Assessment on the Causes and The Effects of Microorganisms on Fresh Water Melon (A Case of Anyigba in Dekina Local Government Area of Kogi State, Nigeria)

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Abstract- ***In this study, samples of sliced and unsliced watermelon (Citrullus lanatus) were obtained from five different vendors in Anyigba, Kogi State Nigeria, to determine the bacteria load and identify the microorganisms present in each sample. Evaluation of the possible microorganisms on the watermelon samples was carried out based on standard microbiological methods Bacterial load of the sliced watermelon samples ranged from 239 x 10 cfu/g to 190 x 10 cfu/g and 239 x 10 cfu/g and 83 x 10 cfug to 64 x 10 cfu/g for the unsliced watermelon samples Total coliform count ranged between 39 x 10 cfu/g to 23 x 10 cfu/g for the sliced watermelon samples while no coliform contamination was recorded for the unsliced samples. Total staphylococcal count ranged between 85 x 10'efug to 65 x 10 cfu/g for the sliced samples while the unsliced samples ranged between 36 x 10'cfu/g to 20 x 10 cfu/g. Staphylococcus aureus (27.7%) was the most frequently isolated, followed by Proteus vulgaris (16.6%) and Micrococcus luteus (13.8%). Staphylococcus epidermidis (11.1%), Bacillus subtilis (11.1%), Escherichia coli (11.1%) while the least frequently isolated was Salmonella spp (8.33%). The result derived from this study shows that both the sliced and unsliced watermelon samples were contaminated with different types of microorganisms, but only the sliced were contaminated with microorganisms such as E coli which is of public health importance that could be responsible for community wide food borne infection and epidemics. Therefore, proper hygiene should be maintained while watermelon fruits are sliced in order to prevent microbial contamination.***

I. INTRODUCTION

Fruits are essential part of human diet required for good health and vitality, they are rich in vitamins and minerals which perform indispensable functions in the body. Regular consumption of fruits is associated with reduced risks of cancer, cardiovascular disease (especially coronary heart disease), stroke, Alzheimer disease, cataracts, and some of the functional declines associated with aging (Liv. 2008), thus, the importance of fruits to humans cannot be overemphasized.

Fruits are widely exposed to microbial contamination through contact with soil. Dust and water and by handling at harvest or during postharvest processing. They therefore harbor a diverse range of microorganisms including plant and human pathogens.

The Water melon (Citrullus lanatus) is a nutrient dense fruit, it provides high number of vitamins, minerals and antioxidants and just a small number of calories. The water melon fruit is sold whole or sliced at retail sales points. The sliced fruit refers 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 treatments such as cutting. peeling and rinsing before 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 (Barro et al., 2007).

Raw foods, especially sliced fruits have been implicated in outbreaks of food borne diseases in both developed and developing countries (WHO, 2007)

Food-borne diseases take a major toll on health globally, millions of people fall ill and die as a result of eating unsafe food. There have been occasional reports of multistate outbreaks of salmonellosis in the United States associated with contaminated fresh fruits and vegetables. (Hedberqg et al., 2010).

The risks associated with consumption of contaminated fruits is so great that drastic action is needed to curb the menace. Fruits contaminated cannot be identified with the naked eyes, they need to be taken to the laboratory for proper analysis and diagnosis to ascertain the level and type of contamination.

The procedure it takes to ascertain the level of contamination in fruits is not available to the common man who assumes the fruit is safe just because it looks clean, hence the risks of a full blown community-wide food-borne disease is on the high side

Foodborne illnesses are usually infectious or toxic in nature and caused by bacteria, viruses, parasites or chemical substances entering the body through contaminated food or water.

Foodborne pathogens can cause severe diarrhoea or debilitating infections including meningitis.

Chemical contamination can lead to acute poisoning or long-term diseases, such as cancer. Foodborne diseases may lead to long-lasting disability and death. Examples of unsafe food include uncooked foods of animal origin, fruits and vegetables contaminated with faeces, and raw shellfish containing marine biotoxins.

