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Improving nutrition and food safety knowledge of small-scale fish processors in Delta State, Nigeria

Grace Adeola Adegoye
Mississippi State University, gaa117@msstate.edu

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By

Grace Adeola Adegoye

Approved by:

Terezie T. Tolar-Peterson (Major Professor)
Rahel Mathews (Co-Major Professor)
Juan L. Silva
Marion W. Evans Jr.
Wen-Hsing Cheng (Committee Member/Graduate Coordinator)
Scott T. Willard (Dean, College of Agriculture and Life Sciences)

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Name: Grace Adeola Adegoye

Date of Degree: May 13, 2022

Institution: Mississippi State University

Major Field: Nutrition

Major Professor: Terezie T. Tolar-Peterson

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Introduction: Fish is an affordable animal source food that provides nutrition and serves as a source of income for many people especially women in Nigeria. Smoking and sun drying are the processing methods in practice that expose the fish products to possible contaminants which may consequentially negate their nutritive value.

Aim: To improve the knowledge of fish processors on nutrition and safe fish handling.

Methodology: A 3-day participatory training was organized to train 122 fish processors, 95 women, and 25 men. The training was conducted in the three senatorial districts in Delta State, Nigeria. Knowledge was assessed using the pre and post quizzes and assessed self-evaluated knowledge using a 5 points-Likert scale survey. The training material was validated using the content validity index (CVI) and modified kappa index (*k**). Comprehensibility was determined using the cloze procedure. Minimum dietary diversity survey (MDDW) was used to determine the dietary diversity of women at baseline and 12 weeks after the training. Low literacy tools and the overall training were evaluated on Likert scales.

Results: The developed seven-module nutrition and food safety flipbook were validated at a content validity index value of 0.983 and kappa index value ≥ 0.67., and the cloze score of 72.1%.

There was a significant improvement in knowledge ($p \leq .05$) in the 7 modules taught. Wristbands and hand fans were rated useful and served as a reminder of nutrition values. There was no significant difference ($p > .05$) between the dietary diversity at the baseline; 5.8 ±.22 and end-line; 6.4 ±.20 at 95% CI. However, the number of women that consumed ≥ 6 of 10 food groups increased by 9.8% after 12 weeks of training intervention.

Conclusion: The developed and validated training material was considered culturally suitable and appropriate. There was an increase in knowledge acquired in all modules taught on nutrition and food safety. Consumption of animal source food increased post-training. However, there is a need for additional training to address food contamination and dietary diversification.

DEDICATION

I dedicate this dissertation to the Trinity; God the Father, Son, and the Holy Spirit.

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CHAPTER I

INTRODUCTION

Background of the Study

Fish is the most common, affordable, and accessible animal-source food (ASF) considered as “rich food for poor people” (Balami et al., 2020), for marginalized men, women, and youth (WorldFish, 2018). Fish is an aquatic food rich in macronutrients: proteins, lipids, micronutrients: vitamins, and minerals (Obiero et al., 2019). Protein in fish has immunogenic properties that fight against bacterial and viral infections (Semple & Dixon, 2020). Studies have shown that fish contains lipids, including the omega 3 fatty acids of fish oil (Long-chain n-3 poly unsaturated fatty acids LC n-3PUFAs) specifically the eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) play a significant role in maintaining normal blood pressure (Innes & Calder, 2020; Tacon & Metian, 2013), promotes cardiovascular health (Damsgaard et al., 2016), supports neurodevelopment in a child (Balami et al., 2020; Murai, 1991), and serves as an excellent source of essential nutrients in pregnancy (Chunda-Liyoka et al., 2020).

Fish also contains Vitamin A which helps in the epithelial tissue and vision maintenance, B12 supports red blood formation (Murai, 1991), Vitamins D and calcium help in building strong bones and teeth, preventing rickets in children, and reducing the risk of osteomalacia in adults (Balami et al., 2020; WHO, 2010). Other studies established that fish is rich in zinc and iron, and other nutrients needed for growth and physiological functions, especially in children and pregnant mothers (Murai, 1991; Mohanty et al., 2019; FAO/WHO, 2005). Although fish consumption is

beneficial, it remains undervalued and less consumed compared with other animal source food (ASF). Recent studies show that there is an association between malnutrition and a lack of nutrition information, education, and awareness of the benefits of fish. (WorldFish, 2018; Balami et al., 2020). In response to the prevalence of malnutrition and nutrient deficiencies in the world especially among children and women, one of the sustainable development goals (SDGs) focuses on eradicating chronic hunger, malnutrition, and poverty through women empowerment, training, and health education (Chaturvedi et al., 2016). In the same regard, the United State Agency for International Development (USAID), World Health Organization (WHO), and International Center for Living Aquatic Resources Management (ICLARM) also known as WorldFish have shared a common goal of raising nutrition advocacy on fish consumption as a nutrition intervention to circumvent the prevalence of acute and chronic malnutrition among children under the age of five years (Agbadi et al., 2017; Oot et al., 2016; *World Fisheries and Aquaculture*, 2012).

Fish is undoubtedly an inexpensive source of protein, locally accessible, and available for consumption. Yet, several challenges remain a constraint to healthy and sustainable nutrition among the population of rural inland communities, especially among women of childbearing age and children under two years (Oot et al., 2016; Agbadi et al., 2017). In low-income countries, the traditional method of fish processing remains a bottleneck to the quality and safety of fish consumption. Main conventional methods used to date include salting, sun drying, and smoking. These methods are commonly used and practiced in the small-scale fishery value chains, especially among petty fish processors. (Abraha et al., 2018). A recent study showed that traditional fish processing methods pose significant health hazards of chemical, biological, and physical components, which are highly detrimental to human health (Ike-Obasi & Ogubunka, 2019).

Fish are exposed to a variety of contaminants in the value chain, from the source or capture (pre-harvest), including pond, sea, or oceans that could be contaminated with organic and inorganic compounds to the post-farmgate processing (Adeyeye, 2016). Post-harvest, sundried fish can be exposed to dust, silts, sand, pest, insects, and microorganisms (Abraha et al., 2018). A study reported that smoked fish could be contaminated with dioxin and accumulated polycyclic aromatic hydrocarbons (PAHs) because of high wood-burning temperatures (Jackson et al., 2004; Stołyhwo & Sikorski, 2005). Fish exposure to heat and sunlight can denature the protein, and alter the nutrient content, for example, degradation of vitamins C and β-carotene when exposed to heat and sunlight (Navale et al. 2018). Evidence shows that traditional methods such as smoking can result in multiple public health safety issues that endanger humans and the ecosystem (Hokkanen et al., 2018). However, modern methods of fish processing present many potentials in preserving the nutritional component of fish and reducing post-harvest loss (PHL) and waste. Solar drying which is rarely used was found advantageous in preventing nutrient loss compared with the sun drying method (FAO.2019). Canning eliminates microbial agents and growth through thermal sterilization and preserves the protein and calcium content of the fish (Adeyeye, 2016). Although fish processing is an integral part of the fish value chain, training on quality and safe processing methods is also essential for preserving the nutrient quality of fish, improving nutrition and dietary standard, and protecting public health from the associated nutrition-related risk (Cailliau, 2013; Adeyeye, 2016).

A persisting challenge to fish quality and safety in low-income countries is pest and insect infestation. A study shows that insect, pest, and rodent infestation accounts for a massive economic loss among fish processors in low-income countries (Adeyeye, 2016). Lack of electricity, sustainable storage facilities, and infrastructures (cold storage, modern fish markets, water supply,

improved toilets) are accountable for fish contamination, accelerated deterioration, and post-harvest loss (PHL) in the low and middle-income country (LMIC). Therefore, fish processors resort to indiscriminate use of pesticides to control pests and insect infestation, aiming to stretch the shelf life of the fish product. This act invariably increases the risk of food poisoning incidence among the population. A study shows the misuse of pesticides and improper disposal of pesticide containers among farmers in Nigeria (Oluwole & Cheke, 2009) as highly consequential in the scope of public health. Study shows that the misuse of pesticides is devastating to the health and well-being of children and pregnant women (Cailliau, 2013).

All these highlighted challenges continue to worsen malnutrition, foodborne disease prevalence, hunger, non-communicable diseases, and poverty in Nigeria. Therefore, the USAID Feed the Future Innovation Lab for Fish, Nourishing Nations project has demonstrated commitment to providing appropriate interventions such as nutrition education, food quality, and safety through organized training, workshops, and innovative strategies to improve nutrition and reduce poverty among women in low-income countries.

Primary institutions and collaborating partners

The USAID Feed the Future Innovation Lab for Fish (FIL) in collaboration with the Global center for aquatic health and seafood is housed at the College of Veterinary Medicine at the Mississippi State University overseeing the Nourishing Nations project in Nigeria. The project involves three collaborating partners whose roles are described below:

WorldFish or International Centre for Living Aquatic Resources Management (ICLARM) – Implementing institution directs the project's activities and coordinates between partners to deliver technical expertise for both scientific and product development outputs and oversee the

value chain operation. WorldFish also advises on market sites and specific instructions on the ongoing fish value chain study.

Mississippi State University – the United States implementing institution: MSU is providing scientific leadership to this project. MSU Ph.D. Student (Grace A. Adegoye), under the guidance of the MSU PI (Dr. Terezie Tolar-Peterson), modified the adapted survey instruments, developed a training curriculum, educational training materials, and low literacy tool, orientate the co-facilitators and enumerators, collected data, completed data entry, analysis, interpretation, and dissemination of results. MSU also developed instructional material and facilitated interactive training for women and youth fish processors, providing scientific and educational advice in the field of nutrition and food security.

University of Calabar (UC), Cross River State, Nigeria– Host country implementing partner: The University of Calabar was responsible for implementing all in-country field research activities, and ethical clearance. The project coordinator supervises the M.Sc. students, monitor fish sample collection from the selected fish markets, coordinate the survey enumerators, organizes workshops and training, and other research responsibility including coordinating project activities that engage women and youth fish processors.

Objectives of USAID FIL

The three objectives formulated by USAID FIL, Nourishing Nation to complete this project are:

i. Develop cost per nutrient guides by analyzing the nutrient and contaminant profile of selected processed fish products in the Delta State of Nigeria.

ii. Build capacity among women and youth fish processors in the Delta State to produce high-quality, safe, and nutritious processed fish products for local consumption.

iii. Educate women and youth fish processors in the Delta State about the benefit of fish in the human diet and develop low literacy tools to help them better market their products

This research study focused on the third objective of the Nourishing Nations Project; to improve knowledge about fish consumption, dietary diversification, improved methods of fish processing and preservation, and to improve knowledge on the quality and safe fish production through training and sustainable low literacy nutrition promotional materials

The primary objective of this dissertation was to improve the knowledge of nutrition and food safety among women fish processors in Nigeria. This was achieved by developing:

1. "*Nutrition education, food safety, and safe fish handling practice guide for fish processors*"
    i. Training manual (flipbook) for fish processors
    ii. Facilitator's guide for the trainers
2. Low literacy tools as promotional materials and
3. Facilitated participatory training in a train the trainer model using the newly developed and validated nutrition and food safety training materials.

This study also aimed to establish a positive behavioral change toward healthy eating, quality, and safe fish production, and improved income among women and youth fish processors in Delta State Nigeria.

CHAPTER II

LITERATURE REVIEW

Malnutrition in Low-Income Countries

Malnutrition remains a health burden globally and a prevalent nutritional bottleneck responsible for 80% of preventable health challenges among children and women in low-income countries. It accounts for 45% of infant mortality in the first 1000 days of life (Black et al., 2013). According to the WHO, malnutrition is defined as deficiencies, excesses, or imbalances in energy and nutrients intake. The triple burden of malnutrition; undernutrition, micronutrient deficiencies, and obesity remain prevalent in low-and middle-income countries (WHO & UNICEF, 2015). Malnutrition is a condition that results from inadequate and or insufficient nutrient intake, also called *undernutrition or undernourishment.* Extreme undernourishment, known as *starvation,* is a prevalent challenge in low- and middle-income countries (LMIC) because of food insecurity, food loss or waste, the impact of climate change, and natural disasters such as drought, flood, hurricane, wildfire, including social and political distress. Non-natural disasters, particularly oil spillage and their counter effect on the ecological fecundity, have been responsible for food insecurity, hunger, poverty, and unemployment among youths and women in the Niger Delta region of Nigeria (Ipingbemi, 2009; Adekola & Igwe, 2013). The World Health Organization (WHO) also affirms that poverty, lack of access to clean water, poor health care services, limited access to education, break in the food supply chain, and lack of good housing are precursors to the population health status. (WHO & UNICEF, 2015).

In this perspective, reducing food insecurity, and eradicating chronic malnutrition and extreme hunger remains an intrinsic part of the Millennium Development Goals (MDG 2020-2025).

According to the UNICEF, WHO, and World Bank Group, an estimated 21.9% or 149 million children under age five globally were stunted in 2018. 7.3% of 49 million children under five globally are experiencing wasting, and an estimated 5.9 % of 40 million children under five globally were overweight in 2018. Malnutrition is severely consequential with a negative outcome on people's health, lives, and economy, particularly in a low-income country (Müller & Krawinkel, 2005). In Nigeria, the national figures (NPC and ICF 2013) show that 10-20% of children under five years old suffer from acute malnutrition, and 29 % were underweight; with evidence of chronic or acute malnutrition. There are relationships and interactions between different indicators of malnutrition, and their direct or indirect impact on a child's nutritional status (Figure 2.1). A study revealed that consumption of variety and nutritionally dense food, including fish as animal source food (ASF) could play a significant role in preventing malnutrition among infants, children, and women of reproductive age (WRA). (Balami et al., 2020). Nutrition intervention including training and food-based strategies such as dietary diversification are effective ways to improve nutrition (Rabaoarisoa et al., 2017). Fish consumption provides affordable macronutrients and micronutrients needed to treat or reverse malnutrition and is vital for good health (Mohanty et al., 2019; Balami et al., 2020). Evidence-based studies have established an abundance of nutrients in fish with their therapeutic, prophylactic, and immunogenic potentials (Roos et al., 2003; Obiero et al., 2019; Holick & Chen, 2008).

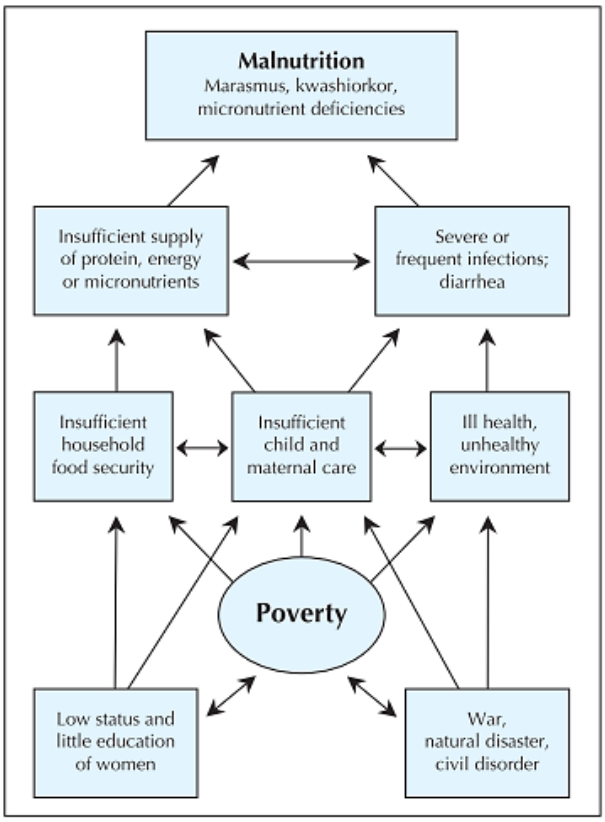


Figure 2.1 Direct and indirect causes of malnutrition

(Müller & Krawinkel, 2005) pg. 280 JAMC • 2 AOÛT 2005; 173 (3)

Micronutrient deficiencies

Vitamins and minerals deficiencies create great concern for public health, especially among children from poor homes in low-income countries. Vitamin A, iron, and zinc deficiencies are the second-highest burden of disease globally (WHO, 2009). Vitamin A Deficiency (VAD) is a prevalent cause of blindness among children under five years old in low-income countries *National Control Programme against Nutritional Blindness Due to Vitamin A Deficiency_ Current Status & Future Strategy).* There is established evidence for a relationship between fish consumption and VAD deficiency (Akhtar et al., 2013).

Protein-energy malnutrition (PEM)

Over 150 million children under age five suffer PEM globally (Udani, 1992). Different forms PEM are kwashiorkor, marasmus, and marasmic kwashiorkor. Prevention of PEM in WRA, pregnant, lactating, and breastfeeding mothers will improve the physical and mental development and academic competency, functionality, and social wellbeing of a child. (Udani, 1992; Ravaoarisoa et al., 2019).

Stunting, Wasting, and Overweight:

Children may suffer a double form of malnutrition such as stunting and wasting or stunting and being overweight (WHO 2019). Stunting is a form of chronic malnutrition where a child has a shorter stature (height) for his/her age while wasting is acute malnutrition which refers to low weight for height. (Oot et al., 2016). Between 2000 and 2018 stunting continued to increase in Africa. In 2018, 65% of all stunted children, 73% of all wasted children, and 36% of overweight children were living in low-income and middle-income countries. (UNICEF/WHO/The World Bank Group, 2018). The WHO World Health Organization Code for global action is to reduce stunting by 40% by 2025.

As earlier mentioned, direct and indirect causes of malnutrition (Figure 2.1) have an influence on poverty, decrease household food security, and consequentially decline supply of protein, energy, and or micronutrients. Lack of adequate child and mother care, illness, and an unhealthy environment; where infectious microorganisms strive and cause sanitation-related infections like diarrhea, and typhoid have shown an association with malnutrition; and micronutrient deficiencies (Müller & Krawinkel, 2005).

Among the effective interventive measures to reduce malnutrition are diet education and dietary diversification, literacy, complementary feeding, and food-based strategies/ interventions.

Strategic improvements to the fish value chain can play a significant role in addressing these dietary deficits (WorldFish, 2018). This study implemented nutrition literacy and food safety training powered towards improving dietary behavior, safe processed fish production, and food security through nutrition and food safety education-based intervention. Strategic improvements to the fish value chain can play a significant role in addressing these dietary deficits (WorldFish, 2018).

The benefit of fish consumption

Fish is a rich source of essential macro and micronutrients, including protein, lipids, vitamins, and minerals, required for nourishment, growth, and development of the body (Mohanty et al., 2019; Balami et al., 2020, Tacon & Metian, 2013). Studies show the health benefits of fish consumption and its role in preventing non-communicable diseases and nutrition deficit-related problems among vulnerable and healthy people (Roos et al., 2003; Thilsted et al., 2014). Fish is undoubtedly a reliable source of essential nutrients and minerals needed for normal physiological and cognitive or mental development in children under five years.

Proteins

Proteins are responsible for building and repairing body tissues, boosting immunity, and improving blood quality. Fish contains 85-95% digestible proteins. It is a potential source of animal proteins that can prevent protein-calorie malnutrition (PCM). (Mohanty et al., 2019) and treat PEMs. (Obiero et al., 2019).

Lipids/Essential fatty acids (EFAs)

Essential fatty acids (EFAs) are essential for life and especially in the early life stage for optimal growth and development. Fish contains long-chain n-3 polyunsaturated fatty acid (LC n-

3PUFAs), specifically Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) that are essential parts of human nutrition (Tacon & Metian, 2013; Sujatha et al., 2013, Mohanty et al., 2019 Innes & Calder, 2020) and has a significant role in the cognitive development of a child (Oot et al., 2016). PUFA; omega-3 fatty acids decrease myocardial infarction rate and can prevent cardiovascular and coronary heart diseases (Balami et al., 2020, Gopinath et al., 2017, Sujatha et al., 2013). DHA is an important nutrient for optimal brain and neurodevelopment in a child and can prevent age-related cognitive decline (Cutuli et al., 2020), while EPA improves cardiovascular health in adults. (Mozaffarian & Rimm, 2006). Lipids and fatty acids also play a biological role in nutrient assimilation and transport (Sujatha et al., 2013).

Vitamins

Fish contains vitamins essential for good health. It is a significant source of Vitamins A, D, B-12, B 6, niacin (B3), and folate (Gropper et al., 2017). Vitamin A is essential for bone and teeth formation and health, cell building, and prevention of VAD blindness in children (*National Control Programme*). A recent study shows that Vitamin D3 (Cholecalciferol) found in fish has a triple potential compared to vitamin D (Ergocalciferol). Vitamin D can prevent osteopenia and osteoporosis in adults and reduces the risk of rickets, low bone mineral density (BMD), and osteomalacia in children. Vitamin D also reduces the risk of autoimmune diseases, hypertension, infectious diseases, and cancers (Holick & Chen, 2008).

Essential Minerals

Essential minerals found in fish include calcium, selenium, iron, magnesium, manganese phosphorus, sodium, choline, folate, and iodine (Tacon & Metian, 2013). Fish and fish bones are a good source of calcium. *Calcium* ions play a significant function in most metabolic processes,

and calcium is also essential for bone density (Balami et al., 2020; Roos, 2021). *Iron* plays a vital role in deoxyribonucleic acid (DNA) synthesis, hemoglobin in the red blood cells formation, oxygen transportation, and various metabolic processes. Iron derived from fish can help in preventing iron deficiency anemia, and improve brain function and learning abilities in children (Abbaspour et al., 2014). *Selenium* is an identified micronutrient, selenoproteins such as selenoproteins-H and glutathione peroxidase-4 function as a cofactor inhibiting the antioxidant enzymatic activities, that is redox reduction supports the thyroid gland functionality, genome maintenance, DNA repair, and epigenetic regulation (Zhang et al., 2016). Selenium could slow down aging and promotes longevity (Wu et al., 2017).

Figure 2.2 gave explicit nutritional components of fish and their functional role respectively.

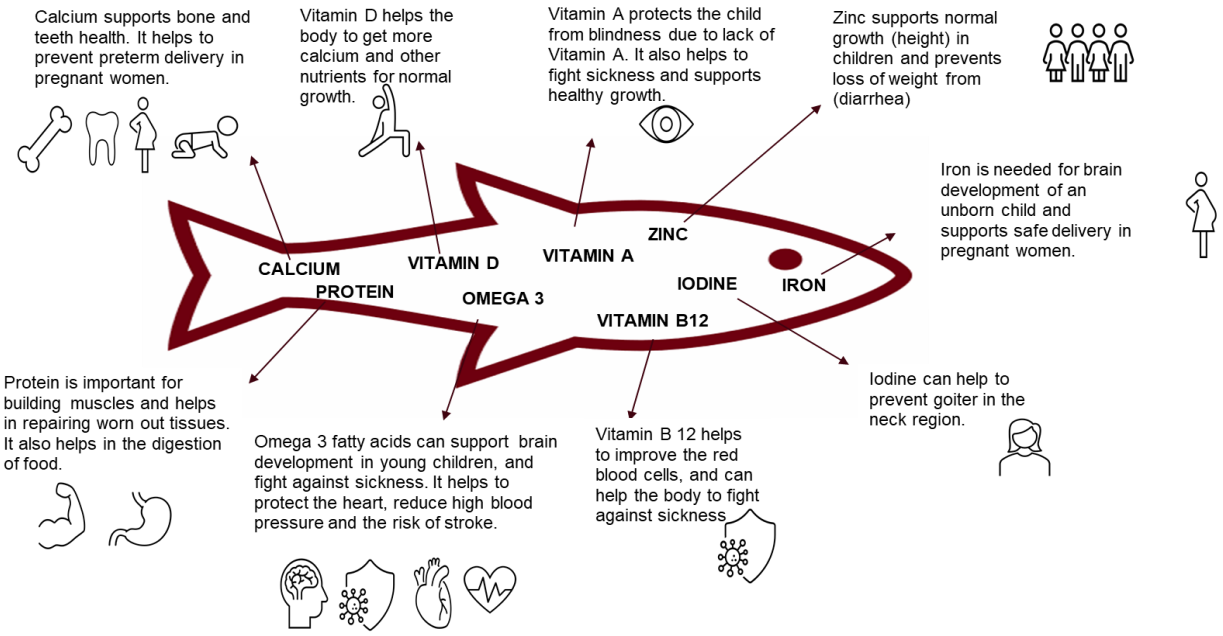


Figure 2.2 Nutritional components of fish.

Showing Protein, Vitamin A, Calcium, Zinc, Iron, and Omega 3 fatty acids (Adegoye, 2022).

Comparison of the nutritional composition of small fish versus large fish

The nutrient composition can vary with the fish source (freshwater or saltwater), species, and size of the fish. Studies show that small pelagic fish species (SIS) have a higher quality of omega-3 fatty acids, and higher minerals and vitamins. They contribute significantly to the recommended dietary intake (RDI) of several vitamins and minerals (Bogard et al., 2015; Tacon & Metian, 2013). Small indigenous fish species are a rich source of vitamins A, iron, and Calcium (Roos, 2021). They are an excellent source of many minerals such as phosphorus, iodine, selenium, iron, calcium, and potassium. (Balami et al., 2020; Tacon & Metian, 2013). SIS can be consumed whole. They also contribute significantly to nutrition, food security, and socio-economy (FAO, United Nations). In addition, small fish contains fewer contaminants compared with large fish. (Chinedu & Chukwuemeka, 2018). Based on the reviews we can infer that small fish is nutritionally dense and safer for children and pregnant women.

Nutrition and cost value of animal source foods (ASF)

Fish has several health benefits and it's affordable. It is widely consumed regardless of financial status, age, religion, and without any bias when compared to other ASF. It has low-level of saturated fat, cholesterol, and calories which shows that it is beneficial for heart health (Mohanty et al., 2019). Fish is more digestible than other ASF because the ratio of muscle protein to connective tissue protein is lesser when compared with beef, mutton, and chicken (Kaimila et al., 2019; Sujatha et al., 2013). A recent study shows that fish contains a higher percentage of digestible amino acids of about 87-98% compared to 87-90% digestibility in beef and poultry (Ayoola, 2010). Fish consumption accounts for 50% of the total animal protein intake in Nigeria. Fish has been a major cheap animal-source protein for economically challenged people compared

with other ASF (Dauda et al., 2016). In Nigeria, most rural households fall below the USD 1.90/ day poverty line, with more than 70% defined as "very poor," based on a measure of daily per capita expenditures (WorldFish, 2018).

Aquaculture and fisheries as income sources in developing countries

Fish is one of the most important groups of vertebrates serving as food for humans. It possesses great economic, nutritional, medicinal, industrial, aesthetic, and religious values and provides employment opportunities for millions of people in different parts of the world (Adebayo, 2014). Aquaculture and capture fisheries are a major source of livelihood for about 200 million people, a chunk population of about 70% working in the traditional small-scale fish processing sector (Selig et al., 2019). Fish production serves as both primary and income providers for millions of Nigerians (Adebayo, 2014). Nigeria has a high dependency on fisheries or aquatic habitats for its nutrition and economy because of its multiple estuaries and access to the ocean (Selig et al., 2019). Within the African region, fish represents over 18.5% of the total ASF (Tacon & Metian, 2013). In Nigeria, fish consumption is estimated at 13.3 kg per capita per year, which is higher than the regional average for Africa (9.9 kg per capita per year). However, fish consumption is lower than the global average of 20.3 kg per capita per year. (WorldFish, 2018).

