SURVEY OF FISH PROCESSING METHOD AND QUALITY APPRAISAL IN EPE AND IKORODU AREA OF LAGOS STATE, NIGERIA.

BY

ALEGBE IGE OLUWAYEMI

2003/14777EA

BEIGN A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BARCHELOR OF ENGINEERING (B.ENG) DEGREE IN AGRICULTURAL AND BIO-RESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

NOVEMBER 2008

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MINNA.

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DECLARATION

I hereby declared that this project is a research work that was undertaken and written by me .It has not been presented before for any degree, diploma or certificate at any university of institution .Information derived from personal communication, published or unpublished works of others were duly refrenced in the text.

ALEGBE IGE OLUWA YEMI

2003/14777EA

19/01/08.

DATE

DEDICATION

This project is dedicated to God almighty in whom is hidden all the treasures of wisdom and knowledge, Jesus Christ my savior, the centre of my joy and Holy Spirit the helper and comforter.

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To God almighty in which there is no shadow of variableness, I ascribe all honour, glory, power and adoration, for without Him, I cannot exist and He's my Alpha and Omega throughout the entire programme.

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ABSTRACT

This survey analyses the major food processing methods and quality appraise of fish product in Lagos state, Nigeria. A primary data was collected from a total of 120 fish processors and consumers. Also an organliptic test was carried out by a test plane to access the quality of smoked fish product been produced in Lagos state, Nigeria and microbial load test was carried out also to determine the various micro-organism in the sample of five (5) fish product. From the primary data collected, the major fish processing method in Lagos state, Nigeria is smoking method. From the survey also the major processor are known. The mean average of the respondants is about 40.5 and the study also shows that, about 50% of the respondants have fish farming as their main occupation. From the organliptic test conducted, the mean average of all the fish access after smoked to determine their quality appraise, the mean average is 8 (eight), which makes the fish very good for consumption. The result of microbial load for the five sample, for sample A is 3.9×10^3 cfu/ml, sample B is 3.6×10^4 cfu/ml, sample C is 6.0×10^3 cfu/ml, sample D is 4.0×10^4 cfu/ml and sample E is 5.2×10^3 cfu/ml. Which makes the fish product been produced in Lagos state okay for consumption.

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CHAPTER ONE

1.0 INTRODUCTION

Fish and fish products are known worldwide as a very important diet because of their high nutritive quality and significance in improving human health. Fish are diverse cold-blooded animals, typically with back bones, gills, and primarily live in water with over 20,500 species known to exist. Fish which contributes 36.6gm per day of net protein utilization in Nigeria homes is still below the recommended requirement by the world health organization (W.H.O).

Fish plays a vital role in feeding the worlds population and contributing significantly to the dietary protein in take of hundreds of millions of the populace on a global scale, almost 16% of the total average intake of animal protein was attributed to fish in 1988(F.A.O 1990). In the developing worlds, fish is highly accepted food that supplies as much as 40% of all animal protein available of the country, where fish is the main source of animal protein, 39% out of the top 40% found in the developing world. Moreover, the poor spend proportionally more on fish than on meat or others source of animal protein (Amao et al, 2006)

According mettheus and Hammond (1999), he harvest from the sea, known as marine captures, in 1996, accounted for about 72% of the total fish harvest. Inland captures (from lakes, rivers, streams and ponds) about 6%. While the remaining 22% came from aquaculture (fish farming), where fish are raised either in inland water (13%)or in specially constructed ponds or cages along coastlines (9%). This brought the global harvest of fish to 120 million tones in

2000 (Huss et al, 2004). This also put fish production well ahead of any one of the four main animal commodity groups (beef and veal, sheep meat, pig meat, and poultry meat). In developing countries, fish production is not far behind the total production of all four animal commodities put together over the past 15 years, however, fish has enjoyed as explosive increase in demand a demand that has also boosted its price and different processing method. There is heightened awareness in the developed world of the nutritional and health benefit of fish products comes in fats and calories an high in protein, vitamin, minerals, and poly unsaturated fatty acids.

Nigeria has an estimated population of 120 million and coastline of 960 kilometers boarding the Gulf of Guinea. Also, Nigeria possesses vast land with resources of about 12.5 million he of water bodies which are made up of natural and man made lakes, rivers and reservoirs. The demand for fish in Nigeria is estimated at 1.83 million metric tons (MT) annually and the potential yield is estimated at 1.83 million metric tons (MT) (Doe, 1983). However, the actual fish supply in 1993 according to Federal Department of Fisheries (FDF), 1995 report was 619, 211 MT with a decline to 511, 135 MT in 1994. These short fall and decline in the fish supply have been attributed to inefficient fisheries management, development, and poor post-harvest technology in term of handling, preservation, processing, storage and distribution.

Fish processing technology is well developed in the traditional areas of freezing, cooling, smoking, drying and salting. Products and processes based on fish mince and surimi are also now use world wide. At the same time, new technologies (method) are making use of fish processing as a response to economic and environmental demands. (Hall, 1993)

Processing method usually change the texture, odour, taste and physical appearance of the fish that deterioration is association with the process used (Microsoft Encarta, 2004). According to Eyo, (2000), fish processing has the followings.

i Converting the raw material to a desirable form.

ii Processing of the product.

iii Maintaining product quality.

iv Assuring costumer's safety and

v Full utilization of the raw material.

1.2 Statement of the Problem.

Fish is one of the most perishable foods. Fish quality deteriorates rapidly after harvest, just as any other dead tissue and biological materials and the potential keeping time is shortened, if they are not stored properly. Substantial physical, economical and nutritional post-harvest losses occur at different points of capture, pre-processing (sorting, grading, de-scaling, gutting, washing and filleting), processing (open air-drying, over drying, solar drying, smoke drying, salting, canning, e.t.c) packaging, storage, at low temperature (freezing, icing, refrigerator) for fresh fish and ambient temperature for dried fish product, transportation and marketing. These losses result from intrinsic and extrinsic factors. These include the concentration of the substrates and metabolites in the tissues of live fish, the activity of the endogerous enzymes, the microbial contamination and the condition after catch (sikorski et al 1990). In addition,

the ambient temperature handling on the heat, the hygiene of the processing area, equipment and personal hygiene of the workers, the method of waste disposal, methods of packaging and storage and the mode of transportation, hasting spoilage by accelerating the activities of bacteria, enzymes and chemical oxidation of fat or fish flesh (Johnson and Clucas 1996)

Nigeria has had a great deal of economic progress which has increased at a significant rate since the oil boom era. This substantial increase in economic activity has however resulted in varied problem for the economy. For the fishery sector, the problem that could be identified are as follow.

The lack of provision of good and motorable access road, Griover and Street (1980), reported that most of our dometic fish farmers are located in the rural area which as a result do not allow for proper monitoring of fish output. The canoes operated in the riverline area only on small fishing villages located along the Nigeria coastline and the villages are not easily accessible from major population centres, this as a result create difficulties in the evacuation and marketing of fish product and the development activities by government agencies.

Inadequecy of fish input such as fishing gears and craft have also hindered production and as such fish is landed in small quantities to meet consumer demand.

The green revolution national committes study group on fisheries(1982) highlighted socio-economic problems associated with fish demand and supply of fish in Nigeria. Some of problem highlighted are lack of proper finance and

poor banking facilities.This problem thus,hinder the purchasing of fish equipment by farmer and as a result lowered their production.

Environmental pollution and lack of proper water management programme have drastically affected fish production especially in commercial area like lagos state and it territory. Another problem is that of indiscriminate and obnoxious fishing method such as the use of poisonous chemicals and explosives also leads to the reduction of fishes in our rivers and lakes.

Essien (1982), highlighted that most fishermen are illiterates and as such they could not effectively manage electronic equipment that are readily available to them. This on the long run affected their output,also there are no suitable storage facilities such as cold store and vessels which in no small measure contribute to the indurability of fish when transported on a long distance.

1.3 Justification of the Study.

Quality can be defined as the characteristics or attributes, which make fish acceptable to the consumers. In assessing the quality of a fish the consumer may consider its freshness, the safety of the fish in terms of the microbial load as the palatability of the fish. Fish quality is undoubtedly the most important factor, which influences consumer`s demand; a product of low quality will have correspondly low market value. A product, which does not meet a required standard of quality, is often rejected and the producer will suffer economic loss. A fish inspection and quality control unit is often an integral part most fishing industries since fish mongers from overseas countries nowadays insist that fish products contain not more than a certain number of bacteria in unit weight.

The two main categories of quality assessment in this project are objective and subjective method.

The objective method of quality assessment are those which rely on the use of instruments and reagent for their determination, while the subjective method involves those test which require the use of human sense organs and not machines, chemicals or reagents for estimation. They are also known as sensory test.

1.4 Objective of the study.

The objective of this study is to assess and compare the different fish processing method in Lagos state and the quality appraisal with the hope to know the common types of processing methods and the nutritional contents of the fish products to the human health. Also:

i To examine the socio- economic characteristics of the respondents.

ii To determine the relationship between socio-economic characteristic of fish processing and their quality on fish.

iii T o determine the selling power of processed fish in each area.

1.5 Scope of study.

The fish processing method is usually carried out in the center part of Lagos state, but the quality differs from each other in term of appearance, odour, taste, and texture of the raw fish. Since the assessment depends upon the senses, these factors are known as SENSORY OR ORGANOLEPTIC. This method will be used to determine the quality of fish processed or produce in

the two part of Lagos state, Nigeria which are Epe and Ikorodu axis of Lagos state Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Status of fish processing technology in Nigeria.

