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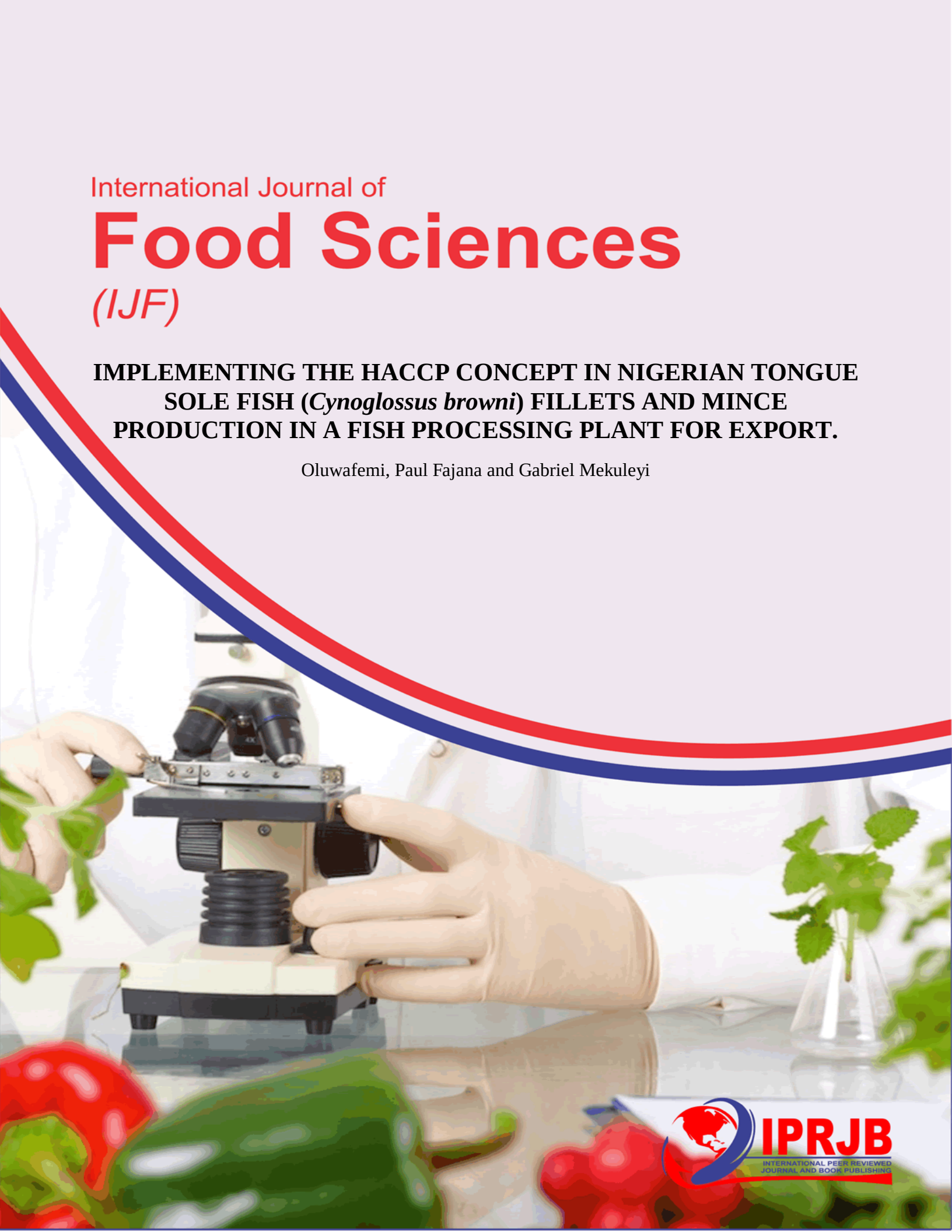

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IMPLEMENTING THE HACCP CONCEPT IN NIGERIAN TONGUE SOLE FISH (*Cynoglossus browni*) FILLETS AND MINCE PRODUCTION IN A FISH PROCESSING PLANT FOR EXPORT.

