



## Microbiological Safety Assessment of Selected Smoked Fish in Lagos Metropolis

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### Authors' contributions

This work was carried out in collaboration between both authors. Author ONO designed the study, wrote the protocol and the first draft of the manuscript. Author TAA performed the statistical analysis, and managed literature searches. Both authors read and approved the final manuscript.

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### ABSTRACT

This research assessed the microbiological quality of smoked fish consumed around the Lagos metropolis to ascertain the safety for consumption. Four samples of selected smoked fish obtained from five market locations in Lagos, Nigeria were analyzed to determine their bacteria loads. The selected smoked fish samples examined were Herring- *Clupea harengus* ("Sawa"), Horse Mackerel - *Trachurus trachurus* ("Kote"), Great Barracuda - *Sphyraena barracuda* ("Panla") and Atlantic Mackerel- *Scomber scombrus* ("Titus"). The examined fish samples that were obtained were contaminated with some bacteria species. The average total aerobic bacterial counts from all the samples ranged from  $4.2 \times 10^6$  cfu/g to  $7.5 \times 10^6$  cfu/g. *Scomber scombrus* (Titus), *Clupea harengus* (Sawa) had higher average total aerobic bacteria counts of  $7.5 \times 10^6$  cfu/g and  $6.0 \times 10^6$  cfu/g respectively. The average coliform counts obtained from the smoked fish were,  $2.2 \times 10^6$  cfu/g, *Trachurus trachurus* (Kote);  $4.8 \times 10^6$  cfu/g, *Clupea harengus*;  $5.1 \times 10^6$  cfu/g, *Scomber scombrus* and  $3.7 \times 10^6$  cfu/g for *Sphyraena barracuda*. Adequate cooking is recommended for consumers of smoked fish to prevent food borne illnesses.

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## 1. INTRODUCTION

Fish smoking is one of the traditional processing methods aimed at preventing or reducing post harvest losses. [1] reported that heat application remove water and inhibit bacterial and enzymatic actions of fish. Fish is a highly perishable product due to its high susceptibility to autolysis, oxidation and hydrolysis of fats and microbial spoilage [2]. The post harvest methods of preserving fish include refrigeration (4°C) and freezing which is effective when such fish is conditioned to a temperature of -10°C. Other methods frequently employed include sun drying and smoke drying all associated with increased germicidal action with increasing temperature [2].

Fish is one of the most important animal proteins available in the tropics, and it represents about 14% of all animal proteins in a global basis [3,4]. In Nigeria, the demand for fish consumption is increasing due primarily to health benefits of eating fish and secondarily to increase in human population and the rinderpest disaster and drought bane which reduce the availability and affordability of red meat (cattle, sheep and goat) [5]. Fish is an extremely perishable food immediately after catch and therefore requires immediate and proper handling and good preservation to retain its quality [6].

The food eaten has a direct influence on health, it is therefore an important task that food inspectors, food manufacturers and food handlers keep food safe from pathogenic microorganisms, especially when such foods are to be consumed without further processing, i.e. fast foods or “ready to eat” foods. Several types of microorganisms have been known to affect the quality of food, thereby constituting health hazards when food contaminated with these organisms are consumed. A number of food items sold locally have been shown to be highly contaminated with *Bacillus* species, *Staphylococcus* species, and other bacteria species [7].

Microorganisms have the potential of causing poisoning and food-borne illnesses in man. Some food poisoning is caused by the physical presence of larger numbers of bacteria in the ingested food. In addition to bacteria infection, viral infection can also lead to gastroenteritis characterized by nausea, vomiting, diarrhea; abdominal pain, paralysis, malaise, and low

grade fever. *Listeria monocytogenes*, a pathogen from infected animals, gives rise to septicaemic aborting in neonatal and immune-suppressed patients.

