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FISH *KILISHI* PROCESSING TECHNOLOGY: A REVIEW

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ABSTRACT

High cost of feeding, diseases and low genetic potential of native livestock species has led to an increased cost of production, hence making it unaffordable to low-income earners in Africa. Although, fish food has become widely accepted as an alternative source of animal protein, its efficient utilization is hampered significantly by post-harvest losses due to its perishable nature. Therefore, if Africa is to attain food security, it is necessary to use effective indigenous technology to minimize such losses. Of the various local value addition processing technology in Africa, *Kilishi* technology is worth mentioning. Although *Kilishi* technology is an age long local technology, its application in fish processing is still a new concept. Therefore, it is still faced with challenges such as inadequate awareness, higher flesh-to-bone ratio, fish species requirement, poor processing, expensive production costs and the notion of it being an outdated product technology. These and many other related issues are reviewed and discussed as reported herein to provide sufficient information on the concept, process and application of this processing technology.

Keywords: Food security, *kilishi*, postharvest losses, processing, value addition.

INTRODUCTION

Fish is one of the many sources of animal protein and a crucial nutrient option for many individuals around the world (FAO, 2020). Fish are generally preferred over other animal protein sources because they have relatively low levels of collagen and cholesterol in the flesh Eyo (2001). They also contain sufficient amount of amino acids, including methionine and lysine, which are hard to find in grains (Elaigwu *et al.,* 2019). In communities without any alternative locally produced sources of protein, fish can provide up to 180 calories per capita per day (Demeke, 2013). In addition to vitamins A, B, and D, calcium, selenium, and phosphorous, fish also contain micronutrients that are beneficial to consumers (Elaigwu *et al.,* 2019). It has also been recognized as a crucial element in the diet of the infant as it is rich in omega-3 fatty acids which play an important role in children's development (Yilmaz *et al.,* 2018). Artisanal fishing is a major source of income in many sub-Saharan areas of african population. The livelihood of people depends heavily on the subsistence fishing. The success of this process (subsistence fishing) defines the difference between food security and starvation, as well as between adequate and inadequate nutrition (Demeke, 2013).

An estimated amount of 59.5 million people are directly employed in the production of fish and other aquatic species, with 85% of them being in Asia and 9% in Africa (FAO,2020). In 2015, Nigeria's fisheries production was 1,027,000 tons, sourced from marine catches (36%), inland waters (33%) and aquaculture (31%) (FAO, 2017). Women are very important in the capture fisheries and aquaculture sector, almost half of the employment in the fisheries value chain are held by women (Belton, 2021). However, due to the perishable nature of fish and production levels that fall short of demand, fish is not easily accessible to all people at all levels. Post-harvest fish losses are nutrient or economic losses that make the product unavailable or nutritionally inadequate for human consumption. Hence, fish post-harvest losses take many different forms, including physical, material losses, quality losses, bycatch discarding, economic losses, nutritional losses, and losses through spoilage. An estimated 10 to 12 million tons of fish per year is attributed to spoilage, meanwhile 20 million tons of fish are dumped at sea each year (Kumolu *et al.,* 2010). According to estimates by various authors, post-harvest losses in the fisheries sector is between 30 to 50% of the landed fish catches (Bolorunduro *et al.,*2010; Emere & Dibal, 2013; Olusegun & Mathew 2016). These losses therefore make it difficult to provide sufficient fish for the ever-growing human population (Mungai, 2014; Olusegun & Mathew,2016).

Food security is only achieved when there is physical and financial access to adequate supply of nutritious food that meets the dietary needs and food preferences for an active and healthy lifestyle (Gunaratne *et al.,* 2021). The Food and Agricultural Organization (FAO, 2010) had earlier noted that food insecurity can be attributed to the large-scale reduction of fish captures. The ability to increase food security while maintaining sustainability is one of the biggest challenges confronting the world (Adelaja *et al.,* 2017). Fish is a highly perishable food item that needs to be handled carefully right after being harvested (Maulu *et al.,*2020). Studies have demonstrated that if fish products are handled effectively, food security can be increased; this means post-harvest losses are reduced in the various distribution stages (Adelaja *et al.,* 2017). Fish loss is of great concern globally, and it is important to reduce it. Reducing post-harvest fish losses are therefore necessary to meet the shortfall that exists between demand and supply of fish (Ibengwe & Kristofersson, 2012).