[1*]Oluwafemi, Paul Fajana
Masters Student: Department of Fisheries;Lagos State University, Ojo, Lagos, Nigeria.
[*]Corresponding Author's Email: polofemo@gmail.com

[2]Gabriel Mekuleyi
Lecturer, Department of Fisheries: Lagos State University, Ojo, Lagos, Nigeria

Abstract

Purpose: This study was carried out in the Fish processing plant of Olokun Pisces Limited from June – November, 2018 with the primary focus on implementing Hazard Analysis Critical Control Point (HACCP) concept as a tool to ensure safety of food products. Sole fish Fillets and Mince were produced from mechanized raw processing of Nigerian tongue Sole fish (*Cynoglossus browni*) using the knowledge of HACCP application.

Methods: The Processing Plant is owned by Olokun Pisces Limited (Lat N 6^0 $28^{'}$ $24^{''}$, Long E 3^0 $22^{'}$ $50^{''}$), a Private Fishing Company located in Otto, Lagos, Nigeria. The Company has over thirty trawlers licensed by the Federal Department of Fisheries (FDF) to fish in Nigerian Coastal waters which falls within Eastern Central Atlantic FAO Area 34. The Nigerian coastal line has eight states it shares borders with. They are Lagos, Ogun, Ondo, Rivers, Delta, Akwa Ibom, Bayelsa and Cross River States. A trawler voyage of about fifty (50) days to and fro covers the coastal waters including the eight coastal states. The study was carried out from June – November, 2018. On board frozen *Cynoglossus browni* is being received in bags (20kg net weight) from the trawler vessels upon arrival and stored in the cold room (with a temperature of -20^0C) prior to processing. *Cynoglossus browni* being a demersal species was caught by method of bottom trawling.

Results: The HACCP concept focused on the safety of sole fish fillets and mince through a systematic and scientific approach to hazard identification, assessment and control. Preventive and control measures in dealing with identified hazards helps to eliminate or reduce hazards to acceptable levels. Pre-requisite programs consolidate the effectiveness of the HACCP in achieving safety of food products. The verification exercise confirmed that the HACCP concept implemented in the processing of Sole fish fillets and mince was adhered to and the products are safe, fit for consumption and ready for export.

Unique contribution to theory, practice and policy: To achieve safety of food products requires the joint effort of the HACCP team. Hence, adequate training of the team members on recent developments and changes in the food industry is very key to consistently improve efforts to always maintain the quality brand the product is known for.

Keywords: *Hazard, Safety, HACCP Plan, Preventive measures*

1.0 INTRODUCTION

The HACCP concept was introduced in the United States in 1971 at the Conference of Food Protection where it was "recommended for widespread use". During the initial period of space exploitation preparation by NASA, it was recognized that absolutely safe food was required for the astronauts. Collaboration by the Pillsbury Company, NASA and the US Army Laboratories proposed HACCP that was based on the Failure, Mode and Effect Analysis (FMEA) as used by engineers in construction designs. In general the US food industry showed little interest, but microbiological problems with low-acid can foods, particularly mushrooms, led to the FDA promulgating specific regulations for control embodying HACCP Principles. Their successful introduction in the canning industry inevitably led to pressure for their wider acceptance by the food industry. Subsequently, as a means of safe food production, it has been adopted world-wide as given in Codex Alimentarius Commission. In European Union Legislative Framework, HACCP Concept was introduced by the EU Food Hygiene Directive 93/43/EEC that was repealed by Regulation (EC) 852/2004 on the hygiene of food stuffs as a tool to ensure food safety (Georgia and Fotoula, 2010). What is HACCP (Hazard Analysis Critical Control Point)? It is a science based system which identifies, evaluates and controls hazards which are significant for food safety. HACCP is a tool used to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change such as advances in equipment design, processing procedures or technological developments.

The HACCP is based on the recognition that hazards exist at various points but measures can be taken to control these hazards. The anticipation of hazard, identification of control points, implementation of corrective actions when the critical limits are exceeded and a comprehensive record keeping are some of the key elements to HACCP. The system offers a rational, practical and logical approach in the control of food hazards and avoids the many weaknesses inherent in the conventional approach. Once established, the main effort of the Quality Assurance programme will be directed towards Critical Control Points and away from endless final product testing. This will assure a higher degree of safety and at less cost. HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health.

DEFINITIONS

HAZARD: A biological, chemical or physical agent in, or condition of food with the potential to cause an adverse health effect.

HACCP Plan: A document prepared in accordance with the principles of HACCP to ensure control of hazards which are significant for food safety in the segment of the food chain under consideration.

CRITICAL LIMIT: A criterion which separates acceptability from unacceptability.

