



Review

Evaluation of Microbial Load in Fast Food Establishments in Kaduna Metropolis

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Abstract

Introduction: The increase in human populations bring about the proliferation of more food manufacturing and dispensing establishments among which are fast food establishments and food vendors or street hawkers in Nigeria. Fast food establishment's indiscriminate activities are often associated with frequent food poisoning in developing countries especially in Nigeria. This scenario could be due to the poor state of food safety and general hygiene in these countries. Consequently, large quantities of food produced and distributed get to the consumer in an unwholesome condition. This study evaluates the microbial load in some selected fast food establishments in Kaduna Metropolis, Kaduna state, Nigeria.

Materials and methods: A descriptive cross-sectional study using multistage sampling technique was adopted to select 174 fast food establishments. The premises were assessed on practice of personal hygiene and implementation of Hazard Analysis and Critical Control Point (HACCP) principles during their food preparations.

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Laboratory analyses were carried out on the samples for bacteriological analyses of 1g of food (Tuwon Shinkafa, Tuwon Masara, Stew, Rice, and Bread).

Results: Majority of the selected fast food establishments were observed to have Predominates bacterial isolates that includes *Pseudomonas* spp. (50%), *Salmonella* spp. (86.7%), *Shigella dysenteries* (68.7%), *Escherichia coli* (20.0%) and *Staphylococcus aureus* (97.3%) respectively. The total number of occurrence of bacteria in all the food sampled were 2,659 cfu/g with Bread having the highest number of 685 cfu/g followed by Tuwon Masara with 629 cfu/g. The study equally found out that *Staphylococcus aureus* is the appeared the highest in the samples with 700 cfu/g followed by *Salmonella* with 629 cfu/g.

Conclusion: The predominates occurrence of bacteria in the food samples is due to poor personal hygiene, environmental sanitation and general cleanliness of the eating utensils which was observed during the study. It is recommended that health education of the food handlers on personal hygiene and HACCP implementation be given more priority.

Keywords: Foodborne diseases; Food handlers; HACCP

Introduction

Food is among the basic substances in the world that support the life of organisms and when consumed it provides essential nutrients that stimulate growth, maintains life and gives protection against diseases. Thus, the food itself may be a source of danger to the organisms if its source, transportation, storage, preparation, cooking, and serving are not effectively carried out under hygienic conditions [1].

Diseases associated with food contamination have been widely documented with prevailing morbidity and mortality rates worldwide [2]. The contamination of food could be due to variety of microbial pathogens, chemicals, and parasites that may find their way into the food chain at different points during the food preparation and production process. These actions may lead to morbidity and disability or death among the consumers. WHO [3] estimation of diarrheal diseases worldwide revealed the proportion of deaths among people suffered with diarrheal disease due to food consumption resulted in 550 million illnesses and 230,000 deaths yearly.

It is difficult to estimate the global incidence of foodborne diseases, but it has been reported that in the year 2000 about 2.1 million people died from diarrheal diseases which many of the cases were attributed to contamination of food and drinking water as reported by Centre for Disease Control. The occurrences of diarrheal diseases continued to increase due to exposure to contaminated food and drink as estimated by the World Health Organization (2009) that up to 1.5 billion episodes of diarrhea and more than three million deaths occur in children every year as a result of food and water contamination. Records also indicated over 600 million cases each year or almost 1 in 10 people in the world fall ill after consuming contaminated food [1].

Sabir et al., [4] pointed out that despite the efforts made on food safety and the environment, 2.1 million adults and three (3 million) children, including two (2 million) in developing countries, die each year from water consumption or contaminated food. The incidence of foodborne illness in developed countries is estimated at 30% of the population been reported yearly [5]. Among the developed countries, i.e. USA 76 million cases were reported with 5000 death representing 1.7 per 100,000 cases. An incidence cases in France is also very staggering, having reported cases of 750,000 representing 1,210 per 100,000 inhabitants [5]. Situations in African countries in relation to foodborne diseases revealed by the World Health Organization (WHO) in 1983 highlighted that foodborne illness in some developing countries alone was responsible for 13.6 per 1000 deaths in children fewer than 5 years in Africa, Asia, excluding China and Latin America.

