PROCESSING AND PRESERVATION OF FISH IN REFERENCE OF SALTING SMOKING AND SUN DRYING

BY

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CERTIFICATION

This is to certify that this research project work has been read and approved having satisfied the requirement for the award of National Diploma (ND) in Hospitality Management Technology Department, Institute of Applied Science (IAS), Kwara State Polytechnic Ilorin.

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DEDICATION

This research work is specifically dedicated to Almighty God. And also to my parents; **MR & MRS AZEEZ**.

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I uphold God Almighty the high honour for His mercy, blessing and protection over me and my family and friends who has always been my ever divine source of inspiration (you are worthy to be glorify).

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TABLE OF CONTENTS

Title pages		i
Certification		ii
Dedication		iii
Acknowledgements		iv
Table of contents		v
Abstract		vii

CHAPTER ONE

1.0	Introduction	1
1.1	Background of the study	1
1.2	Statement of the problem	4
1.3	Objectives of the study	5
1.4	Research questions	5
1.5	Significance of the study	5
1.6	Scope of the study	6
1.7	Limitation of the study	6
1.8	Definition of terms	6

CHAPTER TWO: LITERATURE REVIEW

2.1	Fish	7
2.1.1	Taxonomy	8
2.1.2	Freshness of fish	9
2.2	Causes of spoilage of fishes	9
2.2.1	Process of spoilage	10
2.2.2	Types of fish spoilage	11
2.2.2.1	Enzymatic spoilage	11
2.2.2.2	Microbial spoilage	12
2.2.2.3	Chemical spoilage	13

CHAPTER THREE: RESEARCH METHODOLOGY

3.1	Introduction	23
3.2	Research design	23
3.3	Study area	23
3.4	Population of the study	24
3.5	Sample and sampling techniques	24
3.6	Research instrument and instrumentation	25
3.7	Validity of instrument	25
3.8	Reliability of instrument	25
3.9	Method of data collection	26
3.10	Method of data analysis	26

CHAPTER FOUR: FINDINGS/DISCUSS

4.1	Introduction	31
4.2	Analysis of demographic data of respondents	31
4.3	Sensory evaluation	33
4.4	Handling live fish	35
4.5	Some process fish products	38

CHAPTER FIVE: SUMMARY, CONCLUSION, RECOMMENDATIONS

5.1	Summary	40
5.2	Conclusion	40
5.3	Recommendations	41
	References	42
	Section A	44-47

ABSTRACT

Fish is one of the protein foods that needs careful handling. This is because fish spoils easily after capture due to the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish. Immediately after a fish dies, the autolysis will take place and later digestive juices will invade the flesh and start putrefaction. Then fat is attacked by oxygen and gives rancidity, especially in smoked and dried fish, Sweety flavour in fish, due to inorganic acid, when broken down during autolysis, produce bitter flavour and hypoxanthine formation. Later micro-organisms in the gut and at the surface of skin will multiply rapidly and will pick up more during handling, transportation and processing, accelerating the chemical changes in texture, taste, appearances and qualities. Fish must be preserved by storing it in time of abundance for use in time of shortage. Therefore all methods or any technical method may be resorted to keep the products; (a) free of pathogenic and spoilage micro-organisms and their toxins, (b) free of chemical compounds causing problems, (c) nutritional quality is retained and (d) extending the shelf-life of fish and fishery products by icing and chilling, drying, smoking, salting, boiling and steaming, freezing, using chemical reagent and additives, packaging and radiation. Processing is a function besides, handling, transport and storage involved in the products flow from the production sectors to the consumption sectors. Fish products, as commodities can be divided into primary or basic fish products (in the round form or dressed with minimum processing), low-cost minimum storage products and convenience products.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Fish is one of the protein foods that needs careful handling (Eyo, 2012). This is because fish spoils easily after capture due to the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish. Due to poor handling, about 30 – 50% of fish harvested are wasted in Nigeria. These losses could be minimized by the application of proper handling, processing and preservation techniques (Bate,and Bendall,2010).

The purpose of processing and preserving fish is to get fish to an ultimate consumer in good, usable condition. The steps necessary to accomplish this begin before the fishing expedition starts, and do not end until the fish in eaten or processed into oil, meal, or a feed (Karube et al., 2001). Fish begins to spoil as soon as it is caught, perhaps even before it is taken out of the water. Therefore, the key to delivering a high quality product is close attention to small details throughout the entire process of preparation, catching, landing, handling, storage, and transport. Fish that becomes spoiled or putrid is obviously unusable (Gopakumar, 2000). Fish that is poorly cared for may not be so obviously bad, but it loses value because of off-flavors, mushy texture, or bad color that discourage (Burt, 2003), a potential purchaser from buying. If customers have bought one bad fish, they probably won't buy another. On the other hand, if you consistently deliver good quality at a fair price, people will become loyal customers (Nelson et al., 2004).

Spoilage proceeds as a series of complex enzymatic bacterial and chemical changes that begin when the fish is netted or hooked (Burt, 2003). This process begins as soon as the fish dies. The rate of spoilage is accelerated in warm

climates. The fish's gut is a rich source of enzymes that allow the living fish to digest its food (Lima et al., 2011). Once the fish is dead, these enzymes begin digesting the stomach itself. Eventually the enzymes migrate into the fish flesh and digest it too. This is why the fish becomes soft and the smell of the fish becomes more noticeable.

There are countless bacteria naturally present on the skin of the fish, in the gills, and in the intestines (Karubeet al., 2001). Normally, these bacteria are not harmful to a living fish. Shortly after death, however, they begin to multiply, and after two to four days they ingest the flesh of even a well-iced fish as enzymatic digestion begins to soften it. The bacterial load carried by a fish depends on its health, its environment, and on the way it was caught. Healthy fish, from clean water, will keep better than fish dragged along the bottom of a dirty pond in a trawl net. Both enzymatic digestion and bacterial decomposition involve chemical changes that cause the familiar odors of spoilage (Putro, 2005). Oxygen also reacts chemically with oil to cause rancid odors and taste. The aim of fish processing and preservation is to slow down or prevent this enzymatic, bacterial, and chemical deterioration, and to maintain the fish flesh in a condition as near as possible to that of fresh fish (Bate and Bendall, 2010).

Fresh fish rapidly deterioratesunless some way can be found to preserve it. Drying is of food preservation that works by removing, water from the food, which inhabits the growth of microorganism. Open air drying using sun has been practiced since ancient times to preserve food. Water is usually remove by evaporation (air drying,sun drying ,smoking) but in the case of freeze-drying ,food is first frozen and then the water is removed by sublimation bacteria, yeasts and molds need the water in the food to grow and drying effectively prevent them from surviving in the food.

Fish are preserved through such traditional method as drying smoking and salting. The oldest traditional way of preserving fish was to let the sun dries it (Wikipedia,2016) drying food is the world oldest known preservation method and dried fish has to increase the storage life of fish for years . the method is cheap and effective in suitable climate,

the work can be done by the fisherman and family and the resulting product is easily transported to market (Wkipedia,2016).

Any kind of fish can be smooked or dried .there are three main method of smoking , smoking and roasting ,Hot smoking and long smoking.

