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Research Paper

Microbial Quality of Exposed and Packaged Yam and Plantain Flours Sold in Open Markets and Supermarkets in Portharcourt Metropolis, Nigeria

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Abstract
In Port Harcourt, there has been many cases of food borne diseases especially diarrhea reported by families. This has been linked or attributed to contaminated flour based meals.In this study 20 samples of exposed and package yam and plantain flours from 5 open markets and supermarkets while 3 fresh yam Tubers and unripe plantain were used as control, total of 23samples.Serial dilution of the yam and plantain were done and (0.1ml) each was inoculated onto dried nutrient agar, Maconkey agar for bacterial and Saboraud dextrose agar plates for fungi. Morphological characteristic, Gram staining technique and biochemical tests were used to identify bacteria while lactophenol cotton blue was used for fungi identification.The bacteria isolates include Bacillusspp, Staphylococcus aureus, Escherichia coli while fungi isolates include Aspergillus sp and Micosporum sp.At the end of the study it was discovered that exposed yam and plantain had the highest heterophilc count of $31x10^5$cfu/g and $36x10^5$cfu/g and mean values of $6.2x10^5$ and $7.2x10^5$ while the packaged yam and plantain bought from supermarket had total heterophilic count of $1.7x10^5$cfu/g and $1.8x10^5$cfu/g and mean values of $0.34x10^5$ and $0.36x10^5$ respectively. Lastly, the total heterophilic count for control samples (fresh yam and plantain) are $0.4x10^5$cfu/g and $0.6x10^5$cfu/g and mean value of $0.13x10^5$ and $0.2x10^5$respectively.Conclusively it could be seen that fresh yam and plantain had the least count while expose yam and plantain bought in the open market had the highest count. It is therefore bad to buy expose yam and plantain flours in open markets and this should be discouraged. It is then recommended that strict good manufacturing practice during flour processing and packaging should be done under hygienic condition. In order to drastically reduce microbial load and contamination the presence of pathogens in edible flours is generally considered microbiologically unsafe and this poses a threat to public health and hygiene.

Key words:*Contamination, Pathogens, Heterophilic count, Hygienic , Diarrhea.*

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I. INTRODUCTION

Plantain, and Yam are high starchy staple foods consumed by many families in Nigeria. These staples are highly perishable because of its high moisture content which supports microbial spoilage. Therefore, they are usually processed into edible flours which have reduced moisture content and longer shelf life than freshly harvested yam and plantain. Low moisture content of edible flour is unfavourable to support growth of microorganisms (Dzomeku*et al.* 2011). Yam and Plantain as edible flours have differentfood applications (Fallik and Aharoni, 2004). Apart from its nutritional importance mainly in providing energy to human body, Yam could be beneficial to human health as a result of hypocholesterolemic,antioxidative, hypoglycemic, immunomodulatory and antimicrobial activities of bioactive constituents in the tubers (Prasanna*et al.*, 2007). In Nigeria, some orthodox and traditional medical personnel recommend Plantain flour as a diet that can help diabetic patients manage their health condition (Sharma and Singh, 2000; Brecht *et al.*, 2004). Notwithstanding low water activity of Yam and Plantain flour, contamination of these edible flours by pathogenic and non-pathogenic microorganisms could occur during processing (Irtwange, 2011). Unhygienic handling of these edible products and undue expose to environment during retailing also predisposes edible flours to microbial contamination.

In Nigerian markets, edible flours especially the ones produced by local farmers are usually exposed during retailing while others produced by cottage industries are usually packaged. Consumption of flour-based products could lead to outbreak of diseases such as diarrhea despite application of heat in the form of baking and

cooking at the point where flour is used for food production (Mensah, 2013). Contamination of food takes place along the food production chain i.e. from production to dining table. Microbiological quality is considered as the most important aspect of food safety (Prasanna*et al.*, 2007). Like any other food product, Yam and Plantain processed into flour is susceptible to microbial contamination during processing, packaging and retailing (Eshetu and Tola, 2014). Consumption of microbially contaminated edible flour is considered a threat to public health (Montcel, 1987; Komatsu *et al*., 2010; Mensah, 2013). Ogundare-Akanmu*et al., reported* that insects did not infest plantain flour samples which were stored for four months but moulds were noticed on the samples within the last month of storage except the reference sample.

