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Microwave Heat Treatment Effects on the Microbial Profile of Some Ready-To-Eat Street Vended Snacks

Oleghe P.O.[1*], Orhewere R.D.A.[2], Orhewere V.A.[3], Oboh J.E.[4]

[1]Department of Biological Science Laboratory Technology, School of Applied Sciences and Technology, Auchi Polytechnic,Auchi, P.M.B, 13, Auchi, Edo State, Nigeria.
[2]Department of Basic Sciences, School of General Studies, Auchi Polytechnic, Auchi, P.M.B, 13, Auchi, Edo State, Nigeria.
[3]Department of Microbiology, University of Abuja, FCT, Abuja, Nigeria
[4]Department of Science Laboratory Technology, Isa Mustapha Agwai 1 Polytechnic, Lafia, Nasarawa, Nigeria

[*]*Corresponding Author: peaceoleghe@gmail.com, Tel.:* +2348033867973

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Abstract—The effect of heat treatments on the microbial population of plantain chips and roasted groundnut using microwave sterilization was carried out with the aim of improving food safety of various ready-to-eat street vended Nigerian snack foods. The samples were purchased from different food snacks vendors within Auchi Metropolis and immediately taken to the laboratory for analysis. The samples were divided into four parts and subjected to microwave heat treatments at 72^{o}C for 10, 20 and 30 minutes with the control not treated with any form of heat. Thereafter, each sample were analysed for their microbial density and quality using standard microbiological procedures. The results revealed a reduction in the microbial density of the samples as heat treatment time increased especially among the bacteria population, but the fungal load was not as linear**.** The microbial quality analysis showed that plantain chips contained some microorganisms which survived the heat treatment and could be of public health importance, although their numbers were within the recommended tolerable limits for ready- to-eat foods. It is therefore imperative to educate and sensitize food producers especially ready-to-eat street vended snack food handlers on the necessary sanitary protocols needed to assure food safety during food preparations.

Keywords-Microwave heat treatment, Microbial profile, Ready-to-eat foods, Street vended snacks

I. INTRODUCTION

One of the major challenges facing the health community worldwide is food borne illnesses which has led to reduced economic growth especially in developing nations like Nigeria [1]. The major contributing factor is that foods in developing countries, unlike the industrialized nations are processed and sold using traditional methods which are unregulated and not mechanized. Ready-to-eat foods are mostly sold in the streets especially in developing countries. Street-vended foods are ready-to-eat foods prepared on the spot or at home before being sold to consumers who eat these foods without further processing [2]. There are a list of street vended food among those are plantain chips and groundnut.

Plantain chips are products made from a staple food grown mostly in tropical areas. Plantain contains vitamins, minerals and constitutes a major source of energy for its consumers. Plantain chips can be prepared from unripen, slightly ripened or ripe plantain by slicing into thin sheets or square bits, then deep fried in vegetable oil for about five minutes [3]. The chips are then packed in transparent polythene nylons before displaying them for sale.

Conversely, Groundnut is a legume crop with contains proteins and essential oil and as such it is one of the top choice of diet both humans and animals. In Nigeria, groundnut is sold and consumed in different forms: uncooked, cooked, and roasted or with its shell [4], [5] and are sold in public places such as markets, offices, schools, motor parks, restaurants, supermarkets etc. packaged in transparent nylons or used bottles [5].

Due to the vacillating financial turn of events economically, street vended food have become progressively significant in the financial and economic lives of numerous African nations. They are mostly sold by women who use this as a means of livelihood for their household. Furthermore, street vended foods are source of reasonable cheap nutrients [3].

Microbiological safety and quality of many ready-to-eat foods is of great importance since street foods have been shown to cause varying levels of food borne infections in both developed and developing countries [2], [6]. A considerable amount of these microorganisms might be pathogenic and the consumption of these microorganisms in street vended plantain chips and groundnut represents an

extraordinary threat to general wellbeing of the individuals in that particular society [6].

