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Assessment of Smoked Fish Quality Using Two Smoking Kilns and Hybrid Solar Dryer on Some Commercial Fish Species in Yola, Nigeria

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Abstract

This study was conducted to evaluate the effect of fish processors on the nutritional quality of some commercial fish species (*Clarias gariepinus*, *Synodontis budgetti*, and *Oreochromis niloticus*) which obtained from Lake Geriyo, Yola, Nigeria. One kilogram of each of the fish species was processed using Futy Smoking Kiln (FSK), Improved Hanger Smoking Kiln (IMHSK) and Hybrid Solar Drier (HSD). Each of the three fish species were randomly assigned to the three (3) processors in a completely randomized design replicated thrice containing one (1) kilogram of each of the fish species and processed. The time and weights were recorded. Processed Fish samples were analyzed for proximate and mineral composition, using standard laboratory procedure. Data were also collected on organoleptic taste, and cost benefit using the different processors. Data obtained were subjected to the analysis of variance. Decrease in moisture content was observed during processing using the different processors and constant weight was obtained within 10-20 hours. The proximate composition of the differently processed fish species were significantly ($p<0.05$) affected by the different processors. The IMHSK recorded the highest crude protein of (65.42%) for *Synodontis budgetti* and 62.76% for *Oreochromis niloticus* respectively, The IMHSK indicated significantly ($p<0.05$) higher calcium level of 3.53 mg/kg for *Clarias gariepinus* and 4.77 mg/kg for *Synodontis budgetti*. The different processors used significantly ($p<0.05$) affected the level of acceptability of the processed fish. Fish processed using the improved hanger smoking kiln recorded the highest level of acceptability followed by those processed with Futy smoking kiln. On economic ground, the use of IMHSK was found to be cost effective. The different processors used were observed to influence the nutritional quality of fish however; the use of IMHSK indicated the most beneficial effects on the nutritive value of fish and is therefore recommended for processing fish.

Keywords: Fish pprocessors; Moisture loss; Proximate and mineral; Organoleptic; Freshwater fish species

Introduction

Fish is a nutritious source of food of high quality protein often cheaper than meat though highly susceptible to deterioration without any preservative or processing measures [1].

Al-Jufaili and Opara has reported that due to their chemical compositions, fish muscle is perishable and its flavor and texture changes rapidly after death and during storage. Harvesting, handling, processing and distribution provides livelihood for millions of people as well as providing foreign exchange to many countries [2].

Preservation and processing therefore become important part of industrial fisheries. They are done in such a manner that the fishes retain their freshness quality for a long time, with a minimum loss of flavor, taste, odor and nutritive values [3]. Freshness of fish is usually judged entirely in trade by its appearance, odor and texture of the raw fish, and the assessment depends upon the senses, known as sensory or organoleptic evaluation [4]. There are so many incidents of fish spoilage across the world, particularly in the tropics, which facilitates microbial activities and chemical changes, with a resultant Fish deterioration and spoilage [5]. The spoilage process (*Rigor mortis*) starts within 12 hours of their catch in the high ambient temperatures of the tropics. Rigor mortis is the process through which fish loses its flexibility due to stiffening of fish muscles after few hour of its death [6]. Processing and preservation methods have been considered and used to prevent fish from spoilage. Haruna reported that fish is a low-acid food that supports growth of pathogens if not carefully handled and rapidly processed after harvest [7]

Effiong and Fakunle reported that the decomposition or spoilage of fish flesh occurs mainly due to various chemical, microbial and the enzymatic action, in Nigeria the hot climatic condition favors rapid growth of bacteria and so the spoilage of fish flesh becomes inevitable, landed fishes may ordinarily remain fresh for not more than 8 hours and begin to decompose rapidly leading to post harvest losses [8]. Post-harvest losses in fish occur in various forms, namely Physical, Economical, and Nutritional losses. The physical losses are caused by poor handling and preservation or the discarding of by catch. Economic losses occur when spoilage of fish results in a value-decrease or when there is a need to reprocess cured fish; to raise the cost of the finished product inadequate handling and processing methods can reduce nutrients leading to nutritional loss (FAO) [9]. Preservatives methods such as salting, fermenting, drying, and smoking are still widely accepted around the world because of their specific taste and aroma. However, these methods still differ from country to country and within each country in the amount of additives, percentage of salt or vinegar and maturing temperature [10].

