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GLIMPSE OF FISH AS PERISHABLE STAPLE

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Abstract: **Glimpse of fish as perishable staple was reviewed. Fish is an important animal protein as it supplies good quality protein, vitamins and minerals. It is however highly perishable and spoils quickly, bad fish handling after harvesting, inadequate storage and processing facilities also contributes to fish spoilage in developing countries thus causing a lacuna between fish demand and supply, thus posing a great challenge to food security. Processing of fish facilitates its maximal use as for value-added fish products. Smoking is the preservation method most adopted in many developing countries to extend fish shelf life. Fish post-harvest loss come in different faces including: physical loss, quality loss and market forces loss all of which will lead to reduction in fish shelf life. Antimicrobial properties of plant extracts and proper packaging can extend fish shelf life. There in need to encourage women participation in fisheries subsector as their active role is essential to fighting poverty and ensuring food security within many households.**

Keywords: **Glimpse; fish; perishable; staple.**

I. Introduction

Fish is an important source of animal protein on earth. It is eaten by many because it is cheap in the markets and have nutrient quality including high source of good quality protein and minerals (Iheagwera, 2013). Ali (2012) opined that fish supplies nutrients essential for human body such protein, vitamins and minerals. Damsgaard *et al*. (2006) also reported that fish is an important component of the diet for many people due to its association with improved cardiovascular health and other improved health related effects it has on man. Fisheries resources are very vital for the livelihood of many people living in the coastal communities in Nigeria (Widjaja *et al.*, 2009). However, fish is highly perishable and spoils very quickly (Edah *et al*., 2010). One major problem that has been reoccurring in Nigeria fisheries industry is rapid fish spoilage occasioned by improper handling of fish after harvesting, inadequate processing and storage facilities, thereby widening the gap between demand and supply. This poses a great danger to food security for the entire nation (Ogbonnaya and Ibrahim, 2009). Processing of fish is very vital as it facilitates the use as fish as raw material for the production of other valuable fish products thereby increasing the profits of the fish farmers and increasing Government revenue through tax collected from such value added products (Tawari and Abowei, 2011). Ayeloja (2019) stated that many preservative methods are employed in extending fish shelf life including smoking, sun drying, canning, solar drying among others. However, smoking is the most adopted method in many developing countries (Ayeloja *et al.*, 2020a).

II. Methodology

1. Significance of Fish

Fish is a good protein source and the fisheries sector provide livelihood for millions of people globally (Al-jufaili and Opara, 2006). It is a veritable source of animal protein for low income earners (Abolagba and Melle, 2008; Hasens and Olafsen, 1999). The importance of fish in the life of mankind is enormous as it is an important natural source of protein; it provides useful products as well as contributing positively to the economy of many nations (Ayeloja *et al.*, 2020b; Adebayo and Adesoji, 2008 and Salaudeen *et al.*, 2010). It is a major source of food as it supplies balanced protein, vitamins and minerals to the body therefore making it a major constituent of food of many people in developing countries (George *et al.*, 2014; Ayeloja *et al*., 2011; Obande and Solomon, 2000). Fish have high biological value, this make it a food of choice by protein deficient patients; it is know quickly replenish the warn out cells, replenish the bone nutrients, low cholesterol content and high in unsaturated fatty acids (Oluwatoyin *et al*., 2010). According to Abdullahi *et al.* (2001), fish is a safe

source of essential and nonessential amino acids, minerals, long chain polyunsaturated fatty acids (LCPUFAs) and vitamins making it a good food for supplementing both infant and adult diets. It is also a food of choice required for improved health condition and prevention of diseases in elderly people (Kabaherda *et al*., 2009, Sampels, 2014 and Adebayo-Tayo *et al.*, 2012). According to Sampels (2014), consumption of sea fish has tremendous health benefits such as cancer prevention, reduction in the risk of coronary heart and cardiovascular diseases as well as reduction in arthritis and inflammatory disease. Many Nigerians prefer to consume fish than poultry, beef, mutton, pork and veal because fish contain high essential sulphur-containing amino acids such as cysteine, methionine and lysine as well as its high taurine and choline content; it is also a good source of Vitamins D, B12 and supplies some essential minerals such as calcium, phosphorus, iodine and selenium (Adedeji *et al.*, 2012 and Sampels, 2014). Fish also have low feed conversion rate (FCR) than many land living animals (Masilko, 2014).

III. Discussion

1. Post-Harvest Fish Loss

Animal protein sources such as in Nigeria, Many Nigerians settle for the consumption of fish due to its cheap cost and nutritional benefits as against the high cost of other animal protein sources such as beef, mutton and chicken which are beyond the reach of many low income earner (Adedeji *et al.,* 2012 and Ayeloja, 2020c). Wafaa *et al.* (2011) and Adedeji *et al.* (2012) opined that fish constitute an important food component of many people in the world due to low health risk associated with its consumption. The low fat content of fish and its attendant positive effect on coronary heart disease gives it its preference among health conscious people especially in rich countries where cardiovascular disease mortality is high (Adebayo-Tayo *et al.*, 2012). Emikpe *et al*. (2011) stated that about 60% of the world protein supply is through fish, it also contribute as the highest source of animal protein to many people in the developing world. The global demand for fish is steadily rising while the supply outlet are decreasing, data on domestic fish supply in Nigeria by Ayo-Olalusi *et al*. (2010) indicate that 620,000 tonnes was the average domestic supply of fish while 74,000 tonnes of fish valued at US$594.4 million was imported to augment the shortfall in fish demand leaving a deficit of 1.3 million tonnes. Adewolu and Adeoti (2010) reported that fish makes a good supply of quality protein in the food industry as it contributes about 40% to protein intake of the average Nigerian; and fisheries and allied industries also provide employment opportunities to many people living in the coastal areas in different forms such as production, processing, preservation and transportation. Victor (2014) define postharvest loss as the degradation in both quantity and quality of a food production from harvest to consumption; quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product while the quantity loss refers to those that result in the loss of the amount of a product. According to Kitinoja and Gorny (2010), farmers and food sellers have been concerned about losses from time immemorial yet the problem of how much food is lost after harvest to processing, spoilage, insects and rodents, or to other factors take on greater importance as world food demand grows. Post-harvest fish losses occur in most fish distribution chains throughout the world. The losses results in lost of income to fishers, processors and traders, they also contribute to food insecurity as loss of fish leads to less fish availability for the consumers (Yvette and Yahya, 2011). FAO (2010) reported that fish post-harvest losses amount to about 10 to 20 million tones annually while about 20 million tones of fish are also discarded at sea which is another form of post-harvest loss thus the need for concerted effort at improving food security, which will in turn lead to an increase in the percentage of fish consumed. Increase in fish post-harvest losses occasioned by poor fish handling after death which lead to biochemical and microbiological spoilage of fish after death do lead to fish scarcity and often widen the gap between fish demand and supply (Kumolu-Johnson and Ndimele, 2011; Yvette and Yahya, 2011. However, live fishes have natural defence mechanisms against spoilage but these defence mechanisms stops once a fish dies and chemical and microbial deterioration sets in. Yvette and Yahya (2011) stated that some of the factors influencing the rate of spoilage of fresh fish include: duration of time between death and final use or consumption of fish; ambient temperature which favours spoilage of fish; poor postharvest handling; improper processing methodology; animal predation and insect infestation; inappropriate packaging and storage practices leading to damage of the end product; market dynamics, especially fluctuations in demand and supply of fish and fish products. Imaobong and Mandu (2013) reported that in artisanal fisheries, post-harvest fish losses are characterized by lack of processing and storage facilities. In Nigerian capture fisheries, not less than 50% of post-harvest loses are recorded annually thus the need to preserve and process fish immediately after harvest so as to reduce fish post-harvest losses (Nkeme *et al.*, 2013). Low financial status of artisanal fishers, lack of means of transportation and the remote locations of the fisheries makes catches get spoilt easily thus the need to provide post harvest facilities at fish producing communities (Imaobong and Mandu, 2013). Udong *et al.,* (2010) reported that fish processors in Nigeria still use the traditional processing methods inherited from their forefathers to elongate fish shelf life. However, most of these traditional fish processing methods are not very effective in preventing fish spoilage leading to