Socioeconomic background, and fishing business in Nigeria

Nigeria's fisheries sector is diverse, typically primitive, and contains almost exclusively small-scale fish businesses. Fishing and related activities are done in communities in the coastal area, the southern part of the country, on the Atlantic Ocean (Figure 2.3). Nigeria is enriched with several water bodies, including inland freshwater, brackish water, and marines with a diversity of seafood and ocean resources (Ekpo & Essien-Ibok, 2013). It has a coaster line of about 900 km^2,

an exclusive economic zone area of 210,900 km^2, and a continental shelf area of 37,934 km^2. Over 14 million hectares are estimated inland water bodies in Nigeria, providing fishing opportunities for the fishermen (Dauda et al., 2013). Figure 2.3 shows the coaster basins and major rivers in Nigeria.

In Nigeria, over 86 million people are estimated to be directly engaged in fisheries, and 19.6 million are indirectly employed, 70 % of whom are women. Currently, Nigeria imports over 800,000 metric tons of fish annually (WorldFish, 2018). Unfortunately, the country continues to face diverse challenges such as malnutrition, food insecurity, poverty, increased crime, unemployment, infectious and non-communicable diseases because of the growing population, oil dependency, Boko Haram insurgency, sociopolitical and tribal crisis, lack of infrastructures, and economic development, poor governance, and policies which place large pockets of the population in poverty (Adekola & Igwe, 2013; Ipingbemi, 2009).

The WorldFish projected those fisheries and aquatic life have positive potential contributions to food security, employment, and economic enhancement among LMICs. Therefore, recognizing the importance and potential of fish is vital for improving food and nutrition security, alleviating poverty, reducing youth unemployment, and building profitable business ventures (WorldFish, 2018).

Figure 2.3 Map of Nigeria showing major coaster basins and rivers

Fish species and seafood found in the West African river and coaster basins

Nigeria's estuaries and rivers have diverse fish and aquatic foods. The Food and Agricultural Organization reported different fish commonly found in African coaster basins, which are processed for human consumption. They include Nile Perch, Tilapia, Catfish, African Carp, African Tigerfish, Pike, Bony Tongue, Bony Tongue fish or African Bony Tongue fish or African Arowana, African Knife fish/Aba Aba, Croakers, Snakehead, Snapper, Threadfin, Grouper, Hake, Cod/stockfish, Cod Head, Atlantic Bumpers, Common Carp, Mackerel/Titus, Mormyrids-Elephant Snout Fish, Mudskipper, Moonfish, Longfin Crevalle Jack, Bonga, Saltwater Sardines, Freshwater Sardines (Clupeids), Shad, Common sole, Barracuda, Shiny nose, Mangrove oyster, Periwinkles, Bivalves, Crayfish, Crabs, Prawns/Shrimp, Tuna, Snail. (WHO, 2010).

Geographical information of Delta State, Nigeria

Delta State took its name after the delta region of the river Niger. It can be considered a miniature version of Nigeria due to the heterogenicity of its ethnic group. Delta State lies roughly between longitudes 5°00 and 6°45'E and latitudes 5°00 and 6°30'N. It has a total land area of 16,842 sq. km with an estimated population of about 4.2 million (Wikipedia).

Major ethnic groups are Urhobo, Ijaw (Izon), Isoko, Itesekiri, and Anioma (Igbo). Its capital city is Asaba, other major cities are Warri, Ozoro, Sapele, Oghara, Koko, Agbor, Ughelli, Oleh, Okpanam, Buruku and Ogwashi-ukwu. It shares common boundaries with Ondo and Edo States in the Northwest, Imo and Anambra to the Northeast, Rivers, and Bayelsa State to the Southeast. It has approximately 122 km of coastline of the Bight of Benin in the Southwest and South of the Atlantic Ocean. The state has a wide coastal belt inter-lace with rivulets and streams, which form part of the Niger Delta. The major occupation includes fishing, agriculture, trading, and civil service (Ipingbemi, 2009).

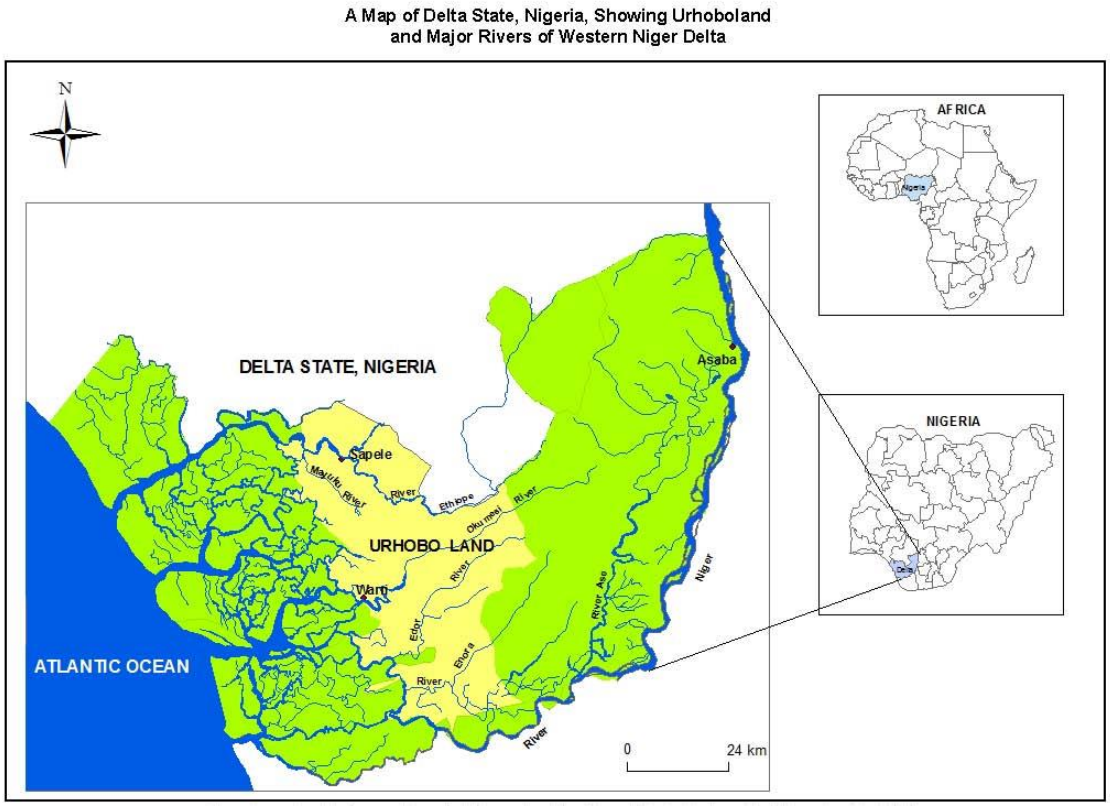


Figure 2.4 Map showing the position of Delta State on the coast of the Atlantic

(a) A map of Delta State showing the major rivers of Western Niger Delta.
(b) Map of Africa, at the top right corner showing Nigeria in blue coat in West Africa.
(c) A map of Nigeria to the middle right of the major map. Map drawn by Professor Francis Odemerho, Southern Illinois, Edwardsville, USA *Urhobo Historical Society 2008.*

Delta State is one of the promising areas for the Nourishing Nations research projects because of its geographical characteristics and location in the coaster zone, which contributes to massive fish production. It also has established fish markets accommodating women as fish processors. The state was selected to leverage our knowledge of the fish value chain from production to consumption. The Fish Innovation Lab for Fish. also has an established network across the state which makes this project feasible (WorldFish, 2018).

Delta State is known for aquaculture and fish farming because of its geographic and intrinsic ecological features. This area is one of the World's largest wetlands, with an incredibly

biologically diversified freshwater swamp and forest. Niger-Delta areas in Nigeria are also known as the oil-producing communities, with significant crude oil exploration activities (Ipingbemi, 2009). Environmental pollution in Niger Delta Nigeria has been responsible for the contamination and distress of aquatic lives and seafood (Ubiogoro & Adeyemo, 2017). Large fish may contain a high level of contaminants and heavy metals such as mercury, lead, PAHs because of bioaccumulation, impacts of which are highly detrimental to the health of children, and pregnant women (Sheehan et al., 2014; Chinedu & Chukwuemeka, 2018; Adekola & Igwe, 2013).

Water pollution and the consequential outcome of continuous progression in oil spillage in the Niger Delta in Nigeria from 1976 to 2014 is worrisome, with an incident rate of about 1500 in 2014 (Chinedu & Chukwuemeka, 2018). Fish sourced from these regions are heavily contaminated with heavy metals. Studies have found that continuous oil spillage disrupts the eco-equilibrium in Niger-Delta basins. Evidence shows that there are great repercussions on the food supply chain, nutrition, health, and socioeconomic status of the people, (Chinedu & Chukwuemeka, 2018, Ipingbemi, 2009). Evidence also indicates that poverty, child malnutrition, youth unemployment, and food insecurity are the resultant effects of oil spillage in these communities. (Adekola & Igwe, 2013).

Fishery value chain system in Nigeria

A fishery or aquaculture value chain is defined as all the stages and activities involved starting from fish-catching or harvesting to consumption (FAO, 2022). It includes harvesting, sorting, transportation, distribution, packaging, marketing, processing, and selling to the final consumer.

Fish processors in Nigeria are predominantly women. Although both men and women engage in fishery production, a high percentage of the seafood is processed and marketed by women. Figure 2.5 shows women fish processors selling their processed fish products in the market. This study focused on emphasizing the importance of quality and safe fish products as a source of nutrients and means of livelihood opportunity for women and youth (WorldFish, 2018). This project focused on women in the small-scale fish processing business, aiming at improving their knowledge of new fish processing techniques, preservation, quality and safe fish products, and entrepreneurship through training intervention.

Figure 2.5 Women fish processors selling dried fish products

Photo source**:** Field; Fish Innovation Lab for Fish (FIL); Nourishing Nations Project Delta State, Nigeria. February 2021)

Fish Processing Methods and Techniques

The two major processing techniques are classified as traditional and modern methods. This classification is probably based on certain characteristics such as procedure, practice, and materials used in processing.

Traditional or Conventional methods

Traditional or Conventional methods remain a predominant practice in the fish processing sector in Nigeria. This method typically includes gutting, washing, salting, splitting, fermentation, sticking the fish, cooking, frying, smoking, and sun drying. The main methods practiced by the post-farmgate handlers and fish processors are salting, sun drying, and smoking (Adeyeye, 2016).

Salting

The use of salt for preserving fish from bacteria spoilage before, during transportation, and after the sale (Akintola & Fakoya, 2017) is not unpopular in developing countries. This method is known for its potential to preserve fish products, especially in the absence of cold chain and temperature-controlled technology. Salting is a principle leveraging the knowledge that food poisoning bacteria cannot survive in an alkaline concentration of 6-10% salt in the fish tissue. However, there is an exception with the salt-loving bacteria (halophytic) that survives conditions above this concentration level and eventually cause fish spoilage. Although, direct application of salt to the fish tissue may be unsustainable in terms of uniformity. ***Brining*** offers a better alternative to ensure a uniform concentration of salt in the fish tissue. The process involves soaking a fish into a pre-prepared salt-water solution of 36% salt concentration. 30-40% salt is the recommended level per weight (kg) of the fish. (Akintola & Fakoya, 2017; Adeyeye, 2016). This

method must be applied with caution because of the tendency for increased salt intake in the diet, which can be a predisposing factor to hypertension.

Sun-drying

Sun-drying is a traditional and natural fish processing and preservation method of removing moist or water content from the fish tissue by exposing the fish directly to sunlight. In developing countries, fish processors spread the harvested or purchased fish on the ground, using mats, sacs, polythene, nets, rooftops, and sometimes on mere concrete or cemented floor (Figures 2.8). This method exposes fish to a greater risk of contamination by dust, animals, and pests. Sun-drying is challenging during the rainy season (FAO, 2019). A study reported that the drying period can take between 3-10 days depending on the weather or humidity, size of the fish, drying surface area, and sun intensity (Akintola & Fakoya, 2017).

Traditional sun-drying of sardine accounts for about 30-40% loss due to pests; rodents, and insect infestation (Natarajan et al., 2022). Exposure to sunlight reduces the nutrient concentration of Vitamins C and Beta-carotene, a precursor of vitamin A (Navale et al., 2018). This method may lead to a total loss of essential micronutrients needed for immune function. However, sun-drying can also improve the concentration of nutrients with high resistance to heat that survive the process. Sun-dried fish has high protein, fat, and minerals retention, and low moisture content, compared to smoked and fresh fish (Longwe & Kapute, 2016).

Smoking

This method is dominantly in use for fish preservation in LMICs and is prominent in Nigeria. The fish processors combine salting, fermentation, and drying before subjecting the fish

to smoking. This traditional method provides antimicrobial treatment to prevent fish spoilage (Akintola & Fakoya, 2017). The shelf life of smoked fish could be several weeks when subjected to sun drying. The Food and Agricultural Organization (FAO, 2010) reported that dried fish exported from Africa is estimated at 500 tons per year, Nigeria being responsible for an estimated 5 tons of smoked fish per month. The demand for smoked fish by Nigerians in and outside the country is high. The national demand for fish in Nigeria is estimated at 2.3 million tons annually, and 1 in every 500 demands represents smoked fish. (*Nigerian Smoked Fish Market Potential-Fish Smoking*.).

Smoking requires burning woods to produce heat high enough to cook and dry the fish. Chemical released from the burning wood also inhibit bacterial or microbial growth and activities, therefore, increasing the shelf life of the fish. There are two methods of smoking depending on the kiln type. **Cold smoking** requires a lower temperature of about 35^0C but not high enough to cook the fish. **The hot smoking** method requires a very high temperature between 300^0C and 700^0C using the traditional kiln with wood burning (Akintola & Fakoya, 2017). Smoked fish has a distinguished aroma and enhanced palatability (Adeyeye, 2016).

However, different antimicrobial and antioxidant chemicals released from the high wood-burning temperatures like polycyclic aromatic hydrocarbons (PAHs), aldehydes, phenols, dioxin, and acetic acids are persisting carcinogenic, mutagenic, and endocrine disruptors. (Turunen et al., 2010; Hokkanen et al., 2018; Stołyhwo & Sikorski, 2005). A recent study shows that women fish processors exposed to indoor air pollution from smoking are at greater risk of lung dysfunction (Umoh & Peters, 2014). Fish smoking increases the risk of chronic obstructive pulmonary diseases (COPD) among women fish processors (Salvi & Brashier, 2014). The established report shows that carbon emission from burning wood contributes to the greenhouse effect and global warming.

In response to this concern, the WorldFish strategy 2017-2022 aimed at a 20% reduction in greenhouse gas emissions and a 10% increase in water and nutrient use efficiency in 0.20 million metric tons of fish per annum through improved processing techniques among other interventions (WorldFish, 2018).

Disadvantages of traditional fish processing methods

- Increase risk of chronic disease from smoke in smoked fish (Hokkanen et al., 2018; Stołyhwo & Sikorski, 2005)
- Loss of vitamin A and C due to exposure to sunlight. e.g., dried fish (Navale et al., 2018).
- Increase risk of high blood pressure from high salt consumption– salted fish (Akintola & Fakoya, 2017)
- Exposure to flies, rodents, and dust in dried fish (Akintola & Fakoya, 2017)
- Excess fat intake from using unhealthy cooking oil can increase the risk of health diseases and obesity in fried fish (Akintola & Fakoya, 2017)

Advantages of traditional fish processing methods

- Fish products taste palatable. e.g., fried, and smoked fish has a unique taste and flavor
- Locally available and accessible materials. e.g., charcoal, wood
- Economical and affordable; no cost for packaging, labeling, distribution, etc.
- Easy to access and culturally acceptable (meets the social and cultural quality)
- No technology or special skills are required.
- Easy processing methods if basic hygiene is followed

Modern Methods

Solar dehydration

This method is an artificial means of dehydrating fish with the use of solar dryers. Fish are placed in the drying chamber and allowed to dry under controlled temperatures inside and outside

the dryers. There is about a 50 cm gap in between the rack layers of the drier, which provides air circulation for uniform drying of the fish. Fish is not exposed directly to sunlight like in the sun drying method. This method is recommended instead of sun-drying. It can preserve the quality and safety of fish in terms of exposure to dust, sand, pest, and insect. Solar drying method compared with sun drying produces a better, quality of dried sardines and a significant reduction in post-harvest loss of dried fish products resulting from pests and pets (Natarajan et al., 2022; FAO. 2019).

Canning

Canning is a method of food (fish, meat, vegetables) preservation that made the food commercially sterile This process deactivates and prevents the growth and activities of most microorganisms. The brine-soaked, half-fried fish are packed and hermetically sealed in air-tight containers and subject to high temperatures for a given time of about 45-60 minutes. Canned fish has a longer shelf-life span, and consumers can access processed fish throughout the year. In the canning method, thermal treatment inactivates microbial activity and calcium in the fishbone is conserved (Adeyeye, 2016). This method is suitable for preserving salmons, sardines, mackerel, tuna, and other seafood (World Fisheries and Aquaculture, 2012).

Cold Storage (Refrigeration)

Cold storage is a value chain system and preservation technique that provides an alternate and sustainable temperature for preserving the physical and nutrient quality of fish when not in the freezer or cold room. In developing countries, lack of electricity and power outage is a serious threat to food safety and preservation, especially in fisheries. Reliable cold storage is required for maintaining fish wholesomeness and healthiness. The recommended temperature for storing fresh

fish is 4°F or below to maintain long shelf life and ensure quality after removing it from the freezer (World Fisheries and Aquaculture, 2012).

Fish contaminants and implications on fish quality, food security, and human health

Contaminants are hazardous substances capable of causing harm or risk to the health of man, animal, or the ecosystem. The two sources and causes of contamination are natural and anthropogenic activities. Poor fish handling and poor hygiene of fish processors are good examples of the anthropogenic source of fish contamination. Contaminants are classified into three major groups: physical, biological, and chemical.

Physical contaminants

Physical contaminants can also be known as ***physical hazards*** (Table 2.1). These substances are physically present in our environment, capable of causing harm and endangering health when found in our food, water, or drinks. Physical food hazards include a piece of glass, wood, dust, sand, piece of metal from cutting devices or food processing machinery, bones or sharp part of fish, shards of bones in meat, pieces of plastic, stones, and other items used by the food handlers. Physical hazards can be exacerbated by non-compliance with food safety, hygiene, and sanitation principles.

Biological contaminants

Biological contaminants or hazards (Table 2.1). in food are pathogenic organisms capable of causing foodborne illnesses or diseases. They are generally microorganisms and worms (helminths). Food spoilage pathogens include bacteria, fungi, viruses, protozoa, and prions (Cailliau, 2013). Biological hazards are classified as Sporulating bacteria (*Clostridium botulinum, clostridium perfringens, Bacillus cereus, etc*), Asporulating bacteria (*Brucella abortis, Brucella*

suis, campylobacter spp., Enteropathogenic Escherichia coli, Salmonella spp. Vibro cholerae, etc.), viruses (Hepatitis A and E viruses, Rotavirus, group of Norwalk viruses) and protozoa and parasites (*Diphyllobothrium latum, Entamoeba histolytica, Ascaris lumbricoides, Taenia spp., Trichinella spiralis, Cryptosporidium parvum*, *Toxoplasma gondii, Cyclospora giardia*). Proper cooking, hygiene, and sanitation can destroy or deactivate these organisms to prevent food poisoning or FBD (Cailliau, 2013). Lack of food safety knowledge, poor personal hygiene, and sanitation can exacerbate the prevalence of biological hazards in food-producing areas.

Chemical contaminants

Chemical contaminants or hazards (Table 2.1). are organic or inorganic substances or compounds that are dangerous to human health, animal, and the ecosystem. They include heavy metals (cadmium, mercury, lead, chromium, nickel) and trace elements. (Sheehan et al., 2014)

Common fish and seafood contaminants are polycyclic aliphatic hydrocarbons (PAHs), dioxin from wood and charcoal fish smoking, persistent organic pollutants (POPs) from pesticides in water (herbicides, rodenticide, fungicide, insecticide, larvicide), excessive use of fertilizers, and poor aquaculture or fisheries practices (use of gammalin 20, poor feeding practices), methylmercury, petrochemicals (crude oil and heavy hydrocarbons) from oil spillage, indiscriminate industrial effluents discharge, municipal, and domestic wastewater (laundry waste, sullage) inflicting deficit to ecological fecundity, leaving a consequential direct effect on aquatic lives and indirectly on nutrition and food security.

Table 2.1 Classification and examples of contaminants.

Physical/Environmental	Chemical	Biological
Floor: Dust, sand, grit, particles, wood dust, broken piece of glass. **Field source:** river, ocean, sea polluted with solid wastes, plastic, and organic wastes. **Fahrenheit:** the temperature at or above 40 °F favors microbial growth. Absence of cold storage system.***" Danger Zone" (40-140 °F or 4.4 -60°C)***	**Fluid:** *(hazard in liquid form)* Industrial waste, Municipal wastewater, laundry waste, liquid chemicals, or emulsions (pesticides) crude oil, grease, **Fumes:** *(hazard in gaseous form)* gases e.g., carbon monoxide, smoke, vapor, dioxin, pesticides; powder, fog, residue, etc. **Fomites:** clothes contaminated with chemical particles, or pesticide residue if not washed **Field source:** river, ocean, sea polluted with inorganic wastes, plastics (BPA), POPs, fertilizers, chemicals e.g., gammalin 20, pesticides, hydrocarbons; crude oil, etc.	**Fingers:** dirty hands carrying germs e.g., bacteria, fungi, viruses. **Fomites:** Dirty clothes, apron, napkin carry germs, may hold dust, hair, etc. if not washed **Fluid:** Wound discharge, (pus, blood, plasma) Mucus, saliva, urine, sweat, droplets, watery stool **Feces:** human excreta, animal dungs, insect and bird droppings **Flies and pests (foes):** biological disease transmission and food contamination (urine and feces) **Forks:** cutleries and cooking utensils harbor germs if not thoroughly washed and sterilized. **Field source:** river, ocean, sea polluted with organic wastes such as human and animal waste, untreated infectious waste, etc. containing, bacteria, viruses, protozoans, prion, fungi

10 Fs concept: hazards are grouped under each classification in low-literacy, easy-to-read, and easy-to-remember terms starting with the letter f: *finger, flies, field, fumes, floor, feces, fluids, fomites, forks, and Fahrenheit (danger zone).* The fork represents and includes cutleries and utensils.

Fish contaminants versus nutrients

Several studies have established the nutritional and health benefits of fish consumption to children, pregnant and lactating women (PLW) (Bogard et al., 2015), women of reproductive age (WRA); non-lactating-non-pregnant women (NLNP), as well as its immunogenic potential (Semple & Dixon, 2020), and benefits to public health (Tacon & Metian, 2013). However, other studies also confirmed the health hazards of fish contaminants, contesting the beneficial potential of fish consumption (WHO, 2010). LCn-3PUFAs; EPA, and DHA contained in fish are essential for neurological and brain development in children (Balami et al., 2020; Udani, 1992), while methyl mercury ($[CH_3Hg]^+$); causes equal and negative action on a child's brain because damages the central nervous system (Jackson et al., 2004; Cunha et al., 2018; Mozaffarian & Rimm, 2006). Mercury in fish is a particular health concern for pregnant or lactating women and young children. This dichotomy of fish consumption is illustrated in figure 2.5. Therefore, interventions such as nutrition education, hygiene, food quality, and safety training are imperative in lowering fish contaminants and strengthening the advantageous potentials of fish consumption. (Silbernagel et al., 2011).

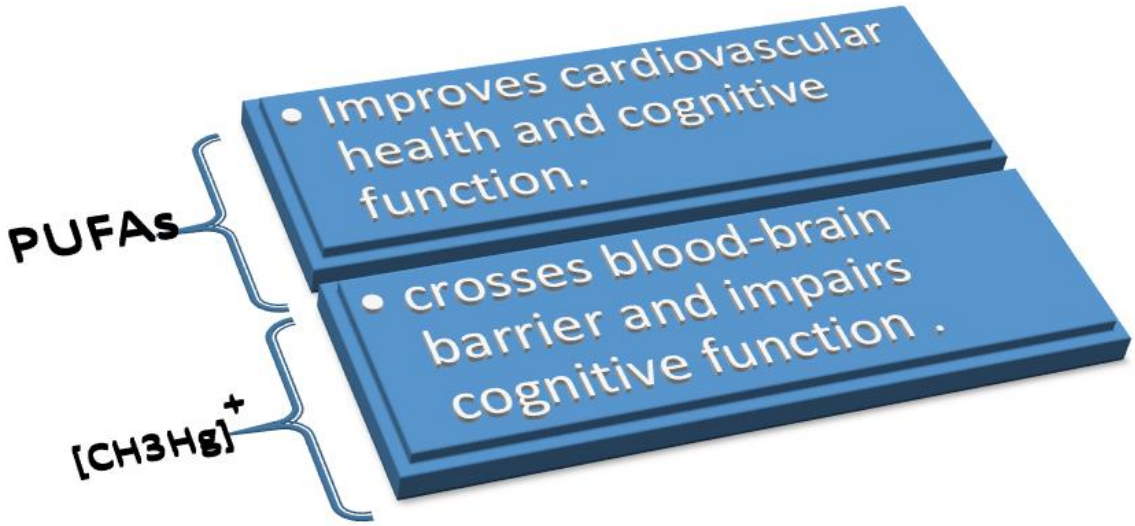


Figure 2.6 Showing a typical example of the dichotomy of fish consumption.

