Asian Food Science Journal

5(4): 1-7, 2018; Article no.AFSJ.45421

Bacteriological Analysis of Selected Street Vended Fried Foods Sold in Wudil Town along Maiduguri Road, Kano State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author BAJ designed the study, conduct the experiment and performed the statistical analysis and wrote the manuscript. Authors AAS and FUS supervised the work. Authors AY and MA manage the work. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2018/45421
Editor(s):
(1) Dr. Vodnar, Dan – Cristian, Assistant Professor, Department of Food Biotechnology, Food Chemistry and Food Microbiology, University of Agricultural Sciences and Veterinary Medicine, Cluj Napoca, Romania.
Reviewers:
(1) Fatma Coskun, Namık Kemal University, Turkey.
(2) Henry Karoki Wambui, University of Nairobi, Kenya.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/27405

Original Research Article

Received 09 September 2018
Accepted 19 November 2018
Published 24 November 2018

ABSTRACT

Aim: A bacteriological analysis of four selected street vended fried ready-to-eat food types (Yam, sweet Potato*, Akara* and *Masa)* sold freely and openly at various location in Wudil town along Maiduguri road Kano, Nigeria was conducted from April, 2017 to August, 2017.
Methodology: The food samples collected were cultured on a Nutrient agar and MacConkey agar plates for isolation and identified using gram staining and motility test and subsequently subjected to various biochemical tests which include; catalase, coagulase, indole, methyl red, Voges – Proskauer, citrate utilisation urease and oxidase tests.
Results: From the total of 200 samples examined, 183 (91.5%) were contaminated by different bacterial agents, total of 191 bacterial isolates were recovered, in which 89(46.6%) were *Staphylococcus aureus,* 45(23.6%) *Escherichia coli,* 38(19.9%) *Pseudomonas aeruginosa* and 19(9.9%) *Klebsiella pneumoneae* but statistically there is a significant difference ($p < 0.05$). Analysis of the food samples revealed mean total bacterial count ranging from 1.6 x 10^3 cfu/g

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(yam) to 1.0 x 10^2 cfu/g (potato), where fried beans ball (*Akara*) had a mean bacterial count of 1.5 x 10^3cfu/g and fried rice *masa* with 1.06 x 10^3 cfu/g, therefore, mean bacterial count were high in fried yam, followed by fried *Akara*, rice *masa* and fried potato has less prevalence.
Conclusion: It is recommended that food vendors should be enlighten on food contamination by food regulatory agencies since most of them are not aware of microbial invasion.

Keywords: Bacteriological analysis; Escherichia coli; Kano; Staphylococcus aureus; street food.

1. INTRODUCTION

Ready to eat foods are foods that can be bought directly from street vendors or hawkers or at local markets and eaten immediately i.e. foods are defined as ready to eat foods and beverages prepared and or sold by vendors and hawkers especially in street and other similar public places [1]. These are very popular worldwide and provide readily available delicacies at a cheaper rate [2]. Street vended foods are prepared and/or sold by vendors on the street and in other public places for immediate consumption or for consumption at a later time without further processing or preparation [3]. Since these food are prone to contamination because they are sold in the open and are often not covered. Street vendors prefer to take their products to their customers they often operate from places such as bus terminal, industrial areas, schools, market places and streets. Such locations usually do not meet food and safety requirements [3].

These foods can endanger public health by causing various acute and chronic food borne diseases through pathogenic microbes or toxic substances produced. Most of the studies done on street food in Nigeria and foreign countries had indicated that these food are not meeting the microbiological standards and are contaminated with various pathogens viz., *Escherichia coli*, *Staphylococcus* sp, *Salmonella* sp, *Vibrio* sp, *Listeria* sp etc. [4], sale of food in the streets is very controversial from a health standpoint, the main health hazard associated with street foods is microbial contamination [1]. A number of observational studies have shown that street foods are sometimes held at improper temperatures, excessively handled by food vendors and sold at very dirty surroundings which make them prone to contaminations [5,6]. In addition most of the vendors had either no formal education or few years of schooling and therefore, they are unaware of improper food handling and their role in the transmission of pathogens [7].

