Tropical Environment, Biology, and Technology

Research Article
Volume 2(1), 2024, 23–33
https://doi.org/10.53623/tebt.v2i1.423

Microbiological Analysis of Hawked-Cooked Food: Evidence from Ready-to-Eat Food Vendors in Dutse Ultra-Modern Market, Northwestern, Nigeria

Afeez Oladeji Amoo[1,2]*, Adeniyi Olarewaju Adeleye[1], Garba Barde Bate[1], Madu Emmanuel Ijanu[1], Suleiman Bashir Adamu[3], Catherine Iyabo Asaju[1], Idris Ireti Olaitan[1]

[1]Department of Environmental Sciences, Faculty of Science, Federal University Dutse, Jigawa State, Nigeria.
[2]Department of Environmental Management Technology, Faculty of Environmenatl Technology, Abubakar Tafawa Balewa University, Bauchi, Bauchi State, Nigeria.
[3]Department of Physics, Faculty of Natural and Applied Sciences, Sule Lamido University, Kafin Hausa, Jigawa State, Nigeria.

*Correspondence: afeezoladeji@fud.edu.ng; amooafeez415@gmail.com

SUBMITTED: 18 March 2024; REVISED: 14 May 2024; ACCEPTED: 16 May 2024

ABSTRACT: These days, public health policy is primarily concerned with the global challenge of food safety. Hawked-cooked foods (HCF) play a vital role in people's everyday food alternatives, as their ever-increasing busy schedules take away the opportunity to eat homemade foods. This study aimed at analyzing the bacteriological quality of HCF sold in Dutse ultra-modern market. This study observed and analyzed the bacteriological quality of the nine (9) most popular foods sold by hawkers in the research region. All samples were analyzed using standard microbiological methods. The total viable bacterial counts in the samples for the reciprocal of dilution 10^5 ranged between 3.2×10^6 and 1.40×10^7 CFU/g, while dilution 10^7 ranged from 1.50×10^8 to 1.10×10^9 CFU/g. A total of twelve bacteria that are of public health importance were isolated and identified from the assayed ready-to-eat foods. All the sampled ready-to-eat foods in this study recorded bacteriological contaminants, which can potentially constitute public health issues. Seven of these bacteria are pathogenic; *Bacillus cereus, Staphylococcus aureus, Escherichia coli, Salmonella, Vibro cholerae, Streptococcus pneumoniae*, and *Klebsiella* sp. Prior to food sampling, most food hawkers interrogated lack western education, demonstrating the low degree of hygiene they practice in the preparation of the hawked foods. Therefore, in order to prevent impending public health catastrophes (food-borne illnesses) that can be brought on by consuming HCF, it is advised that food producers who hawk ready-to-eat foods adopt hygienic practice in the preparation and serving to improve food safety.

KEYWORDS: Food hygiene; food safety; hawked-cooked food; ready-to-eat; total viable counts.

1. Introduction

The primary way that humans obtain nutrition is through food. The vast amount of foods consumed is essential to life's sustenance. Depending on the quality of the foods consumed, a

person may experience either positive or negative effects [1]. The author reiterated further that consuming contaminated food may have negative consequences that could lead to a food infection, which can manifest as food intoxication, posing significant health risks. According to Muendo et al. [2], Khuluse & Deen, [3], HCF is a widespread cultural and economic practice globally, often prepared unhygienic environments in hawkers' homes or improvised buildings situated in busy locations like bus parks, roadsides, and market places. Most of these locations are unkempt, filthy, dusty, and accessible to flies, rats, and insects [2]. In addition, these locations also lack essential amenities for sanitation and hygiene, including toilets, sinks with running water, areas specifically designed for washing and drying utensils and standard places to dispose of solid waste [2]. Despite the socio-economic advantages, food hawking poses considerable risks to public health, especially given the unhygienic food stations and inadequate food handling procedures that are sometimes involved [4, 5]. Globally, microbial food-borne disease is a serious public health concern, with poor food handling and sanitation practices [4, 6]. Food safety issues put everyone's health and the health of humans and animals around the globe at risk. The most susceptible individuals include children, pregnant women, the elderly ones, and those who are ill [5, 7]. These authors pointed out that public health risk is influenced by a low educational background, socio-economic level, lack of knowledge of proper food handling, vendor mobility, diversity, and temporary nature. HCF is frequently not covered thereby exposing such food items to flies and dust, which can invariably lead to food-borne illnesses when consumed [8].