Long Chain n-3 Polyunsaturated fatty acids (LCn-3PUFAs) are an essential nutrient in fish and Methylmercury $[CH_3Hg]^+$ contaminant in fish. (Adegoye, 2022)

Use of pesticides and food safety issues in fish processing

Indiscriminate pesticide use, handling, and application is a concerning issue among farmers, including aquaculture in LMICs, most especially among low-income groups. A study in Nigeria shows that farming households used 48.3% herbicides, 28.2% fungicides, and 23.5% insecticides. About 86.7% of pesticides used are classified as highly hazardous and banned by the WHO in many countries. The study also shows that majority of these farmers (94.7%) have never received training on safe pesticide handling (Oluwole & Cheke, 2009). Damage caused by chemical and pesticide poisoning ranges from mild to severe complications (CDC). Pesticide poisoning consequences include headache, dizziness, disorientation convulsion, respiratory distress, spasm, cancer, epilepsy, leukemia, stomach or intestinal disorder, brain damage, liver problem, low blood pressure, and death. (Blair et.al 2015, Kesavachandran et.al 2009)

Poor aquacultural and fishery practices such as the use of chemicals (gammalin-20) in fishing (Ezemonye & Ogbomida, 2010) excessive fertilizer application on farmlands, misuse of pesticides, storage of water or fish in a pesticide container are common sources of fish contamination with a consequent increase in food poisoning incidents. Capture methods have a broad spectrum of impacts on the quality of fish. Fish subjected to ecological stress such as chemicals, heavy metals contaminants, grease, and petrochemicals such as ethane are more likely to experience histopathological stress (Ezemonye & Ogbomida, 2010), and fish decomposition accelerates after the catch, which results in post-farmgate loss and waste (Adeyeye, 2016). A recent study shows that smoked fish products contain a high level of organochlorine pesticides (Nuntah et al., 2020), which suggests misuse of pesticides. Pest infestation is one of the major challenges faced by small-scale fish processors, which reduces the quality and quantity of their fish products (Ayuba and Omegi 2006). Inference from both studies shows that the fish processors apply pesticides to control pest attacks. Therefore, food safety training on proper preservation/storage, pest control, and safe pesticide use is imperative to improve the quality and safety of processed fish products in Delta State, Nigeria, and protect public health.

Food quality and safety

Food safety is a science and act of ensuring the absence of any form of hazard from harvesting to the final consumption of food. It is a measure of preventing food poisoning, food-borne illnesses, and food-related problems to ensure health, and safety. Food safety ensures the absence of any physical, chemical, or biological contaminant in a food or drink meant for human consumption that could cause hazards or disease. (Cailliau, 2013). Contaminated, adulterated, mislabeled, misbranded food products imposed a tremendous social and economic loss on the global economy annually. According to the World Health Organization (WHO), about 600 million

people get sick because of contaminated food annually, among whom 420,000 die including 125,000 children under the age of 5 years (Kshetri, 2019; WHO 2015). The food safety news reported that World Bank estimated about $110 billion lost in productivity and medical expenses due to unsafe food products cost in low-and middle- income countries (LMICs). Food safety is essential in ensuring food quality and safe food production and delivery. The implementation of food safety systems, good practices, cleanliness, sanitation, and hygiene are the recommendations for achieving safe and quality food products (Olaimat et al., 2020).

Good Practices

The bedrock and prerequisites for efficient implementation of the hazard analysis critical control point (HACCP) system in any food business are good practices and requirements for regulated food premises. Good practices include good hygiene practices (GHP), good aquaculture practices (GAQP in fisheries or aquatic food processing), good transport practices (GTP), good manufacturing practices (GMP), good handling and packaging practices (GHPP), good storage practices (GSP), e.tc. The Environmental Protection Agency (EPA) provides the prerequisites to food processing to include water quality, cold chain maintenance, personal hygiene of the workers, sanitation, and organization of the premises, health services or screening, food safety training, e.tc.

Food Quality

The International Standard for Organization (ISO) defines quality as the level or degree of conformity of a product with the expected and required standard. It is a measure of the degree of standard requirement fulfillment (*International Organization for Standardization)* ISO 9000. Although, quality depends on the manufacturer, individual, or customer's perception in the

conceptual world. Food quality entails meeting all the dietary standards, safety and hygiene requirements, and the consumers' expectations. Quality food must be free from biological, chemical, and physical or environmental hazards while maintaining nutritional values or qualities.

Cailliau (2013) gave highlighted elements of food quality that define and determine the characteristic components to qualify a food product. These include Nutritional quality, which is the healthiness of the food that covers both quantitative and qualitative aspects of the food product. Organoleptic (sensory) quality refers to the taste, palatability, attractiveness, and appearance of the food product. Hygienic and toxicological quality is the absence of pathogens, foreign bodies, pesticides, and toxins in food. Regulatory or humanistic quality is when processed food certifies that the processing or manufacturing procedures respect environmental and moral values. The functional quality or Quality of service shows that the conservation, storage, and transportation of food products meets the safety standard and consumer satisfaction. Social (belonging) and symbolic (cultural) quality mean the food product meets ethical production guidelines. These components are summarized in figure 2.7 below.

Figure 2.7 The six (6) components of fish quality

(Adegoye, 2022. Adapted from Cailliau 2013)

Components of food hygiene

European regulations define hygiene as the measures and conditions necessary to control hazards and ensure the fitness of a foodstuff for human consumption. The two components of food hygiene are **Food safety**, an aspect that guarantees inoffensiveness, wholesomeness, and healthiness of food and ensures the absence of hazardous substance(s) that can adversely affect the consumer's health if consumed. **Food suitability** is the principle that governs and ensures the *acceptability* of food for human consumption. It focuses on the intrinsic characteristics of the

product that can be altered by food spoilage microbes (bacteria, yeast, and mold). Food's inherent qualities include taste, smell, texture, and appearance (Cailliau, 2013). Suitability is the assurance that the food is acceptable for human consumption. Food safety and suitability are paramount at link stages of the food chain.

Water, Sanitation, and Hygiene (WASH)

The Millennium Developmental Goal (MDG) 7 target is to ensure a sustainable environment. Target 7c focuses on sustainable access to safe drinking water and sanitation. WHO report shows that, 1 billion people lack sanitary toilet facilities, and 2.5 billion still lack access to improved sanitary facilities (WHO 2022). An indicator of access to safe drinking water and sanitation is the fraction of the population that uses improved drinking water sources and sanitation facilities (WHO & UNICEF, 2015). Water is a principal linkage to health.

Malnutrition and foodborne illnesses are prevalent with a shortage of quality water supply and poor handwashing practice and sanitation (Lim, et al., 2010). Food and waterborne disease, childhood communicable diseases, and malnutrition remain a trending challenge in developing countries because of poor WASH; lack of potable water for drinking, food production, personal hygiene, and sanitation (WHO, 2019). Water quality, sanitation, hygiene, handwashing, and adequate nutrition are independently instrumental in preventing enteric infections (Arnold et al., 2013) and may be more effective when combined. Inadequate water and sanitation, water pollution, and chronic malnutrition are leading causes of infant mortality and morbidity among children under age five (Lim et al., 2010). A recent study shows that handwashing or hygiene intervention can be an effective strategy in reducing infectious diseases among children (Mbakaya et al., 2017).

Water quantity and quality

Water quantity and quality are two major challenges in low and middle-income countries (LMICs). In Nigeria, especially in the Niger Delta, there are severe water contamination and pollution due to continuous oil spillage and pipeline vandalization (Aishatu et al., 2016, Chinedu & Chukwuemeka, 2018), which makes sanitation and hygiene more challenging. That also constitutes a persistent threat to food security, biodiversity, potable water for drinking, hygiene, and food processing. A recent study shows a significant level of heavy metal contamination in underground water sources (Chinedu & Chukwuemeka, 2018). A study reveals that water and fish samples from some rivers in Niger State, Nigeria contain heavy metals levels above the WHO permissible limits (Ubiogoro & Adeyemo, 2017, Nuntah et al., 2020).

A wholesome water supply is essential for quality and safe food production. Safe water, sanitation, and hygiene are crucial for human health. Water shortage remains a key indicator of personal hygiene and handwashing behavior in LMICs. International Water Management Institute estimated 800 million people are malnourished globally due to a shortage of water. Evidence shows that handwashing with soap and water reduces the disease burden of sanitary-related food-borne infections, prevents fecal-oral disease transmission, destroys pathogenic organism, and reduce the incidence of WASH-related death. (Arnold et al., 2013). Worldwide in 2016, WASH intervention could have prevented 1.9 million deaths and 123 million disability-adjusted life-years (DALYs). (WHO, 2019). WASH intervention strategy implementation is an integral part of ensuring quality and safe fish processing and protecting public health.

Personal Hygiene and Safety

Hygiene is the act of cleanliness that improves and promotes healthful living. Cleaning practices are paramount to maintaining health and preventing diseases. ***Safety*** is an act of

preventing, prohibiting, and eliminating hazards; any action, procedure, animal, or human having risk potential health and wellbeing. In this study, we hope that providing hygiene and safety rules for the fish processors will help to prevent fish contamination and decline the prevalence of foodborne illnesses.

Hygiene rules for fish processors

- Wash your hand with soap and water after using the toilet and before handling food or after changing a child's diapers
- Wash your face and bath with soap and water.
- Cut your fingernails and clean them regularly
- Wash your clothes and aprons after the daily fish processing activity
- Brush your teeth
- Do not spit while cooking or processing fish
- Do not cough into your hands during fish handling, preparation, or processing
- Cough or sneeze into your elbow
- Avoid touching your nose, hair, mouth, or eye during fish preparation.
- Always wear your apron and cap (hear gear) while handling or preparing food.

Sanitation and hygiene rules

- Ensure a clean environment free from rubbish and dirt
- Provide improved sanitary facilities, toilets
- Use clean and enough water for washing utensils and food preparation
- Wash all utensils; dishes, tools, and cutleries needed for the processes with soap and clean water
- Sanitize or wash and clean every surface or slab where fish or food items will be placed or processed
- The food processing site or kitchen must not be close to dumping sites or latrines
- Fly proof or screen the entrance to prevent fly contamination
- Rodent proof and regular disinfestation to prevent rodent

- Provide a sanitary waste bin with a tightly fitted cover
- Wash, and disinfect the waste bin with chlorine regularly.
- Ensure a clean and free-flowing drainage system to prevent the breeding of flies
- Toss spoiled fish or food immediately

Market sanitation and hygiene

Unhygienic environments and poor sanitation continue to pose a serious challenge to food safety in low-income countries. Lack of toilet facilities, good markets or buildings, waste disposal facilities, safe water supply, and other infrastructure is a persistent problem encountered by fish processors, fish sellers, and market users. Fish, seafood, and other food products are exposed to dust, sand, pathogen, droplets, insect infestation, flies, pets, and other physical contaminants (Adeyeye, 2016). Figure 2.8 shows the market condition and displays processed fish for sale.

Figure 2.8 Processed fish products displayed in the market for sale

Photo source: Field (Nourishing Nations Project Delta State, Nigeria. February 2021)

The foodborne diseases, implications, and intervention

Foodborne Infectious Diseases (FBD) are caused by biological hazards found in contaminated food because of a break in the Sanitation Standard of Operating Procedure (SSOP) or poor practices. Pathogens capable of causing food spoilage, food poisoning, and FBD are classified as bacteria, fungi (yeast, mold), helminths, virus, e.tc. WHO identified biological hazards (parasites and pathogens) in ASF include *E.coli, Salmonella species, norovirus, campylobacter jejuni,* Hepatitis A virus, and fish trematodes (*Diphyllobothrium latum*), which increases the burden of diseases in ASF among pregnant women and children (Li et al., 2019). Prevalence of FBD such as typhoid, diarrhea is characterized clinically by dehydration, stooling, vomiting, and is associated with wasting among children in LMICs (Brockett et al., 2020)

The Foodborne Disease Burden Epidemiology Reference Group (FERG) established by the WHO estimated 600 million FBD DALYs in 2010 due to the thirty-one foodborne hazards. Forty percent of the FBD burden was among children under five years old. *Enteropathogenic Escherichia coli, enterotoxigenic Escherichia coli, and Vibrio cholerae* are prevalent in low-income subregions, and Campylobacter spp. in high-income subregions. (Havelaar et al., 2015).

Food safety training as an intervention to foodborne infectious diseases

Food safety training is essential for the prevention of FBD as a crucial measure to achieve food safety. Food safety instruction improves knowledge and instigates behavioral change toward food handling and foodborne illness risk reduction among pregnant women (Kendall et al., 2017). The food safety and quality training and workshop are recommendable and viable methods of improving food processors' knowledge of nutrition, food preparation, food safety, and product quality improvement (World Food Production WFP; Blackburn et al., 2014) to reduce malnutrition, food insecurity, and safety issues such as food contamination (Cailliau, 2013).

Improved food quality and food safety information through training can also play a vital role in alleviating poverty in low-income countries. Nutrition education and entrepreneur training can promote food security, sustain skills, and nutrition literacy acquired beyond the intervention program. (West et al., 2020).

Role of women in child nutrition and prevention of nutrition-related diseases.

Women are the primary caregivers to a child; they are mostly responsible for preparing food and feeding the children. Several studies have established that women are marginalized globally, especially in LMICs. Women are neglected and underpaid compared with their male counterparts due to cultural norms. Most women in low-income countries are extremely poor because they channel all their income into domestic upkeep and childcare. Evidence shows that women are vulnerable to malnutrition and other nutrition-related problems due to economic incapacity and burdens.

Malnutrition remains one of the leading causes of infant mortality and morbidity in low- and middle-income countries. Children from LMICs remain vulnerable to severe acute malnutrition (SAM) (Fagbamigbe et al., 2020, Rabaoarisoa et al., 2017). Globally, about one-third of children under the age of five years are malnourished (WHO, 2009). Women in low-income countries with low or lack of literacy may not utilize the nutrition information provided and are less likely to meet the recommended dietary intake required for improved nutrition status (Ickes, et.al., 2015; Anderson, 2007).

Several studies established the relationship between a mothers' social-economic status such as literacy, education, financial capacity, source of income, and malnutrition. (Ickes, et.al., 2015; Anderson, 2007). A mother’s income and level of education or ability to access, interpret, and

process nutrition information is vital in promoting healthy child feeding (Fagbamigbe et al., 2020). There was an established relationship between higher socioeconomic status and a better-quality diet (Livingstone et al., 2017). A study in Madagascar shows that interventions through nutrition education, food safety training, and women empowerment could improve a child's growth (Rabaoarisoa et al., 2017). Another study in Ugandan, East Africa, shows that women with deficit literacy and no formal education or skills are more likely to have malnourished children (Ickes et al., 2015). Prenatal and postnatal nutrition is essential for a child's growth and development (Brown, 2016). Ickes et al. (2015), established a relationship between maternal literacy, employment, and child feeding with a minimum frequency diet, iron-rich foods, and improved dietary diversity. On the other hand, limited education has a significant association with lower micronutrients (iron, folate, and vitamin D) intake (Rippin et al., 2020). The research finding shows that food safety instruction improves food handling behavior and reduces foodborne illnesses (Kendall et al., 2017). An increase in women's knowledge of nutritional needs during pregnancy and food safety can help in reducing the NCDs prevalence. This was verified by a study in Japan, that shows a strong association between knowledge and the family history of NCDs (Thandar et al., 2019). Mother's understanding and nutrition literacy on eating healthy, child nutrition, hygiene, and food safety are significant in improving a child's growth, development, prevention of malnutrition, nutrition-related diseases, and promoting healthy living. Access to nutrition education and information is an indicator of higher consumption of fruit, vegetable, milk, and fish (Moreira & Padra, 2004). The MDGs are targeted toward eradicating poverty, hunger, diseases, illiteracy, environmental degradation, and discrimination against women (WHO & UNICEF, 2015).

Dietary Diversification

Dietary diversity is consuming a variety of foods containing all the classes of food and nutrients required for optimum health and wellbeing. Low dietary diversity is among the sinister problem eroding quality of life, especially among the poor in LMICs (Chakona & Shackleton, 2017). Micronutrient deficiency is most common among WRA due to dietary intake dominated by starchy foods. (Chakona & Shackleton, 2017). Nutritional deficiency has been the main cause of morbidity and mortality in developing countries worldwide. Undernutrition, food insecurity, and lack of a diversified diet are associated with chronic NCDs. (Abris et al., 2018, Chakona & Shackleton, 2017). There is a strong positive association between the dietary diversity score (DDS) and obesity. (Karimbeiki et al., 2018). However, a recent study shows an inconsistent association between overweight and consumption of diversified diets. (Khamis et al., 2021). Dietary diversity has been validated as a proxy for social-economic status, and proven instrument in determining and monitoring the nutritional need and dietary intake of a population (FANTA, 2006), especially for women of reproductive age (FAO & 360, 2016). It is a validated indicator of dietary quality and nutrient intake in low-income countries. (Workicho et al., 2016). A research study confirmed a link between dietary diversity, quality, and ASF consumption (Gittelsohn & Vastine, 2003). Consumption of ASF is also one of the major indicators to measure dietary intake and quality in LMICs. It provides the body with proteins and micronutrients essential for maximum growth and development. (Neumann et al., 2002; Black, 2003). Lack or insufficient intake of ASFs is strongly associated with stunting, poor cognition, mortality, and morbidity (Kaimila et al., 2019, Black, 2003; Allison et al., 2015). Therefore, ASF such as fish and seafood inclusion in the diet is imperative to improve household diet quality but most importantly the diet quality of women and children under the age of 2 years.

Dietary Diversity Score (DDS)

Dietary Diversity Score (DDS) is an identified vital surveillance indicator for determining the effectiveness of intentions to resolve food insecurity and nutrient deficient related risk (Workicho et al., 2016).

Minimum dietary diversity for women (MDD-W)

Pregnant and lactating women are more nutritionally vulnerable because the physiological demands of their condition are higher and more nutrient intake is required to meet these demands. Inadequate nutrient intakes at prenatal and antenatal and during lactation can negatively impact both women and the child (Adubra et al., 2019).

CHAPTER III

METHODS AND MATERIALS

Aim and Objectives

Aim

This study aims to improve the knowledge of fish processors about the nutrition, food safety, and safety of processed fish products in Nigeria, through education and training.

Research objectives

Primary objective:

1. Improve the knowledge of the nutritional value of fish, food safety, and fish processing techniques and stimulate and sustain behavioral change towards improved nutrition, food safety, and hygiene among low literacy women and youth fish processors in Delta State, Nigeria.

Secondary objectives:

2. Validate the relevancy and test the acceptability of newly developed low literacy materials and tools to teach nutrition and food safety.
3. Analyze the dietary diversity of women fish processors and their children between 6-24 months

Study Area

This study was implemented in the Delta State in Nigeria in West Africa, a USAID zone of influence (ZOI). This state was selected based on the production of fish and sea-foods supply to the food system in Nigeria and it has an established fish value chain that accommodates women.

Study Design

This is an evaluation study by design using mixed methods (quantitative and qualitative). It involves the evaluation of education and training intervention using the baseline and the post-survey. The study aimed at improving knowledge about the nutritional benefits of fish, improving quality and safe fish production through nutrition education and food safety training, promoting dietary diversification, and evoking positive behavioral change toward hygiene and food safety. The training approach was "Train the trainer" using the participatory or interactive teaching method. This study was submitted, reviewed, and approved by the Institution Review Board for Human Studies at the Mississippi State University (IRB number IRB-20-072). All COVID-19 protocols and WHO recommendations were strictly adhered to doing this study.

Methodology for the objectives

The schedule of events is presented in table 3.1, showing the timeframe of the training. Summarized methods and strategies for completing the objectives of this study are presented in tables 3.3 – 3.5. The tables contain objective, formulated hypotheses, the instrument for data collection, methodology, applicable statistical test, and analysis. All instruments used in this study are available in the Appendix.

Objective 1

Improve the knowledge of the nutritional value of fish, food safety, and fish processing techniques and stimulate and sustain behavioral change towards improved nutrition, food safety, and hygiene among low literacy women and youth fish processors in Delta State, Nigeria.

Preliminary meeting

A preliminary ("taking stock") meeting, was held in collaboration with the USAID Feed the Future Innovation Lab for Fish (FTT FIL) Nourishing Nations team, with the representative of the Agricultural Development Program (ADP), the stakeholders, and the representatives of potential participants, women fish processors in Delta State. The University of Calabar PI and the project coordinator facilitated the meeting and led through a discussion forum to engage the women and youth in identifying the main barriers, limitations, and challenges faced by small-scale fish processors. This forum provided the opportunity for the need assessment and examining the expectations of the potential study participants. The meeting also assisted in getting relevant information in preparing our instruction material, and in shaping the learning tool and techniques. We asked for the potential participant's phone numbers and their preferred means of receiving information and updates. Text messages and phone calls were made when necessary to remind and keep the participants in the loop. This also instilled in them a sense of inclusiveness and belongingness.

Recruiting participants and inclusion criteria

The proposed number of participants in this study was a minimum of 100 women and youth fish processors in Delta State, Nigeria. Forty subjects were recruited from the three senatorial districts of the study area: Delta Central, Delta North, and Delta South. (122 participants enrolled

for the study to give an even representation of each district and to account for the approximately 20% dropout rate). Study participants included low-income and low-literacy women and youth fish processors. These participants were recruited in collaboration with the Agricultural Development Program (ADP) agency at the Ministry of Agriculture in Delta State, Nigeria. Inclusion criteria include women aged 19-49 years and youth (including young adult men within 19-35 years of age), who rely on fish processing as a source of livelihood (figure 3.1). Recruited subjects participated in the baseline and end-line survey administered by the trained enumerators and were compensated with incentives after completing the survey.

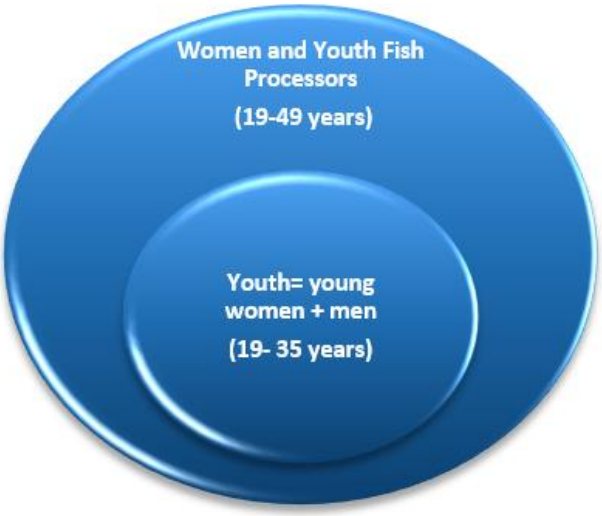


Figure 3.1 Participant's representation.

Participants were women fish processors between 19-49 years and young adults including men between 19-35 years of age.

Recruiting and training enumerators

Three graduate students of Aquaculture and Fisheries Management of a university in Nigeria were engaged to administer the baseline and end-line (post) survey. These enumerators were recruited by the host country's principal investigator (PI) and project coordinator.

The Ph.D. student at the Department of Food Science Nutrition and Health Promotion (FSNHP) at Mississippi State University (lead researcher), trained the enumerators, and familiarize them with both the hard and soft copies of the survey instructions. The enumerators were acquainted with the online version of the questionnaire (Qualtrics online survey), for application and optimum efficiency. Three training meetings were held virtually via zoom. Each recurring meeting lasted for approximately 60 minutes.

Engaging facilitators

Officials from the Delta State Ministry of Agriculture and Natural Resources (MANR), Delta Agricultural and Rural Development Authority (DARDA), and Delta State Primary Health Care Development Agencies; the State Nutrition Officer, Ministry of Health, and the director of planning, research, and statistics, Delta State, Nigeria were engaged as peer facilitators for the nutrition and food safety training alongside the lead researcher, and the FIL Nourishing Nations team.

The lead researcher acquainted the co-facilitators with the training curriculum and materials via internet-enabled platforms such as zoom. All training materials were provided to educators including a facilitator’s guide, flipbook, low literacy tools, and other additional educational materials on arrival at the host country. Facilitators strictly used the training material (*Nutrition education, food safety, and safe fish handling practice guide for fish processors*) designed, validated, and approved for this study. This study also used an appropriate teaching

methodology (participatory) for the low-literacy adult learners. The training material was easy to read (Plimpton & Root, 1994) and tested for comprehension, to facilitate retention and increase the expected outcome of the training intervention. Per diem was given to the co-facilitators at the end of each day of the training.

Baseline (pre) survey

All enrolled fish processors (122) were invited to participate in the baseline study. The study was explained to them in its entirety, and those that were willing to participate in the baseline survey (99) signed the consent form.

The data collected from the baseline survey were reviewed and the training program was tailored to meet additional identified needs and fill the knowledge gaps during the training intervention. For example, in the baseline survey, question A3 (A3.1- A3.5) contains nutrition information and communication survey questions. Questions A3.1- A3.4 explore the participant's preference for nutrition education and communication means. Question A3.5 determined the participant's perception of the effectiveness of the nutrition information and communication tools by computing the five Likert scale scoring. Information obtained from the baseline survey was used as a guide in addressing knowledge deficits on nutrition, food safety, and fish handling practices among the fish processors during the training.

Training overview

Women and youth fish processors were engaged in multiple participatory training sessions of the seven modules on the nutrition and food safety training manual and explored new processing techniques to improve their knowledge about the quality and safe fish products. They also explored

opportunities for new fish products, good practices, and fish business upgrading strategies through the training series.

Participants were given an incentive in form of transportation, tea-break snacks, and lunch throughout the 3-days training. After the training, the low literacy educational tools; aprons, wristband, and hand fan containing nutrition information were given as a reminder. The wristband was chosen as one of the training tools based on existing research that shows that the use of bracelets heightens vaccination awareness and improves immunization coverage. (Siddiqi et al., 2020).

Training procedure

The participatory training was designed to be in three locations within Delta State to accommodate participants from three senatorial districts. These locations were identified by the project coordinator and the in-country Co-PI in the host country. The training was accomplished in three days in each location. There were three training sessions per day, each session was 1 hour, 20 minutes long, with 15 minutes tea-break intervals before the next training session.

Registration and Identification of the participants

There was registration on the arrival of the participants to the training centers on the first day. The registration lasted for 30 minutes, from 9:00 am - to 9:30 am (WAT). The subsequent training days started at 9:30 am and end at 1:30 pm (WAT). Participants were given a name tag and ID number for identification reasons and to facilitate recognition among the participants. The participant's given ID number was used for data analysis. On arrival, each participant also received training material; educational materials including a pen, drawing, and writing materials. They were also given the training outline containing all the sessions, modules, and the facilitator's name.

Following the registration, the participants were briefed about the training sessions and expectations. Participants were encouraged to ask or answer questions and contribute throughout the training.

Training Agenda

The facilitator introduced himself or herself and established a relationship by acknowledging the participant's attendance. After the brief introduction, the facilitator informed the participant that there would be pre and post quizzes for each module taught in the training. The facilitator introduced the topic of the module, and a pre-quiz was administered to the participants as a formative assessment. The quiz contained three multiple-choice questions on each of the seven modules taught during the training. Each quiz lasted for 5 minutes. The facilitator assured the participants that their performances on the quizzes did not affect their benefits and it was okay if they do not know the answers to the questions. The participatory training included interactive sessions that lasted for 45 minutes. The newly developed and validated training manual and other relevant nutrition and food safety educational tools that facilitate learning were used. The participants were randomly grouped into small groups of 5-10 people to discuss the specific question for a short time. Small groups are effective ways of engaging every participant quickly and it serves as an energizer to the group (Permagarden Adult Education Training Resources 2017). There was a closing discussion for another 10 mins, and the modules taught were concluded with the post quizzes, which contain the same question in the pre-quiz for another 5 mins.

