***Original Research Article***

# Evaluationof Hygienic Practices and Microbiological Quality of Street Vended Fruit Saladsin 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 inMorogoro 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 GMP and GHP and had never implemented any of them. All vendors saw the doctor only when they were ill, but none of them 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 foodsalad 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 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 exceeded $1.4\times10^4$ MPN/g of fruit salad samples indicating poor hygiene and fecal contamination.Possible sources of contamination were found to be water quality, cross-contamination, food handling and preparationequipment, 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.


**Comment [L1]:** good hygienic practices

**Comment [L2]:** Total count of bacteria


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




## 1. Introduction

Street foods are ready to eat foodsand beverages prepared or sold by vendorsor hawkers especially in streets and otherpublic places.Street foods may be the least expensive and most accessiblemeans of obtaining a nutritionally balanced meal outside thehome for many low-income people, provided theconsumer is informed and able to choose the appropriatecombination 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 aswounds, 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 thatlead 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 inMorogoro municipality. Poor hygienicpractises 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 soldlocally 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.

**2.2Study 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, towncentre, 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.

Comment [L3]: center

**2.3Data 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.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 collectedon 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.

**2.4Microbiological Analysis**

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.

$$Number\ of\ bacteria\ in\ CFU/g = \frac{number\ \ of\ colonies\ \ x\ reciprocal\ \ of\ dilution\ \ factor}{inocilum\ \ size\,(volume\,)in\ ml}$$ .....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 $37^0$C 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**

The collected data Status of Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) and possible sources of contamination of street fruit salad wereanalysed using SPSS (Statistical Package for Social Sciences), version 20. Descriptive statistics was used to determine the percentage, mean and frequency of the variables.

**3. Results and Discussion**

**3.1. Demographic Characteristics of the Respondents**

The demographic characteristicsof the fruit salad vendors on the streets, in the university cafeterias, and restaurants are shown in Table 1. The results indicated that the majorityof 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 thatmost 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. The low education level may be associated with poor manufacturing and hygiene practices during handling, storage and preparations of salads and juices which can increase the risk of street food contamination(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%).

Comment [L4]: Benny et al 2007

**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 other countriessuch as 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, theresent study by Nkosi and Tabit (2021) revealed that vast majority of the respondents in their study didnot possess a food service/hospitality qualification and the majorityof 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(Madakiand 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 (%) |
|---|---|---|
| Familiarizationwith 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 equipmentused 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 Kingolwirasuburb 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 otherwise 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 *S. 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 quality 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 $5.05\times10^3$ to $2.11\times10^4$ CFU/g of fruit salad homogenate. Furthermore, the fruit salads served in the town restaurants had high Total Aerobic Counts (TAC) of $2.11\times10^4$ CFU/g followed by those which were vended along the town streets with $1.92 \times 10^4$ CFU/g. University cafeteria recorded the lowest amount of total aerobic count of and $5.05 \times10^3$ CFU/g among the other tested groups (Table 7).

**Table 7: Microbial quality 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) | $1.92 \times 10^4$ | 4.25±0.18 | $\geq1.4\times10^4$ |
| Town Restaurants Vendors (TRV) | $2.11 \times 10^4$ | 4.29±0.21 | $\geq1.4\times10^4$ |

Comment [L5]: count

Comment [L6]: count

Comment [L7]: count

| | | | |
|---|---|---|---|
| University Cafeteria Vendor (UCV) | $5.05 \times 10^3$ | 3.92±0.31 | $\geq 1.4 \times 10^4$ |

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 $1.4 \times 10^4$ MPN/g 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 / WHO, 1997), in which all samples tested had higher coliform counts than the maximum recommended limits, meaning that the fruit salads are of poor microbiological quality.

Comment [L8]: don't found in references

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.

## REFERENCES


Abdalla, M., Suliman, S., & Bakhiet, A. (2009). Food safety knowledge and practices of street foodvendors in Atbara City (Naher Elneel State Sudan). *African Journal of Biotechnology*, *8*(24).

Akter, N. (2016). *Study on Bacteriological Quality of Street-vended Foods Collected from Different Private Universities in Dhaka City, Bangladesh* East West University, Dhaka, Bangladesh].

Apanga, S., Addah, J., & Sey, D. R. (2014). Food safety knowledge and practice of street food vendors in rural Northern Ghana. Food and Public Health, 4(3), 99-103.

Bakobie, N., Addae, A. S., Duwiejuah, A. B., Cobbina, S. J., & Miniyila, S. (2017). Microbial profile of common spices and spice blends used in Tamale, Ghana. *International journal of food contamination*, *4*, 1-5.