high loss of fish. Al-Jufaili and Opara (2006) reported that high fish postharvest loss is a major challenge in the struggle of government to realize high income from fish subsector. Kiin-Kabari *et al*. (2011) reported that fungal spoilage, lipid oxidation with attendant production of off-flavours and poor storage stability of smoke-dried fish also constitute challenges in the Nigerian fishery industry. Yvette and Yahya (2011) reported that the main types of fish post-harvest losses include: physical loss; quality loss and market force loss.

2. Physical Loss of Fish

Physical fish loss refers to fish that are not used after capture or landing. It is either thrown away accidentally, voluntary or as authorized. Physical loss can be caused by theft, by insects eating the fish, or by bird or animal predation. Ayuba and Omeji (2006) reported that insect infestation is the cause of most prominent losses in quality and quantity of stored, dried fish in Nigeria. Medugu and Kabir (2013) also reported a large infestation of smoked fish by *D. maculatus* and *N. rufipes* resulting in substantial weight and quality losses. Ayeloja *et al.* (2020c) reported that insects at their larvae stage cause more economic loss to smoked fish than adult insects, while *Necrobia rufipes* and *Dermestes* spp. most common insect species found to infest smoked fishes. The type of fishing gear use also play significant role in post harvest fish losses as some fish would have died in the water and have begun to spoil before the fishing gear is hauled into the canoe thereby commanding low market price that do not worth landing and they are therefore thrown away at sea (Adeleke *et al.*, 2013).

3. Quality Loss of Fish

Quality loss refers to fish that has undergone physical damage, biochemical deterioration and microbial spoilage due thereby leading to reduction in the acceptability of the fish by consumers. Such fish does not command high market price, the fish monger is therefore forced to sell it at a give away price leading to loss of revenue. The poor transportation network in many developing countries usually force fish farmers to hold fish in transit unnecessary and this to quality loss of fish. Inadequate market information also result in prolonged keeping of fish and fish products for long periods by fish mongers thereby leading to degradation in the quality of fish and spoilage. George *et al.* (2014) also stated that fish should be processed as soon as the fish are caught or harvested so as to get good product. Some fresh-fish traders do not use ice and this lead to post-harvest fish loss when the customers do not come to buy them during the day. Therefore, good fish harvest postharvest handling practices should be employed in other to reduce fish post harvest loss.

4. Market Forces Loss

Market is usually driven by forces of demand and supply and situation where supply far exceed demand do result in crash of the value of such commodity thereby leading to loss occasioned caused market forces (Yvette and Yahya, 2011). Market forces usually compel fish farmers to sell their fish product below the expected price expectations if there is glut in the market especially during the peak season (eg raining season) as increased fish production usually lead to increase in fish supply, when fish flood the market, the price will fall leading to economic loss due to market force. Lack of market information is another clog that do prevent fish producers from accessing to the right market with the appropriate fish product at the right time leading to economic loss. Marketing malpractices is another challenge that do lead to cheating or improper pricing of fish and this can cause market force loss. Therefore, there is need by researchers to devote utmost interest and resources towards minimizing fish post-harvest losses as quality loss of fish can lead also lead to loss of revenue by fish producers and if the economic loss lingers, it can lead to loss of interest in fish production (Tawari and Abowei, 2011).

5. Fish Handling

Fish is a major natural resource in world and it provide livelihood for many people involved in fish related activities such as fish harvesting, Aquaculturists, fish processors, fish marketers and service providers eg transporters etc, it is also serve as source of foreign exchange earnings for government (Al-Jufaili and Opara, 2006). Tawari and Abowei (2011) reported that a lot of fish is lost after capture due to improper handling, it is therefore important to adopt appropriate fish handling practice wile handling freshly caught fish so as to increase its shelf life. As a rule of thumb, fish farmers should avoid any rough handling that will make the fish struggle unnecessarily or die of asphyxia or oxygen starvation. Struggling after capture, hastens post-mortem spoilage by accelerating chemical reactions in the flesh of the fish. This usually reduce the duration of rigor mortis or muscle stiffening; thereby fast racking the process of bacteria attack and spoilage. However, catfish is known to remain alive after capture and would need to be stunned quickly after harvest to arrest degradation (Ayuba and Omeji, 2006). Once fish is taken out of their natural habitats, decomposition processes set in which will affect the end product and it is important to ensure quick and safe delivery of fish and fish products to consumers (Imaobong and Mandu, 2013). It is common practice to keep fish clean and maintained at low temperatures in order to minimize spoilage.

There are numerous requirements, including the adequate supply of portable or chlorinated water which has been observed to remove most of the bacteria on fish body (Davies, 2006). Adams and Moses (2008) opined that time and temperatures control is the most important thing to do in other to ensure that seafood retains good freshness quality as long as possible, it is therefore important keep fish storage environment low during transportation and shield them from direct sunlight as fish the high ambient temperature in the tropics also aid fish deterioration (Ayeloja, 2019).

