Original Research Article

Evaluation of Hygienic Practices and Microbiological Quality of Street Vended Fruit Salads in Morogoro, Tanzania

ABSTRACT

Street vended foods have gained popularity due to economic benefits. However, they have been recognized as a potential hazard to public health as a result of poor hygienic practices. The study was conducted to assess the hygienic practices and microbiological quality of street vended fruit salads vended in Morogoro Municipal, Tanzania. A total of 30 respondents were involved in the study to assess of quality of fruit salad vended by town street vendors (TSV), University cafeterias (UCV), and town restaurants vendors (TRV). The findings revealed that most vendors (86.3%) were unaware of food safety, 73.3% were unaware of food safety standards and laws, and every seller evaluated was unaware of food safety initiatives such as Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP) and had never implemented any of them. All vendors saw the doctor only when they were ill. Nevertheless, none of vendor had a quality registration certificate or had undergone training in food safety and hygiene. Most of the salad preparation settings (46.7%) did not adhere to the fundamental requirements of a food preparation facility, and the vending facilities were in disrepair. Piles of dirty were observed in the food salad preparation and vending premises and 80% of the vendors used uncovered waste bins that were observed to encourage pests such as flies and cockroaches in the premises. The total aerobic count (TAC) ranged from 3.92±0.31 to 4.29±0.21 log CFU/g. All fruit salad samples were contaminated with coliforms and the level of coliform count exceeded 1.4×10^4 MPN/g in fruit salad samples indicating poor hygiene and fecal contamination. Possible sources of contamination were found to be water quality, cross-contamination, food handling and preparation equipment, and environmental factors such as dust, pests, and air quality. According to the study's findings, the majority of fruit salad sellers in the study area did not adhere to hygienic practices, and the made fruit salads were of poor microbiological quality, putting consumers at risk for food safety.

Key words: Street food vendors, Microbial quality, Hygiene practices, Fruit salad

1. INTRODUCTION

"Street foods are ready to eat foods and beverages prepared or sold by vendors or hawkers especially in streets and other public places. Street foods may be the least expensive and most accessible means of obtaining a nutritionally balanced meal outside the home for many low-income people, provided the consumer is informed and able to choose the appropriate combination of foods" (FAO, 2013). "Fruit salad is usually a combination of various fresh fruits such as apples, water melon, pineapples, cucumber, pawpaw, and orange. They are usually sliced into small pieces and packaged in small transparent plastic bowls. Salad can be eaten with a fork or tooth pick, with or without milk added" (Brooks, 2014). "Fruits are an extraordinary dietary source of nutrients, micronutrients, vitamins and fiber for humans and are thus vital for health and well-being. Well balanced diets, rich in fruits are especially valuable for their ability to prevent vitamin C and vitamin A deficiencies and are also reported to reduce the risk of several diseases" (Harrison, 2012). "Regular consumption of fruits is associated with reduced risks of cancer, cardiovascular disease (especially coronary heart disease), stroke, Alzheimer's disease, cataracts, and some of the functional declines associated with ageing" (Liu, 2003).

"In Morogoro, fruit salad is prepared and sold in road side, bus terminals, university cafeterias, recreational areas and around the streets. Various fruits used in preparing the fruit salad are usually kept on the ground near the slicing tables without any form of protection, hence the microbiological quality of the prepared fruit salads remain doubtful" (Brooks, 2014). "Fruits are widely exposed to microbial contamination through contact with soil, dust and water, and by handling at harvest or during post-harvest processing. Pathogenic microorganisms can also enter the fruits through damaged surfaces, such as wounds, cuts, and splits. Such pathogens may become internalised, survive, and grow within the fruit and consequently become a health hazard to consumer" (Penteado et al., 2004).

"The number of documented outbreaks of human infections associated with the consumption of raw fruits, vegetables, and unpasteurized fruit juices has increased in recent years" (Bintsis, 2017). "Unhygienic preparation, processing, and handling of raw fruit salads are the key sources of bacterial contaminations that lead to the outbreak of foodborne diseases" (Qadri et al., 2015). "There is high microbial contamination in raw fruit salads locally vended in various areas including Morogoro municipality, something that poses a threat of foodborne diseases to

consumers. Street-vended fruit salads are commonly consumed by residents and visitors in the Morogoro municipality. Poor hygiene practices and the presence of microbial contaminants can pose significant risks to public health, leading to foodborne illnesses. The conditions under which some street vendors operate are reported to be unsuitable for the preparation and sale of food" (Barro et al., 2006). "The place of preparation of fruit salads is not always clean, well lit, and not far from the source of contamination. The preparation surfaces used by some vendors have remnants of foods prepared earlier that can promote cross-contamination. Most of these foods are not covered and are exposed to flies and dust, which may harbour food-borne pathogens" (Rane, 2011). "In about 70 to 90% of cases, the presence of animals, insects, and liquid wastes in food preparation areas has been reported" (Rane, 2011). "Street vendors are mostly uninformed about good hygienic practices (GHP) and food safety knowledge" (Muyanja et al., 2011).

