

Research Article

Community Awareness of Microbial and Heavy Metal Contamination in Fried Street Foods Wrapped in Printed Papers in Dar es Salaam, Tanzania

Ramadhan Abdul Hassan* , Abdulsudi Issa-Zacharia , Davis Naboth Chaula 

Department of Food Science and Agro-processing, Sokoine University of Agriculture, Morogoro, Tanzania

Abstract

Due to poor hygiene, handling, and food safety education, street food poses a substantial public health risk. Foods wrapped in ink-printed papers have been related to cancer, neurological, reproductive, and renal and liver harm. Objective of this study was to assess community awareness regarding potential microbiological and heavy metal contamination in ready-to-eat fried foods wrapped in printed paper in Dar es Salaam, Tanzania. The structured questionnaire was used to assess the awareness of 293 street food vendors in three districts: Kinondoni, Temeke, and Kigamboni. The findings from this study indicated that most (67.8%) of vendors were female, primarily aged 31-40 years (58.0%), and mostly possessing a primary level education (47.7%). Approximately 67.5% of vendors were owners of their businesses, and 36.7% possessed more than four years of experience. Findings revealed printed paper to be the primary wrapping material (44.5%), followed by plastic bags (41.3%). Hygiene practices were reported to be inadequate in which 88.0% of vendors did not cover their hair while 62.2% wore unclean clothing, and 95.1% failed to wash their hands before handling food. It was further revealed that awareness on heavy metal (71.1%) and microbial contamination (67.5%) was markedly inadequate and that the vendors were unaware of these risks, respectively. Although the finding showed poor awareness, 63.6% of vendors favoured the need for regulations on heavy metal contamination, while 56.5% favoured the reinforcement of regulations on the use of printed papers as wrapping materials for foods. These findings highlight the need to educate vendors about the risks associated with using ink-printed paper and personal hygiene practices to reduce microbial and heavy metal contamination.

Keywords

Ready-to-eat Fried Food, Street Food Safety, Community Awareness, Printed Papers, Microbiological Quality, Heavy Metals

1. Introduction

Food plays a crucial role in various social relationships and interactions [7]. Numerous factors, including urbanization, income and employment growth, retail modernization, and heightened demand for convenient shopping due to increasing opportunity costs of time, are rapidly transforming food sys-

tems in many developing countries [27]. The significance of food safety for public health, its environmental impacts, and implications for international trade render it a global issue [11]. In light of the prevailing global economic challenges, individuals are compelled to make informed financial choices to cope

*Corresponding author: aimalikon@gmail.com (Ramadhan Abdul Hassan)

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with increasing living costs. Consequently, many resort to consuming pre-packaged foods, often wrapped in ink-printed materials, which can adversely affect human health [4].

Street foods are important source of nutrition but wrapping in printed papers have significant effects on the health of the consumers caused by ink pigments. The ink pigments contain heavy metals like Cadmium, Mercury, Lead, and Chromium which are reported to cause cancer and reproductive disorders [10]. The ink-based papers include newspapers, magazines, calendars, examination papers, note papers, and pamphlets [23].

On the other hand, wrapping fried food in printed papers may cause microbial contamination due to unhygienic handling at the shops by street newspaper sellers, readers, transport and distribution, dirty stores, and other retail [8]. Pathogenic microbes can endanger public health by causing various acute and chronic foodborne illnesses through food poisoning or intoxication [20]. Although food packaging is necessary to protect food from environmental contamination, the use of ink-printed papers to pack, serve, and carry food items may impact the quality and safety of food if microorganisms transfer from the paper ink [10]. More than half of the world's human population now lives in urban areas, confirming that the world has entered urban society [25]. Most people on earth reside in urban areas, with limited options for food production on their own [12]. People who live in cities around the world purchase their food outside their homes, and these foods typically come packaged or wrapped in paper-based materials such as greaseproof sheets, Kraft paper,

and newspaper [19]. It was found out that as the percentage of households with a single member rise, more people prefer to eat packaged foods, of which some are packed in cheaply available printed papers [24]. The continued habit of eating ready-to-eat foods wrapped in inked printed papers results in serious health risks such as kidney failure, lung cancer, and endocrine disruption; the severity of these health risks is dependent on the level of exposure [13]. According to [22], Tanzania is among the victims of the changing urbanization, which leads to an increase in people using ready-to-eat foods wrapped in ink-printed papers such as newspapers, magazines, and pamphlets. The country lacks clear guidelines or regulations dedicated specifically to matters of eating foods wrapped in ink-printed papers, but rather guidelines regarding food hygiene, including analyzing packaging materials [26]. Several studies have looked at the health risks associated with the use of printed paper-wrapped foods and identified the major complications due to eating fried food wrapped in printed papers [10, 5]. The study by [14] reported different chemicals used in printing papers and their effects on human health, but still, little is known about the presence of heavy metals and microbial contamination. The awareness level of the general public on the effect of eating fried foods wrapped in printed papers is very low or unknown in Tanzania. Therefore, the study aimed to investigate the community awareness regarding microbiological and heavy metal contamination in ready-to-eat fried foods wrapped in ink-printed papers in Dar es salaam, Tanzania.

