

Assessment of Handling Practices of Fresh Vegetable Salads in Restaurants and Street Vendors: A Case of Mwanza City, Tanzania

ABSTRACT

Food safety is crucial for promoting public health and economic development. Food service establishments (FSE) provide a wide range of foods, including raw, mild and well-heat treated. Raw or mild-heat treated foods like fresh vegetable salads, *Kachumbari*, are potentially risky if not well handled. The objective of this study was to assess handling practices of operators involved in the preparation and serving of *Kachumbari* in various FSE in Mwanza City, Tanzania. A cross sectional study involving thirty food handlers from 10 restaurants and 20 street food vending sites was conducted in April 2023. A semi-structured questionnaire and observation checklist were used to collect data. Results indicated that 93.3% lacked formal food handling training, and 66.7% did not prioritize clean-as-you-go practices for food safety. Moreover, 53.3% felt that wearing clean clothes when handling food was not important, and only 26.6% underwent annual medical checkups. Moreover, the majority of the handlers (66.7%) demonstrated a poor understanding of food safety principles and procedures. Based on these findings, we recommend regular trainings on best handling practices among food handlers, coupled with inspections and supervision by relevant government authorities, to ensure that food prepared in FSE in Mwanza City and Tanzania as a whole is safe for human consumption.

Key words: Fresh vegetable salads, handling practices, *Kachumbari*, Mwanza City, Tanzania

1. INTRODUCTION

The consumption of fresh vegetables and mild-heat treated products like salads is increasing in developing countries including Tanzania (Mir *et al.*, 2018). Fresh and mildly heat-treated foods are often prepared without addition of any preservatives (Akoachere *et al.*, 2018; Kibitok and Ndoku, 2016). Fresh vegetable salads offer a healthy and balanced diet option; and are claimed to prevent several micronutrient deficiencies and chronic diseases such as heart diseases, cancer and obesity (Septembre-Malaterre *et al.*, 2018).

Fresh vegetable salads commonly known as *Kachumbari* in Tanzania is mainly prepared from one or more types of vegetables, such as bell peppers, cabbages, cucumbers, carrots, tomatoes, and onions (Mbae *et al.*, 2018). *Kachumbari* could be mildly heat treated or prepared without any heat treatment. Vegetable salads are often consumed in their raw forms; therefore, for public safety, *Kachumbari* should be prepared and handled under hygienic conditions.

Kachumbari is among the foods which are categorized as ready to eat (RTE) cold foods. Cold foods are an extremely diverse group of foods which are served and consumed while cold (Kapeleka *et al.*, 2020). These fresh vegetable salads are normally served with rice, roasted meat, fried potato and/or cassava.

Nevertheless, all types of food, including *Kachumbari*, are subject of contamination during the processes of preparation, serving, or storage. The contamination of food by handlers may result in food borne outbreaks posing a great threat to the consumers' health and economies of nations (Adams and Motarjemi, 1999; Annor and Baiden, 2011; Omaye, 2004). Approximately seventy percent (70%) of cases of diarrheal disease in developing countries are caused by the consumption of contaminated food (Fung *et al.*, 2018; World Health Organization, 2015). Food

prepared and served in large quantities is prone to contamination if strict hygiene and safety principles are not observed (The World Health Organization, 2006; Ali and Immanuel, 2017). Inadequate knowledge of food hygiene and/or negligence in safe food handling have been associated with contamination and transmission of human pathogens worldwide (The World Health Organization, 2006).

Like in many developing countries, the majority of food service providers in Tanzania are neither licensed nor trained in proper food handling (Ndunguru and Ndossi, 2020). Yet, they operate in inadequately designed facilities. Ready-to-eat foods, especially vegetable salads, have high risk of contamination because most of them are prepared in inadequate environment and handled by people with limited knowledge on best handling practices (Lopes and Minussi, 2016; Ndunguru and Ndossi, 2020). Studies to assess the handling practices of vegetable salads in the Tanzanian food service industry are limited. Therefore, the objective of this study was to assess handling practices of vegetable salads (*Kachumbari*) in food service establishments in Mwanza City, Tanzania. The findings of our study could aid in enhancing the proper food handling and sanitation practices among FSE, which may result in a decrease in food-borne illnesses associated with the consumption of RTE foods including vegetable salads and thereby lower treatment costs and promote economic growth.

2. MATERIALS AND METHODS

2.1. Study area and period

The current study was conducted in Ilemela and Nyamagana Municipalities in Mwanza City, in April 2023. This city is positioned in the northern part of Tanzania. It is located between 1°30' and 3° south of the Equator. Longitudinally, Mwanza is situated between 31°45' and 34°10' east of Greenwich. The population of this city is estimated at 1,310,754 (World Population Review, 2022). In Tanzania, the urban settlement of Mwanza ranks second after the city of Dar es Salaam. It is the largest business center for all the regions around Lake Victoria. Mwanza is bordered by three regions; Geita Region, borders it to the west, Shinyanga to the south and Simiyu to the east. While to the north it is bordered by the Lake Victoria.

2.2. Study design

The study employed a descriptive cross-sectional research design to assess the food handling and sanitation practices associated with contamination of *Kachumbari* in food service establishments (FSE) in Nyamagana and Ilemela Municipalities, Mwanza City. The two municipalities were selected because of their high number of street food vendors and restaurants.

2.3. Sampling procedure

This study recruited thirty ($n = 30$) *Kachumbari* handlers from thirty food service establishments, of which 10 were restaurants and 20 were street food vending sites (SFVS), using a multi-stage sampling technique. All the participants had direct contact with food as they prepared and handled it themselves. The number FSEs were restricted to 30 due to financial and time limitations but also the objective of the study was to establish the current status.

First, simple random sampling technique was used to select four wards with a high population of street food vendors in Mwanza City, two wards from each municipality. Igoma and Mirongo wards in Nyamagana, as well as Kirumba and Nyakato wards in Ilemela, were randomly picked from a list of wards with a high population of street vendors in Mwanza.

Thereafter, convenience sampling was used to select the thirty (30) FSE, proportionally between SFVS and restaurants, from the four randomly chosen wards; where 20 street vending sites and 10 restaurants were selected for the study. Convenience sampling is appropriate for studies on urban vending because of the difficulties in accessing urban vendors and their unwillingness to complete surveys (Mramba, 2015). However, only FSE that prepared and served *Kachumbari* were included into the study.

