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Microbiological quality of vendored *Waakye:* comparative study of caregiver vendors and solo vendors

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ABSTRACT

Ghana's thriving street food industry, popular for its convenience and affordability, struggles with ensuring food safety due to multiple influencing factors. This study examines the influence of childcare on the microbial quality of *waakye*, a popular street food in Ada. A comparative analysis was conducted between caregiver and solo vendors, sampling five vendors using convenience sampling. *Waakye* specimens were collected at the start and midpoint of sales, and microbiological quality was assessed using standard methods. An observational study was conducted to evaluate vendors' hygiene compliance. Observations revealed inadequate temperature control and hand-washing facilities among vendors. Statistical analysis showed significant differences ($p < .001$) in total coliform, *Escherichia coli*, and *Staphylococcus aureus* counts between vending groups. Additionally, the microbial quality deteriorated significantly ($p < .000$) from the start to the midpoint of sales. Findings suggest childcare compromises the microbial quality of vendored *waakye*, emphasising the need for improved hygiene practices and infrastructure.

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1. Introduction

Street food businesses in Africa have become widespread to meet consumers' food consumption needs (1). They are typically sold from stalls or on tabletop along the pavement of major streets in urban and rural areas offering accessible ready-to-eat foods to consumers. Street food patronage is driven by factors such as affordability, safety, convenience, nutritional value, and proximity (2). Furthermore, demographic characteristics like education level, age, and

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employment status influence consumers' decisions to purchase street food (3).

Its relatively low cost makes street food an accessible option for its patrons, unlike traditional restaurants. Furthermore, the industry's minimal initial capital requirements make it an attractive employment option for numerous unemployed youth, particularly those with limited or no formal education. However, research has shown that education significantly influences vendors' adherence to hygiene practices (4). This highlights a critical gap, as vendors with lower educational levels may lack the knowledge and skills necessary to ensure food safety. Compounding this issue, food preparation often occurs in unregulated environments, including vending sites and "ghost kitchens," circumventing regulatory inspection and monitoring protocols. As a result, compliance with food safety regulations is undermined, posing potential health risks to consumers.

Ghana's street food vending industry is characterized by a predominantly female workforce, with a significant proportion of vendors falling within the reproductive age range of 15-49 years (5). This demographic characteristic has important implications, as many female vendors concurrently bear childcare responsibilities while conducting business. Consequently, food safety may be compromised due to the challenges of balancing work and childcare. For the purposes of this study, food vendors who concurrently provide childcare are designated as Caregiver Vendors (CGVs), whereas those without childcare responsibilities are classified as Solo Vendors (SVs). A comparative analysis of their duties reveals distinct differences. Solo Vendors typically manage food preparation, customer service, finances, and inventory. In contrast, Caregiver Vendors assume additional responsibilities, including child supervision, feeding, and cleaning. This multitasking can become overwhelming during peak sales periods, increasing the likelihood of intentional and unintentional contamination. Consequently, consumers face elevated risks of foodborne illnesses and intoxication (6-8). Research consistently indicates that street food exhibits poor microbial quality (9), compromising the food security of the growing consumer base reliant on street-vended foods for nutritional and physiological needs (10). Notably, empirical evidence is lacking to substantiate the perceived disparity in microbial quality between foods sold by CGVs and SVs. Addressing this knowledge gap is crucial for informing policy and training initiatives.

Waakye, a traditional and culturally revered dish in Ghanaian cuisine, is prepared by cooking beans and rice together to create a soft, sticky consistency. The addition of an extract from Sorghum bicolor leaves often imparts a distinctive brownish hue. This nutrient-dense meal is commonly consumed with various accompaniments, including *shitor* (indigenous Ghanaian pepper sauce), stew, salad, pasta, and *gari* (a cassava-derived couscous-like product) (11).

Waakye holds significant cultural and social importance in Ghana, symbolizing community, hospitality, and tradition. Its preparation and sharing are often integral to family gatherings, festivals, and social events. As a ubiquitous street food, *waakye* vending is a vital sector in Ghana's informal economy. From a nutritional perspective, *waakye* provides essential energy, protein, and fiber to consumers (11). However, its composition and characteristics render it susceptible to microbial

contamination and proliferation, posing potential health risks.