6. Fish Preservation and Processing

All the balanced biochemical reactions in healthy life fish is reversed after death resulting in gradual degradation and spoilage of fish (Akinola *et al*., 2006). Davies and Davies (2009) stated that fish is highly susceptible to deterioration without any preservative or processing measures and immediately a fish dies, a number of physiological and microbial deterioration sets in thereby degrading the fish. Akinneye *et al*. (2007) reported that method of capturing the fish could also influence the rate of spoilage as unsuitable method of harvesting can result in mechanical damage of fish, creates stress conditions on the fish which can accelerate its rate of deterioration after death. Health status of captured fish also play an important role in fish spoilage, the presence of parasites, bruises and wounds on the skin and the technique used in fish capture influences the health condition of captured fish. Emere and Dibal (2013) opined that it is necessary to preserve and process fish quickly in order to ensure the safety of the product, it is also important to moisture content of fish product to the bearest minimum due to the its perishable nature. Tawari and Abowei (2011) advised that freshwater fish processing should be properly preserved and processed in order to reduce wastes to the barest minimum. Oluborode, *et al.* (2010) also advocated for proper preservation and processing of fish as proper preservation starts the moment fish is harvested until it reaches the consumer's table. Akinola *et al*. (2006) reported different types of preservation methods to include drying, smoking, freezing, chilling and brining while Ayeloja stated that smoking is the most widely used fish preservation method in Nigeria. Kumolu-Johnson *et al.* (2009) reported that smoking resulted in concentrating crude protein components of fish as protein nitrogen will not be lost during drying process rather the protein level of fish will increase after smoking. Emere and Dibal (2013) in their study on the survey of the fish processing and preservation employed by artisanal fishermen in Kaduna city reported that the various methods of fish processing and preservation employed by fishermen in Kaduna city include; smoking, sun drying, salting, frying or a combination of these. However, the most prominent fish preservation method employed in the Niger Delta and entire Nigeria is smoke-drying. Smoking as a method of fish preservation combines three effects including; preservative value of smoke, drying and cooking, the operations involved in fish smoking impart pleasant flavour to product as well as preserving the fish (Abolagba and Nuntah, 2011). Akinola *et al*. (2006) stated that the traditional fish preservation methods employed in Nigeria is rudimentary as there is limited control over the drying process, some fish processors sometimes under-dry or over-dry with unnecessary exposure of the fish dirt, dust and insect infestation. There should be improvement in the traditional method of fish processing in other to reduce fish post-harvest losses in Nigeria. There is need to shorten the time it take to smoke fish using the traditional method as the several hours required to smoke dry fish in the oven couple with uncontrolled smoke make the process laborious. The quality of the product is judged by the degree of drying and appearance. During drying, water is removed from the surface of the fish. As the surface water is removed, it is replaced by water drawn up from the fish tissue, which leaves the fish surface. The rate of drying, consequently, the rate of removal of water is dependent on the air speed, relative humidity and temperature of the surrounding air (Delgade *et al*., 2003; Davies *et al*., 2008), if the surrounding air conditions remain constant then the rate of drying will also remain constant. This stage of drying process of drying is referred to as the "constant rate drying". As the removal of moisture from the fish continues, the drying effect continues. Eventually, the concentration of the moisture at the fish surface falls consequently, the movement of moisture to the surface also drops and the drying rate slows down. This stage is referred to as the "falling rate drying" (Emokpae, 1979 and Davies *et al*., 2008). Both rates drying are under the influence of numerous factors. Notably is the relative humidity of the air. If the air is fully saturated with water vapor, drying will not take place. The relative humidity must be less than 100% for drying to occur. It is obvious therefore that the lower the relative humidity, the faster the drying rate. Increased air speed results in faster drying rates (Eyo, 1997; Krasemann, 2004 and Eyo, 2001). When smoking a fish speed of drying is influenced by a number of factors including; the speed of the air flow, the moisture content of the fish, the temperature and moisture content in the smoke and most importantly, the relative humidity (RH) in the surrounding air (Krasemann, 2004). Humidity can affect the speed of drying by limiting the absorption of water by the air. RH is usually about 65% at 30°C, which are very good conditions for cold-drying. A RH of less than 65% may cause hardening of the product and an RH higher than 65% will prevent effective drying (Krasemann 2004). Daramola *et al.* (2007) recommended that moisture content less than 10% should be maintained in stored smoked fish to reduce the growth of bacteria and moulds. Damage and insect infestation negatively influence smoked fish quality. Smoked fish as source of foreign exchange is gradually losing ground because the laws governing the

exportation of processed fish to developed countries are becoming increasingly stringent due to the emergence set of Food Safety and Agricultural Health Standards, along with changing market requirements (Oyelese, 2006; Abolagba and Nuntah, 2011).

7. Fish Smoking

Man has used smoke for preservation and preparation of food for thousands of years (Krasemann, 2004; Holma and Maalekuu, 2013 and Oluborode *et al.*, 2013). Smoking is a popular traditional method of fish preservation in most developing countries (Tawari and Abowei, 2011; Oyelese, 2006; Abolagba and Nuntah, 2011 and Akinola *et al*. (2006). Several methods are available for smoking; and different smoked products have been developed in various parts of the world in relation to the properties of the locally available raw materials and the general level of technology (Hjorleifur and Arnheiour, 2004; Emere and Dibal, 2013). Today smoking for preservation is common only in less developed countries. Smoking for texture and flavour is popular in developed countries where an integrated logistical infrastructure for the efficient transportation of perishables is in place (Victor, 2014;Yvette and Yahya, 2011 and Krasemann, 2004). Hjorleifur and Arnheiour (2004) and Emere and Dibal (2013) opined that the process of smoking includes different preparatory steps such as salting, drying and smoking; and in the case of hot smoking, application of heat. Smoking combines the effect of the destruction of bacteria by compounds in the smoke, such as phenols and the cooking of the fish, since, high temperatures are normally generated during the hot smoking process. Smoked fish products have long shelf life, attributable to the drying and cooking effects (Tawari and Abowei, 2011). Steps to be followed during smoking process include trimming, brining and drying (Hjorleifur and Arnheiour, 2004 and Emere and Dibal, 2013).

8. Trimming

Fish for smoking must be of high quality, fresh and free from disease. The preparation of raw material for smoking depends on the species, size of the fish and the intended form of the product. Trimming may include filleting, splitting or chunking (Krasemann, 2004 and Holma and Maalekuu, 2013). According to Tawari and Abowei (2011), the process of filleting involves laying the fish on one side and cutting from behind the base of the pectoral fin, surrounding the back of the head. The cut portion is then extended towards the tail along the backbone. The rib bones are freed from the flesh and carved from the skin muscle covering the abdomen. The tail is then separated from the block of flesh. The fish is then turned and the other side treated in the same way. This method if expertly handled produces simple fillets. Block fillets are produced with slight modifications which include not freeing the flesh from the dorsal region so that when the fish is turned on the other side and filleted, the two halves produced are formed along the dorsal region. It was also reported that fish splitting involves cutting open fish from head to tail and the removal of gut. Splitting of fish may be done prior to drying, smoking or salting. In addition, large fish may be cut into pieces (chunking). This facilitates fast cooling with ice, prior to further processing.