Smoking and roasting is a simple method of preservation for consumption either directly after curing or within twelve hours . Re-smoking and roasting can keep the product in good condition for a further twelve hours fresh unsalted fishis put over a wood or coconut hust fire (Adedeji, 2004,Adetunji, 2012)

The hot smoking system can be used for immediate consumption or to keep the fish for a maximum of 48 hours. Small fish can be salted first for half an hour (see wet salting). After salting they are put on iron spits and dried in a windy place or in the sun for another half hour. It is necessary to have an oil drum to make the smoking stove. (Adedeji, 2004,Adetunji, 2012)

Long Smoking: If fish must be kept in good condition for a long time, for instance, two or three months or even longer, it can be done by smoking, provided the fish is not oily. For this purpose, a small closed shed made of palm leaves or other local material can be used.Adedeji, 2004,Adetunji, 2012)

1.2 STATEMENT OF THE PROBLEM

This study is to considering the method of preserving fish(smoking oven dying, NG sundrying method)

1.3 OBJECTIVES OF THE STUDY

The following are the objectives of this study.

1. To provide an overview of the three methods of fish drying
2. To determinethe nutritional value of fish fish drying to human
3. To determine the effect of fish drying.

1.4 RESEARCH QUESTIONS

1. What are the processes of fish drying ?
2. What are the benefits of fish drying ?
3. What is the effect of fish drying and it nutritional values to human?

1.5 SIGNIFICANCE OF THE STUDY

The following are the significance of this study.

1. Outcome of this study will educate on the process and the benefit of fish drying in Nigeria. This study will also reveal the effect of fish drying on the nutritional values of fish.
2. This research will be a contribution to the body of literature in the area of the effect of personality trait on student's academic performance, thereby research in the subject area.

1.6 SCOPE OF THE STUDY

This scope will cover the process and the benefit of fish drying in Nigeria. It will also cover the nutritional value of the dried fish.

1.7 LIMITATION OF STUDY

FINANCIAL CONSTRAINT: Insufficient funds tend to impede the efficiency of the researcher in sourcing for the relevant materials literature or information and in the process of data collection (internet questionnaire and interview) (Eyo, 2012).

TIME CONSTRAINT: The researcher will simultaneously engage in the study with other academic worth. This consequently will cut down on the time devoted from the research work.

1.8 DEFINITIONS OF TERMS

Preservation Of Fish:- Is the method of increasing the shelf life of fish and other fish products by applying the principles of different branches of science in order to keep the fish, after it has landed, in a condition wholesome and fit for human consumption.

Fish:This is an aquatic, craniate, gill-bearing animals that lack limbs with digits.

Salting: Salting is a traditional method of fish processing in many countries of the world. It can be used in combination with drying or smoking.

Smoking: Fish that has been cured by smoking. Foods have been smoked by humans throughout history. Originally this was done as a preservative.

Sun Drying: This process is carried out by exposing target fish directly under the sun.

CHAPTER TWO

LITERATURE REVIEW

2.1 FISH

A fish is any member of a group of animals that consists of all gillbearing aquatic craniate animals that lack limbs with digits (Flajnik, and Kasahara, 2009). Included in this definition are the living hagfish, lampreys, and cartilaginous and bony fish as well as various extinct related groups. Tetra-pods emerged within lobe-finned fishes, so sadistically they arefish as well. However, traditionally fish are rendered obsolete or paraphyletic byexcluding the tetrapods (i.e., the amphibians, reptiles, birds and mammals which alldescended from within the same ancestry). Because in thismanner the term "fish" is defined negatively as a paraphyletic group, it is not considered a formal taxonomic grouping in systematic biology. The traditional term piscses (also ichthyes) is considered a typological, but nota phylogenetic classification (Nelson, and Joseph, 2006).

The earliest organisms that can be classified as fish were soft-bodied chordates that first appeared during the Cambrian period. Although they lacked a true spine, theypossessed notochords which allowed them to be more agile than their invertebratecounterparts. Fish would continue to evolve through the Paleozoic era, diversifyinginto a wide variety of forms (Johnson, 2005). Many fish of the Paleozoicdeveloped external armor that protected them from predators. The first fish with jaws appeared in the Silurian period, after which many (such as sharks) became formidable marine predators rather than just the prey of arthropods (Nelson, 2006).

Most fish are ectothermic ("cold-blooded"), allowing their body temperatures to vary as ambient temperatures change, though some of the large active swimmerslike white shark and tuna can hold a higher core temperature (Goldman, 2011). Fishare abundant in most bodies of water. They can be found in nearly all aquatic environments,

fish exhibit greaterspecies diversity than any other group of vertebrates (Lecointre, 2007).

2.1.1 FRESHNESS OF FISH

The concept of "freshness" in fish is a paramount quality attribute that dictates its market value, consumer acceptance, and safety. It refers to the state of the fish immediately after capture, characterized by specific sensory attributes that indicate its prime condition. Freshness is predominantly a subjective quality, traditionally assessed in the trade through organoleptic evaluation relying on human senses of appearance, odour, and texture of the raw fish (Karube et al., 2001). This sensory assessment provides an immediate and practical means of determining the quality state of fish at various points in the supply chain. The most critical indicators to consider when evaluating the freshness of fish are multifaceted and include a combination of visual, olfactory, and tactile cues. These include the general appearance of the fish, specifically the clarity and shape of its eyes, the colour and condition of its gills, the presence and nature of surface slime, and the integrity of its scales. Furthermore, the firmness or softness of the flesh is a key tactile indicator. The odour emanating from the gills and belly cavity provides crucial information, as specific volatile compounds are associated with different stages of freshness or spoilage. The appearance of the fish's underside, particularly the presence or absence of discoloration along the backbone, can also reveal early signs of deterioration. The state of rigor mortis, or death stiffening, and its subsequent resolution, is a critical physiological indicator directly linked to freshness. Lastly, the appearance and integrity of the belly walls are important, as enzymatic activity often begins here. Understanding these indicators is fundamental to maintaining fish quality from catch to consumption (Bate and Bendall, 2010; Huss, 1995).

2.1.2 NUTRITIONAL BENEFITS OF FISH

Prior to an in-depth examination of fish spoilage, it is imperative to acknowledge and highlight the profound nutritional benefits that position fish as a cornerstone of healthy human diets globally. Fish is not merely a source of calories but a powerhouse of

essential macronutrients and micronutrients vital for human physiological functions and disease prevention. Its high-quality protein content is a significant advantage, providing all nine essential amino acids required for tissue repair, growth, and the synthesis of enzymes and hormones (FAO, 2020).