When fish is processed or preserved, bacterial or enzymatic activity that leads to spoiling is slowed down. These can be achieved by adjusting the temperature or by changing the fish's form (Dauda *et al.,* 2020). Chilling, freezing, canning, irradiation, smoking, drying, boiling, and drying are a few of the preservation and processing techniques used for fish preservation (Aura, 2021). All these methods used to preserve the quality of fish from the time it is harvested or caught until it is consumed are referred to as post-harvest technologies (Bolorunduro *et al.,* 2010). Notable among these technologies is value addition, which is the process of improving fish and fishery products via the use of production techniques, innovation, and handling aimed at raising the market value and customer base of the product (Olorunfemi *et al.,* 2017). Fish is now routinely processed into a wide variety of value-added products due to the surge in demand for food products that are ready-to-eat or require little preparation before consumption. Value addition is a procedure that turns fish fillets into products that the buyer sees as having higher quality and interest (Subhendu, 2013). This review therefore is aimed at summarizing the knowledge available about one of the age long but potentially new post-harvest technology solutions (Fish *kilishi*), with the ability to extend the fish's shelf life through value addition.

Value addition in fisheries and aquaculture

With enormous market values and job prospects, value addition is one of the most popular methods among the numerous processing methods used in the fish and seafood sector. It is a good alternative to exporting fish products in order to earn money in foreign currencies. Hence, in addition to being a profitable method of preserving fish, it can benefit the nation's economy by generating foreign exchange (Ikbal *et al.,* 2021). Value-added markets refer to the social or environmental factors that consumers consider when making food purchases in addition to product quality and price. Over the past ten years, value-added agriculture and fisheries products have grown crucially for international market and sales (Russell, 2002). For some decades now, fisheries and aquaculture have developed into a more dependable and high-quality supply of animal protein, which has increased the possibility of developing value-added goods (FAO, 2020). Value-added processing has several benefits, such as better fish handling and processing in terms of quality, safer products, product variety, preservation of high-quality characteristics, an extension of shelf life, enhancement of economic return to the producer/processor, and stable prices by providing a market for excess and peak catch even during emergency harvest (Morrisey, 2011). To meet customer needs for healthy, nutritious, high-quality seafood products, value-added processing will be a key component of the expanding aquaculture sector (Morrisey, 2011). According to Subhendu (2013), value-added fish products may be, mince-based products, battered and breaded or coated products. Some important value-added fish products are fish chin-chin, fish cake, fish bread, fish cutlet, fish samosa, fish sandwich, fish flakes and many more (Subhendu, 2013).

Fish *Kilishi*

Kilishi is a Nigerian processed meat product that is typically sun-dried, partially roasted, and made from lean cattle flesh with the addition of plant elements (Mgbemere *et al.,* 2011). It originated from the Northern part of Nigeria, especially among the Hausa-speaking states (Jabaka *et al.,* 2021). It is a middle-moist meat product from the tropics made from sun-dried lean beef that has been spiced and mixed with defatted groundnut paste (Ogunsola & Omojola, 2008). The technique of *Kilishi* production is only recently being adopted as a post-harvest technology aimed at value addition in fish; thereby increasing the fish quality, market stability, and increase the nutritional composition of the fish (Jega *et al.,* 2013).

Fish *Kilishi* is an example of a fish value added product that has been proven to be rich in protein (Jega *et al.,* 2013). The *Kilishi* product and the substances used in its production (Table 1), are ideally matched with the demands, tastes, and cultures of the region of its origin. The flow chart as explained by Jega *et al.* (2013) for the production of fish *Kilishi* includes preparation of the fish by descaling, gutting and beheading, then; it is sliced and sun dried to reduce its moisture content, the dried slices are then infused in a slurry of ingredients earlier prepared and dried again. They are then light roasted, packaged and stored to finalize the *Kilishi* production process (Figures 1 – 8).

