MICROBOLOGICAL QUALITY OF TRADITIONAL SMOKED TILAPIA FISH IN ILORIN

BY

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CERTIFICATION

This is to certify that this project work was carried out and reported by Ogunleye Hannah Tunmise with Matric Number HND/23/SLT/FT/0905 to the Department of Science Laboratory Technology, Microbiology Unit, Institute of Applied Science (IAS) Kwara State Polytechnic, Ilorin and it has been approved in partial fulfillments of the requirement of the award of Higher National Diploma (HND) in Science Laboratory Technology, Kwara State Polytechnic, Ilorin

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DEDICATION

I dedicate this project to Almighty God for making it possible and throughout my academic sessions. May it lead me through the right part (Amin)

Also dedicated to my beloved parents Mr. and Mrs. Ogunleye Emmanuel, A for their financial support and prayers that have been my strength. I will forever grateful to you God

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ABSTRACT

This study investigates the microbiological quality of traditionally smoked Tilapia fish sold in Ilorin markets, with the aim of assessing the safety and potential health risks associated with its consumption. Samples of smoked Tilapia were collected and analyzed for microbial contamination, including total plate count and total coliform count, using standard microbiological techniques. The results revealed bacterial loads ranging from 3.1 10 to 5.6 10 cfu/g for total plate counts and 1.0 10 to 2.8 10 cfu/g for total coliform counts, indicating moderate microbial presence despite the smoking process. Biochemical tests identified the presence of both Gram-positive and Gram-negative bacteria, including *Salmonella* spp., *Escherichia coli*, Staphylococcus spp., and Bacillus cereus organisms known to pose significant health risks. The findings suggest that traditional smoking alone may not be sufficient to eliminate microbial contaminants, highlighting the need for improved processing, handling, and storage practices. Educating fish processors and vendors on hygienic methods is recommended to enhance the microbiological safety of smoked Tilapia in Ilorin and reduce the risk of foodborne illnesses.

CHAPTER ONE

1.0INTRODUCTION

Traditional smoked Tilapia fish (Oreochromis niloticus) is a widely consumed delicacy in Ilorin, Nigeria, valued for its flavor, affordability, and preservation method. Smoking is a traditional fish preservation technique that reduces moisture content and inhibits microbial growth. However, despite its popularity and apparent safety, the microbiological quality of traditionally smoked Tilapia may vary significantly depending on handling, processing. and storage practices. Assessing the microbiological quality is therefore vital to ensure the health of consumers and the safety of the food supply chain in Ilorin (Ajimati, 2023).

Microbial contamination in smoked fish can occur at different stages from catching the fish to processing, smoking, packaging, and even marketing. Factors such as water quality, hygiene of the processors, type of smoking equipment used, and the sanitary condition of the environment all play crucial roles. In many parts of Ilorin, smoking of Tilapia is still done under open, uncontrolled conditions, which increases the risk of contamination with

Pathogenic microorganisms such as Salmonella, Escherichia coli, Staphylococcus aureus, molds, and yeasts (Iyapo et al., 2025).

The quality of water used to wash the fish before smoking can introduce harmful bacteria. If the water source is polluted or contaminated with fecal matter, it becomes a primary vector for microbial transmission. Furthermore, the surfaces on which fish are prepared and the tools used may harbor bacteria if not properly sanitized. Smoking in open environments also exposes the fish to airborne microorganisms, dust, and insects, all of which may carry microbes that compromise the quality of the final product (Omoyajowo et al., 2022).

Another important consideration is the internal temperature reached during smoking. If the smoking temperature is not high enough to destroy potential pathogens or if the duration of smoking is insufficient, microbial organisms may survive and multiply during storage. Inconsistent smoking conditions are common in traditional methods, which makes it difficult to guarantee uniform safety levels across different batches of smoked Tilapia (Tawfeuk et al., 2024).

Storage conditions after smoking also significantly affect microbiological quality. In Ilorin markets, smoked Tilapia is often stored without refrigeration and displayed openly on trays or wooden racks, sometimes without any form of protective covering. This makes the fish vulnerable to post-smoking contamination from environmental sources and human handling, especially in high-temperature and high-humidity conditions common in Nigeria (Omoyajowo et al., 2022).