During the preparation and cooking of HCF, contamination occurs due to the poor quality of the raw ingredients [9]. Lack of potable water for various activities causes food sellers to reuse the water for washing dishes and utensils; this has been documented on several continents, including Africa, South America, and Asia [10]. *Staphylococcus* sp., contamination of utensils frequently happens at the seller's point, indicating cross-contamination of dishwater, food preparation surfaces, and HCF [11]. For developing nations like Nigeria, particularly in market areas, ensuring food safety and high-quality management is a major concern. Educating consumers and food handlers about the risks associated with food-borne illnesses, and best hygiene practices in food safety is essential. Therefore, this study aimed at analyzing the bacteriological quality of commonly consumed foods from HCF sellers within Dutse ultra-modern market, Jigawa State in Nigeria. This study was conducted based on the null hypotheses that stated that bacterial contaminants are not present in HCF sold at Dutse ultra-moder market.

2. Materials And Method

2.1.Study site.

Dutse is the capital city of Jigawa State and also the headquarters of the 28 local government areas that make up the state. Dutse is located at 11.76° North latitude, 9.34° East longitude, and has an elevation of 460 meters above sea level. It is an urban area that has about 17,129 inhabitants. Arrays of food products (gurasa, rice, masa, spaghetti, suya, danwake) are sold in Dutse ultra-modern market (Figure 1). However, the ultra-modern market is located just by the side of the main waste disposal site in Dutse as reported by Adeleye et al. [12].

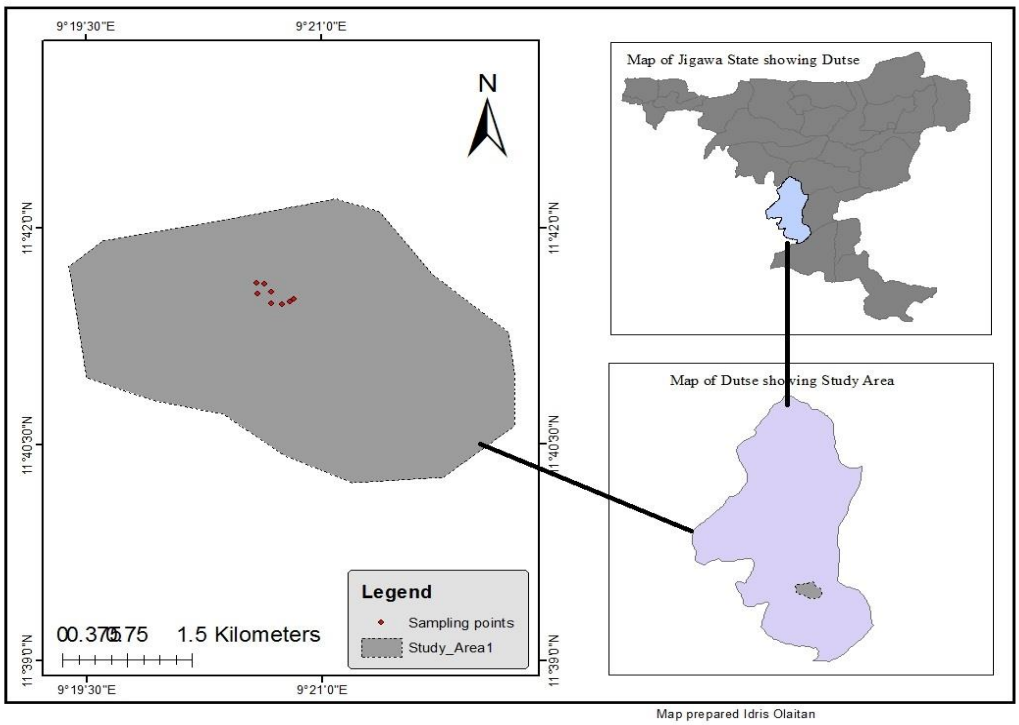

Figure 1. Map of the study site.

2.1.1. Study design, population, and inclusion criteria.

This was a cross-sectional study of cooked foods hawked at the Dutse Ultra-modern market. To be considered for inclusion in the study, a food sample had to be displayed for hawking by a person above the age of 12 years during the time of data collection.