2. Materials and Methods

2.1. Description of Study Area

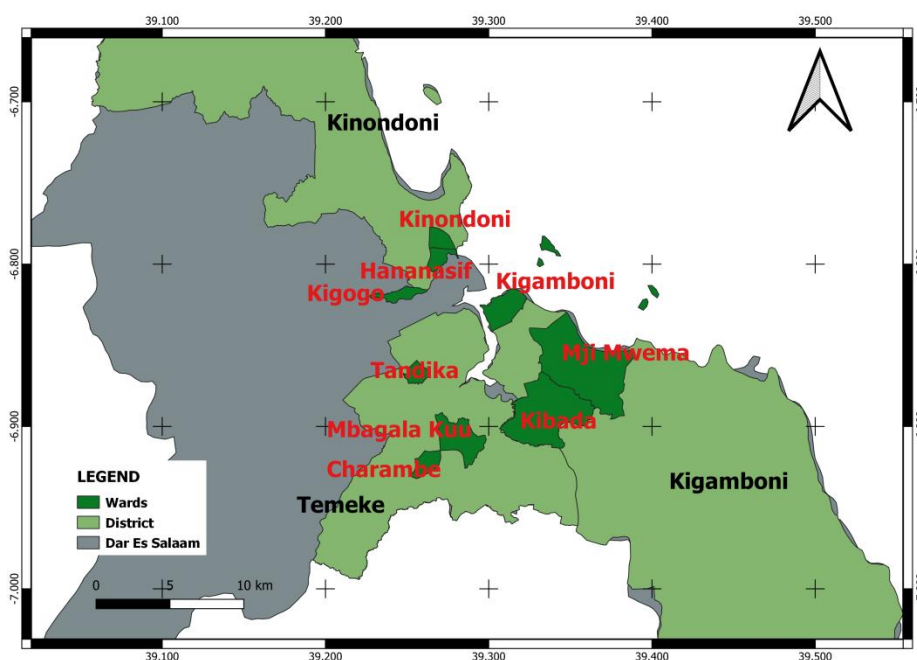


Figure 1. Map of Dar Es Salaam Region showing the area (Kinondoni, Temeke, and Kigamboni District).

The study was conducted in the Dar es Salaam Region, located on the eastern coast of Tanzania. The region is situated between latitudes 6.45 °S and 7.25 °S and longitudes 39.00 °E and 39.55 °E. To the east, it borders the Indian Ocean, while on the remaining sides, it adjoins the Coast (Pwani) Region (Figure 1). The 2022 national census indicates that Dar es Salaam's population exceeds five million, establishing it as the most populous region in the country. This research examined three districts within the Dar es Salaam Region: Kinondoni, Temeke, and Kigamboni. The location was chosen because of its high population density, rapid urbanization, and widespread consumption of ready-to-eat foods. A considerable number of these foods are typically packaged in printed ink paper, which raises potential public health concerns and highlights the importance of this study.

2.2. Research Design and Study Approach

A cross-sectional survey using semi-structured questionnaires through interviews and observations was done to gather

data from street food sellers and a selection of randomly chosen street food vendors. This study employed a multistage sampling method, as described by [2], to ensure representative coverage of street food vendors in the selected locations of the Dar es Salaam Region. The region has five districts, three of which Kinondoni, Temeke, and Kigamboni were purposively selected for their high population density and notable predominance of street food vending activities. In the second phase, nine administrative wards were randomly selected from throughout the three districts, 3 wards from each District; Kinondoni District (Kinondoni, Kigogo, and Hananasif), Kigamboni District (Mjimwema, Kibada, and Kigamboni), and Temeke District (Tandika, Charambe, and Mbagala Kuu). Subsequently, 3 streets were selected within each ward using a simple random sampling procedure and a total of 283 street vendors was selected using a sampling intensity of 5% of the total number of registered street food vendors in each district. Administrative data from district health officers indicates that Kinondoni had 1,880 vendors, Temeke had 1,900 vendors, and Kigamboni had 1,880 vendors as summarized in Table 1.

