COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)
FOOD RESEARCH INSTITUTE (FRI)
GHANA

TRAINING FOR SMALL-SCALE FISH PROCESSORS

TECHNICAL REPORT

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Table of Contents

EXECUTIVE SUMMARY

The Council for Scientific and Industrial Research – Food Research Institute (CSIR-FRI) in collaboration with the Ministry of Fisheries and Aquaculture Development and the Fisheries Commission organized and conducted training for selected small-scale women fish processors in Ghana as part of the Technologies for African Agricultural Transformation (TAAT) programme in support of the Feed Africa Programme. TAAT is funded by the African Development Bank and is being implemented in Ghana by the Fisheries Commission in collaboration with WorldFish. This training workshop was organized between 6th and 10th July 2020 at the CSIR-FRI to demonstrate and promote technologies envisaged through the implementation of the TAAT Aquaculture Component, that is, improved post-harvest technologies, product development and diversification.

The workshop was organized in 2 parts, a theory session and a practical session. The theory sessions took place in a relaxed classroom fashion while the practical sessions on product development occurred in the kitchen. Training topics for the workshop include Fishing processes, Post-harvest utilization of fish, Hygienic fishing practices, Fish selling, Fish processing methods, Equipment needs, Food safety and hygiene, Value addition and Value added fish products. The training was organized in the form of PowerPoint presentations, discussions, questions and answers. Due to the English language proficiency of the targeted audience, the language of instruction was predominantly Akan.

Fish processors need to know where the fish they process comes from, how it is handled and activities involved before and during the time that fish is caught. They were therefore taught a course on fishing processes. Proper handling and processing of fish is important for industry and consumers. Fish processors and traders were taught how to handle fish in a hygienic manner to ensure its safety for consumption. They were introduced to advantages and disadvantages of traditional and industrial fish processing methods such as salting, drying, smoking, fermentation, canning, cooling and freezing. Processors and traders had to also learn about fish selling as an activity along fish value chains and the hygienic and good handling practices associated with such activities. In the process, they were taught that fish could be sold as a fresh commodity, semi-processed or processed product.

In the sessions on fish processing and product development through value addition, training participants were introduced to the scientific basis of fish processing and the importance of value addition. Preservation of fish is essential in order to prolong shelf life. Processing prevents spoilage, adds value, ease transportation, improves sensory properties, reduces risks and creates employment. The advantages of adding value to fish are that value addition to fish creates more convenience in terms of handling, storage and consumption, value addition reduces post-harvest losses, it leads to better income, provides a variety of products and attracts more consumers towards fish consumption.

After the training sessions in the classroom, participants had the opportunity to be taught by the professional kitchen staff and to conduct hands-on practice of fish processing and product development in the kitchen. Varieties of fish products were produced in the process and packaged for preservation. Some of the fish products developed and packaged included fish khebab, fish balls, fish fingers, fish sausage, fish a'lory and spicy diced baked fish. Training participants expressed their willingness to transfer knowledge and skills acquired to their colleagues in their communities who did not get the opportunity to participate in the workshop.

1.0 INTRODUCTION

1.1 Project background

The Ministry of Fisheries and Aquaculture Development (MOFAD) and the Fisheries Commission (FC) of the Republic of Ghana is currently implementing the Technologies for African Agricultural Transformation (TAAT) program in Ghana in collaboration with WorldFish, and funded by the African Development Bank (AfDB). The program is implemented in support of the Feed Africa Program. It is part of WorldFish efforts at partnering with the Government of Ghana to roll out programs that will enable faster and sustainable growth of fish production, improve existing technologies across the value chain, and undertake best management practices.

TAAT is a knowledge- and innovation-based response to the need to scale up proven technologies across Africa. The aim is to boost productivity and make Africa self-sufficient in key commodities. The program is being implemented in 22 countries. It focuses on 9 priority commodity agricultural value chains (maize, wheat, rice, sorghum/millet, cassava, high-iron bean, orange flesh sweet potato, aquaculture and small livestock). The TAAT program for Ghana covers the aquaculture value chain from Tilapia production, processing, marketing and consumption.

The TAAT Aquaculture Compact (2018 - 2021) is one of 15 compacts which is led by WorldFish as part of the Consultative Group for International Agricultural Research (CGIAR) Research Program on Fish Agri-Food Systems (FISH). The Compact aims to disseminate and upscale aquaculture technologies across 10 countries to raise the productivity of aquaculture value chain actors, increase consumption of fish protein and enhance sustainability along the value chain. The technologies being demonstrated and promoted for upscale through the Aquaculture Compact include fast growing quality fish seeds and improved fish rearing technologies using Tilapia (*Oreochromis niloticus)* and Catfish (*Clarias gariepinus*), quality low cost fish feed formulated with local raw materials, and improved post-harvest technologies, product development and diversification.

Specific objectives of the Aquaculture Compact are to:

1. Create an enabling environment for aquaculture technology adoption by the value chain actors
2. Facilitate effective delivery of technologies to fish farmers and other actors along the aquaculture value chain and
3. Increase aquaculture production and productivity through the identification and dissemination of quality tilapia and catfish seed, production of low cost fish feed and value addition

1.2 Purpose of the training workshop

This training was organized as part of program efforts by the Fisheries Commission to demonstrate and promote technologies for upscale that are envisaged through the implementation of the TAAT Aquaculture Component, that is, improved post-harvest technologies, product development and diversification. In addition, the training program was also intended to contribute to the achievement of TAAT's specific objective of increasing aquaculture production and productivity through Tilapia and Catfish value addition. The expected outcome of this program activity is increased value for aquaculture products through improved post-harvest technologies, fish product development and diversification. The purpose of the training workshop therefore was to train small-scale fish processors to acquire knowledge in good manufacturing practices during handling and processing of fish and acquire the skills to be able to transfer the knowledge gained to other fish processors. This objective was achieved through power point presentations, demonstration and practice on fish products. The processors were given handout which informs them about all that they were taught.

1.3 Planning of the training workshop

On 29th May 2019, the Council for Scientific and Industrial Research - Food Research Institute (CSIR-FRI), Ghana received an official letter from the Fisheries Commission that requested the CSIR-FRI to collaborate with the Fisheries Commission to provide training services for a group of small-scale fish processors as part of TAAT activities. The letter requested the CSIR-FRI to train 15 small-scale fish processors in fish handling, quality, processing, product development and diversification. Suggested fish products included fish sausage, fish burger, fish fillet, fish fingers, fish powder and appropriate packaging methods that small-scale fish processors can employ in marketing of fish and fish products.