2.1.2. Sample collection.

The sample size was based on the total estimated number of hawkers of cooked foods as at the time of research in Dutse Ultra-modern market. A simple random technique described by Adeleye et al. [12], was adopted to collect (purchase) food samples among the most consumable foods sold by various food hawkers. Specifically, twenty-seven (27) HCFs were sampled from five (5) sampling points within the market. The sample population targeted food hawkers in the north, east, west, south and center of the market, as shown in Figure 1. At each sampling point, three (3) different hawked foods of the same product were randomly purchased from the food vendors using their plates and subsequently poured into sterile containers that were labeled with the sample name and denoted (A-I) for proper identification (Table 1). The samples were handled with sterile disposable gloves, iced with an ice bag and immediately transported to the Microbiology and Biotechnology Laboratory of the Federal University Dutse, where standard methods were employed for microbiological analysis as documented by Adeleye et al. [12].

2.2.Sample preparation.

Five grams of each hawked food sample was weighed using a precise and sensitive weighing balance machine and then dissolved in 50 mL of distilled water to obtain a homogenized sample. From this homogenized sample, serial dilutions were prepared by transferring the

dissolved sample into seven sets of sterile tubes, each containing 9 mL of distilled water. This step was taken to sufficiently reduce the population of bacteria that might be present therein, following the method outlined by Orpin et al. [13]. Following that, about 1 mL of the homogenized solution was serially transferred into test tubes labeled from 10^1 to 10^7. Furthermore, using the seven-fold dilution, individual tube for bacterial assessment was appropriately tagged with the type of bacteria, dilution factor, and then placed on a test tube rack. Next, utilizing a sterile pipette and employing aseptic techniques, 1 mL of the sample was carefully inoculated into the corresponding dilution tube and the mixture was thoroughly mixed to obtain serial decimal dilutions ranging from 10^1 to 10^7. The highest decimal dilution (10^7) was then employed for the pour plate counts.

Table 1. List of food items selected and collected for the study.

Denotion	GPS Coordinates	Food Item	Method of Cooking
A	Lat.: N 11°41'28.47" Long.: E 9°20'40.866"	Spaghetti	Readily mixed of pepper ingredients
B	Lat.: N 11°41'32.592" Long.: E 9°20'35.574"	Rice	*Jollof* rice mixed with pepper ingredients
C	Lat.: N 11°41'34.69" Long.: E 9°20'39.697"	Yam	Roasted yam mixed with pepper ingredients
D	Lat.: N 11°41'30.438" Long.: E 9°20'49.5"	Beans	*Jollof* beans mixed with *yajii* ingredients
E	Lat.: N 11°41'36.93" Long.: E 9°20'35.292"	*Dan-wanke*	Groundnut oil mixed with pepper (*yaaj*i) ingredients
F	Lat.: N 11°41'33.21" Long.: E 9°20'40.752"	*Masa*	Mixed with pepper (*yaaji*) ingredients
G	Lat.: N 11°41'29.268" Long.: E 9°20'47.91"	*Awara*	Mixed with pepper (*yaaji*) ingredients
H	Lat.: N 11°41'31.452" Long.: E 9°20'42.13"	*Gurasa*	Grinded groundnut mixed with ingredients
I	Lat.: N 11°41'36.684" Long.: E 9°20'38.274"	Beans cake	Mixed with pepper (*yaaji*) ingredients

2.2.1. Preparation of culture media.

Nutrient agar (NA), Eosine methylene blue agar (EMB) and Salmonella Shigella agar (SSA) were used in this study, following the method described by Adeleye et al. [12]. In order to measure the amount of media required for analysis, a sensitive weighing balance machine was used.. The culture media were dissolved and prepared according to the manufacturer's instructions and then sterilized immediately after preparation to ensure rapid multiplication of the contaminating organisms and prevent the composition from being altered as documented by Salamandane et al. [14].

2.2.2 Isolation and enumeration of bacteria

In order to determine the total viable count, a pour plate method employed as described by Buchanan & Gibbons [15]. A batch of 1 mL of the homogenized samples was taken from the test tubes containing the homogenate and transferred into different petri-dishes. The cooled media were poured into the petri-dish containing 1 mL of the homogenized sample and then mixed by rolling on the surface of the workbench and allowed to settle and solidify. Afterward, inoculated plates were incubated at 37 °C for 24 hours. Discrete colonies were purified by sub-

culturing into NA, EMB and SSA plates, which were subsequently identified using standard methods described by Orpin et al. [13].