Table 1. A sampling plan to select respondents (street vendors) from the streets of the three districts in Dar Es Salaam Region.

District	Total Vendors	Wards Selected	Streets Sampled	Vendors Sampled (At 5%)
Kinondoni	1,880	Kinondoni, Kigogo, Hananasif	9	94
Temeke	1,900	Tandika, Charambe, Mbagala Kuu	9	95
Kigamboni	1,880	Mjimwema, Kibada, Kigamboni	9	94
Total	5,660	9 Wards (3 per District)	27	283

2.3. Data Collection Tool

A structured questionnaire was used as the data collection tool to evaluate community awareness of microbiological and heavy metal contamination in ready-to-eat fried foods wrapped on ink-printed papers in Dar es Salaam, Tanzania. The questionnaire comprised both closed and open-ended questions, organized into four sections and was translated and administered in Swahili. The first section gathered demographic data, including gender, age, and educational attainment of the respondents. The second section focused on awareness of heavy metal contamination, encompassing understanding of its sources, related health dangers, and recommendations for control measures and regulatory policies. The third section evaluated awareness of microbiological contamination, examining respondents' comprehension of contamination pathways, health consequences, and preventive measures. The fourth section had an observation checklist intended to evaluate customer awareness on hygienic practices among street food vendors, including food handling,

cleanliness, personal hygiene, and water utilization. The survey was administered through face-to-face interviews with selected street food vendors and consumers in the Kinondoni, Temeke, and Kigamboni Districts. Prior to the primary survey, the questionnaire was subjected to pre-testing in a non-selected ward to ascertain its clarity, reliability, and validity. Participation was voluntary, and all responses were managed with the highest level of confidentiality.

2.4. Data Analysis

The data collected from fieldwork were processed by editing, coding, and subsequently analyzed using the Statistical Package for Social Sciences (IBM SPSS Version 26, Chicago, IL, USA). Descriptive analysis was utilized, and the findings were subsequently presented as frequencies and percentages.

2.5. Ethical Considerations

A permit for research was requested from the Vice Chancellor of Sokoine University Agriculture, Tanzania and con-

duction of research was approved by the Directorate of Post-graduate Studies, Research, Technology Transfer and Consultancy. Prior to initiating the research, the study protocol was developed, submitted to, and approved by the university ethical committee. The Municipal Director of Kinondoni, Temeke, and Kigamboni Districts authorized the execution of this study. Verbal agreement was secured from each food vendor after elucidating the study's goal and significance before initiating data collection. Participation in the study was voluntary. The confidentiality of participant data was maintained throughout the investigation.

3. Results and Discussion

3.1. Demographic Characteristics of Food Vendors in Kinondoni, Temeke, and Kigamboni Districts

The demographic characteristics of food vendors in the assessed districts participating in the study are presented in Table 2. This study examined 283 street food vendors, with a predominant female representation of 67.8%, highlighting a gender disparity within the food business. This may be attributed to the characteristics of the business and related activities (such as frying), which are not preferred by males, while food preparation is perceived as essential for raising a female child. The findings align with previous research, as reported by [9] indicating that 67.5% of food street vendors are female, while 32.5% are male. The studies by [18, 17] indicate that the food vending business is primarily under-

taken by a greater number of women compared to men.

A substantial proportion of respondents were aged 31 to 40 years (58.0%), with the 18 to 30 age group comprising 22.6% of the sample. The results indicate that over 50% of respondents are aged 31-40 years, suggesting that this age group constitutes the majority of food vendors, reflecting a prevalent livelihood strategy for individuals aiming to achieve economic stability. The findings align with those of [15], who indicated that individuals aged 31-40 predominantly engage in entrepreneurship due to their optimal combination of experience and energy, rendering them well-suited to the demands of street food vending. Differences in dominance within this sector can be attributed to several factors, including access to education, alternative employment opportunities, and cultural attitudes towards entrepreneurship across various age groups.

Regarding educational status, approximately 47.7% of respondents completed primary education, while 29.0% had no formal education. The findings indicate that a considerable number of street food vendors in the study areas possess basic education; however, some do not have formal education. This indicates that certain street food vendors possess superior vending skills relative to their peers. The findings align with those reported by [17], indicating that the majority (40.9%) of respondents achieved primary education, followed by those with no formal education. It was observed that the majority of businesses were predominantly owned by the owners themselves, accounting for 67.5%. A significant proportion (36.7%) of street food vendors possessed over 4 years of experience in the industry.

Table 2. Demographic characteristics of fried food vendors in Dar es Salaam.