Street-vended fruit salads are commonly consumed by residents and visitors in Morogoro municipality. Poor hygienic practises and the presence of microbial contaminants can pose significant risks to public health, leading to foodborne illnesses. Understanding the current microbiological quality and hygienic practises is essential for the protection of public health. There is therefore an urgent need to promote food safety practices in the production and consumption of street vended foods, particularly in the developing countries where levels of hygiene standards are questionable, in order to ensure that the health of the consumers is safeguarded, and at the same time ensuring provision of nutritious, healthy and affordable foods that are easily accessible to all. This study aimed to assess the hygienic practices and microbiological quality of street vended fruit salads that are sold locally in Morogoro Municipality, Tanzania.

2. MATERIALS AND METHODS

2.1 Study Area and Sample Collection

The study was carried out in the Morogoro Municipality, Tanzania. Samples of fruits salad were randomly collected from the street fruit salad vendors in the afternoon after questionnaire interview and observations are complete. The samples were kept in aseptic containers and stored in a cool box containing sterile ice packs and taken for immediate analysis. The population evaluated during the study was classified into three groups: town street vendors (TSV),

University cafeterias (UCV), and town restaurants vendors (TRV). A total of 30 respondents (10 respondents from each category of street vendors) were involved in the study.

2.2 Study Design

A cross-sectional and experimental research design were conducted. Initially, a survey of street vendors doing business on the sides of the road, bus terminals, market areas, town center, university cafeteria, and town restaurants was carried out to collect data on knowledge and hygienic practices related to GMP and GHP by using a structured questionnaire. Possible sources of contamination of fruit salads were observed using checklist. Thirty fruit salad samples were collected from interviewed vendors for laboratory analysis of microbiological quality parameters.

2.3 Data Collection Tools

Data collection tools were structured questionnaires and check list. A questionnaire was created logically so that respondents may react quickly and sequentially. The whole questionnaire was organized and separated into different sections: demographic information (such as gender, age, educational level); knowledge about food safety and hygiene; and food safety; hygiene practices of fruit salad vendors and type of infrastructure used in vending business. Check list was organized into different sections including; hygienic condition of the vending environment, personal hygiene of vendors and preparation and serving utensils. The questions regarding water sources and treatment, fruit handling and fruit salad preparation methods, storage, serving equipment and vending sites were administered to the respondents. Salad preparation, handling practices, storage of leftover fruit salad and salad storage practices were observed and noted. Information was collected on the status of the premises, storage conditions for fruit salad, cutting and cutting place, status of the serving plate, cleanliness of the cloth and clothing used, provision for waste disposal and exposure to collected.

2.4 Microbiological Analyses

Fruit salad samples (25 g) were homogenized with a stomacher (Model H-2000C Shimadzu Corp., Kyoto, Japan) in 90 ml peptone water for 2 minutes. Serial diluted samples were plated on plate respective agars and incubated according to specifications for each microorganism. All platings were done in triplicate and mean values were used (Were et al. 2020). Aerobic count of viable organisms is a useful indicator of microbiological status of food. High counts indicate

unsatisfactory sanitation. The Plate Count Agar was tempered to 45 °C then added to the plate and mixed well to ensure even distribution of colony forming units after incubation. The plates were labeled as per every dilution and incubated at 30 °C for 24-48 hrs. Plates with 30-300 colonies were counted and the total count of viable organisms was calculated according to equation 1.

$$Number\ of\ bacteria\ in\ CFU/g = \frac{number\ \ of\ colonies\ \ x\ recip\ rocal\ \ of\ dilution\ \ factor}{inocilum\ \ \ size\ (volume\ )in\ ml} \quad \text{.....eqn. 1}$$

Most probable number (MPN) technique was used for enumeration of total coliform as in (Horwitz, 1975). Samples were serial diluted from 10^{-1} to 10^{-4}. Three (3) tubes containing MacConkey broth were inoculated with 1ml of appropriate dilution from each of the 10^{-2} to 10^{-4} dilutions and incubated at 37^0C for 24 hours. The number of tubes at each dilution level were recorded in tables showing a positive reaction, that is growth, change in color and/ or gas production in inverted Durham tubes (the highest dilution giving growth was used for estimation). The MPN of coliforms/gram of fruit salad sample were then determined using standard MPN tables for 3 tubes.