1. Beyond its protein contribution, fish is an exceptional natural source of long-chain omega-3 fatty acids, specifically Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA). These polyunsaturated fatty acids are renowned for their extensive health-promoting properties, particularly in cardiovascular health, where they contribute to reducing triglyceride levels, lowering blood pressure, and mitigating inflammation (Kris-Etherton et al., 2019; Mozaffarian and Wu, 2011). Furthermore, EPA and DHA are critical for neurological development and cognitive function, playing a role in brain health throughout the lifespan (Swanson et al., 2017). Regular consumption of fish rich in these fatty acids, such as salmon, mackerel, sardines, and trout, has been consistently linked to a reduced risk of coronary heart disease, stroke, and improvements in mood disorders (Lavie et al., 2009; Omega-3 Fatty Acids and Cardiovascular Disease: New Perspectives, 2018).
2. Moreover, fish provides a diverse spectrum of essential vitamins and minerals. It is one of the few natural dietary sources of Vitamin D, a fat-soluble vitamin crucial for calcium absorption, bone health, and immune system modulation, which is particularly important in populations with limited sun exposure (Holick, 2011). Various B vitamins, including Vitamin B12, Niacin, and Vitamin B6, are abundantly present, playing pivotal roles in energy metabolism, nerve function, and red blood cell formation (Otten et al., 2006; Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline, 1998).
3. In terms of minerals, fish contributes significantly to dietary intake of iodine, a trace element indispensable for proper thyroid hormone production and metabolic

regulation (Zimmermann, 2011). Selenium, another vital trace element found in fish, acts as a powerful antioxidant, protecting cells from oxidative damage and supporting immune function (Rayman, 2012). Zinc, essential for immune response, wound healing, and DNA synthesis, is also present (Prasad, 2013). Iron, crucial for oxygen transport via hemoglobin, can be found in varying amounts, particularly in darker-fleshed fish (Hurrell and Egli, 2010). The amalgamation of these nutritional components makes fish an invaluable dietary inclusion, contributing to overall well-being, growth, and disease prevention. Preserving the freshness of fish is therefore not just an issue of quality, but a critical step in ensuring the maximum retention of these vital nutrients for human consumption.

4. Supports eye health:- Omega 3s and antioxidants in fish may help reduce the risk of age related macular degeneration.
5. May improve mental health: The omega 3s in fish have been shown to have a positive impact on mental health, potentially reducing symptoms of depression and anxiety

2.1.3 FISH SPOILAGE

Fish spoilage refers to the natural and inevitable process of deterioration that occurs in fish after it has died, rendering it progressively less palatable, less nutritious, and ultimately unfit for human consumption. This complex phenomenon transforms the desirable sensory attributes of fresh fish, such as its firm texture, characteristic fresh odour, and clear appearance, into undesirable qualities like softness, off-odours (ranging from sour to putrid), discoloration, and sliminess. Beyond the sensory degradation, spoilage also involves biochemical changes that can diminish the nutritional value and, more critically, lead to the formation of compounds that are harmful or toxic to humans. It is a continuous process that begins immediately post-mortem and accelerates rapidly if proper handling and preservation techniques are not employed. Understanding the mechanisms and progression of fish spoilage is fundamental to developing effective

strategies for maintaining fish quality, extending its shelf-life, and ensuring food safety within the fisheries and aquaculture industries (Ghaly et al., 2010; Gram & Huss, 2000).

2.1.4 CAUSES OF SPOILAGE OF FISH

The transition from a state of desirable freshness to overt spoilage is a continuous gradient rather than an abrupt shift, influenced by a confluence of biological, chemical, and physical factors (Gram and Huss, 2000; Hui, 2006). While early changes in colour, odour, and texture are indicative of initial deterioration, complete spoilage signifies a state where the fish becomes putrid and potentially hazardous.

The primary drivers of fish spoilage are endogenous enzymes present within the fish tissues, the activity of microorganisms (predominantly bacteria), and various chemical reactions, particularly oxidation. Upon the death of the fish, the natural defense mechanisms cease, and a cascade of biochemical changes begins. The enzymes, which are vital for metabolic processes in the living fish, continue their activity post-mortem, leading to the breakdown of complex organic molecules. This enzymatic degradation, known as autolysis, contributes significantly to initial quality loss, producing smaller compounds that can serve as substrates for bacterial growth (Huss, 1995; Olafsdottir et al., 2011).

Microbial activity, primarily by psychrophilic (cold-loving) and mesophilic bacteria, is the leading cause of overt spoilage in fish, especially in chilled or ambient conditions. These bacteria, originating from the fish's skin, gills, gut, and handling environment, proliferate rapidly once the fish dies. They utilize the breakdown products of autolysis as nutrients, metabolizing them into undesirable volatile compounds such as trimethylamine (TMA), ammonia, hydrogen sulfide, and various organic acids, which are responsible for the characteristic off-odours and flavours of spoiled fish (Gram and Huss, 2000).

Several intrinsic and extrinsic factors accelerate the spoilage process. Intrinsic factors include the fish's inherent biological characteristics such as its high moisture content, which provides an ideal aqueous environment for microbial growth and

enzymatic reactions. The high protein content offers abundant nitrogenous compounds for bacterial metabolism, while the fat content, particularly unsaturated fatty acids, is susceptible to oxidative rancidity, leading to off-flavours and odours. Furthermore, the presence of weak muscle tissue in some species makes them more vulnerable to physical damage and faster enzymatic breakdown. Extrinsic factors, primarily related to post-capture handling and environmental conditions, exert immense influence. High ambient temperatures are perhaps the most critical accelerant, as microbial and enzymatic activities are significantly enhanced at warmer temperatures. Inadequate chilling, delayed processing, and unhygienic handling practices introduce and propagate spoilage-causing microorganisms, exacerbating the rate of deterioration. Therefore, effective post-harvest management, particularly rapid chilling and hygienic practices, is paramount to mitigating these spoilage factors and extending the shelf-life of fish (Ashie et al., 1996; Ghaly et al., 2010).

2.1.5 PROCESS OF SPOILAGE IN FISH

The deterioration of fish quality after death is a highly dynamic and sequential process, unfolding through three distinct yet often overlapping stages: rigor mortis, autolysis, and bacterial invasion and putrefaction. Understanding these stages is crucial for implementing effective preservation techniques and extending the shelf life of fish products (Amos, 2007). The high nutritional content of fish, composed primarily of water, protein, and lipids, makes it an exceptionally perishable commodity (Adebowale et al., 2008; FAO, 2020).

The initial stage, Rigor Mortis, commences shortly after the death of the fish. This physiological process is characterized by a stiffening and hardening of the muscle tissues. Biochemically, rigor mortis is triggered by the depletion of adenosine triphosphate (ATP) in the muscle cells. In a living fish, ATP is continuously produced and utilized to facilitate muscle contraction and relaxation. After death, the oxygen supply to the muscles ceases, leading to anaerobic metabolism and a rapid depletion of glycogen reserves, which in turn halts ATP synthesis. Without sufficient ATP, the actin and

myosin filaments in the muscle fibers remain locked in a contracted state, resulting in the stiffening of the entire fish body (Erikson et al., 2009; Love, 1980). The onset and duration of rigor mortis are highly variable, influenced by factors such as fish species, pre-mortem stress levels, temperature, and handling conditions. For instance, fish that struggle extensively before death or are subjected to high temperatures will enter and exit rigor more rapidly. While rigor mortis itself does not signify spoilage, it profoundly impacts the texture and water-holding capacity of the fish flesh. Proper handling during rigor, such as avoiding physical damage, is crucial to prevent gaping (the separation of muscle flakes) and maintain desirable textural qualities in the final product. Rapid chilling post-capture can prolong the onset and duration of rigor, thereby extending the pre-spoilage period (FAO, 2011).

