa, students have increasingly relied on informal restaurants, where food hygiene, restaurant environment, and bacteriological quality are inadequate (Agence Congolaise de Presse, 2023). Street foods in particular have been linked to high bacterial risks and public health concerns (Mathaulula et al., 2022; Ahiabor et al., 2024).

Previous studies in resource-limited settings have shown deficiencies in food hygiene and environmental sanitation that contribute to bacterial contamination of foods (Yaou et al., 2024; Atungale, 2022). Despite this, little documentation exists on food hygiene and bacteriological quality within university campus restaurants in the Democratic Republic of the Congo (DRC).

We therefore sought to answer the following research question: *What is the bacteriological quality of food sold in the University of Kinshasa campus restaurants and what is the status of hygiene and sanitation practices in these establishments?*

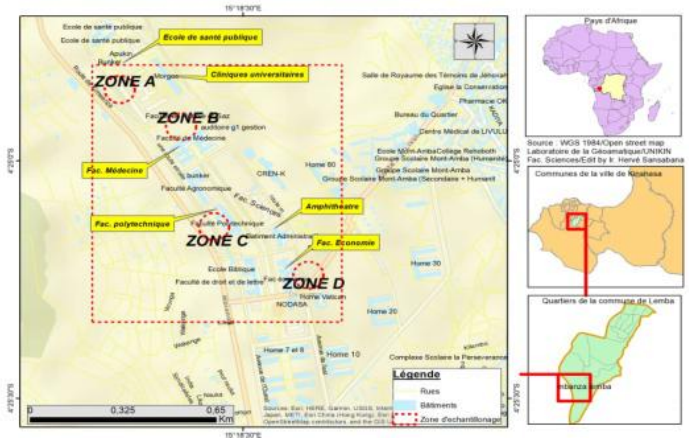
Our objective was to evaluate both bacteriological food quality and hygiene practices in campus restaurants at the University of Kinshasa.

METHODS

Study Design and Setting

We conducted a cross-sectional descriptive study from July to November 2024 in restaurants located on the University of Kinshasa campus, DRC. The campus is situated about 25 km from central Kinshasa, on Mont Amba in Lemba commune.

Figure 1:
Map of the University of Kinshasa campus



Target Population and Sampling

Eligible participants were restaurant operators aged ≥18 years who consented to participate. Food samples were collected from each restaurant. A two-stage sampling approach was used. At stage one, the campus was divided into four zones:

- Zone A: Centre Neuro-Psycho-Pathologique
- Zone B: Faculty of Medicine
- Zone C: Faculty of Agronomy
- Zone D: Amphitheatre Léon de Saint Moulin

At stage two, four restaurants were systematically selected from each zone (16 total). Two composite food samples were purchased from each restaurant (32 samples in total).

Inclusion and Exclusion Criteria

Included: consenting restaurant operators aged ≥18 years, and active restaurants at the time of the study. Excluded: restaurant operators who were ill, absent, or intoxicated during the survey.

Data Collection

Food samples were collected using aseptic techniques, placed in sterile stomacher bags, stored in cool boxes, and

transported to the laboratory for analysis. Samples were homogenised, diluted, and inoculated into various culture media using standard microbiological procedures.

Laboratory Analysis

Culture media used included TBX (Tryptone Bile X-glucuronide), EMB (Eosin Methylene Blue), PCA (Plate Count Agar), and Slanetz and Bartley Agar. The following organisms were targeted: *Escherichia coli*, total coliforms, mesophilic aerobes, and enterococci. Colony counts were converted to CFU/g. Results were compared with FAO and EU microbiological standards (FAO, 2004; Regulation (EC) No 2073/2005).

Data Analysis

Questionnaire and laboratory data were entered in EpiData and analysed with SPSS version 26. Continuous variables were summarised using medians and interquartile ranges, and categorical variables with frequencies and percentages.

Biasand Ethics

Potential biases due to seasonality were noted, as data collection took place during the dry season. Information bias was minimised through trained data collectors and standardised procedures. Ethical approval was obtained from the Ethics Committee of the School of Public Health, University of Kinshasa (ESP/CE/192/2024). All participants provided informed consent.