2.6 Data analysis

Both descriptive and analytical statistical methods were applied. Data for were entered and analyzed using Microsoft Excel version 2010.

The collected data on Status of Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) and possible sources of contamination of street fruit salad were analysed using SPSS (Statistical Package for Social Sciences), version 20. Descriptive statistics was used to determine the percentage, mean and frequency of the variables. For microbiological quality data, means of cfu/g among the assayed fruit salad samples from town street vendor (TSV), University cafeteria (UCV), and town restaurants vendors (TRV) were compared using One-way analysis of variance (ANOVA) and the differences were considered statistically significant when $p<0.05$.

3. RESULTS AND DISCUSSION

3.1. Demographic Characteristics of the Respondents

The demographic characteristics of the fruit salad vendors on the streets, in the university cafeterias, and restaurants are shown in Table 1. The results indicated that the majority of fruit salad vendors were men (67%) while women were only 33%. The findings also showed that the vendors had a relatively low level of education. The majority (73.3%) of the fruit salad vendors had primary education, while 13.3% had acquired a secondary and college education.

Table 1. Demographic information of Fruit Salad Vendors

Parameters	Category	Percentage (%)
Vendor type	Town street vendors (TSV)	33.3 (10)
	Town restaurants vendors (TRV)	33.3 (10)
	University cafeterias (UCV)	33.3 (10)
Gender	Male	67(20)
	Female	33(10)
Age range	15 -24 yrs.	0
	25 - 34 yrs.	80(24)
	35 - 44 yrs.	20(6)
	45 – 54 yrs.	0
	55 and above	0
Level of education	Informal education	0
	Primary	73.4(22)
	Secondary	13.3(4)
	College	13.3(4)
Marital status	Single	66.7(20)
	Married	33.3(10)

*Values in parentheses are number of respondents (n = 30)

Similarly, previous studies revealed that most street food vendors possess low educational training and often lack adequate food safety knowledge and skills (Benny- Ollivierra & Badrie, 2007; Salisbury, 2016; Samapundo et al., 2015). Most street vendors engaged in street food business due to lack of formal employment. A study by Mensah et al. (2002) found that street food vending was common in countries where unemployment of individuals was high due to lack of formal education Poor production and hygiene practices during the processing, storage and preparation of salads and juices, which can increase the risk of contamination from street food, may be associated with low levels of education (Muyanja et al., 2011). The overall age profile showed that those with age ranging from 25 to 34 years constituted the largest proportion of vendors (80%) and respondents with the age 35 to 44 years were few (20%). Majority of the fruit salad vendors are unmarried (66.7%).

3.2. Food Safety and Hygiene Knowledge of Fruit Salad Vendors

The food safety knowledge and health characteristics of fruit salad vendors are shown in Table 2. Most of the fruit salad vendors (86.3%) were unfamiliar with the term 'food safety. In a study conducted in Ireland, it was observed that some of the vendors did not know food safety concepts (Brennan et al., 2007). Most fruit salad vendors (73.3%) were also not familiar with food safety standards and regulations. All fruit salad vendors went for a medical check-up only when sick. A similar study carried out in Sudan urged that routine medical examination of food handlers should be carried out by health officials in order to regulate safe street food handling, preparation, and vending (Abdalla et al., 2009). All fruit salad vendors were not familiar with food safety programmes, including GMP and GHP. This may be due to the fact that street vendors are mostly uninformed of good hygienic practices (GHP) and food safety knowledge (Muyanja et al., 2011). In current study, none of the fruit salad vendors had a quality registration certificate or received training on hygiene and food safety (Table 2). Previous study carried out in the Colombo municipal area of Sri Lanka revealed that the majority of street food vendors did not have an authorized license or proper training in food safety practices (Galgamuwa et al., 2016). Additionally, the resent study by Nkosi and Tabit (2021) revealed that "vast majority of the respondents in their study did not possess a food service/hospitality qualification and the majority of them had not attended any food safety training courses". "Street food vendors require food safety training to boost knowledge and skills in food safety implementation" (Apanga et al., 2014). "It was explained that vendors had not attended a food safety course because of the low frequency of available training courses and the high fees of food safety training courses" (Madaki and Bavorova, 2019). Therefore, there is an emerging need to provide proper training on food safety practices and sanitary practices to street food vendors, as many of them are unaware of GMP, and personal hygienic practices. Similar to the current study, Ranka (2020) reported the key findings as observed in the WHO survey of street-vended foods. In their report, most countries had insufficient inspection personnel, insufficient application of the HACCP concept, and noted that registration, training, and medical examinations were not among selected management strategies (Ranka,2020). This might have led to the poor implementation of hygienic rules and procedures for fruit salad preparation hence leading to poor microbiological quality of fruit salads.