The nature by which foods Street-vended snacks are prepared and sold exposes them to microbial contamination. Microorganisms can gain entry during preparation, packaging, transport, and distribution [7]. Additionally, the hygiene of food vendors and the preparation environment could contributes to microbial proliferation in these foods. This paper aims to investigate the effect of microwave heat treatments on the microbial profile of some ready-to-eat street vended snacks.

II. RELATED WORK

In recent years, the sales of ready- to eat street vended foods is one of the most prospering business endeavours in major cities of Nigeria and are offered by various individuals. In Nigeria, practically all classes of individuals consume street vended foods due to their affordability and ease of use. [8].

Different studies showed different level of contamination of street foods. For instance, in a study done by [9] on the microbial contamination of locally fried plantain sold in Osun State Nigeria, analysis of their findings revealed that fried plantain had total bacterial count of 3.0×10^2 cfu/ml (*Bacillus cereus*) to 4.0×10^8 cfu/ ml (*Staphylococcus aureus*), mean coliform count of 2.6×10^6 cfu/ml (*Klebsiella* spp) to 6.0×10^3 cfu/ml (*Escherichia coli*), and fungal count of 3.0×10^4 cfu/ml (*Penicillium marneffei*) to 3.0×10^8 cfu/ml (Yeast).The authors concluded that most pathogens isolated from their study are of soil and intestinal origin which are transmitted via fecal-oral route and contamination could be from unhygienic preparation, handling, and storage practices [9].

In another study on the enumeration of microbial density in Plantain (*Musa paradisiaca*) Chips Sold in Yenagoa Metropolis, Bayelsa state, south-south Nigeria. The authors reported total heterotrophic bacteria, bacteria of the *Enterobacteriaceae* family and total fungi ranged from 3.99 - 4.73 Log cfu/g, 2.46 – 2.84 Log cfu/g and 2.90 – 3.38 Log cfu/g, respectively. Their study concluded that the microbial density is within tolerable limit for ready to eat food as stipulated by Food and Agricultural Organization, however, there is the need for improve handling processes [10].

Similar studies on microbiological quality assessment of unpeeled Groundnut sold in Yenagoa Metropolis, Nigeria carried out by [4] revealed that bacterial density ranged from 3.68 – 4.56 Log cfu/g, 1.92 – 2.57 Log cfu/g and 1.92 – 2.29 Log cfu/g for total heterotrophic bacteria, total coliform and total Staphylococci counts respectively. The microbial diversity found in unpeeled groundnut were *Staphylococcus aureus, E. coli, Enterobacter, Bacillus, Proteus, Micrococcus* and *Streptococcus* species. While the fungi diversity includes *Aspergillus, Rhizopus, Mucor, Fusarium* and *Penicillium* species [4].

These studies focused on the microbial proliferation of these ready-to-eat street vended food. In order to improve the safety of street vended foods and reduce the occurrence of food borne illnesses, hence this study aims at heat-treating street vended plantain chips and groundnuts in microwave oven using varying temperatures.

III. METHODOLOGY

Sampling

Samples of plantain chips and roasted groundnut were purchased from different food snacks vendors within Auchi Metropolis. The samples were taken to the Microbiology laboratory in the Department of Biological Sciences Auchi Polytechnic, Auchi for analysis.

Heat Treatment

Each samples were separated into four batches and subjected to heat treatment at 72^{o}C for 10, 20 and 30 minutes using an LG® microwave oven (model no. MEZ62332712). The control was not treated with any form of heat while adhering to standard aseptic practices. The heat treated samples and control were then analyzed for their microbial density and quality using the relevant microbiological procedures.

Sample Preparation

The samples were macerated using using a Marlex® Electroline blender (IS 4250; CM/L 7962804). Exactly 10g of the sample were transferred into the blender containing 90 ml of sterile distilled water and homogenized at 160 rpm for 5minutes to get the stock solution for each sample. This was done repeatedly for each sample [10].