Knowing the microbiological quality of street vended foods is important factor to appreciate the safety problems related to street foods so that concerned bodies may take appropriate steps to improve safety and sanitation with respect to this economic sector [8]. It becomes common practice to observe them around schools bus stations and other places where several people found. In Nigeria and other countries, almost all categories of people are consuming street foods; while some are protected from using these foods fear of contamination. Different researchers have shown a various level of contamination of the street foods [3]. The establishment of validated methodologies for the determination of food shelf-life is currently demanded by both food industries and Health Authorities at national and international scale [9]. It is well known that most foods are perishable, since they are subjected to modifications in their structure, composition and properties during storage before consumption [10]. These changes are of physico-chemical origin attributed to food composition together with the action of intrinsic and extrinsic environmental factors, and also microbiological, where spoilage flora, play an important role [11]. The study was aimed to determine the bacteriological quality of selected street vended fried foods sold in Wudil town along Maiduguri road, Kano State-Nigeria.

2. MATERIALS AND METHODS

2.1 The Study Area

This research was carried out at Wudil town, along Maiduguri road Kano state, Nigeria. Where travelers stop over to buy foods by the road side (street food), Wudil is situated at 11.81^{o}N latitude 8.85^{o}E longitude and 375 meters above the sea level [12]. Five different vending sites were selected for the study (from Wudil bus-stop, along Maiduguri road to Kano University of Science and Technology Wudil mini-market). These sites were chosen due to the level of commuters and other people patronising.

2.2 Sample collection

A total of 200 samples comprising of four different fried food types, i.e. Yam, sweet potato, beans ball (*Akara*), and rice *Masa* collected in batches, were collected using random sampling technique [13]. The five sampling sites were visited on different occasions for sample collection within the period of this study in Wudil town (from bus-terminal along Maiduguri road to KUST, mini- market) in same quantity. Fifty (50) samples of each food type were purchased in sterile brown bag envelopes directly from sellers and immediately brought to laboratory of the Department of Microbiology, KUST Wudil for analysis. Each fried food samples were purchased in batches (10 pieces per batch for ten weeks i.e. two weeks interval per each sampling).

2.3 Isolation, Identification and Enumeration of Bacteria

The samples were initially cultured on a Nutrient agar, and MacConkey agar plates. All plates were incubated aerobically and anaerobically at 37°C for 24 hours and plates reading were conducted using viable plate counting according to method described by Cheesbrough [14]. Discrete colonies were identified based on standard bacteriological methods described by Cheesbrough [14] and Uchei, [15]. The organisms were differentiated by gram staining and motility test and subsequently subjected to various biochemical tests for evidence of confirmation, which include; catalase, coagulase, mannitol salt agar incubation, indole, methyl red, Voges – Proskauer, citrate utilisation urease and oxidase tests.

2.3.1 Indole test

Tryptophan broth was inoculated with an isolate of the test organism and incubated at 37°C for 24 hours. About 0.5 ml of Kovack's reagents was added to the broth culture.

2.3.2 Methyl red test

MR-VP broth was inoculated with an isolate of the test organism using sterile inoculating loop and incubated at 37°C for 24 hours. About 5 drops of Methyl-red reagent was added to the broth culture.

2.3.3 Voges Proskauer

MR-VP broth was inoculated with an isolate of the test organism using sterile inoculating loop and incubated at 37°C for 24 hours. Six millilitre (6 ml) of 5% alpha naphthol was added followed by 0.2 ml of KOH. The tube was shaken gently and remained undisturbed for 5 minutes.

2.3.4 Citrate utilisation test

Simmon's citrate agar was streaked back and forth with inoculums of the test organism and incubated aerobically at 37°C for 24 hours.

2.3.5 Catalase test

A microscope slide was placed inside a Petri dish. The Petri dish cover was kept available. Using sterile inoculating loop, a small amount of organism was collected from a well-isolated 24-hour colony and placed it onto the microscope slide. Using a dropper, 1 drop of 3% H_2O_2 was dropped onto the organism on the microscope slide.

2.3.6 Coagulase test

0.5 ml of blood plasma was added into a test tube and 0.1 ml of the test organism was added and observed after 30 minutes at room temperature.

Table 1. Samples collection points and different types of fried food

Sampling site	Code	Yam	Potato	*Akara*	*Masa*	Total
Opposite KUST Wudil	A	10	10	10	10	40
Opposite General Hospital	B	10	10	10	10	40
Near Amana Hospital Wudil	C	10	10	10	10	40
Wudil Motor Park	D	10	10	10	10	40
KUST, Wudil Mini-Market	E	10	10	10	10	40
Total		**50**	**50**	**50**	**50**	**200**

2.3.7 Oxidase test

A small piece of filter paper was soaked in 1% oxidase reagent and let dried. Using a sterile loop a well-isolated colony from a fresh 24-hours culture of bacterial plate was removed and rubbed onto treated filter paper and observed for color changes.