2.4. Assessment of handling practices

Face-to-face interviews using semi-structured questionnaires (containing closed and open-ended questions) were used to collect socio-demographic information on food handlers alongside information on food handlers' knowledge of food safety and hygiene, attitudes, and practices (Ansari-Lari *et al.*, 2010; Ali and Immanuel, 2017). Participation by food handlers was voluntary.

2.5. Interpretation of results

The questionnaire had mainly "yes" or "no" questions, whereas the observation checklist had only "yes" or "no" questions. A one-point score was attributed to the correct answer on every question, and a zero score was assigned to the incorrect answer. Then the overall performance was converted to a percentage (%) by dividing the total score by the total number of questions in a particular section. Total scores $\geq 64\%$ of the maximum score of "knowledge", "attitude", or "practices" were considered good, while lower scores were regarded as poor (Ali and Immanuel, 2017).

The questionnaire's questions concerning the handlers' food safety knowledge were 14 (Table 2), while questions regarding attitudes were 7 (Table 3). On the other hand, the questions dealing with the handlers' food safety practices were 18 (Table 4).

2.6. Statistical analysis

The collected data were analyzed using SPSS (Version 25 for Windows, SPSS Inc., Chicago, IL, USA). Descriptive statistics were employed to compute frequencies, means, and standard deviations. A hierarchical cluster analysis with the furthest neighbor method and squared Euclidean distance was employed to analyze the handling performance data. A non-parametric test (the Mann-Whitney U test) was performed to determine the differences between the clusters in the handling practices. The statistical significance level was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Socio-demographic characteristics

The study included 30 *Kachumbari* handlers, of whom 10 were from restaurants and 20 from street food vending sites. The hierarchical cluster analysis (average linkage) generated a dendrogram (Figure 1) displaying two clusters. Cluster I had 10 *Kachumbari* handlers from restaurants, while cluster II had 20 handlers from street food vending sites. This indicated that food handling practices were more similar within individual clusters than between clusters. Moreover, these findings suggested that the handling of food was different between restaurants and street food vending sites. However, based on Mann-Whitney U test results, no statistically significant ($p > 0.05$) difference in handling practices was observed between the two clusters (restaurants and street food vending sites).

On the other hand, this study was predominated by male food handlers (93.3%) while only two (6.7%) participants were females, one from each cluster (Table 1). The gender distribution in

our study was in contrast with earlier studies conducted in Tanzania, which observed that more than 80% of handlers in FSE were women (Karondo, 2021; Marras, 2018). Nevertheless, the results were in line with other studies conducted in different countries that found higher proportions of male handlers in FSE like restaurants and street food vending sites (Bou-Mitri *et al.*, 2018; Loukieh *et al.*, 2018; Odonkor and Odonkor, 2020). This indicates that the ratio of males to females in the food business depends on several factors, such as the type of food business and the geographical area in question. On the other hand, the age of all handlers (100%) in cluster I FSE (restaurants) ranged from 25 - 45 years old, while the majority (75.0%) of cluster II FSE (SFVS) were between 18 and 25 years old (Table 1). This demonstrated that *Kachumbari* handlers who operated in restaurants were relatively older compared to the workers at street food vending sites. However, none of the handlers was below 18 years old. Similarly, Nizame *et al.* (2019) in Bangladesh and Karondo (2021) in Tanzania observed that the majority of food service workers in street food businesses and restaurants are often adults aged 18 years and older.

Further, all food handlers (100%) had attended primary school, 53.3% of whom furthered their education to secondary school level (Table 1). The high proportions of participants with primary and secondary education in the study could be attributed to the Tanzanian government's initiatives to guarantee universal access to primary education through the provision of free education in public schools from primary to secondary level, as well as to ensure that every child goes to school (Ndibalema, 2019; Right to Education Initiative, 2018). However, in the current study, none of the participants had a qualification higher than a secondary school certificate. In conformity with our findings, several studies established that the vast majority of street food handlers in various parts of the world, including Tanzania, were adults above 18 years old and had completed primary school (Karondo, 2021; Raphael and Mrema, 2017). Mramba (2022) observed that 61% of the food handlers working in FSE in Mwanza City had primary school education. According to a study by Bou-Mitri *et al.* (2018), 60% of handlers in Lebanese restaurants had primary level education. This suggests that street food vending is an economic activity often dominated by people with low educational level and limited training in food hygiene and safety. Nevertheless, education is vital to improving food safety practices in food service establishments (Halim-lim *et al.*, 2023).

Although, appropriate training on food safety and hygiene is key in imparting food handling knowledge and skills to food service workers, so as to enhance their safe food handling practices (Ledo *et al.*, 2021), in our study only 6.7% of the participants reported to have received formal training in food handling (Table 1). These findings are comparable with previous studies done in other countries. Ali and Immanuel (2017) at Allahabad in India found that none of the food handlers (0%) had attended formal training for food handling. Similarly, Al-Kandari *et al.* (2019) in Kuwait reported that 58.0% of the food service workers had not participated in any food safety training program. Odonkor and Odonkor (2020) in Ghana identified lack of training to handlers (i.e., 63%) as the main barrier to food safety in the food establishments. Likewise, most handlers who worked in the visited FSE (both restaurants and street food vending sites) in Mwanza City were inadequately trained on proper food handling, which could compromise quality and safety of food.

Additionally, in this study 70.0% of the participants had been working in the RTE food industry for >2 years (Table 1). Likewise, Ali and Immanuel (2017) reported that 80% of food handlers had the experience of >2 years in this industry. Karondo (2021) and Al-Kandari *et al.* (2019) also revealed that most food handlers had been operating in the RTE food business for several years. Food safety and handling practices improve with experience (Nyarugwe *et al.*, 2020). Bou-Mitri *et al.* (2018) observed that workers with greater food handling experience had higher

knowledge scores compared to those with lower experience. Similarly, Faour-Klingbeil *et al.* (2015) recorded a positive impact of working experience on the food safety awareness among participants operating in food establishments.

Furthermore, the current study observed that all (100%) cluster I establishments (restaurants) had business capital of **Tanzanian Shillings (TSh)** 1,000,000 to 2,500,000, while 100% of the cluster II FSE (street food vending site) had invested between TSh. 100,000 and 500,000 (Table 1). Equally, Mramba (2022), documented that most of the street food vendors in Mwanza invested capital ranging between 100,000 and 500,000 Tanzanian shillings. According to the Tanzanian classification of businesses, businesses with a capital of not more than 5 million Tanzanian Shillings (TSh) are categorized as microenterprise (National Baseline Survey Report, 2012). Thus, all FSE in our study fell within the microenterprise group, indicating that they could not afford to improve the infrastructure, secure cooling facilities, or employee trained personnel. A previous study in Dodoma reported that lack of capital hindered enforcement of food hygiene regulations such as wearing aprons and boiling water for washing hands (Mfinanga, 2018).

