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Qualitative Microbiological Assessment of Ready-to-Eat Fruits Sold in Selected Areas of Kaduna Metropolis

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Abstract

This study assessed the microbiological quality of ready-to-eat pineapple and watermelon fruits sold in selected areas of Kaduna Metropolis. A total of 30 samples (15 each) of ready-to-eat pineapple and watermelon fruits were purchased in a randomized manner from three distinct locations, namely Tudun Wada, Ungwan Muazu, and Ungwan Sarki in Kaduna Metropolis. The samples were carefully collected to prevent contaminations and were placed in sterile polythene bags. The preparation and microbiological analysis of all samples were conducted using established microbiological protocols. The pineapple sample obtained from the Tudun Wada region exhibited the highest bacterial mean count, measuring 8.76 x 104, while the watermelon sample from Ungwan Sarki exhibited the lowest bacterial mean count, measuring 5.72 x 10^4. The bacterial isolates identified in this study included Staphylococcus aureus, various species of Bacillus, Lactobacillus, and Pseudomonas, while the fungal isolates identified included Aspergillus niger, Fusarium solani, Penicillium sp., and Mucor sp. Staphylococcus aureus was the most prevalent bacterium in both samples, accounting for 8 occurrences (26.6%) in pineapple and 7 occurrences (23.3%) in watermelon. Bacillus species were also present, with 4 instances (13.3%) in pineapple and 5 instances (16.6%) in watermelon. Lactobacillus was found in 2 pineapple samples (6.6% of total) and 3 watermelon samples (10% of total). Pseudomonas aeruginosa was minimally detected in only 1 pineapple sample (3.3%). No detection of Pseudomonas aeruginosa was observed in watermelon. These findings suggest that fresh-cut fruits (enclosed in plastic containers or nylon) sold in T/wada, U/muazu, and U/sarki areas of Kaduna metropolis exhibit substandard microbiological quality, posing potential risks to public health. Therefore, it is crucial to improve the hygienic and safe packaging practices employed by these vendors to mitigate possible adverse health consequences.

***Keywords:** Bacterial and fungal isolates, microbiological quality, ready-to-eat fruits,*

INTRODUCTION

Fruits serve as a remarkable dietary reservoir of essential nutrients, micronutrients, vitamins, and dietary fiber for individuals, playing a crucial role in promoting overall health and well-being. According to Jerry et al. (2016), diets that are well balanced and rich in fruits have been documented to prevent hypovitaminosis (especially of Vitamin A and C) and some diseases. Fruits are susceptible to microbial contamination resulting from their exposure to various sources such as soil, dust, and water, as well as mishandling during both harvesting and post-harvest processing stages. Consequently, they harbor a wide array of microorganisms, including pathogens (Jerry et al., 2016).

In recent years, there has been a significant increase in the consumption of commercially available ready-to-eat fruits packaged in nylon or plastic containers in Nigeria. This trend is driven by the convenience, accessibility, and lower cost of these products compared to whole fruits. Other contributing factors include modern lifestyles, industrialization, economic challenges, materialistic tendencies, and time constraints for preparing nutritious meals (Jerry et al., 2016).

It is often challenging for individuals to provide reliable testimony regarding the cleanliness of food processors or the sanitary practices employed during food preparation. This issue is exacerbated by the insufficient storage conditions under which vended fruits are typically handled, resulting in their exposure to flies, dust, and other pathogens (Jerry et al., 2016). There is a correlation between the rise in the consumption of sliced fruits and the increase in incidences of food-borne illnesses.

Uzor and Dick (2022) reported that street vendors with limited educational backgrounds are responsible for processing and packaging various sliced fruits, such as pineapple, pawpaw, coconut, and watermelon, which are frequently sold in certain markets. These vendors often lack adequate knowledge and training in food safety and proper handling hygiene. The prevalence of cross-contamination in street-vended fruits, such as watermelon, pawpaw, and pineapple, is heightened due to unhygienic processing and packaging techniques. The presence of unclean utensils and the visible exposure of fruits can attract intermittent visits from flies and dust, potentially resulting in microbial contamination.

Due to a lack of sufficient data regarding the condition of sliced fruits sold within the study areas, the focus of this study was to assess the microbial quality of the sold fruits to raise awareness of the potential risks and health implications associated with consuming such fruits among the public.