Furthermore, the contribution recorded by the fast food establishments to the burden of foodborne infection revealed by Foodborne Disease Active Surveillance Network (Food Net) in a collaborative project with CDC, and some selected US Food enforcement agencies, that a telephone survey conducted between 1998 to 1999 indicated a possible association between an increased frequency of dining in fast food establishments and increased frequency of gastroenteritis. A total of 11,849 persons who completed the questionnaire reported cases of diarrhea illness and approximately 8.6% reported eating at fast food establishments and additional 5.1% who ate five (5) times in the restaurant for a period of five (5) weeks. Another data released by American National Foodborne disease outbreak surveillance indicated a considerable number of cases associated with foodborne outbreak reported from fast food establishments i.e. from 1998 to 2004 an average of 1,290 foodborne disease outbreak were recorded each year and that 25,600 people were hospitalized each year. Onyeneho, et al., [6] also revealed lack of current knowledge of food safety among restaurant staff and highlighted increased risk associated with fast foods and restaurants. On another study by Hedberg et al., [7] established that lack of effective monitoring of employee illness or a lack of commitment to enforcing policies regarding sick food workers result in food contamination.

Fast foods are prepared to-eat-foods. Food and Agricultural Organization (FAO) referred fast foods as foods which, are prepared and served rapidly at fast food restaurants, shops, market, schools, occasions and other reasonable place [8].

Fast foods establishments are considered with high esteemed this days because it saves time for the customers who patronized them. The place for its preparations may come up with different menus that could be of interest to consumers. FAO, (2002) expressed that the preparation of fast food involved eating in or off the premises with the minimum period between the requesting, preparation and time of service.

There is the likelihood of not completely washing utensils and equipment utilized for food planning and administration. Some fast food is set up in grimy condition. FAO (1995) advised that the place or area of meal preparation and service should be far from sources of contamination, e.g. rubbish heap, waste, dirty water and animals however this is not the major practice.

Fowora [9] opined that the appraisal of knowledge level of food handlers about foodborne infection and their safety practices is an

imperative issue in administration and regulation of outbreak of foodborne infection in Nigeria. Essentially, Smith et al. [10] uncovered that in Nigeria 27.7% of food handlers don't wash their hands prior to food preparation and 28.1% utilize just water to wash their hands and 90% of food handlers have heard of typhoid fever but only 15.6% know how it was cause. The control of foodborne diseases can effectively be achieved through implementation of HACCP in all food preparatory places. HACCP principles gives a more specific and basic way to deal with the control of microbiological hazards in foods than that gave by customary inspection and quality control approaches [11].

Today, microbiological and chemical compounds, which can't be seen, are of more prominent intrigue [12] thus necessitating the need to have more improved way to anticipate and control foodborne diseases. Also, due to the unwholesome condition of food delivered to purchasers; these add to the emergence and re-emergence of foodborne ailment in created and creating nations [13]. A more encompassing way to deal with the anticipation and control of foodborne diseases through inspection of food foundation is the implementation of Hazard Analysis Critical Control Point (HACCP).

Due to the increase of foodborne infectious diseases, several food quality regulations have been imposed in various countries. According to Grace [14], there is the death of information regarding foodborne diseases in developing countries. A key way to deal with the anticipation and control of foodborne diseases through inspection of food premises is the implementation of Hazard Analysis Critical Control Point.

The main focus of HACCP is "prevention" [15], through identifying potential contaminants prior to its occurrences, and instituting of control measures to eliminate possible hazards in every step of the process [16]. Compared with traditional methods of inspection and quality control based on the analysis of finished products. The idea additionally demonstrated the significance of preparing of staff in places of the food industry, government and the scholarly community in HACCP standards, applications and expanding attention to consumers as basic components for viable usage of HACCP strategy [17]. These, if successfully done the fulfillment of a sufficient level of foodborne illness in term of its avoidance and control will be achieved [18].