Moreover, none of the cluster II FSE (street food vending sites) was licensed or registered, while all cluster I (restaurants) (100%, Table 1) were registered by both, Tanzania Revenue Authority (TRA) and Healthy Municipal Council (HMC). These findings were in agreement with a previous study in Tanzania Marras (2018) and Mfinanga (2018) which observed that street food vendors operate in non-licensed premises. Lack of registration among the FSE indicates that they operated in poorly designed facilities which could not comply with food premise registration regulations. Handling of food in such premises may cause cross contamination with various food safety risks.

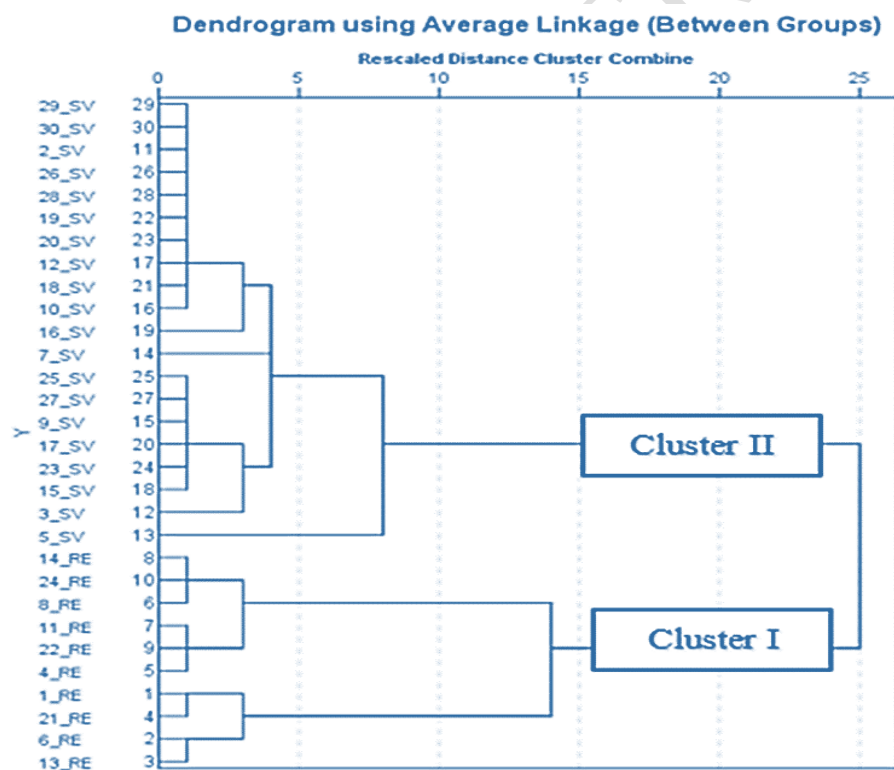


Figure 1. A dendrogram showing clusters by hierarchical cluster analysis on the relationship of *Kachumbari* handlers with respect to their handling practices

Table 1.Socio-demographic characteristics

Variable	Category	Frequency (%)		Total (%)
		Cluster I	Cluster II	
Age (yrs)	<18	0 (0)	0 (0)	0 (0)
	18 – 25	0 (0)	15 (75.0)	15 (50.0)
	25 – 45	10 (100)	5 (25.5)	15 (50.0)
	>45	0 (0)	0 (0)	0 (0)
Gender	Male	9 (90.0)	19 (95.0)	28 (93.3)
	Female	1 (10.0)	1 (5.0)	2 (6.7)
Marital status	Married	7 (70.0)	4 (20.0)	11 (36.7)
	Not married	3 (30.0)	16 (80.0)	19 (63.3)
Educational level	Informal	0 (0)	0 (0)	0 (0)
	Primary	3 (30.0)	11 (55.0)	14 (46.7)
	Secondary	7 (70.0)	9 (45.0)	16 (53.3)
Food preparation knowledge	Experience	8 (80.0)	20 (75.0)	28 (93.3)
	Training	2 (20.0)	0 (25.0)	2 (6.7)
Experience in RTE food industry (yrs)	<1	0 (0)	4 (20.0)	4 (13.3)
	1 – 2	0 (0)	5 (25.0)	5 (16.7)
	>2	10 (100)	11 (55.0)	21 (70.0)
Business capital (TSh.)	1 00,000 - 500,000	0 (0)	20 (100)	20 (66.7)
	> 500,000	10 (100)	0 (0)	10 (33.3)
Registration by relevant authorities	Yes	10 (100)	0 (0)	10 (33.3)
	No	0 (0)	20 (100)	20 (66.7)

Key: FSE = Food Service Establishment, RTE= ready to eat, SFVS = Street Food Vending Site

3.2. Food safety knowledge of food handlers

The findings of food handlers' food safety knowledge showed that all participants (100%) expressed a unanimous belief in the necessity of inspecting raw materials used in salads to ensure the quality and safety of the final product. Similarly, all participants (100%) concurred that proper cleaning of raw materials significantly contributes to minimizing contaminants, underscoring its importance for the safety of food (Table 2).

However, certain questions revealed areas of inadequate understanding. For example, none of the participants (0%, Table 2) recognized the role of wearing gloves when serving salads in reducing the risk of cross-contamination. Likewise, none of the participants (0%, Table 2) acknowledged the necessity of wearing masks during the distribution of unwrapped food. Furthermore, slightly more participants (53.3%, Table 2) considered that wearing clean clothing while handling food was not necessary. Additionally, more participants (66.7%, Table 2) regarded cleaning the food processing environment after services as not important. Overall, the food handlers had poor food safety knowledge. Most of the participants (66.7%, Figure 2) had a food safety knowledge score lower than 64%. However, the handlers in our study were more knowledgeable than those operating in other places in the world (Ali and Immanuel, 2017; Teffo and Tabit, 2020).