MATERIALS AND METHODS

Sample Collections

A total of thirty (30) samples (15 each) of sold sliced fruits, specifically watermelon and pineapple, were purchased from fruit vendors in three distinct locations (Tudun Wada, Unguwan Sarki, and Unguwan Mu'azu) of Kaduna Metropolis. Five samples of each fruit were obtained from each location and placed in a clean, sterile, and appropriately labeled polythene bag. The specimens were promptly transported to the laboratory for further analysis.

Sample Preparation

A total of 10 grams of each sliced fruit sample was measured and subsequently homogenized in 90 millilitres of sterile distilled water using an electric blender. The samples were thoroughly mixed to evenly disperse the bacteria and fungi present into the diluents. Subsequently, the homogenate underwent a series of five-fold dilutions using sterilized distilled water. Following this, 1ml of the 10^{-4} dilutions of the homogenates was aseptically transferred into appropriately labeled petri dishes, employing the pour plate method, and allowed to solidify.

Microbial Enumeration and Isolation

Following the gelation process, the petri dishes containing nutrient agar were incubated at 37°C for 24 hours to allow bacterial growth. In contrast, petri dishes with sabourad dextrose agar were kept at room temperature (25°C) for 3 to 5 days to encourage fungal growth. Afterward, the plates were examined to detect microbial growth, and the colonies were counted using a colony counter. The quantification was expressed as colony-forming units per gram (cfu/g).

Identification of the Bacterial Isolates

A single colony was selected from the primary plate and transferred to a newly prepared nutrient agar medium. The culture was then incubated at a temperature of 37°C for 24 hours to obtain isolated and uncontaminated samples. The pure isolates were then transferred to a new nutrient agar slant and stored in a refrigerator at 4°C until they were needed.

The isolates were identified based on colonial morphology, Gram staining reaction, confirmatory tests, and appropriate biochemical tests such as Catalase, Indole, Oxidase, Coagulase, and Methyl-Red Test (Cheesbrough, 2006).

Identification of Fungal Isolates Lactophenol Cotton Blue Assay

The observed fungal colonies were subcultured on SDA to obtain pure isolates, and they were identified based on macroscopic and microscopic features (Pitt and Hocking 2009).

A single droplet of lactophenol cotton blue stain was carefully placed in the middle of a sterile slide. Subsequently, a small piece of the fungus was collected using a wire loop and deposited into the droplet of stain. The fungus fragment was gently manipulated to separate its components, and a cover slip was then placed over the preparation. The cover slip was not pressed down or tapped to prevent the dislodgement of the conidia from the conidiophores. Following this, the stained isolates were observed using a microscope equipped with x10 and x40 objective lenses to examine their morphological characteristics.

Data Analysis

The mean bacterial and fungal load counts of the sliced fruit samples were analyzed by Analysis of Variance (ANOVA) using SPSS Version 20. A significance level of $P \leq 0.05$ was considered.

RESULTS

Table 1 shows the results for the mean bacterial count of ready to-eat fruits obtained from vendors within Kaduna metropolis. The total mean bacterial count of the samples was observed to be high in T/wada with 8.7 x 10^4 cfu/ml and 8.56 x 10^4 cfu/ml for pineapple and watermelon respectively. While the total mean bacterial count of the sample obtained from U/mu'azu had 7.82 x 10^4 cfu/ml and 7.34 x 10^4 cfu/ml for pineapple and watermelon and the total mean bacterial count of fruits obtained from U/sarki account the lowest with 5.96 x 10^4 cfu/ml and 5.72 x 10^4 cfu/ml for pineapple and watermelon.

Table 2 shows the results of the fungal count of ready-to-eat fruits obtained from vendors within Kaduna metropolis. The total mean fungal count of the samples obtained from T/wada was recorded to be highest with 3.6 x 10^4 cfu/ml and 3.1 x 10^4 cfu/ml for pineapple and watermelon. While the mean fungal count of samples from U/mu'azu were observed to had 1.7 x 10^4 cfu/ml and 2.1 x 10^4 cfu/ml for pineapple and watermelon on the other hand, the lowest mean fungal count of samples was from U/sarki with 1.8 x 10^4 cfu/ml and 1.2 x 10^4 cfu/ml for pineapple and watermelon.