Table 2. Food safety and hygiene knowledge of fruit salad vendors

Parameters	Answer choices	Percentage (%)
Familiarization with the food safety program and implementation	Familiar and implement	0
	Not familiar/do not implement	100 (30)
Awareness of food safety standards and regulations	Aware	26.7 (8)
	Not aware	73.3 (22)
Familiarization with food safety terminology	Familiar	13.3 (4)
	Not familiar	86.7 (26)
Main way of dealing with left overs already prepared left overs	Use them for the next day	73.4 (22)
	Consume	0
	Refrigerate	26.6 (8)
	Give away	0
Main precaution taken in the entire fruit processing	Maintain general hygiene status	20 (6)
	Do nothing	0
	Don't know	80 (24)
Medical certification	Yes	13.3 (4)
	No	86.7 (26)
Training on hygiene and food safety	Trained	0
	Not trained	100 (30)
Do medical check-up frequently	Yes	0
	No	100 (30)
Quality registration certificate	Posses	0
	Do not posses	100 (30)

*Values in parentheses are number of respondents (n = 30)

3.3 Types of Infrastructure and Equipment used in Fruit Salad Handling

Table 3 shows the type of infrastructure used by the fruit salad vendors. All of the fruit salad vendors (100%) indicated that they had access to water and relied on the safety measures taken by suppliers (municipal tap water supply), while none of the fruit salad vendors treated the water. This is similar to observations made in Sudan on the use of poor-quality water by vendors where it was noted by Abdalla et al. (2009) that the main source of water used was municipal tap water.

Table 3. Types of infrastructure and equipment used

Parameters	Answer choices	Percentage (%)
Water availability	Yes	100 (30)
	No	0
Source of water for processing	Deep wells	0
	Municipal tap	100 (30)
How is water ensured safe	Don't treat	100 (30)
	Boil	0
	Add disinfectant	0
	Filter	0
Availability of toilets	Yes	66.7 (20)
	No	33.3 (10)
Hand washing facilities	Yes	100 (30)
	No	0
Cooling facilities	Refrigeration	33.3 (10)
	Cool box	0
	Cooling dispenser	0
	None	66.7 (20)
Waste disposal available	Yes	53.3 (16)
	No	46.7 (14)
Type of waste disposal	Waste bin	60 (18)
	Pit/ earth hole	40 (12)
	Plastic bag	0
	Plastic bucket	0
Processing gear	Hair net/ cap	33.3 (10)
	Gloves	0
	Apron/ Processing coat	0
	None	66.7 (20)

*Values in parentheses are number of respondents (n = 30)

Although there is current results describing the bacteriological quality Morogoro municipal water, previous studies carried out in Kingolwira suburb in Morogoro indicated that the water used was of poor quality and highly contaminated and needed proper treatment before consumption (Shayo et al., 2007). If the situation remains as it was reported by Shayo et al. (2007) or improved still using un-treated water poses a health danger to the consumer. Most of

fruit salad vendors (66.7%) had access to the toilets, while few (33.3%) had no access to the toilets. This was similar to the study conducted by Abdalla et al. (2009) which reported that clean water supply and hand washing or toilet facilities are not available to food street vendors. Most fruit salad vendors used waste bins for disposal of waste (60%) only 40% used Pit/ earth hole for disposal of waste. A large proportion of fruit salad vendors (66.7%) did not have processing clothing, while 33.3% of fruit salad vendors wore hair nets / caps in conjunction with aprons. This indicated presence of poor infrastructure facilities used by vendors which might lead to more cross contamination. All vendors did not wear gloves, although gloves could be hazardous if not properly used. Similarly, street vendors in Uganda also were observed to have variable poor infrastructure for preparation of foods (Muyanja et al., 2011).