Table 2. Food safety knowledge of food handlers

Variable	Yes N (%)	No N (%)
Is covering raw materials crucial for food safety?	15 (50.0)	15 (50.0)
Does inspecting raw materials enhance product safety?	30 (100)	0 (0)
Is proper raw material cleaning essential for food safety?	30 (100)	0 (0)
Can covering vegetable salads lower contamination risk?	16 (53.3)	14 (46.7)
Does wearing gloves when serving salads prevent cross-contamination?	0 (0)	30 (100)
Must one wear clean clothing when handling food?	14 (46.7)	16 (53.3)
Should one wear a mask when distributing unwrapped food?	0 (0)	30 (100)
Is proper handwashing vital for food safety?	30 (100)	0 (0)
Can eating/drinking while chopping salad raise contamination risk?	25 (83.3)	5 (16.7)
Can nail polish impact safety of food?	30 (100)	0 (0)
Can accessories (like rings and bracelets) carry food-borne pathogens?	17 (56.7)	13 (43.3)
Is daily pre-service establishment cleaning crucial for food safety?	30 (100)	0 (0)
Is post-service establishment cleaning key to food safety?	10 (33.3)	20 (66.7)
Does cleaning the food storage area reduce cross-contamination?	27 (90.0)	3 (10.0)

3.3. Food safety attitudes of food handlers

Table 3 shows the food handlers' attitudes toward food safety. All participants (100%, Table 3) agreed that quality specifications play an important role in ensuring the safety and quality of raw materials used in food products. However, only 36.7% of participants expressed that cutting boards should be properly sanitized between salad preparation and handling other raw food items. This suggests the potential for improved understanding of this crucial practice. Further, majority (70.0%, Table 3) of participants found it unacceptable to use one cutting board for chopping both vegetables and raw meat due to awareness of the associated cross-contamination risks. Most handlers (73.3%, Table 3) recognized the importance of using different chopping boards for different types of foods to prevent cross-contamination. This awareness underscores the significance of employing proper practices to maintain food safety.

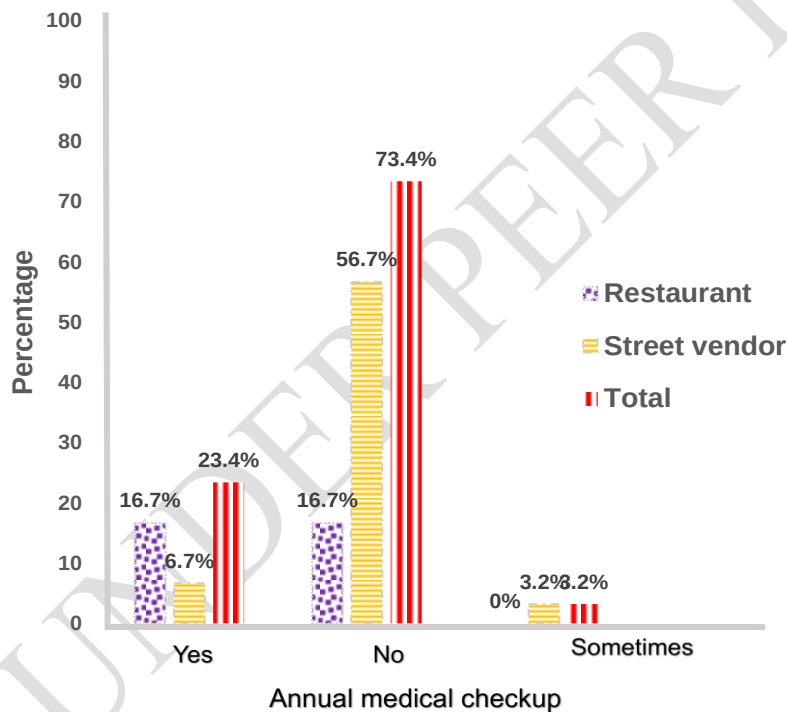
All participants (100%, Table 3) understood that proper hand washing is a crucial practice for reducing the risk of food contamination. A majority (70.0%, Table 3) of participants believed that touching other things while handling food could increase the risk of contamination. On the other hand, about (30.0%) of the handlers did not understand that keeping food at fridge temperature (0 - 4°C) can help reduce the risk of contamination. In conformity with this, Teffo and Tabit (2020) documented that a significant segment of participants in their study stored food at incorrect temperature. Moreover, some previous studies observed that sufficient knowledge and positive attitudes do not necessarily lead to good practices (Akabanda *et al.*, 2017; Asmawi *et al.*, 2018; Bou-Mitri *et al.*, 2018).

Table 3. Food safety attitudes of food handlers

Variable	Yes N (%)	No N (%)
Raw material quality specs not useful for quality and safety.	0 (0)	30 (100)
No need to sanitize cutting boards between salad prep and other raw foods.	19 (63.3)	11 (36.7)
Vegetables and raw meat can share the same chopping board.	9 (30.0%)	21 (70.0%)
Distinguishing between chopping boards is crucial.	22 (73.3)	8 (26.7)
Hand washing minimizes food contamination risk.	30 (100)	0 (0)
Handling food along with other items increases contamination risk.	21 (70.0)	9 (30.0)
Keeping food at fridge temperature (0 - 4°C) lowers contamination risk.	21 (70.0)	9 (30.0)

3.4. Medical checkup of personnel

Majority of the food handlers (73.4%, Figure 2) did not perform any medical checkup before being employed and after every six months. According to Tanzanian food legislation, food handlers shall undergo medical screening at least twice every year (TBS, 2022). This implies that food was sometimes handled by sick handlers in some of the food service establishments in Mwanza city. Health checkup is a component of food safety in ensuring that food is not handled by sick people (Hassan and Fweja, 2020; Odonkor and Carolyn, 2020).

**Figure 2.** Annual food handler medical checkup

3.5. Food safety practices of food handlers

According to the results about food handlers' safety and hygiene practices, a relatively modest percentage (36.7%, Table 4) of the handlers indicated that they wash their hands before touching raw foods. This observation underscores the need for enhanced attention to proper hand hygiene practices among a significant portion of food handlers. Conversely, a substantial majority (83.3%, Table 4) of food handlers demonstrated that they wash their hands after handling raw foods. This finding signifies a strong awareness of the importance of post-contact hand washing in maintaining food safety standards.

Alarming, only 16.7% (Table 4) of the handlers reported that they adequately washed utensils using soap and potable water. In line with this, Halim-lim *et al.* (2023) in the Maldives noted that some food establishments did not properly wash utensils, and others left the dirty utensils inside the sink for a long time. This result suggests the potential existence of gaps in proper utensil cleaning practices that warrant further attention and education. Furthermore, a relatively small proportion (20.0%, Table 4) of participants indicated that they thoroughly washed chopping boards with soap and potable water. This finding proposes consideration of more robust practices to ensure proper board sanitation.

