# Food Hygiene Conditions and Microbial Contamination of Minimally Processed Fruits in Central Ward, Nairobi County

**Mercy Adhiambo Ndiege; Jackim Nyamari; Jasper.K.Imungi**

***Abstract:*** Minimally processed fruits (MPF) vended as street foods, despite numerous benefits, can cause food-borne illnesses due to poor hygiene practices and unsanitary conditions. This study sought to assess food hygiene condition in minimally processed fruit vending businesses in Nairobi Central Ward.

The method used was cross sectional with analytical component through convenient sampling of 76 street food vending environment (FVs). Observational checklist prepared using codex food hygiene and safety principles captured data. Inferential statistics established variable relationships at 95% confidence interval. Food Hygiene Condition (FHC) was ranked according to Bloom cut off points on calculated percentage scores.

Results show that the vending places were washable and cleanable but the environmental surrounding was not very clean as 68% of the stalls had garbage and waste nearby. Most (75%) of the FVs had no houseflies, 89% had adequate water, and 30% had drainage system. Therefore, FHC was generally poor in 57.9% of the cases. Fruit salad samples had the highest bacterial load ($\log_{10}$ 4.65cfu/g) and coliforms ($\log_{10}$ 0.78cfu/g) while pineapples (mean $\log_{10}$ 3.50cfu/g) had the highest mould and yeast count. Hence fruit salad samples were highly contaminated while pineapple and pawpaw samples were least contaminated. However there was no significant association between FHC and microbial contamination of MPF.

In conclusion FHC were poor and MPF were not microbiologically safe. Periodic hygiene training and policy on ready-to-eat food vending should be implemented.

***Index Terms***- minimally processed fruits, food hygiene condition, street food vendors, microbial contamination

## I. BACKGROUND

Fruits are an extraordinary dietary source of nutrients, micronutrients, vitamins (especially C) and fiber for humans [1]. They are vital for health and wellbeing; and reduce the risk of several diseases and their consumption has become a global priority. Minimally processed refrigerated (MPR) fruits and vegetables are slightly modified fruits and vegetables that retain characteristics of freshness during expanded shelf-life [2]. Increasing demand for ready-to-eat fresh-cut fruits due to the paucity of time cost efficiency and increasing demand for low-caloric food products with fresh-like characteristics has caused an expansion of the market for minimally processed products [1]. However, because of the specific forms of preparation, they are highly perishable and associated with new food epidemiological and microbiological safety problems [3] . Food safety is a major concern with street foods. People working in industries and other institutions are more likely to get food safety training as compared to street food vendors and are also more likely to be well educated [4 ]. The main aim of the training is to minimize food poisoning and improve the food safety among all food handlers [5]. Food safety courses and training can be used to curb the food-borne diseases among food and fruit vendors by learning various sustainable and proper methods they can employ in order to maintain a hygienic environment [6 ,7]. Most fruit and food vendors have undergone training but less than half made use of the knowledge learnt [8]. However, improper food handling has in the past increased with increase in the number of fruit vendors trained [5]. In Northern Nigeria, physical factors such as equipment used, furniture used in the vending area and the environment itself, coupled with poor hygiene practices during production and washing of fruits with contaminated water are all sources of contamination. Personal grooming, washing of hands and medical check-up are important preventive measures of contamination [4]. Food preparation premises should be purposely built in areas that are free from dust or smoke, away from heaps of garbage, and the surfaces should be made of material that is easy to clean and free from cracks or crevices so that microorganisms cannot easily grow and multiply [4 , 9] . Street food vending is common in the Central ward of Nairobi County in the form of mobile vendors who hawk, or by stationary vendors set up in stalls, market places and public bus stations [10]. Poor hygiene practices therefore, coupled with low standards of environmental and personal hygiene, improper handling of food, improper storage occur with street foods raising health concerns such as food-borne illnesses [11]. Due to increased demand; and unlimited and unregulated growth, there has been a severe strain on city resources such as water, sewage systems, and interference with city plans through congestion and littering, and the street food vendors are usually unlicensed blocking vehicle and pedestrian traffic [4, 10]. This raises concern with respect to their potential for serious food poisoning outbreaks and exposure of the sliced fruits to flies, dust and other disease causing agents [12]. Intentional or inadvertent contamination of fruits puts the consumer at the risk of suffering food-borne illnesses [4 ].