CRITICAL CONTROL POINT (CCP): A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

CORRECTIVE ACTION: Any action to be taken when the results of monitoring at the CCP indicate a loss of control

CONTROL MEASURE: Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

MONITOR: The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

VERIFICATION: The application of methods, procedures, tests and other evaluations in addition to monitoring, to determine compliance with the HACCP plan. (FAO, 1997)

SEVEN PRINCIPLES OF HACCP

Principle 1 Hazard Analysis
Principle 2 Determine the Critical Control Points (CCP)
Principle 3 Establish Critical limit(s)
Principle 4 Monitoring
Principle 5 Corrective Action
Principle 6 Verification
Principle 7 Documentation

APPLICATION OF HACCP

1. Assemble HACCP Team
2. Describe product
3. Identify intended use
4. Construct flow diagram
5. On-site confirmation of flow diagram
6. 7 principles of HACCP

***Cynoglossus browni* Chabanand, 1949** commonly called Nigerian tongue sole fish has an elongated body, snout rounded with a short rostal hook not reaching to vertical through front margin of upper eye; eyes on left side, small with a broad space between them. Maxilla reading back behind upper eye. Dorsal fin rays 115 – 15; anal fin rays 96 – 99; candal fin rays 12. Eyed side with 2 lateral lines, the midlateral with 84 – 91 scales; scales ctenoid on eyed side, cycloid on blind side. It has eyed side dark brown with a whitish blind side and size could be up to 40cm. Its habitat is benthic on muddy or sandy bottoms of the continental shelf, at depths of 15 – 40, (mainly 15 – 25m). It feeds on a wide range of bottom living invertebrates. It is distributed in West Africa (Congo to Senegal) as well as from the Netherlands Coast (Marine Species Identification Portal, 2018)

Objectives

1. To apply the HACCP concept in a mechanized Sole fish fillets and mince production process in order to achieve safety of the products
2. To meet the requirements and standards acceptable for export to sophisticated international market such as the EU and the United States using the HACCP concept.

2.0 MATERIALS AND METHODS

The Study Area

The Processing Plant is owned by Olokun Pisces Limited (Lat N 6^0 28^{l} 24^{ll}, Long E 3^0 22^{l} 50^{ll}), a Private Fishing Company located in Otto, Lagos, Nigeria. The Company has over thirty trawlers licensed by the Federal Department of Fisheries (FDF) to fish in Nigerian Coastal waters which falls within Eastern Central Atlantic FAO Area 34. The Nigerian coastal line has eight states it shares borders with. They are Lagos, Ogun, Ondo, Rivers, Delta, Akwa Ibom, Bayelsa and Cross River States. A trawler voyage of

about fifty (50) days to and fro covers the coastal waters including the eight coastal states. The study was carried out from June – November, 2018.

Pre-Requisite Programs

In order to consolidate the HACCP concept, strong foundational programs are expected to be in place to address basic operational and sanitation procedures. Some of these that were put in place include Good Manufacturing Practices (GMP), Personnel hygiene program, Standard Sanitary Operating Procedures (SSOP), Pesticides (SMASH SUPER 100% EC) and general fumigation program, first-in first-out (FIFO), Employee training exercise, Medical examination, etc. All these programs were done and documented before executing the HACCP plan.

Collection of Raw Materials

On board frozen *Cynoglossus browni* is being received in bags (20kg net weight) from the trawler vessels upon arrival and stored in the cold room (with a temperature of -20^0C) prior to processing. *Cynoglossus browni* being a demersal species was caught by method of bottom trawling.

Application of HACCP in Sole fish fillets and mince production

The HACCP system was implemented on the twelve steps given by Codex Alimentarius Commission mention as follows