Microbiological analyses of traditionally smoked Tilapia from Ilorin have shown the presence of various bacteria and fungi, some of which are indicators of poor hygiene or spoilage. Total viable counts (TVC), total coliform counts, and the presence of specific pathogens like Staphylococcus aureus or Listeria monocytogenes are commonly used to assess microbial quality. High microbial loads often suggest that the fish is unsafe for consumption and poses a public health risk (Tawfeuk et al., 2024).

The consumption of microbiologically unsafe smoked Tilapia can lead to foodborne illnesses such as gastroenteritis, diarrhea, typhoid fever, and even severe infections in vulnerable individuals. Children, pregnant women, and

the elderly are particularly at risk. Therefore, ensuring the microbiological safety of smoked Tilapia is not only a matter of food quality but also of public health importance (Omoyajowo et al., 2022).

Improving the microbiological quality of traditional smoked Tilapia in Ilorin requires targeted interventions, including training for fish processors on proper hygiene practices, use of clean water, and maintenance of clean smoking environments. The introduction of improved smoking kilns with controlled temperature settings could also enhance product safety. Furthermore, regulatory bodies need to enforce food safety standards and carry out regular inspections in markets where smoked fish is sold.

Public awareness campaigns can also play a role in improving microbiological quality. Educating consumers to recognize signs of spoilage and insist on hygienically prepared smoked fish can create demand for safer products. Similarly, building capacity among local vendors and fish processors through community health programs could help reduce contamination and ensure better handling of fish products (Tawfeuk et al., 2024).

The microbiological quality of traditional smoked Tilapia in Ilorin is influenced by several interconnected factors including water quality, hygiene practices, smoking techniques, and storage conditions. While traditional smoking remains an important and culturally relevant preservation method, steps must be taken to modernize and regulate its practices to safeguard public health. Continuous monitoring and improvement of processing conditions, along with education and policy support, will be essential in ensuring that smoked Tilapia remains a safe and nutritious food option for the people of Ilorin (Alli, 2023).

1.1 Literature Review

The microbiological quality of traditional smoked Tilapia is a critical concern due to its impact on food safety and public health. According to recent studies, traditional smoking methods often fail to sufficiently reduce microbial contamination, leading to potential health risks (Okafor et al., 2023). High levels of bacteria, including pathogenic species, have been reported in smoked fish products, highlighting the need for effective control measures during processing and storage (Adesokan et al., 2021). Factors such as smoking

duration, temperature fluctuations, and post-smoking handling practices significantly influence microbial load and composition in smoked Tilapia (Ibrahim et al., 2022).

Microbial contamination in smoked fish can originate from raw materials, processing environments, and handling practices. For instance, inadequate washing of Tilapia before smoking can introduce spoilage and pathogenic bacteria, impacting the product's microbiological quality (Oyeleke et al., 2020). Moreover, the presence of opportunistic pathogens like Staphylococcus aureus and Escherichia coli in smoked fish poses serious health risks if consumed without proper cooking (Adeyemi et al., 2023). Effective control measures, including proper sanitation practices and adherence to smoking guidelines, are essential to mitigate these risks and ensure food safety (Oladunmoye et al., 2022).

Recent advancements in microbiological analysis have facilitated more precise assessments of microbial contaminants in smoked Tilapia. Molecular techniques such as PCR (Polymerase Chain Reaction) and next-generation sequencing have enabled researchers to identify specific microbial species and

their genetic characteristics in smoked fish products (Olowe et al., 2021).

These methods provide insights into microbial diversity and dynamics during smoking and storage, contributing to improved food safety practices and regulatory standards (Oyewale et al., 2024).

The geographical location of Ilorin, known for its traditional fish smoking practices, influences the microbiological quality of smoked Tilapia. Environmental factors, including ambient temperature and humidity, can affect microbial growth during smoking and subsequent storage (Adeyemo et al., 2023). Studies have shown variations in microbial profiles between different smoking sites within Ilorin, emphasizing the need for site-specific interventions to enhance food safety outcomes. (Olaniyan et al., 2023). Integrating local knowledge with scientific insights is crucial for developing context-specific strategies to minimize microbial contamination in smoked Tilapia.