Bacteria:

- *Salmonella, Campylobacter, and Enterohaemorrhagic Escherichia coli* are among the most common foodborne pathogens that affect millions of people annually-sometimes with severe and fatal outcomes. Symptoms are fever, headache, nausea, vomiting, abdominal pain and diarrhoea. Examples of foods involved in outbreaks of salmonellosis are eggs, poultry and other products of animal origin, Foodborne cases with *Campylobacter* are mainly caused by raw milk, raw or undercooked poultry and drinking water. *Enterohaemorrhagic Escherichia coli* is associated with unpasteurized milk, undercooked meat and fresh fruits and vegetables.

- *Listeria* infection leads to unplanned abortions in pregnant women or death of newborn babies. Although disease occurrence is relatively low, listeria's severe and sometimes fatal health consequences, particularly among infants, children and the elderly, count them among the most serious foodborne infections. Listeria is found in unpasteurized dairy products and various ready-to-eat foods and can grow at refrigeration temperatures. Vibrio cholerae infects people through contaminated water or food. Symptoms include abdominal pain, vomiting and profuse watery diarrhoea. Which may lead to severe dehydration and possibly death. Rice, vegetables, fruits and various types of seafood have been implicated in cholera outbreaks

Antimicrobials, such as antibiotics, are essential to treat infections caused by bacteria. However, their overuse and misuse in veterinary and human medicine has been linked to the emergence and spread of resistant bacteria, rendering the treatment of infectious diseases ineffective in animals and humans. Resistant bacteria enter the food chain through the animals (e.g. *Salmonella* through chickens). Antimicrobial resistance is one of the main threats to modern medicine.

Viruses: Norovirus infections are characterized by nausea, explosive vomiting, watery diarrhoea and abdominal pain. Hepatitis A virus can cause long-lasting liver disease and spreads typically through raw or undercooked seafood or contaminated raw produce. Infected food handlers are often the source of food contamination.

Parasites: Some parasites, such as fish-borne trematodes, are only transmitted through food. Others, for example tapeworms like *Echinococcus spp*, or

Taenia solium, may infect people through food or direct contact with animals. Other parasites, such as *Ascaris*, *Cryptosporidium*, *Entamoeba histolytica* or *Giardia*, enter the food chain via water or soil and can contaminate fresh produce.

Watermelons have been linked to numerous outbreaks, primarily in North America, Africa and the south-west Pacific. However, melons are produced in several regions of the world. While melon production has been stable in the developed world over the last 10 years, watermelon production in developing countries has tripled. The production systems for melon were not considered to vary much from one place to another. However, it was noted that different systems might be implemented to prevent contact between the growing melon and the ground.

The characteristics of the fruit itself are important aspects in terms of contamination and control.

The rugged nature of the skin of the watermelon makes it difficult to remove any surface contamination. Also, washing has been identified as potential sources of contamination as freshly harvested, sun warmed melon may absorb the water and any contaminants therein.

Another important consideration in relation to melons is changes in marketing practices, with an increase in pre-cut melon. The flesh of a watermelon provides an ideal environment for microbial multiplication. Thus, there is a high risk of amplification of foodborne bacterial pathogens that may be present. In terms of hazard control, the quality of the water used for irrigation and washing is critical. However, the difficulty of preventing soil and dust from getting onto the fruit and possibly contaminating it means that there is still a lack of knowledge as to how to minimize contamination at the farm level. Given that melon flesh is ideal to support microbial growth, refrigeration is critical for pre-cut melon. (Nwachukwu 2016)

- Background of the Study

This research was carried out at Anyigba in Dekina local government area of Kogi State Nigeria. Anyigba has a population of 189,262 according to CENSUS 2006. The watermelon is a well consumed fruit all over Nigeria, and well consumed in Anyigba. The incidence of enteric bacteria has been reported in several fruits by a lot of authors, most times arising as a result contamination via sewage or irrigation water, transportation and handling by individual retailers with poor hygiene. Continued use of untreated waste water and manure as fertilizers for the production of fruits and vegetables is also a major contributing factor to contaminations (Amoah et al., 2009).

Nwachukwu and Osuocha, (2014) reported high bacterial load in cut watermelon and pawpaw while Eni et al., (2010) also reported similarly high bacteria load for cut watermelon and other fruits.