Duration of the training and time

The entire training lasted for three weeks. The participatory training was scheduled for the first week, for Delta North, the second week, for Delta Central, and the third week at Delta

South, respectively. There were three participatory training sessions in a day. Each training day lasted a total of 4 hours; an estimate of 1hour and 20 minutes were allotted per module, amounting to 9-10 hours of training altogether.

Day 1 training

Modules 1, 2, and 3 were taught by the assigned facilitators and co-facilitators

Module 1. Nutrition education: Healthy eating habits,

Module 2. Animal source food: Health benefits of fish consumption or fish nutrition

Module 3. Food safety: Fish safety and handling.

Day 2 training

Modules 4, 5, and 6 were taught by the assigned facilitators and co-facilitators.

Module 4. Fish processing: Fish processing techniques

Module 5. Food poisoning: Fish contamination and poisoning.

Module 6. Hygiene rules and good practices: Hygiene rules for fish handlers.

Day 3 Training

Module 7; Economic benefits of quality and safe fish products.

After concluding participatory training, the participants were given a summary evaluation survey for the training and self-knowledge evaluation before and after training retrospectively.

The participants were issued a certificate of participation after the completion of the training and were also given foldable fabric hand fans, wristbands, and aprons containing nutrition and food safety promotional information (figures 3.3, 3.4, 3.6) The co-facilitators also received a certificate of appreciation and per diem.

Table 3.1 Training schedule per senatorial district

Senatorial Districts	**Week**		
	Day 1	**Day 2**	**Day 3**
Modules	1, 2 and 3	4, 5 and 6	Module 7, Training evaluation. Self-knowledge evaluation
Time /duration	1hour 20 mins per Module	1hour 20 mins per Module	1hour 20 mins per Module
Total duration of training	9-10 hours		

End-line (post) survey

The trained enumerators administered the post-survey to the training participants after confirming a sustained willingness to participate in the study by signing the consent form. The post-survey was administered 3 months after the training, to enable us to evaluate the impact of the training intervention and measure the behavior change and the level of improvement in nutrition, quality, and safe fish processing. Participants were appreciated for their cooperation after the completion of the study.

Evaluation and statistical analysis

The improved knowledge was measured by:

i. True pre-and post-quiz of the 7 nutrition and food safety education modules taught. Each module has three multiple choices questions, the maximum score was 3 and the minimum score was one.

ii. Retrospective pre- and post-knowledge survey using the Summary evaluation survey on a Likert scale of 5.

The behavioral change was measured by:

iii. The baseline and post-survey: Session *A2, B1, & B3* (Knowledge, Attitude & Practice, KAP)

- Session A2: Nutrition knowledge and hygiene practices (A2.1- A2.8)
- Session B1: Fish preparation and processing behavior and practices (B1.0- B1.8)
- Session B3: Fish safety and post-harvest handling (B3.1-3.2)

Quantitative Analysis

SPSS Version 27 (IBM) was used for quantitative data. Analysis was done using descriptive analysis of the quantitative data derived from the survey.

The improved knowledge was evaluated and analyzed by comparing the means of the pre-quiz and the post quiz for each of the 7 modules using the paired t-test (p-value ≤ 0.05). The pass mark for the quiz was 2 points (66.6%) out of 3, the maximum score was 3 out of 3 (99.9%), and the minimum was 33.3%. Behavioral changes were to be determined by conducting a comparative analysis of the baseline and the post-survey data using the paired t-test ($p \leq 0.05$). The frequency, average (mean), and standard deviation (SD) was determined and presented in a histogram and normal distribution.

Qualitative analysis

Qualitative data were derived from the open-ended questions of the baseline and post-survey. This analysis involved; (i) coding (ii) identification of common themes, (iii) grouping similar responses to the participant's perception of the survey question, and (iv) selecting compelling extracts that relate to the research question and literature, to produce a scholarly report

for the analysis. Details of the qualitative data were considered and discussed with respect to the quantitative results and available literature.

Objective 2

Validate the relevancy and test the acceptability of newly developed low literacy materials and tools on nutrition and food safety.

Developing training or educational materials

The low literacy training materials on nutrition and food safety procedures for fish processors were developed by the lead researcher, a Ph.D. nutrition student at Mississippi State University. The training materials were evaluated and validated by experts. The low literacy training manual was prepared at the 8^{th}-grade reading level with adequate knowledge and appropriate illustrations. An extensive literature review was done to select relevant scientific information for creating and constructing the instructional material. Books, periodicals, and publications on nutrition, food safety, safe fish processing and handling, water, hygiene, and sanitation were reviewed for content development. The materials were prepared in both Microsoft documents and PowerPoints presentations.

Content Evaluation Panel

The content evaluation panel (group of experts) was invited to evaluate and validate each item of the module and the entire training material. This group of experts included nutritionists or dietitians, experts in low literacy education, fisheries and fish value chain experts, food safety experts, and academics. A total of six experts accepted the invitation to participate in the content validation of the newly developed training material and completed the task within the specified

time (7 days). These panelists also provided recommendations based on their judgment of each item.

Content Validity Index (CVI)

The content validity index (CVI) was used to determine the relevancy or degree of usefulness of each component of the training material. The content validity ratio (CVR) is an item statistic used in determining the rejection or retention of specific items. Using a content validity panel of six members, a minimum value of 0.99 was required for the CVR to satisfy the five percent level, p = 0.05 (Lawshe, 1975). The panelist judged the relevancy or essentiality of each item on a Likert scale scoring. The higher the percentage of the panelist's agreement on the item evaluated, the greater the degree of its content validity. CVI is the mean CVR value of the evaluated items.

$$\text{Content Validity Ratio (CVR)} = \frac{(n_e - N/2)}{N/2} \tag{3.1}$$

n_e is the number of panelists perceiving the item as essential or relevant, N is the total number of panelists, and the CVR is the direct linear transformation of the percentage of panelists indicating relevance. When less than half of the panelist indicates relevance, CVR is Negative. When the panelist responses are equal, CVR is Zero. When more than half of the panelist indicates relevance. CVR will be between zero and 0.99, and when all the panelist (100%) indicates relevance, CVR is One, which will be adjusted to 0.99 for ease of manipulation. Any item, perceived to be essential by over 50% of the panelist, has some degree of content validity (Lawshe, 1975).

Content Validity and relevance

Content validity is the degree of agreement or intersect between performance on the material under investigation and the ability to function in the job performance domain.

Content validation was done using a self-administered five-point Likert scale; ranging from strongly agree (SA; 5 points), agree (A; 4 points), neutral (N; 3 points), disagree (D; 2 points), and strongly disagree (SD; 1 point). Panelists' judgments were analyzed to determine the essentiality or relevancy of the items in the domains. The content validation was based on ten different domains:1) objective, 2) content, 3) relevance, 4) language, 5) infographics, 6) design, 7) motivation and 8) culture and 9) methodology, 10) quiz test.

Table 3.2 Content validity index (CVI) form.

Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Objective					
1.1 Consistency with knowledge need on the module					
1.2 Promotion of positive behavior and attitude changes					
1.3 Promotion of thought on the topic					
1.4 Practicability for the training					
Subtotal					
2. Content					
2.1 Appropriateness for target audience					
2.2 Clear and objective text					
2.3 Highlights on subject matters					
2.4 Informative					
2.5 Logical sequence					
2.6 Achievement of objective					
2.7 Scientific correction					
2.8 The content covered presents relevant information					
Subtotal					
3. Relevancy					
3.1 Key points portrayed					
3.2 Potential of knowledge transfer					
3.3 Scope					
3.4 Suitability for training					
3.5 Applicability					
Subtotal					

Table 3.2 (continued)

Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4. **Language**					
4.1 Literacy adequacy to the target group					
4.2 Clearness and intelligible					
4.3 Spelling Correctly					
4.4 Well organized or structured					
4.5 Comprehensible					
Subtotal					
5. **Infographics**					
5.1 Relevance to content					
5.2 Expression of needed information					
5.3 Motivates understanding of the content					
5.4 Appropriateness of Characters' charisma					
5.5 Sufficiency					
5.6 Similitude with real life					
5.7 Suitable designs for adults					
Subtotal					
6. **Design**					
6.1 Attractiveness					
6.2 Color contrast					
6.3 Font size					
6.4 Number of pages					
6.5 Style					
6.6 Text wrapping					
Subtotal					

Table 3.2 (continued)

Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7. **Motivation**					
7.1 Attractiveness of the content					
7.2 Enthusiasm for readers					
7.3 Sustain reader's interest					
Subtotal					
8. **Culture**					
8.1 Appropriateness for sociocultural level of the target audience					
8.2 Culturally appropriate and acceptable					
8.3 Reflection of the cultural needs of the target audience.					
Subtotal					
9. **Methodology (participatory)**					
9.1 Appropriateness of teaching method to the target group					
9.2 Relevant teaching aids					
9.3 Appropriateness of key message					
9.3 Duration; sufficient time allocation					
Subtotal					
10. **Pre and post quizzes**					
10.1 Clearness & comprehensibility					
10.2 Measures knowledge					
10.3 Suitability for the target group					
10.4 Well structured					
10.5 Relevance					
Subtotal					

Panelist Recommendations

Likert rating and corresponding relevance rate
Items rated 4 and 5 (agree and strongly agree) = 4 relevant and essential
Items rated 3 (Neutral) = 3 item requires minimal further review
Items rated 2 (Disagree) = 2 item requires further review
Items rated 1 (Strongly disagree) = 1 item is not relevant and must be removed.
CVI will be calculated as the number of judges giving a rating of 4 and 5 (agree and strongly agree) divided by the total number of judges.

Method

Content validation was initiated after the first version of the training material was completed. A letter of invitation to participate in the content validity of a newly developed nutrition and food safety training material was sent to 12 identified potential panelists. Thereafter, a cover letter containing specific and clear instructions on how to complete the task was sent only to those that accepted the invitation. Also, a content validation index form (Table 3.2) was sent to the experts via email and harvested through the same medium. Each panelist completed seven validation forms containing the 10 items for each of the seven modules. The content validity index (CVI) and the concordance rate were determined by computing and analyzing the average CVR. After the content validation, necessary adjustments were made based on the panelist's judgment and recommendations. The training material was subjected to the final validation of the entire training material and approval by the experts before it was used for the training.

Comprehensibility test

The comprehensibility test was performed by administering fill-in-the-gap questions to the five (5) non -participants of the target group using the cloze procedure. The test consists of at least one question from each of the training modules. This test was done before the training, for determining the comprehensibility or understandability of the training material that was to be given to the participants

The Cloze Procedure was designed that every fifth word in a sentence extracted from the training material is deleted and the respondent was to fill in the blank gaps with the *exact* word as much as they could. The participants were i.) encourage to answer all the questions as accurately as possible, ii.) read through the sentence before answering, iii.) never mind the spelling errors, iv.) write only one word, v.) It is okay to guess, and vi.) reassured that it is not a timed test. The total correctly filled blanks were the final cloze score of the reader (Bastable, 2014). The comprehensibility score for each participant was converted into percentages for easy data analysis and interpretation.

$$\frac{Total\ number\ of\ correctly\ filled\ blanks \quad X\ 100\%}{Total\ number\ of\ blanks} \tag{3.2}$$

A Score ≥ of 60% indicates that the training material is **better understood**
A Score of 40 – 59% indicates a **moderate difficulty**, supplementary teaching will be needed
A Score of ≤ 40% indicates the **difficulty and unsuitability** of the training material.

Testing literacy material and tools by the target group

The end-line (post) survey question A3.9 was utilized in evaluating the participant's perception of the acceptance, appearance, and usefulness of the low literacy tools; wristbands, and hand fans on a three-scale Likert range scoring. Data were analyzed in descriptive statistics using SPSS.

- How often do you wear the wristband or use the hand fan?
- How comfortable is the wristband?
- How attractive are the wristbands and the hand fans?
- How useful are the tools?
- How often do they remind you of the training on fish nutrition and safety?
- It is a good way to initiate a conversation with others about the benefits of fish consumption.

Objective 3

Analyze the dietary diversity of women fish processors and their children under 6-24 months.

Minimum Dietary Diversity for Women (MDD-W) 15-49 Years of Age.

MDD-W is defined as the summation of food groups consumed by a woman from a total of the required ten food groups. The ten food groups include 1) Grains, roots, and tubers; 2) Legumes/Pulse; 3) Nuts and seeds; 4) Dairy products; 5) Meats or poultry, fish, seafood, and snails; 6) Eggs; 7) Dark leafy green vegetables; 8) Vitamin A-rich vegetables, Vitamin A-rich fruits, and red palm oil; 9) Other vegetables; 10) Other fruits. (*All the food groups were adjusted to reflect the social and cultural diet of Nigerians.)*

This study assessed the Dietary diversity of women fish processors using the 10-point women dietary diversity (WDDS-10 survey). The 10-point WDDS-10 survey is a list-based instrument consisting of 10 food groups from which dietary diversity scores (DDS) or Minimum Dietary Diversity for Women (MDD-W) were generated.

The MDD-W is a dichotomous indicator considered the standard for measuring population-level dietary diversity of women of reproductive age (FAO & 360, 2016). According to the recommended guidelines, an indicator of the probability of micronutrient adequacy for 11 micronutrients in a woman's diet consumption is ≥ 5 of the 10 food groups, which is considered high and portrays the likeliness that the woman consumes animal source foods, nuts or seeds, pulses, fruits, and vegetables. Women who consume ≤ 4 food groups are considered to have low dietary diversity and have a greater probability of micronutrient inadequacy (*International dietary data expansion*).

In this study, we used the WDDS-10 score as a continuous variable and the MDD-W cut-off 6 food groups as an indicator of dietary diversity.

Women's Dietary Diversity Score = *Continuous variable from 0-10*
Minimum Dietary Diversity for Women (Population-level indicator) =*Dichotomous variable*

Women who have MDD score ≥ 6 food groups, from 10 food groups
Women who have MDD score ≤ 6 food groups, from 10 food groups

MDD Score for Women of Reproductive Age 15-49 years old was calculated using the formula:

$$\frac{Women\ 15-49\ years\ of\ age\ who\ consumed\ at\ least\ 6\ food\ groups\ during\ the\ previous\ day\ \ X\ 100}{Total\ number\ of\ WRA\ (15-49\ years\ of\ age)\ that\ participated\ in\ the\ survey} \quad (3.3)$$

Methodology

Information on the food consumed by the respondent; women of reproductive age (WRA 15-49 years) was collected during the baseline and end-line survey after the signing of the informed consent. The MDD-W survey contained in the baseline and post-survey were administered before and after the training on healthy eating and the benefits of fish consumption (as an intervention for malnutrition among women of reproductive ages and their children). The MDD-W method assumes that the participant would know the meals she cooks, serves, and eats. The women were asked to recall and mention all food, and drinks consumed for a day (24-hour recall) and night. These include all meals, snacks, and drinks. They were encouraged to remember every food consumed per meal and in-between meals. Those that do most of the cooking for themselves or the household, were asked to name or describe all ingredients and condiments used for the meal preparation.

Child Dietary Diversity: The Minimum Dietary Diversity (MDD) Score for Children 6-23 months old

The minimum dietary diversity (MDD) score (for children 6-23 months old) is a validated measuring tool designed by the World Health Organization (WHO) to assess diet diversity as part of infant and young child feeding (IYCF) practices among children 6-23 months old at the population-level indicator (Group et al., 2007; Agbadi et al., 2017). MDD is among the eight infants and young child feeding (IYCF) indicators developed by the WHO to provide straightforward, valid, and reliable metrics for assessing IYCF habits at the household level (WHO, 2008). It is also a component of a composite indicator, the Minimum Acceptable Diet (MAD)

Complementary Feeding

Child dietary diversity (MDD) is positively associated with the mean micronutrient sufficiency of the diet (WHO & UNICEF, 2017) and so can be used in assessing the diet quality in IYCF and appropriate complementary feeding practices (FANTA, 2006). MDD is a simple and easy to interpret indicator, appropriate for population-level targeting, monitoring and assessment, and target setting (WHO, 2008).

Methodology

In this study, we asked the participants questions about the child's feeding habits. The minimum dietary diversity for child (MDD) survey embedded in section C of the baseline and the end-line survey was administered before and after the training respectively. Data on a child's dietary diversity was gathered from a questionnaire that was administered to the child's caregiver, or mother. Respondents were asked to indicate whether their child consumed any food over the previous 24 hours from each of the eight food groups. In this study the eight food groups were adjusted to include the Nigerian staple foods in the courtesy of cultural sensitivity. In the questionnaire, we have 10 food groups which include the 8- MDD Food Groups. They are 1) Breast milk; 2.) Grains, roots, and tubers; 3) Legumes, seeds, and nuts; 4) Dairy products; 5) Flesh foods: meats or poultry, fish, seafood, and snails; 6) Eggs; 7) Dark leafy green vegetables; 8) Vitamin A-rich fruits and red palm oil; 9) Other vegetables; 10) Other fruits. (See Appendix B) 1 point was given to each question answered as Yes, and the total number of food groups consumed is summated.

MDD score for children 6-23 months old was calculated using the formula:

$$\frac{Number\ of\ children\ 6-23\ months\ of\ age\ who\ received\ food\ from\ 5\ or\ more\ food\ groups\ yesterday\ during\ the\ day\ or\ night}{Children\ 6-23\ months\ of\ age\ for\ whom\ breastfeeding\ and\ diet\ data\ will\ be\ collected} \quad (3.4)$$

Analysis

Data on Minimum dietary diversity for women (MDD-W) and minimum dietary diversity for a child (MDD) were normally distributed. The dietary diversity and nutrition status of the women fish processors were determined by analyzing and comparing the pre-and post-survey MDD-W and WDDS-10 scores using the descriptive statistics for dichotomous and ordinal continuous variables, respectively at p-value ≤ 0.05

Table 3.3 Summarized methodology for objective 1

Objective	Intervention	Methods	Statistical Analysis
<u>Primary objective</u> ***Objective 1:*** Improve knowledge of the nutritional value of fish, food safety, and fish processing techniques in stimulating positive behavioral change. **n =122** **Research Questions:** **i.** Training intervention improves knowledge and ii. There is a positive behavior change after training **Hypothesis:** ***Ho:*** There is no difference in mean pre and post quiz scores ***Ha:*** There is a difference in mean pre and post quiz scores ***Ho:*** There is no difference in mean baseline and end-line survey data ***Ha:*** There is a difference in mean baseline and end-line survey data	Participatory training for the women and youth fish processors Baseline and end-line survey. Pre and post quizzes	1. Participatory or interactive training, using "Train the trainer's approach" in a face-to-face setting. 2. The validated training material contained seven modules and three multiple-choice questions to evaluate the knowledge acquired. 3. Administer the pre-and post-quiz of the 7 nutrition education modules before and after each module training. 4. Give the low literacy tool to reinforce retention and remembrance. Low literacy tools; infographics, wristband, and hand fans containing nutrition information. 5. Administer end line survey 3 months after the training.	Paired T-test, $P \leq 0.05$. Compute test scores for the pre- and post-quiz of the 7 nutrition education modules for each participant. Compute the average (mean) and the standard deviation (SD) and use paired t-test to compare the means of a pre-and-post quiz to determine the improved knowledge. Compute the mean difference between the baseline and end-line survey using the paired-sample t-test to determine the behavioral change. SPSS Version 27 (IBM) For data analysis

Pre and post quizzes are attached to the Appendix. Baseline and Post survey in Qualtrics online survey.

Table 3.4 Summarized methodology for objective 2

Objective	Instrument	Methods	Analysis
Secondary objective: ***Objective 2***: Validate the relevancy and test the acceptability of newly developed low literacy materials and tools on nutrition and food safety.	1. Content validity index form.	1. Content validity: the training materials (Flipbook; Nutrition education, food safety and safe fish handling practice guide for fish processors, and the Pre and post quizzes) were evaluated and validated by 6-panel experts using the content validity index (CVI) form.	Compute the content validity index (CVI) and the concordance rate. Compute item-level; I-CVI, Scale-level; S-CVI and Modified kappa index.
	2. Comprehensibility test (cloze procedure)	2. non-participants (5) took the comprehensibility test on the training material before it was used for the training.	Compute the mean of comprehensibility scores for the low literacy training material.
	3. Endline survey session A3 (3.1- 3.5 and 3.9) Nutrition Information and Communication.	3. Other low literacy tools (wristband, hand fan) were tested for acceptability by the training participants.	Compute descriptive analysis for A3.1- 4, and Compute the Likert scale scoring for the participant's view on the acceptance, attractiveness, and effectiveness of the tools Questions A 3.5 and 3.9

Graphics of low literacy tools (LLT) are provided in this chapter. The cloze procedure was discussed in the literature review.

Table 3.5 Summarized methodology for objective 3

Objective	Instrument	Methods	Statistical Analysis	
<u>Secondary objective:</u> ***Objective 3***: Analyze the dietary diversity of women of reproductive age (15-49 years) and their Children between 6-24 months. **n =73** **Hypothesis:** ***Ho:*** Women fish processors have a high dietary diversity score ≥ 6 ***Ha:*** Women fish processors have a low dietary diversity score < 6 ***Ho:*** *Children of wo*men fish processors have a high dietary diversity score ≥ 5 ***Ha:*** children of women fish processors have a low dietary diversity score < 5	1. MDD-W 10 survey MDD Survey Baseline and Post survey. Section C (24-hour Dietary recall for women and children) Attached to Appendix B 2. Formula: MDD Score for WRA 15-49 years old. MDD Score for Children 6-23 months old (See chapter 2)	1. Enumerators administered the baseline and end-line survey 3 months after training. MDD-W 10 & MDD survey	Data on MDD-W & MDD were analyzed Compare the means of the baseline and post-survey MDD-W and WDDS-10 score 2. Use MDD-W as the dichotomous variable 3. Use the WDDS-10 score as the continuous variable (0-10) 4. Use MDD-W cut off 6 food groups out of 10, as an indicator of Dietary diversity (DD) for women. 5. Use MDD cut-off food groups out of 10, as an indicator of Dietary diversity (DD) for a child.	$P \leq 0.05$ Descriptive analysis was used for dichotomous and ordinal continuous variables, respectively. Determine and compare the means of the WDDS-10 score for women, and the MDD score for children from the baseline, and the end-line survey was done using paired T-test. SPSS Version 27 (IBM) for data analysis

Minimum Dietary Diversity for Women (MDD-W), Minimum Dietary Diversity for children (MDD), Women Dietary Diversity Score (WDDS-10), Dietary Diversity (DD), Women of Reproductive Age (WRA)

Table 3.6 Nutrition education and food safety training curriculum and content

Sessions, Topics, and Objectives	Lesson Outline	Teaching techniques
Nutrition education ***Healthy Eating Habits*** ***<u>Objectives:</u>*** *i)understand the importance of eating healthy* *ii) identify better food choices and combination* ***Discussion Points: (See facilitator guide)***	1. Pre quiz 2. What is healthy eating? 3. Importance of eating healthy: prevent macro and micronutrient deficiencies, promote growth, and improve health. 4. Choose MyPlate My Plate: • Fruits • Vegetables • Proteins • Grains • Roots and Tuber • Dairy 5. Nutrient and Dietary Diversity 6. Summary 7. Post quiz	**Module 1** • Simple and brief introduction • Introduce the topic and focus on the key learning area. • Key learning area: Healthy eating, eating a variety of food sources to prevent malnutrition. • Establish rapport to give the participants a sense of inclusiveness • Use the approved low-literacy educational tool and materials • Use simple, clear sentences. Make recommendations using voice (action verbs) • Make sure that the participants are comfortable and free from distractions. • Use appropriate visuals e.g., a flipchart showing Myplate. • Encourage active participation, asking questions, and small group (5-10 people) discussion using prompt questions and activities using the social cognitive theory. • Provide practical advice in a way that encourages the positive aspect of the trainee's diet while drawing attention to areas of improvement without being critical or judgmental.

Table 3.6 (continued)

Animal Source Food ***Fish nutrition*** ***<u>Objectives:</u>*** *i)Explain the benefits of eating fish* *ii)Mention a variety of foods that are good for growth and healthy living.* ***Discussion Points:*** ***(See facilitators guide)***	1. Identify animal source foods (ASF)-Aquatic or seafood 2. Nutritional value of Fish • Vitamins • Minerals • Protein • Carbohydrates • lipids 3. Health benefits of fish consumption to: • Infants and Children • Pregnant and breastfeeding women • Adults: Eating fish for a healthy heart. 4. Summary of key learnings 5. Assessment/evaluation	**Module 2** Introducing Animal sources of protein but focusing on fish as an affordable and rich source of protein Key learning area: the potential of fish nutritional composition and consumption in reducing the prevalence of micronutrient deficiencies among children and WRA. • Make sure that the participants do not get overwhelmed during the sessions. • Sustain the trainee's attention, make the session interesting, and be conscious of verbal and nonverbal communications. • Use the training handout and any additional educational aid to enhance your teaching. • Encourage active participation, asking questions, and small group discussion using prompt questions and activities using the SCT. • Provide practical advice in a way that encourages the positive aspect of the trainee's diet, while drawing attention to areas of improvement without being critical or judgmental. • Make recommendations using voice (action verbs)

Table 3.6 (continued)

Food safety ***Fish safety and handling*** ***<u>Objectives:</u>*** *i)understand the concept of food safety.* *ii) understand the consequence of poor food handling* ***Discussion Points:*** ***(See facilitator guide)***	1. Define food safety 2. Why food safety? 3. Foodborne illnesses 4. Safe fish handling rules and practices 5. Fish preservatives and additives 6. Fish storage 7. Fish transportation 8. Summary and evaluation	**Module 3** Introduce food safety but focus on fish safety and handling. Key learning area: why is food safety important? • Make participants feel included and welcome. • Make sure that the participants do not get exhausted during the sessions. • Sustain the trainee's attention, make the session interesting, and watch out for verbal and nonverbal communications. • Use the training handout and any additional educational aid • Use active methods e.g., discussion instead of passive • Encourage active participation, ask questions, and create small group (5-10 people) discussions using leading questions and exercises. Monitor small group discussions and activities. • Return to a full group for general review and round up the session.