2.2.3. Characterization and identification of bacterial isolates.

Bacterial isolates were identified on the basis of cultural attributes (colony morphology, size, colour, shape, appearance, texture), and biochemical test such as: catalase, coagulase, citrate, indole, methyl red, and voges proskauer, according to the methods reported by Salamandane et al. [14]; Buchanan & Gibbons, [15]. Specifically, catalase test was done by utilizing an inoculating loop to transfer a little amount of bacterial colony on the surface of a dry and clean glass slide. Citrate test was conducted by using a needle tip to gently streak a 24-hour-old bacterial colony on a sterilized simmons citrate agar slant. After that, the agar slant was incubated aerobically for 24 hours at 37 ℃. It was seen that there was a huge shift from green to blue, signifying a favourable utilization of citrate. Indole test was done by taking a sterilzed test tubes containing 4 mL of tryptophan broth. A 24-hour bacterial culture was used to extract the growth for the aseptic inoculation of the tubes. After that, the tubes were inoculated for 28 hours at 37 ℃. The broth culture was then given 0.5 mL of Kovac's reagent, and the presence of a ring, which indicated a positive test result and absence of a ring indicating a negative test was monitored. The MR-VP broth was brought to a room temperature in order to achieve this. Next, for at least 48 hours, two tubes containing MR-VP broth and a pure culture of the microorganisms under study were incubated at 35 ℃. The first tube was then filled with five drops of the methyl red indicator solution. For the Voges-Proskauer test, 0.6 mL of 5% α-naphthol and 0.2 mL of 40% KOH were added to the second tube. Ultimately, a positive MR test result was shown by the emergence of red colour after the addition of MR reagent, whilst a negative MR test result was indicated by the absence of red colour. However, within 15 minutes of the chemicals were added, a pink-red hue developed at the surface, indicating a positive VP test while non appearance of this colour indicated a negative VP test result.

2.3.Data Management and Analysis.

All the data collected, especially for the mineral analysis, were evaluated using analysis of variance (ANOVA) and analysed using SPSS statistical package (Version 17.0). Duncan's New multiple range test was used to determine significant differences among the mean values for the samples at $p < 0.05$. All values were expressed as mean ± SD.

Results and Discussion

3.1. Results.

The results of total viable bacterial counts at a dilution factor (DF) of 10^5 in HCF obtained from the study area ranged from 3.2×10^6 to 1.40×10^7cfu/g, while at a dilution factor (DF) of 10^7 ranged from 1.50×10^8 to 1.10×10^9 cfu/g (Table 2). The highest bacterial counts were recorded in ready-to-eat rice and *gurasa* at both DFs of 10^5 and 10^7, while the lowest bacterial counts were recorded in spaghetti at both DFs of 10^5 and 10^7. The low microbial count recorded in ready-to-eat rice indicates that the samples were purchased immediately after the seller entered the study area, and the food, utensils, and water were all in good condition before being exposed to the market surroundings. The findings of the

morphological identification of the bacterial isolates after incubation at 37 ℃ for 24 hours are depicted in Table 3.

Table 2. Total viable bacterial counts in hawked-cooked food samples

Denotion	Samples	CCP	DF 10^5 (CFU/g)	CCP	DF 10^7 (CFU/g)
A	Spaghetti	32	3.20×10^6	15	1.50×10^8
B	Rice	140	1.40×10^7	101	1.10×10^9
C	Yam	100	1.00×10^7	46	4.60×10^8
D	Beans	116	1.16×10^7	33	3.30×10^8
E	*Dan-wanke*	98	9.80×10^6	18	1.80×10^8
F	*Masa*	126	1.26×10^7	22	2.20×10^8
G	*Awara*	120	1.20×10^7	41	4.10×10^8
H	*Gurasa*	130	1.30×10^7	52	5.20×10^8
I	Beans cake	110	1.10×10^7	44	4.40×10^8

Note: DF- Dilution factor; CCP- Colonies counted in plate; CFU- Colony forming unit

Table 3. Morphological identification of the isolates from cultured medium plates.