The implications of an astronomically high bacteria load in ready-to-eat sliced watermelon fruit is a potential risk of epidemics and disease outbreaks such as cholera, staphylococcal food-borne disease, typhoid fever, hepatitis A, and hepatitis E.

- Statement of Research Problem

Lack of proper hygiene has been a major problem in Nigeria. Retailers who sell ready-to-eat sliced fruits have the most responsibility to prepare such fruits in the best hygienic way as possible, such retailers fail to keep to standards required due to lack of education or just do not want to incur extra cost or do not care at all. Some Fruits washed are washed with contaminated water while some are not even washed at all, some vendors do not use gloves, some use dirty knifes, some fruits are cut and sliced by the road side thereby allowing dust laden with microorganisms to settle on such fruits only to be purchased by an end user who sees no use washing before eating.

Despite the publicity and awareness created towards keeping personal hygiene especially while dealing with food items, people still fail to keep it up and this poses a great environmental risk of diseases outbreak.

- Justification of the Study

It is expected to highlight the risks associated with the consumption of unhygienically prepared watermelon fruit.

It is also expected to mark out and recommend between whole unsliced watermelon and the sliced watermelon

This study also aims to highlight the dangers of consuming ready-to-eat sliced watermelon.

This study will therefore contribute to the environment by assessing and recommending the safest form of watermelon to be consumed, thus educating the public on dangers of consuming roadside ready-to-eat sliced watermelon

- Importance of the Study

The importance of consumption of hygienic fruits is often overlooked by the community, micro-organisms are too small to be seen with the naked eye hence people assume any fruit to be clean and safe as long as it looks clean. A lot of research has been done that dispels that opinion, but the reality of food-borne diseases and the dangers it poses to the environment is still strange and unbelievable to majority of the people. Hence this study looks to determine and identify the micro-organisms associated with fresh watermelon as well as highlight the dangers such micro-organisms pose.

- Specific Objectives

The specific objectives are to

1. To identify micro-organism, present in sliced and unsliced water melon fruit.
2. To determine the total number of microbial count or load in the sliced and unsliced water melon
3. To know the public health implication of the micro-organism, present in the water melon
4. To make recommendation and findings.

- Research Question and Hypothesis

Research Question 1

Can micro-organism associated with sliced and unsliced water melon fruit be identified?

Research Hypothesis 1

Micro-organism present in sliced and unsliced water melon fruit can be identified

Research Question 2

Can the total number of microbial count or load in the sliced and unsliced water melon be determined?

Research Hypothesis 2

Microbial count or load in sliced and unsliced water melon can be determined

Research Question 3

Can the public health implication of the micro-organism present in water melon be determined?

Research Hypothesis 3

The public health implication of the micro-organism present in water melon can be determined

Research Question 4

Does the researcher make recommendations and findings in the research work?

Research Hypothesis 4

The researcher makes recommendation and findings in the research work.

II. RESEARCH METHODOLOGY

- Study Design

This research is a cross sectional survey with laboratory components and was conducted between December 2019 and January 2020 at Anyigba town in Kogi State. Nigeria. The Vendors of the watermelon fruits (Citrullus lanatus) were briefed on the purpose of the research and verbal consent was obtained. Before the samples were subsequently taken and analyzed in the medical laboratory science, departmental laboratory of the Prince Abubarkar Audu University, Anyigba Kogi State.

The study comprises of five (5) water melon samples as long as they satisfy the criteria needed for inclusion.

- Study Area

The research work is designed to be done in Anyigba, fresh sliced and unsliced watermelon samples were randomly purchased all over the town. Highly populated areas were given more priority.

- Instrument Design for Data Collection

Instrument for data collection was laboratory microbiological analysis.

- Limitation of the Study

The major constraints faced during the course of this research work are financial constraints and limited sample size.

- Sample Collection

Five (5) each of sliced and unsliced watermelon samples were purchased randomly from vendors location in Anyigba, Kogi State, Nigeria. The samples

were placed in sterile plastic bags and transported immediately to the laboratory. The samples were analyzed within one hour of collection.

- Sterilization of Glass wares and other Items

The glass wares, such as conical flask, beaker, test-tubes etc. were duly soaked in detergent for 12 hours and then washed thoroughly using brush. They were subsequently rinsed in large quantity of clean water. The glass wares were air dried and then sterilized in hot air oven for 2 hours at holding temperature of 160ºc.