Table 3.6 (continued)

Fish Processing ***Fish Processing Techniques*** ***<u>Objectives:</u>*** *i)Learn a better and safer method of fish processing* *ii) know the benefits of new methods on the quality of fish products* ***Discussion Points:*** ***(See facilitator guide)***	Fish Processing Methods Traditional Methods Modern methods • Salting • Solar drying • Smoking • Oven baking • Canning • Cold storage New Fish products • Powdered fish • Fish Paste • Canned fish • Barbequed fish The implication of Fish processing methods Summary of key learnings	**Module 4** Introduce food processing but focus on improved (safe) fish processing techniques and outcome on quality, safe, and nutritious fish products. Key learning area: safe and quality fish processing technique. • Make participants feel included and welcome. • Make sure that the participants do not get exhausted or discouraged during the sessions. • Sustain the trainee's attention, make the session interesting, and watch out for verbal and nonverbal communications. • Use the training handout and any additional educational aid • Use active methods e.g., discussion instead of passive • Encourage active participation, asking questions, and • Apply the concept of social cognitive theory • Create small group (5-10 people) discussions using leading questions and activities. Monitor small group discussions and activities. • Return to a full group for general review and round up the session. • Make recommendations using voice (action verbs)

Table 3.6 (continued)

Food Poisoning ***Fish Poisoning and contamination*** ***<u>Objectives:</u>*** *i)Identity fish contaminants & health risks.* *ii) understand the need for prevention.* ***Discussion Points:*** ***(See facilitator guide)***	1. Define food poisoning 2. Identify fish contaminants 3. Sources of fish contamination • Water: biological *(E. coli, salmonella*, cysts) & chemical (BPA, methane, heavy metals) physical (wastes, runoff) • Air: soot, dust • Soil: sand, grit, • Human (dirty hands) • Animals; pets, pests, and insects 4. Pesticide use & application 5. Health implications of fish poisoning & contamination 6. Preventive measures 7. Summary and evaluation	**Module 5** Introduce food poisoning but focus on how to prevent or avoid food poisoning and contamination Key learning area: Preventive measures • Make participants feel included and welcome. • Make sure that the participants do not get exhausted during the sessions. • Sustain the trainee's attention, make the session interesting, and watch out for verbal and nonverbal communications. • Use the training handout and any additional educational aid • Use active methods e.g., discussion instead of passive • Encourage active participation, asking questions, and • Apply the concept of social cognitive theory (SCT) • Create small group discussions using leading questions and activities. Monitor small group discussions and activities. • Return to a full group for general review and round up the session.

Table 3.6 (continued)

Hygiene and Good practices ***Hygiene rules for fish handlers*** ***<u>Objectives:</u>*** *i) Know the importance of hygiene and sanitation* *ii) Apply good practices in fish processing* ***Discussion Points:*** ***(See facilitator guide)***	1. Hygiene rules 2. Personal hygiene - handwashing, Cleanliness, hygiene & Sanitation 3. Good Practices: Good Hygienic Practices, Good Aquacultural Practices, Good Harvest Practices Good Transport Practices Good Processing Practices Good Handling and Packaging Practices Good Storage Practices, etc.) 4. Summary and evaluation	**Module 6** Introduce food safety rules but focus on safe fish handling, food hygiene regulations, and practices. Teaching method: all methods but mainly ***Discussion*** Key learning area: good practices; emphasis on personal and improved food hygiene practices of fish processors. • Make participants feel included and welcome. • Make sure that the participants do not get exhausted during the sessions. • Sustain the trainee's attention, make the session interesting, and watch out for verbal and nonverbal communications. • Use the training handout and any additional educational aid • Use active methods e.g., discussion instead of passive • Encourage active participation, asking questions, and • Create small group (5-10) discussions using leading questions and activities. Monitor small group discussions and activities bearing in mind the concept of social cognitive theory (SCT).

Table 3.6 (continued)

Economic benefits of quality and safe fish products. ***Nutrition and economic benefits of processed fish*** ***<u>Objective:</u>*** *i). Understand the economic benefits of quality and safe fish products to an individual and country.* ***Discussion Points: (see facilitator guide)***	1. Fish Quality 2. Fish loss and waste in the value chain 3. Poverty reduction 4. Economic empowerment 5. Improve nutrition and dietary diversity. 6. Improve health and wellbeing 7. Summary and evaluation	**Module 7** Introduce Economic benefits of quality, nutritious and safe fish products. Key learning area: Economic empowerment through quality production. • Make participants feel included and welcome. • Make sure that the participants do not get exhausted during the sessions. • Sustain the trainee's attention, make the session interesting, and watch out for verbal and nonverbal communications. • Use the training handout and any additional educational aid • Use active methods e.g., discussion instead of passive • Encourage active participation, and ask questions. • Create small group discussions using leading questions and activities. Monitor small group discussions and activities.

Developing low-literacy nutrition and food safety training materials.

The low literacy training tool was developed for the nutrition and food safety training for the fish processors. The training material was written on the 8th-grade reading level (Plimpton & Root, 1994). The developed nutrition and food safety training materials contain seven models with easy-to-read and comprehensible information using short sentences, void of hard-to-read words or terminologies, and judicious use of appropriate visuals including pictures to sustain attention, improve comprehension and enhance retention (Ip, 2010; Plimpton & Root, 1994; Bastable, 2014).

We also designed educational infographics such as MyPlate for Nigeria, food groups, portion size charts (figure 3.4) and low literacy nutrition promotional materials that contained simple nutrition information (figures 3.2, 3.3 and 3.5), these educational materials were evaluated and validated by a group of experts.

Use of visuals

Pictures and visuals including infographics were used to support verbal and written information in low-literacy training materials. Visuals increase attention, improve comprehension, and reinforce remembrance that promotes adherence to instructions. (Ip, 2010). Attractiveness encourages adults to pick up reading material (Plimpton & Root, 1994) Visualization ideas were borrowed from existing noncopyrighted pamphlets and other related materials.

Audience demographics characteristics

The Institute of Medicine report recommends involving the intended audience in the process of developing health communication materials (Nielsen-Bohlman et al., 2004). Existing information or data gathered through reviewed literature about the nutrition and food safety knowledge and observed data gathered from the on-the-site visit or market survey report gives a

cue about attitudes and behaviors which was utilized in preparing the training material. The demographic characteristics of the potential training participants such as literacy, culture, and language were also considered in preparing the low literacy tool. Low literacy adults may have deficit health and nutrition literacy in their native language (Ip, 2010). Other factors considered in determining the acceptability of the low literacy promotional tool include eco-friendliness of the tool**,** average educational and literacy level of the beneficiaries/ trainees**,** social and cultural acceptance**, c**ommunity need- perceived and expressed need**,** the potential efficacy of the information literacy tool, potential of information retention and reminder based on the evidence of similar studies, and others such as convenience or comfortability.

Comprehensibility Tests

Several standardized tests have been proved valid and reliable in measuring the comprehensibility of reading material by the reader. Usually, pre and post-tests measure recall knowledge rather than comprehension, nevertheless, measuring the reader's comprehension is significant (Doak et al., 1996 cited by Bastable, 2014). Comprehension is the capacity or level at which the reader internalizes the information. This study adopted one of the commonly used standardized test methods; the *Cloze test* or in determining the comprehensibility of the training tool. Cloze procedure has been validated for its adequacy in ranking reading difficulty in the medical literature. It is recommended when the audience function with at least 6th-grade reading skills (Doak et al., 1996).

Low Literacy Tools: nutrition and food safety promotional materials

Low literacy tools (LLTs) were designed by the lead researcher and approved by the Nourishing Nations team of experts. The LLTs are foldable hand-fans, silicon wrist bands, and aprons. Simple nutrition and food safety instructions were printed on the tools to reinforce knowledge and remembrance. A study shows that vaccine reminder bracelets help mothers remember vaccinating their children (Siddiqi et al., 2019). This initiative was implemented to meet Objective 3 of this project and involve training the women and youth fish processors.

The low literacy tools help focus the participant's attention on the position of quality processed fish consumption in addressing malnutrition and other nutritional deficiencies in especially infancy and pregnancy or during lactation. It also helps them better market their products.

Fabric hand fan

A foldable fabric hand fan of various attractive colors containing nutritional information about the benefits of fish was produced (figure 3.2). This tool was included based on the perceived and expressed needs of the fish processors. To help cushion the heat from the wood-burning during the smoking process and serve as a manual air fan during the harsh weather condition in the open market. In addition, fish processors also use a hand fan to blow their charcoal to ignition during smoking. Therefore, it was considered an essential material for their business adventure. We decided to leverage this need to bring the nutrition information and fish consumption advocacy to their proximity.

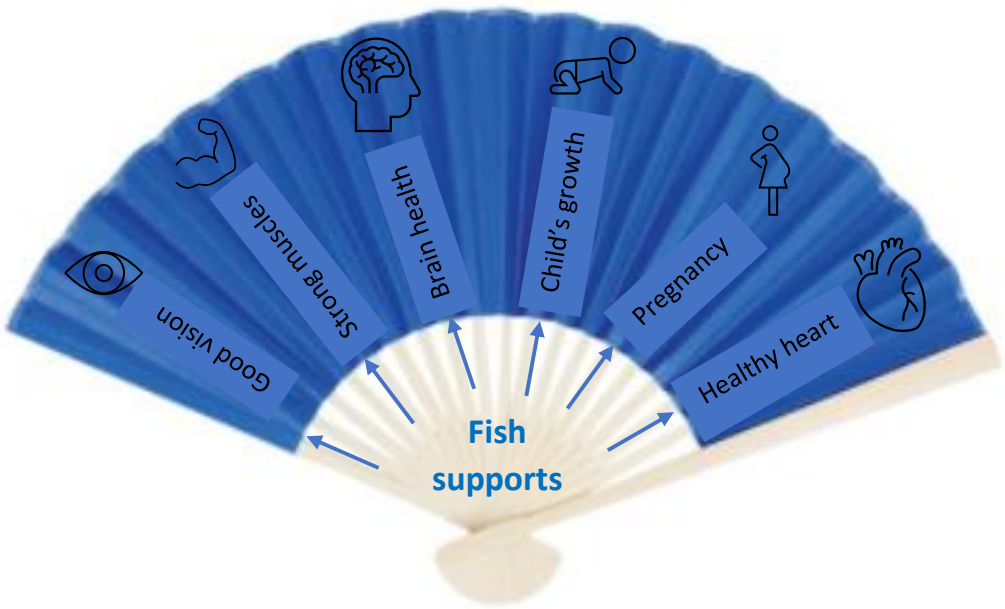


Figure 3.2 Hand fan containing fish nutrition information

(Designed by Grace Adegoye)

Silicone rubber wristband

Silicone rubber wristband (bright colors) was produced in different sizes and colors by a vendor in the host country, Nigeria. The silicone rubber waistband contained an inscription to serve as a reminder of the benefits of fish consumption (Figure 3.3). This was used in this study as an innovative strategic approach to sustain behavioral change and a healthy dietary habit beyond the training program. The wristbands were distributed to the participants to sustain the nutrition information and knowledge gained from the training and with the hope that they will share the information with their customers and colleagues. Based on our findings, the silicone wristband was considered safe in terms of environmental friendliness, and it was socially acceptable among women and youth generally in Nigeria.

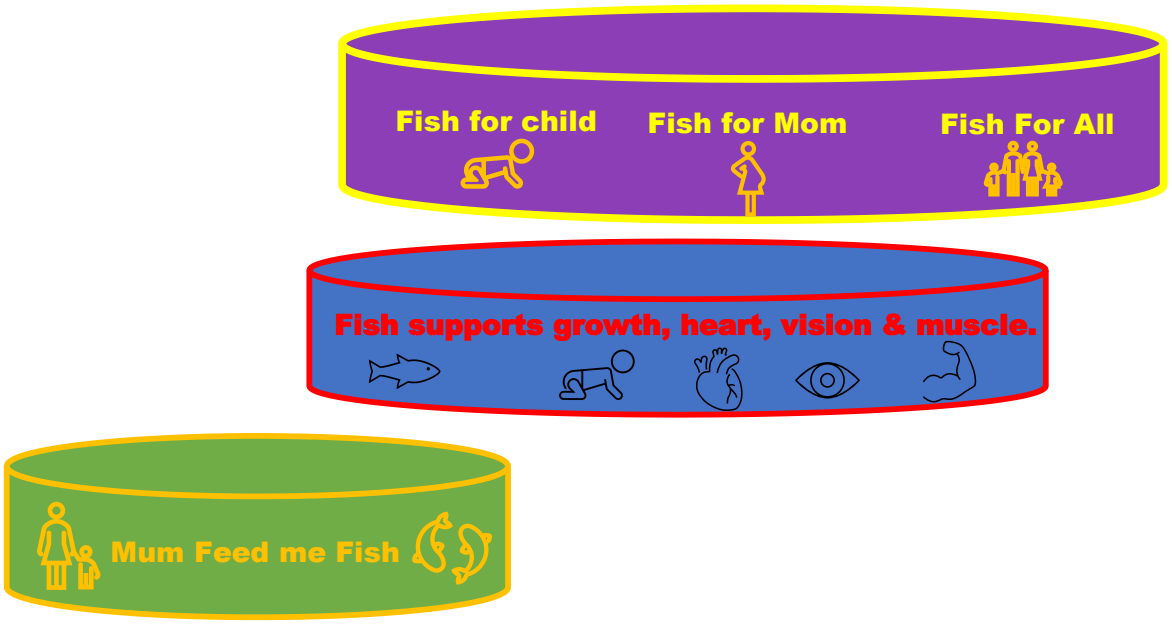


Figure 3.3 Embossed silicone wristband containing simple nutrition information (Designed by Grace Adegoye)

Flipchart showing MyPlate for Nigeria

MyPlate is a nutrition information chat that informs eating the healthy right mix of a variety of foods**.** The MyPlate for Nigeria used in this study includes fruits, vegetables, proteins, dairy, grains, and tubers/roots. Roots and tubers were staple foods in Nigeria, they are included on the "MyPlate" as shown in figure 3.4 to relate to peoples' needs, and respect cultural values, promote acceptance and belongingness. Dairy was also substituted with a locally available and affordable product.

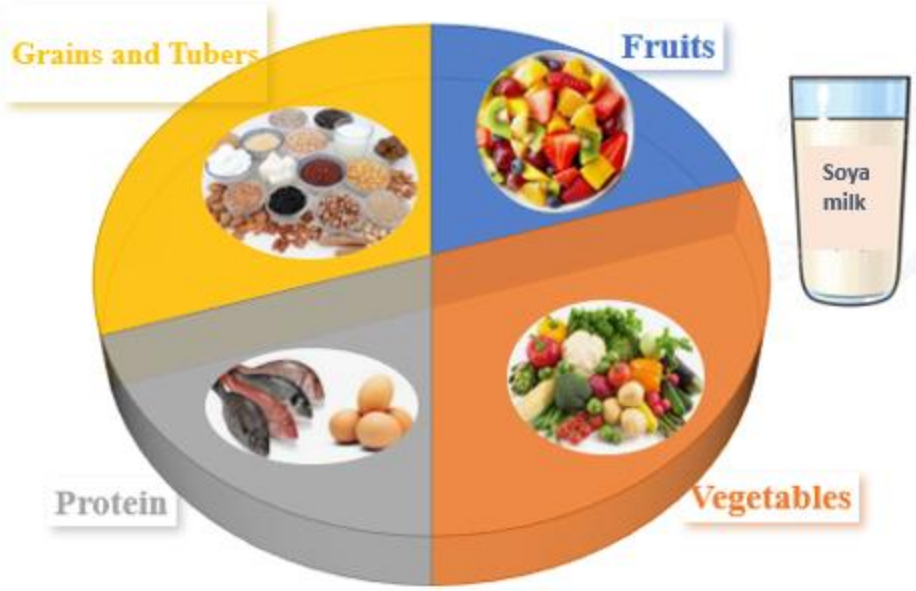


Figure 3.4 MyPlate for Nigeria

Adapted from MyPlate US Department of Agriculture (Adegoye, 2022).

Infographics

Infographics are easy-to-read, comprehensible, and reproducible nutrition and food safety instructional material for the fish processors that will be participating in the training (Mosby et al., 2015).

Apron

An apron was given to the fish processors that participated in the survey and training. A piece of fish business and nutritional promotional information with an acronym BEST; *"Buy fish, Eat fish, Stay healthy and Thrive"* was printed on the apron while it serves as personal protective wear at the same time. This innovation was created to foster behavioral change towards safe fish production, hygiene, and safe fish handling practices.

Figure 3.5 Aprons containing nutrition promotional information.

Graphics or images from amazon.com.

Data Collection Method

A total of 122 participants, mainly women, and youth fish processors that met the inclusion criteria were selected for this study from the three senatorial districts in the Delta State of Nigeria. The trained enumerators assisted in administering the baseline and post-survey using a printed questionnaire for data collection. Data on socioeconomic and household characteristics, dietary and cooking behavior, fish consumption pattern and frequency of fish, nutrition knowledge, food safety and hygiene practices, source of nutrition information and communication means, accessibility to fish, fish preparation and processing, fish business, after-purchase handling, and dietary diversity using woman's dietary, and child dietary recall were collected. This study also utilized the on-the-site data generation strategy; using digital devices for collecting pictorial information where possible and when consent is confirmed.

Instrument for Data Collection

The baseline and end-line survey are the primary instruments for household data collection in this study available in hard copy and softcopy online (Qualtrics online Questionnaire)

The validated household survey was adopted as the template for the baseline and end-line survey used in this study. The survey was recommended by the Feed the Future Innovational Lab for Fish, Nourishing Nations team and approved by the Institution Research Board (IRB) of the Mississippi State University. This survey has four sections: A-D. Please see appendix B

Section A consists of 4 subsections

A. Demographic and Socioeconomic information

A1. Fish business and income-related activities

A2. Nutrition and knowledge hygiene practices

A3. Nutrition education/information and communication.

Section B consists of 3 subsections

B1. Fish preparation and processing behaviors,

B2. Fish business and accessibility,

B3. Fish safety and post-harvest handling.

Section C contains a survey on Measuring the Dietary Diversity status of WRAs and infants.

C1. Woman's Dietary Recall.

C2. Child Dietary Recall

Section D contains a survey on

D1. Fish consumption and cooking behavior and

D2. Fish in complementary foods.

Graphical data collection at the popular fish markets in Delta State, Nigeria

The fish value chain system in Delta State links the fish purchase from the coastal line market where the artisanal purchase their fresh fish from the fishermen. They take this fish to their respective kitchens for processing and sell them at the major and local markets within and in the neighboring states. Some of the popular markets where the fish processors sell or buy the finished products are Abavo, Agbado Market, Edaiken Uselu Market, Ekeosa Market (Queen's Market), Eyaen Cattle Market, Kara Market, Main Market, New Benin Market, Oba Market (Ekioba), Oka Market, Oliha Market, Santana Market, Uselu Market, and Vegetable Market. These markets are

traditionally operating every 4 days. This study focused on the coaster markets (major fish collection points) within the three (3) districts, North District Market, Ogbogongo Modern Market (figure 3.6) serves a coastline and major market, South District market; Cable market (figure 3.7), and the Local market; Ibusa Market (figure 3.8), where inter-trade between the major and local markets is practiced. Processed fish presented for sale to the consumers in open market settings are exposed to a wide range of contaminants such as flies, dirty surfaces, dust or sands, pathogens, pests, animals, and humans (figures 2.8 and 3.9), and environmental factors such as excessive sunlight among others. The M.Sc. students at the University of Calabar (collaborating institution in the host country, Nigeria) are collecting processed fish samples from these markets for both nutrition and contaminant analysis and evaluation to achieve the first objective of the Nourishing Nations Project.

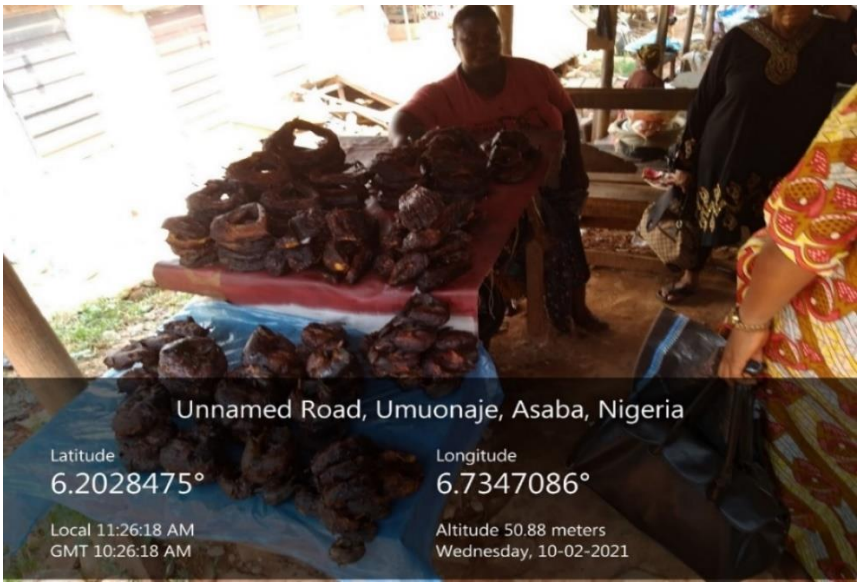


Figure 3.6 Ogbogongo modern fish market, Asaba, Delta State, Nigeria.

Photo source: (FIL; Nourishing Nations Project, Delta State, Nigeria. 2021)

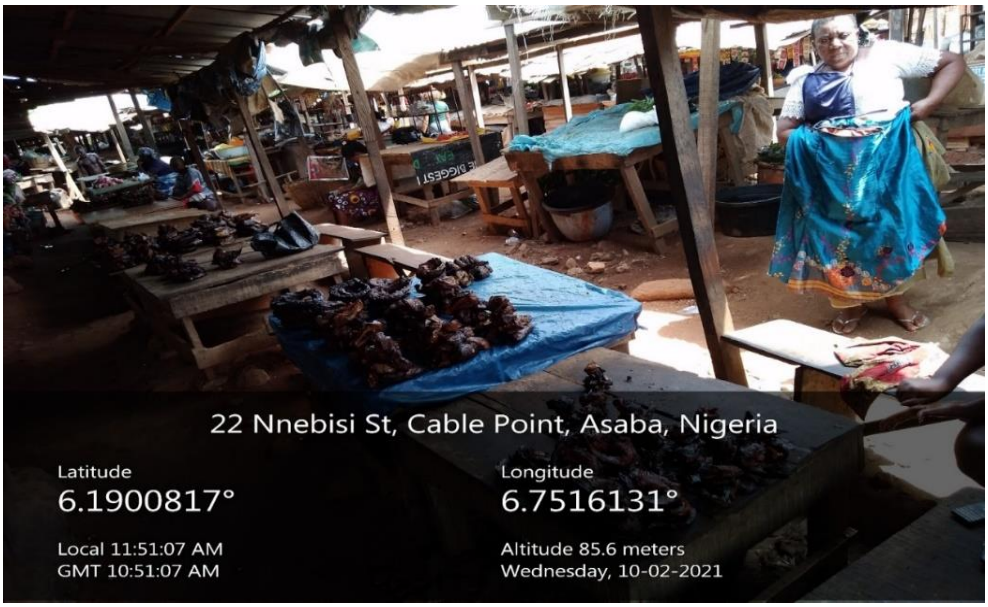


Figure 3.7 Cable market, Asaba, Delta State, Nigeria.

Picture of a fish market in Asaba, showing fish sellers and artisans displaying processed dried and smoked fish. Photo source: (FIL; Nourishing Nations Project Delta State, Nigeria. 2021)

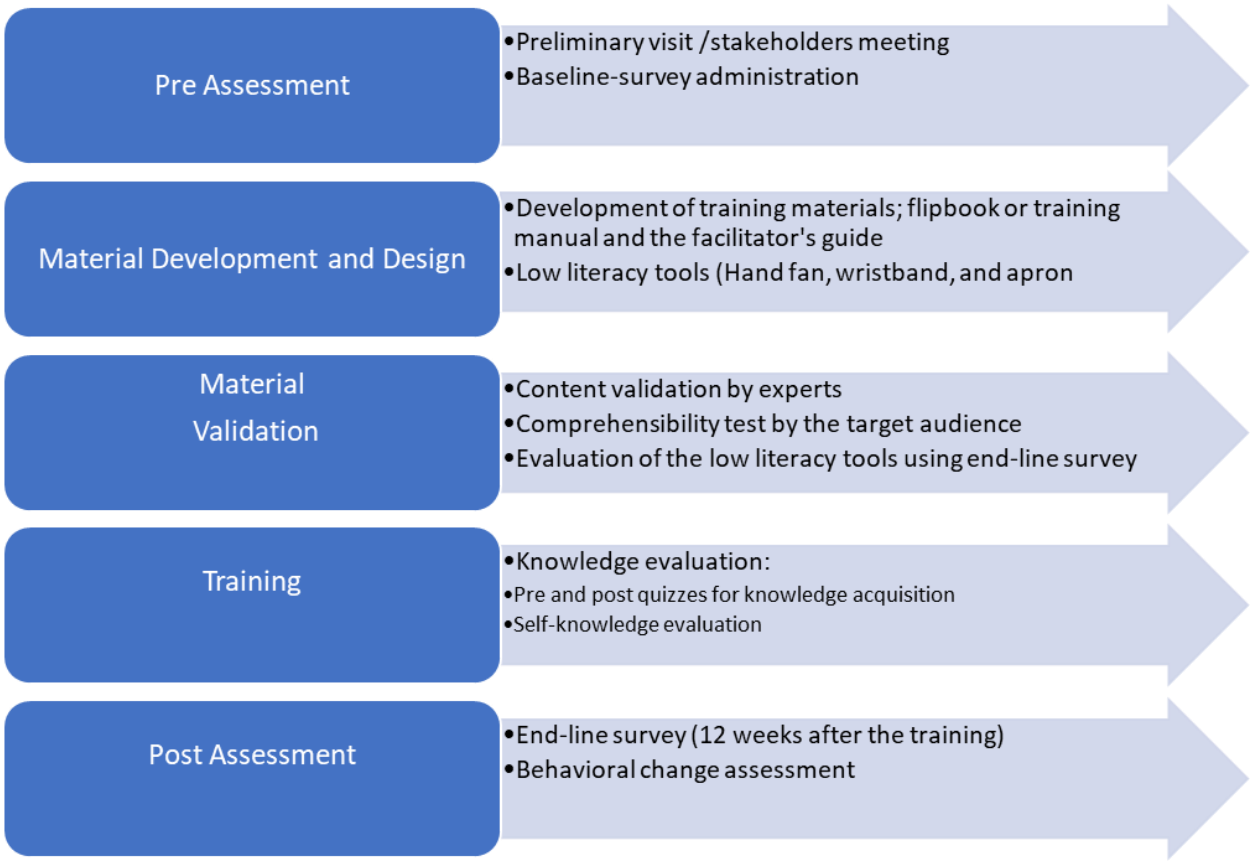
Figure 3.8 Ibusa market, Ibusa town, Delta State, Nigeria

Photo source: (FIL; Nourishing Nations Project Delta State, Nigeria. 2021)

Figure 3.9 Processed dried, smoked, and fresh fish displayed in the market

The artisanal fish processors selling their fish products Photo source: (FIL; Nourishing Nations Project Delta State, Nigeria. 2021)

Research Process



Scheme 3.1 Illustration of the research process

Scheme 3.1 Illustrates the research process and presents the key elements of the study design.