Fish processing is a fairly wide field, covering a large number of processing techniques, fish species, fish products fishing, by the products and processing technologies. The basic functions of fish processing include, preservation of the product, converting the raw fish into a desirable form, maintaining product quality and assuring consumers safety and full utilization of the raw material (Wheaton and Lawson, 1985). How ever, several study on the post-harvest loss in Nigeria has shown that 20-50% of fish produced are lost after harvest at various point of capture. To marketing. This colossal lost has been attributed poor and under developed post-harvest processing and preservation practices in the country (Azeza, 1986; Stumerg,1990; Eyo,1998). As such the importance and need for a developed fish processing and preservation industry in nigeria cannot be over emphasized. Some of the benefits of a developed fish processing and preservation industry include availability of vital protein, food supply and employment generation. For a large labor force (Akande and Asuquo-king, 2000). The processing and preservation method commonly employ in nigeria are; smoking, open air-drying, solar drying, salting, canning, icing and freezing (cold storage).

2.1.1 Smoking Method

As obtained in most developing countries, the main aim of smoking in nigeria is still regarded as a preservative rather than a processing method of fish catch.

Among the new method cured in this way, fish and fish products were the most vulnerable to deterioration. The bacteriostatic, bactericidal and antioxidant function of smoke and the dehydration effect of the process were used inadverterly by the early fish processor in the preservation of fish (Eyo, 2001). Smoking in Nigeria is normally carried out in kilns, which are either traditional or modern. Traditional smoking techniques varies widely at its simplest level, fish may be placed in a pit containing smourdering grasses or wood, so cooking and flavoring of the fish which is usually charred and thus a short storage life alternatively, the fish may be laid on racks contained in an oil drum or mud oven, or hung on baboon sticks in the smoke of the fire. ( ). The heat generated within the kiln is usually neither controlled nor conserved. As such, they are inefficient in their use of fuel. The fish products from the traditional kiln are usually of poor quality due to over cooking flesh inside and burning and charming of the outside. Smoke is usually supplied by wood or dry grass for the traditional kilns. For the modern apart from fire wood other source of fuel are used these include; charcoal and domestic cooking gas. Several modern smoking kiln have been designed and tested in Nigeria these include;Altora, modified Altora, or wateraba, chorkor and kainji ; gas kiln. The modern kilns usually have advantages of traditional kilns are;

i constant alteration is required to control the fire and turn the fish. This may involve working through the night.

ii the operation is both a health and fire hazard

iii many oven are inefficient in their use of fuel and ventilation system.

iv the fish product is of poor quality due to inefficient cooking of flesh inside, and burning and charning on the outside.

2.2.1 Open air Method

Drying is another traditional form of fish preservation in Nigeria. Fish drying is presumably the oldest method of fish preservation using heat from the sun and atmospheric air. Drying or dehydration is to describe any process involving the removal of water from fish or fish products by evaporation. The dried product are usually expressed to dirt, contaminates and are susceptible to climatic conditions and animal attack. Been totally dependent on weather conditions, the processor need dry weather and low humidities which are not available in the rainy season. F.A.O,1981, reported that a typical sun dried has in general, a drying time of about 3-10 days, solar drying is the use of solar driers made of plastic or glass to trap solar energy for a more efficient use in effort to improve on open air drying. temperature in excess of 45°c attainable inside solar dryers, insect and their larvae get killed, at temperature over 60°cthe eggs of the insect are killed. The sun or open air drying is practiced in the sahel zone in the Northern part of the country where sunlight is in abundance.

The factors affecting fish drying rate;

i Size of fish;

The drying rate of a thin fish or a piece of fish is faster than a thick fish of the same weight because a thin fish has proportionality surface area and the diffusion path to the sirface is shorter.

ii Fattness of fish:

Thelower the fat content of the fish the faster the faster the water diffuses to the surface of the fish hence the faster the drying rate. If during the early drying stage, the fish is dried at too high a temperature, (more than 40°c), or when the relative humidity is too low, the outer layer becomes cooled or altered so as to be almost impervious to water.

iii Temperature

The higher the temperature the faster the water diffusion to the surface of the fish and the faster the water evaporates from the surface.

iv Air speed

The higher the speed of the air flowing over the fish, the faster the evaporation rate at the surface of the fish been dried. Air speed has no effect on water movement inside the fish.

v Relative humidity

The lower the relative humidity the faster the water evaporates from the surface of the fish been dried. Beyond the equilibrium water content the drying declines. The equilibrium water is the minimum water content that be achieved at a particular relative humidity.

vi Cooked/ Raw Fish

Cooked fish dries more rapidly than raw fish. Cooking in addition destroy bacteria and enzyme that will cause spoilage of fish.

vii Saltness of the fish

The greater the amount of salt added the more slowly the water diffuses to the surface. Thus drying time is increased in the presence of salt. Heavily salted is in equilibrium moisture in the air at relative humidity of 76%, drying is slow when the relative humidity rises above 70%.

viii Slow and rapid drying:

Slow drying during the early stages result in movement of the soluble components to the surface. The water is evaporated and the soluble material is precipitated in or on the surface.

2.1.3 Fish freezing Method

Fish freezing is the method of fish preservation in which the product is brought into contact with registered air or refridgerated surface in component. As heat is removed from the fish, its temperature falls steadily until the fish begins to freeze. During freezing the temperature falls below that of ice (0°), microbial activity is slowed down and as the temperature goes further down to -30°c most bacteria may die out. Freezing is an efficient method of preservation; frozen fish can have a storage life of more than one year. However, fish may spoil in freezers due to poor handling of the equipment for the following reasons (Eyo, 2000).

i over loading of the freezers resulting in slow freezing of the product, especially the bigger fish. This is because of their big size as it takes a longer time for the fish to go through the region -1°c to -2°c, temperature at which, according to Johnson et al (1994) spoilage enzymes are most active.

ii Equipments if frequently open result in temperature fluctuation creating a warming environment that may lead to dehydration, alteration of the protein and toughering of the product, caused by nutrient losses as drips when the fish them.

2.1.4 Icing Method

Icing of fish is one of the best method of maintaining the attributes of prime freshness in fish depends upon the species characteristics, the fishing ground and season, the condition of the fish, the method of capture, the care in handling and icing on board, and the system of packaging used in retail outlets (Sikorski,1990). In Nigeria, icing usually used for a short term preservation of fresh fish, from the leading site to the market.

Cold storage of fish is predominating in Nigeria especially in retail outlets for commercial frozen fish. A cold store is any building or part of a building used for storage at temperatures controlled by refrigeration at -18°cor lower. Other fish of large size shows sign of incipient spoilage on thawing. The fish appears wrinkled, toughened and whitish spot emerge on the skin surface of the fish.

In a developed fishing industry, the most desirable or choice species are often used for human consumption. The undesirable species are never discarded but rather they are used in the manufacture of by products. Such fishes include the by catches, fish waste, fish offal and other "fresh fishes". Fishery by-products may be consumed directly or indirectly when used in compounding livestock/ feed. These by-products include: fish protein concentrate, fish meal, fish silage, fish protein hydrolysis, marinades and minced fish (Hall and Ahmed, 1992,

2.3.1 Icing/Chilling.

Chilling using ice to store fish immediately after capture is used exclusively in fishing industry to maintain and keep the nutritive quality of the catch. Ice cools the fish to a temperature of about 0°c and it keeps the fish cool for a long time.

Fresh fish spoil very quickly after capture and the rate of spoilage is influenced to a large extent by temperature. Removal of heat from the fish slows down the spoilage (Johnson and clucas, 1996). The heat transfer take place merely between the fish and ice and the cold through out water in direct contact. Thus, to retrieve the highest chilling rate, it is necessary to surround the fish completely by ice. Also, the period for which ice fish can be kept in prime freshness or in acceptable quality depends upon the species characteristics (whether fatty or lean), the fishing ground and season, the condition of the fish, the method of capture, the care in handling and icing on board of the fishing vessel, and the system of packaging used in the retails outlet (sikorske, 1990).

Rapid icing or chilling of fish after catch to about -1°c is one of the most effective means of prolonging the period of prime freshness and extending the shell life of fish, as well as inhabiting the pathogenic mesophiles and retarding the growth of psychotropic pathogenic micro-organism. Fatty fish such as haring and sardine can be maintain in top condition for about 5-8 days and for lean white specie such as cod, haddock, and hake take up to about 14 days. Extending the shell of life of fresh fish for an additional few days, can be achieved by lowering the temperature of the fish to near the initial point of freezing of the tissue water of the fish, which is about -1°c to -5°c. This brings

about significant retardation of spoilage without causing undesirable physiochemical and structural changes in the tissue and texture deterioration. Method used in chilling at sub-zero temperatures include super-chilling, chilling in iced slurry (chill sea water), chilling in refrigerated sea. For example super-chilling at -3° to -4°c increases the shelf life of fish to 4 to 5 weeks by effectively inhabiting the bacteria spoilage. Eyo (2001), highlighted various methods of fish storage on ice. These include bulking, shelving, chilled sea water, refrigerated sea water and super-chilling.

- Bulking:

This is used in sea fishing vessels and it involves patitioning the fish hold so that the fish and ice are contained and there by preventing excessive movement. The recommended practice for bulking is to lay fish on a bed of about 5cm thick and place alternate layer of ice and fish at a fish to ice ratio of one to a total height of about one meter. The fish in bulk storage may suffer damage from pressure of the fish on top, including shrinkage and excessive lose in weight.