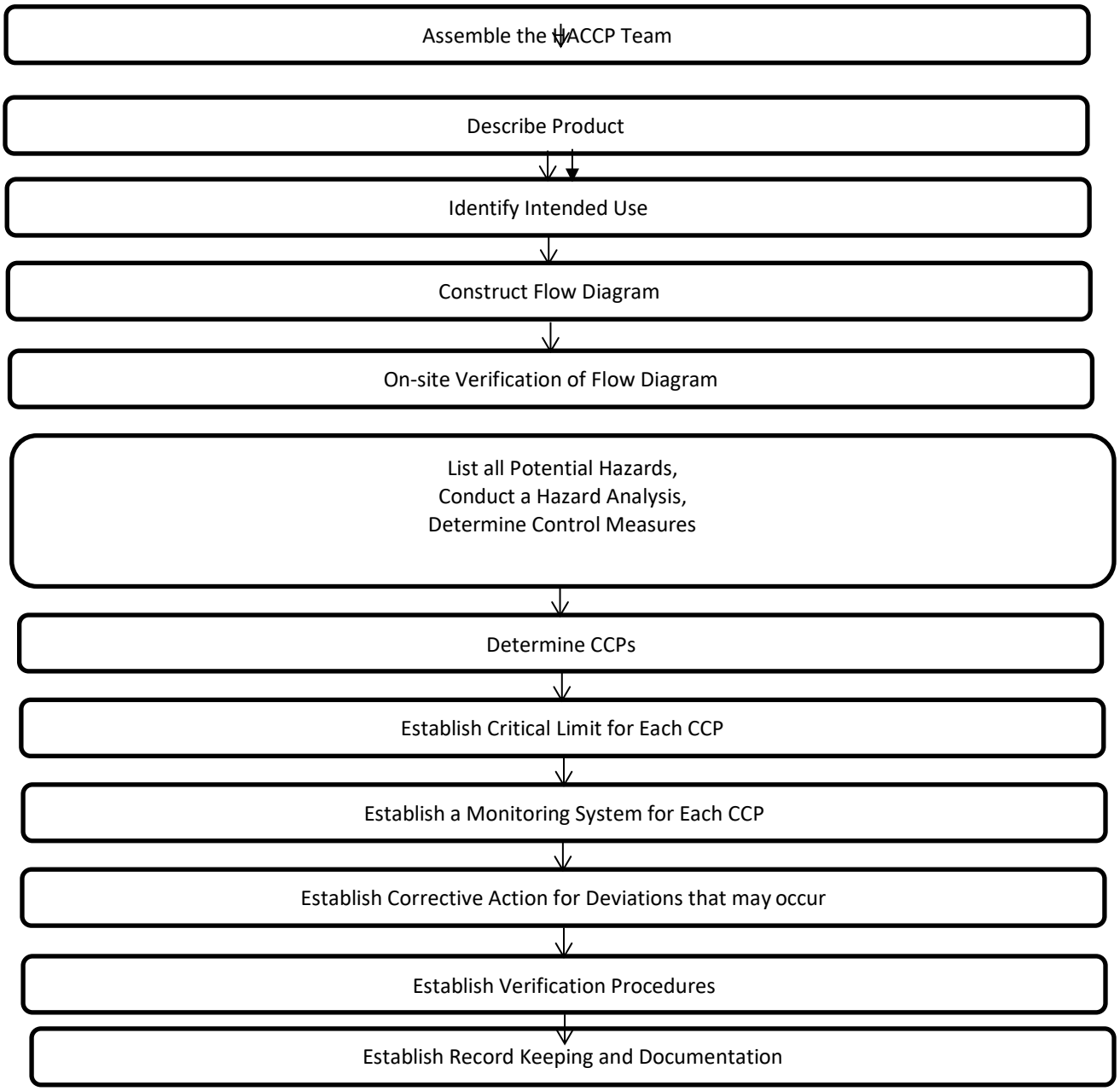

Figure 1: Logical Sequence for the Application of HACCP

Assemble the HACCP team: The first task in the application of HACCP in Sole fish fillets and Mince production was to create a team having the knowledge and expertise to develop a HACCP plan. The team formed was multidisciplinary led by the Quality Control Manager to include Microbiologists, Biochemist, Fisheries Scientists, Quality Assurance personnel, Production supervisors, Engineers, Sanitary personnel, Processing plant personnel and Management staff. The team members had clearly and well defined roles in the production process.

Describe the product: The HACCP Team made a complete description of the product on the basis of raw material (Nigerian Tongue Sole fish), origin, storage temperature and nutritional information as shown in Table 1.

Identify intended use: Intended use was identified based on the normal use of the end consumer. Sole Fish fillets and Mince are not to be consumed uncooked. Fish Mince can be used for baby food and for the Elderly who can't chew. Fillets and Mince has a shelf life of 24 months from production date after which consumption could be hazardous.

Construct a Flow diagram: The Team developed and reviewed the flow diagram for fillets and mince to know the possible paths and sequence of the processing steps. A straight line processing steps was adopted for the fillet and mince.

