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Original Research Article

Microbiological Assessment of Ready-to-Eat Sliced Pawpaw (*Carica papaya*) and Watermelon (*Citrullus lanatus*) Vended in Umuahia, Nigeria

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A B S T R A C T

Microorganisms associated with ready-to-eat sliced pawpaw and watermelon fruits were investigated. Evaluation of the possible bacteria and fungi on the fruit samples was carried out based on standard microbiological methods. Bacterial count ranged from 4.2 x 10^5 to 1.4 x 10^6cfu/g for pawpaw samples and 4.1 x 10^5 to 1.5x10^6 cfu/g for watermelon samples. Fungal count ranged from 3.1 x 10^5 to 8.9 x 10^5cfu/g for pawpaw samples and 1.9 x 10^5 to 5.5 x 10^5 cfu/g for watermelon samples. Microbial isolates included *Salmonella* sp. *Esherichia coli*, *Pseudomonas* sp, *Shigella* sp, *Staphylococcus aureus*, *Aspergillus* sp, *Rhizopus* sp, *Mucor* sp, *Saccharomyces cerevisiae*. *E.coli* and *Salmonella* sp. had the highest occurrence of 70% in pawpaw samples, followed by *Staphylococcus aureus* (60%), *Shigella* sp. (50%) and *Pseudomonas* sp. (30%). Percentage occurrence of *Staphylococcus aureus* in watermelon was 70%, followed by both *E. coli* and *Shigella* sp (60%), *Salmonella* sp. (50%) and *Pseudomonas* sp. (20%). Similar trend occurred in watermelon samples. Of the fungal isolates, *Saccharomyces cerevisiae* occurred higher in water melon with 70%. *Mucor* was the lowest with 30% in pawpaw. From the result obtained, it was deduced that the sliced fruits were contaminated with different types of microorganisms, including those of public health importance which could be responsible for food borne infection. Therefore proper processing of sliced fruits in a hygienic condition should be practiced to prevent microbial contamination.

Keywords

Pawpaw, Watermelon, sliced fruits, micro-organisms; *Pseudomonas sp.*

Introduction

Fruits are rich in vitamins, minerals, antioxidants and many phytonutrients. Fruits and vegetables are essential parts of people's diet and are vital for health and well-being. They help to reduce the risk of several diseases (Kalia and Gupta, 2006).
Sliced fruits refer to fruits that have been cut open, sliced into bits, but remain in the fresh state and displayed for sale in retail outlet for consumption. These sliced fruits are bought directly from the street vendors or hawkers or at local market without necessarily having to undergo any further treatment before consumption.

Consumption of sliced fruits has been on the increase since they are easily accessible, convenient and most especially cheaper than the whole fruit (Nwachukwu *et al.,* 2008). Sliced fruits are commonly processed and sold by unlicensed vendors with poor educational levels and untrained in food hygiene (Muinde and Kuria 2005; Barro *et al*., 2006, Barro *et al*., 2007). Vended fruits have been on the increase in many developing countries due to lack of formal jobs for the working age groups. Sales of sliced fruits can contribute significant income for households and at the same time providing a source of inexpensive nutritious meal (Mosupye and Von Holy 1999).

Outbreak of illness caused by consumption of fruits had been reported (Abdul-Raouf *et al*., 1993; Bean and Griffin 1996). The increase in consumption of sliced fruits has been linked with a parallel increase in food borne illness (Mensah *et al*., 1999; Estrada-Garcia *et al.,* 2004). Fruit produce is known to carry a natural non-pathogenic micro flora, and have an epidermal layer of cells which provides a barrier for penetration of microorganisms. Cutting and slicing can eliminate the protections and microbes can invade the internal tissue (Barro *et al*., 2007). Unsanitary processing and preservative methods could increase the possibilities of contamination. Open display of street food produce encourages sporadic visits by flies, cockroaches, rodents and dust (Bryan *et al*., 1992).

Poorly processed street vended produce have been identified as an important cause of death in developing countries (Mensah *et al.,* 2002). Bacteria causing gastroenteritis can contaminate the sliced produce, thus exposing consumers to greater risk (Jolaoso *et al.,* 2010). Bacteria like *Salmonella* sp, *Shigella* sp, *Campylobacter* sp, and *Escherichia coli* can contaminate sliced fruits through contact with sewage and contaminated water (Fredlund *et al.,* 1987; Beuchat 1995; Gayler *et al*., 1995).

Most fungi sp are known to be common environmental contaminants. Therefore their occurrence is not out of order (Aboloma, 2008). Some of the fungi are known to be spore formers and thus can easily contaminate sliced fruits. Fungi such as *Rhizopus Stolonifer, Saccharomyces cerevisiae*, *Aspergillus niger* , *Aspergillus flavus*, *Cephalosporium* and *Penicillium* have been earlier isolated from sliced fruits sold in various parts of the country The objective of this study, therefore, is to evaluate the microbiological quality of vended ready to eat sliced pawpaw and water melon fruits.