- Shelving:

This is a method whereby fish are layed out on shelves formed between vertical parttion in the fish –hold. This method can be described as shallow bilking and where it is done correctly it is a good method of storage . fish can be shelve by arranging fish orderly belly down wards and heed to tail on ice 5cmthck on shelves with the fish completely surrounded by ice. Shelving is more economical in space than bulking.

- Chilled Sea Water

Chilled sea water (csw) is a method of preservation at sea in which fish after capture is placed in tank or hold of the fish vessel containing fresh water ice and sea-water. The method is practically useful in chillary small pelagic that is not usually gutted at sea. The ice to sea water is usually 2:1 but may vary depending on the amount of insulation in the compactment and the ambient temperature. The surface area of the chilled sea water is larger than that of the crushed blocked ice or small ice which gives a better contact to the fish, better heat transfer and faster cooling. Another advantage is the washing effect of the chilled sea water, which help to reduce microbial population on the fish. In scarily fish, the scales may be removed during storage in chilled sea water. This could be an advantage during subsequent dressing of the fish.

- Refrigerated Sea Water:

The mechanical refrigeration of sea water to a temperature of -1°c in a tank produces a refrigerated sea water (RSW). Refrigerated sea water is particularly useful when the harvest is large and correct bulk storage may be difficult to perform, because of the tendency for fishermen to hurriedly place ice over the catch without proper application of ice by ensuring that each fish is surrounded by ice. Such improper icing may lead to spoilage of the fish located at the bottom of the pile. Storage of such catch in refrigerated sea water will minimize spoilage. Refrigerated sea water is a very fresh and effective chilling method since fish is stored at a little below melting point.

- Supper Chilling;

This is a method of reducing the temperature of the fish to below that which obtains when fish is in melting ice. The lower temperature also extends the shelf life of the fish. Supper chilling requires more expensive investment than icing as it involves the use of refrigeration equipment, fans, and fish rooms. Therefore, supper chilling should be used only in traulers, which embark on long voyage in which icing may not be sufficient to maintain the quality of the fish. During supper chilling, fish temperature is reduced to -2°cat which ½ of the water in the fish is frozen and bacteria action and hence spoilage is slowed down.

2.3.2 Freezing Method

Fish freezing is a method of fish preservation in which the product is brought into contact with refrigerated air or refrigerated surface, in a compartment. Fish composition is largely water, normally60%-80% depending on the species and the freezing process converts most of this water into ice.Sikorski and Kolekioska, (1990), defined freezing of food as the reduction of the food temperature below the freezing point so that the water contained in the material turns ice.

The manner and trend of freezing in fish (Johnson et al, 1994) occur in three stages. During the first stage, the temperature falls rapidly to just below 0°c, the freezing point of water. At the second stage, more heat is required to be extracted in order to turn the bulk of water to ice. The temperature changes by a few degrees and this stage is known as the period "thermal arrest". At the third stage, 55% of the water turns to ice, and the temperature again begins to

fall rapidly till most of the remaining water freezes. A comparatively small amount of heat is removed during the third stage.

As the water in fish freezes out a pure crystal of ice, the remaining unfrozen water contains an ever increasing concentration of salts and other compounds which are naturally present in fish flesh. The effect of this ever increasing concentration is to depress the freezing point of the unfrozen water. The result is that unlike pure water, the complete change to ice is not accomplished. At 0°c, but proceed over a range of sub zero temperatures. By the time the fish temperature is reduced to -5°c about 70% of the water is frozen. And at temperature as low as -30°c, a proportion of water in the fish muscles still remain in the unfrozen state (Johnson et al, 1994).

- Principles of fresh freezing;

Water forms about 60%-80% of the weight of fresh fish. The presence of water produces suitable condition for the growth of bacteria. During freezing some of the water in the fish is rendered unavailable to micro-organisms. Pure water freezes at 0°c but a fish begins to freeze at -1°c due to the presence salt which depresses the freezing point of fish. As freezing continues, more and more water begin to freeze and the remaining unfrozen water become a concentrated salt solution down the freezing process. At -5°c most of the water becomes frozen and only about 20% of the water in the fish remain unfrozen. Even at -30°c, up to 10% of the water in the fish muscles is still unfrozen.

During freezing, changes take place in fish protein causing it to alter its "nature" from thereby becomes denatured. The rate of protein denaturation is influenced by temperature, increasing with increase in temperature and as the

temperature is reduced during freezing the rate of denaturing is also reduced. Further more, the rate of denaturing depends on the concentration of the enzymes and since enzymes becomes more concentrated in the unfrozen liquid in fish tissue, this areas will experience greater denaturation.

It has been observed that slow freezing cause's greater protein denaturation in the fish then fast freezing. This is associated with the phenomenon of osmotic denaturation slow freezing causes the formation of large intercellular ice crystals. The inter-cellular fluid freezes first because of its less high freezing temperature (eutectic point). The eutectic point for cells is reached. The rate of denaturation is greater during slow freezing because of the large ice crystals formed outside stretches and deforms the cell wall but does not damage or rupture it. In addition to protein denaturation, other deteriorative processes of fat oxidation to produce rancidity occur with fatty fish such as herring and mackerel (Lavety, 1993).

Another factor limiting the storage life of frozen fish and of major concern is dehydration (Lavety, 1993, Johnson, 1994) also called freeze burn. When fish get badly dehydrated in cold storage, the surface becomes dry, opaque and strong, as time progresses, these conditions penetrate deeper into the fish until it becomes fibrous.

According to (Johnson et al, 1994), there are three basic methods of freezing fish these are;

i blowing a continuous stream of cold air over the fish- air blast freezes.

ii Direct contact between the fish and the refrigerated surface – contact or plate freezers.

iii immersion in or spraying with a refrigerated liquid using immersion or spray freezers.

2.4 High temperature control methods

Spoilage enzymes and bacteria in fish have optimum temperature which is favourable to their deteriorative actions. Rising the temperature above their optimium temperatures brings about a change in these favorable conditions and render the spoilage organism inactive. At 50°c enzymes are gradually inactive, although some thermophilic bacteria can still metabolize at 60°c. however, at 100°c all enzymes and bacteria are destroyed (therkoronge and Ngoddy, 1995). High temperature control methods include cooking, frying, sterilization, canning and smoking.

2.4.1 Canning

Canning is a process of preserving food by heating and sealing in an air tight containers. Eyo(2001), in describing the canning process and its preservative roles, stated that during canning, heat treatment should be sufficient to destroy all heat sensitive bacteria and spores, inactivate the enzymes and cook the fish so that the product remains acceptable to the consumer after prolong storage. Commercial sterilization is a term usually used to describe the heat treatment during canning. This is designed to kill virtually all micro organisms and spores which if present would be capable of growing in the products. The most heat resistance food poisoning spore forming micro-organisms is clostridium

botulism. This bacterium causes the deadly disease known as botulism. Also the heat treatment reduces to the barest minimum the spores of the most heat resistance food spoilage micro-organism, which is bacillius stearothermophilus. Once this has been done, the canned fish is prevented from contaminations by pathogenic organisms by storing them in virtually air tight package. If the heat treatment is properly carried out fish may remain in storage for several years.

2.4.2 Smoking

The preservative effect of the smoking process is due to drying, and the deposition of the flesh natural word smoking chemicals. Smoked fish is a traditional part of the diet of large section of the worlds population especially where modern preservative method like canning and freezing are not readily available.(Olley et al, 1988, Eyo, 2001).

during smoking, the smoke from the burning wood contain a number of compound which inhabit bacteria, while the heat from the fire causes drying and when the temperature is high enough, the flesh will be cooked, preventing bacteria growth and enzyme activity. Fish may be smoked in a variety of ways, but the longer it is smoked the longer it will keep. The smoked product owes it storage life primarily to the drying and cooking processes, rather than the preservative value of the wood smoke chemicals.

- Smoking Process

Three types of smoking process can be distinguish, cold smoking and smoke drying. In cold smoking, the fish are not cooked and the end product is similar

in keeping qualities to fresh fish. Hot smoked are cooked, a process which prevents spoilage for only a day or two, if the product is not dried. In many traditional processing techniques, there is little distinction between hot smoking and smoke drying which can lead to cooked dried products which tends to break up on handling (Ilo-WEP, 1982). In cold smoking, the protein of raw fish turn edible as a result of their enzymatic ripening which are scored to increase the surface area for salt and / or smoke contact (Ilo-WEP, 1982 and Miler and sikorski, 1990). A number of pre smoking process will generally be required prior the actual smoking of fish, these processes being function of the type of fish used and the type of product required. These process may include washing, gutting and splitting fish and salting and pre-drying.

- Washing Gutting and Splitting

Depending on local customs, the fish may be prepared simply by washing and followed by smoking (e.g herring, bonga). Alternatively, since gutting, splitting, and filleting may be carried out prior to smoking. In general, it is the smaller fish, which are used whole. This has become a traditional method because of the difficulty in gutting large numbers of small fish. This saves labour and prevent excessive dehydration of the product. Medium –sized fish, such as tilapia and cat fish, are normally split and gutting whereas the larger species, such as sharks and rays are cut up into chunks or fillatory which are scored to increase the surface area for salt and /or smoke contact.

- Salting and Pre- drying.