Denotion	Samples	DF	EMB	NA	SSA
A	Spaghetti	10^5	MG	SG	NG
		10^7	MG	SG	GP
B	Rice	10^5	HG	HG	GP
		10^7	HG	HG	GP
C	Yam	10^5	PG	GP	NG
		10^7	PG	GP	NG
D	Beans	10^5	PG	GP	NG
		10^7	PG	GP	NG
E	*Dan-wanke*	10^5	PG	GP	NG
		10^7	PG	GP	NG
F	*Masa*	10^5	PG	GP	NG
		10^7	PG	GP	NG
G	*Awara*	10^5	PG	GP	NG
		10^7	PG	GP	NG
H	*Gurasa*	10^5	GP	GP	NG
		10^7	PG	GP	NG
I	Beans cake	10^5	GP	GP	BG
		10^7	PG	GP	BG

NB: DF-dilution factor; EMB- Eoisine methl blue; NA-nutrient agar; SSA-salmonela shigella agar; MG-medium growth; HG-heavy growth; SG-scanty growth; NG-no growth; GP-growth present; PG-pink growth; BG-black growth

The findings of the Gram staining, aimed at differentiating between Gram-positive and Gram-negative bacteria based on morphological characteristics as well as the inferences drawn from the bacterial isolates, are presented in Table 4. It can be observed that four (4) distinct morphological characteristics of various shapes were recorded under the microscope.

Table 4. Identification of the isolated bacteria from various HCF samples.

Denotion	Samples	Morphological Characteristics	Gram Reaction
A	Spaghetti	Round, smooth, convex, glistening, with entire edge and *cocci* on NA	+
B	Rice	Convex, creamy or white glossy curved rods	+
C	Yam	Translucent, round disks and moist	-
D	Beans	Bluish gray rods colonies	+
E	*Dan-wanke*	Spherical, ovoid or *cocci* shaped often occurs in pairs	+
F	*Masa*	Raised, rod, green metallic sheen colonies	-
G	*Awara*	Raised, pink to purple in colour without green metallic sheet	-
H	*Gurasa*	Smooth, opaque with black centered colonies.	-
I	Beans cake	Spherical, ovoid or *cocci* shaped often occurs in pairs.	+

Note: NA- Nutrient agar

The findings of biochemical characterization tests conducted on the bacterial isolates with a view to identifying the possible bacteria inherently found in the sampled HCF are presented in Table 5. The bacteria isolated are *Bacillus cereus*, *Staphylococcus aureus, Escherichia coli, Salmonella, Vibro cholerae, Streptococcus pneumoniae* and *Klebsiella* sp., as seen in Table 5.

Table 5. Distribution of bacterial isolates from biochemical characterisation.

Denotion	Samples	Gram Staining Identity	Biochemical Classification						Inferences
			CT	CG	CI	IN	MR	VP	
A	Spaghetti	Gram positive cocci in clusters	+	+	+	-	-	+	*Staphylococcus aureus*
B	Rice	Gram positive rods shape	+	+	+	-	+	+	*Bacillus* sp.
C	Yam	Gram negative round shape	+	+	-	+	+	-	*Vibro cholerae*
D	Beans	Gram positive in rods shape	+	+	+	+	+	+	*Bacillus* sp.
E	*Dan-wanke*	Gram positive cocci in chains	-	-	-	-	-	-	*Streptococcus* sp.
F	*Masa*	Gram negative rods shape	+	-	-	+	+	-	*Escherichia coli*
G	*Awara*	Gram positive cocci in chains	-	-	-	-	-	-	*Klebsiella* sp..
H	*Gurasa*	Gram positive cocci in clusters	-	-	-	-	-	-	*Salmonella* sp.
I	Beans cake	Gram positive cocci in chains	-	-	-	-	-	-	*Streptococcus* sp.

Note: CT- Catalase; CG- Coagulase; CI- Citrate; IN- Indole; MR- Methyl red; VP- Voges proskaver.

3.2. Discussion.

This investigation revealed high levels of contamination in the HCFs sold in the Dutse Ultra-modern Market. The detection bacteria in HCFs assayed in our study is in agreement with the studies conducted by Dagninet et al. [16]; Akinyemi et al. [17]. Many of these bacterial contaminants have been discovered to be pathogenic, and the presence of bacterial species in the studied samples paralleled numerous other studies carried out in various parts of the world. In order to provide healthy and hygienic food, HCF vendors must follow the guidelines of good production practices [18]. The results from our study showed that the assayed HCFs harbored bacterial pathogens. The fact that the bacteria detected were isolated from HCFs confirms the submission of [19], about the capability of microbial contaminants being introduced into food materials at each stage, including preparation, handling and selling points.