Given its cultural significance, widespread consumption, and potential for contamination, *waakye* serves as an ideal case study for investigating the intersection of food safety and childcare practices. This research examines the mediating role of childcare practices on the microbial quality of vendored *waakye* in Ada.

2. Materials and Methods

2.1. Study area

The study was conducted in Ada, in the Ada East and West District in the eastern part of the Greater Accra region of Ghana. The principal town of Ada are Big Ada, Ada Foah, Kasseh, and Sege (**Fig. 1**).

2.2. Sampling and sample collection

A convenience sampling technique was employed in this study. Twenty *waakye* samples were collected from sampled vendors. Food samples were collected from vendors at the beginning of sales (morning) and midway through their sales. Samples were obtained from five CGVs and SVs each at the beginning and halfway through sales. The samples were packed in different sterile plastic bowls, sealed, labelled, and transported in an icebox with crushed ice cubes to the Microbiology laboratory of the Department of Food Science and Nutrition, University of Ghana, Legon, for microbial quality assessment. The presence of total coliforms, *Escherichia coli* and *Staphylococcus aureus* were determined as an index of microbial quality of the *waakye* samples.

2.3 Enumeration of total coliform, *E. coli* and *Staphylococcus aureus*

A measured amount of (10 g) of food samples was weighed aseptically into sterilized stomacher bags, 90ml diluents were added and homogenized by blending using the stomacher blender. A measured amount (1 mL) of aliquots of the mixture was pipetted aseptically into sterile disposable petri dishes in duplicates, and 15 mL of the molten agar was also added and swirled. The plates were solidified and incubated at 37oC for total coliforms and Staphylococcus aureus, the E. coli plates were incubated at 41oC for 48 h, and colonies were counted. Eosin Methylene (EMB) Agar, Violet Bile Glucose (VBG) Agar and Baird Parker Agar were used to enumerate the total coliform, E. coli and Staphylococcus aureus counts respectively.

2. 4. Vendor Observation

An observational guide was used to evaluate the vendor's hygiene practices. A total of four (4) vendors, including two (2) Caregiver vendors and two (2) Solo vendors, were observed for 2 h each, utilizing a checklist to evaluate personal hygiene, environmental sanitation, and childcare practices.

3.Results

3.1. Observed practices of food vendors

Table 1 shows how the food vendors displayed the *waaye* for easy visibility to attract consumers and serving ladles were used by all vendors to serve food during sales. Most vendors stored the *waakye* in a polythene bag or an ice-chest in an attempt to keep the food hot. Also, collection of monies was done along vending. Further observation made was that, most vendors had dish washing set-up for washing dishes,

but no hand washing facilities were provided at sales point. Another observation made was that babies were strapped to vendor's backs and breastfeeding was done during brief breaks (Table 1).

3.2. Mean total coliforms, *E. coli* and *Staphylococcus aureus* counts of *waakye* for Solo vendors and Caregiver Vendors

The results of the mean of the microbial quality of *waakye* sold by CGVs and SVs for the three different types of microorganisms, (total coliforms, *E.* coli, and *Staphylococcus*) are presented in Table 2. The highest microbial contamination was total coliform from CGVs with the mean of cfu of 9.64×10^2 whereas the least contamination was *Staphylococcu aureus* from SVs with a mean cfu 1.44×10^1. This high contamination could probably be attributed to poor hygiene practices by the CGVs.

3.3. Mean total coliforms, *E. coli* and *Staphylococcus aureus* counts of *waakye* samples before and at midpoint of sales for Solo vendors and Caregiver Vendors

The mean of the microbial quality of foods sold by CGVs and SVs for the three different types of microorganisms: total coliforms, *E. coli*, and *Staphylococcus* regarding morning and mid-point sales of food. From Table 3, the least contamination occurred in the morning occasioned by *Staphylococcus* with a mean cfu of (1.40×10^1). The highest contamination occurred during mid-point sales with *Staphylococcus* again with a mean cfu of (7.30×10^1). This finding points to the fact that *Staphylococcus occurs* as a result of bodily contact emanating from improper hygiene practices by the vendors.