Barro, N., Bello, A. R., Savadogo, A., Ouattara, C. A. T., & Iiboudo, A. (2006). Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). *African Journal of Biotechnology*, *5*(11).

Bates, R., Morris, J., & Crandall, P. (2001). Principles and practices of small-and medium-scale fruit juice processing. Food and Agriculture Organization. *Agricultural Services Bulletin*, *146*, 135-149.

Benny- Ollivierra, C., & Badrie, N. (2007). Hygienic practices by vendors of the street food "doubles" and public perception of vending practices in Trinidad, West Indies. *Journal of Food Safety*, *27*(1), 66-81.

Bintsis, T. (2017). Foodborne pathogens. *AIMS microbiology*, *3*(3), 529.

Brennan,M., McCarthy, M., & Ritson, C. (2007). Why do consumers deviate from best microbiological food safety advice? An examination of 'high-risk'consumers on the island of Ireland. Appetite, 49(2), 405-418.

Brooks, A. (2014). Evaluation of microbial contamination of street-vended fruit salad in Calabar, Nigeria. *Int. J. Curr. Microbiol. App. Sci*, *3*(7), 1040-1046.

Cardinale, E., Gros-Claude, J. P., Tall, F., Gueye, E., & Salvat, G. (2005). Risk factors for contamination of ready-to-eat street-vended poultry dishes in Dakar, Senegal. *International journal of food microbiology*, *103*(2), 157-165.

Chukwu, C., Chukwu, I., Onyimba, I., Umoh, E., Olarubofin, F., & Olabode, A. (2010). Microbiological quality of pre-cut fruits on sale in retail outlets in Nigeria.

Edeghor, U., John, G., & Origbu, C. (2019). Bacteriological profile of cut fruits sold in Calabar Metropolis. *World News of Natural Sciences*, *23*.

Edward, K., Umoh, E., & Eze, V. (2012). Microbial Quality of already prepared fruit salad sold in Port Harcourt, Nigeria. *J Biol Agri Health*, *2*(11), 74-79.

FAO (2013). *Food for the cities: Street foods*, Food and Agriculture Organization, Rome, Italy, 2013, http://www.fao.org/fcit/food-processing/street-foods/en/.

Galgamuwa, L. S., Iddawela, D., & Dharmaratne, S. D. (2016). Knowledge and practices of food hygiene among food handlers in plantation sector, Sri Lanka. International Journal of Scientific Reports, 2(12), 304-311.

Farzana, K., Akram, M. R., & Mahmood, S. (2011). Prevalence and antibiotics susceptibility patterns of some bacterial isolates from a street vended fruit product. *African Journal of Microbiology Research*, *5*(11), 1277-1284.

Halablab, M., Sheet, I., & Holail, H. (2011). Microbiological quality of raw vegetables grown in Bekaa Valley, Lebanon. *American Journal of Food Technology*, *6*(2), 129-139.

Harrison, F. E. (2012). A critical review of vitamin C for the prevention of age-related cognitive decline and Alzheimer's disease. *Journal of Alzheimer's Disease*, 29(4), 711-726.

Horwitz, W. (1975). *Official methods of analysis* (Vol. 222). Association of Official Analytical Chemists Washington, DC.

James, J. (2006). Overview of microbial hazards in fresh fruit and vegetables operations. *Microbial hazard identification in fresh fruit and vegetables*, 1-36.

Liu, R. H. (2003). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *The American journal of clinical nutrition*, *78*(3), 517S-520S.

Madaki, M. Y., & Bavorova, M. (2019). Food safety knowledge of food vendors of higher educational institutions in Bauchi state, Nigeria. Food Control, 106, 106703.

Mahale, D. P., Khade, R. G., & Vaidya, V. K. (2008). Microbiological analysis of street vended fruit juices from Mumbai city, India. *Internet Journal of Food Safety*, *10*(9), 31-34.

Mattioli, M. C., Pickering, A. J., Gilsdorf, R. J., Davis, J., & Boehm, A. B. (2013). Hands and water as vectors of diarrheal pathogens in Bagamoyo, Tanzania. *Environmental science & technology*, *47*(1), 355-363.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., & Ablordey, A. (2002). Street foods in Accra, Ghana: how safe are they? *Bulletin of the World Health Organization*, *80*(7), 546-554.