## II. METHOD

The study was analytical in design conducted in the Central ward, Nairobi Metropolis. The study randomly observed 76 fruit vending environment. Data was collected using observation checklist. Quality control measures were employed including pre-test, validity and reliability checks. The research permit was obtained from the National Commission for Science, Technology and Innovation and Kenyatta University. Collected

data was cross-checked for completeness and any missing entries updated. Data from observation checklists was analysed into descriptive statistics and non-parametric tests for possible associations using Statistical Package for the Social Sciences (SPSS) version 21. Findings were presented in the form of text, charts, graphs and tables.

## III. Results and Discussion

### Food Hygiene Condition

The main means of vending were stalls (52.6%) and carts (38.2%) mostly on average condition (78.9%). The vending places were made of iron sheets (55.3%) hence they were washable and cleanable but the environmental surrounding was not very clean as 68% of the stalls had garbage and waste nearby. Most (75%) of the street fruit vending places had no houseflies, 89% had adequate water supply for washing fruits, while drainage system was only observed in 30% of the vending places visited. This raises concern with respect to their potential for serious food poisoning outbreaks and exposure of the sliced fruits to flies, dust and other disease causing agents. Similar findings were made in Kibera which showed that 72% of informal outlets had garbage heaps near their vending places [4 ]. Inadequate refuse disposal facilities lead to the accumulation of refuse at food vending sites which leads to an increased pest population and resulted in an increased risk of food contamination [13]. Street foods are sometimes stored at improper temperatures and sold from vending sites which include kiosks, make-shift accommodation, and push carts as well as other temporary structures [14] . They are prepared at very dirty surroundings with waste water and garbage disposed nearby, providing nutrient and breeding ground for rodents and vermin [15] . Similarly in a study in Sudan, in most cases running water was not available at vending sites, washing of hands and crockery were done in bowls or buckets and sometimes without soap and the vending sites had flies [16]. Similar findings were also made in Benin city [17 ] and Owerri, Nigeria [18] where there were sufficient water but few waste bins and the vending environment had flies and rats/cockroaches [17] .

**Table 1 : Hygiene profile of the vending environment**

| Hygiene profile | Category | Frequency | Percent (% N = 76) |
|---|---|---|---|
| Vending setting | Cart | 29 | 38.2 |
| | Wheelbarrow | 7 | 9.2 |
| | Stall | 40 | 52.6 |
| Status of vending place | Good condition | 5 | 6.6 |
| | Average condition | 60 | 78.9 |
| | Bad condition | 11 | 14.5 |
| Nature of construction material | Wood | 31 | 40.8 |
| | Iron Sheets | 42 | 55.3 |
| | Sacs | 3 | 3.9 |
| Building structure washable and surfaces cleanable | Yes | 72 | 94.7 |
| | No | 4 | 5.3 |
| Stalls distance from garbage | Garbage and waste near | 52 | 68.4 |
| | Garbage and waste far | 24 | 31.6 |
| Houseflies and other pests present in stalls | Yes | 19 | 25 |
| | No | 57 | 75 |
| Availability of water for washing fruits | Yes | 71 | 93.4 |
| | No | 5 | 6.6 |
| Adequacy of water for washing fruits | Yes | 68 | 89.5 |
| | No | 8 | 10.5 |
| Presence of drainage | Yes | 23 | 30.3 |
| | No | 53 | 69.7 |

A score of “1” was assigned for the presence of relevant item while a score of “0” was assigned for its absence. The total score was converted to 100 percent. Using Bloom cut off points, more than half (57.9%) of the vending environments were in a poor state, 34.2% had fair hygiene vending environment while 7.9% were categorized as having good environmental conditions. The observation of poor sanitary condition in the majority of the food vending sites was contrary to findings of studies conducted in Owerri, Nigeria [18] , Accra, Ghana [19 ] , and Benin [17 ] where the majority of the food premises were observed to be tidy, with the use of waste bin and the presence of on-site water source for sanitary purposes. This finding was similar to a study

in Ethiopia which found that 21.3% of the establishments had good sanitary conditions [20 ]. This finding is, however, similar with what was reported in an earlier study in Nairobi where it was observed that about 85.0% of the vendors prepared their food in unhygienic condition [10]

**Figure 1 : Hygiene condition score**

Fruit salad samples yielded the highest bacterial load levels (mean $\log_{10}$ 4.65cfu/g) and coliforms count (mean $\log_{10}$ 0.78cfu/g) while pineapples (mean $\log_{10}$ 3.50cfu/g) had the highest mould and yeast count. This showed that fruit salad samples were highly contaminated while pineapple and pawpaw samples were least contaminated. This high contamination might be emanating from food handling during handling, processing or vending [21] . This was similar to studies in Bangladesh [22 , 23] and Ghana [24, 19 ] which found presence of unacceptable levels of Salmonella spp., Escherichia coli and other coliforms in street fruits which constituted a potential microbial hazard to human health. Similar findings were also found in Kibera [4] and Industrial Area [7] where E. coli and coliform present in street foods were of a level of concern.