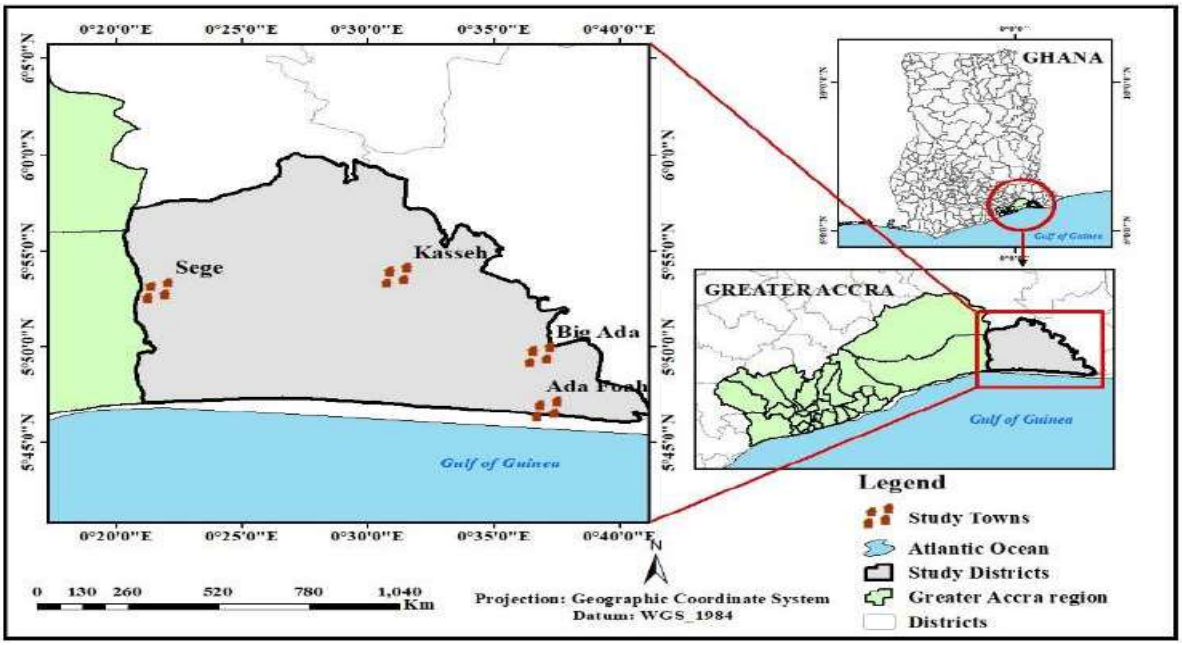

Figure 1. The map of Ada.

Table 1. Observed results on food hygiene practices of *waakye* vendors.

Observed themes	CGV1	CGV2	SV1	SV2
Display conditions of the food	The food was displayed on a covered table.	The food was displayed in a glass food display for sale	The food was displayed in a glass food display for sale	The food was displayed in a glass food display for sale
Serving equipment	ladles only	ladles only	ladle and hands. Vendor wore hand gloves but inappropriately used being a source of contamination	ladles only
Food storage container	Food was stored in transparent polythene bag in a metal basin	Food was stored in an ice chest	Food was stored in a covered non-insulated container	Food was stored in an ice chest.
Money collection	The collection of monies was done concurrently with sales	The collection of monies was done concurrently with sales	The collection of monies was done concurrently with sales	The money was collected concurrently with sales of food.
Dishwashing	Not applicable. Customers dine out.	There was a set up for washing equipment. However, vendor did not follow standard procedure.	There was a set up for washing equipment. However, vendor did not follow standard procedure.	There was a set up for washing equipment. But did not follow standard procedure.
Hand washing facility	No hand washing facility available for both vendors and customers.	Hand washing was done in mid shift dish washing set up.	Mid shift hand washing facility made up of a water receptacle, cup and basin	Mid shift hand washing facility made up of a water receptacle, cup and basin
Hand-washing procedure	No hand washing however, the vendor cleaned her hands on an apron as needed.	Partially follow standard hand washing procedure, Hands were dried with kitchen napkin.	Partially follow standard hand washing procedure. Hands were dried with kitchen napkin.	no hand-washing Hands were cleaned with a kitchen napkin.
Childcare	babies are strapped to vendor's backs and breastfeeding during brief breaks	babies are strapped to vendor's backs and breastfeeding during brief breaks	Not applicable	Not applicable