Mohapatra , A. D., Rath, C., Dash, S., & Mishra, R. (2002). Microbiological evaluation of street foods in Bhubaneswar. *Journal of food science and technology (Mysore)*, *39*(1), 59-61.

Mosupye, F. M., & Von Holy, A. (2000). Microbiological hazard identification and exposure assessment of street food vending in Johannesburg, South Africa. *International journal of food microbiology*, *61*(2-3), 137-145.

Muinde, O. K., & Kuria, E. (2005). Hygienic and sanitary practices of vendors of street foods in Nairobi, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, *5*(1).

Muyanja, C., Nayiga, L., Brenda, N., & Nasinyama, G. (2011). Practices, knowledge and risk factors of street food vendors in Uganda. *Food control*, *22*(10), 1551-1558.

Nkosi, N. V., & Tabit, F. T. (2021). The food safety knowledge of street food vendors and the sanitary conditions of their street food vending environment in the Zululand District, South Africa. Heliyon, 7(7).

Nwachukwu, E., Ezeama, C., & Ezeanya, B. (2008). Microbiology of polyethylene-packaged sliced watermelon (Citrullus lanatus) sold by street vendors in Nigeria. *African Journal of Microbiology Research*, *2*, 192-195.

Oranusi, S., & Olorunfemi, O. (2011). Microbiological safety evaluation of street vended ready-to-eat fruits sold in Ota, Ogun state, Nigeria. *International Journal of Research in Biological Sciences*, *1*(3), 27-32.

Parveen, S., Ahmed, M. S. U., & Nasreen, T. (2008). Microbial Contamination of water in around Dhaka city. *Bangladesh Journal of Scientific and Industrial Research*, *43*(2), 273-276.

Penteado, A. L., Eblen, B. S., & Miller, A. J. (2004). Evidence of Salmonella internalization into fresh mangos during simulated postharvest insect disinfestation procedures. *Journal of Food Protection*, *67*(1), 181-184.

Qadri, O. S., Yousuf, B., & Srivastava, A. K. (2015). Fresh-cut fruits and vegetables: Critical factors influencing microbiology and novel approaches to prevent microbial risks—A review. *Cogent Food & Agriculture*, *1*(1), 1121606.

Rane, S. (2011). Street vended food in developing world: hazard analyses. *Indian journal of microbiology*, *51*(1), 100-106.

Ranka, S. (2020). How corona virus could affect the culture of eating special reference to street food: the new normal. *IOSR Journal of Business and Management*, *22*(6), 1-7.

Rashed, N., Aftab, U. M., Azizul, H. M., Saurab, K., Mrityunjoy, A., & Majibur, R. (2013). Microbiological study of vendor and packed fruit juices locally available in Dhaka city, Bangladesh. *International food research Journal*, *20*(2).

Salisbury, T. (2016). Education and inequality in South Africa: Returns to schooling in the post-apartheid era. *International Journal of Educational Development*, *46*, 43-52.

Samapundo, S., Climat, R., Xhaferi, R., & Devlieghere, F. (2015). Food safety knowledge, attitudes and practices of street food vendors and consumers in Port-au-Prince, Haiti. *Food control*, *50*, 457-466.

SGMRL, W., & Gunasena, G. (2016). Microbiological quality of ready-to-eat meat based food available in temporary food outlets in Gall Face Green, Colombo, Sri Lanka. *International Journal of Agriculture Forestry and Plantation*, *4*, 38-44.

Shayo, N., Chove, B., Gidamis, A., & Ngoma, O. (2007). The quality of water in small community supplies of Kingolwira village, Morogoro, Tanzania. *Tanzania Journal of Health Research*, *9*(1), 56-60.

Tambekar, D., Murhekar, S., Dhanorkar, D., Gulhane, P., & Dudhane, M. (2009). Quality and safety of street vended fruit juices: a case study of Amravati city, India. *Journal of Applied Biosciences*, *14*(1997–5902), 782-787.

Wei, Q.-K., Hwang, S.-L., & Chen, T.-R. (2006). Microbiological quality of ready-to-eat food products in southern Taiwan. *Journal of Food and Drug Analysis*, *14*(1), 17.

Were, L., Were, G., & Aduol, K. O. (2020). Hygiene Practices and Microbial Contamination of Streetvended Foods in Kenyatta University's Environs.

WHO, G. (2005). Informal food distribution sector in Africa (street foods): importance and challenges.

**Comment [L9]:** Edeghor, U., John, G., &Origbu, C. (2019)don't found in article

**Comment [L10]:** SGMRL, W., &Gunasena, G. (2016) don't found in article