Consumer awareness and education play a pivotal role in ensuring the microbiological safety of smoked Tilapia in Ilorin. Understanding the risks associated with consuming improperly processed fish encourages consumers

to adopt safer food handling practices (Adegbola et al., 2022). Public health campaigns and outreach programs aimed at promoting hygiene and proper cooking practices can further reduce the incidence of foodborne illnesses linked to smoked fish consumption (Ogunbanwo et al., 2023). Collaborative efforts between stakeholders, including fish processors, regulatory authorities, and health professionals, are essential for sustaining improvements in the microbiological quality of traditional smoked Tilapia in Ilorin.

1.2 Statement of problem

- Lack of Standardized Smoking Procedures
- Limited Awareness of Food Safety Among Vendors
- Poor Storage Conditions Post-Smoking
- Absence of Regular Microbiological Surveillance
- Health Risks Associated with Consuming Contaminated Smoked Fish

1.3 Aim

To determine the microbial load of traditionally smoked Tilapia sold in Ilorin

CHAPTER TWO

2.0 MATERIALS AND METHODS

2.1 Materials

The materials used for this study included sterile glassware (test tubes, Petri dishes, conical flasks, and pipettes), inoculating loops, spreaders, sterile distilled water, aluminum foil, cotton wool, 70% ethanol, Bunsen burner, incubator, weighing balance, and media such as Sabouraud Dextrose Agar (SDA) for fungal isolation and Nutrient Agar (NA) for bacterial isolation.

2.2 Sample Collection

The samples of smoked Tilapia Fish fish were purchased from local (Ibadan, Ilorin and Osun) markets and transported to the microbiology laboratory of Kwara State Polytechnic, Ilorin. Two different types of traditional smoked fish were analyzed:

- Sample A: Dried Tilapia Fish from Ibadan
- Sample B: Dried Tilapia Fish from Ilorin
- Sample C: Dried Tilapia Fish from Osun

2.2.1 Extraction

The fish samples (A, B and C) were blended into a fine powder using a sterile blender. The extracted samples were mixed with sterile distilled water to obtain homogenized suspensions for microbial analysis.

2.3 Sterilization of Glassware and Other Materials

All glassware used in this study were thoroughly washed, wrapped with aluminum foil, and sterilized in a hot air oven at 150°C for 20 minutes. The workbench was disinfected using cotton wool soaked in 70% ethanol. All media were sterilized inside an autoclave at 121°C for 15 minutes before use.

Inoculation, serial dilution, and sub-culturing were conducted near a Bunsen burner to maintain aseptic conditions.

2.4 Media Preparation

2.4.1 Nutrient Agar (NA)

Nutrient Agar (NA) for Bacteria A total of 14 grams of Nutrient Agar (NA) powder was weighed and dissolved in 500 mL of sterile distilled water inside a 1000 mL conical flask. The mouth of the flask was plugged with cotton wool.

and covered with aluminum foil. The mixture was boiled for 5 minutes for homogenization and then sterilized in an autoclave at 121°C for 15 minutes.

2.4.2 Sabouraud Dextrose Agar (SDA)

Sabouraud Dextrose Agar (SDA) for Fungi A total of 32.5 grams of Sabouraud Dextrose Agar (SDA) powder was dissolved in 500 mL of sterile distilled water inside a 1000 ml. conical flask. The flask was sealed with cotton wool and aluminum foil, boiled for 5 minutes, and sterilized in an autoclave at 121°C for 15 minutes.

2.5 Culturing Techniques

2.5.1 Serial Dilution Method

Serial Dilution Method (10 to 10) A total of 2 mL of sterile distilled water was injected into each sample (A, B and C). Using a sterile syringe, 1 mL of the homogenized sample was transferred into a test tube containing 9 mL of sterile distilled water. This was mixed thoroughly and serially diluted in a set of seven test tubes, labeled 10 to 10. Using a new sterile syringe, 0.1 mL of the dilution (10 and 105) was plated on Nutrient Agar (NA) for bacterial isolation and on SDA for fungal isolation using the spread plate method. The

plates for bacteria were incubated at 37°C for 24 hours, while fungal plates were incubated at 25 deg * C for 3-5 days.

