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Microbiological Assessment of Fast Foods Sold in Lokoja Metropolis, Nigeria

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Abstract

Four food samples namely fried chicken, fried rice, meat pie and cake from four different fast food restaurants in Lokoja were purchased and assessed microbiologically. Ten bacterial species were identified as *Streptococcus* sp., *Bacillus* sp., *Staphylococcus* sp., *Flavobacterium* sp., *Proteus* sp., *Escherichia coli*, *Klebsiella* sp., *Salmonella* sp. and *Pseudomonas aeruginosa*. Four fungal species namely *Penicillium* sp., *Rhizopus stolonifer*, *Mucor* sp. and *Aspergillus flavus* were isolated and identified in the samples. The bacterial count of food samples ranged from 7.0×10^3 to 2.23×10^5 cfu/g while coliform count ranged from 6.0×10^5 to 1.175×10^5 cfu/g and the total fungal count ranged from 1.4×10^3 to 5.75×10^4 cfu/g. These values are more than the required levels stipulated by regulatory bodies responsible for food safety for cooked foods. The organisms identified in the food samples are indicative of poor personal hygiene while handling or processing food, and thus food handlers should take necessary precautions so as to ensure that food safety of the populace is not compromised.

Keywords

Fast Foods, Lokoja, Microbiological, Assessment, Restaurants

Subject Areas: **Microbiology**

1. Introduction

Fast food also known as quick service restaurant is the term given to food that can be prepared and served very quickly. It can also be described as food sold in a restaurant with pre-cooked ingredients and sold to the customer in a packaged form as take-away. Food outlets may be stands, kiosks or restaurants which provide shelter or seating [1]. Fast foods include commercially provided snacks that are retailed as well as food items made by vendors on site or in nearby kitchens [2]. Fast foods can also be called ready to eat foods that are ready for immediate consumption at the point of sale. Ready to eat foods can be raw or cooked, hot or chilled and can be

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consumed without further heat treatment [3]. Examples of ready to eat foods include pastries, burger, moinmoin, salad or coleslaw, fried meat, fried chicken, milk and milk products [4]. The consumption of western style fast foods in developing countries is increasingly gaining popularity in Nigeria [5]. There is a ready demand for convenience food in Lokoja with a population of 195,261 [6] and a significant expansion of fast food restaurants in Lokoja; however, one of the frequent problems in the sale of fast foods is their actual and potential hazard caused by bacterial contamination [7], but there is limited information on the health challenges from food borne diseases of foods sold retailed within a densely populous community like Lokoja. It is therefore necessary to assess the microbiological safety of fast foods sold in Lokoja. The objective of this study is to assess the microbiological quality of fast foods sold in Lokoja town.

2. Materials and Methods

2.1. Sample Collection

Fried chicken, fried rice, meat pie, and cake samples were collected aseptically from four majorly visited restaurants in Lokoja Metropolis in Kogi State, Nigeria in between the months of January to May. The food samples were collected into sterile polythene bags and labeled appropriately at the point of collection. The samples were immediately transported to the laboratory for analysis.

2.2. Isolation and Enumeration of Microorganisms from Food Samples

Nutrient Agar (NA), MacConkey Agar (MA), Mannitol Salt Agar (MSA), Salmonella-Shigella Agar (SSA) and Potato Dextrose Agar (PDA) were used for isolation and were each prepared according to the manufacturer's instruction.

1 g of each food sample was weighed out and homogenized in 9 ml of sterile distilled water using a sterile stomacher. Ten fold dilutions of the homogenates were prepared using sterile pipettes as described by the method of [8]. 0.1 ml of aliquots of 10^{-3} and 10^{-4} dilutions of the homogenate were plated in replicate on MacConkey agar, Mannitol Salt agar, Nutrient agar, potato dextrose agar, Salmonella-Shigella agar using pour plate method. The plates were then incubated at 37˚C for 24 - 48 h to obtain viable bacterial count. MacConkey agar was used for coliform enumeration while Salmonella-Shigella agar was used for the isolation of *Salmonella* and *Shigella*. Total viable bacteria count was performed on Nutrient Agar. Total fungal count was performed on Potato dextrose agar (PDA) and was incubated at 25˚C for 3 - 5 days (PDA containing 0.1% streptomycin). The developed colonies were counted at the expiration of incubation period using the colony counter (Gallenkamp, England). The counts were expressed as colony forming unit per ml of sample homogenate (cfu/ml). Distinct colonies were isolated to obtain pure cultures that were subjected to routine primary and biochemical tests.