Data released by American National Foodborne Disease Outbreak Surveillance indicated a considerable number of cases associated with foodborne outbreak reported from fast food/restaurants i.e. from 1998 to 2004 an average of 1,290 foodborne disease outbreak were recorded each year and that 25,600 people were hospitalized each year [19]. These indicated that fast food/restaurants contribute immensely to the burden of foodborne diseases in majority of developed and developing countries. These data suggest a critical need for action that is focused on preventing disease transmission within the fast food around the world most especially in developing countries like Nigeria. The study aimed to evaluate the microbial load in fast food establishments in Kaduna Metropolis.

Materials and Methods

Study area

Kaduna metropolis is located between Lat. 10023' and 10043' N and Long. 7017' and 7037'E. It is characterized by the tropical

continental climate according to Koppens classification (1928), with seasonal rainfall patterns, which are characteristically of high intensities. Mean annual rainfall totals is about 1,185 mm [20].

Study design

The study design used is descriptive cross-sectional studies to evaluate the microbial load in fast food establishments in Kaduna Metropolis for the purpose of mitigating associated adverse health effects caused as a result of eating contaminated food with pathogenic organisms.

Sampling size determination

The sample size for this study was determined using Fisher’s formula at 95% confidence Interval and 0.05 degree of accuracy/margin of error. For this study the minimum calculated sample size is 174. During the course of this study 24 of the food establishments in the study area didn’t participate due to the period of their operation which was mostly in the night. Therefore the sample size use is 150.

Sampling technique

A multistage sampling technique was adopted in selection of fast food establishments in this study.

Food samples collection

Food samples were collected into sterile containers aseptically from 150 food premises for microbiological examination. A total of 750 food samples were collected and these include 5 food samples per premises (Rice, Tuwon shinkafa, Tuwon Masara, Stew and bread).

Isolation and identification of bacteria isolates

Isolates suspected to be *Pseudomonas* spp., *Staphylococcus aureus*, *Shigella dysenterae*, *Salmonella* spp. and *Escherichia coli* were cultured from 750 food samples using selective agar plates of Mannitol Salt Agar (MSA), *Pseudomonas* Base Agar (PBA), Maccockey Agar (MA) and Eosin Methylene Blue (EMB) for 48 hrs and pure colonies were obtained and identified using standard biochemical test.

Results

Table 1 below presented the order of bacteria occurrences in all the food samples (Rice, Stew, Tuwon Masara, Tuwon Shinkafa and Bread). From the microbiological examination of the food samples,

the order of occurrence of bacteria varied in all the food samples. As for Bread the order was *Staphylococcus aureus* (148 cfu/g) > *Pseudomonas* (141 cfu/g) > *Salmonella* (139 cfu/g) > *E. Coli* (132 cfu/g) > *Shigella* (125 cfu/g), for Rice it was in the order of *Staphylococcus aureus* (146 cfu/g) > *Salmonella* (130 cfu/g) > *Shigella* (103 cfu/g) > *Pseudomonas* (75 cfu/g) > *E. Coli* (30 cfu/g), for stew the order was recorded to be *Staphylococcus aureus* (136 cfu/g) > *Salmonella* (128 cfu/g) > *Pseudomonas* (108 cfu/g) > *Shigella* (97 cfu/g) > *E. Coli* (32 cfu/g), that of Tuwon Masara was in the order of *Staphylococcus aureus* (140 cfu/g) > *Pseudomonas* (138 cfu/g) > *Salmonella* (119 cfu/g) > *Shigella* (97 cfu/g) > *E. Coli* (32 cfu/g) meanwhile for Tuwon Shinkafa the order was *Pseudomonas* (133 cfu/g) > *Staphylococcus aureus* (130 cfu/g) > *Salmonella* (113 cfu/g) > *Shigella* (80 cfu/g) > *E. Coli* (25cfu/g).