On-site verification of Flow diagram: The team leader along with other team members scrutinized the flow diagram on-site for accuracy and completeness. They verified to confirm with the authentic operations it represents on-site. They checked on-site for the arrangement and positioning of equipment, utensils, workbench, plate freezers, chemicals and additives used in the production process of sole fish fillets and mince.

List all potential hazards, conduct a hazard analysis: Hazard analysis is the most important aspect of the HACCP plan to ensure the safety of the product during and after processing and to improve the shelf life and to make it safe to consume. Hazard analysis was conducted by the HACCP team on the basis of HACCP checklist (as per FAO) and all feasible hazards correlated with the raw material (Sole fish), ingredients, process operations, post process operations were identified and marked as Biological, Chemical and Physical hazards. Hazard identification is beneficial to identify potential biological, chemical and physical hazards that may arise during each step of processing. (Jan T et al, 2016).

Determine the CCPs: The identification of CCPs is a very crucial aspect of the HACCP plan. The CCPs were detected on the basis of decision tree given by Codex Alimentarious Commission.

Establish critical limit for each CCP: For each CCP identified a critical limit was established and specified. A critical limit is a boundary that separates acceptability from unacceptability. When operations are within the limit, the product is safe. Critical limits were set for factors such as time, temperature, chemicals such as chlorine usage, product quantity, product weight etc.

Establish monitoring procedures: Monitoring procedures were established to make sure that the HACCP plan is being followed strictly. Quality assurance officers made sure that the production process is according to the HACCP plan. Time and temperature of the product was being monitored every 30minutes with the use of a food grade thermometer. Raw materials, chemicals, additive usage were checked daily and proper record was documented for future reference and traceability.

Establish corrective action: When monitoring discovers a deviation related to a CCP, corrective actions were carried out to bring the process back to order. This happens when the critical limits associated with a CCP is exceeded.

Establish verification procedure: Verification includes methods, checks, appraisals that ensure compliance with the HACCP plan. Verification was carried out by Quality assurance supervisor through routine and regular checks. Microbiological analysis was also carried out weekly by an in-house microbiologist to ensure Total plate counts of microbes were not exceeded.

Establish documentation and record keeping: Records are important aspect of the HACCP plan. Written and computerized records to include records generated from the processing procedures were regularly maintained. Other records include raw material, employee hygiene checklist, ingredients traceability, time and temperature, finished products, sanitation, packaging material, microbial, heavy metals records amongst others were kept in compliance with the HACCP plan in the record archives of the company.

Sole fish Fillets: Thawed and De-skinned *Cynoglossus browni* were filleted with the use of sharp knives on the work bench. The gut, roe and bone (skeletal frame) were separated from the fillets during filleting. Other processes are described in Figure 2.

Sole fish Mince: Bones (skeletal frame) of *Cynoglossus browni* separated from the fillets during filleting were be-headed, blended and frozen to produce fish mince. Detailed processing steps is described in Figure 3

3.0 RESULTS AND DISCUSSION

The HACCP team carefully designed a plan with strict compliance as given by Codex Alimentarius Commission (2003) to achieve safety of sole fish fillets and mince. The CCPs for fillets and mince was agreed on after thorough examination of the process and logically answering the questions as given by the decision tree especially for the fish mince that has two (2) CCPs. Owing to the fact that blending which increases the surface area, texture, appearance, absence of bone and generally the nature of the fish mince are very important, this has led to an increase in the CCP for the fish mince. Cold chain of the processes was maintained at temperatures that will not allow pathogenic bacteria proliferation. The cold chain for the fillets and mince were maintained through the use of ice at each control point (step). Ice will not allow the temperature to exceed limit. The pre-requisite programs such as GMP, SSOP, Pesticide and fumigation program, First-in first-out, training, medical examination for processors etc helped to achieve a safe product. If these programs had gone wrong, the HACCP concept adopted and implemented in the production of frozen sole fish fillets and mince wouldn't have achieved its aim. Sole fish fillets and mince produced are expected to be cooked before consumption as clearly stated in the intended use of the products. The Hazard analysis listed all potential hazards associated with the raw processing of both products as well as measures to prevent these hazards. The frozen products are expected to remain at a cold storage in refrigerator at a temperature of -18^0C knowing fully well that both products has a shelf life of 24 months, though there are still considerations of the Team to reduce the shelf life of Fish mince to 18 months.