Following or sometimes concurrently with the resolution of rigor mortis, the second major stage, Autolysis, becomes prominent. Autolysis is a self-digestion process driven by the inherent enzymes present within the fish's own tissues. Once the fish dies, the cellular compartmentalization that regulates enzyme activity breaks down, allowing these enzymes, particularly proteases, lipases, and carbohydrate-degrading enzymes, to act upon their respective substrates (Olafsdottir et al., 2011; Shahidi&Ambigaipalan, 2015). Proteases break down complex proteins into smaller peptides and free amino acids, some of which are precursors to undesirable volatile compounds. Lipases hydrolyze fats into free fatty acids and glycerol, which can lead to rancidity, especially in fatty fish. While autolysis does not typically produce the overtly putrid odours associated with bacterial spoilage, it contributes to significant textural softening, loss of firmness, and the development of early off-flavours. Crucially, the breakdown products of autolysis, such as amino acids and sugars, provide a rich nutrient broth that facilitates the rapid proliferation of spoilage bacteria, thereby accelerating the subsequent and most noticeable stage of spoilage (Gram & Huss, 2000; Ghaly et al., 2010). The rate of autolytic degradation is highly temperature-dependent, increasing significantly with warmer conditions.

The final and most conspicuous stage of spoilage is Bacterial Invasion and Putrefaction. Although bacteria are present on the fish's surface, gills, and gut even in living fish, their numbers are generally controlled by the fish's immune system. Upon death, this defense mechanism ceases, and the conditions become highly favorable for microbial growth. Bacteria, particularly psychrotrophic species like Pseudomonas, Shewanella, and various Enterobacteriaceae, begin to proliferate rapidly, colonizing the fish's tissues (Dalgaard et al., 1997; Gram & Huss, 2000). They utilize the readily available breakdown products from autolysis as nutrients. Through their metabolic activities, these bacteria produce a wide array of volatile compounds that are directly responsible for the offensive odours and flavours characteristic of spoiled fish. Key spoilage indicators produced by bacterial action include trimethylamine (TMA) from the reduction of trimethylamine oxide (TMAO), ammonia, biogenic amines (e.g., putrescine, cadaverine), hydrogen sulfide, and various organic acids (Connell, 1995; Koutsoumanis&Nychas, 2000). This stage is marked by severe changes in sensory attributes: the fish becomes distinctly soft and mushy, the eyes sink and become cloudy, the gills turn slimy and discolored, and strong, putrid odours emanate. At this point, the fish is unequivocally spoiled and unsafe for human consumption, representing the irreversible end-stage of the spoilage process. Effective chilling and hygiene are paramount to delaying the onset and progression of bacterial spoilage.

2.2.2 TYPES FISH SPOILAGE

2.2.2.1 ENZYMATIC SPOILAGE

Shortly after capture, chemical and biological changes take place in dead fish due to enzymatic breakdown of major fish molecules. (FAO, 2008) stated that autolytic enzymes reduced textural quality during early stages of deterioration but did not produce the characteristic spoilage off-odors and offflavors. This indicates that autolytic degradation can limit shelf-life and product quality even with relatively low levels of spoilage organisms (FAO, 2008). Most of the impact is on textural quality along with the production of hypoxanthine and formaldehyde. The digestive enzymes cause extensive

autolysis which results in meat softening, rupture of the belly wall and drain out of the blood water which contains both protein and oil (FAO, 2008).

A number of proteolytic enzymes are found in muscle and viscera of the fish after catch. These enzymes contribute to post mortem degradation in fish muscle and fish products during storage and processing. There is a sensorial or product associated alteration that can be contributed by proteolytic enzymes (Engvang and Nielsen, 2001). During improper storage of whole fish, proteolysis is responsible for degradation of proteins and is followed by a process of solubilization (Lin, and Park,2006). On the other hand, peptides and free amino acids can be produced as a result of autolysis of fish muscle proteins, which lead towards the spoilage of fish meat as an outcome of microbial growth and production of biogenic amines (Fraserand Sumar, 2008). Belly bursting is caused by leakage of proteolytic enzymes from pyloric caeca and intestine to the ventral muscle. The proteases have optimal pH in the alkaline to neutral range. Martinez, F. and Gildberg, (2011) reported that the rate of degradation by proteolytic enzymes was reduced when the fish was kept at 0°C and a pH.

2.2.2.2 MICROBIAL SPOILAGE OF FISH

Composition of the microflora on newly caught fish depends on the microbial contents of the water in which the fish live. Fish microflora includes bacterial species such as Pseudomonas, Alcaligenes, Vibrio, Serratia and Micrococcus (Gram and Huss, 2000) Microbial growth and metabolism is a major cause of fish spoilage which produce amines, biogenic amines such as putrescine, histamine and cadaverine, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors (Dalgaard et al., 2006; Emborg et al., 2005; Gram and Dalgaard, 2002). For unpreserved fish, spoilage is a result of Gramnegative, fermentative bacteria (such as Vibrionaceae), whereas psychrotolerant Gram-negative bacteria (such as Pseudomonas spp. and Shewanella spp.) tend to spoil chilled fish (Gram and Huss, 2000). It is, therefore, important to distinguish non spoilage microflora from spoilage bacteria as many of the

bacteria present do not actually contribute to spoilage (Huss, 2005). Trimethylamine (TMA) levels are used universally to determine microbial deterioration leading to fish spoilage. Fish use Trimethylamine Oxide (TMAO) as an osmo-regulant to avoid dehydration in marine environments and tissue waterlogging in fresh water.

Bacteria such as Shewanellaputrifaciens, Aeromonas spp., psychrotolerantEnterobacteriacceae, P. phosphoreum and Vibrio spp. can obtain energy by reducing TMAO to TMA creating the ammonia-like off flavors (Gram and Dalgaard, 2002). Pseudomonas putrifaciens, fluorescent pseudomonads and other spoilage bacteria increase rapidly during the initial stages of spoilage, producing many proteolytic and hydrolytic enzymes (Shewan, 2001).

2.2.2.3 CHEMICAL SPOILAGE OF FISH

Lipid oxidation is a major cause of deterioration and spoilage for the pelagic fish species such as mackerel and herring with high oil/fat content stored fat in their flesh (Fraser, and Sumar,2008). Lipid oxidation involves a three stage free radical mechanism: initiation, propagation and termination (Frankel, 2005; et al, 2003). Initiation involves the formation of lipid free radicals through catalysts such as heat, metal ions and irradiation. These free radicals which react with oxygen to form peroxyl radicals.

During propagation, the peroxyl radicals reacting with other lipid molecules to form hydroperoxides and a new free radical (Fraser, and Sumar, 2008; Hultin, 2004). Termination occurs when a build up of these free radicals interact to form non radical products. Oxidation typically involves the reaction of oxygen with the double bonds of fatty acids. Therefore, fish lipids which consist of polyunsaturated fatty acids are highly susceptible to oxidation. Molecular oxygen needs to be activated in order to allow oxidation to occur.