Enumeration Microbial Counts

Pour plating method as described by [11] was used to enumerate the microbial density for each sample. From the stock solution, 1ml was taken and serially diluted [10 fold] with 9ml of sterile distilled water after which 0.1 ml inoculum of the diluted samples were transferred into already labelled sterile petri dishes. Cooled (45^{o}C) molten Nutrient agar (for bacteria) and Potato dextrose agar (for fungi) were poured into the appropriate petridish containing the inoculum [12]. The petri dishes were agitated with gentle swirling to evenly distribute the inoculum and allowed to solidify. The dishes were incubated inverted at 37°C for 18-24 hours for bacterial growth and 25^{o}C for 72-96 hours for fungal growth. After incubation, colonies formed were counted and recorded as colony forming units per gram (CFU/g)

Statistical Analysis

Microsoft® Excel® 2013 was used for the statistical analysis of the log transformed microbial counts. Data were visualized in charts.

IV. RESULTS AND DISCUSSION

Results

The mean counts of bacteria occurring after microwave oven heat-treatment for street vended, ready-to-eat Plantain

chips and Groundnuts for 72°C at 10, 20 and 30 minutes are shown in Figure 1. The mean count of bacteria for plantain chips at 0 minutes ranges from 1.0 x 10^7 CFU/g to 3.2 x 10^7 CFU/g, at 10 minutes, the bacterial load ranges dropped from 5.3 x 10^6 CFU/g to 1.3 x 10^5 CFU/g across all the samples analysed. Increasing the heating time to 20 minutes shows a further drop in microbial load from 10^5 CFU/ml to 10^3 CFU/g which fell within the range 1.5 x 10^3 CFU/g to 6.5 x 10^4 CFU/g. At a constant temperature of 72°C for 30 minutes, the bacterial load in the plantain chips reduced and ranged from 1.1 x 10^3 CFU/g to 5.3 x 10^3 CFU/g.

Groundnut with no heat treatment had a mean count which ranged from 2.5 x 10^8 to 6.2 x 10^8 CFU/g. At 10 minutes, the bacterial load dropped and ranged within 1.8 x 10^6 to 5.7 x 10^6 CFU/g. further heat treatment for 20 minutes brought down the bacterial density to about 10^4 CFU/g ranging between 1.4 x 10^4 to 3.9 x 10^5 CFU/g. With the temperature remaining constant at 72°C, and the heat treatment time raised to 30 minutes, the bacterial load dangled within 4.3 x 10^2 to 2.7 x 10^4 CFU/g.

Fungal growth for the heat-treated street vended, ready-to-eat Plantain chips and Groundnut at 10, 20 and 30 minutes, is shown in Figure 2. For plantain chips at 0 minutes, the fungal load ranges from 1.0 x 10^3 CFU/g to 2.5 x 10^3 CFU/g, increasing heat exposure to 10 minutes revealed that the fungal load ranged from 1.0 x 10^2 CFU/g to 1.0 x 10^3 CFU/g. Heat treatment of the plantain chips for 20 minutes had showed no significant drop in microbial load as counts and ranges from 2.5 x 10^2 CFU/g to 6.3 x 10^2 CFU/g. At 30 minutes, growth was observed and stood at 1.5 x 10^1 CFU/g.

For the Groundnuts samples, their mean fungal counts at 0 minute fell within 2.5 x 10^3 CFU/g with no growth seen in some samples. The mean fungal count of heat treated groundnut samples for 10 minutes dropped and ranged between 2.2 x 10^1 to 2.5 x 10^3 CFU/g. There was a little deviation at heat treatment for 20 minutes as the fungal count increased from the 10^1 CFU/g to 10^3 CFU/g and ranged from 2.0 x 10^3 to 5.0 x 10^3 CFU/g. On further heat treatment for 30 minutes, the fungal load reduced and ranged from 4.8 x 10^1 CFU/g to 2.5 x 10^2 CFU/g.