9. Brining

Kabahenda *et al*. (2009) stated that salting is a popular method of fish preservation which has been in use for centuries and in many places around the world such as Asia, Europe, and Latin America because it is is less costly, and easily performed together with other preservation methods such as drying or smoking. Salting could be by brining or dry salting; and sometimes the injection of salt. The concentration of brine and time of brining depends on the type of product and the amount of salt that is desired in the final product. Various salt concentrations are used for smoked fish products ranging from 2% to 20% (Razavi, 1994 and Emere and Dibal, 2013). Tawari and Abowei (2011) described four standard methods for salting fish. These are brining, dry salting, Kench and pickle salting methods. In brine salting or brining, the fish is immersed in a solution of salt in water. Where granular salt is rubbed into the surface of fish, the process is referred to as dry salting. Coarse salt is more suitably used in Kench salting (Brigitte *et al.*, 2004). However, in this process, the salt is rubbed into the surface of split fish and the fish are stored with salt placed between each layer of fish. The liquid formed is not allowed to drain off the fish but eventually covers it (Brigitte *et al.*, 2004). In pickle salting, one kg of salt is used for three kg of fish, which is equal to 30-35 kg of salt for 100 kg of fish. This method involves putting a thick layer of salt on the bottom of barrel then one layer of fish is put on the salt with the skin facing up after which the fish is covered with a layer of salt and make sure that no parts are left uncovered, layers of salt are then alternated with layers of fish, the final layer of fish is then covered with a thick layer of salt (Brigitte *et al.*, 2004).

10. Drying

Drying is defined as the removal of water by evaporation (Tawari and Abowei, 2011); and is a very important part of the smoking process. When applied to fish, drying is the removal of water by any method as a means of preservation and shelf

life elongation. The energy required to drive the moisture from the surface of the fish can be obtained from a variety of sources including wood, sun, solar drier, electricity and mechanical driers (Davies *et al*., 2008). During drying, water is removed from the surface of the fish. As the surface water is removed, it is replaced by water drawn up from the fish tissue which leaves the fish surface. The rate of drying and consequently, the rate of removal of water are dependent on the air speed, relative humidity and temperature of the surrounding air (Delgade *et al*., 2003; Tawari and Abowei, 2011).While the surrounding air conditions remain constant, the rate of drying will also remain constant. This stage of the process of drying is referred to as the "constant rate drying". As water removal from fish continues, the drying effect continues until the concentration of the moisture at the fish surface falls, consequently the movement of moisture to the surface also drops and the drying rate slows down. This stage is referred to as the "falling rate drying" stage. Both drying rates are mostly influenced relative humidity of the air because if the air is fully saturated with water vapor, drying will not take place because relative humidity must be less than 100% for drying to take place (Tawari and Abowei, 2011). It is obvious therefore that the lower the relative humidity, the faster the drying rate, thus increased air speed results in faster drying rates. It is possible to control the quality of smoke-dried fish products by defining the smoking process with respect to air speed, raw material characteristics and temperature (Razavi 1994; Krasemann, 2004). Daramola *et al.* (2007) recommended that moisture content less than 10% should be maintained in stored smoked fish to reduce the growth of bacteria and moulds. Daramola *et. al*. (2007) recommended that the optimum storage period of smoked fish under normal tropical temperatures at 10% moisture content is 4-5weeks.

11. Hot and Cold Smoking

Idah and Nwakwo (2013) reported that fish smoking and its effects have been of interest to several researchers many of whom have reported that smoking of fish accelerates drying and prevents microbial activities on the fish. Olayemi *et al.* (2013) opined that smoking is the simplest method of preservation among the several methods preserving fish as it does not require sophisticated equipment or highly skilled workers. Bukola *et al*. (2008) reported that smoke drying methods used in Nigeria require low capital investment as smoke drying is conducted in fishermen camps and fish processing centers using traditional smoking kilns of clay, cement blocks, drums or iron sheets. Methods of fish smoking vary between different countries and within same country depending on the species of fish and the type of product desired (Chukwu and Shaba, 2009). Smoking as a method of preservation produces commonly acceptable products as it imparts desirable colour and flavor (Idah and Nwakwo (2013). After salting, a combination of drying and smoking at temperatures of about 20-30°C for cold smoking and 70-80°C for hot smoking is used for smoked products (Food Reference Website, 2004, Obodai *et al.*, 2009). Tawari and Abowei (2011) reported that when wood and sawdust are burnt, smoke is produced as a result of incomplete combustion. The smoke thus produced depends on the amount of air available and the quality of wood or sawdust. Obodai *et al.* (2009) stated that smoking may be done in a variety of ways including: salting before smoking; pre-smoking and cold-smoking, these processes involves the use of fuel-wood. Wood smoke is a mixture of complex chemical products including gases, vapor and volatile substances absorbed on the wet surfaces of fish during smoking; and produce the characteristic aroma (Tawari and Abowei, 2011). Obodai *et al.* (2009) stated that type of smoke determines the colour, which is one of the qualities that attract consumers and this colour is largely dependent on the type of fuel wood used for smoking the fish and the method of smoking adopted. Soft woods produce a lot of smoke, which may lead to blackening of the finished products, while hard wood produces golden brown or light brown products.

12. Role of Women in Fish Processing

In Nigeria, the social setting is patriarchal and men usually hold the sovereign power, and control households and the society as a whole; while women are assigned a lower status compared to men (Akinpelu *et al.*, 2013). The historical deprivations of women socially, legally, politically and technologically aggravate their position and they are often relegated only to roles of bearing and rearing children (Nwabueze, 2010 and Ahmad, 2001). Furthermore, economic issues and other public institutions are gender-biased; and often ignore the needs of women, in some cases men are better paid than women (Rosemond and James, 2012). Some of the gender-biased differentiations within the household including access to processing resources, control over family labour, inequality in consumption and responsibility for domestic expenditure (Rosemond and James, 2012 and Baden 1997) identified. Tamale (2004) argues that the non-recognition of women's labour on domestic chores is reinforced by the unequal allocation of resources. Thus, the lack of access to and control over productive resources is the main factor limiting women participation in economic activities including fish processing thereby hampering the human development process (Ibrahim *et. al.*, 2010). The role of women in food production, processing and marketing has become more relevant as a way of fighting poverty and ensuring food security within the household (Ibrahim *et. al.*, 2010). Ayo-Olalusi (2010) reported that women (80%) are more involved in fish marketing in Nigeria than men. A similar opinion was expressed by Lawal and Idega (2004) that 90% women participation in fish