Inoculating wire loop used were sterilized by flaming with a Bunsen burner until red hot and then allowed to cool before using. The surfaces of the workbench were sterilized by cleaning with 75% alcohol before and after each working period.

- Preparation of Media

Four media used for this research work; they were nutrient agar (NA), potato dextrose agar (PDA), Manitol salt agar, and Violet Green Red Bile agar. They were all of analytical grade and were gotten from the Microbiology Laboratory of Medical Laboratory Science Department, Prince Abubarkar Audu University, Anyigba. All were prepared strictly according to the manufacturer's specification and were all autoclaved at 121°C for 15 minutes.

- Microbiological Analysis
  - Serial dilution technique

Nine (9) mls of distilled water was pipette into 10 clean test tubes each, they were covered with cotton wool and aluminium foil, and then they were autoclaved at 121°C for 20 minutes. One gram from each of the sliced and unsliced watermelon samples was obtained (using a sterile knife and wearing sterile disposable hand gloves) and transferred into 9 ml of distilled water in a glass beakers. The beaker was shaken thoroughly. One milliliter of the solution was added to make 1:9 of sample water ratio i.e. 10. The mixture was shaken well to suspend the propagules then a sterile pipette was used to measure Im from the supernatant into another test tube containing 9ml sterile distilled water. The mixture was shaken to homogenize this makes 10. This procedure was repeated for all 10 samples comprising of 5 sliced and 5 unsliced watermelon samples.

- Total microbial count

The pour plate method was adopted for the culturing of the organisms. 1ml of each of the aliquot of 10 were dropped in pre-labelled separate sterile Petri dishes, 20ml of molten agar at 45°C was poured on it and the Petri dishes were swirled to homogenize. The plates were allowed to solidify on working bench and then they were incubated inverted in incubator at 35 +2°C for 18 16 24hrs for bacteria and 27-2°C for 3 days for fungi. The colonies were counted after incubation and discrete colonies were sub-cultured on nutrient agar slant for further analysis.

- Characterization of Isolates
  - Cultural and morphological characteristics of the colonies

The cultural and morphological characteristics of the colonies were observed based on the criteria of Berger's Manual of Determinative Bacteriology. These include the following: shape of the colonies, elevation, edge, optical characteristics, consistency and pigmentation.

- Biochemical characterization

Biochemical characterization of the isolates was done using the methods described by Mcfaddin (1980) and Cruickshank et al, (1975). These include Gram staining reaction, sugar fermentation, catalase, oxidase, citrate, urease, indole and motility tests.

- Gram staining

A smear of each isolates was made on clean grease-free glass slide with a sterile inoculating loop. It was air dried and then heat fixed by passing over a Bunsen burner flame 3 times. The slide was allowed to cool and then flooded with crystal violet solution for 30 seconds. It was washed off in running tap water and again was flooded with gram's iodine for 30seconds. It was again washed off in running tap water and then washed with ethanol for few seconds to decolourize the stear, it was later washed off in running water. The smear was then counter stained with safranin solution for 30 seconds. This was also washed off gently under the tap and the smear was allowed to air dry.

The stained smear was then examined under the microscope using X 100 oil immersion lens. Purplish blue indicated gram positive while pink to red indicates gram negative.

- Catalase test

Catalase, an enzyme that converts hydrogen peroxide to water and oxygen on contact with hydrogen peroxide leads to production of bubbles. A smear of the isolate was made on a clean slide and then 2 drops of hydrogen peroxide was made on the smear. Production of bubbles within 5 seconds signified positive catalase.

- Coagulase test

This test was used to differentiate the pathogenic S. aureus from the non-pathogenic staphylococci. A discrete colony was emulsified in a drop of sterile normal saline which had been placed on a clean oil-free slide. The mixture was homogenized then a drop of human plasma was added to it. Clumping within 10 seconds indicated positive result. 3.9.6Oxidase test the isolates were picked with sterile inoculating loop and smeared on a filter paper moistened with a few drops of 1% tetramethy-P-phenlene diamine dihychloride (oxidase reagent). Oxidase activity was examined within 10 seconds. Development of a dark-purple colour indicated a negative result.