Materials and Methods

Sample Collection

Fifty of each of sliced pawpaw and water melon samples were purchased randomly from vendors in Umuahia, Nigeria. The samples were placed in sterile plastic bags in ice crystal packed box and transported immediately to the laboratory. The samples were analysed within two hours of collection.

Enumeration and identification of microorganisms

One gram from each of the water melon and pawpaw samples was obtained (using a sterile knife and wearing sterile disposable hand gloves) and transferred into 9 ml of distilled water in a glass beaker. The beaker was shaken thoroughly. Serial dilution of the solution was done by transferring 1ml into 9 ml of distilled water. From the appropriate dilution, 0.1ml was plated onto different media using the spread plate technique. Nutrient agar, Eosin methylene blue agar (EMB), Salmonelle Shigella agar (SSA) were used for bacterial enumeration and identification while Sabouraud dextrose agar (SDA) was used for fungi. Each inoculated sample was in duplicates and the plates were incubated for 24 to 48 hours at 37◦C for bacterial growth, and 72 hours at 25^oC for fungal growth on SDA plate. Thereafter, the plates were examined for growth and the colonies counted and recorded as cfu/g. The morphological and microscopic features of the colonies were also noted. Gram stain reaction, motility test and biochemical (catalase, coagulase, oxidase, indole production, sugar fermentation) were performed for identification of bacteria (Cheesbrough, 2002).

Results and Discussion

Bacteria and fungi count for pawpaw samples ranged from $4.2 \times 10^5 – 1.4 \times 10^6$ cfu/g, and 3.1×10^5 - 8.9×10^5 cfu/g respectively (Table 1). Bacteria and fungi count for water melon samples ranged from $4.1 \times 10^5 – 1.5 \times 10^6$cfu/g, and $1.9 \times 10^5 – 5.5 \times 10^5$cfu/g respectively (Table 2) Percentage occurrence of bacterial isolates in pawpaw is shown in Table 3. *E. coli* and *Salmonella* occurrence was 70% each, followed by *Staphylococcus aureus* (60%), *Shigella* sp. (50%) and *Pseudomonas* sp. (30%). Percentage occurrence of *Staphylococcus aureus* in water melon was 70%, followed by both *E. coli* and *Shigella* sp (60%), *Salmonella* sp. (50%) and *Pseudomonas* sp. (20%) (Table 4).

Tables 5 and 6 showed the percentage occurrence of fungal isolates in both pawpaw and water melon samples which ranged from 30% - 60% and 40 – 70% respectively. Tables 7 and 8 showed the distribution of the isolates in the fruit samples. *Staphylococcus aureus* and *E. coli* are higher (65%) in both pawpaw and water melon samples.

Table.1 Total viable count of bacteria and fungi in pawpaw samples

Locations	Bacterial count(cfu/g)	Fungal count(cfu/g)
Ahiaeke	1.4×10^6	3.1×10^5
Isigate	4.2×10^5	4.6×10^5
Amawom	4.4×10^5	5.5×10^5
Orieugba	1.1×10^6	7.2×10^5
Ndoro	9.0×10^5	8.9×10^5

Table.2 Total viable counts of bacteria and fungi from Water melon samples

Locations	Bacterial count(cfu/g)	Fungal count(cfu/g)
Ahiaeke	4.1×10^5	5.5×10^5
Isigate	1.5×10^6	4.6×10^5
Amawom	7.8×10^5	1.9×10^5
Orieugba	1.3×10^6	5.0×10^5
Ndoro	4.3×10^5	4.9×10^5

Table.3 Percentage occurrence of bacterial isolates in pawpaw samples

Location	*E.coli*	*Pseudomonas* sp	*Salmonella* sp	*Shigella* sp	*S.aureus*
Ahiaeke	20	0	20	10	20
Isigate	10	10	20	10	10
Amawom	10	0	10	10	10
Orieugba	10	20	10	10	10
Ndoro	20	0	10	10	10
	70	30	70	50	60

Table.4 Percentage occurrence of bacterial isolates in water melon samples

Location	*E.coli*	*Pseudomonas* sp	*Salmonella* sp	*Shigella* sp	*S.aureus*
Ahiaeke	20	10	10	0	0
Isigate	10	10	10	20	20
Amawom	0	0	20	20	10
Orieugba	20	0	0	20	20
Ndoro	10	10	10	0	20
	60	20	50	60	70