Variable	Respondent/categories	Frequency	Percent
Gender	Male	91	32.2
	Female	192	67.8
Age (in years)	Below 18	23	8.1
	18 – 30	64	22.6
	31 – 40	164	58.0
	41 – 50	19	6.7
	Above 50	13	4.6
	Education level	Non formal	82
	Primary	135	47.7
	Secondary	47	16.6
	Vocational Training	14	4.9
	University	5	1.8
Work position	Owner	191	67.5

Variable	Respondent/categories	Frequency	Percent
Work experience (in years)	Labourer	92	32.5
	Below 1	69	24.4
	1 – 2	48	17.0
	3 – 4	62	21.9
	Above 4	104	36.7

3.2. Characteristics of the Working Areas and Printed Papers Information

The distribution of respondents across the study area (Kinondoni, Temeke, and Kigamboni) regarding characteristics of the working areas and printed papers information are shown in Table 3. The results indicate that approximately 44.5% of street food vendors use printed paper for wrapping fried food, whereas 41.3% use plastic bags or films. The majority of respondents do not cover their hair (88.0%) and do not wear clean clothing or aprons (62.2%), suggesting that a considerable number are neglecting appropriate hygiene standards, thereby heightening the danger of contamination. These findings correspond with a research by [17], which indicated that food contamination can arise through multiple avenues. Hair can harbor bacteria, and if it contaminates food, it may introduce pathogenic microbes, presenting health hazards. Additionally, proper clothing helps prevent dirt, sweat, and microbes from harboring, reducing contamination. The majority of respondents also do not wash their hands after receiving money or

before serving food to customers (95.1. 1%). For example, a vendor might receive money from a customer and continue handling or serving food without washing their hands. This is similar to the results of studies by [16, 21] which found that most street food vendors use the same hands to collect money and serve wrapped food without washing. Over half (60.4%) of the food vendors cover their food by placing it in a closed plastic container, and some use a hot pot to prevent flies, dust, and to maintain hot storage. These results show that many street food vendors take steps to protect their food by covering it, which helps prevent foodborne illnesses caused by contamination. This practice directly mitigates key risk factors, as the absence of protective covering remains a strongly correlated factor with microbial contamination in recent street food analyses [1]. Preventing fly access is critical since flies are acknowledged as mechanical vectors for several enteric pathogens, such as Salmonella and E. coli, in food environments [6]. It was observed that a significant proportion of respondents (52.3%) store their wrapping or serving sheets in unsanitary situations, such as in open baskets, on mats, or in open buckets, which may attract flies and dust.

Table 3. Characteristics of the working areas and printed papers information.

Variable	Respondent/categories	Frequency	Percent
Location (District)	Kinondoni	94	33.2
	Temeke	95	33.6
	Kigamboni	94	33.2
Do you know printed paper?	Yes	279	98.59
	No	4	1.41
Which type do you commonly use for wrapping or serving fried food?	Newspapers	215	76.0
	Written papers	24	8.5
	Pamphlets	10	3.5
	Magazines	34	12.0
Which container is used to carry or pack fried food (Chapati)?	Printed papers	126	44.5
	Plastic bags or films	117	41.3
	customer container	12	4.3

Variable	Respondent/categories	Frequency	Percent
	Khaki parcels	28	9.9
Which way do you think is safer of the two?	To serve in printed paper	188	66.4
	To wrap in printed papers	65	23.0
	Not applicable	30	10.6
Are the printed papers for wrapping fried foods handled in hygienic conditions?	Yes	101	35.7
	No	182	64.3
The printed papers are stored in hygienic conditions and are free from flies.	Yes	135	47.7
	No	148	52.3
Do the fried foods covered to prevent flies and dusts?	Yes	171	60.4
	No	112	39.6
Do food street vendors cover hair?	Yes	34	12.0
	No	249	88.0
Do street vendors wear an apron?	Yes	107	37.8
	No	176	62.2
Do food street vendors wash their hands after receiving money before serving food to another customer?	Yes	14	4.9
	No	269	95.1

3.3. Awareness on Risks of Heavy Metals on Printed Papers and Their Use in Food Wrapping

Street vendors' awareness on risks of Heavy metals on printed papers and their use in food wrapping is presented in Table 4. The results of this study indicate that the majority (71.1%) of food vendors were unaware of the presence of heavy metals in printed papers. The findings of this study reveal that a significant majority (71.1%) of food vendors were unaware to the existence of heavy metals in printed papers. This may emanate from their educational background, as previously detailed in part 3.1, where it was observed that most of these vendors (77%) possess only primary education or lack formal schooling entirely. Additionally, 81.3% of respondents did not know about the possible migration of heavy metals from

printed paper to food once wrapped. Most (83.4%) respondents are unaware of the health effects of heavy metal consumption on humans. Conversely, 63.6% of respondents believe that if heavy metals are present in printed papers and can migrate to the food, posing a health risk, it is important to establish policies or regulations that prohibit the use of printed papers for wrapping, carrying, or serving fried food. There is limited knowledge regarding the potential for heavy metal contamination from printed paper to food. Further investigation is required to elucidate this matter for both the community and regulatory bodies. Very limited research in Tanzania has been conducted to evaluate community awareness regarding the presence of heavy metals in printed papers and their potential migration to food. Research conducted by [3] indicates that the migration of heavy metals from food packaging materials to food remained below the maximum regulatory levels, with the exception of arsenic and lead.