3.4 Hygienic Condition of the Vending Environment

The results of the hygienic conditions of the vending environment are presented in Table 4. The status of the vending place was in poor condition among the vendors visited (46.7%), and most preparation settings did not meet the basic standards for a food preparation premises. During the survey, piles of dirty items were seen in the fruit salad preparation and vending areas. Moreover, (80%) of the vendors used uncovered garbage cans that were observed to encourage pests such as flies and cockroaches in the premises. This is contrary to Codex general requirements for food hygiene which recommend that, a place for food preparation should be kept clean at all times and should be far from any source of contamination (rubbish, waste water, dust and animals). Such similar observations were also recorded in other studies by Muinde and Kuria (2005) and Chukwu et al. (2010). This situation is likely to be contributed by limited hygiene education and inadequate food and premises inspections by health and food inspectors who would stop such food mishandling practices. The results indicate that (66.7%) of the vendors had dustbins present in their stalls but only 20% of those vendors covered them as a form of practice, and 53.3% of those dustbins were overfilled at the time of visit. Waste water and refuse were also not disposed properly (waste water and dirt near the stalls) by about 73.3% of the stalls. The working surfaces were generally not clean with visible dirt in (66.7%) of the stalls visited. The results are similar to a study carried out by Barro et al. (2006) in which conditions under which some street vendors operate have been reported to be unsuitable for the preparation and selling of food.

Table 4. Hygienic condition of the vending environment

General profile	Answer choices	Percentage (%)
Status of vending place	Good condition	20 (6)
	Average condition	33.3 (10)
	Bad condition	46.7 (14)
Building surface washable and working space cleanable	Yes	33.3 (10)
	No	66.7 (20)
Environmental surroundings of street fruit salad vendors	Garbage and waste near stall	73.3 (22)
	Garbage and waste far from stall	26.7 (8)
Presence of garbage receptacles/dustbins	Yes	66.7 (20)
	No	33.3 (10)
Dustbin covered	Yes	20 (6)
	No	80 (24)
Waste and refuse disposed of properly (no waste water or refuse near stalls).	Yes	26.7 (8)
	No	73.3 (22)
Preparation surfaces (wiped, no visible dirt)	Clean	40 (12)
	Dirty	60 (18)
Dustbin overfilled during the time of the visit	No	46.7 (14)
	Yes	53.3 (16)

*Values in parentheses are number of respondents (n = 30)

3.5. Personal Hygiene of Fruit Salad Vendors

The results of the vendor personal hygiene are presented in Table 5. Parameters assessed for personal hygiene were; if a worker wears suitable clean clothes for processing, no decorative articles or jewelry, cleanliness of hands and nails, washing of hands before and after work, usage of gloves, hair net/ hat and handling of fruits. In the current study, the general practices of the fruit salad vendors towards fruit handling, juice preparation, and display for sell were found to be poor. The general hygiene of the fruit salad vendors and the premises was also poor and were observed to encourage contamination of the juices in the aspects of washing fruits and cleaning of utensils, preparation methods, storage of the juices and the general hygiene. Most vendors

93.3% did not wear processing gears such as aprons, gloves, or hair net, which could be a great source of cross contamination. Also 80% of the vendors handle money while serving the fruits which is also a source of cross contamination. It was also found that (66.7%) of the vendors handled the fruits with their bare hands. The hands of the food handlers have been reported to be the most important vehicle for the transfer of organisms from environment (food surfaces), nose and skin to the food (Rane, 2011). This supports the reports of contamination of street vended fruit salads with toxigenic *Staphylococcus aureus*, the major being suppurative lesions of human beings and the environment (Mohapatra et al., 2002). A study conducted "on hand rinses, stored water, and source waters in Bagamoyo Tanzania indicated that both water and hands are important means of transmission of bacterial pathogens" (Mattioli et al., 2013). "Majority of street vendors did not comply with the general codes of hygiene as laid by national and Codex Alimentarius requirements. This emphasises the importance of training street vendors on the importance of personal hygiene to avoid contamination of food" (James, 2006).