Recent reports indicated that there is a rise in fish intake due to decrease in meat consumption caused by prevalent high price of meat and it has been estimated that demand for the fish has risen by 25% in Nigeria in recent time. In actual fact, all our foods harbor a natural population of microorganisms and during processing these may have opportunity to grow and to be augmented by contamination from atmosphere or utensils or workers garment. Most food-poisoning agents cause symptoms only when eaten in large quantities after multiplication in foods. Diseases caused by contaminated foods constitute one of the most widespread health problems and thus an important cause of reduced economic productivity.

Fish and fish products apart from satisfying the appetite and taste are essentially cheaper than other sources of animal protein. They are also excellent sources of adequate amounts of dietary essentials including proteins, lipids, minerals, and vitamins [8]. They have rich source of essential nutrients required for supplementing both infant and adult diets [9]. Fish protein is an excellent source of amino acids especially, the three that are lacking in protein of plant origin namely lysine, methionine and tryptophan. Fish contain mineral elements such as: zinc, phosphorus, iron and calcium when the bones are eaten. Fish is also a good source of riboflavin, vitamin A & D. The presence of these nutrients also aids the proliferation of microbes. This research aimed at assessing the safety of smoked fish in the Lagos metropolis.

## 2. MATERIALS AND METHODS

### 2.1 Samples Collection

A total of 16 samples of four types of selected smoked fish such as Herring *Clupea harengus* (Sawa). Horse mackerel-*Trachurus trachurus* (Kote). Atlantic mackerel- *Scomber scombrus* (Titus), and *Sphyraena barracuda* (Panla) were purchased randomly from Oyingbo, Ketu, Mushin, Mile – 12 and Oshodi markets in Lagos State, (Representing densely populated area of States). Each sample was transported to the laboratory in a sterile polythene bags for analysis.

## 2.2 Preparation of Media

The media used are Nutrient agar (N.A.), Shigella Agar (SSA), Eosin Methylene Blue Agar (EMB Agar). All media used were prepared according to the manufacturers' instructions. The mean counts of bacteria in colony forming units per gram of samples were determined.

## 2.3 Preparation of Cultures

The samples were serially diluted after maceration under aseptic conditions. The appropriate dilutions were inoculated on the different agar media. All cultures were incubated in duplicate at 37°C for 24 – 48 hours. The bacteria were inoculated on Nutrient Agar for 24-48 hours, *Salmonella* - *Shigella* Agar (SSA) for 24 hours, and coliform on Eosin Methylene Blue (EMB) agar for 24 hours. Colonies on plates containing 30 - 306 colonies were counted and multiplied by the dilution factor.

## 2.4 Identification of Isolates

The isolates were identified using a number of characteristics. Their cultural and morphological characteristics were of vital importance in this process and were thus observed. Motility tests as well as biochemical test were also carried out.

## 3. RESULTS AND DISCUSSION

Bacteria load of selected smoked fish obtained in Lagos Environment

The predominant bacteria isolated from all samples in five locations were *Klebsiella* sp, *Serratia* sp, *Bacillus* sp, *Enterobacter aerogenes*, *Citrobacter freundii*, *Escherichia coli*, *Alcaligenes eutrophs*, *Salmonella* sp, *Micrococcus* sp, *Flavobacterium* sp, *Corynebacterium* sp.

## 4. DISCUSSION

From the results obtained from this study, smoked fish samples were highly contaminated with microorganisms. The arithmetic mean of the total aerobic bacteria, Coliform and Salmonella counts (cfu/g) of all samples analysed ranges from  $4.2 \times 10^6$  cfu/g to  $9.14 \times 10^6$  cfu/g,  $2.2 \times 10^6$  cfu/g to  $5.1 \times 10^6$  cfu/g and  $2.7 \times 10^5$  cfu/g to  $3.6 \times 10^4$  cfu/g as shown in Tables 2, 3 respectively. The colony counts obtained are more than the maximum count of  $1 \times 10$  cfu/g of fish for good bacteriological quality. The moisture content levels in the fish samples were high, which encourages the growth of microorganisms. The presence of coliform in relatively high level may