According to Eyo, 2012, transition metals are primary activators of molecular oxygen (Hultin,2004). In fish, lipid oxidation can occur enzymatically or

nonenzymatically. The enzymatic hydrolysis of fats by lipases is termed lipolysis (fat deterioration). During this process, lipases split the glycerides forming free fatty acids which are responsible for: (a) common off flavour, frequently referred to as rancidity and (b) reducing the oil quality (Huisin't Veld, 2006; FAO, 2005). The lipolytic enzymes could either be endogenous of the food product (such as milk) or derived from psychrotrophic microorganisms (Huisin't Veld,2006). The enzymes involved are the lipases present in the skin, blood and tissue. The main enzymes in fish lipid hydrolysis are triacyl lipase, phospholipase A2 and phospholipase B (Audley et al., 2008; Yorkowski and Brockerhoft, 2005).

Non-enzymatic oxidation is caused by hematin compounds (hemoglobin, myoglobin and cytochrome) catalysis producing hydroperoxides (Fraser, and Sumar, 2008). The fatty acids formed during hydrolysis of fish lipids interact with sarcoplasmic and myofibrillar proteins causing denaturation (Anderson and Ravesi, 2009). Undeland, et al (2005) reported that lipid oxidation can occur in fish muscle due to the highly pro-oxidative Hemoglobin (Hb), specifically if it is deoxygenated and/or oxidized.

PRESERVATION FOR LONG DURATION OF FISH

SALTING

There are many different kinds of salt, some being better than others for fish curing. However, in islands or in outlying places there is often no choice, and whatever is available in the way of salt has to be used, whether it is bought in a shop, prepared on the spot, or extracted from earth containing salt. A distinction must be made between the two chief techniques of salting: wet salting and dry salting (FAO, 2005)

WET SALTING

The principle is to keep the fish for a long time in brine. The equipment needed consists of a watertight container, which can be a tin, drum, canoe, barrel, etc. To make

the brine, one takes four parts of clean water (sea or fresh water) and one part of salt. If the salt is coarse, it has to be ground or pounded first (Tys, and Peters,2009). It is then dissolved into the water by stirring with a piece of wood. To be good, the brine must float a fish. The next step depends on what kind of fish one wants to salt. It is best first to cut off the head, and gut and clean the fish, though small fish can also be salted whole. Large fish must be cut open, and it is preferable to take out the backbone. Fish with a heavy armour of scales must be scaled. Inplaces where the flesh is thick, slashes must be made so that the salted brine can penetrate the flesh. Very large fish should be cut in thin fillets. After the fish has been prepared according to its size, it must be cleaned and put in the brine (FAO, 2008). A plank or matting is laid over it and weighted with rocks so that the fish is entirely covered with brine. This salted fish can be kept for a long time in a dark or at least a shady place (Leistner, and Gould,2002).

The remaining brine can be used three times, but water and salt must be added every time until a fish can again float on the liquid. In any case, fresh brine is always best.

DRY SALTING

In this method, the fish is salted but the juices, slime and brine are allowed to flow away. Dry salting can be done in an old canoe, or on mats, leaves, boxes, etc. In any case, the brine formed by the fish juices and the salt must be allowed to run away. For two parts of fish, one needs one part of salt (Kauffeld et al., 2005). Layers of fish must be separated by layers of salt. It is a valuable method when one has no containers. This method is used to salt down flying fish in open fishing boats while at sea, and the fish in this case are kept whole. Some people like the salty taste of fish prepared in this way, but it is always possible to wash the salt away by soaking it in fresh water before use (FAO, 2005).

DRYING

Very small and thin fish can be dried straight away in the sun if they are brought in early enough in the morning (and if, of course, the sun is shining). If these conditions are not fulfilled the fish must be put for one night in brine, or dry salted. They can then be dried the next morning (Deepchill,2010). If it happens to be raining the next day, it is necessary to wait until the weather has cleared up, which could take from a few hours to a couple of days. In this latter case it will be necessary to wash the salt away from the fish by soaking it in fresh or sea water for a couple of hours before drying it; this depends again on the tastes of the consumers and on the purpose for which the fish is cured (Huss, 2009).

Small fish are mostly sun dried on mats, or suspended. When it rains the fish must be kept dry by covering or transferring them under shelter. If fish are laid on mats or other material to dry, it is best to turn them over every two hours so that they will dry quickly and not become maggotty. In the case of large fish, hanging is better if they are merely split (Ananou et al., 2007).

Salted fish can also be dried, but they should first be cleaned in water. Normally the fish will be dried after three days. If a great quantity of fish has been dried and is to be kept for some time, the best way is to pile it up in a dark place, off the ground and preferably on wooden boards. It should then be covered with a sack or mat. After a fortnight the fish should again be laid in the sun for one or two hours and then put away as before. These are only indications of the main principles of fish drying; variations are possible (Leister and Gould, 2002).

SMOKING

Any kind of fish can be smoked. There are three main methods of smoking:

(a) Smoking and roasting;

(b) hot smoking;

(c) long smoking.

Smoking and Roasting: This is a simple method of preservation, for consumption either directly after curing or within twelve hours. Re-smoking and roasting can keep the product in good condition for a further twelve hours (Kauffeldet al., 2005). Fresh unsalted fish is put over a wood or coconut husk fire. This should be kept very small and the fish turned over every five minutes. In about half an hour the fish is ready for consumption or, if it is the intention to keep it for a while, it should be put in an aerated container (Tys, and Pieters,2009).

Fish can be preserved in this way even in open fishing boats, but the smoking has to be done in a tin or a half-drum. Salted fish can also be smoked by this method, but this is used mostly for immediate consumption or in order to bring the produce in smoked form to a nearby market.

Hot Smoking: The hot smoking system can be used for immediate consumption or to keep the fish for a maximum of 48 hours. Small fish can be salted first for half an hour. After salting they are put on iron spits and dried in a windy place or in the sun for another half hour. It is necessary to have an oil drum to make the smoking stove. The top of the drum is cut out and holes are made 8 inches below the rim to place spits. Near the bottom a rectangular opening is made to control the fire. This opening should be closed with a small door or piece of steel plate. A fire of hardwood or coconut husks is made in the stove, and once it is well started it is regulated so as to give no flames (Tys, and Pieters, 2009). The fish are then placed over the spits. During the smoking operations the top of the drum must be covered with a sack or with palm fronds laid as close together as possible; the fire control opening should also be closed. The fire must be watched from time to time. The fish will be ready in about one hour. An indication that they are done will be found in the golden yellow colour of the skin. For big fish, l to 2 feet long, the

best method is to split them in halves, to the right and left of the backbone. Each half fish is fixed between two flat bamboo slats or sticks. These halves are then rested head down on racks built four feet above ground. A number of split fish can be lined up next to each other.

A fire of hardwood or coconut husks, or several separate fires, are then lit under the rack. The number of fires depends on the quantity of fish one has to smoke. There should be a slow fire for about half an hour followed by a brisk one for one hour. A small fire is then kept going for six hours (just smoking) (Alasalvar et al., 2011).

After this treatment the fish is ready for transport and will keep in good condition for two to three days under tropical conditions. This method is used in particular in the Celebes for skipjack and other tunas (Ananoui et al., 2007).