A large amount of fish is lost after harvesting with respect to quality and quantity which is due to hot weather, low levels of post-harvest technologies and poor handling methods [11]. Fish is a highly perishable commodity and undergoes spoilage as soon as it landed. Spoilage occur before, during, and after processing or preservation and the odor, flavor, texture, color, composition and nutritive value changes in light of spoilage. The idea of fish processing and preservation is adopted to reduce post-harvest losses [12]. The available processors currently in use at the moment lack information on the best processor among the three under study therefore the study was design to bridge such information gap. The aim of the study is to evaluate the best processor that will enhance better fish qualities.

Adebowale et al. reported that appropriate improved processors and preservation techniques can significantly reduce fish spoilage thereby prolonging the fish shelf life, improving their nutritional values, taste, and market quality. It is in view of these that the study is design to generate useful information on the use and effect of the different processors on the nutritive quality of fish species under study [6]. Ugwumba states that the changes are characterized by a series of biochemical changes such as glycolysis caused by enzymes action, rigor mortising the muscle (stiffening of muscle), muscle tendering by post-rigor, autolysis caused by the action of proteinases (muscle protein enzymes) and finally, spoilage due to microbial action and release of mucus. The major composition of fish tissues are water, lipid, protein and micro nutrients. The proximate composition of fish varies depending on certain factors, such as the geographical location, season of the year, feed intake, and metabolic efficiency of the fish, energy expended by the fish, sex, species, age and size. It can also vary within the individual fish [13]. Fish flesh contains negligible quantity of carbohydrates, glycogen is present in living fish and is rapidly converted to lactic after death, fish also contain appreciable qualities of vitamins which are necessary for maintaining good health, fat soluble vitamins known as vitamin A,D,E and B complex mainly thiamin, riboflavin and nicotinic acid.

Bulk of minerals are concentrated in hard parts of scales, bones, otolith, about 1.0-2.0% of the fish flesh are formed by minerals such as calcium, magnesium, potassium, phosphorus, sulphur and iron, iodine, fluorine. The deficiency of these principal mineral elements induces a lot of malfunctioning, thereby reduces productivity and causes diseases. [14].

Proximate composition of fish, post-harvest history, environmental conditions, initial microbial load, type and nature of bacteria and their interaction is paramount in order to minimize the loss [15].

In processing, efforts are taken to counter the activities of these factors, in other to ensure a longer shelf life for fish meat, prevent fish spoilage and retaining physical and chemical characteristics of fish with its biological value and taste. Cooling, freezing, drying, smoking, heat treatment, salting and applying antimicrobial agents and antioxidants are used for processing and preservation [16]. It is essential to ensure a hygienic handling of fresh or processed fish products in each and every phase of production, storage and transportation, to avoid the health, fire risk and air pollution involved in fish smoking from charring of fish [17].

Tawari and Abowei Stressed that proper preservation starts the moment fish is harvested until it reaches the consumers, efforts is geared towards increasing fish production through, improved resource management, effective post-harvest handling, preservation and processing to prevent spoilage. Fish smoking and its effect have been of interest to several researchers [18]. Emere and Dibal had shown that among the several methods of fish preservation, smoking is perhaps the simplest method as it does not require sophisticated equipment or highly skilled worker, and it accelerates fish drying (that is, lowers moisture content or water activity) and prevents microbial activities on the fish. Smoke curing method is not affected by climatic condition and it has a special taste and odor, which was accepted worldwide as fish food. These fishes are rich in protein and fat content as well as different vitamins and minerals [19].

Preservation and processing therefore become a very important part of commercial fisheries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of flavor, taste, odor, nutritive value and the digestibility of their flesh. Freshness is usually judged in the trade entirely by its appearance, odor and texture of the raw fish. Assessment depends upon senses known as sensory or organoleptic evaluation [20]. Smoking is a traditional method of processing fish around the globe, thereby extending its shelf life. Its acceptance is based primary upon the sensory characteristics, and its impacts on the fish [21]. Fish smoking in the tropics is conducted in smoke houses, ovens or kilns with varying equipment and designs from place to place. They are categorically classified into traditional, improved traditional and Mechanical smoking kilns. Some smoking kilns used in various localities includes; Coal–pot kiln, whole drum kiln, Box kiln, Chorkor oven, and smoking platform [22]. In hot smoking, temperature may be between 60-110 for 4-12 hours to eliminate spoilage by bacteria; fish are laid in trays or hung in the column of smoky air above the fire [11].