Fish intended for hot smoking is salted to a concentration of 2% Nacl, a level that satisfies the consumer demand for a proper salty taste of the product. The

duration of salting as well as the fish to salt ratio or the concentration of the brine depends on the species and size of the fish and on its water contents (Miler and sikoski, 1990). In traditional African smoking proceduces, the fish are not usually salted at all. It is recommended to dip the fish intended for smoking in 70-80% saturated brine for about 10 minutes. This results in a salt uptake of only 2.3%, and produces a good gloss on the surface. Prior to smoking, the fish should be pre-dried preferably in the shade. Pre-drying tends to enhance the surface gloss on the product, and helps prevent case hardening which tends to develop the smoking process. Drying is best carried out on the frames or hooks on which the fish will eventually be smoked. If frames are used, the fish should be spread out in one single layer and spaced out to allow passage of heat and smoke. However, it is advantageous to hang the fish on hooks since this avoids leaving frame contact marks on the flesh where the smoke is not able to penetrate. Frames also allow a more efficient flow of smoke and hot air especially the product furthest away from the heat/smoke source.

- Smoking Equipment.

Fish can be successfully smoked in smoke houses and smoking ovens or kilns. The design of smoking equipment varies from place to place. The various smoking equipment can be classified into traditional and mechanical smoking kilns. These kilns are associated with some merits and demerits. Among the traditional smoking kilns (TSK) described by Eyo, (2001) where traditional smoke house, pit oven, traditional conical mud kiln, down type kiln,

earthenware port type kiln some of the associated merits of traditional smoking kiln were:

It is relatively cheap and easy to construct.

The drum type is portable and could be used in swampy areas.

The associated demerits are:

It is difficult to control the smoke and heat production; occasionally the fire may burst which may cook the fish or chear the production. The product because dirty due to exposures to soot.

The process is labor intensive, i.e great deal of labour is needed to fetch the firewood and a super-vise the operation.

Traditional smoking seldom gives a uniform standard products depends on the amount of fire and the length of exposure to smoke.

There is often wastsge and financial losses from cooked fish that falls on the fix and are burnt. These are known as droppers.

The improved traditional smoking kilns (TSK) where designed to remove the drudgencies associated with the smoking kiln. Eyo (2001) described some of the commonly available improved smoking kilns in the tropics. These include altone, modified altone or waterrab, chorkor oven and kanji gas kiln, (KGK). Some of the associated merits of these kilns include.

Fuel efficiency

Uniformity of product

High carrying capacity

High durability

Easy operation and high mobility and portability

Less labour intensive.

The kiln is environmentally friendly as in the case of kanji gas kilns which uses sawdust, and wood showing for smoke production and there is no deforestation for the fish smoking. Some of the associated demerit of (IFSK) includes:

The initial high cost of the kiln due to the high cost of construction materials.

In case of kanji gas kiln uses natural gas (cooking gas) may be unavailable in some localities in the tropics. And when available it may be beyond the reach of an average fish processor.

Mechanical fish smoking kilns (MSK) are very advanced smoking kilns, which have been developed through years of research (Eyo, 2001). Their excellent performance has enhanced their popularity in technological advanced countries. A popular example of a mechanical smoking kiln is Tony smoking kiln in Britain. Some of the merit associated with the mechanical smoking kiln includes:

The smoking process is under the control of the operator.

The duration of smoking is much shorter than TSK $ ITSK.

Less labour intensive compared to TSK and ITSK.

for the same protein between different fish species, been related to the environmental temperatures in which the fish live.

Generally speaking about 90% of the protein is denatured at about 60 to 65°c, the remaining 10% (tropomyosin) may be held at 100°c for a prolonged period of time without been denaturized. Heating proteins at temperature of about 115°c i.e up to 145°c causes extensive destruction in several amino acids. The ultimate result is severe depression of protein utilization (opstive 1988). With extensive heating (140-150°c), reductions available methione cystore and tryptophe are also possible FAO, 1981)

- Lipid:

Heating undoubtedly causes oxidation of lipids in fish (Alker and consell 1979). Perhaps the major impact of this oxidation lies on the potential loss of available lysine. (Cuttory 1962), reported the loss of biologically available lysine and histder due to reaction of oxidation products with basic nitrogenous constituents or fish flesh. This was further reported to be responsible for darkening, toughening and the unpalatable, better flavor associated with lenthy drying processes and storage of dehydrated fish.

- Vitamins:

The flesh of fish contains small amounts of nearly all the vitamins with the exception of ascorbic acid of which only in significant amounts are present and of vitamins which is present in substantial qualities in the flesh of fatty fish. However unless a diet is based largely on fish, the stability of vitamins during processing is of minor importance.

The fat-soluble vitamins (A, D, E. and K) generally more stable than water soluble (pyridoxine, vitamins B12,Nacl, partothenic acid and folic acid) ones but are prone to degradation at high temperatures in the presence of oxygen, perhaps by free radical mechanisms.

- Shelf Life:

Smoke fish are generally perishable commodities their shelf life depends on many factors. These include mainly the species and initial quality of the raw material, the concentration of salt and the corresponding water activity flesh, the temperature region during smoking, the contents of smoking components the type of packaging, personal hygiene of the processor, the hygiene standard of the processes and the temperature of storage. For example, lightly hot-smoked fish, stored at 4°c, generally have a shelf life of 2 weeks, while cold-smoked more heavily salted and exposed to the action of smoke for at least 6 to 8 hours can be kept in good quality for about 2 months.

- Smoke Sensory Properties.

Smoke caring is a processing method where in due to the action of smoke constituents fish attains a unique smoky odour, taste and clour. Most often these charges in sensory properties go long with a partial dehydration of the fish tissues and alterations in their texture (Miler and Sikorski, 1990). The quality of smoked fish affected its colour, flavor and texture.

Colour formation in smoked fish has been attributed to the dominating the role of glycolic altydes and methylglyoxal components of smoke. The glossy surface of smoked fish is a factor highly appealing to the consumers. Gloss is

always developed in fat fish due to the presence of a thin, oily film on their surface.

The flavor of smoked foods results from the composite action of smoke constituents, heat and salt as all these factors induces physical and chemical changes in the product. The role of smoke components consists primarily in developing the characteristic smoking odour and taste. They interact also with proteineous matter, including some changes in the texture of fish. This effect, however is negligible, compared to that induced by heating, drying or salting (Dawr, 1979).

Smoke icing process exerts terderizing action upon the fish tissue. Heat deneturation of proteins occurs in hot-smoked products while in cold-smoked fish it is caused predominantly by the action of proteolytic enzymes. Smoke components also seem to affect the texture properties of smoked fish. In some cases, they make tissues tougher (Miler and Sikorski 1990).

2.5 Moisture Removal/Drying Principle.

There are three forms of heat transfer in drying; conduction, convection and radiation heat transfers. In practice, two or all the three forms take place simultaneously and the net transfer would be determined by the extent of the influence of each mode of transfer (Olley, 1983). Fish dried by the evaporation of water which has diffused through the fish muscle and skin to an exposed surface. Initially the rate of drying is governed by the rate of evaporation from the exposed surfaces after a time, depending on the evaporation rate and the rate of which the water can diffuse to the surface, the surfaces start to dry and the drying rate falls.

- Basic Principle:

During drying, water is removed from the fish by evaporation in two phases. During the first phase, only water on the surface of the fish or very close to the surface evaporates. The rate at which the fish dry depends on the surface area of the fish, the air temperature, the speed of current of air passing over the fish and the relative humidity or wetness of the air. The drying rate during the first phase may be increased by: increasing the fish surface area by splitting the fish and secondly, choosing a drying site where the wind is strong. Choosing a drying site where the air is dry and to avoid if possible marshy area and places where the air has blown over water.

Once the surface is dry, water will evaporate at the rate at which it rises from inside the flesh to the surface of the fish. This rate slows down as the fish gets drier.

During the second phase, the drying rate is a function of: the type. For example the rate at which water rises to the surface is slower for fatty fish. The thickness of the fish, the temperature of the fish, the water content of the fish and the wetness is of the surrounding air.

If moisture is removed from the fish surface sufficiently quickly, the drying rate is independent of the level of humidity contained in the air. It depends only on the rate at which water reaches the surface of the fish. If drying is very fast during the early period the surface may dry too quickly, thus producing a hard layer which will slow down the rise of the water to the surface.

- Water Activity:

The basic concepts of water activity and water absorption isotherms of foods are described by (Troller and Christian 1978) and Lupin (1986).

Water activity, AW is a measure of the water available in a system for biochemical and chemical reactions, and for microbial activity (FAO, 1981).

AW is defined as: AW=P/Po, where P is the vapour pressure of the product and Po is the vapour pressure of pure water at the same temperature. The water content of fish is more appropriately expressed in terms of its water activity since this relates to the keeping quality. The water activity is a measure of the free or available water in a food that is able to react chemically or in spoilage to support the growth of micro-organisms such as bacteria and moulds. The water activity of pure water is assigned a numerical value of 1. Other substances have their water activity expressed relative to pure water.

Most of the factors which influence the acceptability and suitability of foods can be related to water activity (Doe et al 1988). The main rationale for drying is to lower the water activity of the fish and so reduce microbial level. In particular, the growth of micro-organisms in dried fish is strongly dependent on water activity. If the water activity is reduced below about 0.62, no bacteria or mould will grow. The growth of pathogenic and putrefactive bacteria in fish can be supported by reducing the water activity below 0.91 (Lupon 1986). No mycotoxin is produced where the water activity is reduced to 0.81 (Troller 1980). Drying reduces other deteriorative processes such as lipid oxidation.

- Enclosed Drying Systems.