FISH CANNING

This is a process involving heat treatment of fish in sealed containers made of tin plates, aluminum cans or glass, until the product has been fully sterilized (Idachaba, 2001). During caning, heat treatment should be sufficient to destroy all heat sensitive bacterial and spores, in activate, the enzymes and cook the fish so that the product remains acceptable to the consumer after prolonged storage i.e (FAO, 2005) commercialized sterilization this is used in thermal processing to describe the heat treatment designed to kill substantially all microorganisms and spores which is present and cable of growing in the product (FAO, 2008). The canned food fish is also prevented from contamination by pathogenic organisms by storing them in a virtually airtight package. If heat treatment is properly carried out canned fish may remain in storage for several years without refrigeration (Leistner and Gould, 2002). Traditional canned fish are obtained from small pelagic fish species such as herrings (Clupeaspp), Sardines (Sardinellasp), Mackerels (Scomberomerussp), Anchovies (Engraulissp), Tuna (Thunnussp). Bonga (Ethmalosasp) (Gopakumar,2010). Fish intended for canning must

be in first class condition and must be handle in hygienic manner to reduce microbial load on the fish. Poor quality fish will produce canned fish with offensive odour and flavour, poor texture (Burt, 2003).

DEMERITS OF FISH PRESERVATION

Although the preservation and processing constitute a very important aspect of the fish industry, it has certain draw backs; (Bate and Bendall, 2010).

1. Chilling brings about denaturation of flesh. This is because of ice crystals formed during chilling and causing mechanical damage to the muscles. Cell walls burst, structure gets deformed and the flesh loses much of flavour and taste. The flesh also becomes dehydrated and losses texture (FAO, 2008).
2. If proper hygienic measures are not taken during the processes like washing, guttation and evisceration, etc. more harm would be done to the preserved material, owing to increase in the bacteria population.
3. Incomplete or poor preservation leads to decarboxylation of histidine of fish flesh into histamine. The latter some other related substances, collectively called saurine, are common causes of food poisoning (Karube et al., 2001).
4. Drying reduces weight, nutritive value and the digestibility of the flesh.
5. Excess salting allows growth of salt tolerant bacteria, causing pink eye spoilage of fish flesh.
6. Salting combined with smoking results in loss of protein, about 1 to 5 % due to salting and 8 to 30 % due to smoking.
7. Smoking also accelerates rancidity of fat and so reduces digestibility of fat products.
8. Canning leads to much loss of vitamin B1, panthotenic acid, vitamin-C and pteroxylglutamic acid (FAO, 2005).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes and discusses the various techniques and procedures currently being used in this study to collect and analyze the data. This approach is deemed appropriate for addressing the research objectives related to the processing and preservation of fish using salting, smoking, and sundrying.

3.2 RESEARCH DESIGN

For this study, a sensory evaluation research design is being adopted. This design specifically focuses on evaluating the sensory attributes and overall acceptability of fish processed using different preservation methods: salting, smoking, and sundrying. The research aims to compare the organoleptic characteristics (appearance, aroma, taste, texture, and overall acceptability) of fish processed through these methods. This study is being conducted in Ilorin metropolis.

3.3 STUDY AREA

This research is being conducted within the Hospitality Management Department, Institute of Applied Sciences (IAS), Kwara State Polytechnic, Ilorin. This area is chosen for its accessibility and the availability of the target population (students and staff of hospitality management) suitable for conducting sensory evaluation of processed fish products.

3.4 POPULATION OF THE STUDY

The target population for this study comprises students and staff within the Hospitality Management Department, Institute of Applied Sciences (IAS), Kwara State Polytechnic, Ilorin. This group is chosen due to their relevance and experience in food

evaluation, culinary arts, and consumer perspectives, making them suitable panelists for assessing the sensory qualities of processed fish.

3.5 SAMPLE AND SAMPLING TECHNIQUES

A non-probability sampling technique, specifically convenience sampling and purposive sampling, is being employed for this study. A panel of 10 evaluators is being selected from the students and staff of the Hospitality Management Department. These evaluators are chosen based on their availability, willingness to participate, and their capacity to provide informed sensory assessments of the fish products. The sensory evaluations are being performed and assessed by these carefully selected panelists.

3.6 RESEARCH INSTRUMENT AND INSTRUMENTATION

The primary instrument for data collection is a structured sensory evaluation scorecard, specifically designed for this study. The scorecard consists of two sections:

Section A: Demographic Information: This section collects general information about the respondents, including Gender, Age range, Marital status, Educational background, and Category of respondents.

Section B: Sensory Evaluation: This section is dedicated to assessing the sensory attributes of the processed fish samples. Separate scorecards are being used for fish processed by salting, smoking, and sundrying. For each processing method, panelists evaluate the fish samples based on specific attributes: Colour, Texture, Taste, Flavour, and Overall Acceptability. A 4-point descriptive scale is being utilized for each attribute, with options including: "Excellent," "Very Good," "Good," "Fair" and "Very Poor".

The evaluations are being conducted in a standardized sensory environment within the department to minimize external influences and ensure consistent conditions for all panelists during the assessment of the fish samples.

3.7 VALIDITY OF INSTRUMENT

The sensory evaluation scorecard is being subjected to face validity. This process involves a review by experienced lecturers and supervisors within the Hospitality Management Department who possess expertise in sensory science and food product evaluation. Their feedback is crucial in assessing the clarity, relevance, and appropriateness of the evaluation criteria, instructions, and terminology used on the scorecard, particularly for the 4-point descriptive scale. Based on their recommendations, the scorecard is being adjusted and refined to ensure it effectively measures the intended sensory attributes of the processed fish samples before its final administration.

3.8 RELIABILITY OF INSTRUMENT

To enhance the reliability of the sensory evaluation, standardized procedures and conditions are being strictly maintained throughout the evaluation sessions. Panelists receive clear and consistent instructions on how to evaluate the samples and use the scorecard, ensuring a common understanding of the descriptive terms (e.g., "Very Satisfactory," "Satisfactory"). The consistency of the evaluation environment, including lighting, temperature, and absence of distracting odors, is being carefully controlled. While a formal statistical reliability test is beyond the scope of this project, these measures aim to ensure that the panelists provide consistent and repeatable assessments of the processed fish products.

3.9 METHOD OF DATA COLLECTION

The sensory evaluation sessions are being conducted at the Hospitality Management Department, Kwara State Polytechnic, Ilorin. Each panelist is provided with coded samples of the fish processed by salting, smoking, and sundrying, presented randomly to avoid bias. Water or a suitable palate cleanser is also provided between samples. Panelists are instructed to evaluate each sample individually and record their responses on the sensory evaluation scorecard using the provided 4-point descriptive

scale. The completed scorecards are collected immediately after each session for data entry and subsequent analysis.

3.10 METHOD OF DATA ANALYSIS

The data collected from both Section A (demographics) and Section B (sensory evaluation) of the scorecards are being analyzed using descriptive and inferential statistics.

For demographic data (Section A), frequencies and percentages are being used to summarize the characteristics of the respondents.

For sensory evaluation data (Section B), descriptive statistics such as frequencies, percentages, and mean scores (after assigning numerical values to the 4-point scale, e.g., 4=Very Satisfactory, 3=Satisfactory, 2=Fairly Satisfactory, 1=Unsatisfactory) are being used to summarize panelists' evaluations for each sensory attribute across the different processing methods.