marketing in Benue state Nigeria. It has been observed that all over Africa, women provide 60 to 80% of agricultural labour force (Sofranko, 1984; Rosemond and James, 2012). Rural women play a vital role in production and provision of food for households, and are involved in post-harvest activities and marketing of farm produce in order to supplement family income (Ibrahim *et al.*, 2010). Women play a crucial role in fisheries; with their main activities including processing and marketing of fish products (Paris and Chi, 2005: Ahmad, 2001). Ibrahim *et al.*, 2010 reported that Nigerian women engage in fish processing in order to pay their wards school fees, procure household assets, generate savings, and purchase goods and services. Rosemond and James (2012) reported that fish processing offers Ghanaian women in the coastal areas income, savings and investment opportunities, wealth creation, employment and improvement in the socio-economic conditions of their households. Women as members of the fishing communities globally play important roles in the processing and preservation of the fish products through the use of indigenous knowledge (Pidatala and Khan, 2003). Women participate actively in the fish preservation sector on small scale, private and cooperative associations' levels (Oluwatoyin *et al.*, 2010). In general women have been reported to be more involved in post-harvest activities than men (Nwabueze, 2010). Nwabueze (2010) also reported that most fish preservation techniques, such as smoking, drying, and fermentation are employed by women near or inside the house to preserve fish and other food products; and are often considered as domestic activities, enabling them to combine these activities with other domestic chores. Yisa *et al*. (2011) also reported that women's contribution in the fishery sub-sector is particularly important especially in the area of marketing and processing. According to Williams (2006) the socio-economic potentials of women in riverine small scale fishery in Nigeria is significant. Yisa *et al.* (2011) reported that most fish processors and marketers from the village level to the city merchants in Nigeria were largely women. Moreover, most of the women are found to be full time fish processors and marketers. In Delta State Nigeria, marketing of fish provides most rural women their only source of income. In some cases, restricted time budgets, social and cultural factors limit the ability of the woman to participate fully in fish marketing (Nwabueze, 2010).

13. Shelf Life

Shelf-life is defined by Mifflin (2006) as the term or period during which a stored commodity remains effective, useful, or suitable for consumption. David and Persis (2000) defined shelf-life as the time during which a food product will: (i) remain safe (ii) be certain to retain desired sensory, chemical, physical, and microbiological characteristics (iii) comply with any label declaration of nutritional data when stored under the recommended conditions. This definition emphasizes the important issue of storage conditions on product shelf-life.

14. Factors Influencing Shelf-Life

David and Persis (2000) reported that many factors can influence shelf-life. These factors can be categorised into intrinsic and extrinsic factors. Intrinsic factors are the properties of the final product; and include: Water activity (*A*w), pH value and total acidity, Redox potential (*E*h), available oxygen, nutrients, natural micro flora and surviving microbiological counts, natural biochemistry of the product formulation (intrinsic enzymes, chemical reactants) and use of preservatives in product formulation (e.g. salt). Fish is a low acid food and is therefore highly susceptible to pathogenic and enzymatic spoilage (Mifflin, 2006 and King, 2001). It is one of the most perishable of all staple commodities especially in tropical regions of the world, and if not consumed within one day of capture, becomes unfit for human consumption, unless subjected to some form of processing (Ihuahi *et al.*, 2010 and Abolagba *et al*., 1996). Several studies regarding shelflife of freshwater tropical fish including tilapias have been done by many researchers (Kapute *et al.*, 2013). Sengul *et al.* (2008) studied the shelf life and some nutritional components of gilthead seabream (*Sparus aurata* L., 1758) after Cold and Hot Smoking. Packaging materials, temperature fluctuation and post processing handling influences the shelf-life of of fish sausage and fish ball (Siddique *et al.*, 2013). In Nigeria, over 80% of fish harvested is preserved by various methods of curing to prolong shelf life; and these products are highly acceptable by the local consumers (Salawu *et al*., 2004 and Idah and Nwakwo, 2013). The longer fish is smoked, the longer its shelf life (Arthur and Osei-Somuah, 2004; Abolagba *et al.*, 2002). The need to protect smoked fish from pests is imperative when the crucial role it plays in ensuring food security, income generation and employment opportunities is considered (Akinwunmi, 2011). The realization of the serious limitations including health hazards, cost, development of highly resistant strains etc. offered by the use of highly persistent chemicals as fish protectants had elicited interest in seeking alternative methods of controlling fish spoilage. One of such promising area is in the use of plant-derived pest control agents (Akinwunmi, 2011). Many Nigerian medicinal plants and spices have been cited as pest control agents of stored grains, legumes and smoked fish (Adedire and Lajide, 2000; Okonkwo and Okoye 2001; Fasakin and Aberejo 2002; Ofuya 2003).