The chorkor smoker oven is gaining acceptance in traditional fish smoking. The design based has a long life, low construction cost, and low firewood consumption. Smoking of fish could also be achieved with pit oven, mud kiln, and drum smoking kiln with a simple smoking rack earthen wave pot. However, the structures and the types of the smoking kilns vary from place to place. Improved smoking kiln equipments include; Futy improved kiln, Altona smoking types of ovens and inners walker smokers. Efforts to improve the kilns and driers designs have in general been successful and have been introduced to small scale fish processor [9]. Small and medium fish may be smoked whole or spilt, large fish are cut into fillet. This smoking process yields a product with 10 -15 percent moisture content and may require being stored for up to 9 months in the tropics. The need to improve these smoking kilns is necessary in order to minimize losses due to chemical changes and microbial activities, this will enhanced the shelf – life and increased consumers' preference [7].

Materials and Methods

Three freshwater fish species were collected from fishermen in Lake Geriyo, and were transported to fisheries laboratory in sterile polythene bags to avoid any type of microbial contamination. The fish species are; *Clarias gariepinus*, *Synodontis budgetti*, *Oreochromis niloticus*. Processing starts immediately fish was caught onboard and brought to the laboratory. Fish was first weight before it was washed with clean water and brine salt solution to remove slim, bacteria and debris on the body surface. After the removal of the guts, the fish were weight again and were distributed into the three different processors used for processing, (Futy Smoking kiln (FSK), Improved Hanger Smoking kiln (IMHSK) and Hybrid solar Drier (HSD). One kilogram of each of the fish species were processed using as a whole not in filleted form. The weight loss of the fish was taken after every two hours interval until a constant weight was reached, and was recorded along with time. Fish are turned during the smoking cycle in the Futy smoking kiln (FSK) while the improved hanger smoking kiln (IMHSK), those not need turning [23]. Mineral and Proximate composition of the of the processed fish product were analyzed for Ca, Mg, Na, Fe, K, Crude Protein, Moisture, Ash, Crude Lipid, Crude fiber, and Nitrogen free extract (digestible carbohydrate). Standard method of the Association of Official Analytical Chemist AOAC, was used for determination. Data on the pH and peroxide value were also analyzed [24].

Results and Discussions

The result obtained from the study indicated weight loss as presented in Table 1. Shows that the fresh fish sample used during processing using the different processors, indicated lost in moisture content due to dehydration during smoking which varies between 10-20 hours depending on the final constant weight obtained on the final product, these findings is in line with Sigurgisladottir et al. who reported that the time of smoking varies depending on the final product, characteristics, and parameters used in the processing such as; time, temperature, quality of raw material which are highly important for yield and quality of the final product [25].

Table 1: Weight loss of Fish during Processing Using Two Smoking kilns and a Hybrid Solar Drier

Fish species	Parameters	FSK	IMHSK	HSD
Clarias gariepinus	Initial weight (kg)	1	1	1
	Final-weight (kg)	0.3	0.3	0.2
	% weight lost	70	70	80
	Duration of smoking (hours)	16	12	18
	Efficiency (L/hour)	4.37b	5.83a	4.44b
Synodontis budgetti	Initial-weight (kg)	1	1	1
	Final-weight (kg)	0.3	0.3	0.3
	% weight lost	70	70	70
	Duration of smoking (hours)	14	12	20
	Efficiency (L/hour)	5a	5.83a	3.5b
Oreochromis niloticus	Initial-weight (kg)	1	1	1
	Final weight (kg)	0.2	0.2	0.2
	% weight lost	80	80	80
	Duration of smoking (hour)	12	10	16
	Efficiency (L/ hour)	6.66b	8a	5b

FSK: Futy Smoking Kiln; IMHSK: Improved Hanger Smoking Kiln; HSD: Hybrid Solar Drier.

Aminullahi et al. has also observed that weight variation during fish processing are determine by type of raw material, manual processing methods, brine type, quality and smoking conditions (tempreture, moisture, air flow rate, and drying) [26]. However the difference in the processing time means that labour cost may be higher for longer smoking period. Time and tempreture change with higher lossess, these may be attributed to the type of species, weight, smoking temperature and time which is in line with Chukwu, who observed that the principles of fish smoking is the removal of water just as the same principles with salting and drying as a result of heat production from smoking. However IMHSK recorded higher efficiency of (5.833 L/hour) on *Clarias gariapinus* and, *Synodontis budgetti* while *Oreochromis niloticus* recorded (8 L/hour) [27].