Table.5 Percentage occurrence of fungal isolates in pawpaw samples

Location	*Aspergillus* sp	*Saccharomyces cerevisiae*	*Mucor* sp	*Rhizopus* sp
Ahiaeke	10	10	0	10
Isigate	20	20	0	0
Amawom	10	10	10	10
Orieugba	0	10	20	10
Ndoro	20	10	0	20
	60	60	30	40

Table.6 Percentage occurrence of fungal isolate in water melon samples

Location	*Aspergillus* sp	*Saccharomyces cerevisiae*	*Mucor* sp	*Rhizopus* sp
Ahiaeke	10	20	10	10
Isigate	20	10	0	10
Amawom	0	20	0	0
Orieugba	0	10	20	0
Ndoro	10	10	10	20
	40	70	40	40

Table.7 Distribution of bacterial isolates in fruits samples

Bacterial isolates	Pawpaw (50)	Watermelon (50)	Total fruits (100) (%)
S. aureus	36	29	65 (65)
Salmonella sp	33	27	60 (60)
E. coli	28	37	65 (65)
Pseudomonas sp	15	15	30 (30)
Shigella sp	25	30	55 (55)

Table.8 Distribution of fungal isolates from fruit samples

Bacterial isolates	Pawpaw (50)	Watermelon (50)	Total fruits (100) (%)
Aspergillus sp	30	20	50 (50)
Rhizopus sp	20	20	40 (40)
Mucor sp	15	20	35 (35)
Saccharomyces cerevisiae	35	25	60 (60)

Microorganisms associated with ready- to-eat sliced pawpaw and water melon fruits were investigated. The isolates obtained included *Salmonella* sp., *Shigella* sp., *Pseudomonas*, *Staphylococcus aureus*, *E. coli*, *Aspergillus*, *Rhizopus*, *Mucor*, and *Saccharomyces cerevisiae* at various pencentages. Presence of these organisms in fruits can be due to the nutritional composition and available water in the fruit, which are very beneficial for the growth and survival of the microorganism.

The International Commission on Microbiological Specification for Food (ICMSF, 1996) stated that ready to eat foods with plate counts between 0-10^3 is acceptable, within 10^4-10^5 is tolerable and 10^8 and above is unacceptable. From the result obtained, the level of contamination can thus be tolerable based on the recommended standards. Generally the microorganisms had higher occurrence in watermelon than in pawpaw. This might be due to the fact that melon grows close to the soil and can easily be contaminated with organisms from soil debris. Most of the organisms isolated might have been introduced due to failure of food handlers to observe basic safety rules. Packaging materials, the use of simple facilities like wheel barrows, trays to hawk the fruits or display on tables are possible sources of food contamination.

Staphylococcus aureus is a normal flora of the skin, and could have been introduced through unclean hands of the vendor and customers. *Salmonella* and *Shigella* could have been introduced from water during washing or by soil and flies. Presence of *Salmonella* could possibly be due to fecal contamination of water and hands or poor personal hygiene (Little *et al*; 1998, Jolaoso *et al*., 2010). *E. coli* is associated with fecal contamination and its presence poses a serious threat to public health. Presence of *E. coli* in the fruit indicates possibilities of secondary contamination.

The possible sources of contamination of sliced fruits could be the processing and rinsing water. The presence of *Salmonella* and *E.coli* calls for concern as these organisms are frequently associated with poor sanitary practices and could be pointers to danger of possible food infections. *Pseudomonas* species are known to be environmental contaminants, and have been isolated from plants, humans, skin, animals, and dairy products. Their presence can be through unclean hands of the vendors, package materials or soil.

Fungi may have been introduced into fruits from package materials, soil contaminated materials used during processing of sliced fruits. Some fungi produce toxins that are carcinogenic especially species of *Aspergillus* that produce the toxin aflatoxin. Ingestion of aflatoxin in moldy foods has been implicated in the development of liver cancer (Nester *et al*., 2004). The occurrence of *Aspergillius* and *Mucor* in fruits may be due to the fact that they are spore formers and are common environmental contaminants. The presence of *S. cerevisiae* and other molds is in agreement with the report of Splittstroesser (1987) who implicated fungi as contaminants of fresh fruits especially in the presence of injuries like slicing. Water and the environment may have played major roles in fungal contamination of the samples especially during washing of the fruits. Low occurrence of mucor may be due to the fact that the species require organic matter for growth (Nwachukwu *et al.*, 2008).

This study showed that ready to eat sliced fruits were contaminated with microorganisms at various levels and included *E.coli, Salmonella* sp, Shigella sp, *Pseudomonas*, *Staphylococcus aureus*, *S. cerevisiae*, *Aspergillus*, *Mucor*, *Rhizopus*. Therefore to ensure reduced microbial load and safety, good personal hygiene and proper sanitary ways of processing fruits must be adopted

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