The verification report presented by in-house Microbiologist, external analyst and regulatory agencies on finished products proved that the microbial load and heavy metals present in the sample of sole fillets and mince examined were within limits and are fit for export.

3.1 Challenges in adopting the HACCP Concept

The challenges faced in the implementation of the HACCP concept are enormous. They include lack of training of personnel, Management irresponsiveness, lack of adequate remuneration, lack of consistent handlers, and lack of Government intervention to encourage the use of safety procedures such as HACCP in food production.

PRODUCTS DESCRIPTION: Deep Frozen Tropical Sole Fillets and Frozen Sole Mince

Origin: Nigeria

Intended use: Not to be consumed uncooked

Table 1: Product Description for Sole fish Fillets and Mince (*Cynoglossus browni*)

Product Name		**Frozen Sole Fillets**	**Frozen Sole Mince**
Temperature		-18^0C	-18^0C
Additive		Citric Acid E330	Citric Acid E330
Storage		24 hours in Refrigerator	24 hours in Refrigerator
Expiry Date		24 Months from Production date	24 Months from Production date
Packaging (Certified Food Grade)		6×2 Kg per Carton Transparent Poly Sheet (LDPE) (L)31.5cm by (w) 2.3cm of 6.1g weight	3×7.5 Kg per Carton Non-absorbent Polyethylene(PE) board 305gsm,(L) 51.4cm (W)43.2cm (H)6.8cm of 66g weight
Nutritional value/100g	Energy Kcal	74.1	74.1
	Kjoule	315	315
	Protein	17.8%	17.8%
	Carbohydrate	<0.2%	<0.2%
	(Sugars)	<0.2%	<0.2%
	Fat	0.3%	0.3%
	(of which saturates)	0.156g	0.156g
	Salt	0.12g	0.12g
Catching zone		Central Eastern Atlantic FAO 34	Central Eastern Atlantic FAO 34

Figure 2: Flow diagram for Sole Fillets production

1. temp <5^0C — Raw material receiving
2. Temp <5^0C — Thawing
3. Temp <5^0C

4. Deskinning
5. Temp <5^{0}C — Filleting and Trimming
6. Temp <5^{0}C — Washing
7. Temp <15^{0}C — Wrapping
8. Temp <18^{0}C — Filling
9. Temp <18^{0}C — Weighing
10. Temp <-40^{0}C CCP 1 — Freezing
11. Temp <-18^{0}C — Packaging
12. Temp <-20^{0}C — Cold storage
13. Temp <-20^{0}C — Stuffing
14. Temp <-20^{0}C — Export

Figure 3: Flow diagram Sole fish Mince Production

1. Temp <5^{0}C — Raw material receiving

2 Temp <5^{0}C — Thawing

3 Temp <5^{0}C De-skinning

4 Temp <5^{0}C Filleting

5 Temp <5^{0}C Be-heading of bone

6 Temp <5^{0}C Soak in portable Water and 1.8% Citric Acid

7 Temp <15^{0}C Draining

8 Temp <15^{0}C CCP 1 Blending

9 Temp <15^{0}C Weighing

10 Temp <18^{0}C Filling and Packing

11 Temp -40^{0}C CCP 2 Freezing

12 Temp -20^{0}C Cold Storage

13 Temp -20^{0}C Export

Table 2: Hazard Analysis for Frozen Sole Fish Fillets

#	Processing Step	Identify potential hazards	X	Justify hazards	What preventive measures can be applied for the significant hazards	CCP ?

1	Raw Material Receiving	Biological	Marine Pathogens	Y	Raw Material can be a source of marine pathogens if fishing was done in contaminated fishing grounds	Every lot must be sampled, tested and passed before reception. Avoid fishing in shallow waters. Source from approved companies	N CP1
		Chemical		Y	Due to oil contamination of some fishing grounds	Avoid fishing in polluted areas Source from only approved companies	N
		Physical		Y	Possibility of having damaged or dehydrated product from other sources	Every lot must be sampled (Organoleptic) before reception	N
2	Thawing	Biological		Y	Microbial Growth Contamination by pathogens due to contact with food handlers	Temperature/ Time Control Controlled by GMP & SSOP	CP2 N
		Chemical		N			N
		Physical		Y	Presence of particles, Colour changes		N
3	Deskinning	Biological		Y	Possible Thermal abuse could result in pathogenic growth and possible contamination through handlers	Time/Temperature control of filleting Product to be cooked before consumption	N CP3
		Chemical		N			N
		Physical		Y	Presence of skin	GMP	N
4	Filleting & Trimming	Biological		Y	Microbial Growth Contamination by pathogens due to contact with food handlers	GMP	N CP4
		Chemical		N			N
		Physical		Y	Presence of foreign bodies	GMP	N
5	Washing	Biological		Y	Temperature abuse and proliferation	Time/Temperature control and GMP Product to be cooked	N CP5
		Chemical		Y	Chlorine Concentration	Correct dosage and monitoring (Test kit)	N
		Physical		Y	Thermal abuse and microbial proliferation	GMP	N
6	Wrapping	Biological		Y	Temperature abuse and proliferation	Time/Temperature control and GMP Product to be cooked	**CP6**
		Chemical		N			N
		Physical		Y	Presence of foreign body	GMP	N