Table 1 indicated the frequency of occurrence and numbers of bacteria in the food samples. *Staphylococcus aureus* (*S. aureus*) occurred with highest number in Bread, Rice, Stew, Tuwon Masara and Tuwon Shinkafa the number of occurrence was estimated to be 148 cfu/g, 130 cfu/g, 146 cfu/g, 140 cfu/g and 136 cfu/g respectively.

Pseudomonas occurred with highest number in Bread (141 cfu/g), Tuwon Masara (138 cfu/g), Tuwon Shinkafa (133 cfu/g), Stew (108 cfu/g) and Rice (75 cfu/g). Similarly, *Salmonella* was also predominant in bread (139 cfu/g), rice (130 cfu/g), stew (128 cfu/g), Tuwon Masara (119 cfu/g) and Tuwon Shinkafa (113 cfu/g). Generally, *Shigella* occurred less in Tuwon Shinkafa (80 cfu/g) and the highest was found in bread (125 cfu/g). The results revealed that bread was more contaminated than other food samples.

The order of bacteria occurrences in all the food samples (Bread > Tuwon Masara > Rice > Stew > Tuwon Shinkafa) is presented in table 2. From the microbiological examination of the food samples, the order of occurrence of bacteria varied in all the food samples. As for Bread the order is *Staphylococcus aureus* > *Pseudomonas* > *Salmonella* > *Shigella* > *E.coli*. For Tuwon Masara the order is *Staphylococcus aureus* > *Pseudomonas* > *Salmonella* > *Shigella* > *E. coli*. Rice is in the order of *Staphylococcus aureus* > *Salmonella* > *Shigella dysenterae* > *Pseudomonas* > *E. coli*, for stew the order was recorded as follows *Staphylococcus aureus* > *Salmonella* > *Pseudomonas* > *Shigella* > *E. coli*, and for Tuwon Shinkafa the order is *Pseudomonas* > *Staphylococcus aureus* > *Salmonella* > *Shigella* > *E. coli*.

Bacteria isolates	Rice (n=150)	% occurrence in Rice	Tuwon Shinkafa (n=150)	% occurrence in Tuwon Shinkafa	Tuwon Masara (n=150)	% occurrence in Tuwon Masara	Stew (n=15)	% occurrence in Stew	Bread (n=150)	% Occurrence in Bread
<i>Staphylococcus aureus</i>	146 cfu/g	97.3	130 cfu/g	86.7	140 cfu/g	93.3	136 cfu/g	90.7	148 cfu/g	98.67
<i>Pseudomonas</i> spp.	75 cfu/g	50	133 cfu/g	88.7	138 cfu/g	92	108 cfu/g	72	141 cfu/g	94
<i>Shigella dysenterae</i>	103 cfu/g	68.7	80 cfu/g	53.3	97 cfu/g	64.7	96 cfu/g	64	125 cfu/g	83.33
<i>Salmonella</i> spp.	130 cfu/g	86.7	113 cfu/g	75.3	119 cfu/g	79.3	128 cfu/g	85.3	139 cfu/g	92.67
<i>Escherichia coli</i>	30 cfu/g	20	25 cfu/g	16.7	32 cfu/g	21.3	15 cfu/g	10	132 cfu/g	88

Table 1: Relative frequency and Percentage distribution of bacteria isolates in food samples.

Bacteria isolates	Rice (n=150)	Tuwon Shinkafa (n=150)	Stew (n=150)	Tuwon Masara (n=150)	Bread (n=150)	Total No. of Each Bacteria occurrence
<i>Staphylococcus aureus</i>	146 cfu/g	130 cfu/g	136 cfu/g	140 cfu/g	148 cfu/g	700 cfu/g
<i>Pseudomonas</i> spp.	75 cfu/g	133 cfu/g	108 cfu/g	138 cfu/g	141 cfu/g	595 cfu/g
<i>Shigella dysenteriae</i>	103 cfu/g	80 cfu/g	96 cfu/g	97 cfu/g	125 cfu/g	501 cfu/g
<i>Salmonella</i> spp.	130 cfu/g	113 cfu/g	128 cfu/g	119 cfu/g	139 cfu/g	629 cfu/g
<i>Escherichia coli</i>	30 cfu/g	25 cfu/g	15 cfu/g	32 cfu/g	132 cfu/g	234 cfu/g
Total No of Bacteria occurrence in each sample	484 cfu/g	481 cfu/g	483 cfu/g	629 cfu/g	685 cfu/g	2659 cfu/g

Table 2: Summary of bacteria occurrence in each isolates from 150 fast food establishments in Kaduna Metropolis.