2.4 Statistical Analysis

Data were analysed using one way analysis of variance (ANOVA) and t- test using statistical software openstat version 08.12.14. Probability level was set at $p<0.05$.

3. RESULTS AND DISCUSSION

The type of bacteria isolated from the food samples was presented in Table 2. The result shows that 4 bacterial genera were recovered from 200 samples of different fried food types examined; the isolates include; *Staphylococcus aureus, Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*.

The distribution of bacterial isolates according to food samples examined was presented in Table 3. The result indicated that 191 bacterial isolates were identified, the genus *Staphylococcus* has the highest isolates obtained from the total number of food samples with 89 (46.6%) among which fried Yam had the highest number of bacterial isolates 31 (34.9%), followed by fried *Akara* 28 (31.5%), fried rice *Masa* 17(19.1%) and fried potato was the least with growth of 13 (14.7%) isolates.

The distribution of bacterial isolates according to sampling sites is presented in Table 4. The result indicated that site B had the highest bacterial contamination with 50 isolates (26.2%), followed by site C, with 47 isolates (24.6%), which is also very close to site B. Site D had 35 isolates (18.3%) while Site E with 30 isolates (15.7%) and site A had a slightly low bacterial contamination of 29 isolates (15.2%).

The distribution of bacterial isolates according to the source of the food sample is presented in Table 5. The result showed that fried foods purchased from uncovered source are contaminated with total of 140 bacteria isolates which accounted for 76.5% while those purchased from covered source contain a total of 43 isolates (23.5%).

Table 2. Types of bacteria isolated from the food samples

Food sample	No. of bacteria isolated	Bacteria isolated
Fried yam	4	*S. aureus, E. coli, P. aeruginosa and Klebsiella*
Fried potato	2	*S. aureus and P. aeruginosa*
Akara	4	*S. aureus, E. coli, P. aeruginosa and Klebsiella*
Masa	3	*S. aureus, E. coli and P. aeruginosa*

Table 3. Distribution of bacterial isolates according to selected street vended fried food samples examined

Bacterial specie	Yam	Potato	*Akara*	*Masa*	Total
Staphylococcus aureus	31^{a}	13^{c}	28^{a}	17^{b}	89(46.6%)
Escherichia coli	18^{a}	0^{c}	16^{a}	11^{b}	45(23.6%)
Pseudomonas aeruginosa	11^{b}	6^{c}	15^{a}	6^{c}	38(19.9%)
Klebsiella pneumoniae	6^{b}	0^{c}	13^{a}	0^{c}	19(9.9%)
Total	66(34.6%)	19(9.9%)	72(37.7%)	34(17.8%)	191(95.5%)

Key: Values having different superscript along the same row are considered significantly different at p<0.05

Table 4. Distribution of Bacterial isolates according to sampling sites

Food items	Site A	Site B	Site C	Site D	Site E	Total
Yam	10^{b}	15^{a}	14^{a}	9^{b}	8^{b}	56(29.3%)
Potato	6^{b}	9^{a}	7^{b}	7^{b}	6^{b}	35(18.3%)
Akara	7^{b}	16^{a}	14^{a}	10^{b}	9^{b}	56(29.3%)
Masa	6^{c}	10^{a}	12^{a}	9^{b}	7^{b}	44(23.0%)
Total	**29(15.2%)**	**50(26.2%)**	**47(24.6%)**	**35(18.3%)**	**30(15.7%)**	**191(100%)**

Key: Values having different superscript along the same row are considered significantly different at p<0.05

Table 5. Distribution of bacterial isolates according to the source of street vended fried foods examined

Food type	Covered food	Uncovered foods	Total	t-value
Yam	15(27.2%)	40(72.7%)	55(28.8%)	5.2551*
Potato	8(19.0%)	34(81.0%)	42(22.0%)	
Akara	6(12.0%)	44(88.0%)	50(26.2%)	
Masa	15(34.1%)	29(65.9%)	44(23.0%)	
Total	44(23.0%)	147(77.0%)	191(100.0%)	

** The calculated t-value is 5.2551 and the critical value at n= 4 and df = 3 is 2.353 showed significant difference in the number of isolates obtained from covered and uncovered food at p<0.05*

The mean bacterial count per gram of food sample according to the sample was presented in Table 6. Fried yam had the highest mean bacterial count of 1.6 x 10^3cfu/g while fried potato has the least mean bacterial count of 1.0 x10^2cfu/g.