Table 5 presented the percentage occurrence of bacterial isolates in the ready-to-eat fruits analyzed. There were variations in the prevalence rates of different species of bacteria in the fruits. *Staphylococcus aureus* exhibited the highest occurrence in both samples, with 8 (53.3%) in pineapple and 7 (46.6%) in watermelon. *Bacillus species* accounted for 4 (26.6%) in pineapple and 5 (33.3%) in watermelon. Lactobacillus had 2 (13.3%) in pineapple and 3 (20%) in watermelon, while *pseudomonas aeruginosa* had the lowest percentage occurrence in pineapple, with 1 (6.6%), and was not detected in watermelon.

Table 6 presents the percentage occurrence of fungal isolates in the ready-to-eat fruits analyzed. There are variations in the prevalence rates of different species of fungi in the fruits. *Aspergillus niger* exhibited the highest occurrence in both samples, with 6 (40%) in pineapple and 5 (33.3%) in watermelon. *Mucor species* had the same occurrence rate of 4 (26.6%) in both pineapple and watermelon, while *Penicillium* and *Fusarium* species had the lowest occurrence rate of 2 (13.3%) in both pineapple and watermelon.

Table 1: Total Mean Bacterial Count of Ready-to-eat fruits within Kaduna Metropolis

Location	Pineapple (cfu/ml) + SD	Watermelon (cfu/ml) + SD
Tudun wada	8.76 x 10^4 + 26.55	8.56 x 10^4 + 25.06
Unguwan Mu'azu	7.34 x 10^4 + 9.39	7.82 x 10^4 + 9.40
Unguwan Sarki	5.96 x 10^4 + 6.89	5.72 x 10^4 + 10.27

Table 2: Total Mean Fungal Count of Ready-to-eat fruits within Kaduna Metropolis

Location	Pineapple (cfu/ml) + SD	Watermelon (cfu/ml) + SD
Tudun wada	3.6 x 10^4 + 25.98	3.1 x 10^4 + 1.30
Unguwan Mu'azu	1.7x 10^4 + 6.69	2.1 x 10^4 + 4.12
Unguwan Sarki	1.8 x 10^4 + 1.17	1.2 x 10^4 + 11.66

Table 3: Morphological and Biochemical Characteristics of Bacterial Isolates

Morphological Characteristics	Off white Smooth, Small and round colonies	Opague, rough, large and white colonies	Opaque, Smooth Rod small and white colonies	Pale Colonies
Gram reaction	Cocci	Rod	Rod	Rod
Gram staining	+ve	+ve	+ve	-ve
Catalase	+	+	-	-
Coagulase	+	-	-	-
Oxidase	-	-	-	+
Indole	-	-	-	-
Methyl red	+	-	-	-
Probable Organisms	*Staphylococcus aureus*	*Bacillus cereus*	*Lacto bacillus*	*Pseudomonas aeruginosa*

Table 4: Morphological and Microscopic Characteristics of Fungal Isolates

Morphological Characteristics	Microscopic Examination	Probable Organisms
Cotton like white growth spotted with black colour	Sporangia contain spores	*Mucor* species
Filamentous white growth that sporulate black powdery spores	Non-branched conidiosphore with bulb end carries conidia like sun rays	*Aspergillus niger*
Brown or pink in center with white edges	Spindle like conidia multicelluar	*Fusarium solani*
Green - greyish colour colonies	Brush like conidiosphore carries conidia	*Penicillium* species

Table 5: Distribution of Bacterial Isolates in Sliced Fruit Samples in Kaduna Metropolis

Bacterial Isolate	Pineapple Frequency (%)	Water melon Frequency (%)
Staphylococcus aureus	8 (53.3)	7(46.6)
Bacillus cereus	4 (26.6)	5 (33.3)
Lacto bacillus	2 (13.3)	3(20)
Pseudomonas aeruginosa	1(6.6)	0

Table 6: Distribution of Fungal Isolates in Sliced Fruit Samples in Kaduna Metropolis

Fungal Isolate	Pineapple Frequency (%)	Watermelon Frequency (%)
Aspergillus niger	6 (40.0)	5 (33.3)
Mucor species	4 (26.6)	4 (26.6)
Fusarium solani	2 (13.3)	4 (26.6)
Penicillium species	3 (20)	2 (13.3)

DISCUSSION

Bacteria and fungi are common contaminants in fruits, often transmitted from vendors to processed fruits due to mishandling practices. The microbial contamination found in ready-to-eat fruits from different vendors in Tudun Wada, Unguwan Mu'azu, and Unguwan Sarki in the Kaduna metropolis highlights potential health risks.