RESULTS

The study conducted on the university campus to assess the bacteriological quality and food hygiene produced the following findings:

Sociodemographic Characteristics

Table 1 shows that of the 16 restaurant operators surveyed, 93.7% were female and 56.3% were aged 18–30 years. Most (87.5%) had no formal training in food handling, and 93.3% had less than five years' work experience.

Table 1:
Sociodemographic characteristics of restaurant operators (n = 16)

Characteristic	n	%
Sex		
Female	15	93.7
Male	1	6.3
Level of education		
Primary	5	31.3
Secondary	9	56.3
Tertiary/University	2	12.5
Years of service		
< 5 years	15	93.7
≥ 5 years	1	6.3
Training in food handling/hygiene		
Yes	2	12.5
No	14	87.5
Age		
18–30 years	9	56.2
≥ 31 years	7	43.8

Median age (IQR): 27.5 years (IQR 5 years).

Hygiene Practices

Table 2 reveals that

- **Hand hygiene:** 62.5% used liquid soap, but 68.8% washed their hands only 1–2 times per day.
- **Protective equipment:** 87.5% did not wear personal protective equipment.
- **Food storage:** 62.5% stored food in freezers, but 81.3% stored raw and cooked foods together.
- **Waste management:** 56.3% used buckets as bins, 75% had bins without lids, and 81.3% did not disinfect bins after emptying.

Table 2:
Hand hygiene practices and water sources of restaurant operators (n = 16)

Variable	n	%
Handwashing product used		
Liquid soap	10	62.5
Solid soap	4	25.0
None	2	12.5
Frequency of handwashing per day		
1–2 times (not acceptable)	11	68.8
3 times (minimally acceptable)	3	18.8
4–5 times (acceptable)	2	12.5
Timing of handwashing		
Before any activity and before cooking	13	81.3
After toilet use/after sneezing	5	31.3
After handling waste	4	25.0
Source of water for handwashing		
REGIDESO (piped)	9	56.3
Boreholes/wells	7	43.7

The results in **Table 3** show that 87.5% of operators did not wear personal protective equipment, 81.3% disinfected their premises without a fixed schedule, and 93.8% did not use any disinfectant products. Furthermore, 62.5% stored

food in a freezer, 81.3% stored raw and cooked foods together, and 87.5% were unaware of the appropriate storage temperature.

Table 3:
Protective equipment use, premises hygiene and food storage (n = 16)

Variable	n	%
Use of personal protective equipment (PPE)		
Yes	2	12.5
No	14	87.5
Frequency of premises disinfection		
No fixed schedule	13	81.3
Every other day	1	6.3
Daily	2	12.5
Disinfectant products used		
None	15	93.8
Disinfectant available	1	6.3
Food storage location		
Freezer	10	62.5
Private home	4	25.0
Refrigerator	1	6.3
Neighbour's facility	1	6.3
Storage method		
Raw and cooked foods together	13	81.3
Raw and cooked foods separated	3	18.8
Knowledge of correct storage temperature		
Yes	2	12.5
No	14	87.5

As shown in **Table 4**, 56.3% used a bucket as a waste bin, 75% had bins without lids, 81.3% did not disinfect their bins after emptying, and 87.5% had only one waste bin.

Table 4:
Solid waste management practices in restaurants (n = 16)