15. Antimicrobial Properties of Plant Extracts

In Nigeria the use herbs and plant extracts in the treatment of diseases is well known. Traditional medicine is the oldest method of curing diseases and infections; and various plants have been used in different parts of the world to treat human diseases and infections (Nuray *et al.*, 2015; George *et al.* 2009, Ekpo and Etim, 2009; Oluborode *et al.*, 2013; Kumolu-Johnson and Ndimele, 2011; Sahgal *et al.*, 2009; Owhe-Ureghe *et al.*, 2010; Aibinu *et al.*, 2007; Ayoola *et al.*, 2008; Idris *et al.*, 2010 and Omojowo *et al.*, 2008). Indu and Nirmala (2010) reported that medicinal plants possess biological activity, antibacterial, antifungal and antioxidant properties and this encourages the use of spices from ancient times for different purposes including: flavouring, keeping away the pests, and in perfumery. In recent years, however, medicinal plants have represented a primary source for the pharmaceutical industry (Ajose, 2007 and Nuray *et al.*, 2015). No less than 400 compounds derived from plants are currently used in the preparation of drugs; such as vincristine and vinblastine used in the treatment of cancer (Ajose, 2007; Indu and Nirmala, 2010; Aibinu *et al.*, 2007 and Djamel *et al.*, 2011). Leaf poultice is used for headache, swelling, cold and wound dressing. Chopped pieces of the dried stem and roots are usually steeped in alcohol and used for stomach ache and as worm expellant in humans in the Delta region of Nigeria (Onocha and Olusanya, 2010; Lee *et al.*, 2008; Nair *et al.*, 2005 and Ayoola *et al.*, 2008). Jimoh *et al.* (2020) stated that *Moringa oleifera* seed can be used as fish preservative as it possesses some antimicrobial effect against some food borne microorganisms often implicated in spoilage of smoked fish. In the past decade interest on the antibacterial property of plant extracts has been growing (Lee *et al*., 2007 and Nuray *et al.*, 2015). Food processors and agencies are very concerned with the high and growing number of food-borne outbreaks and illnesses associated with microorganisms, especially bacteria. Bacteria also have become far more resistant to many antibacterial agent (Mahida and Mohan, 2006). Out of the two million people who acquired bacterial infections in United States of America (USA) hospitals annually, 70% involved the strains that are resistant to at least one antibacterial agent (Cushnie and Lamb, 2005). According to Mahida and Mohan (2006) the emergence of antibiotic-resistant microorganisms had swiftly reversed the advances of previous fifty years of research on antibiotics. Consumers are also questioning the safety of foods containing the synthetic antibacterial agent as preservatives (Shan *et al*., 2007). Pirimiphos-methyl (Actelic) is the synthetic preservative recommended for elongating the shelf life of dried fish (Daramola e*t al.*, 2007). There has therefore been an increasing interest in developing new types of highly effective and non-toxic antibacterial agents from natural sources (Shan *et al*., 2007). Over the past two decades, scientists have turned back to traditional folk medicines or natural products to uncover the scientific basis of remedial effects such as antibacterial agents (Djamel *et al.*, 2011 and Haslam, 1996). Beside plants, fruits also have become a subject of interest for researchers investigated since their bioactive compounds closely-related with herbs are commonly referred to as phytochemicals: such as carotenoids, polyphenols and anthocyanins that are present in such fruits and vegetables as tomatoes, grapes, pomegranates and strawberries are gaining lot of interest due to their functional property (Nuray *et al.*, 2015; Jayaprakasha *et al*., 2001; George *et al.*, 2009; Li *et al*., 2006; Rao and Rao, 2007). Furthermore, natural compounds in fruits and vegetables such as polyphenols e.g. flavonoids and tannins have shown very promising results in combating bacteria, fungi and viruses (Ahmad and Beg, 2001; Cushnie and Lamb, 2005). According to Onyeagba *et al.* (2004) the antimicrobial effect of *in vitro* application of aqueous and ethanolic extracts of garlic (*A.sativum* Linn.), ginger (*Zingiber officinale* Roscoe) and lime (*C. aurantifolia* Linn.*)* juice was assayed against *Staphylococcus aureus; Bacillus spp., Escherichia coli* and *Salmonella spp.* All the test organisms were susceptible to undiluted lime-juice. Garlic (*A. sativum*) has long been used as both a flavoring agent and for its potential benefit of preventing and curing ailments in many cultures. Epidemiological, clinical, and preclinical studies have shown the close relationship between dietary habits, including garlic intake, and the occurrence of disease. Garlic has been investigated extensively for health benefits, resulting in more than 1000 publications over the last decade alone; and is considered one of the best disease-preventive foods, based on its potent and varied effects (Harunobu, 2006, Owhe-Ureghe *et al.*, 2010 and Fareed *et al*., 2007). The popularity of garlic and onions in folk medicine through the centuries for treatment of such varied disorders as dog bites, insect stings, earaches, burns and wounds, baldness, headaches, chest colds, respiratory ailments, asthma, pneumonia, diabetes, cardiovascular disorders, and rheumatism, among others, can be attributed to their pungent aroma, strong taste and, in the case of onion, its potent lachrymatory effect (Owhe-Ureghe *et al.*, 2010; Onyeagba *et al.*, 2004; and Eric *et al.*, 1993). Owhe-Ureghe *et al.* (2010) suggested that a paste made by blending garlic and lime could be used as a mouth wash in the treatment of dental caries, mouth-sore and sore-throat; and could also be incorporated into toothpaste to prevent dental caries because garlic (*A. sativum* Linn.) and lime (*C. aurantifolia* Linn.) had inhibitory activity on seven bacterial species (*Streptococcus mutans*, *Lactobacillus acidophilus*, *Norcadia asteroides*, *Pseudomonas aeruginosa*, *Actinomyces viscosus*, *Staphylococcus aureus* and *Veillonella alcaligens*) isolated from 240 extracted, carious teeth when investigated using standard techniques. Lime (*C. aurantifolia* Linn.) is also known to be an essential ingredient in the preparation of most herbal concoctions. It is used to suppress stomach ache, added to honey and palm oil to relieve cough, and lime mesocarp is also used as a good facial scrub to prevent pimples (Oyagade *et al.*, 1999). Its antimicrobial activities have also been

described as various parts of the plant were found effective against gram-positive and gram-negative bacteria, as well as *Candida albicans* (Aibinu *et al.*, 2007; Owhe-Ureghe *et al.*, 2010; Kelvin, 2010 and Lee *et al.*, 2008). The antimicrobial activity of the volatile oils of tangerine (*Citrus reticulata*) fruit peel has equally been described (Ayoola *et al.*, 2008). Garlic (*A. sativum* Linn) on the other hand, has been reported to help prevent heart disease, including atherosclerosis (Owhe-Ureghe *et al.* and Durak *et al.*, 2002), as well as high blood pressure and cancer (Nishino, 1990; Imai, 1994). As early as 1858, Louis observed garlic's antibacterial activity; and it was used as an antiseptic to prevent gas gangrene during world war II (Kock and Lawson, 1996). It has also been reportedly used in AIDS patients to treat *Cryptosporidium* infections in an uncontrolled study in China, it was observed that garlic, ginger and lime was reported have powerfull antimicrobial effect (Fareed *et al.*, 2007 and Onyeagba, *et al.*, 2004).