To determine if there are statistically significant differences in the sensory attributes and overall acceptability among fish preserved by salting, smoking, and sundrying, non-parametric tests are more appropriate given the ordinal nature of your 4-point descriptive scale. The Kruskal-Wallis H-test is being employed for comparing the three independent groups (salting, smoking, sundrying) for each sensory attribute. If a significant difference is found using the Kruskal-Wallis test, Mann-Whitney U tests will be conducted as post-hoc analyses to identify which specific processing methods differ from each other. All statistical analyses are being performed using Statistical Package for the Social Sciences (SPSS).

FLOWCHART OF FISH PRESERVATION BY SMOKING METHOD

PANLA (HAKE)

↓

WASHING

↓

SALTING

↓

SMOKING

METHOD OF PRESERVATION OF SMOKING PANLA (HAKE)

The Panla (Hake) fish was cut then wash with clean water and remove all the fish Gills and little salt was added to it and then put on half drum for smoking and can keep product in good condition for twenty four hour.

Smoking also accelerate rancidity of Fat and so Reduce Digestibility of Fat Product.

RECIPE OF SMOKING

Water	500ml
Salting	25g
Panla (Hake)	5 pieces

FLOWCHART OF FISH PRESERVATION BY SUNDRYING METHOD

PANLA (HAKE)

CUTTING

WASHING

SALTING

SUN DRYING

The Panla (Hake) fish was cut then wash with clean water and remove all the fish Gills and little salt was added to it and then put into the sun for Drying and can keep product in good condition for twenty four hours

Sundrying also accelerate rancidity of Fat and so Reduce Digestibility of Fat Product.

RECIPE OF SUN DRYING

Water	500ml
Salting	25g
Panla (Hake)	5 pieces

FLOWCHART OF FISH PRESERVATION BY SALTING METHOD

PANLA (HAKE)

CUTTING

WASHING

SALTING

The Panla (Hake) fish was cut then wash with clean water and remove all the Gills and little salt was added to it

This principle is to keep the fish for a long time in brine

RECIPE OF SALTING

Water	500ml
Salting	25g
Panla (Hake)	5 pieces

CHAPTER FOUR

FINDINGS/DISCUSS

4.1 INTRODUCTION

This chapter deals with the presentation and analysis of the result obtained from questionnaires. The data gathered were presented according to the order in which they were arranged in the research questions and simple percentage were used to analyze the demographic information of the respondents while the chi square test was adopted to test the research hypothesis.

SECTION A

4.2 ANALYSIS OF DEMOGRAPHIC DATA OF RESPONDENTS

TABLE 1: GENDER OF RESPONDENTS

		Frequency	Percent	Cumulative Percent
Valid	Male	20	40	40
	Female	30	60	60
	Total	50	100	100

Source: Field Survey 2025

Table 1 above shows the gender distribution of the respondents used for this study, which indicate 20 respondents representing 40% of the population are male while 30 respondents representing 60% of the population are female.

TABLE: 2: AGE RANGE OF RESPONDENTS

		Frequency	Percent	Cumulative Percent
Valid	20-30years	10	20	20
	31-40years	20	40	40
	41-50years	10	20	20
	51-60years	10	20	20
	above 60years	-	-	-
	Total	50	100	100

Source: Field Survey 2025

Table 2 above shows the age grade of the respondents used for this study which revealed that out of the total 50 respondents of the population 10 respondents represent 20% are between 20-30years, 20 respondents representing 40% are between 31-40years, 10 respondents representing 20% are between 41-50years, 10 respondents representing 20% are between 51-60years while none of the respondent are above 60years.

TABLE 3: EDUCATIONAL BACKGROUND OF RESPONDENTS

		Frequency	Percent	Cumulative Percent
Valid	ND	33	66	66
	HND	10	20	20
	BSC	7	14	14
	MSC	-		-
	Total	50	100	100

Source: Field Survey 2025

Table 3 above shows the educational background of the respondents used for this study. Out of the total population of 50 respondents 33 respondents representing 66% of the population are ND holder's, 10 respondents representing 20% are HND holder's, 7 respondents representing 14% are BSC holder's while none of the respondents are MSC holder.

TABLE 4: MARITAL STATUS

		Frequency	Percent	Cumulative Percent
Valid	Single	20	40	40
	Married	10	20	20
	Divorced	5	10	10
	Widowed	15	30	30
	Total	50	100	100

Source: Field Survey 2025

Table 4 above shows the marital status of the respondents used for this study. 20 respondent which represent 40% of the population are single, 10 respondents which represent 20% are married, 5 respondents representing 10% are divorced while 15 respondent representing 30% are widowed.

4.3 SECTION B: SENSORY EVALUATION DATA ANALYSIS

The following statistical results are obtained from the analysis of the Sensory evaluation data analysis questions as structured in the administered sensory evaluation form:

Table 5: Appearance of Smoking Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	28	56%
Very Good	16	32%
Good	6	12%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 28 respondents representing 56% agreed that the appearance of the production is excellent, 16 respondents represent 32% agreed that the product is very good, 6 respondents representing 12% agreed that the product is good, while no respondents selected fair or poor.

Table 6: Taste/Flavour of Smoking Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	27	54%
Very Good	15	30%
Good	8	16%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 27 respondents representing 54% agreed that the total sensory evaluator rated the taste/flavour of the product is excellent, 15 respondents representing 30% agreed that the product is very good, 8 respondents representing 16% agreed that the product is good, while no respondents selected fair or poor.

Table 7: Consistency of Smoking Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	26	52%
Very Good	18	36%
Good	6	12%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 26 respondents representing 52% agreed that the product is excellent, 18 respondents representing 36% agreed that the product is very good, 6 respondents representing 12% agreed that the product is good, while no respondents selected that the product is fair or poor.

Table 8: Overall Acceptability of Smoking Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	18	26%
Very Good	26	52%
Good	6	12%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 18 respondents representing 26% agreed that the product is excellent, 26 respondents representing 52% agreed that the product is very good, 6 respondents representing 12% agreed that the product is good, while no respondents selected that the product is fair or poor.

Table 9: Appearance of Salting Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	29	58%
Very Good	18	36%
Good	3	6%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 29 respondents representing 58% agreed that the product is excellent, 18 respondents representing 36% agreed that the product is very good, 3 respondents representing 6% agreed that the product is good, while no respondents selected fair or poor.

Table 10: Taste/Flavour of Salting Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	25	50%
Very Good	22	44%
Good	3	6%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 25 respondents representing 50% agreed that the product is excellent, 22 respondent representing 44% agreed that the product is very good, 3 respondent representing 6% agreed that the product is good while no respondents rated fair and poor.

Table 11: Consistency of Salting Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	28	56%
Very Good	13	26%
Good	9	18%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 28 respondents representing 56% agreed that the product is excellent, 13 respondents representing 26% agreed that the product is very good, 9 respondents representing 18% agreed that the product is good, none of the respondents rated the product is fair or poor.

Table 13: Overall Acceptability of Salting Fish

VARIABLE	NO OF RESPONDENTS	PERCENTAGE (%)
Excellent	23	46%
Very Good	18	36%
Good	9	18%
Fair		-
Poor	-	-
Total	50	100%

Source: Research Field Survey, 2025.