**Table 2 : Microbial contamination of the minimally processed fruits(cfu/g)**

| | Bacteria count | Coliforms count | Mould & Yeast count |
|---|---|---|---|
| Fruit salad | 4.56 | 0.78 | 2.27 |
| Water melon | 3.63 | 0.72 | 2.00 |
| Pawpaw | 1.99 | 0.72 | 1.05 |
| Pineapple | 1.44 | 0.72 | 3.50 |

In all the fruits, level of contamination was not significantly associated with the hygiene condition of the vending environment. Lack of basic infrastructure, absence of potable water, lack of proper storage facility and unsuitable environments for food operations can contribute to poor microbial quality of foods [***20*** ] . Unhygienic environment are breeding place for houseflies and other disease causing microbes thus plays an integral role in preventing food from being contaminated hence the need for food vendors to operate within a clean environment. Contrary findings were made in Ghana which found that poor environmental condition continues to be a constant factor contributing to food contamination [ ***25*** ] .

**Table 3 : Food Hygiene Conditions and Microbial Contamination**

| **Fruit** | | **Bacteria** | **Coliform** | **Moulds and Yeast** |
|---|---|---|---|---|
| | r | -0.214 | -0.072 | 0.162 |
| Fruit salad | p | 0.645 | 0.878 | 0.728 |
| | r | -0.286 | -0.414 | -0.162 |
| Water melon | p | 0.535 | 0.355 | 0.728 |
| | r | -0.291 | -0.036 | -0.709 |
| Pawpaw | p | 0.527 | 0.939 | 0.074 |
| | r | -0.371 | -0.408 | -0.429 |
| Pineapple | p | 0.413 | 0.364 | 0.337 |

* r - Spearman correlation; p – p - value

## IV. Conclusions

Hygiene condition of the vending environment poor and although fruit vendors tried to maintain proper standards of hygiene, some environmental factors such as poor structures, poor waste disposal systems, pollution by vehicles passing by and garbage damps and litter near them could not be controlled. Minimally processed fruits were not microbiologically safe as levels of up to 10.5 cfu/g were seen in the fruit samples. Coliform counts in the fruits suggest contamination of the fruit samples by fecal material possibly from poor personal hygiene by vendors, water used for washing, the poor vending environment, or a combination of all these factors. Also, the hygiene condition of the vending environment did not determine the microbial status of the fruits.

## Acknowledgments

**The authors of this publication** *"Food Hygiene Conditions and Microbial Contamination of Minimally Processed Fruits in Central Ward, Nairobi County"* **would like to thank Kenyatta University and the University of Nairobi for supervision and Exactitude Research Consultants (Ltd) for data management services.**

**Competing interests**

All authors declare that: there are no significant competing financial, professional or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

**Authors' contributions**

Authors made substantial contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data.

## References

[1] P. J. Simitu, "Consumption and conservation of drylands' indigenous fruit trees for rural livelihood improvement in Mwingi District, Kenya," Masters Thesis 2011.

[2] M. A. McCarthy and R. H. Matthews, "Nutritional Quality of Fruits and Vegetables Subject to Minimal Processes.," Springer US, vol. 313-326, 1994.

[3] F. Artés, P. A. Gómez, and F. Artés-Hernández, "Physical, Physiological and Microbial Deterioration of Minimally Fresh Processed Fruits and Vegetables," Food Science and Technology International, vol. 13, no. 3, pp. 177-188, 2007.

[4] A. W. Monica, "Food safety and hygiene practices in the informal outlets (a case study of food kiosks in Kibera slums, Nairobi," Kenyatta University, Nairobi, Thesis 2011.

[5] H. Kassa, G. Silverman, and K. Baroudi, "Effect of a manager training and certification program on Food Safety and Hygiene in Food service operation," Environmental health insight, pp. 13-20, 2010.

[6] E. Walker, C. Prichard, and S. Forsythe, "Food handling knowledge in small business," Food control, pp. 339-343, 2003.

[7] M.G. Gitahi, J. Wangoh, and P.M.K. Njage, "Microbial Safety of Street Foods in Industrial Area, Nairobi," Research Journal of Microbiology, vol. 7, pp. 297-308, 2012.

[8] A. Nurudeen, A. Lawal, and S. AJayi, "A survey of hygienic and sanitary practices of street vendors in the central state of Northern Nigeria," Journal of public health and epidemiology, pp. 174-181, 2014.