The CSIR-FRI responded positively to this request because the Institute possesses the human resource capacity and physical infrastructure to successfully deliver on this important assignment. The CSIR-FRI is mandated to conduct applied market-oriented research into problems of food processing and preservation, food safety, storage, marketing, distribution, utilization as well as national food and nutritional security in support of the food industry. It is also mandated to advise government on its food policy. The Institute's mission focuses on providing scientific and technological support to the growth of the food and agricultural sectors of the national economy in line with corporate prioritization and national objectives. The overall goal of the Institute is to develop and improve cost effective and environmentally friendly post-harvest technologies that have the potential to enhance livelihoods by generating and increasing incomes within the micro-, small-, medium- and large-scale food industry, contribute to food security and foreign exchange earnings.

After acceptance of this request, a team of CSIR-FRI Research Scientists was assembled to develop a training program based on request from the Fisheries Commission in consultation with members of staff from the Commission. It took both teams some time to put the program together, there were also administrative delays with the program's approval, and just around the time that the training program was scheduled to take place COVID-19 emerged. The program did not take place until July 2020.

1.4 Organization of the training workshop

A 5-day training workshop on fish handling, quality, processing, product development and diversification was organized for small-scale fish processors from different parts of Ghana in the Apesiwa Conference Hall of the CSIR-FRI from 6th to 10th July, 2020. A total of 34 participants, including members of staff of the Fisheries Commission, CSIR-FRI, small-scale fish processors and media representation participated in this training workshop. There were a total of 11 members of staff of the Fisheries Commission, 8 members of staff of CSIR-FRI, 13 fish processors and 2 representatives from the media (Akuafo TV). Fish processors were strategically selected to include fish smokers, dryers, fryers, as well as those who engaged in salting and fermentation.

The workshop was organized in 2 parts, a theory session and a practical session. The theory sessions took place in the Apesiwa Conference Hall in a relaxed classroom fashion while the practical sessions on product development occurred in the CSIR-FRI kitchen. The program was prepared to include the following topics; Fishing processes, Post-harvest utilization of fish, Hygienic fishing practices, Fish selling, Fish processing methods, Equipment needs, Food safety and hygiene, Value addition and Value added fish products. The training was organized in the form of PowerPoint presentations, discussions, questions and answers. Due to the English language proficiency of the targeted audience for this training workshop, the language of instruction was predominantly Akan, the local language spoken by a majority of people in Ghana. The facilitators of the training adopted the adult learning approach. Therefore, proceedings of the training were more interactive rather than instructive, in a free and relaxed atmosphere where all participants were encouraged to openly express themselves and share their views. Proceedings were manually recorded by a rapporteur who also had an electronic recorder for the same purpose. Several photos were also taken in addition to live records taken by TAAT Enablers from the Fisheries Commission via Whatsapp (an open access social media platform).

This report summarizes the presentations, discussions and outcomes from the training workshop on fish handling, quality, processing, product development and diversification conducted by the CSIR-FRI in collaboration with the Fisheries Commission for small-scale fish processors in Ghana. It was intended to be a Trainer-Of-Trainers workshop for selected fish processors who acquired knowledge in different fish processing, product development and diversification techniques for diversified livelihoods, income generation and poverty reduction. It is expected that knowledge gained would be transferred to the wider groups of small-scale fish processors resident in fishing communities across Ghana.

2.0 SPEECHES AND STATEMENTS OF SUPPORT

2.1 Welcome address: Director, CSIR-FRI, Prof. Mary Obodai

As Ghanaian custom demands, the workshop started with an opening prayer by one of the training participants followed by self-introduction of all members present. Immediately after the introduction, a welcome address was given by the Director of CSIR-FRI, Prof. Mary Obodai. She started her speech by welcoming all the training participants and members of staff of the Fisheries Commission and representatives from the media to the CSIR-FRI. In a brief message, she spoke about the mandate of the CSIR-FRI and gave an account of activities that are carried out by the Institute in accordance with the mandate. Some of the activities she spoke about include the preservation and value addition of food materials such as fish, roots and tubers (cassava, plantain), cereals and legumes (groundnut, maize, sorghum).

Prof. Obodai justified the need for the preservation of food materials by indicating that preservation of available food materials is important in order to reduce or eliminate post-harvest losses. In addition to preservation, value addition to available food materials is also carried out to avoid damage by micro-organisms and rodents to extend the shelf life of food products and also to increase profits. Food processors therefore make more profits from preservation and value addition to their products thereby generating more income to reduce poverty. She gave some examples of value added products that have been developed by the CSIR-FRI which include fufu flour, cereal grains and cereal mix.

In her remarks about the fishing industry and its contributions to the Sustainable Development Goals (SDGs), she emphasized that fishing provides both food for consumers and employment for millions of people around the world particularly in developing countries. She noted that consumers have more than ever become more concerned about what they eat and therefore look for quality in terms of how fish is handled before they buy. She added that many countries that import fish have regulations in place to control the quality of imported fish to ensure that consumers are protected from the consequences of eating unsafe fish and fish products. She stated that a potential outcome of failing to meet such requirements is that fish cannot be exported from one country to another to be marketed. The related consequences are that fish processors and traders may lose their businesses which may impact negatively on their livelihoods and income.

Prof. Obodai continued with her remarks by saying that fish processors and traders in many countries often rely on simple low cost equipment and those who work in remote areas where these facilities are not available may lack skills, knowledge and ideas to invent new equipment.

This may also mean that, fish may be processed in unhygienic conditions leading to contamination and spoilage therefore increasing post-harvest losses. She explained that the workshop was planned and organized by the CSIR-FRI in collaboration with the Fisheries Commission to introduce participants to best fish handling practices in order to make more of the fish they catch, process and sell thereby reducing post-harvest losses. She said participating in the workshop would also improve their knowledge in fish handling, hygienic practices and sanitation. She noted that the duration of the workshop was five (5) consecutive days from Monday 6th July to Friday 10th July 2020. She said the lecturers were going to educate participants on how to process fish in a more hygienic way and also to increase shelf life.

Prof. Obodai urged participants to observe all COVID-19 protocols by social distancing, washing and sanitizing of hands. She ended her address by expressing how confident she was that the training would be beneficial to the participants and therefore urged them to learn well and carry the knowledge forward to pass it on to other fish processors and traders who didn't have the opportunity to be selected to participate in the training workshop due to inadequate resources. This would contribute to the development and long-term sustainability of the fishing industry in Ghana.

2.2 Statement of support from the Fisheries Commission: Deputy Director, Inland Fisheries Management and Aquaculture Division, Mr. Emmanuel Aryee

After the welcome address by the Director of the CSIR-FRI, the Deputy Director of Inland Fisheries Management and Aquaculture Division of the Fisheries Commission in the person of Mr. Emmanuel Aryee had the chance to also give an opening remarks from the perspectives of the Commission. He started by welcoming all workshop participants, members of the media and officials of the CSIR-FRI and the Fisheries Commission present. He then gave a short background to the workshop by acknowledging that the workshop was sponsored by the African Development Bank through the Technologies for African Agricultural Transformation (TAAT) Program headquartered in Abuja. He explained that the TAAT program focuses on technologies that are intended to develop farming activities including fish farming.