The mixed storage of raw foods with ready-to-eat products results in cross-contamination (Montville *et al.*, 2001). Encouragingly, in our study, all participants (100%) exhibited a strong understanding of cross-contamination prevention by confirming their commitment to separating raw materials from ready-to-eat *Kachumbari*. Likewise, previous studies reported that it was vital to separate the raw foods from the ready-to-eat foods (Halim-lim *et al.*, 2023). However, notable gaps were identified in temperature control practices. None of the participants reported maintaining *Kachumbari* at fridge temperature, suggesting room for improvement in this critical aspect of food safety.

Notably, none of the participants reported the use of clean, sterile gloves during the serving of *Kachumbari*, and a minority (40.0%, Table 4) reported wearing clean food processing clothing while handling food. These findings indicate potential areas for improvement in personal protective equipment (PPE) usage. In terms of chopping board practices, only a small percentage (10.0%) of participants reported using boards of different colors, commonly employed to prevent cross-contamination. A moderate proportion (43.3%, Table 4) of participants reported sanitizing chopping boards when transitioning between cutting different products, signifying a partial awareness of this practice.

The scores for washing utensils using soap and potable water as well as properly washing hands before touching food were lower than in the previous works (Abdul-Mutalib *et al.*, 2012; Al-Shabib *et al.*, 2016). Poor hygiene, unsafe practices, and improper handling of food are the main causes of foodborne illnesses. Hence, food handling needs proper hand washing at every step of preparing food, especially before handling the food, after touching raw food material and any other contaminated surfaces or materials, as well as after using toilets (Souza *et al.*, 2018).

Overall, in this study, the food safety practice level of the food handlers was poor, with 86.7% of the participants not practicing recommended hygienic and safety standards (Figure 3). Conversely, some previous studies documented high levels of good food safety practices in FSE, such as restaurants, cafeterias, and stationary street food vendors (Asmawi *et al.*, 2018; Bou-Mitri *et al.*, 2018; Souza *et al.*, 2018). However, in conformity with our findings, a number of earlier studies showed comparable degrees of poor hygiene practices among food handlers (Salhadi *et al.*, 2017). This inconsistency in food safety practice level might be due to differences in the study tools used, geographical area, and sociodemographic characteristics.

Table 4. Food safety practices of food handlers

Variable	Yes N (%)	No N (%)
Do you properly wash your hands before touching raw foods?	11 (36.7)	19 (63.3)
Do you properly wash your hands after touching raw food?	25 (83.3)	5 (16.7)
Do you properly wash utensils by soap and potable water?	5 (16.7)	25 (83.3)
Do you wear nail polish while handling <i>Kachumbari</i> ?	0 (0)	30 (100)
Do you thoroughly wash the chopping board with soap and potable water?	6 (20.0)	24 (80.0)
Do you eat while preparing <i>Kachumbari</i> ?	1 (3.3)	29 (96.7)
Do you separate raw materials from ready-to-eat <i>Kachumbari</i> ?	30 (100)	0 (0)
Do you keep <i>Kachumbari</i> at fridge temperature (0 - 4°C)?	0 (0)	30 (100)
Do you keep <i>Kachumbari</i> at ambient temperature?	30 (100)	0 (0)
Do you cover the <i>Kachumbari</i> container or plate after preparation?	10 (33.3)	20 (66.7)
Do you properly clean your tables after each meal?	21 (70.0)	9 (30.0)
Do you wear clean, sterile gloves when serving <i>Kachumbari</i> ?	0 (0)	30 (100)
Do you wear clean protective clothing?	12 (40.0)	18 (60.0)
Do you use chopping boards of different colors?	3 (10.0)	27 (90.0)
Do you sanitize chopping boards when switching to another product?	13 (43.3)	17 (56.7)
Do you have a special storage room for raw materials?	6 (20.0)	24 (80.0)
Do you chop vegetables on the same board used to chop raw meat?	5 (16.7)	25 (83.3)
Do you mix leftovers <i>Kachumbari</i> with fresh <i>Kachumbari</i> ?	0 (0)	30 (100)

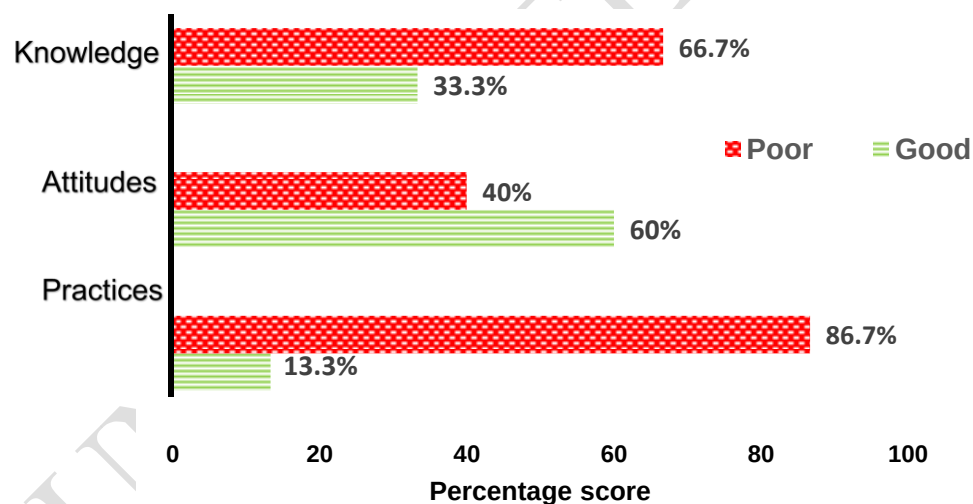


Figure 3. Food handlers' level of food hygiene and safety knowledge, attitudes and practices

3.6. Hygiene and safety of food processing environment

The surveyed FSE had no access to potable water (96.7%, Table 5). Although thermal or chemical treatment of water is an important step towards ensuring food safety (Ehuwa *et al.*, 2021; Jarvis *et al.*, 2016), very few FSE (13.3%, Table 5) used boiled or treated water for salad preparation. This practice creates opportunities of contamination with various food safety hazards.