2.3. Identification of Fungal and Bacterial Cultures

Pure cultures of bacterial and fungal isolates were prepared by repeated streaking of distinct colonies on solidified nutrient agar and Potato dextrose agar (PDA) slants respectively in McCartney bottles and incubated at 37˚C for 24 h for bacteria and 25˚C for 3 - 5 days for fungi. The pure bacterial cultures were characterized using biochemical tests such as Gram staining, spore staining, capsule staining, catalase test, gelatin hydrolysis, starch hydrolysis and sugar fermentation tests. The fungal isolates were identified based on their colonial morphology and cellular morphology (wet mount). The method of [9] was employed for identification using colonial characteristics. The parameters used in describing the colonial morphology were colour and texture of hyphae.

The wet mount stain technique was used for determining cellular morphology. A drop of cotton blue-in-lactophenol was placed on a clean slide. An inoculating needle was used to remove a small piece of mycelium and was transferred to the stain, the mycelium was teased out using a needle. A cover slip was used to cover the stain. The slide was examined under the ×40 objectives lens. Vegetative characteristics used were nature of hyphae *i.e.* septate or non-septate, shape of hyphae.

3. Discussion

Pathogenic bacteria are the most common known causes of food contamination and food borne illnesses. **Table 1** indicates the presence of the following pathogenic bacteria *Bacillus*, *Staphylococcus*, *Klebsiella*, *Salmonella*,

Table 1. Morphological and biochemical characteristics of bacterial isolates from food samples.

Isolates	Colonial morphology	Arrangement	Gram reaction	Spore Stain	Capsule stain	Catalase test	Coagulase test	Starch hydrolysis Gelatin hhydrolysis	Glucose	Fructose	Sucrose	maltose	Organism identified
MPO1	Irregular, flat, lobate, opaque, viscid, smooth, yellow.	Cocci (scattered)	+	––	–	+	–	– +	AA	--	--	AA	*Staphylococcus* sp.
MPO2	Circular, raised, entire, opaque, butyrous, smooth, cream.	Cocci (scattered)	+	–	–	+	–	+ +	AA	AA	--	AA	*Staphylococcus epidermidis*
MPO4	Circular, raised, entire, opaque butyrous, smooth, cream.	Rod (single)	++	++	––	++	––	– –	AG	--	AG	AG	*Bacillus cereus*
CO1	Circular, raised, entire, opaque butyrous, smooth, cream.	Rod (single)	–	–	–	+	–	+ –	--	AA	--	AG	*Pseudomonas aeruginosa*
RO1	Circular, convex, entire, opaque, butyrous, smooth, cream.	Rod (single)	+	+	–	+	–	– +	AG	--	AG	AG	*Bacillus* sp.
RO2	Irregular, flat, undulate, opaque, butyrous, smooth, cream.	Rod (single)	+	+	–	+	–	– –	AG	--	AG	AG	*Bacillus cereus*
CK02	Circular, flat, entire, translucent butyrous, smooth, cream.	Rod (scattered)	–	–	+	+	+	– –	AG	AA	AA	AG	*Flavobacterium* sp.
CTI	Circular, flat, entire, opaque, butyrous, smooth, yellow	Cocci (scattered)	+	–	–	+	–	+ +	AA	--	--	--	*Staphylococcus* sp.
CT2	Circular, flat, entire, opaque, butyrous smooth, cream.	Cocci (clustered)	+	–	–	+	–	+	– AG	--	AA	AA	*Staphylococcus* sp.
MPT1	Irregular, raised, lobate, opaque, butyrous, rough, cream.	Rod	–	–	–	+	–	+ +	AG	--	AG	A-	*Klebsiella* sp.
MP2	Irregular, flat, lobate, opaque, viscid rough, yellow.	Rod (chains)	+	–	–	+	–	+	+ A-	--	A-	A-	*Corynebacterium* sp.
RT1	Irregular, flat, dentate, opaque, butyrous, rough, cream.	Rod (singles)	–	–	–	+	–	– +	--	--	--	A-	*Proteus* sp.
CKB1	Circular, flat, entire, opaque, butyrous, smooth, cream.	Rod (singles)	+	+	–	+	–	+ +	A-	--	AG	AG	*Bacillus* sp.
CKB2	Circular, raised, entire, translucent butyrous, smooth, yellow.	Cocci (cluster)	+	–	–	+	+	+ +	AG	AG	AG	AG	*Staphylococcus aureus*
CKB3	Irregular, flat, lobate, translucent, viscid, rough, cream.	Rod (singles)	–	–	–	+	–	– +	A-	--	A-	A-	*Pseudomonas* sp.
CKB4	Circular, flat, entire, opaque, butyrous, smooth, cream.	Rod (singles)	–	–	–	+	–	+ –	AG	--	AG	A-	*Klebsiella* sp.
CB1	Irregular, flat, dentate, opaque, viscid, rough, cream.	Rod (chains)	+	+	–	+	–	+ –	A-	--	AG	A-	*Bacillus* sp.
MPB1	Irregular, flat, dentate, opaque, butyrous, smooth, cream.	Cocci (sensing)	+	–	–	–	+	– +	A-	--	--	A-	*Streptococcus* sp.
MPB2	Irregular, flat, dentate, opaque, viscid, smooth, cream.	Cocci (cluster)	+	–	–	+	–	– +	AG	-G	-G	AG	*Staphylococcus* sp.
RB1	Irregular, flat, dentate, opaque, viscid, smooth, cream.	Rod (scattered)	+	+	–	+	–	+ –	AG	--	AG	AG	*Bacillus cereus*
CS1	Irregular, flat, lobate, opaque, viscid, smooth, yellow.	Rod (singles)	–	–	+	+	+	+ –	AG	AG	AG	AG	*Escherichia coli*
CS2	Circular, flat, entire, translucent butyrous, smooth, cream	Cocci (scattered)	+	–	–	+	+	– +	AG	AG	AG	AG	*Staphylococcus aureus*
CS3	Circular, flat, entire, opaque, butyrous, smooth, cream.	Cocci (cluster)	+	–	–	–	+	+ +	AG	AG	AG	AG	*Streptococcus* sp.
RS1	Irregular, flat, rhizoid, translucent butyrous, smooth, cream.	Rod (chains)	+	+	–	+	–	– +	AG	A-	AG	AG	*Bacillus* sp.
RS2	Irregular, raised, lobate, opaque, viscid, wrinkle, cream.	Rod (singles)	–	–	+	+	–	+ +	AG	AG	AG	AG	*Klebsiella* sp.
MPS1	Circular, raised, entire, opaque, butyrous, smooth, cream.	Cocci (cluster)	+	–	–	+	–	+ +	AG	--	AG	A-	*Staphylococcus* sp.
CKS1	Irregular, raised, lobate, opaque, butyrous, rough, cream.	Rod (singles)	–	–	–	–	–	– +	AG	AG	AG	AG	*Salmonella* sp.