CGV: Caregiver Vendor

SV: Solo Vendor

Table 2. Mean total coliforms, *E. coli* and *Staphylococcus aureus* counts of *waakye* for Solo vendors and Caregiver Vendors.

Microbial Quality	Vendor	N	Mean	Std Deviation	t-test	P-value
Total Coliform	CGV	10	9.64×10^2	1.47		
	SV	10	3.86×10^2	1.43	5.34	**.001**
E. Coli	CGV	10	3.17×10^1	3.96		
	SV	10	7.10×10^1	3.33	2.32	**.001**
Staphylococcus aureus	CGV	10	5.98×10^1	1.94		
	SV	10	1.44×10^1	1.13	4.37	**.0001**

SV: Solo Vendors; CGV: Caregiver Vendors

Table 3.Mean total coliforms, *E. coli* and *Staphylococcus aureus* counts of *waakye* samples before and at midpoint of sales for Solo vendors and Caregiver Vendors

Microbial quality	Period	N	Mean	Std Deviation	t-test	P-value
Coliform	Morning	10	4.76×10^1	2.06		
	Mid-point	10	1.65×10^2	3.74	63.41	**.000**
E. Coli	Morning	10	1.40×10^1	1.31		
	Mid-point	10	3.74×10^1	1.23	23.1	**.000**
Staphylococcus aureus	Morning	10	1.40×10^1	0.73	43.69	
	Mid-point	10	7.30×10^1	2.14		**.000**

4. Discussion

4.1. Observed hygiene practices of food vendors

It was observed that caregiver vendor (CGV1) stored *waakye* in a basin lined with polythene bags, a practice that poses significant food safety risks. Using polythene bags for hot food storage is toxic and hazardous to human health (8), as they can leach harmful chemicals into the food. Furthermore, polythene bags provide inadequate insulation, causing food temperatures to drop below acceptable levels during vending. According to food safety regulations, hot foods should be displayed and served at a minimum temperature of 63°C (12). Additionally, displayed food should not exceed 2.5 h to ensure safety (12). The observed vending practices deviated significantly from these guidelines, demonstrating noncompliance with food safety regulations. Specifically, the vendors' unhygienic serving practices and inadequate temperature control compromised the microbial quality of the *waakye* samples. The dishwashing facilities set up by the vendors failed to adhere to standard food safety protocols. As stipulated by Tesanovic et al. (13), effective cleaning of food surfaces necessitates a sequential wash-rinse-sanitize cycle, followed by air drying. However, both vendor groups only implemented a two-stage process, omitting sanitization. Moreover, the dishwashing water was not changed as required, leading to repeated use of contaminated water and dishwashing sets. This inadequate practice potentially escalates microbial contamination on washed dishes and service equipment. Consequently, the microbial quality of the water and dishwashing facilities used by food vendors' warrants further investigation to ensure compliance with food safety standards. Both vending groups handled money whiles vending. Handling money while vending poses a significant public health concern, as it creates a critical risk of transmission of pathogens to consumers. Money, serves as a fomite for the dissemination of microorganisms, having passed through multiple hands before reaching vendors (14). Furthermore, inadequate hand hygiene practices among both CGVs and SVs facilitate the cross-contamination of pathogens from contaminated currency to food, thereby posing substantial health risks to consumers (14). The absence of standard hand-washing facilities was ubiquitous among all vendors. Instead, some vendors utilized makeshift dishwashing stations for hand washing, which was insufficient for maintaining proper hand hygiene. Although, the district assemblies enforced stringent hand-washing regulations during the COVID-19 pandemic, these guidelines appeared to be relaxed during the vending period. Notably, vendors failed to adhere to the established hand-washing protocol, which necessitates washing hands under running warm water with soap and disposable tissues (15). The food code, by Novakovic and Grujic (16) stipulates that proper hand washing requires washing hands under running warm water with soap, by rubbing hands together for 10-15 seconds, thorough rinsing, and drying with clean towels or hot air, taking at least 20 seconds. Regrettably, many vendors neglected hand washing altogether, opting to clean their hands with aprons or tissues as needed. Both CGVs and SVs engaged in suboptimal hand-washing practices, constituting a significant source of contamination for vendored *waakye* (15). The observed non-compliance with hand-washing