2.5.2 Total Viable Colony Plate Count

Total Viable Colony Plate Count From dilution tubes 10 ^ - 2 and 10, 1 mL of each sample was dispensed at the center of sterile Petri dishes. Melted Nutrient Agar (NA) was aseptically poured into bacterial plates, and Sabouraud Dextrose Agar (SDA) was poured into fungal plates. The plates were gently swirled to mix and then incubated at their respective temperatures. The number of colony-forming units (CFU / m * L) was recorded after the incubation period.

2.6 Characterization and Identification of Isolates

2.6.1 Bacterial Isolate

Bacterial Isolate Bacteria were characterized based on colony morphology, cellular morphology, and biochemical tests. Morphological characteristics such as shape, color, edge, optical properties, elevation, surface texture, and pigmentation were recorded.

2.6.1.1 Gram Staining

Gram Staining To differentiate Gram-positive and Gram-negative bacteria, Gram staining was conducted on sample A, sample B and sample C. A sterile grease-free slide was used to make bacterial smears, air-dried, and heat-fixed.

The smears were subjected to the following staining sequence:

- Crystal violet for 60 seconds (primary stain)
- Lugol's iodine for 60 seconds (mordant)
- 70% alcohol for 30 seconds (decolorizer)
- Safranin for 60 seconds (counterstain) The slides were rinsed, blotted dry, and observed under a microscope using an oil immersion lens (x100 magnification).

2.6.2 Fungal Isolate

Fungal Isolate Fungi were identified based on colony morphology, pigmentation, and microscopic features. Distinct characteristics such as texture, color, growth pattern, and hyphal structure were recorded.

2.6.2.1 Fungi Staining

A Lactophenol Cotton Blue (LPCB) mount was prepared to examine fungal structures on sample A, Sample B and Sample C. A drop of LPCB stain was placed on a clean slide, and a portion of the fungal colony was transferred using a sterile needle. The specimen was covered with a coverslip, gently pressed to remove air bubbles, and observed under the microscope at x40 magnification for morphological identification.

2.7 Catalyst Test

The catalase test was performed to differentiate bacterial species based on their ability to produce the enzyme catalase. A small amount of bacterial isolate (A106, B106 and C10) was placed on a clean slide, and a drop of 3% hydrogen peroxide was added. The presence of bubbling indicated a positive catalase reaction, while no bubbling indicated a negative reaction.

CHAPTER THREE

3.0 RESULTS

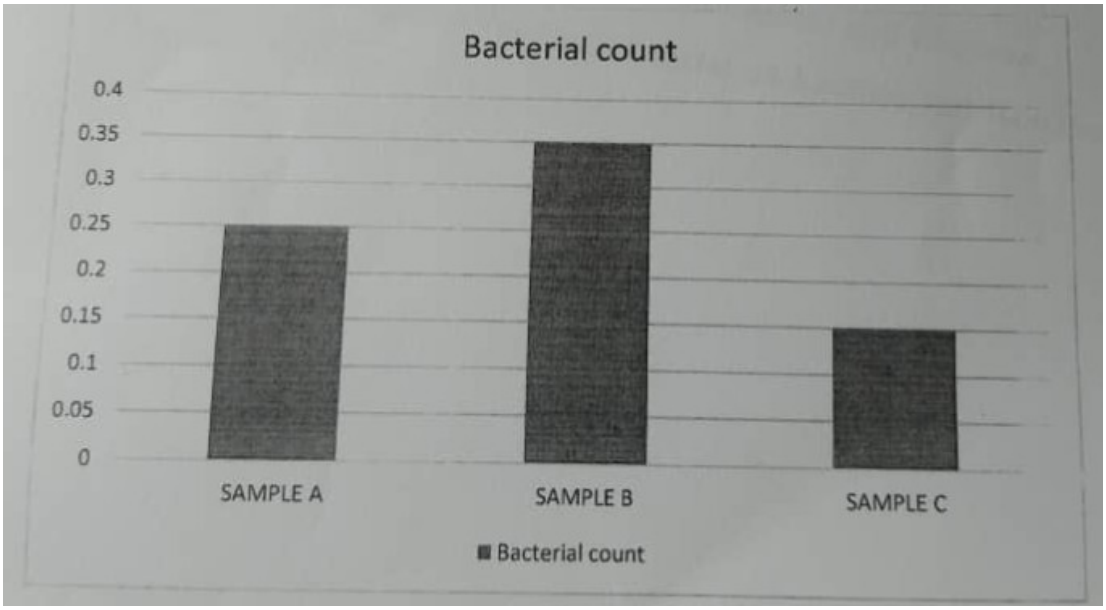
3.1 Microbial Load on Traditionally Smoked Tilapia Fish