Solar dryers are enclosed drying devices designed to collect or concentrate solar energy so that the drying is faster or the product quality is improved. Ajisegiri 2001, categorized enclosed drying systems into three groups or according to:~ exposure of drying commodities, mode of air flow, the temperature of the circulated air. From the classifications there were twenty types of solar dryer that are theoretically possible. These are; the direct, free convection dryer, the direct, forced convection dryer, the direct, ambient temperature dryer, the direct, elevated temperature dryer, the indirect, free convection dryer, the indirect, forced convection dryer, the indirect, ambient temperature dryer, the indirect, elevated temperature dryer, the free convection elevated dryer, the forced convection ambient dryer, the forced convection ambient temperature, the dryer of direct, forced convection with elevated temperature, the dryer of direct, forced convection with ambient, temp, the dryer of direct, free convection with ambient temp, the dryer of direct, free convection with elevated temp, the dryer of indirect, forced convection with elevated temp, the dryer of indirect, free convection with ambient temp, the dryer of indirect, free convection with elevated temp.

According to Trim and Curran 1983, stated that enclosed solar dryers can be categorized into two classes on the basis of the mode air flow through the dryer i.e. natural convection or forced convection. Dryers that employ forced convection required a source of motive power, usually electricity to drive the fan that provides the air flow. In many areas of tropical developing countries, motive power from any source is either available or at best unreliable and

expensive and forced-convection dryers would not be a practical proposition for the majority of astiseral fishermen in these areas.

Solar dryers are designed so that air flow is induced through natural convection. At the same tune, the air temp is increased and the relative humidity is reduced.

A study comparing the cost and effectiveness of several designs of solar dryers, and traditional such drying was undertaken in Ecuador by Trim and Curran, 1983. The study concluded that fish dried on racks were a better product and dried the fish at a higher rate than that of the sun-drying method.

2.6 Salting:

Preservation of fish by salting is one of the most ancient techniques, which can be traced back to 4000 BC, having reached the peak in 18th and 19th centuries. Salting is often used in conjunction with drying and smoking, however it may be used on its own (Clucas, 1990). When a fish salted water is removed from the fish by the salt through osmotic process. As water is removed, salt enters fish flesh and continues to draw out even more water. This creates an environment in which the spoilage bacteria. But salting will not prevent spoilage due to enzymes.

Ilo-Wep 1982, stated that the good salt used for curing fish (fishery salt) is a mixture of chemical compounds. A fishery salt contains from 95% to 98% of common salt known chemically as sodium chloride. Since fishery salt generally originates and from the sea, it contains impurities such as chlorides and sulphates of calcium and magnesium, and sodium sulphates and

carbonates. Other types of fishery salt include rock salt (i.e mined salt) and sun-salt or solar (i.e salt obtained through water evaporation from coaster lagoons or ponds)

There are three main salting methods: kench-salting, pickle, curing and brining. The first two methods yield fish with a relatively high salt concentration while the third method (brining) is commonly used for productions with a low salt concentration.

- Kench Salting:

In kench salting, the fish are mixed with dry crystalline salt and piled up, the brine which forms as the salt takes water from the fish being allowed to drain away. This method is especially popular for large lean fish species. Kenching can be carried out in shallow concrete tanks fitted with a drain, or on raised platforms or racks of approximately 1m/sq are and 8-10cm off the ground. Starting at the centre of the rack, 2 or 3 rows of prepared fish are laid flesh side up over a bed of salt. Salt is then sprinkled or rubbed all over the fish, more being put on the thick parts of the fish than on the thin parts. Whenever scores have been made, these should be filled with salt. A pile of fish is built up by moving out wards from the centre and sprinkling each layer of fish with salt before covering with the next layer. To ensure good drainage, the centre of the pile should be about 10cm higher than the outside edges and it should not be higher than about 2m. the edges of the kench pile should also be regularly sprinkled with salt to prevent contamination. In the tropics, fish are usually left in the kench pile for 24 to 48 hours after which it is dried.

The advantage of kench salting is that the fluids are drained off leaving the flesh fatty dry.

- Pickle Curing:

In pickle curing, a barrel tank is used to hold the brine which form as the salt mixes with the water contained in the fish. From 20 to 35 parts by weight of salt to 100 parts by weight of fish may be used depending on the cure required. Fatty fish, such as Mackerel are commonly pickle-cured.

In this salting method, a layer of dry salt is spread over the bottom of the tank upon which the first layer of fish is laid. There is, however, no need to stack fish higher in the centre as drainage is not required. The layers of salts and fish are overlapped without a salt layer between them since this could cause the fish to stick together.

Pickle curing is recommended in preference to kench salting as it produces a more even salt penetration and provides a better protection of the fish against insects and animals since they are caused with brine.

- Brine Salting:

In brining, or brine salting, the fish are immersed in a solution of salt and water. By varying the strength of the brine and the curing period, it is possible to control the salt concentration in the final product. The method is commonly used in developed countries when a smoked product is to made and the salt concentration required in the food product must be lower than 3% e.g as for hot-smoked Mackerel.

A fully saturated brine contains about 360g of salt to each litre of water (316 10 02 of salt per imperial gallon). Full strength or saturated brine is called 100°c brine. 10°c brine which is made up by mixing 1 part of 100° brine with a part of water is sometimes used to soak fish before salting.

- Salt Quality:

The type and quality of salt used affect the appearance, flavor and shelf life of cured fish. If pure sodium chloride is used for curing, the product is pale yellow in colour and soft. A small proportion of calcium and magnesium salts is desirable as the letter yield a whiter, firmer cure which is preferred by most people. However, if the proportion of these chemicals is too high, the rate at which the sodium chloride impregnates the fish is slowed down. Furthermore, the salt becomes damp as the chemicals absorbs moisture from the air and make the product taste bitter, Ilo Wep, 1982.

Effects Of Salt On The Fish Drying:

Adding salt to fish alters its drying characteristics. The constant rate period becomes shorter and the drying rate is reduced because of the lowering of the water vapour pressure at the surface. The drying rate is also reduced during falling rate drying is diffusivity of water in the fish muscle is lowered by addition of salt (Jeson and Peters, 1983). Fatty fish dry slower than non-fatty fish. The diffusivity decreases with increasing fat content (Doc and Olley, 1990).

QUALITY OF DRIED FISH:

Recommended Quality Control Standards For Dried Fish

Factors Of Quality	**Normal (no defects)**	**Tolerance A**	**Tolerance B**	**Tolerance C**
Discoloration of cut surface (white, yellow, brown, green)	Normal (yellowish, brown)	Light	Significant	Excessive
Bitterness	None	Moderate	Moderate	Significant
Clearing defects (residuals of blood viscera, other objects foreign to the product)	Normal (slight residuals)	Moderate	Significant	Excessive
Insect infestation	None	None	Slight	Significant
Mould contamination	None	None	Slight	Significant
Odour defects (rancidity ammonia, smoky)	Normal (moderately rancidity)	Slightly ammonical, smoky	Significant rancidity smoky	Excessive smoky rancidity.
Water and salt content form A(none salted)	Water maximum 35% salt under 1%	_	Water 35 to 50%salt under 1%	Water under 50%salt under 1%
Form B (salted)	Water maximum 45%,salt 8-15%	_	Water 45%to 50%, salt 5-8%or 25to 20%	Water over 50% salt under 5% or over 20%.

Source F.A.O (1981).

a four or more defects under grade A reduce product to grade B

b five or more defects under grade B reduce product to grade C

This table shows the recommended quality control standards for dried fish (F.A.O, 1981). Factors of quality considered include:

Discolouration of cut surface.

Brittleness

Cleaning defects

Insect infestation

Mould contamination

Odour defects

Water and salt content.

Summarizing the nutritional quality of dried fish Deoand Olley (1990), stated that the original material is manufactured with respect to the individual nutrients, (proteins, amino acid, vitamins, polyunsarturated fatty acid, minerials, and individual elements), if there is a minimum temperature above and oxidation during drying.

2.7 Composition of fish.

The major composition of fish tissues are water, lipids, protein and micro nutrients. The proximate composition of fish may vary depending on certain factors such as the geographical location, season of the year, the feed intake, the metabolic efficiency of the fish, the energy expended by the fish, sex, species, age and size. It can also vary within the individual fish.

- Water

Water accounts for about 80% of the flesh lean fish and about 70% of fatty species. This means that in lean fish such as cod, the water content is about 80%, while in fatty fish such as mackerel it may be as low as 50% depending on the season (Love,1982). There are individual variations but for most species the water content is between 30 and 90%.

The water content of fish is more appropriately expressed in terms of its water activity since this relate to the keeping quality. The water activity is the measure of the free or available water in a food that is able to react chemically or in spoilage to support the growth of micro-organism such as bacteria and moulds. It is abbreviated as aw or an. The water activity of pure water is assigned a numerical value of 1. Other substances have their water activity expressed relative to pure water.

- Protein

Proteins are complex substance occurring naturally and formed from combination of amino acids linked together by peptide bonds, sulythydyl bond and Vander Waal forces. Proteins are the most important constituents of fish body. They are made up of carbon, oxygen, hydrogen and nitrogen; some proteins contain sulphur and phosphorus in addition. The molecular weight of protein is usually in excess of 100,000.

Proteins are present in different forms, in different parts of the animals e.g globular proteins are found in blood and tissue fluids. Collagerous proteins occur in the skin or cell membrane, fibrous proteins are present in the hair, and

muscles e.t.c and crystalline protein are found in the lens of the eye. Most proteins are soluble in water and alcohol. Heating, freezing and exposure to high contamination of salt easily denature proteins.

The quality of animal protein consumption varies from place to place. In developing countries it is about 11kg per capture compared to 5.3kg in developed countries (F.A.O, 1979). In Nigeria, the per capture protein consumption is 7.8kg (F.A.O, 1998).