Mr. Aryee emphasized that fish catches from the wild have been reported to be lower than expected in the last few decades. As a response to this challenge, ten (10) African countries including Ghana, Kenya and Nigeria have been selected for pilot studies to improve fish catch and processing. The African Development Bank encourages project countries to adopt outcomes of the pilot studies for up-scaling in the respective countries. Such projects would then be funded through loans to be provided by the Bank. He clarified that Ashanti Region was selected for the pilot studies in Ghana. As part of the TAAT project implementation in Ghana, training

workshops were conducted for fish farmers with a focus on hatchery and fish feeding. In addition, there are aspects of the project that focus on fish post-harvest activities because fish preservation and value addition are equally important to extend the shelf life of fish and fish products, and that was the basis for organizing the training for fish processors and traders.

Mr. Aryee justified the selection of the CSIR-FRI to offer this training because the Institute possesses the required human resource and infrastructure capacity. He further elaborated that fifteen (15) people were initially selected to be trained in technologies for fish processing, product development and diversification through value addition and transfer the knowledge to others in their communities. He indicated that although Ashanti Region was selected for the pilot studies, participants selected for the training workshop on fish processing and product development came from other Regions in Ghana as well. The workshop was therefore a trainer-of-trainers program for the transfer of technology and knowledge acquired to fish processors and traders from different Regions in Ghana.

Mr. Aryee concluded his speech by mentioning that officials of the Fisheries Commission as a follow up to the training would visit training participants in their communities to see how the knowledge acquired from the training would be utilized to improve their work for personal development and the development of their communities. He encouraged the training participants to learn well and make sure they understand what they were going to be taught. Mr. Aryee ended his remarks by praying for God's protection and support in the course of the training workshop.

2.3 Statement of support from the Course Coordinator: Dr. Godfred Ameyaw Asiedu, Research Scientist, CSIR-FRI)

Before the end of this session of speeches and statements of support, Dr. Godfred Ameyaw Asiedu, the training course coordinator and the lead organizer of the workshop joined the previous speakers to welcome everyone to the training workshop and expressed his appreciation to members present for accepting to be part of the program. He gave a short background to the planning of the workshop and program preparation which commenced a few months back but could not take place because of the COVID-19 pandemic that broke out in early March. He was therefore happy to see the workshop taking place and asked all training participants to actively participate to make the training an interactive one.

Dr. Ameyaw's brief speech was followed by a closing remarks from a prominent member of the Fisheries Commission in the person off Mr. Samuel Manu, the Head of the Fish Post-Harvest of the Commission. In his remarks, he asked participants to learn well in order to help family, society and Ghana. His remarks were followed by a closing prayer by Dr. Mrs Charlotte Oduro-Yeboah, a Principal Research Scientist at the CSIR-FRI. This session ended with all members

present participating in a group photograph outside the conference room observing all COVID-19 protocols.

3.0 PRESENTATION TOPICS AND DISCUSSIONS

3.1 Session 1: Fishing processes (Dr. Godfred Ameyaw Asiedu, Research Scientist, CSIR-FRI)

The first session on presentation of training topics, discussions, contributions and interactions started after the group photographs and a short tea break with a PowerPoint presentation on Fishing Processes by Dr. Godfred Ameyaw Asiedu, the training workshop coordinator. The presentation on fishing processes was important because fish processors need to know where the fish that they process comes from and how it is handled, as well as the activities involved before and during the time that fish is caught.

Even though this training workshop had the processing of fish grown from aquaculture as its main focus, training participants were drawn from both inland and marine fisheries who process fish from both sources. Participants therefore needed to know both the processes involved in both capture fisheries and aquaculture. In the process, fisheries was broadly defined as all activities that involve the catching, processing and selling of fish. Fishing activities are categorized into pre-harvest fisheries, harvest fisheries and post-harvest fisheries. Relevant pictures were shown to describe these three fishing processes with examples.

It was explained that pre-harvest fisheries involves work that takes place before catching fish. Examples of pre-harvest fisheries activities include boat building, gear fabrication and mending, bait provisioning, vessel registration and licensing, input supplies and distribution as well as investments and finance. Harvest fisheries were described to involve work that takes place during the capture and landing of fish. This includes operating fishing gear, setting nets, traps and lines, pulling back, loading and unloading fishing equipment and freshly caught fish. Post-harvest fisheries takes place from fish landing to consumption. It was stated that improving post-harvest handling, processing and marketing of fish has the potential to improve livelihoods.

3.2 Session 2: Post-harvest utilization of fish landings (Dr. Godfred Ameyaw Asiedu, Research Scientist, CSIR-FRI)

The next presentation was on Post-harvest Utilization of Fish Landings which was also facilitated by Dr. Godfred Ameyaw Asiedu. He explained that, proper handling and processing of fish is important for industry and consumers. It is therefore essential for fish processors and traders to handle fish in a hygienic manner to ensure its safety for consumption. Improving processing and handling of fish techniques results in an increased economic activity and employment and also contributes to effort related to nutritional goals.

In addition, to maximize earnings from fish, products must be diversified with value addition. The preferred method for processing fish depends on the type of fish. There are two types of fish processing which are industrial and traditional. Industrial processing normally involves the method of caning. Traditional fish processing involves smoking, salting, drying, freezing, icing and cold storage. The processing method and type of fish determines the price of fish e.g. salted tilapia ('koobi') and grilled tilapia.

It was recommended that when transporting fresh fish it must be packed with ice to ensure freshness. The fish and ice must be arranged in a ratio of 1kg of ice to 2kg of fish so as to prevent spoilage. Fish spoils quickly within 12 hours after harvest due to high temperatures. Proper hygiene must be ensured to prevent fish contamination. Contamination can come from people, soil, dust, sewage, surface water, manure or spoiled foods. Advantages and disadvantages of traditional processing methods are described below:

1. **Salting:** an inexpensive method when salt is cheap and its storage can be at room temperature. Also its quality and nutritional value are reasonable and longer storage life
2. **Drying:** inexpensive method, no electricity required, little equipment needed, airtight storage is required, quality and nutritional value are reasonable
3. **Smoking:** the most common method of fish processing, 80% of fish is consumed smoked. Smoking is inexpensive, little equipment and energy needed but fuel must be available.
4. **Fermentation:** inexpensive, but the fish taste and odor are radically changed. Storage life varies depending on the product.
5. **Canning:** Fairly expensive method. Labor intensive and requires plenty of energy, water and equipment such as tins or jars with lids, sterilizers and canning machines. Packaging is expensive. Storage is easy and possible for long periods
6. **Cooling and Freezing:** Very expensive method, involves high use of energy and large investments in equipment

3.3 Session 3: Hygienic fishing practices (Dr. Godfred Ameyaw Asiedu, Research Scientist, CSIR-FRI)

The last presentation before a questions and answers session was on Hygienic Fishing Practices which was also facilitated by Dr. Godfred Ameyaw Asiedu. It was presented that for good fish handling practices, potentially dangerous objects from the boats must be removed, fish must be placed in a good container, glass object should not be taken onboard, fishing in polluted waters must be avoided, fish must be placed in a good closed box, boat and fishing gear must be kept clean, good personal hygiene must be observed and animals must be kept away from the boat.