16. Determination of Fish Spoilage

Issues regarding quality and safety of fish and fish products is gaining global attention due to many reasons including the fact that fish is a highly perishable commodity (Kapute *et al.*, 2013). Abbas *et al.* (2006) defined shelf life of a fish as the time from when it is taken from the water until it is no longer fit to eat. Suhendan *et al.* (2002) and Ihuahi *et al.* (2010) reported that there are many methods for the determination of fish spoilage. The determination of the sensory quality, microbial growth and chemical changes are based on the measurement of postmortem deteriorative changes in fish. Autolytic deterioration is the cause of the loss of freshness and occurs as soon as fish dies. Bacteriological assessment, total volatile amine (TVBN), and trimethylamine (TMA-N) contents and pH analyses describe latter postmortem deteriorative changes only (Linda and John, 2010; Nilgun, 2006; Luong *et al.*, 1992). Izci *et al.*, (2011) examined chemical changes in fish fingers produced from smelt sand (*Atherinaboyeri*) during a period of freezing (6 months at -18˚C), and the report demonstrated that significant chemical changes as there was decreases in the contents of moisture and protein while there was significant increase in lipid and ash contents. Olayinka *et al.*, (2009) also studied microbiology in food ingredients and conducted sensory evaluation of fish finger samples prepared from shrimp; the study concluded that fish finger produced from shrimp was safe and healthy in terms of microbiological evaluation and it had good nutritional value and maintained a high amount of protein. Tokur *et al.*, (2006) examined the effects of freezing (-18˚C), on fish finger samples produced from washed and unwashed ground meat mirror carp fish (*Cyprinuscarpio*L.,1758), and reported that sensory parameters of color, odor, flavor, and general acceptability decreased for both groups during frozen storage but evaluators still rated the product as acceptable. Oyelese (2006) in their study on the maximum amount of storage time for fish paste and fish cake made of Tilapia fish reported that paste made of healthy fish, processed according to eight different procedures could be kept for a period of 3 months. Rezaei and Hedayatifard (2013) in their study on the evaluation of qualitative changes of fish fingers made from big head carp *(Aristichthys nobilis*) during frozen storage compared qualitative changes and nutritional values of the three tested fish finger formulations stored at -18˚C and were sampled at various storage days of 0, 30, 60 and 90 days for changes in peroxide (PV), thiobarbituric acid (TBA) and *total volatile nitrogen* (TVN) contents, their result using PV index indicated that the 90 days was the longest shelf life for samples stored at -18˚C. Daramola *et al.* (2007) also establish that keeping quality of smoked fish stored in plastic basket for 56 days under ambient conditions decreases with increase in length of storage using total volatile nitrogen (TVN), pH, peroxide value (PV), free fatty acid (FFA) levels and physical quality of fish as indices. Another study conduct by Nilgun (2006) indicated that surimi produced from anchovy (*Engraulis encrasicholus* L., 1758) could be stored under frozen condition for 5 months with its spoilage condition remaining within limits. Siddique *et al.*, (2013) in their study of the quality and shelf life of fish sausage and fish ball prepared from bombay duck observed that coliform bacteria was absent in all their products during the first 7th day of storage at room temperature (28^{o}C) and in the refrigerator. Serkan *et al.* (2010a) determined the total volatile basic nitrogen (TVB-N), thiobarbituric acid (TBA), trimethylamine (TMA), proximate composition and sensory evaluation of raw and hot smoked garfish (*Belone belone euxini*, Günther, 1866) stored at ambient and refrigerated temperatures for 25 days, it was observed that TVB-N, TBA, TMA values increased during storage time. Egbal *et al.* (2013) reported no pathogenic micro-organisms like *Escherichia coli*, *Salmonella* spp and *Staphylococcus aureus* were detected on smoked *Clarias lazera* immediately after smoking while E. coli and *Staphylococcus* were observed on 21th and the 28th days of storage at refrigerated temperature (5 $\pm$ 1^{o}C). They also observed a significant ($p < 0.05$) increase in the percentage of total protein, lipid and ash contents with increased storage time while percentage crude fat and moisture content decreased significantly ($p < 0.05$) with increased storage time. Akise *et al.* (2013) reported an increase in the moisture content and fungi count of smoked *Lutjanus agennes* (Red Snapper), *Mugil cephalus* (Mullet), Chrysichthys walker during storage at room temperature for 6 weeks. Ihuahi *et al.* (2010) found *Clarias angullaris* to be in acceptable conditions for 12 days of ice-storage in insulated ice box. Abolagba and Melle (2008) in their study of the chemical composition and keeping qualities of a scaly fish tilapia, *Oreochromis niloticus* smoked with two energy sources observed reduction in the protein and amino

acid profiles after 1 month of storage which could be due to the denaturing or even spoilage of the protein samples. Similar report was given by Abolagba and Osifo (2004) who worked on fatty fish *Clarias gariepinus* that protein decomposes with increased storage time. Holma and Maalekuu (2013) observed significant ($P < 0.05$) changes in ash, crude fibre, nitrogen-free extract, moisture, and crude fat content of the processed fish after 14 days of storage at ambient. Daramola *et al.* (2007) observed an increase in the moisture content of smoked fish with increased length of storage which could be as a result of the difference in the moisture of smoked fish relative to that of the surroundings. Egbal *et al.* (2010a) observed that smoking significantly ($p<0.05$) improve the colour, taste, texture and flavour of fish. Christiannah and Fagade (2010) reported the reduction in percentage crude protein of smoked fish is as a result of protein degradation. Salaudeen *et al.* (2010) observed no significant change in the pH and peroxide values (PV) of smoked catfish during 6 weeks storage at ambient temperatures. Abolagba *et al*. (2011) observed microbial contamination in smoked fish product collected from different markets in Benin metropolies which was attributed to factors like poor smoking of fish products i.e. inappropriate temperature control or application, poor personal hygiene of processors/seller, poor hygiene/sanitary practices relating to smoked fish products, smoke/workhouse, packaging and storage as well as the use of inadequate and inefficient traditional processing facilities, poor environmental sanitation and high human trafficking. Similar report was given by Atuanya *et al.*, (2011), Ayeloja *et al.* (2012) and Okonko *et al.* (2011). Idah and Nwakwo (2013) reported that crude protein, crude fibre, crude lipid and ash contents of smoked fish increased with increased storage time while the moisture content decreased with increased storage time. Sengul *et al.* (2008) opined that smoking reduces the microbial content of the fish while the microbial content of smoked fish increased during storage.