- Indole, Urease and Motility test

A sloppy Motility-Indole-Urease medium was inoculated with the isolate with the aid of straight wire. Then, an indole paper strip was placed in the neck of the tube and corked tight and the set up was incubated at 35°C overnight. Motility was shown by diffused turbidity in the medium. Indole paper turns red if positive while a red pink colour in the medium indicates positive urease production.

- Sugar fermentation

Peptone water containing 0.5% of the sugars was dispensed in test tubes. An indicator (0.01% phenol red) is incorporated into the medium, Durham tube is placed inverted into the set up. The media is then sterilized by steaming for 30mins on three successive days after which the indicator-sugar-broth is inoculated with the isolate and is incubated at 35°C for 2-3 days. Yellow colour indicates acid production while gas production is indicated by airspace and displacement of the Durham tube.

III. RESULTS

- Microbial load of the sliced and unsliced watermelon fruit

The microbial load of the sliced and unsliced watermelon samples from five watermelon vendors within Anyigba are presented in Table 1. All the watermelons sampled in this study showed various degree of contamination varying from vendor to vendor. Microbial load in the sliced watermelon samples ranged between 190 x 10 cfu/g -239 x 10 cfu/g while that of the unsliced watermelon ranged between 64 x 10 cfu/g - 82 x 10 cfu/g.

The highest microbial load of 239 x 10'cfu/g was obtained in sliced watermelon from vendor D, while the least microbial load of the sliced watermelon samples was recorded in vendor B with 190 x 10 cfu/g. Table 1 also shows that the highest microbial load (82 x 10 cfu/g) of all the unsliced watermelon was found in vendor D. Unsliced watermelon from vendor B had the least microbial load of 64 x 10 cfu/g.

The result also shows that the unsliced watermelon samples had zero coliform count across all the vendors. The sliced watermelon samples all had coliform contamination. The total coliform count was highest in watermelon samples from vendor D with a total coliform count of 39 10'cfu/g, vendor D while the least (23 x10 cfu/g) v was recorded in watermelon samples from vendor B.

The staphylococcal count as displayed in table 1 shows that all watermelon samples including the sliced and unsliced from all vendors had staphylococcal contamination. The highest total staphylococcal count of 85 x 10 cfu/g was found in sliced watermelon from Vendor D, total staphylococcal count of 36 x 10^2cfu/g was recorded for the unsliced watermelon sample from vendor D which is also the highest amongst unsliced watermelon samples from all vendors. The least total staphylococcal count was 76 x 10'cfu/g and 20 x 10 cfu/g for both the sliced and unsliced watermelon samples respectively.

No fungal contamination was recorded and observed for all watermelon samples from all vendors.

- Organisms isolated from the sliced and unsliced watermelon fruit.

Based on several identification and isolation tests carried out, a total of seven bacteria were identified across both sliced and unsliced watermelon samples. The watermelon samples including the sliced and unsliced from each vendor had different degree of contamination as shown in Table 2. Staphylococcus aureus (27.7%) was the most frequently isolated as it was present in all samples of watermelon. Proteus vulgaris was isolated on six occasions (16.6%) followed by Micrococcus luteus (13.8%). Staphylococcus epidermidis (11.1%) was isolated on four occasions and it was also observed that it was not isolated from any of the unsliced watermelon samples. Escherichia coli (11.1%) was isolated four times as well but it was not however isolated from any of the unsliced watermelon samples. Salmonella spp(8.33%) which was the least frequently isolated was not isolated from any of the unsliced watermelon samples as shown in Table 2.

Table 1: The microbial count on street vended sliced and unsliced water melon samples (x 10^2cfu/g)

Vendors	Sample	TBC	TCC	TSC	TFC
A	Sliced	217	38	79	-
	Unsliced	72	-	26	-
B	Sliced	190	23	65	-
	Unsliced	64	-	21	-
C	Sliced	202	31	77	-
	Unsliced	77	-	24	-
D	Sliced	239	39	85	-
	Unsliced	82	-	36	-
E	Sliced	228	30	76	-
	Unsliced	69	-	20	-

Key: - = no growth, TBC = Total bacterial count, TCC = Total coliform count, TSC = Total staphylococcal count, TFC = Total fungal count.