Moreover, the presence of bacterial pathogens and microbial load in foods are prominent determinants of food quality and the potential health risk they provide to consumers [20]. The elevated microbial load in items such as rice, beans, *awara*, yam, *masa*, *gurasa*, and bean cake can be linked to direct exposure to air in the market. The results of previous related research on street vended foods, as investigated by Dagninet et al. [16]; Akinibosun & Ojo [21], are pertinent to the findings of the quantitative analysis of the food samples in this study, which revealed a high load of bacteria ranging from 3.2×10^6 to 1.10×10^9 CFU/g. The maximum and minimum viable bacterial counts were found in *rice* and *spaghetti*. However, *spaghetti* had the lowest rate in terms of bacteria. A number of factors, including the hygienic state of food handlers, filthy surroundings and utensils, dirty water, improper handling and processing of

food items, lack of proper storage, and unhygienic display of food, can be attributed to the contamination of the HCF sold in our study area. These findings are in agreement with the reports of the studies conducted by Nwiyi & Elechu, [1]; Oranusi & Olorunfemi, [22]. These authors detected variety of bacterial contaminants in the food samples assayed in their respective studies. In addition to the harmful Gram-positive (*Staphylococcus aureus*) and Gram-negative entero-pathogens (*Salmonella* sp.), some of the bacterial isolates (*Bacillus cereus, Escherichia coli* and *Klebsiella* sp. and other coliforms) that can be associated with food spoilage were detected in our study.

Despite our study's high levels of HCF contamination, the majority of the food samples examined had total viable counts between 10^6 and 10^9 CFU/g. As a result, these foods have been deemed unsafe for human consumption [23, 24]. Foods having viable plate counts $>10^6$ CFU/g were reported as unfit for human consumption by the ICMSF [23] standard. The detection of *Staphylococcus aureus* and *Escherichia coli* in the assayed foods in our study indicates poor sanitary management and procedures of the vended and sampled foods. Food-borne disease outbreaks have been linked to these infections, which can also be referred to as food-borne pathogens [25, 26]. *Streptococcus* sp. may be more common because of its function in the fermentation of agricultural crops. It is generally known that *Streptococcus* sp. ferments carbohydrates into alcohol and other aroma substances such as esters, carbonyl compounds, and organic acids. Sometimes the presence of *Streptococcus* sp. in food indicates that galactose, glucose, and lactic acid have been ingested [21]. Food safety is improved by checking HCF for the presence of pathogens [27]. Low levels of food pathogens indicate low risk, and their existence may point to production and/or handling errors that, if left unchecked, could result in an unacceptable rise in risk [28]. In-addition, *Bacillus* sp. having been identified in the HCF samples suggests that spices like pepper (*yaajji*) may have been introduced after the primary cooking procedure. Evidence suggests that food can act as a reservoir for epidermic strains of *Escherichia coli* that causes severe infections such as simple urinary tract infections and other extra-intestinal infections [21]. Hawked cooked food sellers usage of trays, stalls, and wheelbarrows raises the possibility of food contamination. Food hawking is done without adequate storage conditions, exposing the foods to flies harbouring microorganisms and also ensuring that the food is kept at ambient temperature, which favours the proliferation of microbial contaminants, pathogenic mesophiles, and other disease-causing agents [29, 30].

3. Conclusion

The research was carried out to assess the current state of bacteriological quality of the most consumed HCF offered for sale in the study area. Based on the results generated in this study, the null hypothesis set earlier is therefore rejected and the alternative hypothesis which stated that HCF sold in Dutse ultra-modern market harbour bacterial contaminants is hereby accepted. Notably, rice samples exhibited a substantial colony count, indicating potential contamination, while spaghetti samples showed comparatively lower counts. These findings highlight a concerning aspect of the unregulated nature of HCF in the study area. Despite the sector's importance to the country's food security, HCF in Nigeria have remained mainly unregulated. Food security is positively impacted by wholesome, nutritious HCF, whereas consumption of HCF below the minimal safety threshold is either acutely or chronically harmful to human health.Owing to the findings recorded in this study, preventive measures that will ensure hygienic status of HCF are therefore recommended to the HCF hawkers. To avoid

contamination by flies and airborne germs, food sellers should constantly cover the foods unless serving. Food preparation equipment should be thoroughly washed, food handlers must wash their hands frequently, especially after handling money or visiting convenience stores.

Author Contributions

Afeez Oladeji Amoo: Conceptualization; Investigation; Data curation; Writing – original draft. **Catherine Iyabo Asaju, Garba Barde Bate:** Funding acquisition and supervision. **Adamu Suleiman Bashir:** Data curation and validation. **Adeniyi Olarewaju Adeleye, Madu Emmanuel Ijanu:** Writing-review and editing. **Idris Ireti Olaitan:** Data curation and investigation.