17. Fish Packaging

Food packaging enhances marketing and also helps in the preservation of foodstuffs, especially processed ones. It is one of the most important unit operations in the agro-processing industry. Packaging can be defined as a tool that protects and contains the goods with the aim of minimizing environmental impact on the consumption of the product (Shruti, 2007). Steve (2010) opined that many high quality fish loose value in the marketing and distribution chain, while consumers only purchase fish of best quality at good price, thus the need to package good quality fish within the shortest possible time so that high-quality fish could be available in relatively short time from reception through to distribution and display to ensure the restaurant or consumer obtain seafood at its best. Packaging technologies are important to protect products against deteriorative effects, which may include microbial, biochemical, and physical activities from environmental influences; and involve retardation of spoilage, extension of shelf-life, and maintenance of quality in packed food. Other functions of packaging include containment, convenience, marketing, and communication (Restuccia *et al.*, 2010). The primary objectives of food packaging are to provide protection from spoilage, ease in distribution, display and handling, communication between the manufacturer and customer, convenience, avoidance of loss, brand confidence, printing and machine suitability. Post processing handling of fish has an impact on the shelf life of the product and includes packaging techniques, storage condition and marketing techniques (Abolagba, 2006). Packaging forms an important part of food processing because it facilitates handling during storage and distribution within the market chain (Abolagba *et al.*, 2011 and King, 2001). Khanipour and Mirzakhani (2013) stated that packaging enhances quality and increased the shelf life of rainbow trout (*Oncorhynchus mykiss*) during refrigerated storage at 0-2ºC condition. Effective packaging controls insect infestation of dried fish (King 2001). Packaging has the tendency to prolong the storage life of foods significantly (Arritt *et al*., 2007 and Mangaraj and Goswami, 2009). Inappropriate packaging, poor temperature control, poor personal hygiene of processors among others were the causes of high microbial load of smoked fish sourced from different markets Benin metropolis as reported by Abolagba *et al.* (2011). Oluborode (2013) opined that the application of spices and proper packaging of *Clarias gariepinus* can prolong the shelf life of the fish. They also stated that proper packaging will help to protect the product against spoilage and breakage, promote sub regional trade of fishery products as well as enhance reliable information network for effective marketing in an organized industry . Sacks, paper cartons, wooden rackets and bamboo baskets are the most predominantly used artisanal packaging containers in Nigeria (Abolagba *et al.*, 2011 and King, 2001). Davies *et al.* (2009a) reported that in the Niger Delta of Nigeria, fish packaging materials used include: woven bags, jute bags, wooden trays and boxes, raffia baskets, plastic bags, sturdy boxes and wooden crates. Mexis *et. al*., (2009) reported that Polyvinyl chloride (PVC), polyethylene (PE), polypropylene (PP), polyester (PET), polyamide (PA), polyethylene terephthalate (PT) polyvinylidenchloride (PVDC) and ethylenevinyl alcohol (EVOH) are the polymers commonly used in food packaging. However, Olusegun and Jacob (2015) noted in their study of the microbial load (bacteria, coliform and mould count/flora) of some common hot smoked freshwater fish species using different packaging materials that packaging did not limit the existence of micro-organisms during 12 weeks of storage as six bacteria species including micrococcus (*Acidiophilus, luteus*), bacillus (*Subtilis, cereus, aureus*), *Staphylococcus aureus*, *Streptococcus*

lactis, Proteus (*vulgaricus*, *morganii*), *Pseudomonas aureginosa*, three fungi species (*Aspergillus* (*niger*, *tamari*), *Rhizopus nigricans*, and *Fusarium oxysporum* were found on the packaged smoked fish.

18. Emerging Markets for fish

In recent years, fast food technology has been acquiring importance rapidly due to increase of civilization and socioeconomic factors. In the last two decades, fish consumptions have increased by awareness of consumers about essential fatty acids, mineral and vitamin content of fish. There is several kind of ready-to-eat fish based seafood in supermarkets such as cakes, crackers, burgers, fish fingers, marinated products (Zayde, 2011). Michael and Bula (2014) considered marketing as the process by which companies create value for customers and build strong customer relations in order to capture value from customers in return. Akpabio and Ekanem (2008) stated that fishery marketing enterprise is an important agricultural domain in Nigeria. Roheim and Sutinem (2006) also stated that fish is one of the most extensively traded commodities in the world and export of fish produce from developing countries, comprise 20% of agriculture and food processing exports and is likely to increase as demand for fish produce continues to increase. Akpabio and Ekanem (2008) declared that fish marketers provide a vital link between artisanal fishermen and the consuming public Nigeria. Fish marketing in Nigeria, however, is hinged on the basic questions of: What do consumers want? Which species? What price, size, form, quality, quantity and grading (Agbebi, 2010)? Others are: What services do they want? When to sell? Where do people buy? The need to rationally manage the great fish potential in Nigeria by improving our fish marketing system, so as to enhance a reliable marketing system in addition to the development of large-scale post harvests technologies and the improvement of transportation systems that can support the delivery of fish products to market was elucidated by Agbebi (2010). The need for all the stake holders in Eritrea fish market to play their role in identifying ways to build strong and sustainable fish production, formulate policies on how to move up to the value chain; niche marketing opportunity; converting comparative into competitive advantage and overcoming technical and structural barriers the fish market chain was also expressed by Teweldemedhin (2008). Mustapha *et al*. (2014) reported that one line of business in Nigeria that continues to promise greater returns on investment is the quick service restaurant amidst the current global crisis, despite the presence of economic, social and political dilemma in the country and fish is one of the major products sold by these outlets. Konwea (2012) and Akinbile (2008) opined that fast-food eating as a dietary pattern that used to be foreign has gradually become a part of the lifestyle of people in Nigeria especially those in urban areas and fish is one the products in high demand at restaurants. In many cities in Nigeria, one can find numerous fast food restaurants where most of the foods sold are usually snacks, burgers, fries, chicken, fish , cola drinks, ice cream, fruit drinks and other foods that are high in fat, sodium and sugar (Konwea, 2012). Fridah *et al.* (2014) opined that improving on value addition will increase the sales of sea food. Michael and Bula (2014) observed that product branding, sales promotion, market positioning and core competences marketing strategies are the factors that influence the economic stimulus of commercial fish farmers. Value addition for fish is an important strategy that will add economic value and possibly widen the market performance while reducing a problem of post harvest losses in sub-Saharan Africa (Kyule *et al.*, 2014 and Mohamad *et al.*, 2011). Salehe *et al.* (2014) recommended that there should be training and promotion of value added fish products as this will boost fish consumption as well as enhancing market performance for aquaculture industry.

Conclusion

Fish is one of the most important foods on earth with high quality protein, vitamins and minerals with very low carbohydrate content; it is either taken fresh or cured in a variety of ways such as smoking, salting, drying, charring, icing and chilling. However, fish is highly perishable and spoils quickly a problem that has been identified in the storage of fish in many developing countries. Poor post-harvest handling, lack of processing and storage facilities also contributes to fish spoilage thereby creating the gap between demand and supply of fish thereby posing a great challenge to food security for the entire nation. Processing of fish facilitates its maximal use as raw material for the production of value-added products, which is the basis of processing profitability. However, smoking is the most adopted fish preservation method in many developing countries. Fish post harvest loss come in different faces including: physical loss, quality loss and market forces loss all of which will lead to reduction in fish shelf life. Many researchers are now looking into antimicrobial properties of plant extracts to extend fish shelf life. Proper packaging of fish will also extend its shelf life, the role of women in fisheries subsector especially in fish productions, processing and production, processing and marketing was also buttressed as their active role is essential to fighting poverty and ensuring food security within many households.

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