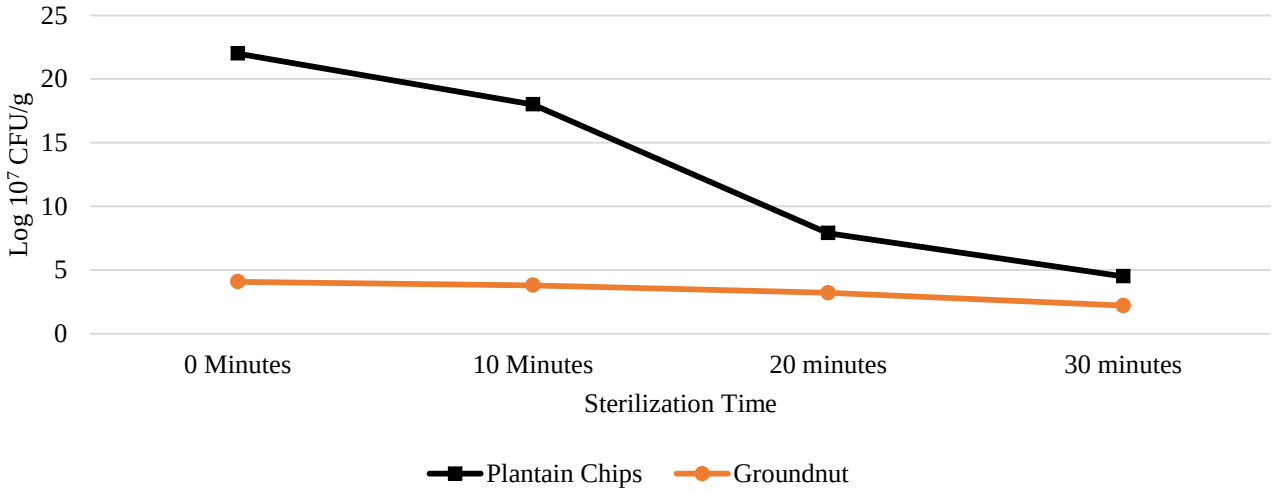

Figure 1: Mean count of Bacteria in microwave oven heat-treated street vended plantain chip and Groundnut samples for 72°C at different times

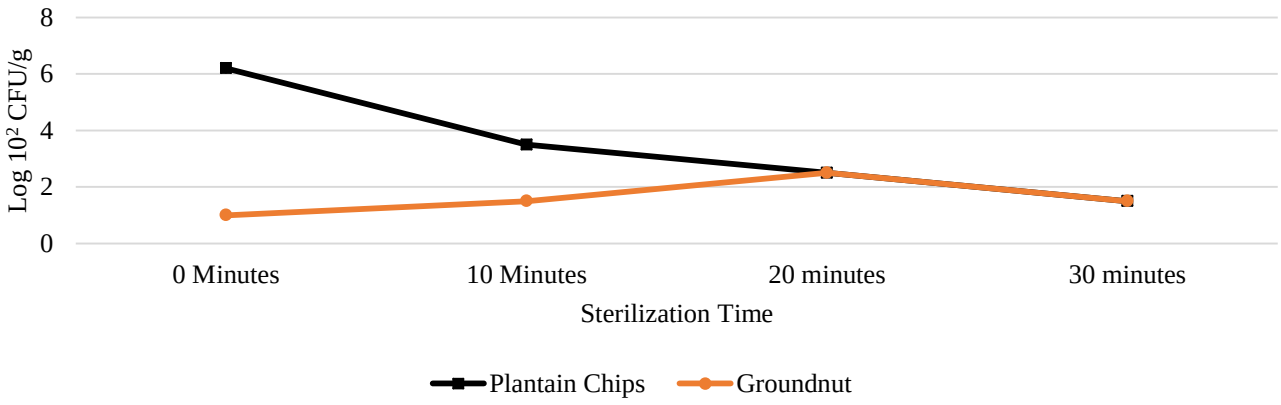

Figure 2: Mean count of Fungi in microwave oven heat-treated street vended plantain chip and Groundnut samples for 72°C at different times

Table 1: Cultural, Morphological and Biochemical Characteristics of Isolates obtained from microwave oven heat-treated street vended plantain chip and Groundnut samples for 72^{o}C at different times.