Pseudomonas, *Flavobacterium*, *Corynebacterium*, *Escherichia coli* and *Proteus* and this correlates with the work of [10] [11] who reported the incidence of these organisms in ready to eat foods and food sold in food canteens respectively. The occurrence of these organisms in the food could be attributed to poor personal hygiene by the food handlers, unclean food utensils and cleanliness of the environment of the fast food outlet.

The presence of *Aspergillus*, *Penicillium* and *Mucor* could be attributed to the surrounding air and packaging materials as shown in **Table 2**. *Aspergillus* sp. is very common fungal agents of food borne illness [12] [13]. They can also get into the food samples during the milling process in which a food ingredient that pours on the floor is packed and reintroduced into the food and also from the environment, and this conforms to work by [10]. The presence of *Rhizopus*, *Penicillium* and *Mucor* can affect the good health of the consumers.

Table 3 shows the total bacterial count of food samples varied between 7.0×10^3 and 2.23×10^5 cfu/g. Restaurant O and T had the highest bacterial counts which are the most patronized restaurants in the town.

Table 4 shows that meat and fried rice had the highest coliform count which may have arisen from faecally contaminated water used in food preparation. Coliform in food causes major food borne diseases.

The total fungal count ranged from 1.4×10^3 to 5.75×10^4 cfu/g (**Table 5**) with the highest occurrence in meat pie and chicken. The presence of fungi in these food samples may be from the surrounding air and materials used in packaging of food [14].

Table 6 shows that *Shigella* sp. was not indicated at all in all the food samples analysed from all the restau-

Table 2. Microscopic characteristics of identified fungal isolates from food samples.

Microscopic Characteristics	Probable Fungi
Single celled conidia, presence of a specialized conidiophores called phialide (flask shaped), conidia is globose and smooth.	*Penicillium* sp.
Conidial heads are radiate, globose conidia and conidiophores are hyaline and rough.	*Aspergillus flavus*
Erect sporangiophores, with large multispored sporangia with well developed columella, sporangiospores are hyaline and smooth walled.	*Mucor* sp.
Presence of stolon, pigmented rhizoids, sporangiospores that are ovoid in shape.	*Rhizopus stolonifer*

Table 3. Total mean bacteria count of food samples (cfu/g).