Acknowledgement

The authors would like to thank the entire staff of the Department of Microbiology and Biotechnology, Federal University Dutse, Nigeria, for their assistance in the conduct of the laboratory analyses.

Conflict of Interest

We, authors of this article, solemnly declare that we have no conflict of interest.

References

[1] Nwiyi, I; Elechı, J.O.G. (2022). Evaluation of Food Safety and Nutritional Quality of Indigenous Beverages Vended in Informal Market of Nasarawa State, North Central, Nigeria, *Eurasian Journal of Food Science and Technology*, *6*(2), 100–112.

[2] Muendo, C.M.; Kikuvi, G.; Mambo, S. (2022). Determinants of microbial contamination of cooked foods hawked in Tharaka Nithi County, Kenya: a cross-sectional study. *Pan African Medical Journal*, *22*(41), 232. https://doi.org/10.11604/pamj.2022.41.232.33755

[3] Khuluse, D.S.; Deen, A. (2020). Hygiene and safety practices of food vendors. *African Journal of Hospitality, Tourism, and Leisure*, *9*(4), 597–611.

[4] Rifat, M.A.; Talukdar, I. H.; Lamichhane, N.; Atarodi, V.; Alam, S. S. (2022). Food safety knowledge and practices among food handlers in Bangladesh: A systematic review. *Food Control*, *142*, 109262. https://doi.org/10.1016/j.foodcont.2022.109262

[5] Mot-taleb, K.A.; Rahut, D.B.; Kruseman, G.; Erenstein, O. (2018). Changing food consumption of households in developing countries: A Bangladesh case. *Journal of International Food & Agribusiness Marketing*, *30*(2), 156–174. https://doi.org/10.1080/08974438.2017.1402727

[6] Zanin, L.M.; da Cunha, D.T.; de Rosso, V.V.; Capriles, V.D.; Stedefeldt, E. (2017). Knowledge, attitudes and practices of food handlers in food safety: An integrative review. *Food Research International*, *100*, 53–62. https://doi.org/10.1016/j.foodres.2017.07.042

[7] Zubaer, H.; Sabiha, A. (2019). Microbial Quality of Common Restaurant Foods: Food Safety Issue in Bangladesh. *Journal of Food and Nutrition Sciences*. *7*(4), 56–59. https://doi.org/10.11648/j.jfns.20190704.11

[8] WHO estimates of the global burden of foodborne diseases - Foodborne disease burden epidemiology reference group. (accessed on 5 March 2024) Available online: https://www.who.int/publications-detail-redirect/9789241565165.

[9] Imathiu, S. (2017). Street vended foods: potential for improving food and nutrition security or a risk factor for foodborne diseases in developing countries. *Current Research in Nutrition and Food Science Journal*, *5*(2), 55–65.. https://doi.org/10.12944/CRNFSJ.5.2.02