CHAPTER IV

FISH BUSINESS AND CONSUMER'S BEHAVIOR, SAFETY, AND AFTER-PURCHASE HANDLING IN DELTA STATE, NIGERIA

Introduction

Aquaculture and capture fisheries are a major source of livelihood for about 200 million people, with about 70% working in the traditional small-scale fish processing sector (Selig et al., 2019). Fish production serves as both primary and income providers for millions of Nigerians (Akintola & Fakoya, 2017; Grema et al., 2020). Nigeria has a high dependency on fisheries or aquatic habitats for its nutrition and economy because of its multiple estuaries and access to the ocean (Selig et al., 2019). Fish represents over 18.5% of the total animal source food (ASF) (Tacon & Metian, 2013). In Nigeria, fish consumption is estimated at 13.3 kg per capita per year, which is higher than the regional average for Africa (9.9 kg per capita per year). However, fish consumption in Nigeria is lower than the global average of 20.3kg per capita per year (WorldFish, 2018). Rural inland communities face several challenges, particularly in regard to malnutrition resulting from low-quality diets (Müller & Krawinkel, 2005).

Fish is often an inexpensive and accessible ASF that may provide nutrients such as iron, vitamin A, zinc, iodine, calcium, and omega 3 fatty acids which are essential for health (Murai, 1991), Bogard et al., 2017; Mohanty et al., 2019; Byrd et al., 2021). However, processing methods, and unsafe fish handling practices may alter the nutrient content of fish. In Nigeria, fish handling methods remain limited to traditional salting, sun drying, and smoking. These methods expose fish

products to contamination from pests, microorganisms, sand, and grit. Smoked fish using traditional processing techniques can be the source of high levels of polycyclic aromatic hydrocarbons (PAHs) and dioxins due to high wood-burning temperatures (Abraha et al., 2018, Adeyeye, 2016).

Bacterial growth and spoilage from sun drying can be challenging during the rainy season. Although fish processing is important for reducing post-harvest and after-purchase loss, traditional methods can lead to several food safety problems, that endanger the consumers' health. In the contemporary time, consumer awareness of food safety is increasing, but there has been little attention given to addressing fish sourcing, handling, hygiene practices, safety, and quality concerns of traditionally processed fish products among the fish processors in Nigeria. Understanding how processing methods impact nutritional loss and gains can help better quantify the nutritional potential of fish.

Socioeconomic Background, and Fishing Business in Nigeria

Nigeria's fisheries sector has highly diverse, typically primitive, and almost exclusively small-scale fish businesses. Fishing and related activities are done in communities in the coastal area, the southern part of the country, on the Atlantic (Figure 4.1).

In Nigeria, over 86 million people are estimated to be directly engaged in fisheries, and 19.6 million, 70 percent of whom are women, are indirectly employed. Currently, Nigeria imports over 800,000 metric tons of fish annually (WorldFish, 2018; Bradley et al., 2020). Unfortunately, the country continues to face diverse challenges such as malnutrition, food insecurity, poverty, increased crime, unemployment, infectious and noncommunicable disease because of the growing population, oil dependency, Boko Haram insurgency, sociopolitical and tribal crisis, lack of infrastructures, and economic development, poor governance, and policies which place large

pockets of the population in poverty (Adekola & Igwe, 2013; Ipingbemi, 2009). The impact of COVID-19 on the national and global level has worsened the situation in many low-income countries like Nigeria.

Figure 4.1 Map of Nigeria showing major coastal basins and rivers.

Source: (Bradley et al., 2020)

The overall project aimed to improve the quality and safety of processed fish products in Delta State, Nigeria using the train the trainer model. This project was accomplished by a steadily growing network of government agencies, particularly in Delta State where this study was conducted, the Ministry of Health, Ministry of Agriculture, Delta Rural and Agricultural Development Agency (DARDA), university researchers from the University of Calabar in Nigeria, Mississippi State University, USA, and non-governmental partner, WorldFish.

The objective of this current study was to describe fish processing practices, consumer behavior, safety, and after-purchase handling in Delta State, Nigeria**.** We hope that the findings in this study will be resourceful in predicting innovative strategies to improve the quality and safety of processed fish products in low-income countries.

Methodology

Study design

This study was submitted, reviewed, and approved as an exempt study by the Institution Review Board for Human Studies at The Mississippi State University (IRB number IRB-20-072). It was a descriptive evaluation study by design using mixed methods (quantitative and qualitative). A comprehensive survey was used to collect information on the fish business, safety knowledge, handling, and processing. Participants were women and youth fish processors (n=99) of low-income and low literacy from the three senatorial districts in Delta State, Nigeria (figure 4.2). COVID-19 protocols and WHO's recommendations during data collection were observed.

Data collection

Data collection was conducted by three trained enumerators, graduate students of Fisheries and Aquaculture from Nigerian University under the supervision of the project coordinator and overseen by the host country Principal Investigator (PI), a professor from Nigerian University. These enumerators were indigenous to the target population and have a good understanding of the common language spoken within the study area. The survey questionnaire was administered in English using a paper printed copy. The lead author had three training meetings virtually via zoom with the enumerators, acquainting them with the survey instructions, and familiarizing them with

the survey questions and questionnaire administration. Each recurring meeting lasted for approximately 45 minutes.

We adapted a household survey questionnaire from WorldFish and modified it to align with the objective of this study. The comprehensive survey captured information on fish production practices, hygiene practices, value chain productivity, knowledge on nutrition and food safety, quantified the livelihoods of fish processors and after-purchase activities, and challenges. The survey also included the demographic and socio-economic characteristics of the fish processors. Data were collected from individual fish processors after they had signed the consent form to participate in the study. This study focused on the women and youth fish processors, therefore most of our respondents (women) were considered the primary respondent on household information. Data quality control and input into Microsoft excel were supervised by the project coordinator.

Quantitative Data Analysis

Univariate frequencies were completed in SPSS version 27 (IBM).

Qualitative Data Analysis

The trained enumerators assisted in writing the respondent's responses to the open-ended questions of the survey. The survey was prepared and administered in the English language. Most of the respondents responded in English language or at least Pidgin English which is gradually becoming a community language in this region particularly Delta State. Information was coded into themes and salient quotes were recorded.

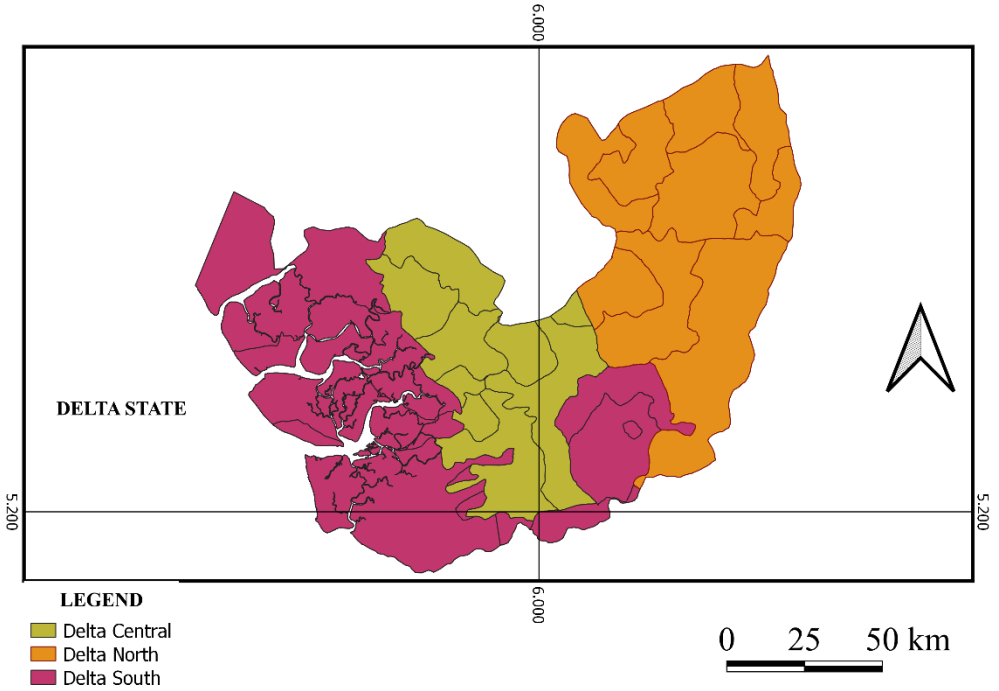


Figure 4.2 Map of Delta State, Nigeria shows the three senatorial districts.

Quantitative Results

Demographic representation of the participants

Table 4.1 Demographic information of the participants

Variable	
Number of participants (n)	99
Men	26
Women	73
Age group	
15-18	6
19-29	21
30-39	37
40-49	35
Primary Language	**n= 99**
Igbo	35 (35.4%)
Ijaw	39 (39.4%)
Urhobo	16 (16.2%)
Itsekeri	4 (4%)
Isoko	4 (4%)
English	1 (1%)
Household size	**n= 99**
1-3	31 (31.3%)
4-6	54 (52.5%)
7-9	15 (15.2%)
≥ 10	1 (1%)
Religion	**n =88**
Christian	88 (100%)
Educational status	**n = 86**
Preschool or no formal education	3 (3.5%)
Some primary education	2 (2.3%)
Completed primary education	10 (11.6%)
Some secondary	11 (12.8%)
Completed secondary	35 (40.7%)
College or higher	24 (27.9%)
Other	1 (1.2%)
Physiological status	**n =73**
Pregnant	2 (2.7%)
Lactating	11 (15.1%)
Not pregnant not lactating (NPNL)	60 (82.2%)
Marital status	**n =86**
Single never married	9 (10.5%)
Widowed	5 (5.8%)
Divorced	1(1.2%)
Married	68 (79.1%)
Separated	3 (3.5%)

The findings in table 4.1 present demographic and socio-economic characteristics of 99 households mainly fish processors. Missing data are exempted from the analysis

Table 4.2 Household characteristics

Variable	
Number of participants (n)	
Household own TV set	**n =99**
Yes	92 (92.9%)
No	7 (7.1%)
Own a smart phone	**n= 99**
Yes	63 (63.6%)
No	36 (36.4%)
Household electricity	**n= 99**
Yes	42 (42.4%)
No	57 (57.6%)
Household energy source for cooking	**n =89**
Electricity	1 (1.1)
Gas	75 (84.3%)
Kerosene	8 (9.0%)
Charcoal	1(1.1%)
Firewood	4 (4.5%)
Household toilet facility	**n = 99**
Flush toilet (pour-flush or WC)	86 (86.9%)
Pit latrine with slab	5 (5.1%)
Pit latrine without a slab	3 (3.0%)
Use bush or field	1 (1.0%)
Stream	4 (4.0%)
Household water supply source	**n =96**
Stream or river	3 (3.1%)
Borehole	83 (86.5%)
Tap	8 (8.3%)
Purchased	2 (2.1%)
Mode of Transportation to market	**n =71**
Walk	4 (5.6%)
Motorcycle	23 (32.4%)
tricycle	32 (45.1%)
Shared vehicle	8 (11.3%)
Private vehicle	2 (2.8%)
Canoe/boat	2 (2.8%)
Minutes from a household the market	**n= 98**
Less than 30	43 (43.9%)
30-60	37 (37.8%)
61-90	6 (6.1%)
91-120	6 (6.1%)
121-150	5 (5.1%)
Above 150	1 (1.0%)

The findings in table 4.2 present the household characteristics of fish processors in Delta State, Nigeria. Missing data are exempted from the analysis

Fish business and income-related activities

Table 4.3 Fish business and income-related activities.

Family participation in the fish business	**n = 38**
Fish farming	1 (2.6%)
Fish trading	6 (15.8%)
Fish processing	38 (81.6%)
Other sources of income	**n =83**
Crop production	7 (8.4%)
Poultry-keeping	6 (7.2%)
Livestock production	3 (3.6%)
Trading	6 (7.2%)
Support from husband and relatives	8 (9.6%)
Work for government or public	7 (8.4%)
Skilled salary employment	3 (3.6%)
Petty trading	9 (10.8%)
Wholesale or retail business	1 (1.2%)
None (fish processing only)	31 (37.3%)
Others	2 (2.4%)
Years in fish processing	**n = 98**
Less than one year	4 (4.1%)
1-2	16 (16.3%)
3-5	36 (36.7%)
6-10	22 (22.4%)
More than 10 years	20 (20.4%)
Low season income in Naira (USD) per week	**n = 99**
5,000 -10,000 (12.135 - 24.269 USD)	45 (45.5%)
10,001-20,000 (24.272 - 48.538 USD)	35 (35.4%)
20,001-30,000 (48.54 1- 72.808 USD)	10 (10.1%)
40,001-50,000 (97.080 - 121.347 USD)	2 (2.0%)
Above 50,000 (≥ 121.349 USD)	7 (7.1%)
Peak season income in Naira (USD) per week	**n= 99**
Less than 20,000 (48.535 USD)	35 (35.4%)
20,001-40,000 (48.541 -97.098 USD)	37 (37.4%)
40,001-60,000 (97.080- 145.616 USD)	15 (15.2%)
60,001-100,000 (145.619- 242.695 USD)	5 (5.1%)
Above 100,000 (≥ 242.697 USD	7 (7.1%)

Table 4.3 (continued)

Interest in new fish product to improve income	**n= 99**
Yes	91 (91.9%)
No	1 (1.0%)
Indifferent	7 (7.1%)
Likelihood of trying new fish products	**n = 99**
Most likely	69 (69.7%)
Likely	25 (25.3%)
Less likely	2 (2.0%)
Not likely	3 (3.0%)

Table 4.3 presents the business attitude and income-related activities of fish processors in Delta state. (Exchange rate used was 1 USD= 412.04. OANDO currency converter)

The low season income per week is presented in naira, the Nigerian currency, and the US Dollar equivalent was presented using an average rate of randomly selected three different dates in August 2021 using the OANDO currency converter. An estimated income of 50,000 Naira approximately 121 USD is realized by fish processors in the low season which is usually between November to April. An income as high as 100,000 Naira (approximately 243 USD) and above could be attained by the processors during the peak seasons between July to early October.

The majority (62.4%) of the fish processors engage in other activities to improve their income (Table 4.3). An estimate of 20.4% of participants were two years or less in the fish processing business while the majority had a minimum of three years of experience.

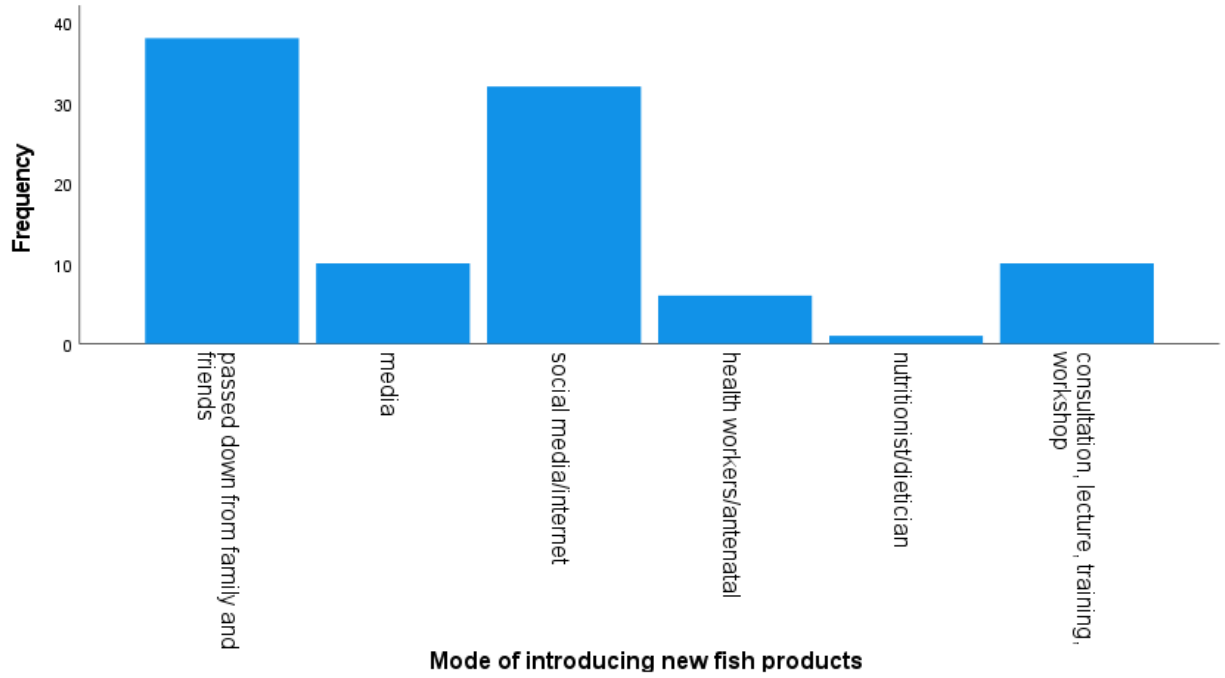


Figure 4.3 Participant's preferred means of Introducing new fish products

Nutrition and food safety information and communication

Nutrition and food safety information (NFSI) is as important as the communication media. The majority reported having received nutrition and food safety instructions in the past month while 44.4% did not. Almost half of the respondents indicated television and social media as the preferred means of receiving NFSI. We found out that financial affordability was less considered when choosing an NSFI communication channel as shown in table 4.4. Accessibility or ease of obtaining information accounts for 50%, followed by 45% for understandability, which was the most important reason for their preference. However, a greater number of the respondents agreed on the effectiveness of possible NSFI communication means as detailed in figure 4.4.

Table 4.4 Nutrition and food safety information source preference

Variables	
Number of participants (n)	
Received nutrition and food safety information in the past month	**n = 99**
Yes	55 (55.6%)
No	44 (44.4%)
A Preferred source of information	**n =60**
Family and friends	5 (8.3%)
Formal education	4 (6.7%)
Books including textbooks	1 (1.7%)
Booklets, pamphlets	1 (1.7%)
Media (TV, radio)	15 (25.0%)
Social media	16 (26.7%)
Health workers	8 (13.3%)
Nutritionists or dieticians	7 (11.7%)
Consultation or lectures	3 (5.0%)
Reasons for preference	**n =60**
Physically accessible and easy to get	30 (50%)
Financially affordable	2 (3.3%)
Easy to understand	27 (45%)
Other	1 (1.7%)

Table 4.4 presents the preferred source of nutrition and food safety information and communication by the participants. Missing data are exempted from the analysis

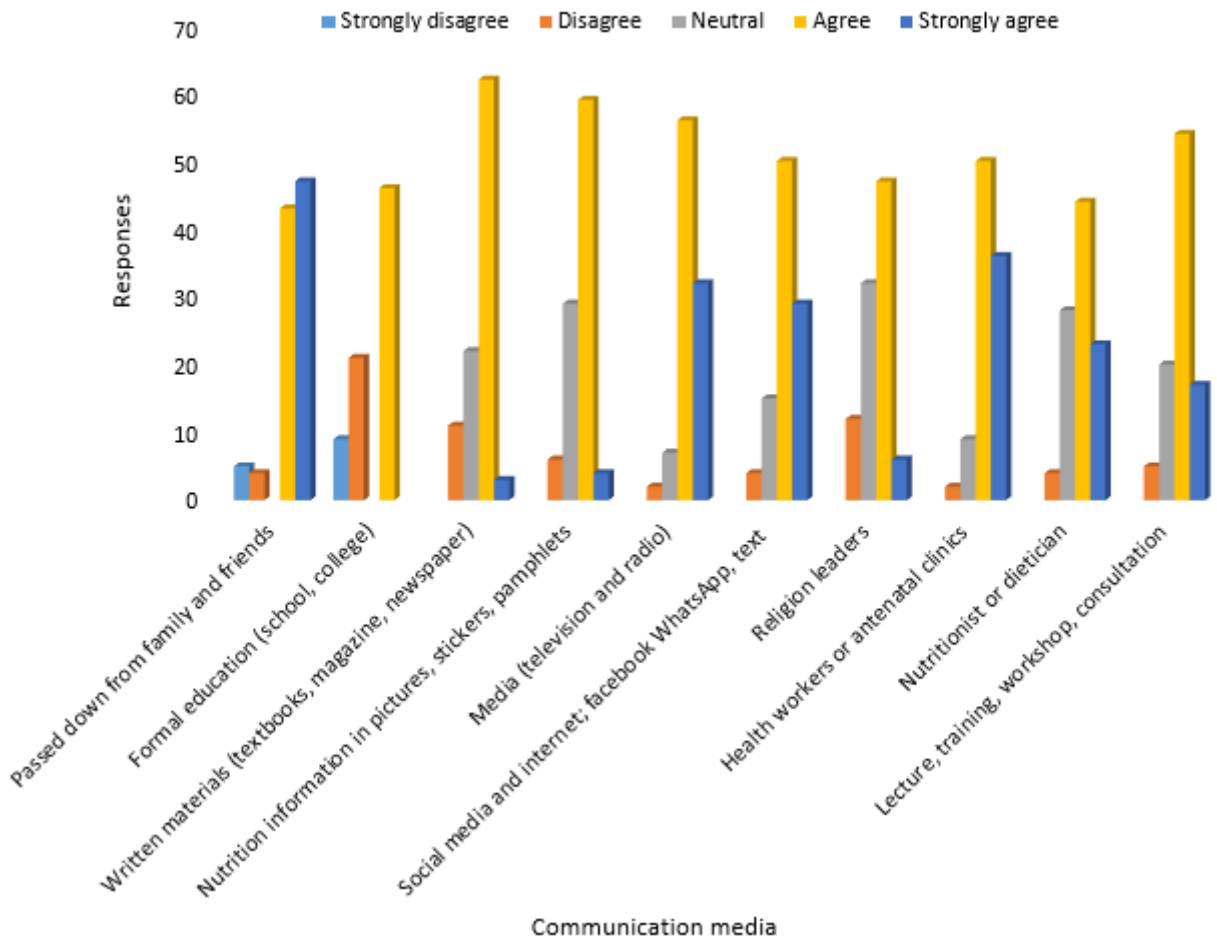


Figure 4.4 Respondent's perceptions of nutrition communication media

Participant's perception of different communication media in disseminating nutrition and food safety information on a scale of 1-5 (n=99)

Table 4.5 presents information about the knowledge level of the fish processors on associated problems with the traditional fish processing methods, particularly smoking and sun-drying. 81.8% and 87.4% were not aware of the food safety risks associated with these methods. A larger percent, 92.9% reported that they do not have formal training on fish processing and handling. An estimated value of 10.1 % reported that their child or a member of the family had had diarrhea, typhoid, cholera, or any other food-borne related illnesses in the last 30 days.

Results in figure 4.5 presented that most of the fish processors perceived that smoked, salted, canned, paste, and powdered fish are less likely to be contaminated. Fried and barbecued fish are more likely to be contaminated while fresh and dried (sun-dried) are most likely to be contaminated.

Table 4.5 Knowledge of food contamination and safety.

Variable	
Are there problems associated with smoked fish	**n= 99**
Yes	18 (18.2%)
No	81 (81.8%)
Are there problems associated with sundried fish	**n= 95**
Yes	12 (12.6%)
No	83 (87.4%)
Do you have the option to wash your hand under running water with soap?	**n= 99**
Yes	81 (81.8%)
No	18 (18.2%)
Did your child or any family member have diarrhea, typhoid, or cholera within the last 30 days?	**n= 99**
Yes	10 (10.1%)
No	89 (89.9%)
Do you have any formal training on fish processing	**n = 99**
Yes	7 (7.1%)
No	92 (92.9%)

Table 4.5 presents the knowledge of fish processors on food safety and related issues

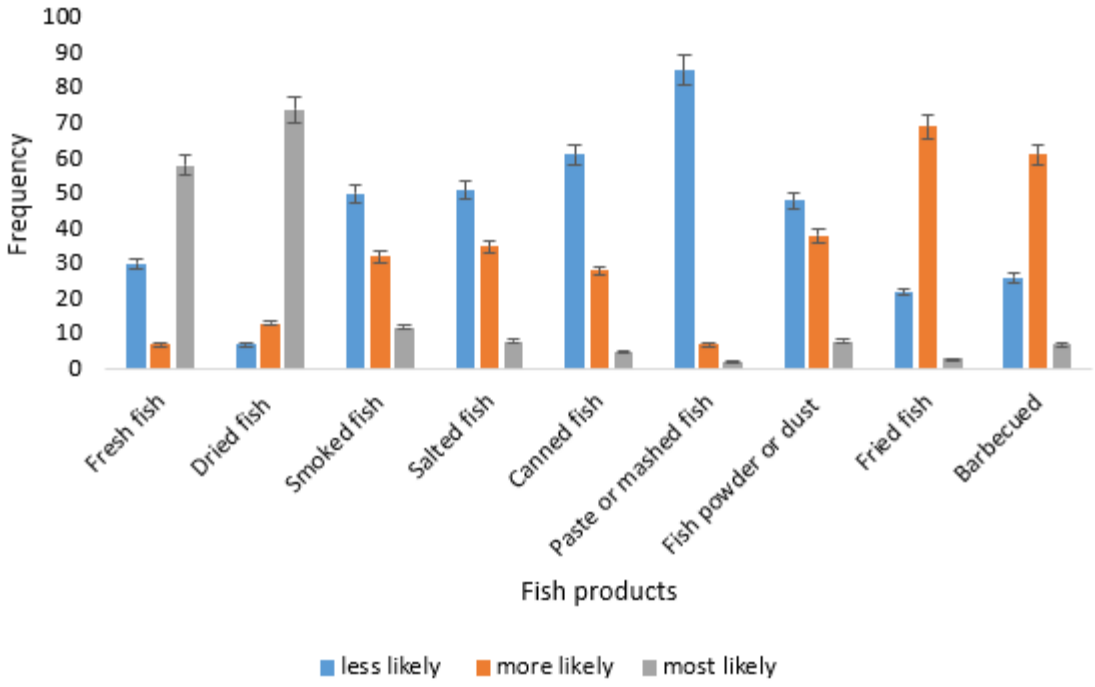


Figure 4.5 Participant's perception of fish forms exposure to contamination

Figure 4.5 presents the participant's knowledge of the likelihood of various processed fish products being exposed to contamination during processing and after

Fish sourcing, preparation, processing, and handling practices

Catfish was the most purchased fresh fish species (92.5%) among the fish processors in Delta State, Nigeria as shown in figure 4.6 below.