regulations among vendors underscores the need for targeted interventions. CGVs simultaneously cared for infants while vending, often breastfeeding during brief breaks. However, childcare responsibilities, such as managing restless children (observed in CGV1), compromised vendor attention and potentially jeopardized hygiene compliance. Access to social support, including assistance with childcare, is crucial for vending mothers' mental well-being and infants' development (17). Although informal work environments may facilitate breastfeeding flexibility (18), the practice of carrying children and periodic breastfeeding may increase microbial contamination risks, particularly *Staphylococcus aureus*, in vendored food.

The microbial quality of *waakye* samples among food vendors revealed that the total coliform counts were present in the food samples of both SVs and CGVs respectively. In terms of morning and mid-point sales for both vendors, the total coliform contamination was higher in the mid-point than that of the morning. This shows that vendors did not take into account the practices of food and kitchen hygiene seriously thereby increasing cross contamination rate. The total coliform count of *waakye* samples among food vendors exceeded the required amount of (1.0×10^2 cfu/g) (Tables 2, 3). This result is similar to work done by Tebri et al. (19) who identified the total coliform counts of fufu to exceed the acceptable limit of 1.0×10^2 cfu/g. This shows the non-hygienic practices among the food vendors.

A comparative analysis of *waakye* samples revealed significantly higher *E. coli* contamination levels in SVs' samples. Furthermore, the *E. coli* contamination levels increased from morning through mid-point sales samples, with a highly significant difference (Table 2, 3). The presence of *E. coli* in these food samples is unacceptable, indicating human and fecal contamination (20). Notably, while CGVs demonstrated better hygiene practices than SVs, their childcare responsibilities may have introduced additional contamination sources. Analysis of *waakye* samples from CGVs and SVs revealed notable variations in *Staphylococcus aureus* contamination. The CGVs' samples had a substantially higher *Staphylococcus count* compared to the SVs' samples. The morning samples from both vendor groups had a mean *Staphylococcus count* increasing as sales continued to mid-point (Table 2, 3). These findings are particularly concerning, as the acceptable limit for *Staphylococcus aureus* in ready-to-eat foods is 100 cfu/g or below (21). The significantly higher values recorded in this study pose a substantial risk to public health (22).

5. Conclusions

This study highlights significant food safety concerns among *waakye* vendors in Ada. The findings of this study demonstrate that *waakye* vendors' non-compliance with basic food safety protocols, including toxic storage, inadequate sanitation, hazardous money handling, and insufficient hand-washing, poses a significant threat to public health, demanding swift and decisive action to mitigate these risks. The presence of *E. coli* and *Staphylococcus* aureus in *waakye* samples poses substantial health risks to consumers. While, CGVs had a lower total coliform and *E. coli load*, their childcare responsibilities may introduce additional contamination sources. *Waakye* from CGVs however are higher in *Staphylococcus aureus*. Urgent interventions are necessary to improve food handling and hygiene practices both CGVs and SVs their levels of contaminations are both above acceptable limits.

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Authorship contribution

Grace Osanyogmor

Conceptualization of idea, Resources, Visualization, Data curation, writing of original draft, writing of review and references.

Doreen Dedo Adi

Conceptualization, Supervision, Data curation, Formal analysis, Validation, Reviewing, and Editing.

Ellen Louise Olu Fagbemi: Methodology, Software, Supervision, Validation, Data curation, review and editing.

Declaration of competing interest

The authors have disclosed that there are no financial and personal relationships with other people or organizations that could inappropriately influence or bias the work.

Data availability

All relevant data have been duly presented in this work.

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Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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