Although, fish *Kilishi* has not been extensively studied, those produced from *Clarias gariepinus* and *Bagrus bayad* were reported to have a shelf-life of 12 weeks Magawata and Oyelese (2000). The study by Ipinjolu *et al.* (2004) however, reported 6 to 8 weeks as the consumer acceptable storage period for *Kilishi* made from *Labeo coubie* and *Hyperopisus bebe occidentalis*. The results of several studies are also indicative that fish *kilishi* samples are considered safe for consumption after four weeks of storage period (Tables 2 and 3). Also report from Jega *et al.,* (2013) showed that fish *kilishi* packaged in a paper envelope was still acceptable between 14-16 weeks of storage as the sensory attributes were cherished by the panellists. This suggest that fish *Kilishi* adoption as an alternative preservation technique can help reduce fish spoilage particularly during periods of excess catches of those species in addition to fish product diversification. Other studies includes the evaluation of the microbiological quality of fish (*Kilishi*) produced from *Heterotis niloticus*, *C. gariepinus* and *Tilapia zilli* by Aliyu and Falusi (2006), while Jega *et al.* (2013) evaluated the slurry formulations and storage media for *Kilishi* of African bony tongue and African lungfish.

Table 1: Table 1: Common Ingredients for Fish *Kilishi* Preparation

S/N	Ingredients	Weight (g)	Proportion (%)	Function
1	Groundnut dough	1989	69	Adds flavor and fat content
2	Curry powder	30	1.0	Adds flavour and enhances taste
3	Dried(hot) pepper	90	3.0	Adds spiciness and aids preservation
4	Clove	60	2.0	Adds spice and antibacterial properties
5	Artar root	60	2.0	Enhances flavour and color
6	Knor cube	60	2.5	Enhances taste
7	Onion	420	14.0	Adds flavor and aroma
8	Ashanti pepper	90	3.0	Enhances colour and aroma
9	Salt	30	1.0	Enhances taste and serves as a preservative
10	Ginger	180	1.5	Flavor enhancement and antimicrobial properties
11	Garlic	8.4	1	Adds flavor and aids preservation
	TOTAL		**100**	

Adapted from: (Jega *et al.*, 2013; Magawata & Faruk, 2014; Adeola & Okeke, 2014 and Ibrahim & Adaka, 2022)

"Fish
↓
Descaling, gutting and beheading
↓
Slicing of fish
↓
First sun drying
↓
Infusion of dried slices in a slurry of ingredients
↓
The second sun drying
↓
Light roasting
↓
Final *Kilishi*
↓
Packaging and storage"

Figure 1. Flow chart stages of fish "*Kilishi*" processing (Source: Jega *et al.,* 2013)

Fig 2: Degutted fresh fish

Fig 3: Sun-drying of sliced fish

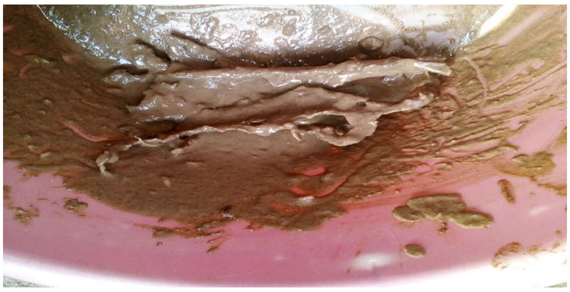

Fig 4: Infusion into slurry of ingredients

Fig 5: Second sun-drying

Fig 6: Light Roasting

Fig 7: Final *Kilishi*

Fig 8: Packaging

3.1. Advantages of *Kilishi* over smoked fish

Although, many modern methods have been utilized to preserve fish, the oldest, frequently used and popular method in Nigeria is the fish smoking (Onimisi *et al.,* 2022). During fish smoking, wood and its derivatives are often used because of the flavour, aroma, and visual appeal they have (Bolorunduro *et al*., 2010; Adeyeye *et al*., 2015). The average Nigerian fish processor simply uses any form of wood to smoke fish without actually considering the wood's components or their impact on the fish, the processors, or the consumers (Dauda *et al*., 2020; Onimisi *et al*., 2022). Due to the presence of poisonous substances in form of polycyclic aromatic hydrocarbons, the woods used in fish smoking may have impacts on human health (Diagne, 2002; Clucas & Ward, 2008; Atanda *et al.,* 2015; Bede-ojimadu & Orisakwe, 2020; Dauda *et al.,* 2020). Fish becomes inoculated with these poisonous compounds when exposed to firewood and charcoal over an extended period. These possibilities have raised concerns among scientists and consumers in recent years as a result of their potential heath implication and toxicity. *Kilishi*, on the other hand, has a lower risk of such dangerous polycyclic aromatic hydrocarbons exposure or depositions due to its unique processing method. This involves a brief and mild roasting, hence, making it much safer for consumers and also lowers the potential risks for fish processors when compared to conventional fish smoking methods.