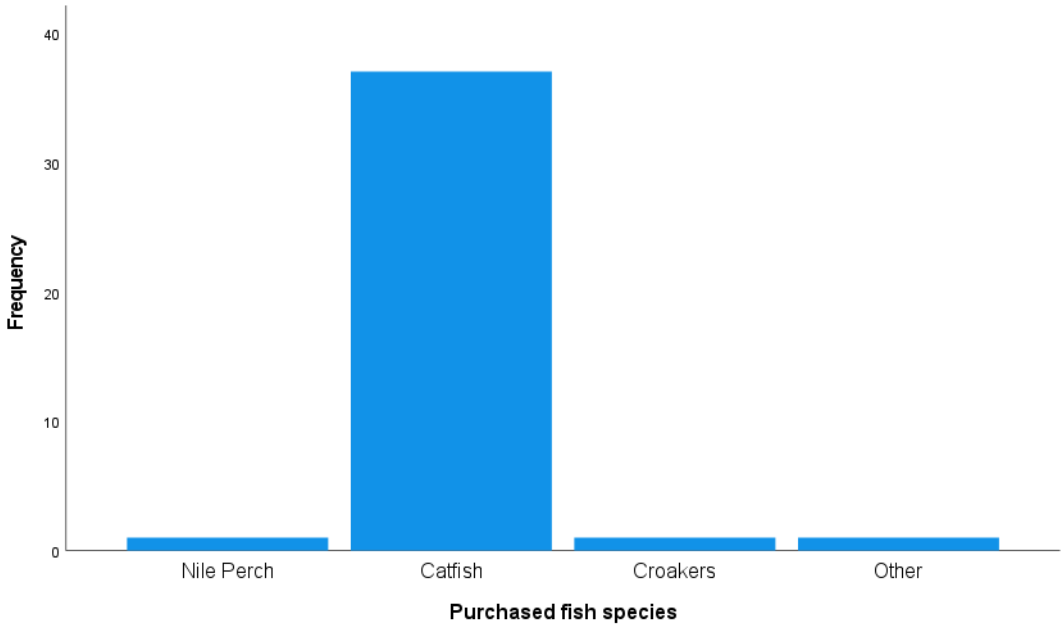


Figure 4.6 Fish species commonly purchased by processors

Figure 4.6 presents the means of fish preservation. Most respondents (87.5%) process their fish by placing over charcoal in a smoking kiln and 11.5% place it in a basket over a fireplace as a means of preservation. Only 5.2% indicated that they have access to cold storage for fish preservation

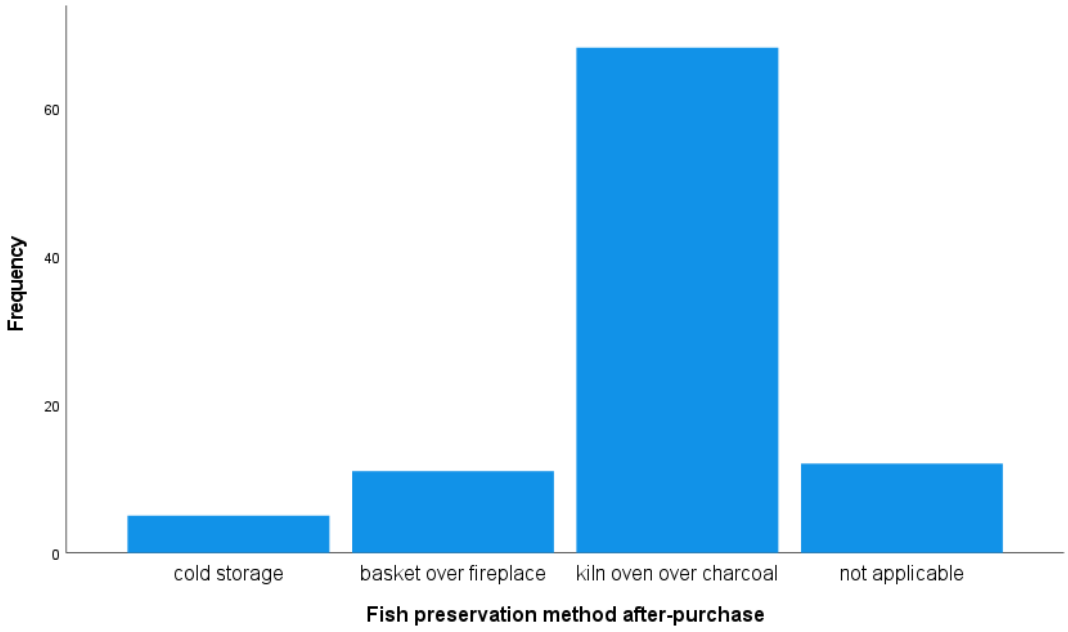


Figure 4.7 Fish preservation method used by the respondents

The majority of processed fish in Delta State, Nigeria is sourced domestically as indicated by 87.9% of the respondent (figure 4.8). Further details of domestically produced fish species are presented in figure 4.9. We found that most locally sourced fish are caught from capture fisheries while approximately 9% are farmed in Nigeria (aquaculture).

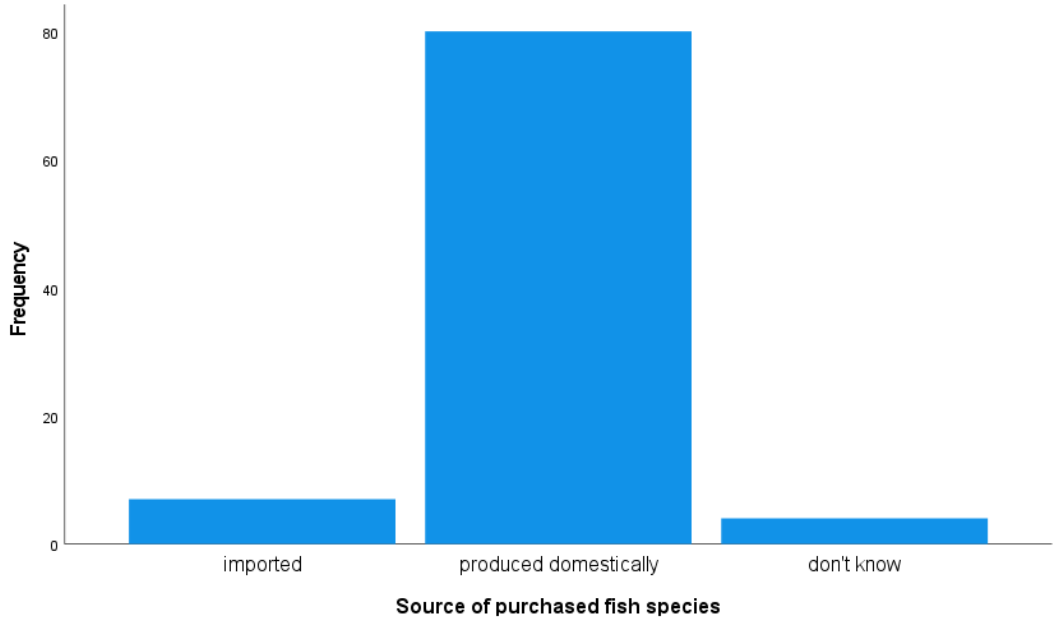


Figure 4.8 Sources of purchased fish species

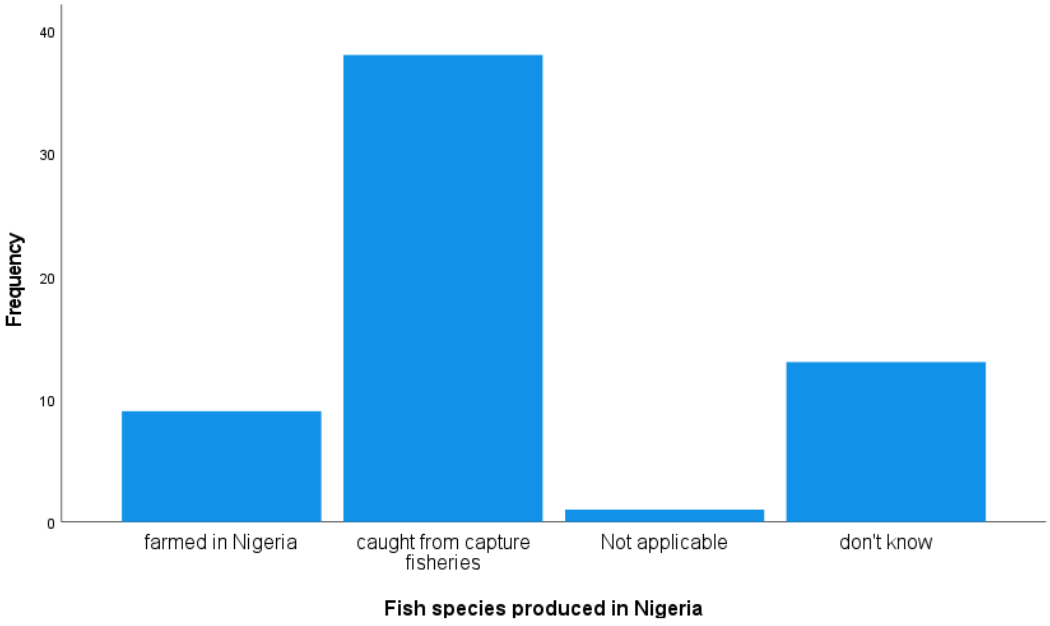


Figure 4.9 Source of Nigerian produced fish species

Table 4.6 Fish form sold and price per kg

Variable	
Processed fish form sold	**n = 55**
Fresh	3 (5.5%)
Dried	6 (10.9%)
Smoked	45 (81.8%)
Boiled	1 (1.8%)
Processing methods	**n = 99**
Cooking or boiling	1 (1.0%)
Smoking	97 (98.0%)
Sun-drying	1 (1.0%)
Price sold in naira per kg per week (USD)	**n = 93**
Less than 2000 (<4.854 USD)	26 (28.0%)
2001-3000 (4.856 - 7.281 USD)	22 (23.7%)
3001-4000 (7.283- 9.708 USD)	26 (28.0%)
4001-5000 (9.710- 12.134 USD)	14 (15.1%)
Above 5000 (>12.137 USD)	5 (5.4%)

Table 4.6 present the fish form sold and price in Naira (Nigeria currency) per kg. Smoked fish is predominant in Delta State, Nigeria. (Missing data were exempted from the analysis)

Figure 4.10 shows the various energy sources used by the fish processors. Wood and charcoal represent 51.5% and 25.3% respectively and are the main energy sources used for fish processing.

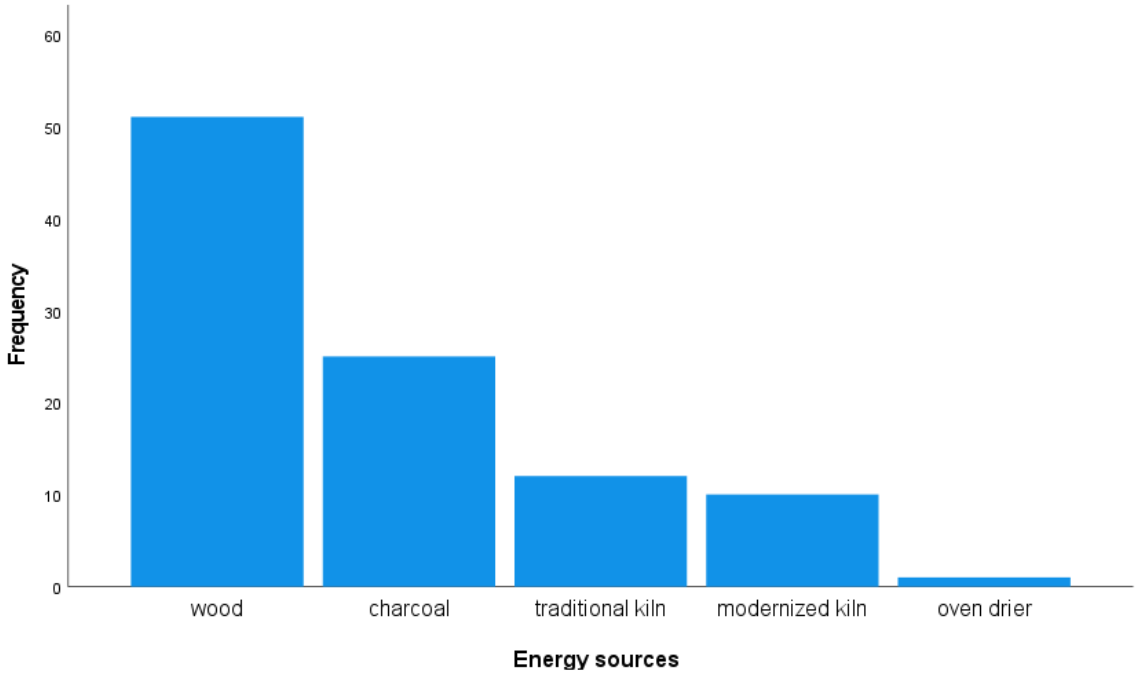


Figure 4.10 Energy source for fish processing

Fish availability and accessibility

Table 4.7 presents information on the accessibility of the fish processors to fish in the market. 77.6% indicate that they always have access to fish while 4.1% report occasional access to fish. Figure 10 shows various available and accessible fish species in the fish market by the fish processors in Delta state Nigeria. Catfish (64.3%) is the most available and accessible fish, followed by tilapia (24.5%). Other available species are Moonfish, African fish knife or Aba Aba and Nile perch, snapper, croakers, and Bonga.

Table 4.7 Accessibility to fish products

Access to fish	**n = 98**
Always	76 (77.6%)
Most of the time	7 (7.1%)
Sometimes	11 (11.2%)
Occasionally	4 (4.1%)

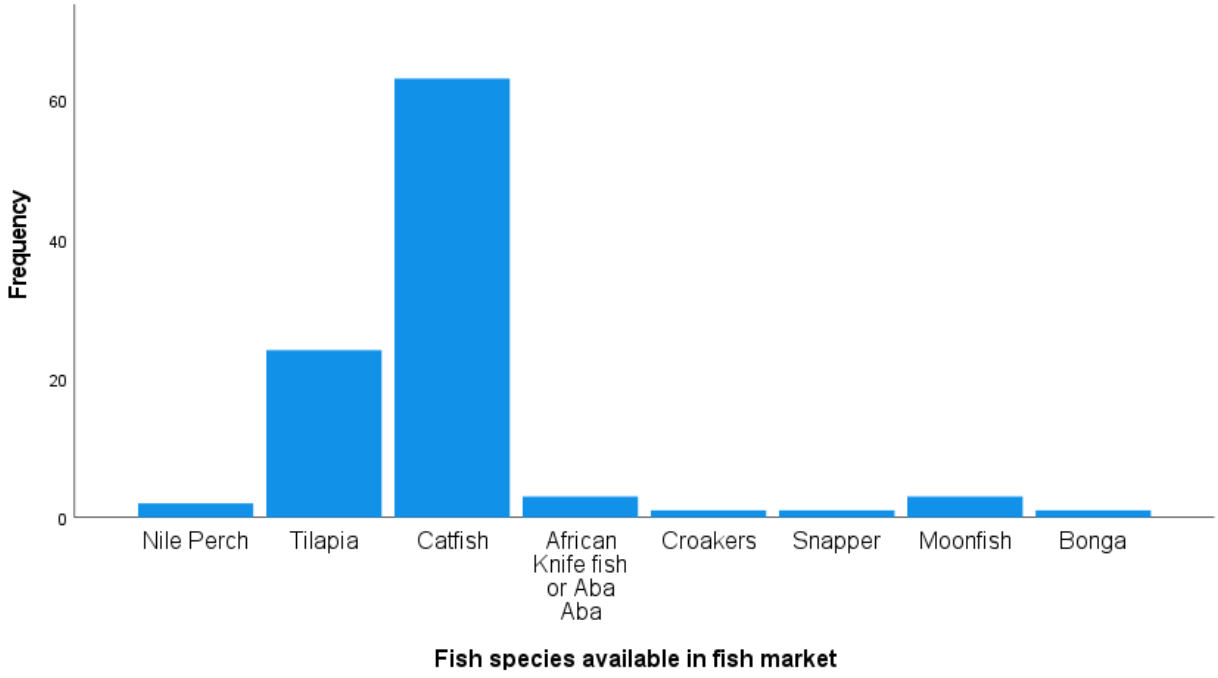


Figure 4.11 Available and accessible fish species in the fish market in Delta State

Consumers prefer both fresh and smoked fish products, therefore there are readily made available in the market by fish processors. Dried fish is the least demanded by the customers as shown in Figure 4.11.

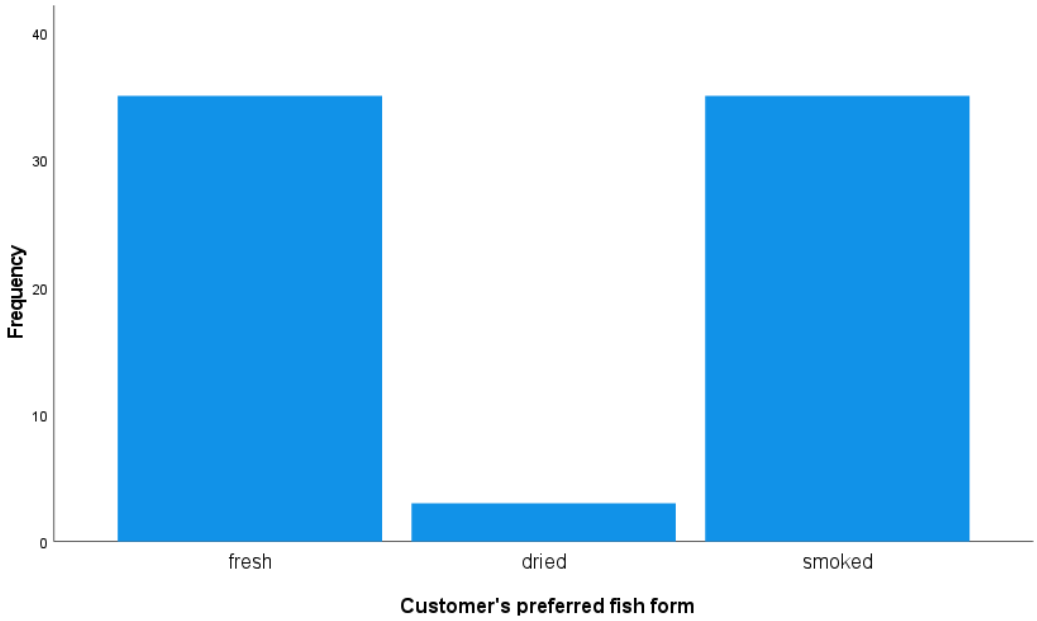


Figure 4.12 Customer's preferred fish forms.

Smoking is a cost-effective processing method for low-income fish processors. In table 4.6, majority; 84.3% of the participants indicated that they engaged in fish smoking because it involves the use of readily and locally available, inexpensive energy sources such as wood and charcoal. Nine percent of the respondents also consider fresh fish as an affordable product.

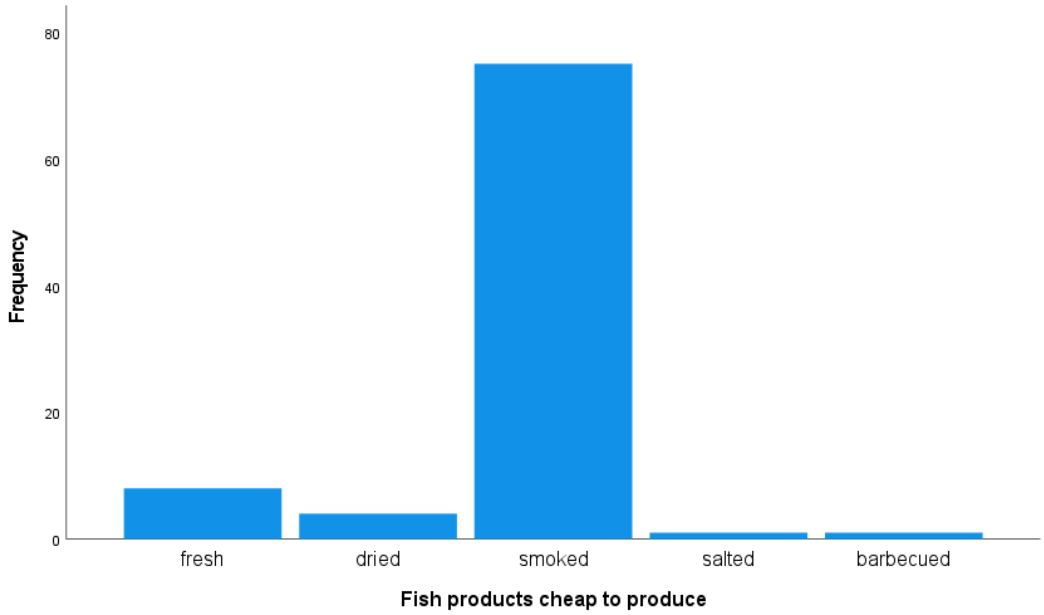


Figure 4.13 Participant's responses on the cost-efficacy of fish processing

Table 4.8 Processing methods interested in learning.

Fish products interested in learning	**n =31**
Fresh	2 (6.5%)
Solar drying	11 (35.5%)
Smoked	1 (3.2%)
Salted	2 (6.5%)
Canned	9(29.0%)
Paste or mashed	4 (12.9%)
Others	2(6.5%)

Fish processor's interest in learning new processing methods. (Missing data were exempted from the analysis.)

Fish handling, safety, and after-purchase storage

Table 4.9 Fish safety and after-purchase handling

Variables	
Time-lapse between purchase and sales	**n = 73**
Less than 1 hour	37 (50.7%)
1-12 hours	3 (4.1%)
13-24 hours	8 (11.0%)
25-36 hours	1 (1.4%)
37-48 hours	5 (6.8%)
49-60 hours	1 (1.4%)
61-72 hours	17 (23.3%)
I don't know	1 (1.4%)
How is fish transported to your business site?	**n = 99**
Ice container	28 (28.3%)
Refrigerated container or vehicle	7 (7.1%)
Other (bucket, cartoon)	64 (64.6%)
Do you wash your hand with clean water and soap before handling fish?	**n= 99**
Yes	10 (10.1%)
No	86 (86.9%)
Sometimes	3 (3.0%)
Do you use gloves when handling fish?	**n= 99**
Yes	91 (91.9%)
No	4 (4.0%)
Sometimes	4 (4.0)
Do you have access to clean water at your business site?	**n= 99**
Yes	14 (14.1%)
No	82 (82.8%)
Sometimes	3 (3.0%)
What kind of toilet facility is present at your business site?	**n = 98**
Flush toilet	9 (9.2%)
Pit latrine	8 (8.2%)
Bucket	77 (78.6%)
Others	4 (4.1%)
How would you rate the quality of fish you purchased for sale?	**n=88**
Very bad	81 (81.8%)
Bad	5 (5.1%)
Fair	1 (1.0%)
Good	1 (1.0%)
Reasons for fish spoilage	**n= 99**
Electrical outage	30 (30.3%)
Fish had deformities, wounds, cuts	46 (46.5%)
Poor fish handling	23 (23.2%)

Challenges encountered by fish processors in Delta State, Nigeria: 68.1% of the respondents identified pests as one of the major challenges they encountered in fish businesses, followed by a lack of financial support representing 18.8% of the respondents, lack of storage facilities, electricity among others were also identified (figure 4.14).

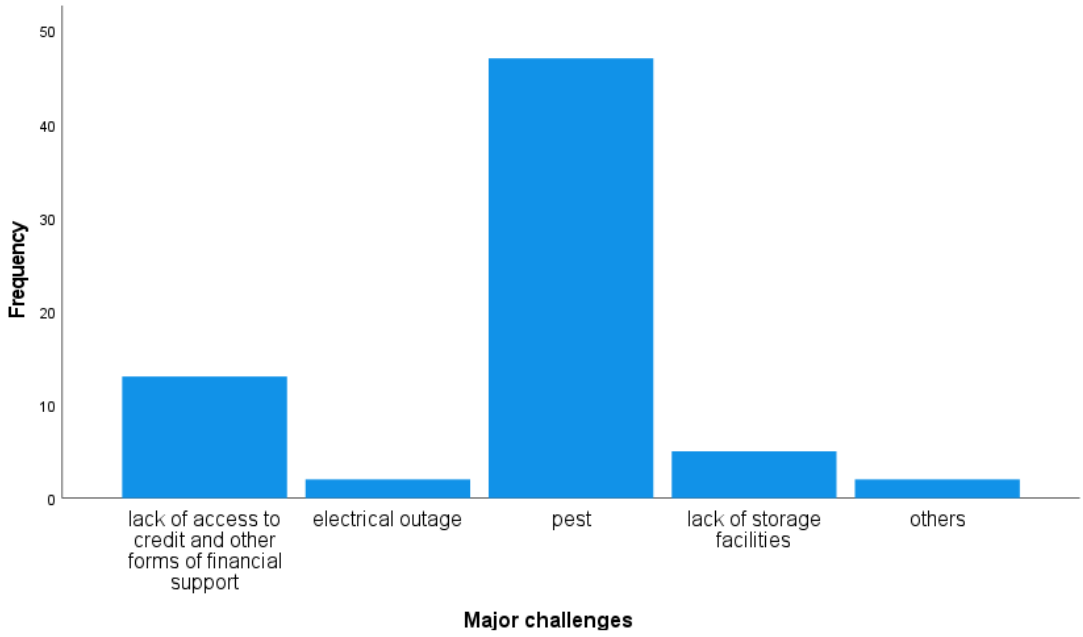


Figure 4.14 Major challenges of fish processors in Delta State, Nigeria

Participants reported their most common methods of disposing of spoiled fish and fish products:12.9% eat it to avoid waste, 9.7% use it as compost, 3.2% use the bad fish to feed other animals or toss it and 71% use other means including selling away at a lower price to poor customers or retailers (figure 4.15).

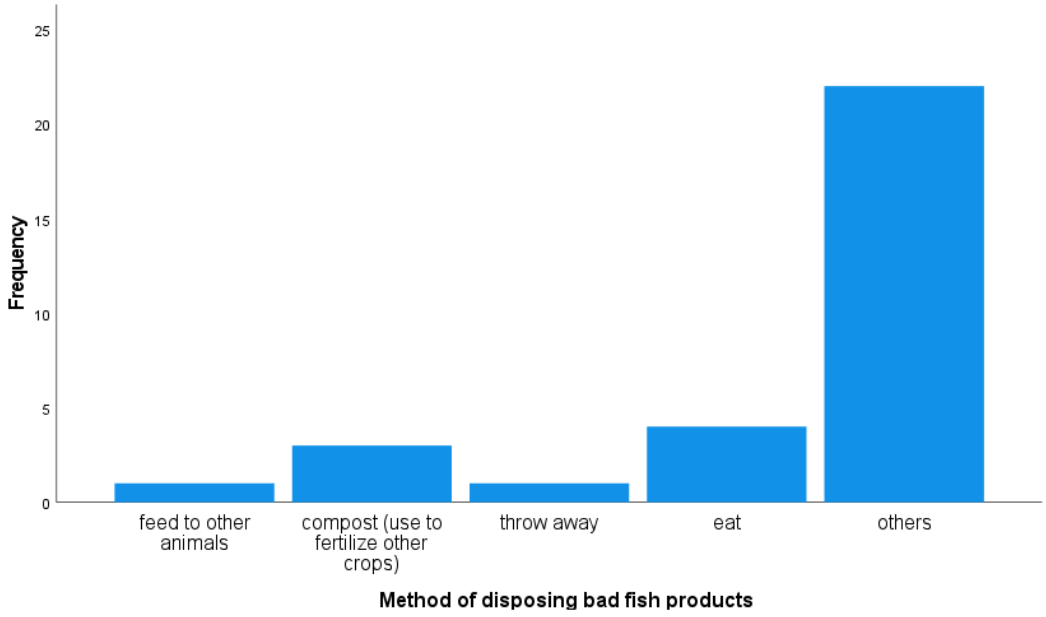


Figure 4.15 Disposal of spoiled fish and fish products

Discussion

Demographic and socio-economic factors have been an indicator to determine the socioeconomic status and standard of living of a particular group of people within a population. In this study, we found that most women and youth fish processors had some or at least completed secondary education or higher. A higher percentage also own a television and have access to social media through their smartphones. They also have access to a wholesome water source, such as a borehole, tap, and sanitary toilet system at the household level. The majority (84.3%) use an alternative clean energy source; gas for cooking which is relatively cheaper than electricity and produces fewer amounts of harmful emissions than other fossil fuels like wood and charcoal (Table 4.1). On the contrary, the sanitary and infrastructural conditions of their business sites are paradoxical to the household status. A higher percentage of the fish business site lacks cold storage

systems, clean running water, and sanitary toilet facility. Further study may be required to investigate the behavioral discrepancy.