be as a result of the failure of food handlers to observed basic sanitary rules. "kote", *Scomber scombrus* "Titus", *Clupea harengus* "Sawa" and *Sphyraena barracuda* "Panla" from different location as shown in table 2 had high bacteria counts which ranged from  $4.2 \times 10^6$  cfu/g to  $9.14 \times 10^6$  cfu/g, this may be due to the relatively high moisture content of these intermediate moisture foods. Coliform organisms are indicator organism that is indicative of the possibility of fecal contamination. The coliform present are higher than 1000 cfu/g recommended limit of bacteria contaminant [10]. The result presented in Table 1 and 3 heralded the fact that these foods could be sources of diarrhea's and gastrointestinal disturbances to both adults and children.

Most of these foods are kept at ambient temperature at a length of time sufficient to encourage the proliferation of pathogenic bacteria species which may lead to food intoxication. *Salmonella* sp. was analyzed from the fish sample as shown in Table 3 at range of  $3.6 \times 10^4$  to  $3.0 \times 10^5$ . The highest frequency of occurrence of isolates from the fish samples was obtained from *Scomber scombrus* while *Trachurus trachurus* had the lowest frequency compared to others from other locations, the fish samples from Mushin is more polluted compared to others. Moreover, most of the organisms isolated in this study might have been introduced into these foods from water used for washing, utensil and wrapping materials, the exposures of the products to high temperature storage and unhygienic condition of handling, reheating of kept food and the open market which are heavily polluted by various microorganisms. Mushin, Ketu and Oyingbo have the highest microbial load, which may be due to the environmental condition and also due to the fact that the place is highly congested with traffic, which may create dust from which the fish may be contaminated. According to [11] Smoked fish and shell fish products can be sources of microbial hazards including *Listeria monocytogenes*, *Salmonella spp*, and *Clostridium botulinum*. [12,13] also reported that smoked fish samples from four local markets in Minna and Kainji Lake area of Nigeria were dominated by gram – positive bacteria, potential pathogens, coagulase – positive *Staphylococcus* and *Escherichia coli*. [14,15,16] stated that bacteria such as *Staphylococcus aureus*, *Proteus*, *Bacillus*, *Micrococcus*, were the most common microorganism associated with smoked fish. These findings suggest that most of our ready to eat fish in Lagos market may constitute sources

**Table 1. Total aerobic bacteria count of selected smoked fish sample**

Total aerobic bacteria count in (n.a) cfu/g				
Location	<i>Clupea harengus</i>	<i>Scomber scombrus</i>	<i>Sphyraena barracuda</i>	<i>Trachurus trachurus</i>
Ketu	6.3 x 10 <sup>6</sup>	7.3 x 10 <sup>6</sup>	4.4 x 10 <sup>6</sup>	4.2 x 10 <sup>6</sup>
Oyingbo	7.4 x 10 <sup>6</sup>	8.4 x 10 <sup>6</sup>	5.6 x 10 <sup>6</sup>	Nil
Oshodi	5.3 x 10 <sup>6</sup>	5.6 x 10 <sup>6</sup>	3.9 x 10 <sup>6</sup>	Nil
Mushin	4.9 x 10 <sup>6</sup>	9.3 x 10 <sup>6</sup>	6.0 x 10 <sup>6</sup>	Nil
Mile 12	6.1 x 110 <sup>6</sup>	6.8 x 10 <sup>6</sup>	5.8 x 10 <sup>6</sup>	Nil
Average	6.0 x 10 <sup>6</sup>	7.5 x 10 <sup>6</sup>	9.14 x 10 <sup>6</sup>	4.2 x 10 <sup>6</sup>