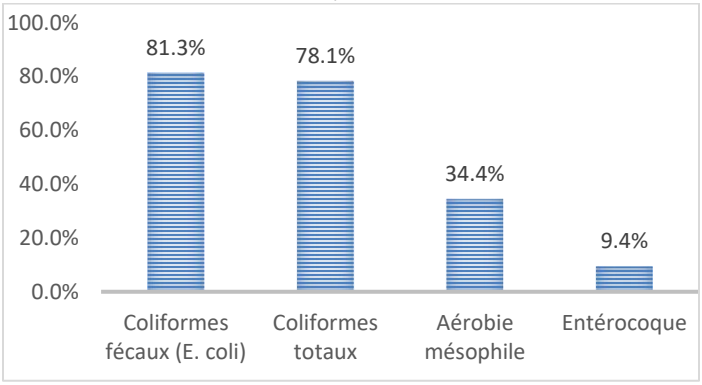
Variable	n	%
Type of bin used		
Bucket	9	56.3
Bag	5	31.3
Hygienic bin	2	12.5
Bin with lid		
Yes	4	25.0
No	12	75.0
Frequency of bin emptying		
Daily	13	81.3
Three times per week or more	2	12.5
Once per week	1	6.3
Bin disinfected after emptying		
Yes	4	25.0
No	12	75.0
Number of bins per restaurant		
One	14	87.5
Two or more	2	12.5

Table 5:
Results of bacteriological analysis of food samples by zone

Restaurant zone	No. of samples	*E. coli* (+)	Total coliforms (+)	Mesophilic aerobes (+)	Enterococci (+)
Zone A (CNPP)	**32**	**6**	**5**	**4**	**2**
Zone B (Medicine)	**32**	**6**	**7**	**4**	**0**
Zone C (Agronomy)	**32**	**7**	**6**	**2**	**1**
Zone D (Amphitheatre)	**32**	**7**	**7**	**1**	**0**
Total	**128**	**26**	**25**	**11**	**3**

Highest contamination rates were observed in Zones C and D for E. coli and coliforms.

Figure 2:
Bacterial contamination rates in the analysed food samples



Bacteriological Analysis

From **Table 5**,

Out of 32 food samples:

- 26 (81.2%) were contaminated with *E. coli*.
- 25 (78%) with total coliforms.
- 11 (34.3%) with mesophilic aerobes.
- 3 (9.4%) with enterococci.

In at least one food sample from Zones A and C, all tested microorganisms were detected. Several samples exceeded international microbiological standards.

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Figure 3:
Distribution of bacteria by food type and restaurant zone

Overall, the majority of foods sampled from all four zones were contaminated with *E. coli* followed by total coliforms, with levels exceeding the recommended standards.

DISCUSSION

We conducted this study to assess the bacteriological quality of food and hygiene practices in restaurants on the University of Kinshasa campus. More than three quarters of restaurant operators (87.5%) had received no formal training; 87.5% did not use personal protective equipment (PPE); 68.8% reported washing their hands only once or twice a day; and 56.3% used a bucket as a waste bin.

Bacteriological analysis revealed that most food samples from the four study zones were contaminated with *Escherichia coli*, followed by total coliforms at levels exceeding international standards. At least one food sample from Zones A and C contained all the microorganisms tested.

The predominance of young, female restaurant operators with secondary-level education reflects the profile of the informal workforce in the Democratic Republic of the Congo. This finding agrees with previous studies. For example, Yaou et al. (2024) reported that over 90% of food vendors were women; Lwanga et al. (2024) observed a predominance of young food vendors in Kisangani; and Faye et al. (2025) found that 75.9% of food vendors held only a high-school diploma. As Tamene et al. (2022) suggest, tailored training programmes for food handlers remain one of the best strategies to improve hygiene quality.

The low level of work experience among the operators points to the informal and unstable nature of these establishments. Tamiru et al. (2022) showed that food safety practices are strongly associated with length of service; inexperience may therefore explain the widespread disregard for hygiene measures.

According to the Codex Alimentarius Commission (2022), all food-sector workers who come into contact with food must be trained in food hygiene. The near absence of training among the operators studied likely reflects the informal status of their businesses and the lack of a regulatory framework on the campus. This aligns with the findings of Nkosi and Tabit (2021), who showed that most food vendors had not undergone training. Such deficiencies negatively affect food quality and underline the need for training.

Codex standards also recommend regular handwashing with soap before handling food, after breaks, after using the toilet, and after handling waste or raw food (Codex Alimentarius Commission, 2022). The failure of many operators to use soap or disinfectant while washing hands may have contributed to food contamination. Tohonon et al. (2025) linked poor hand hygiene to faecal contamination in restaurants. Similar findings were reported by Doffou (2021) and Cui et al. (2021) in Cameroon and China, respectively, showing how difficult it can be to enforce hygiene rules in restaurants.