Parameter	Isolate 1	Isolate 2	Isolate 3	Isolate 4	Isolate 5	Isolate 6	Isolate 7	Isolate 8	Isolate 9
Cultural characteristics	Large Creamy, circular, elevated on nutrient agar	Small creamy colonies on nutrient agar	Brown pigmented colony which diffuses into the Nutrient agar	Whitish to creamy irregular colonies on Nutrient agar	Small round colonies on nutrient agar	Small bright grayish colonies on Nutrient agar	Cream smooth colonies on Nutrient agar	Flat, creamy colony on nutrient agar	Small circular colonies spreading like palm fronts on nutrient agar
Morphological characteristics	Cocci	Cocci	Rods	Long Rod	Rod	Rod	Shorts rod	Short rod	Short rods
Cell arrangement	Clusters	Single	Single	Single	In pairs	Pairs	Pairs	Single	
Gram reaction	+	+	+	+	+	-	-	+	+
Catalase	+	+	+	+	+	+	+	+	ND
Coagulase	+	-	ND	ND	-	ND	ND	ND	ND
Oxidase	ND	ND	ND	ND	ND	-	ND	ND	ND
Nitrate	ND	-	+	+	-	-	ND	+	+
Urease	ND	ND	-	-	-	ND	ND	-	-
Motility	-	ND	+	+	+	+	+	+	-
Methyl Red	ND	-	ND	ND	ND	ND	-	ND	ND
Vogues Proskaur	ND	ND	ND	ND	ND	ND	+	ND	ND
Glucose	A	A	A	A	A	A	A	A	A
Lactose	A	A	A	A	A	A	-	-	AG
Sucrose	AG	-	A	A	A	AG	-	AG	A
Maltose	AG	A	-	A	A	A	A	A	A
Mannitol	AG	A	-	A	A	A	-	A	A
Probable bacteria	*Staphylococcus aureus*	*Micrococcus luteus*	*Bacillus cereus*	*Bacillus subtilis*	*Bacillus pumilus*	*Listeria grayi*	*Staphylococcus saprophyticus*	*Bacillus megateriu m*	*Corynebacterium xerosis*

Key: + : positive -: negative, A: Acid only produced, AG: Acid and Gas Produced, ND: Not Determined

Table 2: Cultural, Morphological and microscopic characteristics of Fungi obtained from microwave oven heat-treated Street vended plantain chip and Groundnut samples for 72^{o}C at different times

Sn	Cultural characteristics	Microscopy	Isolate
1	Cinnamon to brownish coloured colonies with velvety surface	Fine hyphae which aer not fragmented with sparse areal mycelium	*Aspergillus terreus*
2	White yellow-green velvety to flaky surface due to intense sporulation	Septate hyphae with the conidial heads smoothly defined which inflates to form vesicles	*Aspergillus flavus*
3	Gray-green velvety to flaky surface due to intense sporulation	Septate hyphae with conidiophores inflates to form vesicles giving rise to conidia	*Aspergillus fumigatus*
4	Powdery dark brown-black colonies with intense	Septate hyphae with conidiophores on the hyphae	*Aspergillus niger*

	sporulation		
5	Powdery light green buff to yellow colonies which spread, raised on the surface of the medium	Hyphae are septate with conidiophore born laterally on the hyphae	*Aspergillus nidulans*
6	White colony which later turns blue-green with velvety surface	Conidiophores arise from septate hyphae giving a brush-like appearance	*Penicillum italicum*
7	Cover agar surface. They are white and fluffy that later turned grey. Reverse side is white.	Sparsely septate, broad hyphae, sporangiophores, sporangia and spores were visualized	*Mucor mucedo*
8	Creamy powdery growth that later turned black	Aseptate hyphae, unbranched sporangiospores are from the foot of rhizoids that enlarged in a cup-shaped form with the mycellial region	*Rhizopus stolonifer*
9	white to cream-colored, soft, dull, smooth or slightly wrinkled	Multilateral budding; ellipsoidal to cylindrical in chains.	*Candida albicans*
10	white to cream-colored, soft, dull, rough edges with rug like surface	Small clusters; ovoid, ellipsoidal, or cylindrical, multilateral budding. No true hyphae	*Hansenula anomala*

Table 3: Occurrence of the isolates at different time of heat treatment of with microwave oven.