[10] Maroko, R. A. (2016). Dynamics of Cooked Food Vending in Kayole Location, Nairobi County, Kenya. Masters Dissertation, Kenyatta University, Kenya.
[11] Kariuki, E.N.; Ng´ang´a, Z.W.; Wanzala, P. (2017). Food-handling practices and environmental factors associated with food contamination among street food vendors in Nairobi County, Kenya: a cross-sectional study. *East African Health Research Journal, 1*(1), 62–71. https://doi.org/10.24248/EAHRJ-D-16-00382
[12] Adeleye, A.O.; Yalwaji, B.; Shiaka, G.P.; Amoo, A.O.; Udochukwu, C.C. (2019). Bacteriological Quality of Freshly-Cut and Ready to eat Vegetables Sold in Dutse Market North West, Nigeria. *FUW Trends in Science and Technology Journal, 4*(1), 054–057.
[13] Orpin, J.B.; Mzungu, I.; Osuji, C.G. (2018). Isolation and Identification of Bacteria Associated with Suya (Roasted Meat Product) Sold in Dutsinma Local Government Area, Katsina State. *Journal of Advances in Biology and Biotechnology, 20*(2), 1–8. https://doi.org/10.9734/jabb/2018/v20i230071
[14] Salamandane, A; Silva, A.C; Brito, L; Malfeito-Ferreira, M. (2021). Microbiological assessment of street foods at the point of sale in Maputo (Mozambique). *Food Quality and Safety, 1*, 5. https://doi.org/10.1093/fqsafe/fyaa03.
[15] Buchanan, R.E.; Gibbons, M.E. (2014). Bergeys Manual of Determinative Bacteriology, 8th edition; Williams and Wilkins: Baltimore, USA; p. 305–318.
[16] Dagninet, A.; Manaye, Y.; Muluken, B.; Yisiak, O.; Kassaw, B.; Kaleb, A. (2023). Bacteriological Quality and Antimicrobial Resistant Patterns of Foodborne pathogens Isolated from Commonly Vended Street Foods in Arba Minch Town, Southern Ethiopia. *Infection and Drug Resistance*, *16*, 2883–2899.
[17] Akinyemi, K; Fashola, M.; Habib, N.; Akinwande, E. (2013). Vended foods In Lagos, Nigeria: a potential reservoir for the spread of emerging strains of drug resistant bacteria. *Health*, *5*(4), 675–680. https://doi.org/10.4236/health.2013.54089.
[18] Ogidi, O.C.; Oyetayo, V.O.; Akinyele, B.J. (2016). Microbial Quality and Antibiotic Sensitivity Pattern of Isolated Microorganisms from Street Foods Sold in Akure Metropolis, Nigeria. *Jordan Journal of Biological Sciences, 9*(4), 227–234.
[19] Pepple, N. (2017). Environment and Food Poisoning: Food Safety Knowledge and Practice among Food Vendors in Garki, Abuja – Nigeria, *Journal of Health Education Research and Development*, *5*, 217. https://doi.org/10.4172/2380-5439.1000217.
[20] Sharma, I.; Mazumdar, J.A. (2014). Assessment of bacteriological quality of ready to eat food vended in streets of Silchar city, Assam, India. *Indian Journal of Medical Microbiology, 32,* 169–171 https://doi.org/10.4103/0255-0857.129809.
[21] Akinnibosun, F.I.; Ojo, K.N. (2015). Comparative study of ready-to-eat foods from road-side and eateries in Benin city, Nigeria. *African Journal of Microbiology Research, 9*(13), 929–933. https://doi.org/10.5897/AJMR2015.7418.
[22] Oranusi, S.; Olorunfemi, O.J. (2011). Microbiological safety evaluation of street vended ready-to-eat fruits sold in Ota, Ogun state, Nigeria. *International Journal of Research Biological Science*, *1*, 27–32.
[23] ICMSF (2017). Microorganisms in Foods 5 –Characteristics of Microbial Pathogens, 1st ed. Blackie Academic & Professional, London, UK.
[24] Regional conference on food safety for Africa. Harare, Zimbabwe. Pp 22.. (accessed on 5 March 2024) Available online: https://openknowledge.fao.org/server/api/core/bitstreams/d774ec29-aa2b-4d1f-adec-6988963203cc/content.
[25] Oranusi, U.S.; Braide, W. (2012). A study of microbiological safety of ready-to-eat foods vended on highways Onitsha-Owerri, south east, Nigeria. *Interantional Research Journal of Microbiology*, *3*(2), 166–171. https://doi.org/10.15580/GJBS.2012.1.07301217.

[26] Yadav, N.; Saini, P.; Kaur, D.; Srivastava, N.; Pandey, D. (2011). Microbial quality and safety of ready- to-serve foods vended in Allanhabad City, India. *Journal of Food Safety, 13*, 6–10.
[27] Willis, C.; Little, C.L.; Sagoo, S.; de Pinna, E.; Threlfall, J. (2009). Assessment of the microbiology safety of edible dried seeds from retail premises in the United Kingdom with a focus on *Salmonella spp. Food Microbiology, 26*(8), 847–852. https://doi.org/10.1016/j.fm.2009.05.007.
[28] Health Protection Agency (HPA) (2009). Guidelines for assessing the microbiological safety of ready-to-eat foods. Health Protection Agency: London, UK.
[29] Addo, H.O.; Dzigbede, B.A..; Agidi, J.E.; Adjei, J.; Koranteng, A. (2014). A Study into Microbial Quality of Ready To Eat Foods Sold in the Sunyani Municipality of Ghana. *Global Journal of Biology, Agriculture & Health Sciences, 3*(3), 84–91.
[30] Barro, N.; Bello, A.R.; Itsiembou, Y.; Savadogo, C.A.T.; Outtara, A.J. (2007). Street Vended Foods Improvement: Contamination mechanisms and application of food safety objective strategy. *Critical Review, 6*, 1–10. https://doi.org/10.3923/pjn.2007.1.10.