**Table 2. Coliform count of selected smoked fish in Lagos**

Coliform count In (EMB AGAR) cfu/g				
Location	<i>Clupea harengus</i>	<i>Scomber scombrus</i>	<i>Sphyraena barracuda</i>	<i>Trachurus trachurus</i>
Ketu	4.1 x 10 <sup>6</sup>	5.6 x 10 <sup>6</sup>	2.7 x 10 <sup>6</sup>	2.2 x 10 <sup>6</sup>
Oyingbo	3.8 x 10 <sup>6</sup>	6.4 x 10 <sup>6</sup>	5.6 x 110 <sup>6</sup>	Nil
Oshodi	4.9 x 10 <sup>6</sup>	3.2 x 10 <sup>6</sup>	2.5 x 10 <sup>6</sup>	Nil
Mushin	5.2 x 10 <sup>6</sup>	6.0 x 10 <sup>6</sup>	5.1 x 10 <sup>6</sup>	Nil
Mile 12	5.9 x 10 <sup>6</sup>	4.3 x 10 <sup>6</sup>	4.3 x 10 <sup>6</sup>	Nil
Average	4.8 x 10 <sup>6</sup>	5.1 x 10 <sup>6</sup>	3.7 x 10 <sup>6</sup>	2.2 x 10 <sup>6</sup>

**Table 3. Salmonella count of selected smoked fish samples**

Salmonella count In (S.S. Agar) cfu/g				
Location	<i>Clupea harengus</i>	<i>Scomber scombrus</i>	<i>Sphyraena barracuda</i>	<i>Trachurus trachurus</i>
Ketu	1.0 x 10 <sup>3</sup>	2.0 x 10 <sup>3</sup>	3.0 x 10 <sup>5</sup>	2.7 x 10 <sup>5</sup>
Oyingbo	4.6 x 10 <sup>5</sup>	1.0 x 10 <sup>3</sup>	3.9 x 10 <sup>5</sup>	Nil
Oshodi	3.9 x 10 <sup>5</sup>	1.0 x 10 <sup>3</sup>	3.8 x 10 <sup>5</sup>	Nil
Mushin	3.2 x 10 <sup>5</sup>	6.0 x 10 <sup>5</sup>	2.7 x 10 <sup>4</sup>	Nil
Mile 12	3.5 x 110 <sup>5</sup>	1.7 x 10 <sup>5</sup>	2.9 x 10 <sup>5</sup>	Nil
Average	3.0 x 10 <sup>5</sup>	3.6 x 10 <sup>4</sup>	2.8 x 10 <sup>5</sup>	2.7 x 10 <sup>5</sup>

of bacteria food poisoning due to high coliform count which may cause diarrhea, consequently public health hazards. Spreading of *Salmonella*, *Escherichia coli* and others can cause gastroenteritis, characterized by vomiting, abdominal pain, paralysis and low grade fever. The need for improvement and maintenance of good hygienic practices by food processors, consumers or handlers should be emphasized, especially when organism such as *Bacillus*, *Escherichia coli* *Salmonella* Sp, and so on occur in high number which are known to be associated with food poisoning or infections.

## 5. CONCLUSION

This work demonstrates that all the smoked fish samples from the five locations have higher bacteria count than the international microbiological standard recommended limits of bacteria contaminants for foods therefore, they are microbiological unacceptable. In conclusion, there is need to introduce routine sanitary

measures to control of contamination of food products with these microorganisms. High level of *Bacillus* Sp, Coliforms and other pathogenic bacteria in food should not be dismissed as mere contamination, since they are capable of causing serious infections and food poisoning.

## 6. RECOMMENDATIONS

Greater attention should therefore be paid to the microbiological standard of the activities of roadside market all the time. There must be good hygienic condition for food presented or market on the road side (smoked fish) such as using clean glass boxes, clean food wrappers to prevent excessive environmental contamination for smoked fish. The food handlers must observe basic sanitary rule on the smoked fish (food) as their direct consumption may pose a lot of health hazard to the life of man. Further research should be carried out using different species of fish since they have different proximate composition and obtained the samples every

month on each location to improve their sanitary condition. Standard organization should set standard/surveillance on the smoked fish. If these measures are put in place, they will go along way to significantly reduce toxin and contaminants foods, thereby reducing the health hazards to man. This is one of the challenges of our time and I am sure we are up to the task.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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