The findings of this study indicate that the pineapple samples obtained from T/wada had the highest mean bacterial count. Conversely, the watermelon samples obtained from U/sarki exhibited the lowest mean bacterial count. The fungal mean count in pineapple was determined to be very high in Tudun wada as observed in the study. Conversely, the lowest fungal count was recorded in watermelon from Unguwan sarki. The present study found that all of the fruit samples that were analyzed were contaminated with a number of bacteria and fungi within the study areas. This is consistent with the microbial isolates documented by Odebisi et al. (2015) in their study on the microbial contamination of ready-to-eat fruit at Abakpa main market in Abakaliki, Ebonyi state. This assertion is also supported by the research conducted by Oranusi and Olorunfemi (2011), who successfully identified the presence of *Staphylococcus* sp., *Bacillus* sp., *Pseudomonas* sp., *Salmonella* sp., *and Mucor* sp. in commercially available fruits in Otta, Ogun state. Additionally, Tambeker et al. (2009) also reported similar findings in their study.

The majority of the isolates examined in this study were likely introduced into the fruits through the use of water contaminated with fecal matter during the washing of utensils such as knives, trays, and polythene bags used for packaging the sliced or cut fruits. Additionally, the exposure of these fruits to low temperatures may have facilitated the growth of these pathogens (Jerry et al., 2016).

Additionally, the potential introduction of *Staphylococcus aureus* into the ready-to-eat fruits could be attributed to the physical contact between vendors and the fruits. This is due to the fact that *Staphylococcus aureus* is commonly found as a part of the normal microbial community inhabiting the nasal passages, hands, and skin of healthy individuals. According to the study conducted by Jerry et al. (2016), the bacterium *Staphylococcus* was found to be the most frequently isolated microorganism, with an occurrence rate of 50%. This finding is consistent with the research conducted by Odebisi et al. (2015) and Ganguli (2006), who similarly reported that *Staphylococcus aureus* had the highest occurrence in fruits and foods, respectively.

Fowoyo (2012) also observed a limited presence of *Pseudomonas aeruginosa* in their investigation of air-borne contamination in fruits sold in Lokoja, Kogi State. The contamination of various substances, including fresh vegetables and fruits, can be attributed to the presence of *Mucor* species. These species are widely distributed and can be found in abundance due to their ubiquity. The high occurrence of *Mucor* contamination may be a consequence of the exposure of ready-to-eat fruits to dusty or muddy environments. The majority of these fruit vendors tend to operate in close proximity to stagnant water found in gutters, which can potentially facilitate the introduction of contaminants to the fruits.

CONCLUSION

In conclusion, the findings of this study indicate that the pineapple and watermelon samples examined exhibited poor microbiological quality. Specifically, the pineapple sourced from the central market demonstrated the highest bacterial count of 8.76 x 10^4 cfu/ml, whereas the watermelon from Kasuwan barci exhibited the lowest bacterial count of 8.56 x 10^4 cfu/ml. Similarly, the pineapple from the central market displayed the highest fungal count of 3.6 x 10^4 cfu/ml, while the watermelon from Kasuwan barci had the lowest fungal count of 1.2 x 10^4 cfu/ml. The identified bacteria included *Staphylococcus aureus, Bacillus cereus,* lactobacillus species, and *Pseudomonas* aeruginosa, while the fungi isolated were *Aspergillus niger*, *Fusarium* species, *Mucor* species, and *Penicillium* species. It is crucial for vendors to prioritize personal and environmental hygiene to mitigate contamination risks posed by these potential pathogens in the examined fruit samples.

RECOMMENDATIONS

- Government health authorities should direct their focus towards the market, particularly on fruit vendors, to monitor the processing and packaging of the fruits sold. This entails assessing factors such as the type and origin of water used, the state of utensils, and, crucially, the personal hygiene practices of the fruit vendors. The objective is to mitigate the incidence of fruit contamination in the vending sector.

- Public awareness programs should be implemented as a strategy to educate fruit vendors about the importance of personal and environmental hygiene in order to mitigate contamination risks.
- Lastly, consumers who purchased sliced fruits should be advised to wash them thoroughly before consumption. Interviews with some consumers indicated that these purchased fruits were often consumed without being washed.

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