The proteins of fish muscles fall into three categories, the myofibrillae proteins (65-75%), the myogenes or sarcoplesmic proteins (20-30%), and the connective tissues protein (5-8%)(Suzuki,T, 1981). The myofibrillae proteins are those involved in muscles contraction such as myosin, actinide tropomyosin. The connective tissue proteins contain proteolytic enzymes such as cathepsins. Fish muscles are very rich in high quality protein. It is known that the protein content of the fresh fish muscles lies between 15-20%. However, the protein content can be lower than 15% and as high as 28% thus making fish a very good source of animal protein (Murray et al, 1977).protein is present in all tissues of the fish and make up a very large part of the structure of the cell.

Thus fish protein provides these vital constituents which enable the body to carry out certain function such as growth. Proteins is also important for the repair and removal of the tissue, which are constantly undergoing wear and tear, such tissues are found in the soles of the feet, nails, hair and skin.

- Fish Lipids.

Lipids are fats soluble components found in plants and animal tissue and are made up of fats (primary energy deports of animals), phospholipids of cellular membrane, sphingomylins (present in brain and nervous tissue) waxes (also an energy source) and sterls (component of hormone).

Lipids are made up of the chemical elements carbon, hydrogen and oxygen that are found in carbohydrates but unlike the letter, the numbers of hydrogen and oxygen atoms in the molecule are not in the ratio of two to one.

Fat varies more widely than any other component of fish. The pelagic species have higher fat contents than the demersal species. In both pelagic and demersal species, fat content varies with the behavior of the fish. When the is feeding, fat content increase, when the fish migrates and spawn it no longer feeds but lives on the reserves of fats and the fats content falls. Fish lipids are tightly susceptible to oxidation. This may be responsible for the rapid spoilage of fatty fishes such as sardine, herny and mackerel.

The lipid content of fish can vary more widely than the water, protein or mineral content. Murrey and Burt, reported that while the ratio of the highest to the lowest vvalue of protein or water content encountered is not more than three to one, the ratio between the highest and the lowest fat value is more than 300 to 1. The fats supplied by fish form part of the total fat in the body and these perform a series of function in the body as follows: they provide energy and heat, serves as cushion or packing material in the body and help to support the kidneys, eyes, and most internal organs.

- Fish carbohydrates

Fish contains negligible amount of carbohydrates therefore inclusion of a generous portion of fish in the diet is important in controlling body weight.

- Micro- Nutrients.

These are nutrients required in small quantities, they are mainly three types:

i water soluble vitamins

ii fat soluble vitamins

iii minerals.

Mineral contents of fish are another reason of interest that makes fish unavoidable in the diet. Fish is a source of different minerals that contribute greatly to good health. These minerals include: sodium, which is present in body fluid, magnesium, phosphorus, and calcium in the bones, potassium in cell fluids and iron in the blood hemoglobin.

Fish also contain appreciable quantity of various vitamins which are necessary food substances required in minute quantities, which are necessary for the maintenance of good health. Fish contains all the fat soluble vitamins known as vitamin A,D,E,and K. these vitamins perform useful functions in the body. Fish liver oils are the most potent source of vitamin A. the vitamin content of liver oil varies with species, age, size, set, nutritional condition and sprawing stage of the fish as well as the geographical location and season of the of the catch (Karrick, 1981). The vitamin E content in fish flesh is related to fat

content, geographical location sexual maturity, and seasonal factors, which include diet and temperature.

From the foregoing highlight, there is no doubt that fish can form a very nutritious part of the diet.

2.8 Fish spoilage or deterioration.

As soon as a fish dies, spoilage begins. Spoilage is the result of a whole series of complicated changes brought about by the dead tissue by its own enzymes, by bacteria and by chemical action. The well known characteristics of spoilage in fish are therefore the resultant effects of a host of different charges, few of which are well understood. It is, then all the more remarkable that the changes in the flesh of any particular species of fresh fish caught on a certain ground and stored in ice, generally follow a definite pattern. It is necessary to know that this spoilage parttern in order to be able to asses the freshness of any particular sample, an exercise that is becoming of greater importance in those forms that are establishing quality control on their processing lines.

- Causes of fish Deterioration.

Fish spoilage is manifested by a gradual change on the natural characteristics of the fish after death. Using his or her sense of smell, the consumer can detect changes on the flavoiur of the fish from that of sweet (acceptable) flavor to that of putrid (unacceptable) odour. At the onset of the spoilage, bacteria present in the spore and the gut multiply rapidly and invade the fish. The digestive enzymes in the gut also track down the tissues surrounding the visors creating openings for bacteria to penetrate into the flesh. This invasion continues until

the flesh of the fish which initially was firm to touch becomes soft and flabby. The usually bright red gills also change to brown and later becomes green with strong offensive odour. The skin becomes dull and gritty and the eyes which initially were bright and convex become sunken and cloudy.

Wastage of fish through spoilage has been estimated at about 20 to 50% of domestic fish production in tropical countries. This means that a high proportion of fish produced in these countries do not get to the consumers in a wholesome state. This has in adverse effect on the protein intake at the people who are already facing scarcity of animal protein due to shortfall or meat production.

The prone cause of fish spoilage are bacteria, enzymatic action which result in the production of various volatile compounds, and chemical action involving the oxygen of the air and fat in the flesh of the fish. Spoilage in fish is accompanied by various physical and chemical in gills, eye, slone, skinned tissues. Such charges are undesirable where fish is required.

CHAPTER THREE

3.0 MATERIALS AND METHODOLOGY

3.1 Area of study

The study was carried out in Lagos state metropolis. The state is approximately on 28` 40` East longitude and 6`20` North latitude. The two local government areas which were covered in the state are Epe and Ikorodu.

3.2 Method of data collection

The simple random selection method was employed to cover the two axis of fishing areas in Lagos state, Nigeria. In this two areas only 10 (ten) fishing areas was covered or visited, five in each places for proper coverage. The respondents used were the fisher men, fish processor and fish consumers in these two local government areas. The primary data were collected through the administration of questionnaire. The questionnaires were interpreted when necessary and they were prepared to collect information such as:

- Personal information
- To know whether respondent is a fisher men or not
- Type of processing method employed and why
- Quality that determines the sell power
- The marketing structure of their area.

The villages in which the LGA were picked at random and their LGA headquarters inclusive during the survey; the state map was use as guide to cover the various villages in both LGA areas, in other to ensure a good

coverage of the total area. For example, on a market day in Ikorodu market and Magbonrielede in Epe area, a series of interview was carried out over there i.e. the fish consumer and fish buyer were interviewed to know there acceptability of fish before buying.

A total of 100 questionnaires were administered for each of the two local government areas of Epe and Ikorodu, out of this 200 questionnaires, 70 and 50 were returned and used for the analysis respectively.

3.3 Assessment parameters

Assessment of fish quality using subjective methods involves those tests, which require the use of human sense organs and not machines, chemical or reagent for their estimation. They are also known as sensory tests.

3.3.1 Sensory evaluation of fish

Sensory evaluation for organoleptic changes in the raw chilled, frozen and smoke fish will be conducted on the exposed organs such as the eyes, gills, scale and the entire body of the fish. A taste panel of judges for changes in general, appearance, odour, texture and condition of the scale in the case of scaly fishes may examine samples.

3.3.2 Organoleptic test

This test utilizes the sense of touch, small, sight and taste for quality assessment of fish. This test may either use single or in combination with each other frequently to assess the appearance of the fish including the gill color and presence or absence of indentations.

3.3.2.1 Appearance/ visual inspection

The sense of sight is used either alone or in conjunction with other four senses in quality assessment. The sense of sight can detect in the raw fish, changes in the colour of gills, the condition of the eyes, the condition of the belly, and the general appearance of the fish. Visual examination in cure fish, determine the general appearance, the degree of insect and the mode of infestation, the intensity of smoking will judge by the colour and appearance of smoked fish.

3.3.2.2 Touch

The sense of touch is also important in quality assessment. The sense of touch is used mainly to access the texture of the fish. The textures determine the mechanical behavior of the fish musculature. By the sense of touch it is possible to access whether the fish muscle is elastic, firm, sold or flabby. The tendency of dry whole fish to ferment can be access by subjectively by bending. If the fish bends without break it is flexible; if it is break into large pieces while bending, it is firm, but if it is break into small ferment, it can be said to be brittle.

3.3.2.3 Smell

The sense of smell is very unique, in that so far, no instrument is capable to perform this task. The human sense of smell can differentiate between good and bad quality fish. The help of sense of smell can also be detect the flavor of smoked and cooked fish.

3.3.2.4 Flavor

Flavor is a combination of taste and odour. Volatile organic compound directly influence the taste and odour originally present in the fresh state or produce during spoilage or processing. Since flavor is so important in quality assessment, attempt were made to measure it by objective test than subjective method of taste panel evaluation

3.3.3 Taste panel

Taste panel were set up to examine any change in fish processing and obtain numerical score the different sample evaluated. The taste panel may be train or untrained. The train panel may involve screening of group of people for primary test which are; sweet, sour, bitter and salty. For the untrained panelist, a large population is often recommended in other to minimize error in the judgment. The use of small number is accepted but it was ensured that the judges give accurate information of the state of fish quality during the assessment

3.4 Microbial load

Microbial load can be measured by a number of methods depending on the particular micro-organism in question. Method commonly used in practice include indirect cell count, direct cell count, colony size, dry weight and turbidity.