[9] Food and Agriculture Organization; World Health Organization, Fodd Hygiene Basic Texts. Rome: Codex Alimentarius Commission, 2009.

[10] K. Muinde and E. Kuria, "Hygienic and Sanitary Practices of Vendors of Street Foods in Nairobi, Kenya," African Journal of Food Agriculture and Nutritional Development, vol. 5, no. 1, 2005.

[11] J. G. Kariuki, "Food handling practices and the prevalence of food borne pathogens among food handlers in Embu municipality, Kenya," Kenyatta University, Nairobi, Masters Thesis 2012.

[12] S. W. Kamunyori, "A Growing Space for Dialogue: the Case of Street Vending in Nairobi's Central Business District," Massachusetts Institute of Technology, 2007.

[13] M. D. Khairuzzaman, Fatema Moni Chowdhury, Sharmin Zaman, Arafat Al Mamun, and Latiful Bari, "Food Safety Challenges towards Safe, Healthy, and Nutritious Street Foods in Bangladesh," International Journal of Food Science, vol. 2014, pp. 1-9, 2014.

[14] Food and Agricultural Organization, "FAO Food and Nutrition Paper," Food and Agricultural Organization, Jakarta, Indonesia, Report of an FAO expert consultation 1990.

[15] Nicolas Barro et al., "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, vol. 5, no. 11, pp. 1107-1112, 2006.

[16] M. A. Abdalla, S. E. Suliman, and A. O. Bakhiet, "Food safety knowledge and practices of street food vendors in Atbara City (Naher Elneel State Sudan) ," African Journal of Biotechnology, vol. 8, no. 24, pp. 6967-6971, 2009.

[17] P. W. Okojie and E. C. Isah, "Sanitary Conditions of Food Vending Sites and Food Handling Practices of Street Food Vendors in Benin City, Nigeria: Implication for Food Hygiene and Safety," Journal of Environmental and Public Health, vol. 2014, no. 2014, pp. 1-6, 2014.

[18] Comfort O. Chukuezi, "Food safety knowledge and practices of street food vendors in Owerri, Nigeria," Studies in Sociology of Science, vol. 1, no. 1, pp. 50-57, 2010.

[19] Patience Mensah, Dorothy Yeboah-Manu, Kwaku Owusu-Darko, and Anthony Ablordey, "Street foods in Accra, Ghana: how safe are they?," Bulletin of the World Health Organization, vol. 80, no. 7, pp. 546–554, 2002.

[20] Mulugeta Kibret and Bayeh Abera, "The Sanitary Conditions of Food Service Establishments and Food Safety Knowledge and Practices of Food Handlers in Bahir Dar Town," Ethiopian Journal of Health Sciences, vol. 22, no. 1, pp. 27–35, 2012.

[21] M Abadias, J Usall, Anguera M, C Solsona, and I Viñas, "Microbiological quality of fresh, minimally-processed fruit and vegetables, and sprouts from retail establishments," International Journal of Food Microbiology, vol. 123, no. 1-2, pp. 121-129, 2008.

[22] Z. Tabashsum et al., "Prevalence of Foodborne Pathogens and Spoilage Microorganisms and Their Drug Resistant Status in Different Street Foods of Dhaka city," Agriculture Food and Analytical Bacteriology, vol. 3, no. 4, pp. 281-292, 2013.

[23] Mohammad Ali, M. R. Khan, and Mihir Lal Saha, "Antibiotic resistant patterns of bacterial isolates from ready-to-eat (RTE) street vended fresh vegetables and fruits in Dhaka City," Bangladesh Journal of Scientific Research, vol. 24, no. 2, pp. 127–134, 2011.

[24] F. Amponsah-Doku et al., "Bacterial contamination of lettuce and associated risk factors at production sites, markets and street food restaurants in urban and peri-urban Kumasi, Ghana," Scientific Research and Essays, vol. 5, no. 2, pp. 217-223, 2010.

[25] Boateng Acheampong Emmanuel, "Assessment of food hygiene practices by street food vendors and microbial quality of selected foods sold: A study at Dunkwa-On-Offin, Upper Denkyira East municipality of the Central Region," Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, Master's Thesis 2014.

## AUTHORS

**First Author** – Mercy Adhiambo Ndiege, P.O. Box 00400-70525, Email: mercyajfand@gmail.com, Mobile: +254723216571, Nairobi, Kenya
**Second Author** – Jackim Nyamari: Kenyatta University Nyamari.jackim@ku.ac.ke
**Third Author** – Jasper K.Imungi: University of Nairobi imungij@yahoo.com