	Time (Minutes)			
Isolates	**0**	**10**	**20**	**30**
Staphylococcus aureus	$+^{ab}$	$+^{ab}$	$+^{ab}$	$+^{a}$
Micrococcus luteus	$+^{a}$	$+^{a}$	$+^{a}$	-
Bacillus cereus	$+^{a}$	-	-	-
Bacillus subtilis	$+^{ab}$	$+^{ab}$	$+^{ab}$	$+^{ab}$
Bacillus pumilus	$+^{a}$	$+^{a}$	-	-
Listeria grayi	$+^{a}$	-	-	-
Staphylococcus saprophyticus	-	-	$+^{a}$	-
Bacillus megaterium	-	$+^{ab}$	$+^{ab}$	$+^{a}$
Corynebacterium xerosis	$+^{a}$	-	-	-
Aspergillus terreus	-	-	$+^{a}$	-
Aspergillus flavus	-	-	$+^{a}$	-
Aspergillus fumigatus	$+^{a}$	$+^{a}$	$+^{a}$	$+^{a}$
Aspergillus niger	$+^{a}$	$+^{a}$	$+^{a}$	$+^{b}$
Aspergillus nidulans	+	+	+	+
Penicillum italicum	$+^{a}$	-	$+^{a}$	
Mucor mucedo	$+^{ab}$	$+^{ab}$	$+^{ab}$	$+^{a}$
Rhizopus stolonifer	-	-	-	$+^{b}$
Candida albicans	$+^{b}$	$+^{b}$	-	$+^{a}$
Hansenula anomala	-	-	$+^{b}$	$+^{b}$

Key: a: Plantain chips b: groundnut +: present -: absent

Discussion

This study's microbial density is similar to those obtained in prior studies on street-vended plantain chips and groundnut in Nigeria. For example, in unpeeled groundnut marketed in Benin City, total heterotrophic bacteria and total fungal counts ranged from 0.5 to 2.1 x 10^4 cfu/g and 3.4 to 6.6 x 10^4 cfu/g, respectively [2]. Total heterotrophic bacteria and total fungal counts in roasted groundnut sold in certain markets in Bauchi town varied from 4.25 to 5.82 x 10^5 cfu/g and 7.0 to 8.6 x 10^4 cfu/g respectively, according to [13]. Similarly, bacteria with average count of 3.0x 10^2 cfu/ml and 1.47 x 10^7 cfu/ml in Local Fried Plantain (*Dodo Ikire*) in Osun State, Nigeria has also been reported [9]. The heat treatment of the groundnut reduced the bacterial load in the samples to the accepted level of 10^5cfu/g [14] but have no significant effect on the fungal load which was however still within the acceptable level of 10^3 CFU/g (in ready-to-eat foods) as suggested by the International Commission on Microbiological Specification for Food [14].

In general, following heat treatment, the microbial loads in the ready-to-eat meals in this investigation were below the tolerated limits (10^4–10^5 CFU/g) for ready-to-eat foods [4], [11], [15]. It was also lower than the Food and Agricultural Organization's (FAO) recommended level (10^5 CFU/g) and

the Food Quality Check Program's (10^6 CFU/g) guideline [16]. [17].