According to Tanzanian food law, all FSE should have clean and well-furnished toilets (TBS, 2022). However, a significant proportion (43.3%) of the FSE had no toilets (Table 5) as several were street vendors. Further, 30% of the FSE lacked the handwashing facilities. Legesse *et al.* (2017) recorded similar findings that indicated lack of basic sanitation facilities like toilets, hand washing facilities, potable water, and waste disposal facilities in several food establishments in Arba Minch Town, Ethiopia. Nevertheless, the availability of sanitary facilities is a pre-requisite intended to minimize, control, and/or prevent food contamination and disease spread (Garcia *et al.*, 2019). Equally, hand hygiene is crucial in preventing the transmission of pathogens during food handling, and having a dedicated hand washing facility is a positive food safety indicator (Souza *et al.*, 2018).

Additionally, in this study, the majority of FSE (66.7%, Table 5), used the same chopping board for all products, which raises concerns as it can lead to cross-contamination between different food items, compromising food safety. Likewise, Ncube *et al.* (2020) observed high levels of food contamination and poisoning in food establishments, which were associated with the use of unhygienic food chopping boards.

Furthermore, proper waste management is essential to maintain cleanliness and prevent the growth of harmful microorganisms (Kumwenda, 2019). However, only 20.0% of the FSE (Table 5) had sufficient waste disposal facilities such as waste bins with a lid. A secure lid helps prevent pests and insects from accessing the waste, reducing the risk of contamination. Thus, the use of inadequate waste disposal facilities in most FSE suggests high risk contamination and cross-contamination in their foods.

About 26.7% (Table 5) of the establishments were reported to be dusty. The presence of unwanted materials such as dust and particles during the processing and preparation of food can be a source of pathogenic organisms (Kamboj *et al.*, 2020). Therefore, the presence of dust in some of the establishments is an indication of poor food safety and quality.

Furthermore, a small percentage of establishments were located near dumping sites (6.7%), sewerage systems (10.0%), or waterlogging places (13.3%) (Table 5). Additionally, a few establishments had a bad smell (3.3%) and/or pets (26.7%, Table 5). Some previous studies also reported that pets and pests like rodents were present in FSE (Alimi, 2016). Of note, all domestic, wild, and pet animals are reservoirs of some pathogenic organisms, such as *Salmonella* spp. (Ehuwa *et al.*, 2021; Simpson *et al.*, 2018). Thus, the presence of pests in a handful of the FSE in the current study rises food safety concerns. This suggests that there is a significant need for improvement in hygiene practices in the majority of the establishments studied.

Table 5.Hygiene and safety of food processing environment

Variable	Yes (%)	No (%)
Potable water available	1 (3.3)	29 (96.7)
Boil water for salad preparation	4 (13.3)	26 (86.7)
Toilets available	17 (56.7)	13 (43.3)
The toilets are clean	16 (53.3)	14 (46.7)
A hand washing facility available	21 (70.0)	9 (30.0)
A clean knife used to chop salads	26 (86.7)	4 (13.3)
Use the same knife to chop other products	18 (60.0)	12 (40.0)
Thoroughly clean the knife before and after chopping products	22 (73.3)	8 (26.7)
The knife is made of stainless steel	30 (100)	0 (0)
The knife has rust	30 (100)	0 (0)
A functioning refrigerator is available for storing Kachumbari	0 (0)	30 (100)
A cool box is available and used to store Kachumbari	0 (0)	30 (100)
A waste disposal facility is available	29 (96.7)	1 (3.3)
The waste disposal facility is lid type and sufficient	6 (20)	24 (80)
The establishment is located near the dumping site	2 (6.7)	28 (93.3)
The establishment is located near sewerage system	3 (10.0)	27 (90.0)
The establishment is located near the water logging place	4 (13.3)	26 (86.7)
The place is dusty	8 (26.7)	22 (73.3)
The place has bad smell	1 (3.3)	29 (96.7)
Pets (such as cats or dogs) are present in the establishment	8 (26.7)	22 (73.3)

4. CONCLUSION

The current handling practices of players in food service business in Mwanza City do not guarantee quality and safety of *Kachumbari*, a mild heat-treated product. Lack of trained handlers on best food handling practices indicate that the product is most likely contaminated. Moreover, preparation in advance accompanied with a long duration before serving increase risk of pathogen growth. In addition, inadequate facilities and equipment to ensure hygiene raise even more concerns on the safety of products handled in such environment. If the quality and safety of vegetable salads especially in tropical settings, the players should observe hygienic handling and adopt refrigeration storage. As compared to well-treated products, mild heat products are risky to contamination and growth of pathogens if best handling practices are not observed. Regardless, the potential risk to contamination, such product is preferred by consumers. Therefore, strategies to ensure safety of the product are essential at all levels. The food control authorities should monitor such establishment to ensure that they observe food hygiene regulations. The players need also to be trained on handling practices to maintain quality and safety across the chain.

REFERENCES

- Abdul-Mutalib, N. A., Abdul-Rashid, M. F., Mustafa, S., Amin-Nordin, S., Hamat, R. A., & Osman, M. (2012). Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers in Kuala Pilah, Malaysia. *Food Control*, 27(2), 289–293.