Protein content of the processed fish species as shown in Table 2 indcated significant difference within the species used and between the different methods. The proximate composition of the fish samples as affected by the different processors were significantly ($p<0.05$) Influenced by the different methods. The result indicate highest crude protein (65.42%) in IMHSK followed by (64.76%) in HSD while FSK has the lowest value (61.48%). Fat content recorded highest value of (9.85%) in IMHSK followed by (9.24%) FSK has the lowest value 8.45%) HSD.

Table 2: Proximate composition of fish species processed using two Smoking Kilns and Hybrid Solar Drier.

Processor	Protein	Fat	Moisture	Fiber	Ash	Carbohydrate
FSK						
1	61.45 ± 6.67b	8.65 ± 3.33b	10.21 ± 1.24ab	4.36 ± 0.14b	8.15 ± 6.93a	4.36 ± 0.14b
2	61.48 ± 5.20a	9.24 ± 2.34a	10.28 ± 1.70a	5.26 ± 0.07a	7.34 ± 4.53c	5.26 ± 0.12a
3	61.47 ± 6.06ab	8.44 ± 2.65c	10.15 ± 1.30b	4.44 ± 0.08c	7.85 ± 5.82b	4.44 ± 0.14b
IMHSK						
1	60.03 ± 5.65c	9.85 ± 0.06b	10.29 ± 1.50a	4.71 ± 2.09c	8.40 ± 3.04a	4.71 ± 3.09c
2	65.42 ± 6.60a	8.24 ± 0.66a	10.27 ± 1.25a	5.80 ± 1.70a	7.61 ± 2.24c	5.80 ± 2.49a
3	62.76 ± 6.40b	8.12 ± 0.45ab	10.28 ± 1.3a	4.94 ± 0.09b	7.83 ± 1.70b	4.94 ± 1.60b
HSD						
1	60.84 ± 3.22b	7.76 ± 3.98c	10.05 ± 1.90c	4.72 ± 2.55c	8.43 ± 5.83a	4.18 ± 0.01b
2	64.76 ± 4.00a	7.97 ± 2.50b	10.15 ± 1.54b	5.71 ± 1.40a	7.62 ± 4.32c	7.81 ± 0.03a
3	60.04 ± 3.50b	8.45 ± 2.40a	10.25 ± 1.95a	4.93 ± 2.34b	7.85 ± 3.56b	4.18 ± 0.04b

Data in the same column with different superscripts are significantly different ($p<0.05$); Data = ± SD, Key: 1=*Clarias gariepinus*, 2=*Synodontis budgetti* 3=*Oreochromis niloticus*,

FSK: Futy Smoking Kiln; IMHSK: Improved Hanger Smoking Kiln; HSD: Hybrid Solar Drier.

Moisture revealed higher value of (10.25%) in IMHSK followed by (10.28%) FSK has the lowest value (10.29%) HSD. The result also indicated lower Fiber content (5.26%) in FSK followed by HSD. (5.71%), IMHSK Lower Ash content (8.15% was shown in FSK.

Sajib et al. has mentioned that proximate composition of fish varies with species, body size, season, environmental factors and nutritional status [28]. The increase of the protein content may be due to product dehydration which concentrated the protein during the heat treatment of the fish, thus increasing the nutrtive value of the fish, similar findings was also reported by, Kumolu et al. who compared crude protein levels of *Clarias gariepinus* dried with local cut drum oven and NSRRI developed smoking [29].

Fawole et al. also reported that increase in protein may be attributed to the fact that fish are good source of crude protein and the difference in crude protein could be due to the fish consumption, absorption capacity and conversion potentials of essentials nutrient from their diet or local environment into such biochemical attributes needed by the organisms [30].

Fat content increase could be as a result of heat produced by smoking kiln which result in moisture content loses, increasing the concentration of nutrient in the reaming mass of fat as related to lipid oxidation, which produced volatile compounds known to be unsaturated and very prone to oxidation. These findings is in line with Salan et al. who report that during fish smoking and sun drying fish losses its moisture content, which result in increase in the concentration of nutrient in the remaining mass of fats [31].