Table 2: Distribution of the isolates on the sliced and unsliced watermelon sample

	Vendor A		Vendor B		Vendor C		Vendor D		Vendor E	
Organisms	Sliced	unsliced	Sliced	unsliced	Sliced	unsliced	Sliced	unsliced	Sliced	unsliced
Staphylococcus aureus (27.7%)	+	+	+	+	+	+	+	+	+	+
Staphylococcus epidermidis (11.1%)	+	-	+	-	+	-	+	-	+	-
Micrococcus luteus (13.8%)	-	+	-	-	+	-	+	+	+	-
Bacillus subtilis (11.1%)	+	+	+	-	+	-	-	-	-	-
Escherichia coli (11.1%)	+	-	-	-	+	+	+	-	+	+
Proteus vulgaris (16.6%)	+	-	-	-	+	-	+	-	-	-
Salmonella spp (8.33%)										

Key: + = present, - = absent

Table 3: Vendor A

Organisms	%	Sliced	Unsliced
Staphylococcus aureus	22.2	+	+
Staphylococcus epidermidis	11.1	-	+
Micrococcus luteus	11.1	+	-
Bacillus subtitlis	22.2	+	+
Escherichia coli	11.1	+	-
Proteus vulgaris	11.1	+	-
Salmonella spp	11.1	+	-

Table 4: Vendor B

Organisms	%	Sliced	Unsliced
Staphylococcus aureus	50	+	+

Staphylococcus epidermidis	25	+	-
Bacillus subtitlis	25	+	-

Table 5: Vendor C

Organisms	%	Sliced	Unsliced
Staphylococcus aureus	22.2	+	+
Staphylococcus epidermidis	11.1	+	-
Micrococcus luteus	11.1	+	-
Bacillus subtitlis	11.1	+	-
Escherichia coli	11.1	+	-
Proteus vulgaris	22.2	+	+
Salmonella spp	11.1	+	-

Table 6: Vendor D

Organisms	%	Sliced	Unsliced
Staphylococcus aureus	28.5	+	+
Micrococcus luteus	28.5	+	+
Escherichia coli	14.2	+	-
Proteus vulgaris	14.2	+	-
Salmonella spp	14.2	+	-

Table 7: Vendor E

Organisms	%	Sliced	Unsliced
Staphylococcus aureus	28.5	+	+
Staphylococcus epidermidis	14.1	+	-
Micrococcus luteus	11.1	+	-
Escherichia coli	11.1	+	-
Proteus vulgaris	28.5	+	+

The following table (table 8) has been developed based on the guidance documents developed the UK Food Protection Agency. The table provides guidance on the status of the food.

Table 8: Guidance level for determining the microbiological quality of ready-to-eat foods

Test	Microbiological result (cfu/g unless otherwise stated)			
	Good	Acceptable	Unsatisfactory	Potentially hazardous
Standard plate count				
Category A	$<10^2$	$<10^2$	$<10^2$	N/A
Category B	$<10^2$	$<10^2$	$<10^2$	N/A
Category C	N/A	N/A	N/A	N/A
Indicators				
Entero bacteriaceae	$<10^2$	10^2 to $<10^2$	$\geq 10^2$	N/A
E. coli	<3	3 to $<10^2$	$\geq 10^2$	N/A
Pathogens				
Coagulase +ve staphylococci	$<10^2$	10^2 to $<10^2$	10^2 to $<10^2$	$\geq 10^4$
C. perfringens	$<10^2$	3 to $<10^2$	10^2 to $<10^2$	$\geq 10^4$
B. cereus	$<10^2$	10^2 to $<10^2$	10^2 to $<10^2$	$\geq 10^4$

v. parahaemolyticus	Not detected in 25g	If detected then as per below		
	<3	3 to $<10^2$	10^2 to $<10^4$	$\geq 10^4$
Camplobacterspp	Not detected in 25g			Detected in 25g
Salmonella spp	Not detected in 25g			Detected in 25g
Monocytogens				
Food group 1	Not detected 25g			Detected in 25g
Food group 2	Not detected 25g	Detected but $<10^2$		
Food group 3	Not detected 25g	Detected but $<10^2$		

DISCUSSION, CONCLUSION AND RECOMMENDATION

Foodborne diseases have always been a menace that needs to be dealt with accordingly and appropriately in other to forestall epidemics to public. A lot of losses both in human resources and economic resources have been incurred due to foodborne diseases.