II. MATERIALS AND METHODS

Total of twenty-three samples (23) were used for this study. Five edible flours each of packaged Yam and Plantain Flours totaling ten (10) samples were obtained from five (5) different Supermarkets in Port Harcourt, Nigeria. Similarly ten (10) plastic sterile containers were used to separately put five (5) samples each of exposed yam and Plantain flour purchased from five (5) different retailers in five (5) popular open markets within Portharcourt Metropolis. Also for the control samples, Three (3) healthy yam tubers and bunch of unripe plantains were purchased from three (3) retailers in three (3) different open markets in Portharcourt. The Open Markets includes; Mile 3 Market, Mile 1 Market, Rumuokoro Market, Timber Market and Oil mill Market. The Super Markets includes; Welcome U Super Market at Iwofe, SPAR shopping Mall at Azikiwe road beside Government house, Market Square located at Ada George, Prettys Supermarket located at RumuokoroJuntion and Fortunes Supermarket located at new GRA in Portharcourt, Rivers State, Nigeria.

Serial Dilution and Sample Preparation

This was achieved by carrying out serial dilution of the flours and plating onto appropriate agar plates. About 1gram of the flour was weighed and transferred into 9 ml of sterile normal saline and was shaken to make a homogeneous mixture. Thereafter 1.0ml was transferred into another test-tube containing 9ml of sterile normal saline giving a 10^{-2} dilution. This process was repeated until a 10^{-4} dilution was gotten (Paul and Clark, 1988). From 10^{-4} dilution of each flour sample, an aliquot (0.1ml) was transfered onto a freshly prepared Mac Conkay agar and Nutrient agar for bacterial growth and onto a freshly prepared Sabraud dextrose Agar (SDA) containing 0.1g of streptomycin for Fungal growth.

The inoculated plates were incubated aerobically at 37°C for 24-48hours for bacterial growth and SDA plates were incubated at 28°c for 5-7 days for Fungal growth, after which the plates were examined.

Yam tubers and Unripe Plantain; The yam tuber and Unripe Plantain samples were peeled and rinsed in sterile distilled water, and cut open with a sterilized knife. 1g of each healthy yam and Unripe Plantain sample was cut using the sterilized knife from each of the sample and it was transferred separately into a sterile mortar and pestle, Sterile normal saline was added into the motar, it was then crushed. Thereafter, 1ml of the crushed yam and unripe Plantain sample was transferred respectively into 9ml of Sterile normal saline using a Sterile pipette giving a 10^{-1} dilution. Another 1ml was transferred from 1:10 into another tube containing 9ml of sterile normal saline giving a 10^{-2} dilution. This process was repeated until a 10^{-4} dilution was gotten (Joanne *et al*., 2008). From 10^{-4} dilution of each flour sample, an aliquot (0.1ml) was transfered onto a freshly prepared Mac Conkay agar and Nutrient agar for bacterial growth and onto a freshly prepared Sabraud dextrose Agar (SDA) containing 0.1g of streptomycin for Fungal growth.

The inoculated plates were incubated aerobically at 37°C for 24-48hours for bacterial growth and SDA plates were incubated at 28°c for 5-7 days for Fungal growth, after which the plates were examined.

Total Heterotrophic Bacterial Count

Bacteria count was carried out on each of the plates to determine the number of bacteria growth. This was obtained by counting the bacteria colony on the plate and using the number to multiply the dilution factor. Bacteria count was analyzed in Colony Forming Unit per Mil (CFU/ml).

Methods of Characterisation of Bacterial Isolates

Cultural Characteristics: The discrete colonies were examined morphologically after 24-48hour incubation on different agar plates. Other biochemical test carried out includes Gram staining, motility test, Coagulase test, Catalase test and Indole test.