Table 5. Personal hygiene of fruit salad vendors

General profile	Answer choices	Percentage (%)
Vendors wash fruits before processing	Yes	73.3 (22)
	No	26.7 (8)
Wash your hands before or after fruit preparation	Yes	66.7 (20)
	No	33.3 (10)
Use aprons or uniforms	Yes	6.7 (2)
	No	93.3 (28)
Handle fruits with bare hands	Yes	66.7 (20)
	No	33.3 (10)
Short nails and clean hands	Yes	60 (18)
	No	40 (12)

Vendor wearing jewelry	Yes	20 (6)
	No	80 (24)
Handle money while serving the fruits	Yes	80 (24)
	No	20 (6)

*Values in parentheses are number of respondents (n = 30)

3.6. Preparation and Serving Utensils

Results of preparation and serving utensils used in fruit salad preparation are presented in Table 6. Washing of the utensils was poorly done using cold water, without detergents. It was also observed that reusing the water that had been used several times was a common practice. Approximately 60% of the fruit salad vendors were found to predispose the fruits and utensils to contamination by poor methods of washing. The prepared fruit salads were not handled with care due to poor handling of the salads. These results of current study are similar to the previous study conducted by Muyanja et al. (2011), which reaffirm the findings of WHO in year 1984 that street vendors in various parts of the world are known to wash their utensils including those in which food has been served, in water that has been previously used, perhaps many times. The use of same water for several times a day creates an environment for cross contamination from dirty rinse water to ready prepared fruit salads with the rinsed plate (WHO, 2005).

The findings show that the majority of vendors washed their utensils in basins that were also used to prepare fruit salads, which could lead to cross-contamination. Additionally, some already produced fruit salads (46.7%) were not stored in sealed containers, which permitted pest and bug infestation. On the other hand, the water used to wash the utensils was reused numerous times before being changed. The fruit salad was likely contaminated as a result of the utensils being washed in such filthy water. The results are consistent with those of Tambekar et al. (2009) and Cardinale et al. (2005), which also reported unclean habits.

Table 6. Preparation and serving utensils

Parameters	Answer choices	Percentage (%)
Prepared salads kept in sealed conditions	Yes	53.3(16)
	No	46.7(14)
Modes of cleaning utensils	No cleaning	0
	Cold water &	40(12)

	soap	
	Cold water	60(18)
	Hot water	0
Utensils in good working conditions	Yes	60(18)
	No	40(12)
The basin for washing utensils is also used for fruit Salad preparation	Yes	33.3(10)
	No	66.7(20)
The prepared fruit salads handled carefully	Yes	40(12)
	No	60(18)
Basin for washing utensils also used for fruit salad preparation	Yes	60(18)
	No	40(12)

*Values in parentheses are number of respondents (n = 30)

3.7. Microbial Quality of Fruit Salad

The microbial count of the fruit salads samples from town street vendors (TSV), town restaurants vendors (TRV) and university cafeteria vendor (UCV) were evaluated in terms of Total Aerobic Count (TAC) and Total coliform counts (Table 7). The present investigation reveals a high microbial load in the fruit salad studied. Results for the total aerobic count from fruit salad vendors show that a large proportion of the samples had high total aerobic counts ranging from 5.05×10^3 to 2.11×10^4 CFU/g of fruit salad homogenate. Furthermore, the fruit salads served in the town restaurants had high Total Aerobic Counts (TAC) of 2.11×10^4 CFU/g followed by those which were vended along the town streets with 1.92×10^4 CFU/g. Samples of fruit salad vended at the University cafeteria recorded the significantly lower amount of total aerobic count of and 5.05×10^3 CFU/g (3.92±0.31) among the other tested groups (Table 7).

Table 7. Microbial count of fruit salad vended at town, restaurant and University cafeteria

Street Vendor Category	TAC		Total Coliforms (MPN/g)
	CFU/g	Log CFU/g	
Town Street Vendors (TSV)	1.92×10^{4a}	4.25 ± 0.18^{a}	$\geq1.4\times10^{4a}$
Town Restaurants Vendors (TRV)	2.11×10^{4a}	4.29 ± 0.21^{a}	$\geq1.4\times10^{4a}$
University Cafeteria Vendor (UCV)	5.05×10^{3b}	3.92 ± 0.31^{b}	$\geq1.4\times10^{4a}$

The mean ±SD values with different superscript were considered significantly different at $p<0.05$