Some dangers that make fish unsafe to eat were described. This included contamination of fish with pieces of wood or metal, contamination of fish with fuel or oil, contamination of fish with disease causing germs on the boat, contamination of fish with disease causing germs on fishermen's hands and clothing and contamination of fish with disease causing germs found in dirty ice or dirty salt. Causes of fish spoilage include fishing method, poor handling, contaminating the fish with germs, not placing the fish in ice or protecting it from the sun, poor handling by dropping, throwing and standing on the fish, physical damage, bacteria growth and enzyme activity.

The three presentations were combined for a one questions and answers session since they were all short presentations to introduce participants to general fishing activities before focusing on processing in subsequent presentations. Below are questions, responses and contributions after the presentations:

Questions and contributions during presentation

Questions	Responses/contributions
How is fish processed?	Processor: fish is processed by first washing of hands, followed with 3 times washing of fish where salt is added to the third washing to give it a good taste
What is the condition of Tilapia before it is used as salted fish?	Processor: fresh Tilapia is used for salted fish which makes it more expensive with the seller making more profit. However, if fish stays for a long time and loses its freshness then it is processed as fermented fish ('momone')
How is fish handled if all is not processed in a day?	Processor: fish is kept in a freezer

What sometimes causes yellowish colouration on fish?	Processor: yellowish colouration on fish come from the oils from the fish Facilitator: Yellowish colouration on fish occurs due to the reaction between salt, oils and oxygen which cause the fish to go rancid
What's the cause of mould growth on fish?	Facilitator: When fish is not well dried it leads to the growth of mould Facilitator: Causes of fish spoilage include not only touching fish with dirty hands but also contamination with storage containers
How is fish stored?	Processor: four blocks is put under the edge of the fish tray lined with black polyethylene. Fish racks are then loaded onto the blocks. The racks are then covered with the polyethylene to prevent exposure to moist air
Contributions	Processor: Onions and ginger are added to coconut oil when frying so as to reduce the pungent smell Processor: good nuts are mixed with bad ones during oil processing thereby affecting the taste
Contributions	Processor: Fish are washed with alum to remove mucus slime on fish Processor: It is better to wash the fish in lime instead
Contributions	Facilitator: good salt should be used in fish processing to ensure quality Facilitator: Avoid the usage of already used salt for preserving different batch of fish to avoid contamination Facilitator: Clean water should be used for ice blocks to ensure quality of fish

3.4 Session 4: Fish selling (Mr. Emmanuel Saka, Principal Technologist, CSIR-FRI)

The session on fish selling was delivered by Mr. Emmanuel Saka, a Principal Technologist of the CSIR-FRI. Mr. Saka's presentation highlighted on fish selling as an activity along fish value chains and the hygienic and good handling practices associated with such activities. He explained that fish could be sold as a fresh commodity, semi-processed or processed product. Fish selling could be conducted as a small-scale activity, for instance, the type of selling that is normally done by women fishmongers at the landing beaches or small fish markets, medium- or large-scale activity in an auction house. This means that fish selling can occur at different levels with associated political, economic, sociological (sourcing and customer care), technological (cleaning, preservation and packaging), legal (Metropolitan Authority, Food and Drugs Authority, Ghana Standards Authority) and environmental (good hygienic practices) dimensions.

Training participants were made to understand that poor hygienic practices along fish value chains occur as a result of the irresponsible behavior and attitude exhibited by beneficiaries (fisher-folk, processors, transporters and fish traders/retailers) in their workplace. Good hygienic practices come about as a result of the good behavior and desired attitudes displayed by the practitioners. Poor sanitation practices associated with fish selling include selling in dirty places, pets that are kept on the market, improper use of toilet facilities, poor solid and liquid waste management, storing of fish in dirty places, flies on improperly covered fish.

The consequences of poor sanitation conditions may lead to the spread of high risk diseases and health issues such as chronic diarrhea, intestinal worms, bilharzia, hepatitis and scabies. In order to ensure best fish selling practices, fish processors and traders must clean and sell the good parts of fish that are desirable, practice first-in-first-out system of trade, sell or display fish products on clean tables, arrange fish with bellies down to allow melting ice to drain away from the fish in order to reduce the chances of spoilage.

In conclusion, it was recommended that fresh fish should be kept away from non-edible products so as to avoid cross-contamination. Fish processors and traders were advised to desist from the use of obnoxious substances such as formalin for the preservation and processing of fish and must sell fish using appropriate packaging materials.

Contributions

1. Fish processors sell their fish to customers at different prices without any regulations. Therefore there is no fairness in the selling of fish which needs to be addressed
2. To ensure good hygienic practices, a processor suggested that the selling environment should be cemented and swept before selling
3. Facilitator urged processors to stop using chemicals such as formalin to preserve fish
4. Deputy Director of Inland Fisheries Management and Aquaculture Division of the Fisheries Commission asked processors to explain how to process fish without any interruptions

3.5 Session 5: Fish processing methods (Mr. Papa Toah Akonor, Senior Research Scientist, CSIR-FRI)

In the previous sessions, training participants were introduced to fishing processes, fish selling, hygiene and good fish handling practices because fish processors need to know where the fish they process comes from, how fishers or fish farmers handle fish during the production phase as well as how fish must be handled during the selling phase. Based on the purpose of this training workshop, perhaps the most important parts of the training were the sessions on fish processing and product development through value addition. In this session of the training, training participants

were introduced to the scientific basis of fish processing and the traditional and industrial methods for the processing of fish.

The session on fish processing methods was presented by Mr. Papa Toah Akonor, a Senior Research Scientist at the CSIR-FRI Food Technology Research Division. His presentation focused on basic principles of processing, methods of processing, equipment needed, fish handling as well as risks and hazards in fish processing. Mr. Papa Toah started his presentation by mentioning that preservation of fish is essential in order to prolong shelf life. He continued by saying that fish is highly perishable due to its high moisture content, nutrients and enzymes. Therefore, appropriate control measures need to be applied to preserve fish. In that regard, two critical factors which are temperature and water content must be controlled when processing fish. Temperature and water content in fish are controlled through processing and preservation. He emphasized that processing prevents spoilage, adds value, takes care of excess fish, ease transportation, improves sensory properties, reduces risk, ensures convenience, storage for lean seasons and creates employment.