Table 4. Awareness on Heavy metals on printed papers and their migration to foods.

Variable	Respondent/categories	Frequency	Percent
Do you know heavy metals?	Yes	80	28.3
	No	203	71.7
Can heavy metals migrate from printed paper to the wrapped foods?	Yes	53	18.7

Variable	Respondent/categories	Frequency	Percent
If yes, which metal?	No	230	81.3
	Mercury	65	23.0
	Lead	15	5.3
	Not applicable	203	71.7
The health effects when consumed	Cancer	47	16.6
	Not applicable	236	83.4
Is it important to set a policy or regulation on this matter?	Yes	180	63.6
	No	103	36.4
If yes, why is it important?	To stop or reduce the effects of heavy metals on human health	180	63.6
	I don't know	103	36.4
Do you propose to set policy on that case?	Yes	180	63.6
	No	103	36.4

3.4. Food Vendors Awareness Regarding Microorganism Contamination from Printed Papers

Table 5 presents the vendors' awareness regarding the micro-biological contamination from the printed papers used for wrapping street foods. Most of the printed papers, such as newspapers, pass through different stages from printing media to the public and then from the public to the food vendors, where it is used to pack ready-to-eat foods. Throughout that path or unhygienic handling, the paper can be contaminated by microorganisms, some of which are pathogenic, potentially causing diseases to human beings when contaminated with food that is to be eaten. This study shows that majority of the respondents (67.5%) are not aware of microorganisms. The findings reveal that 70.0% of the respondents do not

know if printed papers may be contaminated by microbes when handled in unhygienic conditions, resulting in contamination of the food when wrapped, carried, or served in them. The results indicate low awareness among the street food vendors of the potential risks of using printed papers for food handling. The low awareness can lead to practices that may endanger food safety. The results agreed with the study by [16], showing that the majority of the street food vendors do not know about microbes and their possible transfer to the food when it comes in contact through wrapping or serving. About 48% of the respondents know that microbes can cause illness in humans when eating contaminated food while the majority of the respondents have experienced the illness due to microbes in food. A larger number of respondents (56.5%) agreed on setting up the policy or regulation to inhibit the use of printed papers to wrap, carry, or serve food.

Table 5. Information regarding microorganisms in printed papers.

Variable	Respondent / categories	Frequency	Percent
Do you know what a microorganism is?	Yes	102	32.5
	No	191	67.5
Do you know that wrapped materials can be contaminated with MOs?	Yes	85	30.0
	No	198	70.0
If yes, how do they contaminate the printed papers used?	Through the handler's hands	51	18.0
	In store	15	5.3
	Through transport	19	6.7
	I don't know	198	70.0

Variable	Respondent / categories	Frequency	Percent
Do you know that microbes can cause illness when eating contaminated food?	Yes	136	48.1
	No	37	13.0
	Not applicable	110	38.9
Have you experienced illness due to microbes in wrapped foods?	Yes	33	11.7
	No	250	88.3
Do you propose a policy to prohibit the use of printed papers to wrap ready-to-eat food?	Yes	160	56.5
	No	32	11.3
	Not applicable	91	32.2

4. Conclusion and Recommendation

The study highlights significant gaps in street food vendors' knowledge and practices related to hygiene, heavy metals, and microbial contamination with many vendors unaware of the health risks linked to their practices. The results highlight critical need for focused initiatives to enhance food safety knowledge among street food vendors, policy enforcement, and regulatory actions to improve food safety so as to control health risks associated with the use of ink-printed papers.

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Author Contributions

Ramadhan Abdul Hassan: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing—original draft, Writing—review & editing

Abdulsudi Issa Zacharia: Conceptualization, Investigation, Supervision, Validation, administration, Writing—review & editing

Davis Naboth Chaula: Conceptualization, Investigation, Supervision, Validation, administration, Writing—review & editing

Data Availability

The authors confirm that the data supporting the findings of this study are available within the article.

Conflicts of Interest

The authors declare no conflicts of interest.

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