The table also indicated the number of occurrence/appearance and total bacteria count in each sample food. The range of occurrence of *Staphylococcus aureus* from the sampled food, i.e. (rice > tuwon shinkafa > stew > tuwon masara > bread) is in the following order 130 cfu/g > 136 cfu/g > 140 cfu/g > 146 cfu/g > 148 cfu/g. The total *Staphylococcus aureus* count in all the aforementioned samples is 700.

Salmonella is the second bacteria that appeared with high numbers in the sampled food and range from 113 cfu/g to 139 cfu/g. The order of occurrence in the food is as follows (Tuwon Shinkafa > Tuwon Masara > stew > rice > bread) i.e. 113 cfu/g > 119 cfu/g > 128 cfu/g > 130 cfu/g > 139 cfu/g. The total count of *Salmonella* spp. in the entire food sample mentioned is 629 cfu/g.

The occurrence of *Pseudomonas* in all the food sample range from 75 cfu/g to 141 cfu/g and it is in the following order (Rice > Stew > Tuwon Shinkafa > Tuwon Masara > bread) i.e. 75 cfu/g > 108 cfu/g > 133 cfu/g > 138 cfu/g > 141 cfu/g. The sum total of *Pseudomonas* count in all the sampled food is 595 cfu/g.

Shigella dysenteriae is the fourth bacteria isolated in the sampled food (Tuwon Shinkafa > stew > Tuwon Masara > rice > bread). The range is from 80 cfu/g to 125 cfu/g in the following order 80 cfu/g > 96 cfu/g > 97 cfu/g > 103 cfu/g > 125 cfu/g. The sum total *Shigella dysenteriae* count in the entire food sample is 501 cfu/g.

The occurrence of *Escherichia coli* in all the food sample appeared in the following order (stew > Tuwon Shinkafa > Rice > Tuwon Masara > bread) i.e. 15 cfu/g > 25 cfu/g > 30cfu/g > 32 cfu/g > 132 cfu/g. The total count in the food, sampled is 234 cfu/g.

The result of occurrence of all the bacteria in all the food samples is in the order of Tuwon Shinkafa (481 cfu/g), Stew (483 cfu/g), Rice (484 cfu/g) Tuwon Masara (629 cfu/g) and Bread (685 cfu/g). The sum total of bacterial occurrence in all the food samples is 2,659 cfu/g. The highest occurrence of bacteria in the bread may not be unconnected with the process of its preparation. The observation made during visit of some of the bakeries indicated the method of handling the dough, while mixing, food handler or mixers handle it with bared hands and were in mufti.

Discussion

Foodborne diseases encompass a wide spectrum of illnesses and are a growing public health problem worldwide. They are the result of ingesting contaminated foodstuffs, and range from diseases caused by a multitude of microorganisms to those caused by chemical hazards. The most common clinical presentation of foodborne diseases

takes the form of gastro-intestinal symptoms, but such diseases can also lead to chronic, life-threatening symptoms including neurological, gynecological or immunological disorders as well as multi-organ failure, cancer and death.