Collection Point	Food Samples	Mean total bacteria count (cfu/g)
Restaurant O	Chicken	8.5×10^3
	Fried Rice	1.15×10^4
	Meat Pie	1.75×10^4
	Cake	2.085×10^5
Restaurant B	Chicken	7.0×10^3
	Fried Rice	9.65×10^4
	Meat Pie	1.25×10^4
	Cake	1.65×10^4
Restaurant T	Chicken	2.33×10^5
	Fried Rice	8.7×10^4
	Meat Pie	1.3×10^4
	Cake	NG
Restaurant S	Chicken	6.75×10^4
	Fried Rice	4.55×10^4
	Meat Pie	1.9×10^4
	Cake	1.3×10^4

NG = No Growth.

Table 4. Total mean coliform count of food samples (cfu/g).

	Chicken	Fried Rice	Meat Pie	Cake
Restaurant O	1.15×10^4	NG	NG	6.5×10^3
Restaurant B	5.0×10^3	NG	8.0×10^3	1.85×10^4
Restaurant T	NG	8.35×10^4	1.175×10^5	NG
Restaurant S	3.0×10^4	NG	7.5×10^3	6.0×10^3

NG = No Growth.

Table 5. Total fungal count of food samples (cfu/g).

	Chicken	Fried Rice	Meat pie	Cake
Restaurant O	2.25×10^4	1.4×10^3	NG	7.5×10^3
Restaurant B	5.5×10^3	6.5×10^3	5.75×10^4	1.35×10^4
Restaurant T	6.0×10^3	6.5×10^3	1.35×10^4	1.85×10^4
Restaurant S	6.5×10^3	7.5×10^3	6.0×10^3	NG

NG = No Growth.

Table 6. Total mean colony count of pathogenic organisms in food samples (cfu/g).

Collection Point	Food Samples	*Staphylococcus* sp.	*Salmonella* sp.	*Shigella* sp.
Restaurant O	Chicken	NG	NG	NG
	Fried Rice	NG	NG	NG
	Meat Pie	NG	NG	NG
	Cake	NG	NG	NG
Restaurant B	Chicken	2.5×10^3	NG	NG
	Fried Rice	1.5×10^3	NG	NG
	Meat Pie	6.0×10^3	NG	NG
	Cake	NG	1.5×10^4	NG
Restaurant T	Chicken	NG	NG	NG
	Fried Rice	NG	NG	NG
	Meat Pie	2.15×10^4	2.15×10^4	NG
	Cake	NG	NG	NG
Restaurant S	Chicken	NG	NG	NG
	Fried Rice	1.0×10^4	1.0×10^4	NG
	Meat Pie	2.0×10^3	2.0×10^3	NG
	Cake	6.5×10^3	6.5×10^3	NG

.NG = No Growth.

rants; however there were indications of *Staphylococcus* sp. and *Salmonella* sp. in chicken, fried rice and meat pie samples in the restaurants and this may be attributed to poor personal hygiene from the food handlers and contaminated water [15].

The presence of *E. coli*, *Klebsiella* sp. is of concern and further supports the possibility of faecal contamina-

tion of products due to poor sanitation [16] [17]. Cross contamination of food during preparation has been identified as an important factor associated with food borne illness [18] [19]. Epidemiological evidences have implicated food as a vector of pathogenic organisms [20]. When these organisms are ingested, this will cause greater harm to human health. Biological contaminants of bacterial origin are a major cause of food borne disease giving rise to acute chronic illnesses such as *E. coli* gastroenteritis. The prevalence of mesophilic bacilli shows that rice grains and ingredients such as rice and wheat flour used in preparation of these fast foods generally contain spores of *Bacillus* [21]. This organism produces heat-sensitive (diarrheal) and heat-stable (emetic) toxins associated with food poisoning [22]. *Klebsiella* sp. causes gastrointestinal infection.

Staphylococcus aureus could have been introduced through unclean hands and mouth of the vendor and customers. *S. aureus* is an opportunistic pathogen and enterotoxigenic strains are known to cause food intoxication and poisoning [23].

Fast foods are consumed by majority of the populace in cities and towns because of the busy lifestyle, and thus it is mandatory that these foods are free of microbial contamination as much as possible. Food borne illnesses can be prevented by good hygiene practices during the preparation of food. The occurrence of food borne illnesses can be prevented by ensuring that foods sold are safe and hygienic; public awareness programs are encouraged in order to enlighten food processors, food vendors and personnel involved in food preparation. There is also a need for this group of individuals to be educated on the requirement of water meaning for food processing and consumption [24]. Proper sanitation of all equipment and utensils, care for the environment and the packaging materials so as to prevent the spread of contaminants will help in safety of food.

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