<https://doi.org/10.1016/j.foodcont.2012.04.001>

- Adams, M., & Motarjemi, Y. (1999). Basic Food Safety for Health Workers World Health Organization Basic Food Safety for Health Workers. *Geneva*, 24–27.
https://apps.who.int/iris/bitstream/handle/10665/65992/WHO_SDE_PHE_FOS_99.1?sequence=1
- Akabanda, F., Hlortsi, E. H., & Owusu-Kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. *BMC Public Health*, 17(1), 1–9.
<https://doi.org/10.1186/s12889-016-3986-9>
- Akoachere, J. F. T. K., Tatsinkou, B. F., & Nkengfack, J. M. (2018). Bacterial and parasitic contaminants of salad vegetables sold in markets in Fako Division, Cameroon and evaluation of hygiene and handling practices of vendors. *BMC Research Notes*, 11(1), 1–7.
<https://doi.org/10.1186/s13104-018-3175-2>
- Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, 103, 103–110.
<https://doi.org/10.1016/j.foodcont.2019.03.040>
- Al-Shabib, N. A., Mosilhey, S. H., & Husain, F. M. (2016). Cross-sectional study on food safety knowledge, attitude and practices of male food handlers employed in restaurants of King Saud University, Saudi Arabia. *Food Control*, 59, 212–217.
<https://doi.org/10.1016/j.foodcont.2015.05.002>
- Alimi, B. A. (2016). Risk factors in street food practices in developing countries: A review. *Food Science and Human Wellness*, 5(3), 141–148. <https://doi.org/10.1016/j.fshw.2016.05.001>
- Annor, G. A., & Baiden, E. A. (2011). Evaluation of Food Hygiene Knowledge Attitudes and Practices of Food Handlers in Food Businesses in Accra, Ghana. *Food and Nutrition Sciences*, 02(08), 830–836. <https://doi.org/10.4236/fns.2011.28114>
- Ansari-Lari, M., Soodbakhsh, S., & Lakzadeh, L. (2010). Knowledge, attitudes and practices of workers on food hygienic practices in meat processing plants in Fars, Iran. *Food Control*, 21(3), 260–263. <https://doi.org/10.1016/j.foodcont.2009.06.003>
- Asmawi, U. M. M., Norehan, A. A., Salikin, K., Rosdi, N. A. S., Munir, N. A. T. A., Basri, N. B. M., Selamat, M. I., & Nor, N. M. (2018). An assessment of knowledge, attitudes and practices in food safety among food handlers engaged in food courts. *Current Research in Nutrition and Food Science*, 6(2), 346–353. <https://doi.org/10.12944/CRNFSJ.6.2.09>
- Bou-Mitri, C., Mahmoud, D., El Gerges, N., & Jaoude, M. A. (2018). Food safety knowledge, attitudes and practices of food handlers in lebanese hospitals: A cross-sectional study. *Food Control*, 94(June), 78–84. <https://doi.org/10.1016/j.foodcont.2018.06.032>
- Ehuwa, O., Jaiswal, A. K., & Jaiswal, S. (2021). Salmonella, food safety and food handling practices. *Foods*, 10(5), 1–16. <https://doi.org/10.3390/foods10050907>
- Faour-Klingbeil, D., Kuri, V., & Todd, E. (2015). Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. *Food Control*, 55, 166–175.
<https://doi.org/10.1016/j.foodcont.2015.02.045>
- Fung, F., Wang, H. S., & Menon, S. (2018). Food safety in the 21st century. *Biomedical Journal*, 41(2), 88–95. <https://doi.org/10.1016/j.bj.2018.03.003>

- Garcia, S. N., Osburn, B. I., & Cullor, J. S. (2019). A one health perspective on dairy production and dairy food safety. *One Health*, 7(March), 100086. <https://doi.org/10.1016/j.onehlt.2019.100086>
- Halim-lim, S. A., Mohamed, K., Sukki, F. M., David, W., Fatimah, U., Zainal, U., & Jamaludin, A. A. (2023). *Food Safety Knowledge , Attitude , and Practices of Food Handlers in Restaurants in Mal é , Maldives*. 1–15.
- Hassan, J. K., & Fweja, L. W. T. (2020). Assessment of Food Safety Knowledge and Compliance to Hygienic Practices among Street Food Vendors in Zanzibar Urban District. *Current Journal of Applied Science and Technology*, 39(7), 59–72. <https://doi.org/10.9734/cjast/2020/v39i730577>
- Idris Ali, A., & Immanuel, G. (2017). Assessment of Hygienic Practices and Microbiological Quality of Food in an Institutional Food Service Establishment. *Journal of Food Processing & Technology*, 08(08). <https://doi.org/10.4172/2157-7110.1000685>
- Jarvis, N. A., O'Bryan, C. A., Dawoud, T. M., Park, S. H., Kwon, Y. M., Crandall, P. G., & Ricke, S. C. (2016). An overview of Salmonella thermal destruction during food processing and preparation. *Food Control*, 68, 280–290. <https://doi.org/10.1016/j.foodcont.2016.04.006>
- Kamboj, S., Gupta, N., Bandral, J. D., Gandotra, G., & Anjum, N. (2020). Food safety and hygiene: A review. *International Journal of Chemical Studies*, 8(2), 358–368. <https://doi.org/10.22271/chemi.2020.v8.i2f.8794>
- Kapeleka, J. A., Sauli, E., Sadik, O., & Ndakidemi, P. A. (2020). Co-exposure risks of pesticides residues and bacterial contamination in fresh fruits and vegetables under smallholder horticultural production systems in Tanzania. *PLoS ONE*, 15(7 July), 1–23. <https://doi.org/10.1371/journal.pone.0235345>
- Karondo, J. V. (2021). *THE ROLE OF STREET FOOD VENDING TO THE VENDOR'S HOUSEHOLD WELFARE IN ILALA MUNICIPALITY IN DAR ES SALAAM, TANZANIA.pdf* (p. 9). <http://www.cbe.ac.tz/bej%0ATHE>
- Kibitok, S. K., & Ndoku, J. M. (2016). Journal of Food Safety and Hygiene Evaluation of microbial contamination of consumed fruits and vegetables salad (Kachumbari) around Egerton University , Kenya. *Journal of Food Safety and Hygiene*, 2(1), 3–6.
- Kumwenda, S. (2019). Challenges to Hygiene Improvement in Developing Countries. *The Relevance of Hygiene to Health in Developing Countries*, 1–18. <https://doi.org/10.5772/intechopen.80355>
- Ledo, J., Hettinga, K. A., Bijman, J., Kussaga, J., & Luning, P. A. (2021). A tailored food safety and hygiene training approach for dairy farmers in an emerging dairy chain. *Food Control*, 124(January), 107918. <https://doi.org/10.1016/j.foodcont.2021.107918>
- Legesse, D., Tilahun, M., Agedew, E., & Haftu, D. (2017). Food Handling Practices and Associated Factors among Food Handlers in Arba Minch Town Public Food Establishments in Gamo Gofa Zone, Southern Ethiopia. *Epidemiology: Open Access*, 07(02). <https://doi.org/10.4172/2161-1165.1000302>
- Lopes Nonato, I., & Almeida Minussi, L. O. De. (2016). Nutritional Issues Concerning Street Foods. *Journal of Clinical Nutrition & Dietetics*, 02(01), 1–9. <https://doi.org/10.4172/2472-1921.100014>
- Loukieh, M., Mouannes, E., Abou, C., Hanna, L., Francesco, W., Marc, F., & Zeidan, B. (2018).