The table above shows that 13 respondents representing 43.3% agreed that the product is excellent, 8 respondents representing 26.7% agreed that the product is very good, 9 respondents representing 30% agreed that the product is good, while no respondents rated fair and poor.

Table 14: Appearance Of Sun Drying Fish

VARIABLE	NUMBER OF RESPONDENTS	PERCENTAGE %
Excellent	30	60%
Very good	16	32%
Good	4	8%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Field Survey, 2025

The table above shows that 30 respondents representing 60% agreed that the product is excellent, 16 respondents representing 32% agreed that the product is very good, 4 respondents representing 8% agreed that the product is good, while no respondents rated fair and poor.

Table 15: Taste/Flavour Of Sun Drying

VARIABLE	NUMBER OF RESPONDENTS	PERCENTAGE %
Excellent	22	44%
Very Good	16	32%
Good	12	24%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Field Survey, 2025

The table above shows that 22 respondents representing 44% agreed that the product is excellent, 16 respondents representing 32% agreed that the product is very good, 12 respondents representing 24% agreed that the product is good, while no respondents rated fair and poor.

Table 16: Consistency Of Sun Drying

VARIABLE	NUMBER OF RESPONDENTS	PERCENTAGE %
Excellent	20	40%
Very Good	16	32%
Good	14	28%
Fair	-	-
Poor	-	-
Total	50	100%

Source: Field Survey, 2025

The table above shows that 20 respondents representing 40% agreed that the product is excellent, 16 respondents representing 32% agreed that the product is very good, 14 respondents representing 28% agreed that the product is good, while no respondents rated fair and poor.

Table 17: Overall Acceptability Of Sun Drying

VARIABLES	NUMBER OF RESPONDENTS	PERCENTAGE %
Excellent	20	40%
Very Good	18	36%
Good	12	24%
Fair	-	-
Poor	-	-
Total	50	100

Source: Field Survey, 2025

The table above shows that 20 respondents representing 40% agreed that the product is excellent, 18 respondents representing 36% agreed that the product is very good, 12 respondents representing 24% agreed that the product is good, while no respondents rated fair and poor.

CHAPTER FIVE

SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

Demand for fishery product is rising globally, therefore operative preservative techniques are needed food irradiation is considered a successful technique not only in activating pathogenic microorganism without decreasing food quality. Food stuff are usually irradiated by gamma irradiation generated by a radio scope source. The amount of energy absorbed by the foodstuff during irradiation is called the absorbed does ,this chapter present a comprehensive review of irradiation research for fish and fishery products. Its also examine the impact of irradiation on the survival of spoilage and pathogenic microorganism gamma irradiation of 2.7kg is considered a successful method of preservation since it can reduce the population of food borne bacterial pathogens as well as many fish specific bacterial spoiler and can extend the shelf life of fish.

5.2 CONCLUSION

From the practical study on the preservation and processing of fish salting, smoking, and sun-drying methods, it was observed that salting is not an effective method for long-term preservation. Fish preserved by salting can only lasting for a short period and therefore is not suitable for future use. In contrast, smoking and sun-drying proved to be more reliable and effective methods, as they significantly extend the shelf life of fish while maintaining quality for longer storage. Based on these findings, smoking and sun-drying are recommended as best preservation methods for fish intended for long-term use.

5.2 RECOMMENDATIONS

The preservation and processing of fishes should be taken seriously by all as to avoid wasting of the fish products.

Government should invest more on the fish processing as a lots of Economic benefits could be derived from proper processing and preservation of the fishes. It is recommended that more research should be carried out on the processing of the fishes as not much research work has been done on it.

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APPENDIX I

Department of Hospitality Management,
Institute of Applied Sciences,
Kwara State Polytechnic,
Ilorin,
Kwara State,

29th June, 2022.

Dear Sir/Madam,

I am a student of Hospitality Managements of the above mentioned schools. I am carrying out a research on the processing and preservation of fish in reference of salting, smoking and sun drying.

May I solicit for your help in answering the question below and would like to assure you that every information you give will be treated in strictest confidence and will be solely for academic purpose.

Thanks

Yours Sincerely,

AZEEZ NOFISAT OMOWUNMI
ND/23/HMT/PT/0044

APPENDIX I

SECTION A

(i) Gender of Respondent: a. Male ( ) b. Female ( )

(ii) Age range of Respondents: a. 20-30years ( ) b. 31-40years ( ) c. 41-50years ( ) d. 51-60years ( ) e. above 60 years ( )

(iii) Marital status of the respondents: a. Married ( ) b. Single ( ) c. Divorced ( ) d. Widowed ( )

(iv) Educational background of the respondents:
a. FSLC ( ) b. WASSCE/GCE/NECO ( ) c. OND/HND/BSC ( )
d. MSC/PGD/PHD ( ) e. OTHERS ( )

(v) Category of respondents: a. Civil Servant ( ) b. Self-employed ( ) c. Students ( ) d. Unemployed ( )

SECTION B

SENSORY EVALUATION

ON THE PROCESSING AND PRESERVATION OF FISH IN REFERENCE OF SMOKING FISH

Grade	Excellent	Very Good	Good	Fair	Poor
Colour					
Texture					
Taste					
Flavour					
Over all acceptability					

APPENDIX II

SECTION A

(i) Gender of Respondent: a. Male ( ) b. Female ( )

(ii) Age range of Respondents: a. 20-30years ( ) b. 31-40years ( ) c. 41-50years ( ) d. 51-60years ( ) e. above 60 years ( )

(iii) Marital status of the respondents: a. Married ( ) b. Single ( ) c. Divorced ( ) d. Widowed ( )

(iv) Educational background of the respondents:
a. FSLC ( ) b. WASSCE/GCE/NECO ( ) c. OND/HND/BSC ( )
d. MSC/PGD/PHD ( ) e. OTHERS ( )

(v) Category of respondents: a. Civil Servant ( ) b. Self-employed ( ) c. Students ( ) d. Unemployed ( )

SECTION B

SENSORY EVALUATION

ON THE PROCESSING AND PRESERVATION OF FISH IN REFERENCE OF SALTING FISH

Grade	Excellent	Very Good	Good	Fair	Poor
Colour					
Texture					
Taste					
Flavour					
Over all acceptability					

APPENDIX III

SECTION A

(i) Gender of Respondent: a. Male ( ) b. Female ( )

(ii) Age range of Respondents: a. 20-30years ( ) b. 31-40years ( ) c. 41-50years ( ) d. 51-60years ( ) e. above 60 years ( )

(iii) Marital status of the respondents: a. Married ( ) b. Single ( ) c. Divorced ( ) d. Widowed ( )

(iv) Educational background of the respondents:
a. FSLC ( ) b. WASSCE/GCE/NECO ( ) c. OND/HND/BSC ( )
d. MSC/PGD/PHD ( ) e. OTHERS ( )

(v) Category of respondents: a. Civil Servant ( ) b. Self-employed ( ) c. Students ( ) d. Unemployed ( )

SECTION B

SENSORY EVALUATION

ON THE PROCESSING AND PRESERVATION OF FISH IN REFERENCE OF SUNDRYING FISH

Grade	Excellent	Very Good	Good	Fair	Poor
Colour					
Texture					
Taste					
Flavour					
Over all acceptability					