Available methods of fish preservation were discussed which include freezing, salting, drying, fermentation and canning. He explained that freezing occurs in two phases which are slow and quick freezing. Slow freezing takes more than 30 minutes before freezing is achieved. Using a deep freezer is an example of slow freezing. Quick freezing on the other hand takes less than 30 minutes, for example, when using a tunnel freezer. Freezing works at low temperatures, slows down activities of organisms that cause fish spoilage, retains freshness and nutrient content of fish.

Salting was also discussed as another preservation method which is done by applying excessive amount of salt to control the availability of water. Salting can be done by rubbing salt on fish (dry salting) or immersing fish in saturated salt solution (brining).

The next method of preservation discussed was drying. Drying takes place by evaporating water from fish. During drying, fish shrinks and becomes firm and dry. There are different types of drying which include open sun drying, solar drying and mechanical drying.

The next method of preservation discussed was smoking. Smoking is a combination of heat and chemicals from wood. Smoking can be carried out at a temperature of about $30^{O}C$ (cold smoking) and 70-80 ^{O}C (hot smoking). Cold smoking and hot smoking partially and fully cook the fish respectively.

Another method of fish preservation is fermentation. Fermentation normally involves the use of low value fish which is salted and allowed to ferment. Fermented fish also known as "*momone*" has a soft texture and strong odor which is mostly used as condiments.

Canning is also used as another method of fish preservation. During canning, fish is placed in cans and filled with oil, brine or sauce and hermetically sealed and sterilized. Fish can also be

preserved by frying which involves cooking of fresh fish in vegetable oil. Vacuum packaging is also another fish preservation method where fish is placed in pouch, vacuum packed and frozen.

This session was concluded with a discussion on fresh fish handling. Fresh fish should not be exposed to sunlight, should not be kept in water for too long and must be kept in ice immediately fish is caught. Causes of fish spoilage include bad handling, activities of microorganisms (in intestines, gill and skin of fish) and enzymes (in fish stomach).

3.6 Session 6: Food safety and hygiene (Mr. Papa Toah Akonor, Senior Research Scientist, CSIR-FRI)

After the presentation on preservation and fish processing methods, Mr. Papa Toah Akonor continued to the next session with a presentation on food safety, risk and hazards in fish processing. The purpose of this session was to expose training participants to the potential dangers that fish consumers face when they eat contaminated fish and fish processed under unhygienic conditions.

In the context of this training, food safety was explained to be understood as the assurance that food will not cause harm when eaten or during handling. This is very much related to food contamination with substances not intentionally added to food. Food contamination reduces quality and safety of food which is very likely to cause food-borne illnesses. Promotion of good hygienic practices such as personal hygiene, cleaning and sanitation, environmental hygiene and control of contamination is therefore paramount to reduce the occurrence of human diseases.

Fish processors are exposed to some common occupational health and safety risks such as cuts and bruises, exposure to fish toxins and knee joint pains. The presenter referred to a report by Adei *et al*. (2019) that identified different risks associated with fish smoking, frying, freezing, drying and canning. This report says that fish processors are exposed to heat, eye and nose irritation, respiratory disorders and fires (smoking), smoke, burns from hot oil or flame, eye irritation, oil spillage (frying), numbness, skin irritation (freezing), exposure to formalin (drying), ear problems and low temperature (caning).

Following the presentation were questions and contributions from participants and responses from the presenter as captured in the table below:

Questions	Responses / Contributions
Is it better to remove intestines from fish before freezing?	Facilitator: yes removing intestines from fish before freezing will increase shelf life
How is salted fish processed for persons who take in low amounts of salt?	Facilitator: consumers are encouraged to soak salted fish in water in order to reduce the level of salt before use

How does drying fish with a gas cooker differ from fish smoking?	Facilitator: drying with gas and smoking are similar processing methods but smoking gives fish a more preferred aroma to drying with a gas cooker
Can the same cooking oil be used to fry fish on different occasions?	Facilitator: Reusing frying oil several times over is discouraged since the breakdown can lead to the formation of chemicals which may be harmful
Using one gallon or two gallons of cooking oil to fry same quantity of fish, which one will be fresh and sell more	Processor: Using adequate amounts of fresh oil gives fried fish a better appearance and taste
Is it good to mix used oil with fresh oil to fry fish?	Facilitator: during mixing, oil quality is reduced which could be hazardous to health
Is it good to use an insecticide spray to prevent cockroaches and flies from fish?	Facilitator: Not during processing, since this practice exposes fish to chemical hazards. Indeed insecticides used in processing must be approved by the Ghana Standards Authority for use in food facilities.
Contribution	A processor encouraged her colleagues to stop drying fish on the floor
Contribution	A fish processor gave an example of the challenges she encountered when she used an Ahotor oven to smoke fish by saying that she could smoke only small quantities of fish at a time. Another fish processor responded to this by saying that firewood for smoking must be positioned well to distribute heat evenly in the oven which can help to smoke larger quantities of fish at a time by using more smoking racks. Also, the oven must be heated in advance before smoking fish

3.7 Session 7: Value addition (Dr. Charlotte Oduro-Yeboah, Principal Research Scientist, CSIR-FRI)

The next major topic for this training after fish processing and preservation methods was value addition and product development which was delivered by Dr. Mrs. Charlotte Oduro-Yeboah, a Principal Research Scientist at CSIR-FRI. Dr. Oduro-Yeboah introduced value addition as a process of changing or transforming a product from its original state to a more valuable state or preferred product in the market place. She said the advantages of adding value to fish are that fish is readily available, value addition to fish creates more convenience in terms of handling, storage and consumption, there are minimum issues of waste disposal for consumers in urban areas, value addition reduces post-harvest losses, it gives more quantity and variety from a given quantity of fish, it leads to better income, provides a variety of products and attracts more consumers towards fish consumption.

There are various ways that value can be added to fish to develop different products which were explained to training participants. These include value addition to develop fish fillets, steaks, split/deboned, battered and breaded products, extruded cooked products, and breakfast/lunch/dinner packs. To ensure quality fish product development, there should be full maintenance of cold chain and immediate processing within few minutes of harvesting fish. Producing good quality safe fish helps to make more money, helps consumers grow healthy, and ensures that fish processors and traders can sell their products in different markets, both internationally and locally. Participants were taught how to reduce fish spoilage and also add value to fish. These can be achieved by improving fish infrastructure and facilities on fish landing centers or fishing harbours, ice storage, drainage, transportation, providing more primary processing centres for fish dressing, value addition, changing of mindset of stakeholders on importance of proper handling, preservation, hygiene, product development and product presentation.