Table 2: Proximate composition (%) of freshly prepared "*Kilishi*" from different fish species

Fish species	Moisture	Ash	Lipid	Crude fibre	C/Protein	NFE	Source
Protopterus annectens	16.33±0.58	7.33±1.15	14.67±1.15	2.00±0.00	41.03±0.66	18.37±0.83	(Jega *et al*., 2013)
Heterotis niloticus	7.60±0.81	5.00±0.16	6.00±0.81	6.00±0.08	50.76±0.02	19.45±0.58	(Bello & Tekwata, 2015)
Momyrus rume	10.92±0.29	6.09±0.01	19.45±0.58	1.77±0.06	27.13±1.01	37.11±0.64	(Ibrahim & Adaka , 2022)
Lates niloticus	12.33±0.29	4.17±0.29	1.33±0.29		30.49±0.17	30.50±0.17	(Magawata & Faruk 2014)
Clarias gariepinus	10.02±0.46	4.21±0.01	20.95±0.87		38.44±0.58	23.64±0.01	(Comfort, 2017)
Bagrus docmac	4.75±2.63	3.31±2.21	10.75±0.28	0.87±0.47	33.15±0.96	47.09±1.47	(Rabiu, 2019)

Table 3: Proximate composition (%) after 4 weeks of storage of fish *Kilishi* from different fish species

Fish species	Moisture	Ash	Lipid	Crude Protein	NFE	Source
Lates niloticus	6.83±0.29	7.00±0.50	2.50±0.00	54.37±1.47	0.67±0.29	(Magawata & Faruk, 2014)
Heterotis niloticus	6.42±2.84	12.67±1.15	10.00±2.00	23.010±0.10	43.89±3.12	(Jega *et al.,* 2013)
Clarias gariepinus	8.45±0.52	6.09±0.01	19.45±0.58	27±0.23	37.11±0.64	(Comfort , 2017)
Bagrus docmac	7.20±0.45	4.80±0.45	10.90±0.42	33.86±0.51	45.97±0.62	(Rabiu, 2019)

Challenges of *Kilishi* as a post-harvest technology

Despite being a potential value-added product for extending the shelf-life of fish, the production of fish *Kilishi* has not received attention like other fish processing and preservation techniques. This might be partially due to its being a relatively recently applied technology in fish with little research done on it. Production of beef *Kilishi* is well established and has received a lot of attention compared to fish (Jega *et al.,* 2013). Recent findings have shown that only fish with a higher flesh-to-bone ratio are suitable for use in making Fish *Kilishi* (Magawata & Faruk, 2014). This in particular limits the number and type of fish species that are usable for *Kilishi* manufacturing since only the flesh portion is required. Issues of poor processing, and expensive production cost, excessive coating of ingredients that leads to masking of the natural fish colour as well as the out-dated nature of the technology are also some of the limiting factors to be considered during fish *Kilishi's* production (Ipinjolu *et al.,* 2004; Bello & Tekwata 2015).

Ways of improving fish *Kilishi* as post-harvest technology

Increasing research on the fish *Kilishi* production, through the development of more modern and acceptable industrialised procedures will ensure reduction of production cost and time. Development of varieties of slurry ingredients can be done to have different flavours of the product, hence increasing the market coverage for diverse consumers who might not consume the current spicy slurry formulations. Development of a standard reference for fish *Kilishi* production is also required as a way of ensuring product quality and safety standard monitoring of different producers of the product in different parts of the world. This can be used as a benchmark of safety reference for consumers who will be buying the product in the future.

CONCLUSION

Since fish is a perishable food and a valuable source of protein and other nutrients, it needs to be preserved using correct post-harvest methods. One of the alternative means of doing this is the *Kilishi* production which can ensure that the product remain nutritious and safe whenever it is to be consumed. *Kilishi* shelf life from many studies has been documented to be between 4-12 weeks depending on the species used. Also, the microbial count of the product within this storage period are within safe limit recommended for consumption. Although more research is still needed to elucidate the prospect of this age long technology, however, its adoption is highly recommended to fish processors. This is because of its potential to reduce post-harvest losses, as well as help overcome food insecurity and its attendant issues like famine, malnutrition, disease infections and economic losses.

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