Moisture content differences could be due to certain factors such as genetic makeup, feed intake, metabolic efficiency, size, sex, and season of the year. These observations are in line with the findings of Olayemi et al. who reported that the moisture content of smoked fish reduces during heat treatment which differs with species [32].

Carbohydrate content of the fish samples where within the reccommended range 12-16 g which shows that the species could be dependable sources of dietary carbohydrate these agrees with Daramola et al. who reported that carbohydrates contents in fish is generally low and practically zero [33].

Ash content was also significant which could be attributed to the fish species, season, sex, and food availability similar findings was also reported by Bilgin et al. who observed significant difference in ash content of some nutritional composition of smoked Gilthead sea bream [34].

The difference in the mineral composition as shown in Table 3. The Mineral analysis in shows variations in the contents of all the minerals Studied. There was significantly ($p<0.05$) Influenced by the different methods on all the minerals indicated highest Ca (3.84 mg/kg) HSD followed by (3.53 mg/kg) IMHSK while FSK has the lowest value (3.13 mg/kg). Na indicated highest (4.77 mg/kg) in IMHSK, (4.23 mg/kg) FSK and the lowest value (4.42 mg/kg) in HSD. Fe recorded (0.08 mg/kg) in all the processors. K was high in IMHSK (0.95 mg/kg), FSK (0.93 mg/kg) while HSD. (0.84 mg/kg) Mg was lower in FSK (0.42 mg/kg), followed by (0.57 mg/kg) in IMHSK and (0.63 mg/kg) HSK.

Table 3: Mineral composition of fish species processed using two Smoking kilns and Hybrid Solar Drier

Methods	Ca	Na	Fe	K	Mg
FSK					
1	3.13 ± 0.26a	0.43 ± 0.01a	0.08 ± 0.23a	0.83.034 b	0.25 ± 0.05b
2	2.36 ± 0.10c	3.94 ± 0.02c	0.04 ± 0.01b	0.52 ± 0.02b	0.23 ± 0.06b
3	2.77 ± 0.03b	3.84 ± 0.05b	0.04 ± 0.01b	0.93 ± 0.04a	0.42 ± 0.03a
IMHSK					
1	3.53 ± 0.98a	4.77 ± 0.50a	0.85 ± 0.03a	0.85 ± 0.9b	0.27 ± 0.02b
2	2.62 ± 0.40c	4.11 ± 0.07b	0.05 ± 0.02c	0.67 ± 0.2c	0.24 ± 0.05c
3	2.86 ± 0.07b	3.57 ± 0.06c	0.06 ± 0.02b	0.95 ± 0.01a	0.57 ± 0.98a
HSD					
1	3.84 ± 0.10a	4.42 ± 0.70a	0.08 ± 0.46a	0.77 ± 0.84b	0.26 ± 0.08a
2	2.76 ± 0.06c	4.24 ± 0.80b	0.06 ± 0.28a	0.66 ± 0.98a	0.32 ± 0.16a
3	2.77 ± 0.84b	3.21 ± 0.60c	0.04 ± 0.01c	0.84 ± 0.60a	0.63 ± 0.01a

Data in the same column with different superscripts are significantly different ($p<0.05$); Data=± SD, Key: 1=*Clarias gariepinus*, 2=*Synodontis budgetti* 3=*Oreochromis niloticus*; FSK: Futy Smoking Kiln; IMHSK: Improved Hanger Smoking Kiln; HSD: Hybrid Solar Drier.

The differences may be due to the effect of heat produced by the smoking kiln which has effect on the nutritional properties of the fish, it may also be due to variation in the chemical nature of the element concentration in the environment. Effiong and Fakunle reported that the difference in the mineral composition is attributed to the forms of variation in the chemical nature [8]. The abundance of calcium could be attributed to the availability of the element in the water body and the ability of the fish to absorb it. However Sajib et al. has documented a similar finding on the effect of traditional fish processing [28].

Variation in concentration levels of Mg among the species may be attributed to the chemical nature of the fish species [35].