Table 1: Microbial Load on Traditionally Smoked Tilapia Fish

Sample	Total Plate Count ($x10^3$ cfu/g)	Total Coliform Count (cfu/g)
A	4.2	1.5×10^2
B	5.6	2.8×10^2
C	3.1	1.0×10^2

3.2 Microbial Cout on Smoked Tilapia ($x10^3$ cfu/g)

Figure 1 Microbial Count on Smoked Tilapia ($x10^3$ cfu/g)



3.3 Biochemical Characteristics of Isolates

Table 2 Biochemical Characteristics of Isolates

Isolate	**Gram Staining**	**Cell Morphology**	**Catalase**	**Oxidate**	**Citrate**
Salmonella spp.	Negative (-)	Rod-shaped	+	+	-
Escherichia coli	Negative (-)	Rod-shaped	+	+	-
Staphylococcus spp.	Positive (+)	Cocci-shaped	+	+	-
Bacillus cereus	Positive (+)	Rod-shaped	+	+	-

3.4 Fermentation profile of Isolates on lactose and Glucose

Table 3: Fermentation Profile of Isolates on Lactose and Glucose

Lactose	**Glucose**
-	+
-	+
-	+
-	+

CHAPTER FOUR

4.0 DISCUSSION AND CONCLUSION

4.1 DISCUSSION

Smoking is a widely used traditional method for preserving Tilapia fish, involving heat application to reduce moisture and inhibit microbial growth (Kumolu-Johnson et al., 2010). According to Tzourous and Arvanitoyannis (2000), microbial stability in smoked fish is influenced by salt concentration from brining, heat intensity during smoking, antimicrobial compounds from smoke, and moisture reduction.

The microbial load data (Table 1) show that Sample B had the highest total plate count (5.6 x 10 cfu/g) and total coliform count (2.8 × 102 cfu/g), followed by samples A and C. These values indicate that traditional smoking reduces but does not eliminate microbial contamination. This aligns with studies showing that inadequate smoking and post-processing handling can allow survival or contamination by pathogenic bacteria (Lobelo et al., 2021; Ayeloja et al., 2020).

Consumption of smoked Tilapia contaminated with bacteria such as Salmonella spp., Escherichia coli, Staphylococcus spp., and Bacillus cereus (all isolated in this study) can cause foodborne illnesses presenting symptoms like diarrhea, nausea, and abdominal pain (Olawole et al., 2022).

Figure 1 illustrates that microbial loads vary between samples, reflecting differences in smoking methods, storage, and handling. The presence of both Gram-positive and Gram-negative bacteria confirms potential health risks, consistent with findings from similar studies on smoked fish (Ayeloja et al., 2020).

Moreover, smoking kilns and overcrowding during smoking can cause uneven heat distribution, promoting fungal growth and microbial contamination. Improper storage and unhygienic market conditions, such as open display near waste sites, further facilitate contamination and possible toxin formation (Ayeloja et al., 2022).

4.2 CONCLUSION

The study concludes that traditionally smoked Tilapia fish sold in Ilorin markets contain microbial contaminants, some of which are pathogenic. The microbial loads are within ranges reported by other studies but remain a public health concern. To improve safety, it is recommended that fish processors and sellers adopt improved smoking, handling, and storage practices, alongside training on hygiene standards.

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