- Street foods in Beirut city : An assessment of the food safety practices and of the microbiological quality. January, 1–11.* <https://doi.org/10.1111/jfs.12455>
- Marras, S. (2018). *STREET_FOOD_IN_TANZANIA_A_literature_rev (1)*. www.fao.org/publications
- Mbae, K. M., Ndwiga, M. K., & Kiruki, F. G. (2018). Microbiological Quality of Kachumbari, a Raw Vegetable Salad Popularly Served Alongside Roast Meat in Kenya. *Journal of Food Quality*, 2018. <https://doi.org/10.1155/2018/8539029>
- Mfinanga, F. A. (2018). *COMPLIANCE OF FOOD VENDORS TO FOOD VENDING REGULATIONS IN TANZANIA-A CASE OF DODOMA MUNICIPALITY*. <http://www.ijmra.us>
- Mir, S. A., Shah, M. A., Mir, M. M., Dar, B. N., Greiner, R., & Roohinejad, S. (2018). Microbiological contamination of ready-to-eat vegetable salads in developing countries and potential solutions in the supply chain to control microbial pathogens. *Food Control*, 85, 235–244. <https://doi.org/10.1016/j.foodcont.2017.10.006>
- Montville, R., Chen, Y., & Schaffner, D. W. (2001). Glove barriers to bacterial cross-contamination between hands to food. *Journal of Food Protection*, 64(6), 845–849. <https://doi.org/10.4315/0362-028X-64.6.845>
- Mramba, N. (2022). Exploring Street Vendors Characteristics and Social-Economic Significance in Mwanza Tanzania. *Journal of Business and Management Review*, 3(3), 208–228. <https://doi.org/10.47153/jbmr33.3382022>
- Mramba, N. R. (2015). The Conception of Street Vending Business (SVB) in Income Poverty Reduction in Tanzania. *International Business Research*, 8(5), 120–129. <https://doi.org/10.5539/ibr.v8n5p120>
- Ncube, F., Kanda, A., Muzeketwa, D., & Chiripamberi, V. (2020). Risk factors for food poisoning among self- catering university students. *International Journal of Environmental Health Research*, 00(00), 1–11. <https://doi.org/10.1080/09603123.2020.1723498>
- Ndibalema, P. (2019). Making Sense of Basic Education Statistics in Tanzania: Emerging Issues and Implications for Future Practice. *International Journal of Elementary Education*, 8(1), 26. <https://doi.org/10.11648/j.ijeedu.20190801.14>
- Ndunguru, J. N., & Ndossi, D. G. (2020). Bacteriological Analysis of Ready-to-eat Foods from Morogoro Municipal Market. *Tanzania Veterinary Journal*, 37(November), 17–24. <https://doi.org/10.4314/tvj.v37i1.4s>
- Nizame, F. A., Alam, M. U., Masud, A. A., Shoab, A. K., Opel, A., Islam, K., & Luby, S. P. (2019). *Hygiene in Restaurants and among Street Food Vendors in Bangladesh*. 101(October 2013), 566–575. <https://doi.org/10.4269/ajtmh.18-0896>
- Nyarugwe, S. P., Linnemann, A. R., Ren, Y., Bakker, E. J., Kussaga, J. B., Watson, D., Fogliano, V., & Luning, P. A. (2020). An intercontinental analysis of food safety culture in view of food safety governance and national values. *Food Control*, 111(September 2019), 107075. <https://doi.org/10.1016/j.foodcont.2019.107075>
- Odonkor, S. T., & Odonkor, C. J. A. (2020). An Assessment of Food Safety Knowledge and Practices in the Ghanaian Hospitality Industry. *Journal of Food Quality*, 2020. <https://doi.org/10.1155/2020/5618492>

- Omaye, S. T. (2004). Food and Nutritional Toxicology. *Food and Nutritional Toxicology*. <https://doi.org/10.1201/9780203485309>
- Raphael, G., & Mrema, G. I. (2017). Assessing the Role of Microfinance on Women Empowerment: A case of PRIDE (T) -Shinyanga. *Business and Economic Research*, 7(2), 35. <https://doi.org/10.5296/ber.v7i2.10238>
- Review, W. P. (2022). world Population Review. In *World Population Review*. <https://worldpopulationreview.com/world-cities/mwanza>
- Right-to-Education-Initiative. (2018). 28 january 2016. January 2016. [www. right-to-education. org](http://www.right-to-education.org)
- Salhadi, N. A., Ab Hamid, M. R., Osman, N. S., & Md Nor, N. (2017). A Qualitative Study on the Determination of Healthy Cafeteria Practice in Selangor, Malaysia. *Environment-Behaviour Proceedings Journal*, 2(5), 141. <https://doi.org/10.21834/e-bpj.v2i5.691>
- Septembre-Malaterre, A., Remize, F., & Poucheret, P. (2018). Fruits and vegetables, as a source of nutritional compounds and phytochemicals: Changes in bioactive compounds during lactic fermentation. *Food Research International*, 104, 86–99. <https://doi.org/10.1016/j.foodres.2017.09.031>
- Simpson, K. M. J., Hill-Cawthorne, G. A., Ward, M. P., & Mor, S. M. (2018). Diversity of Salmonella serotypes from humans, food, domestic animals and wildlife in New South Wales, Australia 05 Environmental Sciences 0502 Environmental Science and Management 07 Agricultural and Veterinary Sciences 0707 Veterinary Sciences. *BMC Infectious Diseases*, 18(1), 1–11. <https://doi.org/10.1186/s12879-018-3563-1>
- Souza, C. V. S. de, Azevedo, P. R. M. de, & Seabra, L. M. A. J. (2018). Food safety in Brazilian popular public restaurants: Food handlers' knowledge and practices. *Journal of Food Safety*, 38(5), 1–9. <https://doi.org/10.1111/jfs.12512>
- Survey, N. (2012). Tanzania National Baseline Survey Report. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, 6(August), 128. <https://www.fsdt.or.tz/wp-content/uploads/2016/05/MSME-National-Baseline-Survey-Report.pdf>
- TBS. (2022a). *Guidelines for a client who wish to apply for registration of non-manufacturing premises for food and cosmetics*. <https://www.tbs.go.tz>
- TBS. (2022b). *TANZANIA STANDARD Food Hygiene – Code of hygienic practice for street-vended food*. 1(1121), 1–7.
- Teffo, L. A., & Tabit, F. T. (2020). An assessment of the food safety knowledge and attitudes of food handlers in hospitals. *BMC Public Health*, 20(1). <https://doi.org/10.1186/s12889-020-8430-5>
- The World Health Organization (WHO). (2006). Five Keys to Safer Food Manual. *Five Keys to Safer Food Manual*, 1–30. http://www.who.int/foodsafety/publications/consumer/manual_keys.pdf
- World Health Organization. (2015). Food-Borne Disease Burden Epidemiology Reference Group. *WHO Estimates of the Global Burden of Foodborne Diseases*, 1068–1069. https://doi.org/10.1007/978-3-662-43978-4_3884