Dr. Oduro-Yeboah ended her presentation by discussing the different processing methods available for some value-added fish products such as fish sausage, fish burger, fish fillet, fish finger, etc. with participants and teaching them the actual steps to be followed and the required materials in the preparation of these products. After the training sessions in the classroom in the first two days of the training, participants had the opportunity to be taught and conduct hands-on practice of fish processing and product development in the CSIR-FRI Test-kitchen by experts. Activities involved in these processes, examples of fish products developed and processing techniques, materials and methods have been provided at the Annex column of this report.

3.8 Practical sessions (Ms. Constance Boateng and Ms. Alice Padi, CSIR-FRI)

The practical sessions of the training took place outside the classroom at the CSIR-FRI Test-kitchen. These sessions were facilitated by two of the CSIR-FRI seasoned technologists in the persons of Ms. Constance Boateng and Ms. Alice Padi. In the practical training sessions, participants were taught how to develop different fish products with Cassava fish from the sea, Tilapia and Catfish grown in aquaculture systems by following well laid down steps according to good fish handling practices using the right quantities of recommended food ingredients. After the theoretical sessions in the kitchen, participants had a lot of fun to practice with the actual processing of fish. Varieties of fish products were produced in the process and packaged for preservation. Some of the fish products developed and packaged included fish khebab, fish balls, fish fingers, fish sausage, fish A'lory and spicy diced baked fish. Photos of these products have been provided in the Annex of this report.

4.0 TRAINING OUTCOMES AND THE WAY FORWARD

4.1 Training outcomes

After successful conduct of the theoretical and practical sessions, the training programme was evaluated on the last day to assess the preparation and organization of the workshop, overall outcomes, performance of instructors and participants, successes and failures with respect to learning objectives as well as lessons learned to improve upon the programme in future. Based on the proficiency level of the training participants, this was done through an informal oral evaluation exercise by way of questions and answers. The evaluation session was facilitated by the training coordinator Dr. Godfred Ameyaw Asiedu. The table below shows the presentation of the workshop evaluation questions and responses from training participants and officials of the Fisheries Commission.

Questions	Responses/Contributions
1. How would you rate the quality of the value-added products developed?	• Majority of the participants rated the quality of the fish-based products developed as 100%
2. What were your observations during the training in terms of what was learned, what went well and what did not go well?	• Fish sausage product development went very well • The session on fish value addition went very well • Good teaching methods were used during the training in both the theory and practical sessions • The session on fish processing and preservation was the best • Participants learned how to use underutilized fish for different products • Hotel accommodation for participants was poor • Some participants did not observe social distancing at some points during the practical sessions

3. Would you recommend a similar training programme for other fish processors and traders? If so, how should the next training session be improved?	• Yes, similar training is recommended for other fish processors and traders • There should be practical sessions on fish cake and fish toffee product development in the next training • It was suggested that in the next training, processors will suggest what should be included in the practical sessions
4. Were the theory sessions of the training relevant and adequate? If not, what do you suggest should be added or taken out?	• How to market fish products should be included in the theory session • A training participant suggested to her colleagues to start marketing their products by displaying them during special occasions and events such as outdooring and marriage ceremonies and provide some of the products for free in the first instance as a way of advertising the products
5. How would you rate the overall performance of training instructors, the conduct of the training and learning by participants	• Participants rated the overall programme as very successful and scored it as 100% • Training instructors were good • Participants learned a lot that they are taking away to improve on their livelihoods
6. How would you implement the technologies learnt in your respect communities?	• We will teach other fish processors in our communities • It was emphasized that the aim of the workshop was to train participants so that they could also transfer knowledge gained to others in their communities • It was also suggested that training participants should go back and train District Executives of NAFPTA for them to train local executives in their communities in turn • Participants were encouraged to keep good records of their activities and promote team work

4.2 Conclusions and way forward

The general impression carried by the training instructors at the CSIR-FRI based on the observation and information gathered in course of the training as well as feedback received from training participants and officials of the Fisheries Commission was that the training program was very successful. Training participants were grateful and expressed their appreciation to officials of the Fisheries Commission for selecting them to participate in such an important capacity building programme. They also expressed their gratitude to the CSIR-FRI for organizing the training and hosting participants for the duration of the programme, and also to training instructors for impacting on them such an amount of knowledge that was going to help them improve on their livelihood diversification and income generation to reduce poverty in their communities.

On behalf of the CSIR-FRI, the training coordinator also expressed his appreciation to the Fisheries Commission for selecting the CSIR-FRI to prepare, organize and conduct the training. In his appreciation message, he spoke about the willingness of the CSIR-FRI to collaborate with the Fisheries Commission on a long-term basis and that the successful organization of this training programme should not be seen as the end but rather the beginning of a long-term mutually beneficial partnership between the two institutions. He assured the Fisheries Commission that the CSIR-FRI was ready to work with the Fisheries Commission to follow up with the fish processors and traders who have received training to assess how knowledge gained would be applied and implemented in their everyday lives. The CSIR-FRI would positively respond to any such request from the Fisheries Commission. He ended by thanking all the participants for attending the training to learn and share knowledge with others. He wished them a safe journey back home to their various destinations to unite with their families.

The course coordinator's speech was followed by concluding remarks from officials of the Fisheries Commission. The Deputy Director of the Inland Fisheries Management and Aquaculture Division of the Fisheries Commission took the opportunity to thank everybody for being part of the training particularly the processors. He advised fish processors and traders to take their jobs seriously because the roles that women fish processors and traders play in fish value chains are very critical and could not be underestimated. He encouraged the women to practice what they had come to learn and also transfer the knowledge to other processors in their communities. He ended his remarks by asking the CSIR-FRI to conduct more research in the area of fish post-harvest activities and collaborate with the Post-harvest Unit of the Fisheries Commission to communicate the results and disseminate the knowledge to processors. The Head of the Fisheries Post-harvest Unit also thanked the women for participating in the training even with all the uncertainties about COVID-19. Training participants were then issued with certificate of participation.