The bacteria isolates encountered in this study as shown in Table 1 include; *Staphylococcus aureus, Micrococcus luteus, Bacillus cereus, Bacillus subtilis, Bacillus pumilus, Listeria grayi, Staphylococcus saprophyticus, Bacillus megaterium* and *Corynebacterium xerosis*. The Fungal isolates encountered in this study as displayed in Table 2 are; *Aspergillus terreus, Aspergillus niger, Aspergillus nidulans, Aspergillus flavus, Aspergillus fumigatus, Penicillum italicum, Rhizopus stolonifer, Mucor mucedo, Hansenula anomala* and *Candida albicans.* Similar organisms were isolated from previous work carried out by [18] in their study on micro-organisms associated with preparation of plantain pudding in Western Nigeria. Also similar findings with [11] who determine the microbial load of dry and wet plantains. The sources of this microbes present in plantain chips could be air, environment or contaminations due to processing and handling of samples.
Staphylococcus aureus was present in plantain samples at 0, 10, 20 and 30 minutes and in groundnut samples at 10 and 20 minutes of heat treatment, with a percentage occurrence of 11% while *Staphylococcus saprophyticus* had an occurrence of 3% and appeared only in the plantain chips (Table 3). This result is in line with that of [9] who had *Staphylococcus aureus* as the most prevalent isolated bacteria with average count of 3.0 x 10^2 cfu/ml and 1.47 x 10^7 cfu/ml. *Staphylococcus* species do produces endotoxin which can cause vomiting and diarrhea, isolation of this bacteria could be from skin. It may also indicates poor hygienic conditions and contamination during manufacturing/handling [9].

Micrococcus luteus with an occurrence rate of 8% is found in a wide range of terrestrial and aquatic environments, including soil, fresh and salt water, sand, and vegetation. Micrococcus strains commonly infect foods of animal origin, and the skin of warm-blooded animals, including humans, which are a major reservoir for them [19].

Bacillus cereus, Bacillus subtilis, Bacillus pumilusn and *Bacillus megaterium* were identified in the samples with percentage occurrence of 3%, 11%, 5% and 5% respectively (Table 3). *Bacillus* cereus appeared only at 0 minute, *Bacillus pumilus* at 0 and 10 minutes, *Bacillus megaterium* at 20 and 30 minutes while *Bacillus subtilis* appeared in all heat treatments. *Bacillus* species are aerobic spore bearer which are usually heat resistant, ubiquitous and toxin-producer which can cause illness. *Bacillus* species infections are characterized by the onset of a rapid emetic sickness and a slower-onset diarrheal illness [20].
Listeria grayi with a percentage occurrence of 3% was present only at the onset of heat and disappeared at heat treatment increases. *Listeria grayi* is a non-pathogenic specie of the *Listeria* genus [21]. *Corynebacterium xerosis* with occurrence of 5% appeared only at 20 and 30 minutes of heat treatment in the plantain chips (Table 5). *Corynebacterium xerosis* is a commensal bacteria that lives on human skin and mucous membranes [22]. Their presence in this study has to do with improper handling.

The species Aspergillus were largely distributed in the samples at different times during heat treatment. *Aspergillus terreus* (3%), *Aspergillus niger* (8%), *Aspergillus nidulans* (11%), *Aspergillus flavus* (3%) and *Aspergillus fumigatus* (8%) were identified at different temperatures but *A. nidulans* appeared from onset of heat treatment till the end. The most frequent fungus identified in this study were *Aspergillus* spp, and this finding is comparable to that of [23], which also reported *Aspergillus* spp as the most isolated fungi. The most prevalent *Aspergillus* spp. was *Aspergillus nidulans*, which had 11% incidence rate, followed by *Aspergillus niger* and *Aspergillus fumigates*, both of which had an 8 percent incidence rate each. However, this study's findings contradicted those of [24], which claimed that *Aspergillus niger* was the most common, with a 50% incidence rate, followed by *Aspergillus flavus*, which had a 6.25 percent incidence rate, and so on. Because of the poisonous metabolites (aflatoxins) produced by *Aspergillus* spp, the high incidence rate of *Aspergillus* spp. in these food samples may make them unsafe for human consumption.
Penicillium italicum had a percentage occurrence of 5% and appeared during 0 minutes and 20 minutes of heat treatment of plantain chips. *P. italicum* have been identified as the causative agent responsible for post-harvest spoilage of banana and plantain. If the fruit is injured during handling and storage, the fungus will gain access, and its rot can spread from fruit to fruit. These species develop quickly at 20–25 degrees Celsius, but slowly below 5 degrees Celsius and over 30 degrees Celsius [9].