3.4.1 Indirect cell count method

When bacterial suspensions are planted out on ager a living bacterial cell may give rise to a bacterial colony. Hence plating is used to determine the number of bacterial in a given material. The sample is serially diluted, plated and incubated and the colonies which subsequently develop are counted. The number of colonies is then multiplied by the degree of dilution (dilution factor) to obtain the number of bacterial in original sample.

3.4.2 Medium required

The medium contain the following compositions;

Beef extract - 3.0g

Peptone - 5.0g

Ager - 12.0g

Sodium chloride – 8.0g

PH – 7.3 $\pm$ 0.2

Five Samples of Smoked Fish

The nutrients ager is used for the cultivation of bacterial and for the enumeration of the organism in water, food, fish, sewage e.t.c. it is called GENERAL PURPOSE MEDIUM.

3.4.3 Procedure

28g of nutrient ager powder is suspended into 1litre(one liter) of Distilled water, mix thoroughly head to dissolve completely, sterilize by autoclaving at 121°c for 15minutes and pour plates.

3.4.4 Preparation of diluents

1g of peptone water was suspended into 100ml of distilled water; 9ml of solution was dispensed into six test tubes in six different places. The test tubes were autoclaved at 121°c for 15minutes. They were kept to cool after autoclaving.

1g of fish sample was introduce into the first test tube labeled 10^{-1} and shakes. 1ml from the 10^{-1} was taken and introduced into 10^{-2} to10^{-6}. That was repeated to the subsequent samples.

SAMPLE "A" 10^{-3} was plated on the nutrient ager

SAMPLE "B" 10^{-4} was plated on the nutrient ager

SAMPLE "C" 10^{-3} was plated on the nutrient ager

SAMPLE "D" 10^{-4} was plated on the nutrient ager

SAMPLE "E" 10^{-3} was equally plated too.

The plates were incubated at the temperature at 37°c for 24hrs.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

This chapter focuses on the detailed analysis of data collected from various fish farming areas visited in parts of Lagos state, Nigeria, during the course of this study.

This chapter also contains the major methods in which fish products are normally processed in Lagos, state, Nigeria. The quality assessment parameters of fish products after processing in Lagos state and microbial load or count of fish products after the processing.

4.1 Results of data collected

The first subsection is devoted to socio-economic characteristics of the respondents while subsection two is devoted to the type of processing employed in Lagos state .And the last section examines the sell power of the processed fish product in Lagos state ,Nigeria.

Table1: Distribution of respondents according to their socio-economic characteristics in Lagos state, Nigeria.

Socio-Economic Characteristics	frequencies	percentages
Age		
21-30	12	10.00
31-40	50	41.67
41-50	45	37.50
51-60	13	10.83
Total	120	100.00
Mean age = 40.5		
Marital status		
Single	25	20.83
Married	85	70.83
Divorced	10	8.33
Total	120	100.00
Education		
None	20	16.67
primary	70	58.33
secondary	30	25.00
Total	120	100.00

Occupation		
Fish farming	60	50.00
Civil servant	20	16.67
Artisan	10	8.33
others	30	25.00
Total	120	100.00
Gender		
male	40	33.33
female	80	66.67
Total	120	100.00

Table 1 shows the distribution of respondents according to their personal characteristics from the study area. Both the frequency and percentage distribution were shown in the table. The mean age was found to be 40.5 years indicating that they are in their active and productive age.

The study shows that the area was dominated by married people, in indication of the fact that many of the respondents are stable and they consume fish products. However, the type of processing method one employs may be different from the other.

Furthermore, about 50% of the respondents indicate that fish farming is their major occupation. Also, many consumers and processors are female; about 66.67% because women are food planners in their families in most cases and

they are the major ones interviewed for this study. To know which type of fish processing methods they prefer for their family. The male respondents are men who are either fishermen or bachelors that normally went to market to buy fish products.

Table 2: Processing Method used at visited Areas in Lagos State

Serial Number	Local government area	Location	Type of processing methods
1	Epe	Ilubirin	Smoking method
		Magboalade	Smoking method
		Eleko	Smoking method
		C.M.S	Smoking method
		Eti osa	Smoking method
2	Ikorodu	Biaoku	Smoking method
		Ofin	Smoking method
		Igbogbo	Smoking method
		Ijede	Smoking method
		Meran	Smoking method

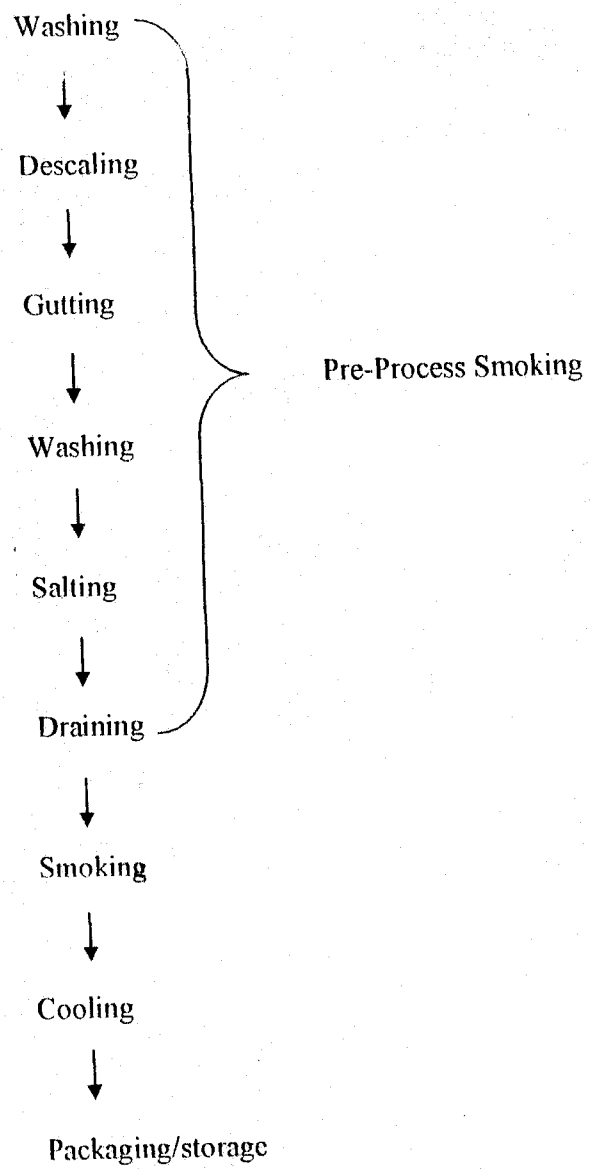
Table 2 also showed that the major fish processing method in Lagos state is the smoking method because the consumers of fish product prefer smoked fish than any other processing methods and smoking is often at do ne at low temperature to produce the desired colour and flavor while other processing methods are relied upon for preservation.

4.2 Types of smoking methods used at various sites visited

Smoking method is the major processing method in Lagos state and environment. Fish smoking is normally carried out by women at the various processing centre visited because of the belief that smoking is a woman's activity and some of the pre-smoking exercise was normally carried out by the processing women at the various processing sites.

Smoking of fish in Ede and Ikorodu area of Lagos state is normally carried out by the use of traditional smoking kiln. The smoking kiln used is a drum cut by a traditional blacksmith to give the shape of an oven in which firewood or smoking catalyst is kept. The smoking kiln was initially heated up to a temperature of about 650c to 700c as observed. Smoking of fish product according to F.A.O report in 1993 of women of chorkwi that helped to extend the shelf life of fish products.

Smoking method was used for coiling of fish species like pale,kote etc at Epe and Ikorodu area of Lagos state, this coiling method of smoking where fishes are bend into shape and sticks which are shaped like pegs are used I n pegging the head of the fish to its tail. The pegged fish are smoked and thus makes it bend physically permanent.



4.3 The process of smoking fish product

The production of smoked fish in various part of Lagos, state involves a number of preparatory operations, many of them are vital for manufacture of good salcable articles in the state.

Splitting and canning:

This is one of the precise treatments that depend on the product; care was always taken not to bruise the fish. All pieces of gut, gill and kidney were normally removed because these g o bad quickly and may spoil otherwise good fish.

Salting:

This is also done by soaking the fish in brine .one of the permitted dyestuff is added, it is washed to colour the fish. The duration of the brine dip depends on the brine strength and the size and flatness of the fish product, although if the fish is not very thick, most of the salt enters during the first three to four minutes .brining time also depends on the degree of stirring of the fish product in the brine. 70% - 80% saturated brine is usually employed for all the common types of smoked fish. If a fully saturated or 100%, brine was used, the appearance of the finished product may be massed by fine powdery crystals of salt on the gill cover or skin.

In a 50% brine, fish swell slightly and although they will still take up to 2.3% salt, they also give 2.3% of the weigth.the additional water has to evaporated during smoking. In 90% – 100% brine, there is a 2.3% weight loss. Fish can be contaminated by scale brine and they do not then keep as well as they would otherwise.

Hanging:

fish product is normally hung to drip water either on racks or in the kiln. Protein dissolves in brine to give a sticky solution; during the dripping period this dries on the cut surface and produces the peculiar glossy skin which is one of the commercial criteria of quality. The best gloss is usually obtained with a 70% – 80% of brine; brines weaker or stronger than this may sometimes produce a rather duller appearance .smoked fish that has not been salted at all has no gloss and looks dull and rough.

Packing:

It is well known that fish should be allowed to cool after it is removed from the rack or kiln and before it is packed. During the cooling period it goes on loosing weight and if it is packed hot, it develops a most moist or flabby appearance .these moist condition encourages the growth of mould.

