MICROBIAL CONTAMINATION OF MINIMALLY-PROCESSED READY-TO-EAT FRUITS SOLD IN ELDORET TOWN, UASIN-GISHU COUNTY, KENYA

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Abstract

Foodborne diseases contribute significantly to the global burden of morbidity especially in low and middle-income settings. While food safety is generally well-addressed for high-value exports from developing countries, domestic consumers remain at risk, with Kenya in particular experiencing major problems of non-compliance with basic food safety and agricultural health practices in local markets. Due to the unhygienic conditions in which they are often prepared, stored and served, minimally-processed ready-to-eat fruits pose a significant risk to urban health, especially with regards to microbial contamination. This study aimed to establish the occurrence of microbial contamination on minimally-processed fresh fruits sold in Eldoret town. 20 Samples of different fruits were collected from six vendors at a designated marketplace in the month of April 2018 and analyzed using standard laboratory procedures. Results showed that all the fruits were contaminated with microbes, majority of which were Gram positive cocci (GPC) and a few fungal species. These organisms are potentially pathogenic and may be harmful to consumers. Hygiene education and sensitization of buyers is recommended.

Keywords: Minimally-processed fruits, microorganisms, Eldoret, Uasin-Gishu

Introduction

Foodborne diseases contribute significantly to the global burden of morbidity and mortality across the human population especially among children under the age of five years. Geographically, the greatest burden occurs in Africa, especially in low and middle-income settings (Kirk et al., 2015; Torgerson et al., 2014), but even in developed countries, the incidence of many foodborne infections remains unacceptably high despite ongoing food safety efforts (Crim et al., 2015).

It is estimated that over 200 diseases can be transmitted through contaminated food, but the World Health Organization has identified and analyzed 32 major foodborne diseases contributing to this burden, the causative agents of which include bacteria, viruses, parasites, toxins and chemicals. Of these, bacterial infections typically account for the majority of the illnesses; the most common species including, *Campylobacter jejuni/coli, Salmonella, Clostridium perfringens, Staphylococcus aureus, Shigella, Clostridium botulinum, Vibrio parahaemolyticus, Listeria monocytogenes,* Shiga toxin-producing E. coli (STEC) O157 and enterotoxigenic E. coli. (Kirk et al., 2015; Hara-Kudo et al., 2013; WHO, 2015; Ramos, Miller, Brandão, Teixeira, & Silva, 2013; Nyenje & Ndip, 2013).

Incidentally, contamination of food can occur at any stage of the food production/processing and supply chain from primary production to final consumer; extending from pre-harvest contamination in farms where crops are grown and animals raised, to food processing and manufacturing factories, as well as during preparation and storage in shops, restaurants, markets and in the home (Nerín, Aznar, & Carrizo, 2016; Dziubanek, Piekut, Rusin, Baranowska, & Hajok, 2015; Nauta, 2016; Strawn et al., 2013; Park et al., 2013; Liu, Hofstra, & Franz, 2013). A study by Kirezieva et al. (2015) shows that farmers generally have less knowledge and overall awareness regarding microbiological hazards, which definitely impacts negatively on food safety management at the farm level.

Especially vulnerable to microbial contamination are fresh fruits and vegetables which are either taken raw or minimally-processed. These are classified as high-risk foods and need careful intervention to prevent/minimize contamination by potentially pathogenic microbes (KEBS, 2009). Since they are intended for immediate consumption without further processing, their microbial contamination can easily affect the health of consumers (Ramos et al., 2013).

The main contributing factors to contamination of food include: Unsafe water used for the cleaning and processing of food; poor food-production processes and food handling; the absence of adequate food storage infrastructure; inadequate or poorly enforced regulatory standards and intensive animal husbandry (WHO, 2015). The UN's Food and Agriculture Organization observes that "many consumers, through no fault of their own, lack adequate education concerning appropriate food handling practices in the home and may have only limited or no access to information on these practices" (FAO, 2008).

Risk factors associated with foodborne illness in low and middle-income countries include preparing food with unsafe water; poor hygiene and inadequate conditions in food production and storage; lower levels of literacy and education; and insufficient food safety legislation or implementation of such legislation (WHO, 2015). The leading species of bacteria associated with foodborne illnesses are Staphylococcus, Salmonella, Clostridium, Campylobacter, Listeria, Vibrio, Bacillus, and Entero-pathogenic Escherichia coli (Nyenje & Ndip, 2013).

It is internationally consented that best way to tackle food safety is through a risk-based, farm-to-table approach focusing on the most important risks and cost-effective controls, while providing support for capacity building and supply chain coordination, and improving incentives for food safety management (Unnevehr, 2015). Various systems of ensuring food safety exist, including HACCP, GMPs, GHPs, GAPs and adherence to international standards such as ISO 22000 food safety management system and Codex Alimentarius (Escanciano & Santos-Vijande, 2014; Kafetzopoulos, Psomas, & Kafetzopoulos, 2013; Aung & Chang, 2014; Alli, 2016).

Fresh-cut market has expanded considerably in recent years. However, quality and safety of such products are an issue of concern as these products can act as vehicles for transmitting infectious diseases. Moreover, fresh-cut produce is more susceptible to spoilage and can facilitate rapid growth of spoilage micro-organisms as well as the micro-organisms of public health significance. The destruction of surface cells during processing (such as peeling, slicing and shredding) of fresh-cut produce exposes the cytoplasm and provides micro-organisms with a richer source of nutrients as compared to intact produce (Barry-Ryan, Pacussi, & O'Beirne, 2000).