In this study all the bacteria isolated have been implicated in foodborne illnesses. This study therefore corroborated with the study of Jacqueline et al., [21] which identified 19,531 confirmed cases of foodborne illnesses from biological sources that include *Shigella* spp., *Salmonella* and *E. coli* and some of the existing information on foodborne bacteria. Also, in line with this study is the findings of Ronald [22] and Sharmila [23] which pointed out that *Staphylococcus aureus*, and *Salmonella* are among those bacteria that cause disruption of normal cells activities resulting in serious ill health and are implicated as sources of street food contamination. The presence of these pathogens are due to poor sanitary conditions of catering establishment and personal hygiene of food handlers which also corroborated with Haileselassie et al., [24] that indicated the presences of *Staphylococcus aureus*, *Salmonella*, *E. coli* and *Campylobacter* as organisms that were always established due to poor sanitary condition of catering establishments. Although numerous control strategies are in place, person-to-person disease transmission has not ceased. This study also made it abundantly clear that food handlers play an important role in ensuring food safety throughout the chain of production, processing, storage, and preparation. Regrettably, this study confirmed the assertion that approximately 10 to 20% of foodborne disease outbreaks are due to contamination by the food handlers. The mishandling of food and the disregard of hygienic measures enable pathogens to come into contact with food and, in some cases, to survive and multiply in sufficient numbers to cause illness in consumers.

Similarly, the level of personal hygiene and environmental sanitation which is the key factors in food contamination and transmission of foodborne diseases in all the fast food establishments were observed to have been poor during course of this study. This follows the trend of investigations of outbreaks of foodborne disease throughout the world which show that, in nearly all instances those foodborne diseases are caused by the failure to observe satisfactory standards in the preparation, processing, cooking, storing or retailing of food. This is in line with WHO [1] and Akintaro [13] findings which indicated that the level of food contamination due to poor handling methods, inefficient processing equipment and storage practice, high ambient tropical temperature and humidity conditions to be the major sources of food contamination.

In most countries, the most common foodborne illness is *Staphylococcus* food intoxication. The study found abundant *Staphylococcus aureus* in all the isolates with bread having the highest number,

which corroborated with the study of Bennertt and Monday (2003) and Saadia Maria et al. [25], who revealed the common vehicle of transmission to include air, dust, sewage, and food preparatory equipment, human, animal and environmental surfaces. In another study revealed by Patience and Ridwan [26] that *Staphylococcus* spp., *Salmonella* spp., *Pseudomonas aeruginosa* and *E. coli* in fast food restaurants investigated in Lokoja, Kogi State, Nigeria. The findings of this study also corroborated with the investigation carried out in 15 restaurants by Saadia M. (2010) where a total of 10 species of 10 genera of bacteria i.e *E. coli*, *Pseudomonas aeruginosa*, *Salmonella* and *Staphylococcus aureus* were abundantly found in fast food restaurants in El-Qassium, Saudi Arabia.

The organisms isolated in this study are among the most commonly recognized foodborne infections except *Campylobacter* which was not encountered in this study but *Staphylococcus*, *Salmonella*, and *E. coli* were abundantly present and this is in consonance with the reports of CDC. *Staphylococcus* spp. has been reported to cause food poisoning due to the heat stable Staphylococcal enterotoxin which is resistant to gastrointestinal enzymes. *Salmonella* is also a bacterium that is widespread in the intestines of birds, reptiles and mammals. It can spread to humans via a variety of different foods of animal origin. The illness it causes, salmonellosis, typically includes fever, diarrhea and abdominal cramps. In persons with poor underlying health or weakened immune systems, it can invade the bloodstream and cause life-threatening infections. However, *E. coli* could also cause clinically important infections. The bacteria only become pathogenic when it reaches tissues outside of their normal intestine or less common normal flora sites. *Shigella* spp. causes bacillary dysentery. *Shigella* infections are almost always limited to the gastrointestinal tract and are highly communicable. *Shigella* produces a heat-labile exotoxin that affects both the GIT and the central nervous system.

Recommendation

It is mandatory that foods must be free from contaminations as much as possible. The presence of *E. coli*, *S. aureus* and *Shigella* demonstrates a potential health risk as these organisms are pathogenic and have been implicated in foodborne diseases [27]. Foodborne illness can be prevented by good hygiene practices such as the use of Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP) application in the chain of food production and processing.

Education of the food handlers/food vendors on food safety practices and a close and stringent supervision of food handlers should be carried out by relevant authorities to prevent food contamination that could result in foodborne illness by using the principles of HACCP at every stage of food production.

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