7	Grading and Weighing	Biological	Y	Microbial growth and proliferation	Time control and GMP product to be cooked before consumption	N CP7
		Chemical	N			N
		Physical	Y	Presence of foreign bodies	GMP	N
8	Filling	Biological	Y	Microbial Growth and proliferation	Time control and GMP product to be cooked before consumption	N CP8
		Chemical	N			N
		Physical	N	Presence of foreign bodies	GMP	N
9	Plate Freezing	Biological	Y	Likely due to discontinuous operation	Transfer of product or stop productions	Y CCP1
		Chemical	N			N
		Physical	N			N
10	Packaging	Biological	Y	Microbial Growth and proliferation	Time control and GMP product to be cooked before consumption	N CP 9
		Chemical	N			N
		Physical	N			N
11	Storage in the Cold Store	Biological	Y	Microbial Growth and proliferation	Time control and GMP Product to be cooked before consumption	N CP10
		Chemical	N			N
		Physical	N			N
12	Stuffing	Biological	Y	Microbial growth and proliferation	Controlled by GMP	N CP11
		Chemical	N			N
		Physical	N			N

X = is the potential hazard significant? N= No Y= Yes, GMP= Good Manufacturing Practice, SSOP= Sanitary Standard Operating Procedure, CCP = Critical Control Point CP= Control Point.

Table 3: Hazard Analysis for Frozen Sole Fish Mince

#	Processing Step	Identify potential hazards	X	Justify hazards	What preventive measures can be applied for the significant hazards	CCP ?

1	Raw Material Receiving	Biological Marine Pathogens	Y	Raw Material can be a source of marine pathogens if fishing was done in contaminated fishing grounds	Every lot must be sampled, tested and passed before reception. Avoid fishing in shallow waters. Source from approved companies	N CP1
		Chemical	Y	Due to oil contamination of some fishing grounds	Avoid fishing in polluted areas Source from only approved companies	N CP1
		Physical	Y	Possibility of having damaged or dehydrated product from other sources	Every lot must be sampled (Organoleptic) before reception	N
2	Thawing	Biological	Y	Microbial Growth Contamination by pathogens due to contact with food handlers	Temperature/ Time Control Controlled by GMP & SSOP	N CP2 N
		Chemical	N			N
		Physical	N	Presence of foreign body	GMP	N
3	Deskinning	Biological	Y	Possible Thermal abuse could result in pathogenic growth and possible contamination through handlers	Time/Temperature control of filleting Product to be cooked before consumption	N CP3
		Chemical	N			N
		Physical	Y	Presence of skin	GMP	N
4	Filleting	Biological	Y	Thermal abuse and proliferation	Time/Temperature control and GMP product to be cooked before consumption	N CP4
		Chemical	N			N
		Physical	Y	Presence of foreign body	GMP	N
5	Be-Heading	Biological		Microbial Growth and proliferation	Time control and GMP product to be cooked before consumption	N CP5
		Chemical	N			N
		Physical	Y	Presence of foreign body	GMP	N
6	Washing	Biological	Y	Temperature abuse and proliferation	Time/Temperature control and GMP. Product to be cooked	N CP6
		Chemical	Y	Chlorine concentration	Correct damage and monitoring (xxy)	N
		Physical	Y	Presence of foreign body	GMP	N
7	Draining	Biological	Y	Microbial Growth and proliferation	Time control and GMP product to be cooked before consumption	N CP7
		Chemical	N			N
		Physical	Y	Presence of foreign body	GMP	N
8	Blending	Biological	Y	Microbial growth and proliferation. Likely presence of bone		Y CCP1