Problem Statement

Foodborne infections are a global public health challenge, especially in low and middle-income settings (Kirk et al., 2015; Torgerson et al., 2014). But even in developed countries, the incidence of many foodborne infections remains unacceptably high despite ongoing food safety efforts (Crim et al., 2015). While food safety is generally well-addressed for high-value exports from developing countries, domestic consumers remain at risk (Unnevehr, 2015), with Kenya in particular, experiencing major problems of non-compliance with basic food safety and agricultural health practices in local markets (Oloo, 2010). Microbial contamination accounts for the majority of foodborne illness, with bacterial infections resulting in most hospitalizations and deaths (Nyenje, Odjadjare, Tanih, Green, & Ndip, 2012). Due to the unhygienic conditions in which they are often prepared, stored and served, minimally-processed ready-to-eat street-vended food pose a significant risk to urban health, especially with regards to microbial contamination.

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The continuing burden of foodborne infections despite ongoing efforts to ensure food safety underscores the need for further prevention measures in order to make food safer and achieve national health objectives (Crim et al, 2015). One important preventive measure is ongoing food safety surveillance to detect microbial contamination, especially in high-risk foods. The knowledge thus acquired would then inform food safety policy and direct requisite interventions to protect consumers, while adding to the knowledgebase of the global burden of foodborne infections (WHO, 2015).

Objectives

Broad

To determine microbial contamination of minimally-processed ready-to-eat fruits sold along the streets of Eldoret town, Uasin Gishu County, Kenya.

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- To establish the occurrence of microbial contamination of freshly cut fruits sold in Eldoret town
- To identify the microbes present in the freshly-

cut fruits sold in Eldoret town.

- To determine the colony count of the micro organisms in each freshly-cut fruits sold in Eldoret town.

Methodology

Study Area and Design

Employing a cross-sectional study design, this study was done in Eldoret town, the largest urban center and the **administrative capital of Uasin-Gishu County**. With urban population estimated at 289,380, Eldoret is among the fastest growing cities in Kenya and an important education and transport centre linking Kenya to Uganda and South Sudan. Boosted by agribusiness and sports tourism, due to its renowned world runners, the city enjoys a robust economy and a vibrant day and night life. Night shoppers and revellers go around their business throughout the night as many nightclubs, stores and restaurants keep their doors open through dawn.

Study Population and Sample Size

The study population comprised fruit vendors of minimally-processed fruits in a designated market-place in Eldoret town. A total of 20 samples were collected from 10 vendors in a designated market place in Eldoret town. The 6 fruits of interest were sampled as presented in table 1.

Table 1

Sample Matrix

#	Fruit	No. of samples	Vendors
1	Pineapple (*Ananas comosus*)	5	1
2	Orange (*Citrus cinensis*)	4	2
3	Tangerine (*Citrus tangarina*)	2	1
4	Water Melon (*Citrullus lanatus*)	5	3
5	Mango (		

These findings are similar to a study done in Maiduguri metropolis which found that sliced fruits sold in were contaminated by pathogenic bacteria (Al-lamin, Borkoma, Ibu Abbas, & Wazin, 2015). Likwise, Qadri, Srivastava, Yousof, & Yildiz (2015) concluded that fresh-cut produce is more susceptible to spoilage and can facilitate rapid growth of spoilage micro-organisms as well as the micro-organisms of public health significance.

In addition Chukwu et. al. (2010) found that samples of minimally-processed fruits were not wholesome despite their aesthetics, as 90.67% of the pre-cut fruits were contaminated with bacteria including Staphylococcus spp. In Kenya, Ndiege, Nyamari, & Imungi (2017) reported that minimally-processed fruits in Central ward, Nairobi county were not safe for consumption due to contamination with bacterial, mould and yeast cells in the samples collected.

Colony Count for the Microorganisms in Each Fresh-Cut Fruits Sold in Eldoret Town

As presented in table 3, there were varied microbial counts with jack fruit (1.6 x 105 cfu/ml), and water melon (5.4 x 105 cfu/ml) leading in the count. Minimally processed fruits should have satisfactory levels of bacteria, yeasts and moulds of up to 104. Levels of 105 and 106 in fruits represent a significant potential risk to health. 107 is indicative of spoilage and 108 is indicative of odour development (Mekonnen, Taddele, & Adhana cited in Adhiambo, 2016). Chukwu et. al. (2010) also concluded that water melon had the highest microbial count of the minimally processed samples collected. Similarly, Ndiege et. al. (2017) also found water melon as one of the fruits with the highest bacterial count.

Table 3

Results of Microbial Colony Count

Fruit Sample	Dilution Plate	No. of Colonies
Jack fruit (*Artocarpus heterophilus)*	1:100	172
	1:1000	25
	1:10000	16
Pineapple fruit (*Ananas comosus)*	1:100	147
	1:1000	1
	1:10000	2
Orange (*Citrus cinensis)*	1:100	11
	1:1000	6
	1:10000	1
Mango fruit (*Mangifera indica)*	1:100	30
	1:1000	16
	1:10000	7
Water melon (*Citrullus lanatus)*	1:100	154
	1:1000	60
	1:10000	54

Conclusion and Recommendations

In conclusion, the findings of this study indicate that minimally-processed ready-to-eat fruits sold in Eldoret town were not microbiologically safe for consumption with jack fruit, and water melon being the highly contaminated. The most common microbes found in the minimally processed ready-to-eat fruits sold in Eldoret town were Staphylococci sp., *Aspergillus* sp., and other fungi.

It is recommended that health education should be given to the vendors and consumers on proper food handling techniques to prevent contamination. Additionally, Policies and laws on ready-to-eat food vending should be implemented (CAP 254) by relevant authorities.

On further research, studies should be done involving various towns and comparing difference in contaminations in each town. Further research involving the contribution of the vendors in the extent of microbial contamination of fruits should also be done.

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