The results found that four different bacterial genera were isolated (*Staphylococcus aureus, Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*). The highest bacterial count occurred in fried yam with mean total bacterial load of 1.6 x 10^3cfu/g, followed by fried beans ball (*akara*) with the mean total bacterial count 1.5 x 10^3cfu/g while least mean total bacterial count was found in fried potato (1.0 x10^2cfu/g). This result conformed to the work of Ochei et al. [16], and also in agreement with research of Maduake et al. [17] who investigated the bacteriology of some selected ready to eat fried food and found that the food samples were contaminated by various bacterial agents such as *S. aureus, Klebsiella, E. coli* and *Bacillus*. The mean count shows bacterial contamination in the food samples which may probably be as a result of improper processing, handling/serving, or consumption and also sold at very dirty surroundings [5,6]. Low bacterial load in fried Potato may likely be as a result of low moisture content of potato among all the samples examined.

Out of the 200 samples analysed, 183 yielded bacterial growth while 17 had no significant growth. From 183 samples that yielded significant growth, some of them are in pure culture growth, while others yielded mixed culture growth. The bacterial species were; *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa and Klebsiella pneumoniae.* According to this study, *S. aureus* shows the high frequency of bacterial isolates from the 200 Samples of the 4 selected street vended fried food types examined. The presence of *Staphylococcus aureus* in the samples is about 20% to 40% in healthy individual's nose [15], and is an indicative of human contamination after the food production. This could be from direct human contact such as fingers or indirectly through additives or utensils; hence sale of food in the street is very controversial from a health standpoint. The main health hazard associated with street foods is microbial contamination [1]. The organism is associated with endotoxin characterised by short incubation period (1-8 hours), violent nausea, vomiting and diarrhea [18]. The subsequent bacterial prevalence were *Escherichia coli*, *Pseudomonas aeruginosa*, and followed by *Klebsiella pneumonia* such organisms may likely be from the feacal origin even though, members of *Enterobacteriaceae* encountered in the study, including *Escherichia coli* and *Klebsiella pneumonia* can be attributed to environmental contamination by unwholesome materials like feaces and they are known to be causative agents of food borne gastroenteritis and bacterial diarrhea disease. This finding supported the work of Bukar et al. [19] who reported that about 5 (10.0%) of 50 food handlers in three small-scale food industries in Kano metropolis investigated contained *E. coli* on their hands.

Table 6. Mean total aerobic bacterial count per gram of food sample according to food type

Food items	Mean bacterial count (cfu)	Log. number
Fried yam	1.6 x 10^3	3.2
Fried potato	1.0 x 10^2	2.0
Fried beans ball (Akara)	1.5 x 10^3	3.1
Fried rice *masa*	1.06 x 10^3	3.0

On the basis of sample sites, site B had the highest bacterial contamination with total of 50 isolates (26.2%), this may probably be because hospital is a place where people with different aliments which could be communicable or non communicable are attending regularly in which all the food types sampled yielded high bacterial growth. This was followed by site C, with 47 isolates (24.6%) and then Site D had 35 isolates (18.3%). Most of the vendors had either no formal education or few years of schooling and therefore, they are unaware of improper food handling and their role in the transmission of pathogens [7]. Site E (KUST Mini market) with 30 isolates (15.7%) and site A (opposite KUST, Wudil) had a slightly low bacterial contamination of 29 isolates (15.2%), such two vending sites had low bacterial contamination because they are patronised by almost same literates individual (students) and high number of covered food samples were obtained from the two vending sites. This study showed that food samples purchased from uncovered source are contaminated with total of 140 isolates accounted for 76.5% while those purchased from covered source contain a total of 43 isolates (23.5%). This implies that uncovered foods were more contaminated. It is possible that foods prepared in our locality could be contaminated especially when not covered with air borne microorganisms mostly at the point of selling. Some microorganisms on the surface of the skin, mouth, nose of the vendors can be introduced directly into the foods, or by coughing and sneezing [20,21].

4. CONCLUSION

Based on the finding of this study, it has been concluded that *Staphylococcus aureus* was found to be the most prevalent bacterial isolate obtained from the samples examined. The incidence of the isolates according to sampling sites showed that high isolates were recovered in site B and C where vendors lack formal education. Certainly, uncovered street fried food type has the highest bacterial contamination than the covered samples. It is recommended that food vendors should be enlighten on the issue of food contamination by food regulatory agencies since most of them are not aware of microbial invasion.

ACKNOWLEDGEMENT

The authors wish to acknowledge to the entire street vendors in the study area for sample provision, maximum cooperation and patience to the end this research. However, we also appreciate the effort of technical staff of Microbiology Department, Kano University of Science and Technology, Wudil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://prh.sdiarticle3.com/review-history/27405