Annex 1: Copy of the Training Programme

CSIR – FOOD RESEARCH INSTITUTE AND FISHERIES COMMISSION
TRAINING FOR FISH PROCESSORS: FISH HANDLING, QUALITY & PROCESSING

Course Coordinator: Dr. Godfred Ameyaw Asiedu (Fish and Fisheries Research Scientist)
Email: gameyawasiedu@gmail.com
Telephone: 0243 242 885

Monday

8:30 – 8:45 **Arrival & Registration** *(Training Participants)*
8:45 – 9:00 **Welcome Address** *(Director, CSIR-FRI)*
9:00 – 10:30 **Fishing Processes** (*Dr. Godfred Ameyaw*)
- Fish pre-harvest activities
- Fish harvest activities
- Fish post-harvest activities

10:30 – 11:00 **Break**
11:00 – 12:30 **Post-harvest Utilization of Fish** (*Dr. Godfred Ameyaw*)
12:30 – 13:30 **Break**
13:30 – 15:00 **Hygienic Fishing Practices** (*Dr. Godfred Ameyaw*)
- Good fish handling practices
- Dangers that make fish unsafe to eat
- Sources of contamination
- Actions to reduce spoilage & contamination

15:15 – 16:30 **Fish Selling** (*Mr. Emmanuel Saka*)
- Bad and good fish selling practices
- Handling fish during selling
- Fish selling place/markets

Tuesday

9:00 – 10:30 **Fish Processing Methods** (*Papa Toah Akonor*)
- Basic principles of processing & preservation
- Methods of processing & preservation
- Risks and hazards
- Equipment needs
- Freezing, smoking, salting, drying, frying
- Fermentation

10:30 – 11:00 **Break**
11:00 – 12:30 **Food Safety and hygiene** (*Papa Toah Akonor*)
- Basic food safety principles
- Quality control

- Good hygienic practices
- Basic food safety principles
- Basic food hygiene
- Personal hygiene and habits
- Cleaning and sanitation
- Waste management

12:30 – 13:30 Break

13:30 – 15:00 Value Addition (*Dr. Charlotte Oduro-Yeboah*)

- What is value addition?
- Why value addition?
- Ways of adding value to fish
- Quality of fish
- Reduction of spoilage and addition of value
- Expected outcome

15:15 – 16:30 Value Added Fish Products (*Dr. Charlotte Oduro-Yeboah*)

- Types of fish products
- Fish sausages
- Fish burgers
- Fish fillets
- Fish fingers

Wednesday

9:00 – 10:30 Value Added Fish Products (*Papa Toah Akonor*)

- Fish powder
- Fish balls
- Fish khebab
- Fried fish alory
- Poached fish
- Fish in vegetable sauce

10:30 – 11:00 Break

11:00 – 12:30 Practical (Fish Product Development) (A*lice &Constance, Kitchen*)

12:30 – 13:30 Break

13:30 – 15:00 Practical (Fish Product Development) (A*lice &Constance, Kitchen*)

15:15 – 16:30 Practical (Fish Product Development) (A*lice &Constance, Kitchen*)

Thursday

9:00 – 10:30 Practical (Fish Product Development) (A*lice &Constance, Kitchen*)

10:30 – 11:00 Break

11:00 – 12:30 Practical (Fish Product Development) (A*lice &Constance, Kitchen*)

12:30 – 13:30 **Break**

13:30 – 15:00 **Practical (Fish Product Development)** (A*lice &Constance, Kitchen*)

15:00 – 15:15 **Break**

15:15 – 16:30 **Practical (Fish Product Development)** (A*lice &Constance, Kitchen*)

Friday

9:00 – 12:30 **Wrap-Up** (*Dr. Godfred Ameyaw*)

- Course summary
- Course evaluation
- Next steps and follow up

12:30 – 13:00 **Presentation of Course Certificates** (*Director, CSIR-FRI*)

13:00 – 14:00 **Lunch14:00** **Closing & Departure**

Annex 2: List of Training Participants

CSIR – FOOD RESEARCH INSTITUTE

Participant/Attendee List

No.	Name	Position	Organization	Email Address	Phone Number
1	Rebecca Eshun	National Treasurer	National Fish Processors and Traders Association	nafpta.aek@gmail.com	0246694613
2	Eva Attitsogbe	Regional President (Volta Region)	National Fish Processors and Traders Association	lewueva@gmail.com	0246675232
3	Peace Abla Gavor	Regional President (Central Region)	National Fish Processors and Traders Association	peaceag61@gmail.com	0242743270
4	Akoefa Azaledzi	Regional Organizer (Volta Region)	National Fish Processors and Traders Association	_	0241996766
5	Beatrice Amedeka	Regional Vice President (Eastern Region)	National Fish Processors and Traders Association	_	0544513174
6	Bernice Addigbo	National Secretary	National Fish Processors and Traders Association	_	0249657210
7	Rose Kpevu	Regional Secretary (Brong Ahafo Region)	National Fish Processors and Traders Association	_	0248886127
8	Juliana Gidisu	Regional President (Brong Ahafo Region)	National Fish Processors and Traders Association	_	0208172443
9	Florence Ivy Ahadzie	Regional Treasurer (Ashanti Region)	National Fish Processors and Traders Association	_	0243375318
10	Victoria E. Kporha	National Vice Secretary	National Fish Processors and Traders Association	_	0557039919
11	Margaret Graham	National Organizer	National Fish Processors and Traders Association	_	0245300772

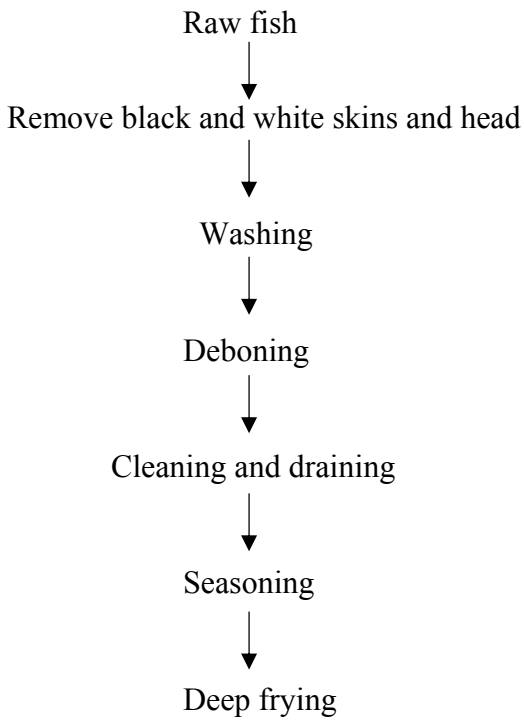
12	Constance Mensah	Regional Treasurer (Western Region)	National Fish Processors and Traders Association	_	0207397473
13	Tasha Senaya	National Coordinator	National Fish Processors and Traders Association	tashasenaya@gmail.com	050000772
14	Emmanuel Aryee	Deputy Director	Fisheries Commission	osubibibio@gmail.com	0502169625
15	Samuel Manu	Director-PHU	Fisheries Commission	sdmanu123@yahoo.com	0244571903
16	Doris Yeboah	Director M&E	Fisheries Commission	nwsfdpgh@yahoo.co.uk	0242774779
17	Matthew Oyih	Director-Aquaculture	Fisheries Commission	moyih@hotmail.com	0243260969
18	Dr Peter Ziddah	Head-Fish Health Unit	Fisheries Commission	peterzid@gmail.com	0244254048
19	Jennifer Viglo	Senior Fisheries Manager	Fisheries Commission	jeglo2005@yahoo.com	0242914391
20	Yaa Tiwaah Amoah	Principal Manager-PHU	Fisheries Commission	madamyat@yahoo.com	0244510124
21	Salahudeen Mustapha	Principal Production Manager	Fisheries Commission	musdeengh@gmail.com	0267851402
22	Hanson Dzamefe	TAAT Enabler	Fisheries Commission	bevedem@yahoo.co.uk	0243162990
23	Edem Adzaku	TAAT Enabler	Fisheries Commission	manuelalozy@gmail.com	0244974257
24	JK Soale	Extension Officer	Fisheries Commission	-	0276095614
25	Dr Charlotte Oduro-Yeboah	Senior Research Scientist	Food Research Institute	adwoaadom3@gmail.com	0266416122
26	Thomas Najah	Marketing Officer	Food Research Institute	auchankabenye@yahoo.com	0243759744
27	Emmanuel Saka	Principal Technologist	Food Research Institute	emmanuelsaka@yahoo.co.uk	0554753166