The microbial load recorded in this study were all above the recommended range by The International Commission on Microbiological Specification for Food (ICMF, 1974) where they recommended that the limit of bacterial contaminants for food should be in the range of 102-10'cfu/g for coliform organisms and less than 10 cfu/g for total aerobic count. The result revealed that all the sliced watermelon samples from all vendors had total aerobic counts and coliform counts that were very high above the acceptable limits whereas the unsliced watermelon samples had zero coliform count. This may be attributed to the fact that the sliced samples had had contact with possible contaminants such as utensils used, water used in washing, packaging materials used and dirty hands of the vendors. The sliced samples investigated were microbiologically unacceptable to be consumed without adequate cleaning.

Despite the high microbial counts obtained especially for the sliced samples in this study, it is important to note that these samples had no visible signs of spoilage or filthiness. Thus outward appearance alone may not be good enough to judge the microbial quality of fruits and this poses a big health risk to the public.

The result also shows that none of the unsliced watermelon samples had any coliform contamination; this low frequency of E. coli recorded may be because the unsliced watermelon samples were not exposed to external contamination.

According to Bhunia (2007) the microorganisms present in fruits area direct reflection of the sanitary quality of the cultivation water, harvesting, transportation, storage, and processing of the produce. The high microbial contamination observed in the Sliced and unsliced watermelon samples used in this study may be a reflection of storage conditions and how long these produces were kept before they were obtained for sampling. Bacteria on storage materials may transfer to produce and cross contamination between produce is probable particularly where produce are pre-washed with the same wash water by the vendor or processor. More importantly, bacteria on the produce may multiply over time depending on the storage conditions especially those that are psychotropic (Abadias et al., 2008).

The following bacteria were isolated from the sliced and unsliced watermelon samples: Staphylococcus aureus, Staphylococcus epidermidis, Micrococcus luteus, Bacillus subtilis, Salmonella spp, Escherichia coli and Proteus vulgaris.

Most of the organisms isolated might have been introduced due to failure of food handlers to observe basic safety rules. Package in materials, the use of simple facilities like wheel barrows, trays to hawk the fruits or display on tables are possible sources of food contamination.

Bacillus subtilis was isolated from the samples just like Oranusi and Olorunfemi (2011) reported 100% occurrence of Bacillus subtilis isolated in street vended fruits. Bacillus are spore-formers and are known environmental contaminants, they have been indicted as food borne pathogens.

Staphylococcus aureus is a normal flora of the skin, and could have been introduced through unclean hands of the vendor and customers picking up and sampling the product, it is found in all individuals and usually expelled from the respiratory tract through the skin, nose and mouth which may also account for their presence in the fruit. In addition, S. aureus could elaborate toxins in foods, which are dangerous to human health (Uabol-Egbenni, 2003).

The presence of Salmonella spp could also have been introduced from water during washing or by soil and flies. Presence of Salmonella could also possibly be due to faecal contamination of water and hands or poor personal hygiene (Jolaosoet al., 2010).

E. coli is associated with faecal contamination and its presence poses a serious threat to public health. Presence of E coli in the watermelon samples indicates possibilities of secondary contamination. Outbreaks and sporadic cases of E. coli have been reported globally; in most of these outbreaks, contaminated meat, meat products, unpasteurized milk and leafy green vegetables and fruits fertilized with contaminated animal manure was the source of contamination (Sartz et al., 2008; CDC, 2011).

The possible sources of contamination of the sliced watermelon fruits could have been 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 which have far reaching implications on public health.

CONCLUSION

This study showed that ready to eat sliced watermelon sold publicly are contaminated with microorganisms at various levels such microorganisms include E.coli, Salmonella spp and Staphylococcus aureus. Therefore to ensure reduced microbial load and safety to the public, good personal hygiene and proper sanitary ways of processing fruits must be adopted.

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