		Chemical	N			N
		Physical	Y	Presence of bones	GMP	N
9	Weighing	Biological	Y	Microbial growth and proliferation	Time control and GMP Product to be cooked before consumption	CP 8
		Chemical	N			N
		Physical	Y	Presence of foreign body	GMP	N
10	Filling and packing	Biological	Y	Microbial Growth and proliferation	Time control and GMP Product to be cooked before consumption	CP 9
		Chemical	N			N
		Physical	Y	Presence of foreign body	GMP	N
11	Plate Freezing	Biological	Y	Likely due to discontinuous operation	Transfer of product or stop production	Y CCP2
		Chemical	N			N
		Physical	N			N
12	Master Cartons	Biological	Y	Microbial growth and proliferation	Time control and GMP Product to be cooked before consumption	N CP10
		Chemical	N			N
		Physical	N			N
13	Storage in the cold store	Biological	Y	Microbial growth and proliferation	Controlled by GMP	N CP11
		Chemical	N			N
		Physical	N			N
14	Stuffing	Biological	Y	Possible thermal abuse that could lead to an elevated number of pathogens	Temperature control with a recorder Product to be cooked before consumption	CP12
		Chemical	N			N
		Physical	N			N

X = is the potential hazard significant? N= No Y= Yes, GMP= Good Manufacturing Practice, SSOP= Sanitary Standard Operating Procedure, CCP = Critical Control Point CP= Control Point

Table 4: HACCP Plan for the Critical Control Point of Sole fish Fillets

CCP	Hazard	Control Measure	Critical Limit	Monitoring				Corrective Action	Verification
				What	Who	Frequency	How		

Freezing	Biological: Microbial growth and proliferation	Pre-cooled plate freezer and continuous freezing at -40°C for 3hrs	Core temperature -20°C	Temperature gauge check, core temperature of the product and visual inspection	Quality Control Supervisors, Production Supervisor and Refrigerator Engineer	Every discharge	Call the attention of the Ref. Engineer	Organoleptic analysis of finished product by in-house microbiologists, external analyst & regulatory agencies report.

Table 5: HACCP Plan for the Critical Control Point of Sole fish Mince

CCP	Hazard	Control Measure	Critical Limit	Monitoring				Corrective Action	Verification
				What	Who	Frequency	How		
Blending	Biological: Microbial growth and proliferation	Increase speed and GMP	<5 minutes to blend 5kg of Sole bone at <15°C	Blending of sole bone. Check temperature	Quality Control Supervisors	Every 30 minutes	Use of a blender. Thermometer	When temperature or time exceed critical limit, increase speed	Organoleptic analysis of finished product by in-house microbiologists, external analyst & regulatory agencies report.
Freezing	Biological: Microbial growth and proliferation	Pre-cooled plate freezer and continuous freezing at -40°C for 3hrs	Core temperature -20°C	Temperature gauge check, core temperature of the product and visual inspection	Quality Control Supervisors, Production Supervisor and Refrigerator Engineer	Every discharge	Thermometer	Call the attention of the Ref. Engineer	Organoleptic analysis of finished product by in-house microbiologists, external analyst & regulatory agencies report.

4.0 CONCLUSION AND RECOMMENDATIONS

Conclusions

The HACCP concept focused on the safety of sole fish fillets and mince through a systematic and scientific approach to hazard identification, assessment and control. Preventive and control measures in dealing with identified hazards helps to eliminate or reduce hazards to acceptable levels. Pre-requisite programs consolidate the effectiveness of the HACCP in achieving safety of food products. The verification exercise confirmed that the HACCP concept implemented in the processing of Sole fish fillets and mince was adhered to and the products are safe, fit for consumption and ready for export.

Recommendations

To achieve safety of food products requires the joint effort of the HACCP team. Hence, adequate training of the team members on recent developments and changes in the food industry is very key to consistently improve efforts to always maintain the quality brand the product is known for. In Nigeria's Fisheries subsector, workers are not well paid and this affects the workers' productivity. Government should look into the issue of expatriates coming into the country to do jobs that Nigerian citizens can effectively do. The overhead cost on these expatriates increases the cost of processing and production. Awareness of the role of HACCP to achieving safety of food products should be increased so that intending food organizations would see the concept as a necessity.

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