4.4 Result of assessment parameter

Quality can be defined as the characteristics or attributes which makes fish product acceptable to the consumers .in view of this the assessment of the smoked fish being produced in Lagos state was carried out by a testing plane, to determine the quality of the fish product, the testing plane which consist of the consumer and some students are able to consider its appearance ,texture etc and the safety of fish in terms of the microbial load on the presence or absence of pathogenic organism as well as the palatability of the fish product.

The testing plane consist of 10 members consisting of consumers and students to determine the quality of smoked fish produced in Lagos state .a guide line was produced in assessing this fish product. And a different type of smoked fish which was processed in Lagos state was provided for assessing its quality.

4.5 Use of statistical method

From the assessment guide a method was used to determine the mean of various smoked fish product been produced in Lagos state

From the assessment procedure different quality appraisal like taste, colour, odour etc, these mean was determine by using this statistical method.

However, each member of testing plane score the smoked fish product with a different grade depends on the quality of the fish product.

Colour:

$$\frac{8+8+8+9+9+8+8+8+7+7}{10} = 8.0$$

Flavor:

$$\frac{7+7+8+7+8+8+7+9+9+8}{10} = 7.8$$

Texture:

$$\frac{8+9+8+9+7+7+8+8+7+9}{10} = 8.0$$

Taste:

$$\frac{8+8+8+9+9+8+9+8+8+7}{10} = 8.2$$

Overall acceptability:

$$\frac{8+9+8+8+9+9+7+7+8+8}{10} = 8.1$$

From this assessment guide which graded the fish product from 8 to 10 very good product. This means that all the smoked fish product being produced in the two axes of Lagos state i.e. (Epe local government area and Ikorodu local government area) are processed by the processor.

4.6 Result of microbial load on fish samples

The results of the microbial load of the five samples of smoked fish were obtained after 24 hours of incubation of the five samples.

Sample A: $39 \times 10^{-3} = 3.9 \times 10^{3}$ CFu/ml

Sample B: $36 \times 10^{-4} = 3.6 \times 10^{4}$ CFu/ml

Sample C: $60 \times 10^{-3} = 6.0 \times 10^{3}$ CFu/ml

Sample D: $40 \times 10^{-4} = 4.0 \times 10^{4}$ CFu/ml

Sample E: $52 \times 10^{-3} = 5.2 \times 10^{3}$ CFu/ml

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The survey was conducted to assess the major fish processing method and quality appraise in the Lagos state, Nigeria.

The survey shows that the major fish processing method in Lagos state, Nigeria is smoking method which is mainly of wood and sawdust. Apart from the other processing method, the smoking of fish product is the easiest and cheapest of all other processing method. The survey also shows that the major processors of fish product are women.

The survey also shows that the selling power of fish product in Lagos state, Nigeria is dependent on the appearance of the fish after it is been smoked and the quality of the fish product in term of freshness, colour, odour, texture and the safety of the fish in term of the microbial load.

5.2 Recommendations

- Since the major fish processing method in Lagos state is smoking method, it is best to keep the temperature in the smoking chamber or oven below 30°C at the start of the smoking processing. Ensure that during the cold smoking the temperature is kept at this level throughout the process. All racks of fish have to be moved to different parts of the kiln so that all the fish get the same smoking treatment.

- Grants, loans and subsidies should be given to fish farmers and marketers to enable them purchase modern equipment in order to increase supply.
- Private individuals and corporate bodies should be encouraged to venture into fish production.
- Since it was discovered that many people preferred smoked fish than other processing method, efforts should be made to help the processor in the area of improving the smoking kiln and encouraging the local fish farmers through incentives

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QUESTIONNAIRE

RESEARCH TITLE:- Case study of fish processing methods and quality appraisal of products in Lagos State, Nigeria.

RESEARCHER:- ALEGBE-IGE-OLUWAYEMI
Department of Agricultural Engineering
Federal University of Technology, Minna, P.M.B. 65,
Niger State, Nigeria.

Dear Respondent,

It is a fact that effective storage strategy can adequately enhance the shelf life of agricultural product, such as fish, meat, grains, vegetables and berrie state etc. It is in view of this strategy, that this questionnaire was designed in order to gather useful information on the various methods of fish processing and the quality appraisal of the various end products in Lagos State, Nigeria.

Your prompt response to this questionnaire would contribute immensely to devising a better technological means of improving fish processing methods in Lagos State in particular and the country in general.

..... **Thanks you for your response.**

PERSONAL DETAILS

(A).

Name of Respondent..... TAOFEEK AJALA.....

Local Government Area... MAGBON ALADE/ETI OSA LGA

Town/Village:- Town ☐ Village ☑

Sex:- Male ☑ Female ☐

Age:- 20 – 25 years ☐ 26 – 30 years ☐ 31 – 35 years ☐ 36 – 40 years ☐

41 – 45 years ☐ 46 – 50 years ☑ 51 – 55 years ☐ 56years and above ☐

Education Status:- Primary ☐ Secondary ☐ NCE/OND ☐

Non-Formal ☑ HND/Graduate ☐

Primary Occupation:- FISHING.....

Other Occupation [Specify]:-.....

Marital Status:- Single ☐ Married ☑ Divorce/Separate ☐

- If married, number of wives
- Number of children
- Residential Status
- Language:- Yoruba ☑ Ibo ☐ Hausa ☐ Nupe ☐

English ☐ & Other ☐

FISHING

(B).

- Do you fish? Yes ☑ No ☐

- Where do you fish?
  - From the Shore?..... Yes ☑ No ☐
  - From the Lake?..... Yes ☐ No ☐
  - From the Pond?..... Yes ☐ No ☐
  - Any other information.....

- What fishing gear do you have or own?

TYPE	NUMBER
Gill net	
Cast net	
Beach	
Trap	
Hooks	
Boats	

- Who has she bought it from? The fisherman ☐ Another trader ☐

- When did you start fish business?

PROCESSING

(C).

- What fish processing method do you practice?

  Sundrying ☐ Smoking ☑ Frying ☐

  Fermentating ☐ Salting ☐ Canning ☐

- Why do you preferred his type of processing method?

  Faster ☑ Cheap ☑ Easier ☑ Other ☑

- For how many days do you preserve/store the fish before selling?

  Immediately ☑, 2/3 day ☐, 5 to 7 days ☐, Others ☐

- How fresh is the fish immediately before processing?

  100% fresh ☑, 80% ☐, 50% ☐, Others ☐

- Is the fresh fish prepared before it is processed or sold fresh? Yes ☑ No ☐

- What type of storage used to store the fish after processing? BASKET

- What type of fish do you purchase? ANY

- What is the time interval between when the fish is bought and when it is sold fresh? IMMEDIATELY

- How often do you go to the river or pond for fishing or harvesting?
  Daily ☑, twice in a week ☐, weekly ☐, monthly ☐

- Is the fish kept cool before processing? Yes ☐ No ☑

- In all types of processing method which one do people prefer most?
  Smoking ☐, Frying ☐, Sundrying ☐, Fermentating ☐

- In terms of odour which one did you prefer most after processing? ALL

- In terms of taste which one did you prefer most after processing? ALL

- Will the bought fish be sold fresh or processed? Fresh ☑ Processed ☑

- How many did you sell in the next day? N3000

- In terms of appearance which one did you prefer most?

- How is the fish prepared?
  - Is it gutted? ☐
  - Is it gilled? ☐
  - Is it washed first? ☑

- What factors determine how fish is purchased or bought?
  Freshness ☑, Size ☑, Quality ☑, Other ☑

SMOKING

(D).

- What equipment is used for processing?
  Drum and Oven ☑, Improved Kiln ☐, Other ☐

- How are the fish arranged for smoking? Vertically ☑, Horizontally ☑

- What happened to other fresh fish which cannot fit into the smoker? ALL WILL BE SMOKED BECAUSE OF ELECTRICITY

- Is the product burnt/charred? Is the interior of the fish still moist after smoking?
  Yes☐ , No☑

- What is the weight of fuel consumed per kg of fish smoked? NOT FUEL BUT SAWDUST

- Is the operation easy? Yes☑, No☐

- Are there any safety hazards? Yes☑, No☐

- What is the source of energy? Sun☐, Fuel☐, Wood☑, Other☑

DRYING

(E).

- Is salt used in drying? Yes☐, No☐

- If not, is salt available to use and would the taste of the product be acceptable?
  Yes☐, No☐

- Why is salt used during the drying processing?
  - for flavour? ☐
  - to increase storage life? ☐

- Is enough salt used to deter blowfly and beetle infection? Yes☐, No☐

MARKETING STRUCTURE

(F).

- Who sell the processor's product(s)? THE PROCESSOR/CHILDREN

- Where is her product (s) sold? Marketing☑, Street☐, Other☐

- Who does she sell to? TRADERS/SALESPERSONEL

- What is the storage life of the processed fish?
  2 to 5 days☐ Weekly☐ Monthly☐ Other☑

- How long is the period between processing and selling? IMMEDIATELY

- How/where is the product stored? BASKET

- Is any processed fish rejected after storage? Yes☑, No☐

- Is the processed fish damaged during transport? Yes ☑, No ☐

- What determine the selling price of the fresh fish?
  Quality ☐, Size ☐, Appearance ☑, Taste ☐, Odour ☐ etc

- How much time does the processor spend on processing fish?
  2 to 3 hours ☐, 6 to 7 hours ☐, The whole day ☑

- What are the costs of processing?..... NONE .....

- What other economic activity does the processor engage in?.....

- Is the processor satisfied with her income from fish processing? Yes ☑, No ☐

- How does she think it could be improved?