Codex guidelines further emphasise personal cleanliness and PPE use to prevent cross-contamination. Our study found that most restaurant operators did not wear PPE—likely reflecting poor professional awareness and lack of

training. These findings mirror those of Carmen Gnele et al. (2023), who also observed low PPE usage among food vendors. Inadequate protective clothing facilitates microbial proliferation in food preparation areas. Doffou (2021) similarly noted that many restaurants operate in unsanitary environments that do not comply with hygiene protocols, despite Codex recommendations to prevent pest infestation through effective cleaning.

Regarding food storage, most operators froze their leftovers and stored raw and cooked food together. Atungale (2022) observed similar practices. This behaviour may stem from a lack of appropriate storage facilities on campus and insufficient knowledge of food storage techniques. Such practices risk cross-contamination and microbial growth, particularly when storage temperatures are not properly monitored. Codex guidelines recommend separating raw and cooked foods and maintaining safe storage conditions to reduce contamination risk.

Waste management practices were also inadequate. Codex standards specify that waste should be collected in lidded bins without accumulation or overflow, and removed in ways that avoid contaminating food. Our findings show widespread use of unsuitable bins and lack of regular cleaning—likely due to limited investment by food operators. Nazari and Aziz (2020) reported similar findings, with most bins in their study being unhygienic. This absence of physical barriers increases the likelihood of vectors contacting waste and contaminating food, underscoring the need for awareness campaigns promoting hygienic waste management.

The high contamination observed in Zone A may be explained by its location downstream from campus drainage channels; restaurants there are situated along these collectors. In Zone C, poor sanitation around restaurants is exacerbated by the presence of an interim waste dump. According to FAO (2004) and European regulations (Regulation (EC) No. 2073/2005), ready-to-eat food should not contain more than 10 CFU/g of *E. coli* or 10^3 CFU/g of faecal coliforms. In our study, several samples far exceeded these thresholds.

The high prevalence of *E. coli* and total coliforms indicates faecal and environmental contamination, reflecting non-compliance with hygiene measures ranging from handwashing to waste disposal. Tohonon et al. (2025) similarly linked faecal or environmental contamination to poor hand hygiene among food vendors in Benin. This situation represents a significant public health threat and calls for a sustainable, multi-stakeholder solution involving university authorities, sanitation officers, restaurant operators, consumers, and government agencies. Such a strategy should include an enforceable hygiene policy, multisectoral monitoring, continuous training in waste management, provision of hygiene materials, and establishment of systems to guarantee sanitary waste handling. Tamene et al. (2022) and Ahiabor et al. (2024) have shown in Ghana that enforcing food safety laws, especially in the informal sector, protects public health.

Limitations

- The small, convenience-based sample size limits generalisability.
- Bacteriological analysis covered only a few microorganisms due to laboratory constraints.
- Hygiene observations were made on a single day only.
- Seasonal variations, which could affect microbial proliferation, were not considered.

CONCLUSION

This study highlights major deficiencies in the bacteriological quality and food hygiene of campus restaurants at the University of Kinshasa, including lack of training among restaurant operators, poor waste management, and non-compliance with hygiene measures. These conditions expose consumers to severe foodborne diseases that can impair their health and academic performance.

We therefore recommend:

- Training all campus restaurant operators in good hygiene practices.
- Enforcing strict compliance with regulations governing food establishments.
- Conducting regular inspections and monitoring to ensure sustained compliance.

Such actions should be considered a public health priority to guarantee food safety and protect consumers. Future research should evaluate the effectiveness of these interventions and include analyses of additional foodborne

pathogens to better document health risks within the university setting.

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Ethical Approval: Ethical approval was obtained from the Ethics Committee of the School of Public Health, University of Kinshasa (ESP/CE/192/2024).

Conflicts of Interest: None declared.

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