The higher total aerobic count recorded on the salads served in the town streets and restaurants would be due to poor compliance with hygiene practices among vendors and contamination by moving vehicles, as well as dust particles, smoke generated, and crowds of people. These findings are more similar to previous studies by Nwachukwu et al. (2008), Farzana et al. (2011), Oranusi and Olorunfemi (2011) who recorded microbial load in fruits in the range of 10^4 - 10^9 CFU/ml. The presence of these microorganisms can be linked to a number of risk factors such as improper handling and processing, use of contaminated water during washing and dilution, cross contamination from rotten fruits, or the use of dirty processing utensils such as knife, flies, and trays, which are relevant with the study of Parveen et al. (2008) and Rashed et al. (2013). Also, the presence of these organisms in high numbers in fruit salad is of serious safety concern about the consumption of street vended foods. Some of the organisms encountered in this study are similar to those reported in similar studies from different countries (Edward et al., 2012; Mahale et al., 2008; Rashed et al., 2013).

Regarding the total count of coliforms, it was established that all fruit salad samples were contaminated since none of the samples registered 0.00 MPN/g (not detected status) as the lowest range value expected for vended fruit salads. The coliform concentration in the fruit samples amount to more than 1.4×10^4 MPN/g and was not significant difference between tested groups ($p>0.05$) indicating poor hygiene and fecal contamination. The results of a study conducted on street vended foods in Sudan and South Africa also indicated high counts of coliforms (Abdalla et al., 2009; Mosupye & Von Holy, 2000). It has been recommended that no sample should contain more than 10 coliform organisms per 100 ml (FAO, 2013), in which all samples tested had higher coliform counts than the maximum recommended limits, meaning that the fruit salads are of poor microbiological quality.

According to Bakobie et al. (2017) and Halablab et al. (2011), the total coliform counts in food samples are a sign of faecal contamination and poor hygiene procedures by food sellers. Since certain coliforms, particularly *E. coli*, are frequently found in high concentrations in feces from both humans and animals, the presence of these coliforms could also be linked to faecal contamination. When consumed by people, certain E. coli strains in food might result in

gastroenteritis and diarrhea (Akter, 2016). In this study the coliform counts observed for the fruit salads (Table 7) could suggest a high level of background faecal contamination of the fruit salads sold to the consumers in Morogoro. Total coliform contamination in food groups can be attributed to improper processing, the use of contaminated water during preparation and washing, or secondary contamination through food handlers' skin infections and nose nares as well as contact with contaminated tools like cutting boards, knives, and serving wares (Wei et al., 2006). Codex Alimetarius on the safety of fresh juices recommends taking precedent and strict limits on production, harvest, transportation, storage, manufacture, processing, labeling and distribution. These are incorporated into Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) with Hazard Analysis and Critical Control Point (HACCP) procedures being applied throughout the food chain (Bates et al., 2001).

3.8 Possible Sources of Contamination of Street Fruit Salad

The survey in current study revealed that fruit salads were particularly vulnerable to a number of microbial contamination sources, including the use of low-quality water to wash the fruits, cross-contamination with other vegetables and fruits, or the use of filthy processing tools like knives, cutting sticks, slicing tables, and trays, as well as negligent food handling procedures like insufficient hand washing, improper storage temperature, and improper ingredient storage. Cutting boards, knives, counters, and food storage containers are examples of items and surfaces that might harbor bacteria if they haven't been well cleaned and sterilized (Wei et al., 2006).

4. CONCLUSIONS

In conclusion, fruit salad vended in Morogoro town street, university cafeteria, and town restaurants exhibited high levels of microbiological contamination and as a result did not adhere to Tanzania national or Codex Alimentarius food safety regulations. The results of current study attributed subpar processing and poor hygiene practices to cross contamination rendering the product unfit for consumption. The preparation practises and selling environments were unsatisfactory and unhygienic. Additionally unsafe, the processing water appeared to taint the fruit salads. Samples had significant coliform counts, which indicated poor microbiological quality and the potential for food illness. It can be concluded that most fruit salad vendors in Morogoro municipality did not follow hygienic procedures, and that the manufactured fruit salads were of poor microbiological quality. The findings demonstrate how easily contaminated fruit salads growing on the street can become. Consumers of fruit salad are exposed to the danger

of contracting a food borne illness as a result of these organisms, which are known to cause gastrointestinal ailments and may have entered the product through improper processing. Authors recommends that development of unique food safety messages tailored to vendor mindsets and measurement of the efficacy of the provided food safety messages require additional tactics in addition to food safety sensitization or education, which may be beneficial.

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