28	Winifred Arthur	Principal Technologist	Food Research Institute	winarts20@yahoo.com	0504018722
29	Papa Toah Akonor	Senior Research Scientist	Food Research Institute	_	
30	Alice Padi	Principal Technical Officer	Food Research Institute	alicepadi@yahoo.com	0541949625
31	Constance Boateng	Chief Technical Officer	Food Research Institute	consboateng@gmail.com	0244207489
32	Sally Mawusi	Service Personnel	Food Research Institute	sallymawusi100@gmail.com	0501431747
33	Akuafo TV	Media			

Annex 3: Ingredient and Procedures of Fish Value added product

1. **Fried fish in batter (a'lory)**

Flow chart:



Ingredients	**Percentage/quantity**
Sole fish	4kg
Lemon	4 tablespoons
Chopped parsley	2 tablespoons
Flour	400g
Fish seasoning	2 tablespoon
Ginger	4 tablespoons
Garlic	2 tablespoons
Eggs	2
Salt	to taste

Preparation

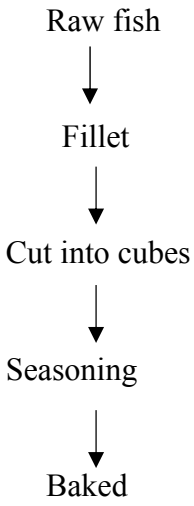
1. Remove the black skin and scales from sole fish
2. Remove the head and side bones, clean well and debone
3. Wash well and drain. Cut or divide fish into four parts
4. Season, marinate the fillets in a little oil, lemon and chopped parsley for a few minutes at least for 5 minutes
5. Pass through batter
6. Deep fry at 175^{o}C, drain well and serve with fried or pickled parsley
7. Serve with tomato sauce

Preparation of frying batter

Recipe	**Quantity**
Flour	400g
Salt	to taste
Eggs	2
Water	500 ml

2. **Diced baked fish**

Flow chart:



Ingredient

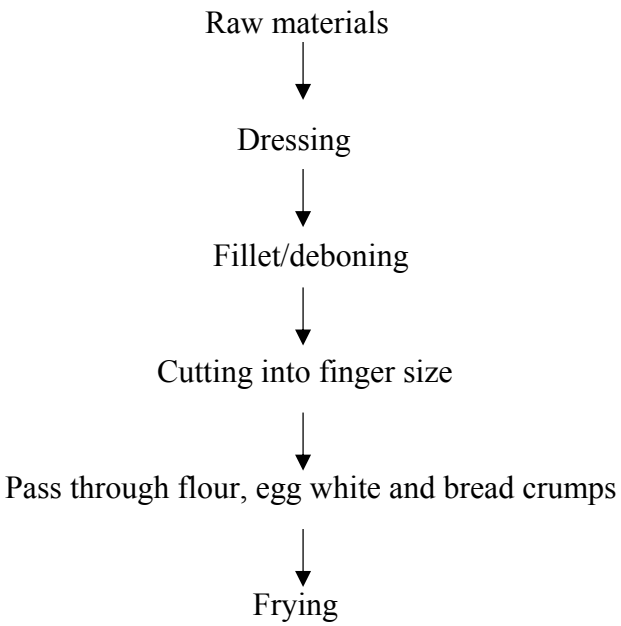
Materials	**Quantity**
Mustard	½ teaspoon
Fish	2kg
Ginger	2 tablespoons
Garlic	1 ½ tablespoons
Fresh pepper	2 tablespoons
Vinegar or lemon juice	½ teaspoon
Salt	to taste
Fish seasoning	1 tablespoon

Method

1. Remove the head, gut scales and fins from the fish
2. Fillet fish and cut into cubes
3. Season fish and allow to marinate for 10 minutes
4. Grease baking pan and arrange fish to bake at 160^{o}C till is dried.
5. Leave to cool and bag

3. Fish Fingers

Flow chart:



Ingredients

Materials	**Percentage**
Fillet fish	2kg
Salt	to taste
Fresh green pepper	0.3
Bread crumbs	500g
Egg white	4 singles
Vinegar	5mls
Oil	1 litre
White flour	200g

Preparation procedure

1. Remove the head, gut, scales and fins from the whole fish
2. Remove bone from fish flesh and cut the meat into finger size
3. Season fish and leave for 5 minutes
4. Pass through the flour, egg white and bread crumps

5. Deep fry in a moderate oil approximately 160ºC till golden brown
6. Arrange in a serving dish garnished with lemon

Annex 4: Selected pictures taken during the training

Group photograph of training participants

Dignitaries present at the training

Director of CSIR-FRI interviewed by Akuafo TV

Fish processor responding to a question

Participants paying attention during a presentation session

Media man taking coverage during the training

Pictures showing the presentation of course certificates to participants

Annex 5: Pictures of activities during the practical session on fish value-added products

Picture showing cassava fish

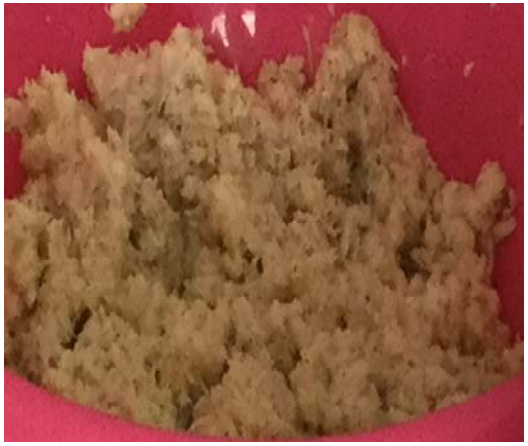
Picture showing cat fish

Demonstration on how to fillet fish

Filleting of tilapia fish

Fish processors observing how to fillet fish

Fish fillets in cubes



Flaked fish for fish balls

Cooked fish balls

Cassava fish in Oven

Fish processors demonstrating on how to add value to fish

Fish processors frying fish balls

Exhibition of value-added fish products