Mucor mucedo has a percentage occurrence of 11% and appeared throughout the heating process. *Mucor*, like many other mucoralean fungus, is the first saprophytic colonizer of dead or decaying plant matter. Mucor infected food poses a minor health risk when consumed in moderation. Mucor has yet to produce a particular mycotoxin that has been identified. [25], [26].

Candida albicans was identified only at 30 minutes of heat treatment of plantain chips and 0 and 10 minutes of heat treatment of groundnut with an occurrence of 3% (Table 3). The presence of this organism could be due to poor handling during sample processing or uncontrolled exposure of the sample. The identification of *Candida* spp is of public health importance. *Candida* may survive on the skin and within the body, in locations including the mouth, throat, stomach, and vaginal canal, without creating any issues [27]. *Candida* may cause infections when it develops out of control in immunocompromised persons or when it penetrates the body deeply. *Candida* is a yeast that is the most common cause of skin fungal infection. It causes thrush in men and women and is the chief pathogen in the cause of vaginal yeast infection.

Hansenula anomala with a percentage occurrence of 2 % was present in the groundnut samples at 20 and 30 minutes

of heat treatment (Table 3). *Hansenula anomala* has been characterized as a contributor to the microbial flora of the skin, throat, and alimentary system, and has been detected in soil, plants, and fruit juices. Although it is an uncommon infectious agent, it has been identified as a new opportunistic pathogen that causes devastating infections in immunocompromised patients and neonates in critical care units [28].

V. CONCLUSION AND FUTURE SCOPE

The results from the heat treatment of street-vended ready-to-eat plantain chips and groundnut using microwave oven at 72^{o}C for 10, 20, and 30 minutes justifies the need for heat treatment sterilization of these ready-to-eat foods before consumption in order to reduce the incidence of food poisoning. The microbial analysis of these heat treated food snacks at different times yielded a reduction in the microbial load as treatment time increases, a necessary condition for food-borne disease not to occur. Since this microbial quality analysis showed that they still contained some microorganisms capable of surviving varying heat treatment conditions, they could be of public health importance. It is therefore imperative to educate and sensitize food producers especially ready-to-eat street vended snack food handlers on the necessary sanitary protocols needed to assure food safety during food preparations.

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AUTHORS PROFILE

OLEGHE, Peace Omoikhudu is currently a Chief lecturer in the Department of Biological Science Laboratory Technology, School of Applied Sciences and Technology, Auchi Polytechnic. He holds a BSc. in Microbiology from Edo State University, Ekpoma and a dual MSc. in Food and Industrial Microbiology and Pharmaceutical Microbiology from University of Benin and University of Nigeria Nsukka respectively. His research focus is in Food and Industrial Microbiology and Pharmaceutical biotechnology. He has over 25 academic publications in both Nigerian and international peer review scientific journals and has also organized and attended various conferences and professional workshops. Furthermore, he is a member of the Society for Microbiology and Nigerian institute of Science Laboratory Technology.

Orhewere, Regina Dada has over 28 years high school teaching experience and she has successfully transitioned into lecturing tertiary school undergraduate students. She holds a degree in Animal and environmental biology. She has been involved in developing the biological science research curriculum for first and second grade students in tertiary institutions. She is a member of various professional bodies. Most of her high school products are distinguished post-doctoral fellows. She is happily married with children.

Orhewere, Victory "Tory" holds a BSc. in Microbiology and always poised in attaining results in a challenging, fast-paced working environment and delighted in serious drive for professional distinction, proficiency at all times. She is a research associate who applies her expertise and skills to develop and execute innovative research in microbiology and biotechnology.

Emmanuel John Oboh is a trained Laboratory Technologist with specialty in Biology/ Microbiology from the Auchi Polytechnic Auchi, Edo State Nigeria. He also completed a retraining course on Biosafety and Biosecurity from the Center for Bioethics and Research, West Africa. His main research interest is in Food Microbiology and Safety and Ethnomedicine and shows interest in Bioinformatics. He is an attendee of various conferences and also presented and published several papers in both local and international journals. He has sound statistical knowledge with proficiency in Microsoft Excel.