III. RESULTS

The result obtained from the cultures are presented in Table 4.1 showing the total heterotrophic count in exposed yam and plantain flours. In the exposed yam flour samples from 5 different open markets the results obtained are $6.0x10^5$, $8.0x10^5$, $6.0x10^5$, $5.0x10^5$ and $6.0x10^5$ respectively, Similarly in the exposed plantain flour samples the results obtained are $5.0x10^5$, $7.0x10^5$, $9.0x10^5$, $7.0x10^5$ and $8.0x10^5$ respectively. The total

heterotrophic count in packaged yam and plantain flour samples was also obtained, For the packaged yam flour samples from 5 different open markets the results obtained are $0.4x10^5$, $0.3x10^5$, $0.4x10^5$, $0.3x10^5$ and $0.3x10^5$ respectively, similarly in the packaged plantain flour samples the results obtained are $0.5x10^5$, $0.4\ x10^5$, $0.3\ x10^5$, $0.4\ x10^5$ and $0.2\ x10^5$.

The control samples had relatively low total heterotrophic counts, the results for Healthy yam samples obtained are $0.1x10^4$, $0.2x10^4$ and $0.1\ x10^4$. similarly unripe plantain samples had the following results $0.2\ x10^4$, $0.2\ x10^4$ and $0.2\ x10^4$ respectively.

Table 4.1 Total Heterotrophic Count of bacteria from samples obtained from different markets, supermarkets and control samples

	PY (cfu/g)	PP (cfu/g)	EY (cfu/g)	EP (cfu/g)	RY1 (cfu/ml)	UP1 (cfu/ml)	RY2 (cfu/m)	UP2 (cfu/ml)	RY3 (cfu/ml)	UP3 (cfu/ml)
SM1	0.4×10^5	0.5×10^5	-	-	-	-	-	-	-	-
SM2	0.3×10^5	0.4×10^5	-	-	-	-	-	-	-	-
SM3	0.4×10^5	0.3×10^5	-	-	0.1×10^4	0.2×10^4	-	-	-	-
SM4	0.3×10^5	0.4×10^5	-	-	-	-	-	-	-	-
SM5	0.3×10^5	0.2×10^5	-	-	-	-	-	-	-	-
OM1	-	-	6.0×10^5	5.0×10^5	-	-	-	-	-	-
OM2	-	-	8.0×10^5	7.0×10^5	-	-	0.2×10^4	0.2×10^4	-	-
OM3	-	-	6.0×10^5	9.0×10^5	-	-	-	-	0.1×10^4	0.2×10^4
OM4	-	-	5.0×10^5	7.0×10^5	-	-	-	-	-	-
OM5	-	-	6.0×10^5	8.0×10^5	-	-	-	-	-	-
Total	1.7×10^5	1.8×10^5	31×10^5	36×10^5	RY=	0.4×10^4	UP=	0.6×10^4		
Mean	0.34×10^5	0.36×10^5	6.2×10^5	7.2×10^5	RY=	0.17×10^4	UP=	0.22×10^4		

Interpretation
SM = Supermarket
OM= Open Market
PY = Packaged Yam
PP = Packaged Plantain
EY = Exposed Yam
EP = Exposed Plantain
RY= Raw Yam
UP = Unripe Plantain
cfu/g = colony forming units per gram
cfu/ml = colony forming units per mil.

Table 4.2 Frequency of Occurrence of Bacteria Isolated From Packaged and Exposed Edible Flours, Healthy Yam Tubers and Unripe Plantains

	Exposed Yam	Exposed Plantain	Packaged Yam	Packaged Plantain	Raw Yam	Unripe Plantain	Total No of Occurrence	Percentage of Occurrence (%)
Staphylococcus aureus	-	-	7	3	-	-	10	34.5
Streptococcus	-	-	-	-	1	1	2	6.9
Bacillus	6	4		2	-	-	12	41.4
Escherichia coli		2	1	2	-	-	5	17.2
Total	6	8	8	7	1	1	29	100.0

Table 4.3 Frequency of Occurrence of Fungi Isolated From Packaged and Exposed Edible Flours, Healthy Yam Tubers and Unripe Plantains