The main effect of the pH value on the fish species processed using the different methods as presented in Table 4. Indicated that there were no significant difference ($p>0.05$) on the processed fish species, however *Clarias gariepinus* recorded (6.85 and 6.70) in FSK and HSD, while IMHSK recorded (6.22). *Synodontis budgetti* in FSK and IMHSK recorded the same value of (6.40) while HSD was (6.45) respectively. *Oreochromis niloticus* processed in FSK observed higher value of (6.70) while IMHSK (6.45) and HSD recorded lower value (6.25).

Table 4: pH Values of the Processed Fish Using the Different Methods

Fish species	FSK	IMHSK	HSD	± SEM
Clarias gariepinus	6.85	6.22	6.7	0.08
Synodontis budgetti	6.4	640	6.45	0.09
Oreochromis niloticus	6.7	6.45	6.25	0.09

abc-means with different superscript of significant difference

SEM: Standard Error of the Mean; FSK: Futy Smoking Kiln; IMHSK: Improved Hanger Smoking Kiln; HSD: Hybrid Solar Drier.

The pH of the processed fish is almost neutral in the study as shown in Table 3.

pH value of fresh fish was 6.8 and Drops after addition of salt 6.6. These may be as a result of decomposition of nitrogenous compounds and the production of basic components induced by bacteria which leads to increase in pH in the fish. The pH value recorded from the Hybrid Solar Drier are less to those of the Futy Smoking Kiln these agrees with the findings of Haruna who reported that pH of fish tissue is 6.6 or more, the growth of moulds brings about rise in pH [7]. Many spoilage organisms finds low pH so hostile, values obtained from the study is an indication that of fish being a low acid food [36].

It's important to note that pH depression occurs due to the hydrolysis of ATP, nucleotide degradation, protease action, and catabolism of lipids. The Peroxide value on the fish species processed using the different methods as presented in Table 5. Shows that there was no significant difference ($p>0.05$) on *Clarias gariepinus* processed on the different methods, those processed in FSK recorded (4.74 mg/kg) as the lower value; HSD recorded a high value (6.13 mg/kg) while IMHSK has low value of (5.34 mg/kg).

Table 5: Peroxide Values PV (mg/kg) of the Processed Fish Using the Different Methods

Fish species	FSK	IMHSK	HSD	± SEM
Clarias ariepinusg	4.74	5.34	6.13	3.33
Synodontis budgetti	4.17	5.04	4.73	3.33
Oreochromis niloticus	5.3	5.02	4.82	3.33

Abc-means with different superscript of significant difference

SEM: Standard Error of the Mean; FSK: Futy Smoking Kiln; IMHSK: Improved Hanger Smoking Kiln; HSD: Hybrid Solar Drier.

Synodontis budgetti shows that IMHSK has high record of (5.04 mg/kg), followed by (4.73 mg/kg) in HSD while FSK rcorded (4.17 mg/kg) as the lower records. *Oreochromis niloticus* indicated that, processed fish in FSK observed higher value of

(5.30 mg/kg) followed by IMHSK (5.02 mg/kg) and an HSD recorded lower value (4.82 mg/kg). The various peroxide value (PV) levels of *Clarias gariepinus*,(fatty fish) *Synodontis budgetti*, (fatty fish) and *Oreochromis niloticus* (lean fish) processed using the three different processors, indicates variation in the PV of each of samples which may emanate from the type or efficiency of processor used for moisture and oil removal, storage period and onset of Rigrmotis before processing. Daramola et al. has reported that large amount of polysaturated fatty acid found in fish lipids makes them susceptible to oxidation by an auto catalytic mechanism which leads to the production of higher peroxides. The oxidation reactions through a catalytic reaction occur faster in dead tissues than living tissues [33]. These are in line with Olayemi et al. who observed that rigor mortis starts immediately or shortly after death of a fish and the exhaustion of the glycogen reserves [32].

From the analyses conducted on the proximate and mineral composition, and microbial load drawn from the various fish samples, the most efficient processor between the two smoking kiln and hybrid solar drier improved hanger smoking kiln was most effective. The peroxide value was a clear indicator of the shelf- life of the products, which showed the level of deterioration with time of the various products, that is the higher the peroxide value the higher the level of deterioration of the quality of the fish. Other parameters like the physical appearances of the various product dictate the efficiency of the processor that is involved thus IMHSK processors is the most effective processor in the study, in conclusion, the use of the processor is profitable for fishermen and women, marketers and aqua culturists in the utilization of IMHSK compared to the traditional smoking kilns as losses in cultured in the use of it is minimal [37].

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