	Exposed Yam	Exposed Plantain	Packaged Yam	Packaged Plantain	Raw Yam	Unripe Plantain	Total No of Occurrence	Percentage of Occurrence (%)
Aspergillus sp.	5	5		2	-	-	12	42.9
Candida tropicalis	3	-	-	-		-	3	10.7
Penicillium sp.			2	3	-	-	5	17.8
Microsporum sp.	3	5			-	-	8	28.6
Total	11	10	2	10	-	-	28	100.0

IV. DISCUSSION

This study revealed that population of different categories of microorganisms present in exposed plantain and yam flour samples were higher than that of similar packaged flour samples, fewer amount of microorganisms were seen in the control sample (healthy yam tubers and Unripe Plantains) used for the processing of these exposed and packaged edible flours. On average, higher microbial load in exposed flour samples compared with similar packaged flour samples could be as a result of exposing plantain and yam flour to atmosphere filled with numerous and diverse microorganisms, indiscriminate touching of the products with bare hands during retailing and contact with other contaminating materials. High level of hygiene during processing of yam and plantain flour as control could be responsible for minimal variation of microbial population (total heterotrophic count) among the flour samples represented in Table 4.1. Results obtained from this study also revealed that four bacterial species were isolated from exposed and packaged plantain and yam flour samples, healthy yam tubers and Unripe plantains which are *Bacillus sp., Escherichia coli, Staphylococcus sp. and Streptococcus sp.* This result is in agreement with bacteria genera isolated from plantain flour retailed at Urban market in Ondo state, Nigeria (Aruwa and Ogundare, 2017). The result obtained in this study in Table 4.2 is in agreement with another related study, Gacheru*et al*. In 2017 which reported that *Staphylococcus sp.* and *Esherichia coli* were present in Plantain and yam flours sold in Nairobi and coastal regions in Kenya. According to International Commission on Microbiological Specification for Food (ICMSF), total bacterial count in food should not exceed $1x10^{6}$cfu/g; Staphylococcus aureus should not exceed $1x10^{5}$cfu/g and total coliforms should not exceed $1x10^{4}$cfu/g (Omohimi*et al.*, 2019).The total bacterial count present in packaged yam and Plantain flour samples obtained from five different Supermarkets in Portharcourt Metropolis was given as 1.7×10^{5} and 1.8×10^{5} respectively. The total bacterial count present in exposed yam and plantain flour samples obtained from five different open markets in Portharcourt was given as 31×10^{5} and 36×10^{5} respectively. This is an indication that health hazard could occur if the public consume these products directly without further treatment (Olowoyo*et al*., 2001). The control samples prepared in the Laboratory aseptically contained lesser amount of bacterial count, this could be because of the hygienic practice used for the processing of the flours, Yam and Plantain flours had 0.4×10^{4} and 0.6×10^{4} heterotrophic counts respectively. Unnecessary handling of yam flour with bare hands during retailing of the product could have resulted in contamination of yam flour with *Escherichia coli.* The result shown in Table 4.2 is also in agreement with a related study Somorin *et al.* in 2001 which reported the presence of *Escherichia coli* in white yam flour. It is interesting to note that *Bacillus sp., Staphylococcus aureus* and *Escherichia coli* that were present in some samples of exposed and packaged plantain and yam flour were not detected in the control samples. This could be as a result of hygienic practices involved during processing of yam and plantain flour in the laboratory. Packaging of the flour samples could be responsible for reduction of microbial contamination of the products to a level comparable with that of control flour samples prepared under hygienic conditions in the laboratory. This study further revealed that the control samples had a relatively lower total viable count than similar flour samples obtained from five open markets and five supermarkets in Port Harcourt metropolis which were either exposed or packaged. Djeri*et al*. In 2010 reported similar findings from a related study. That notwithstanding, packaged and exposed plantain and yam flour samples recorded relatively high microbial count. The result of this research is in agreement with the result of Omohimi*et al*. In 2019 from a related study.

V. CONCLUSION

It is very important to implement regular monitoring of microbial quality of edible floursavailable in the markets (Supermarkets and Open markets) for public consumption, because of health risk posed by these products.

VI. RECOMMENDATION

Further prolonged study should be conducted using molecular based techniques for further identification of the organisms present in the edible flour samples.

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