The majority 78.6% use bucket latrine at their business site which is a significant risk factor for foodborne or fecal-oral diseases such as Hepatitis A, diarrhea, typhoid, dysentery, etc. Fish processors having direct contact with human waste is of great concern to public health, fish safety, and after-purchase handling also show that handwashing practices at the workplace are poor (Table 4. 9). Approximately 87% said that they do not wash their hands with soap and clean water before handling fish. However, 92% claim to use gloves when handling fish. Though, the hygienic situation and removal or disposal of the gloves were not examined in this study. Research has proven that contaminated gloves are potential hazards and risk sources of food contamination when the food handler is not safety conscious or when not properly disposed of (Snyder, 2001).

We found in this study that the incidence of food-borne disease is very high among fish processors. Approximately 10% of the respondents reported that a child or member of their family has had diarrhea, typhoid, or cholera in the last 30 days. Although the finding aligns with the estimation of the World Health Organization (WHO) reports of high food-borne diseases in LMICs (Havelaar et al., 2015; WHO, 2015). Several studies established the relationship between, hygiene, hand washing, kitchen hygiene, lack of potable water, and lack of sanitary facilities and infrastructure to the high prevalence of FBD, especially in low-income countries (Oloo, 2015; Losasso et al., 2012; Cailliau, 2013). A research study also identifies clinical symptoms of FBDs such as diarrhea, vomiting, stooling, and dehydration with wasting and FBD-related malnutrition (Chen, 1983). The WHO reported an estimate of 40 percent of children under the age of 5 years suffers from foodborne diseases (WHO, 2015). In Nigeria, the national figures show that 10-20% of children under five years old suffer from acute malnutrition, and 29 percent were underweight;

with evidence of chronic or acute malnutrition (National Population Commission of Nigeria, 2014). Several other studies show the relationship between food-borne diseases and malnutrition (Baker & Davis, 1998; Chen, 1983; Das & Gulshan, 2017; Fagundes-Neto & Scaletsky, 2000; Maggioni & Lifshitz, 2020). Hence, there is a need for food safety campaign and emphasis on hygiene practices in fish processing.

Aside from electricity outages and other identified challenges by the participants. Pest infestation has been identified as a major threat by 68.1% of the participants, which may reduce the quality and safety of fish products. Smoked, fried, or dried fish is characterized by a unique flavor and smell that may attract pests like rodents which may eat and contaminate the fish products with their urine and droppings, thereby rendering the fish unfit for human consumption. This challenge remains a serious concern to the fish processors because of the financial implication of the loss invoked by pest activities. Fish processors apply pesticides as an inexpensive control measure in different forms which have the potential of contaminating the fish products. A recent study found organochlorine pesticides in smoked fish (Nuntah et al., 2020). Several studies show that fish may contain a high level of pesticides of organochloride compounds (Eqani et al., 2013; Wang et al., 2012; Yang et al., 2006). We proposed that the unhygienic condition of the fish processing areas may encourage pest infestation. This proposition may be affirmed by the established association between pests and unhygienic environments (Bonner et al., 2007; de Masi et al., 2009; Lambropoulos et al., 1999; Masi et al., 2010). Therefore, a sustainable pest management program may be required to circumvent fish loss and contamination. Environmental sanitation, kitchen hygiene, and sanitary disposal of waste are recommended as preventive measures to reduce the loss and risk of fish contamination that may be imposed by the pest.

In this study, we found that about one-fifth of the participants started the fish processing business in the past 3 years. Recently, there has been an increase in unemployment due to the covid-19 impact at both the national and global levels. Many low- and middle-income countries have experienced economic meltdowns and crises that cause many to slide into poverty. The findings of this study show that the fish processors have low-income, thus the majority engage in other sources of income such as crop production, poultry keeping, trading, etc. (Table 4.3). The minimum income in the low season per week was 5000 naira (12.13 USD) and above 50,000 Naira (121.35 USD) at maximum. Peak season income was between the range of 20,000 (48.54 USD) and above 100,000 naira (242.69 USD). The situation may likely persist with the covid-19 pandemic trend. Hence, we predict that the fish processing business may be overtaken by the low-income unemployed literate women and youth, as a result, shifting the low-income low literate group into extreme poverty.

We found that the fish processors are highly interested in trying new fish products to improve their income. Friends, family, and social media associates are profound participants' strategies to introduce new products to their customers.

This study also revealed the quality of the fish or fish products in the market, though the processors reported that are always available most of the time and they could readily access fish in the market. However, the majority (86.9%) of the respondents rated the quality of available fish for purchase in the market as bad. Fish deformities such as wounds, cuts, and bruises were the leading cause of spoilage identified by almost half of the respondents. The electrical outage was the second identified reason for fish spoilage followed by poor fish handling. Participants fish processors in this study preferred to purchase cheaper and not necessarily high-quality fish and use an affordable energy source for processing the fish (figure 4.10). Therefore, smoking remains a

predominant method of fish processing among the low-income women fish processors in Delta State Nigeria. We also found out that eating is one of the practices of disposing of stale fish products. Approximately 13% of the participants claimed to eat their spoiled fish if not sold. This was associated with a supposed common practice in *Urogbo*, a section of Delta State, Nigeria on their use of rotten fish to prepare what is called the *owo* soup, a traditional delicacy in the area that was alluded to add a specific flavor to the soup. Health education on nutrition literacy and security is strongly recommended to improve the knowledge of healthy and nutritious eating.

Most fish available in the market were domestically produced in Nigeria (figure 4.8). A larger proportion was either caught from capture fisheries or farm-raised (aquaculture) (figure 4.9). Nile perch, tilapia, catfish, African knife fish, moonfish, croakers, snappers, and Bonga were the available fish species accessible by the fish processors (table 4.7 and figure 4.11). Consumers prefer either fresh or smoked catfish to other forms of processed fish. However, catfish are the most purchased fish. The majority (84.3%) of the respondents engaged in fish smoking because of its cost production efficiency (figure 4.13).

Fish preservation and after-purchase practice or fish handling among the fish processors is another area of food safety concern. The time-lapse between purchase and sales is concerning. 34.3% responded that they purchased fish more than 24 hours before the sale. Approximately 15% indicated a time-lapse between 1-24 hours before they could sell their fish products. Only 35.4% of the fish processors transported fish to their business site either by an ice or refrigerated container. While the majority use other containers such as buckets, cartons, or planks. Although participants opined that catfish could not be preserved by freezing, therefore they leave their unprocessed fish in a bucket containing cold water and cover it with a clean cloth.

The fish safety and after-purchase handling situation seem to negate the food regulation standards that stated that fresh fish preserved between -1^0 C and 2^0 C will better maintain quality and may double the shelf life. Part of the recommendation stated that fish caught should be gutted, cleaned, and stored at the proper temperature below 4^0 C until they are ready to be processed (Dey et al., 2005; WHO, 2015). We identify the poor fish safety practice, lack of adequate preservation, and poor after-purchase handling as some of the major factors that deteriorate the quality of fish products and escalate post-farm fish waste and loss. We, therefore, suggest that investigation of innovative fish preservation techniques is prioritized to provide a sustainable solution to after-purchase and post-harvest fish handling.

Limitation of the study.

This project was designed to take place in Delta State, Nigeria within two years, but the covid-19 pandemic and the global lockdown affected the study duration. Therefore, the data were collected in August 2021. The data were analyzed, and the report was written in 2022 during the omicron variant prevalence of the pandemic. The findings in this study may be influenced by the gradually changing environment due to C-19. We are optimistic that the findings provide a relevant C-19 era situation of fish processing, business, and after-purchase handling and provide an insight into considering how the fish processing and supply will change in response to C-19.

Conclusion

Fish is a highly demanded and consumed animal source food (ASF) in Nigeria. Smoked catfish is the most preferred common form of processed fish product in Delta State, Nigeria. Fish are produced domestically in Nigeria through catch from fisheries and aquaculture.

Firewood and charcoal remain the common and affordable energy sources for fish processing while the emissions such as polycyclic aromatic hydrocarbons (PAH) and dioxin are identified as persistent threats to the quality and safety of processed fish products.

The absence of sanitary, and infrastructural facilities such as sanitary toilets, wholesome water supply, electricity, cold storage system, and sanitary waste disposal at the fish processing sites may continue to forfeit efforts towards improving the nutrition and safety of processed fish products. There is a need for promoting the adoption of safety and quality improvement practices along the value chain. In addition, Integrated pest management (IPM) is highly recommended to curb the menace of pests and its consequential impact on the quality of processed fish and the producer's income. Fish quality and safety should be promoted through a behavior change campaign through media and social media platforms.

Increasing fish production in Nigeria and business workshops to diversify fish products can provide more income opportunities and strengthen the value chain to produce more fish and fish products. We believe that the findings can help policymakers prioritize investments and interventions to ensure the safety of these important food products as well as the health of the consumers.

CHAPTER V

DEVELOPING AND VALIDATING NUTRITION AND FOOD SAFETY EDUCATIONAL MATERIAL FOR FISH PROCESSORS IN NIGERIA

Abstract

Fish can be an affordable and accessible animal-source food in many low-income countries. Traditional fish processing methods however have a risk of exposing fish to different contaminants that may reduce the nutritional potential of fish to mitigate malnutrition. Lack of literacy may increase women's vulnerability to malnutrition and foodborne diseases. This study presents the development and evidence for the validity of low-literacy nutrition and food safety flipbook for women fish processors. The material was validated with a high content validity index of 0.983, at $p = 0.05$. The study shows that developing and validating instructional material requires understanding the population, high-quality and relevant graphics, and the involvement of relevant experts. The material developed may be suitable for training fish processors in Nigeria and other low-income countries.

Keywords: content validity; content validity index; nutrition; food safety; fish processing; literacy; low income

Introduction

Developing a suitable, comprehensible, culturally appropriate, and relevant training material is critical for improving nutrition and food safety knowledge, food handling behavior, and quality fish production. In addition, content validity is a crucial factor in instrument development (Grant & Davis, 1997). Validating newly developed education materials is paramount for reliability, appropriateness, and efficiency.

Nutrition and food safety as an innovative intervention to improve the nutritional status, quality, and safety of fish products. Nutrition and food safety literacy (NFSL) is an integral component of food security and is of global importance that is not fully appreciated by many public health authorities despite a constant increase in the prevalence of foodborne illnesses (Kaferstein & Abdussalam, 1999). Awareness of nutrition and food safety is a principal concern for disease prevention and lifestyles (Losasso et al., 2012).

Nutrition literacy is the degree to which individuals can obtain, process, and understand nutrition information and skills needed to make appropriate nutrition decisions (Silk et al., 2008; Gibbs & Chapman-Novakofski, 2012). It is a strategy for improving the quality of nutrition and diet (Velardo, 2017) and intervention for improving food security (West et al., 2020). Food security is when people at all times have physical, social, and economic access to sufficient, safe, and nutritious food to meet dietary needs and food preferences for active and healthy life (Food and Agricultural Organization of the United Nations, 1996)

A recent study shows that food safety instruction creates a positive shift in the knowledge paradigm, stimulates a behavioral change towards safe food handling, and minimizes the risk of foodborne illnesses among pregnant women (Kendall et al., 2017). Health education and promotional tools are effective interventions for modifying health behavior (Cushing et al., 2014).

Printed educational materials such as modules and flipbooks enhance learning, facilitate the delivery of key messages in an entrancing mode, serve as reminders and reinforcement for oral communication (Birhanu et al., 2011), and improve knowledge, satisfaction, and adherence to health instruction (de Oliveira et al., 2014).

The educational level or literacy status of the audience or target population is important in providing nutrition and food safety instruction. Although literacy skills can facilitate nutrition and food safety literacy but not synonymous with nutrition or food safety literacy. Despite the high educational attainment reported in Nigeria by the National Population Commission, 45 percent of women and 62 percent of men have a secondary or higher level of education (National Population Commission of Nigeria, 2014). Foodborne diseases are prevalent, wasting and nutrition insecurity as a result of poor food processing and handling (Grace, 2015). Therefore, there is a justification for nutrition and food safety literacy.

The United States Agency for International Development (USAID), the Fish Innovation Lab for Fish (FIL) has been working towards achieving the Sustainable Development Goals (SDGs) targets 1, 2, and 4 through innovation central to advancing novel solutions that support the goals to reduce global hunger, poverty, undernutrition and food-borne disease-related malnutrition in African countries including Nigeria. This study aimed to develop and validate low literacy material on nutrition and safe fish handling and processing to meet the pressing needs and knowledge gaps evident with increasing nutrition insecurity, poor quality processed fish products, and food safety issues in Nigeria.

To the author's knowledge, no validated nutrition and food safety literacy material is available for training fish processors to improve the quality and safety of processed fish in Nigeria. The most widely reported measure of content validity index was done in nursing and

health research which has been used for many years. However, researchers who use the content validity index (CVI) to evaluate the content validity of their scales irrespective of their discipline frequently cite methodologic work in the nursing literature on health literacy (Polit & Beck, 2006).

The newly developed and validated nutrition and food safety flipbook will be used in interactive training, train the trainer model of women and youth fish processors of reproductive age 19-49 years to achieve the USAID Feed the Future Innovation Lab for Fish, Nourishing Nations project to improve the quality and safety of processed fish products. This study explores building nutrition and food safety knowledge among fish processors in Nigeria to improve the nutritional status, quality, and safety of fish products through a validated and suitable training material.

Method

Study Design

This is a methodologic descriptive study. The study was determined as exempted by the Institutional Research Board (IRB) of the Mississippi State University, MSU, Starkville, Mississippi, USA

Content development

Curriculum development

The first step in developing the low literacy educational material is the development of the curriculum (Scheme 5.1). The themes of the curriculum were decided upon by the research team to meet the objectives of the project. The designed curriculum includes collaborative or complementary topics on nutrition and food safety to form the content focusing on improving nutrition knowledge, safe fish handling, and processing among fish processors. Table 5.1 presents

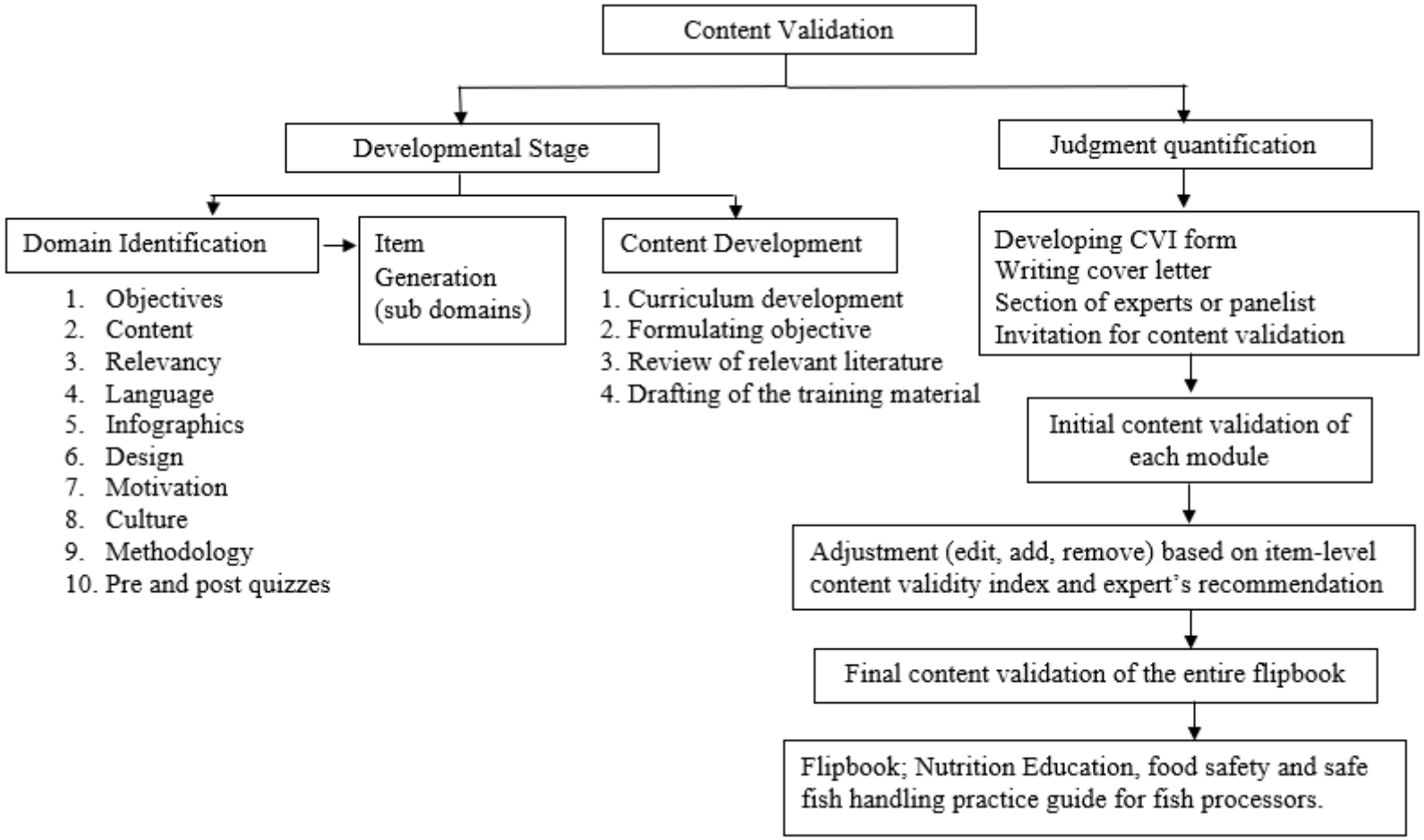
the content of the nutrition and food safety flipbook which contains the seven modules: (1) Healthy eating (2) animal-source protein- fish nutrition (3) food safety (4) fish processing techniques (5) food poisoning and contamination- fish contamination (6) hygiene rules and good practices (7) economic and nutrition benefits of fish consumption.

Formulating specific objectives

Specific objectives were formulated for each topic as shown in table 5.1, as an approach to maximizing the minimum achievement among the set goal; "improving knowledge of women fish processors on nutrition, and food safety."

Review of relevant literature

Selecting relevant scientific information for content development involved an extensive literature review of books, periodicals, and publications, on nutrition, food safety, safe fish processing, hygiene, and sanitation. The low literacy training material was developed and prepared in the English language, written at the 8th-grade reading level, containing few words with adequate information and appropriate illustrations, pictures, and high-quality and culturally appropriate infographics (Ip, 2010). In developing the material, jargon was avoided based on recommendations from the literature to facilitate readability and comprehensibility, with minimal use of technical terms (Plimpton & Root, 1994). The draft of the material was created using Microsoft Word and PowerPoint. A high-resolution camera and smartphones in capturing the graphics were also used. The seven-module flipbook was developed with a minimum of ten slides on each module and titled: "*Nutrition education, food safety, and safe fish handling practice guide for fish processors in Nigeria",* to train women and youth fish processors on nutrition and safety



Scheme 5.1 Flowchart for the content validation process.

Table 5.1 Nutrition and Food Safety Curriculum and Content

Modules/ Topics	Lesson outline (Content)	Objectives	Key learning area
Module 1 **Nutrition education** ***Healthy eating habits***	1. What is healthy eating? 2. Healthy diet; white, brown, and rainbow foods 3. Benefits of eating healthy 4. Benefits of breastfeeding for infants Choose MyPlate for Nigeria: Fruits, Vegetables, Proteins, Grains, Dairy, Roots, and Tubers. 5. Dietary Diversity-how to make a healthy meal 6. Summary and evaluation Pre and post quizzes	i) Understand the importance of eating healthy ii) Identify better food choices and combinations	Key learning areas: Healthy eating, eating a variety of food sources to prevent malnutrition.
Module 2 **Animal source protein.** ***Fish nutrition***	1. Identify animal-source protein (ASP)-Aquatic or seafood 2. Nutritional value of Fish 3. Health benefits of fish consumption to: ● Infants and children ● Pregnant and breastfeeding women 4. Adults 5. Dietary recommendations for eating fish 6. Summary and evaluation Pre and Post quizzes	i) Understand the benefits of eating fish ii)Mention a variety of foods that are good for growth and healthy living.	Key learning area: The potential of fish nutritional composition and consumption in reducing the prevalence of micronutrient deficiencies among children and women of reproductive age (WRA).

Table 5.1 (continued)

Modules/ Topics	Lesson outline (Content)	Objectives	Key learning area
Module 3 **Food safety:** ***Fish safety and handling***	1. Define food safety 2. Keys to food safety 3. Foodborne illnesses 4. Safe fish handling and practices 5. Unsafe conditions that spoil fish 6. Foodborne illnesses 7. Safe practices: handwashing, personal hygiene, personal protective wears 8. Summary and evaluation Pre and Post quizzes	i) Understand the concept of food safety. ii) Understand the consequence of unsafe food handling	Key learning area: why is food safety important? Introduce food safety but focus on safe fish handling.
Module 4 **Fish processing** ***Fish processing techniques***	1. Fish processing methods ● Traditional methods; salting, solar drying, smoking ● Modern methods; oven baking, canning, cold storage 2. Local and new processed fish products 3. Fish processing: preparation and procedure 4. Summary and evaluation Pre and post quizzes	i) Learn a better and safer method of fish processing ii) Recognize the advantage of new methods in improving the quality of fish products	Key learning area: Safe and quality fish processing technique. Introduce food processing and focus on improved (safe) fish processing techniques and outcomes on quality, safety, and nutrition.

Table 5.1 (continued)

Modules/ Topics	Lesson outline (Content)	Objectives	Key learning area
Module 5 **Food poisoning** ***Fish poisoning and contamination***	1. Define food poisoning 2. Identify fish contaminants 3. Classification of contaminants; biological, chemical, and physical. 4. Sources of fish contamination ● **10 Fs concept**: flies, fingers, fork, fomites, fluid, foe (pests), fumes, field, feces, and Fahrenheit (temp). 5. Safety guidelines for pesticide use 6. Health implications of fish poisoning & contamination 7. Preventive measures 8. Summary and evaluation Pre and Post quizzes	i) Identity fish contaminants & health risks. ii) Know the preventive measures.	Key learning area: Preventive measures Introduce food poisoning and focus on how to prevent or avoid food poisoning and contamination

Table 5.1 (continued)

Modules/ Topics	Lesson outline (Content)	Objectives	Key learning area
Module 6 **Hygiene rules and good practices** ***Hygiene rules for fish handlers***	1. Hygiene rules 2. Sanitary requirements for fish processing premises 3. Personal hygiene, sanitation & disinfection 4. Good practices: Good hygienic practices, good aquacultural practices, good harvest practices, good transport practices, good processing practices, good handling and packaging practices, good storage practices, etc.) 5. Summary and evaluation Pre and post quizzes	i) Know the importance of hygiene and sanitation ii) Apply good practices in fish processing	Key learning area: Good practices; emphasis on personal and improved food hygiene practices of fish processors. Introduce food safety rules and focus on safe fish handling, food hygiene regulations, and practices.
Module 7 **Economic benefits of quality and safe fish products.**	1. Fish quality 2. Fish loss and waste in the value chain 3. Poverty reduction 4. Economic empowerment 5. Improved nutrition and dietary diversity. 6. Improved health and wellbeing 7. Summary and evaluation Pre and post quizzes	i). Understand the economic benefits of quality and safe fish products to an individual and family.	Key learning area: Economic empowerment through quality fish production. Introduce Economic benefits of quality, nutritious and safe fish products.

Selection of experts

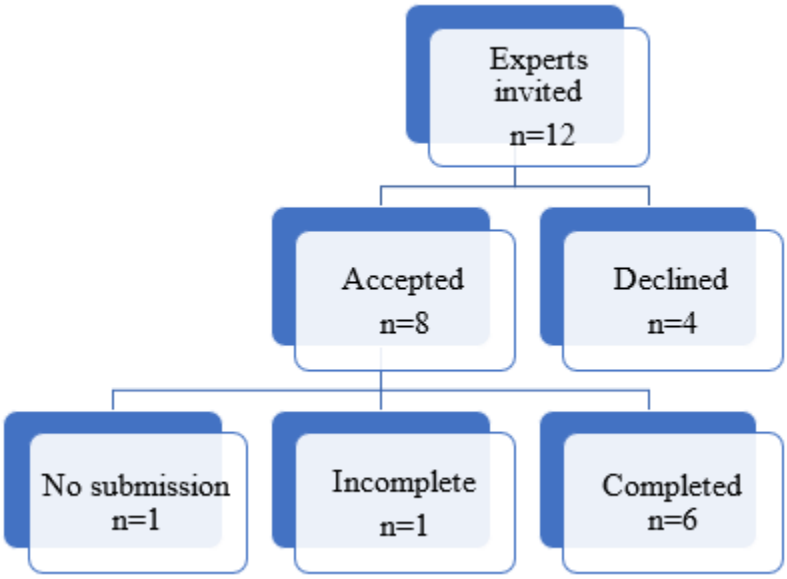
A content evaluation panel is a group of experts that validate each item of the material at the initial stage individually and entirely at the final stage **(**Garcia et al., 2010**).** We selected a group of experts that included nutritionists or dietitians, experts in low literacy education, fisheries and fish value chain experts, and food safety experts. Grant et al. (1990) proposed that selection of members from different geographical locations can raise the chance of recognizing colloquial terms inappropriate for an instrument. Twelve experts were therefore selected representing Nigerian and USA nationalities using well-defined criteria such as areas of expertise, experience, and qualifications as proposed by Grant and Davis (1997). A cover letter was used to solicit the panel's participation. Four of the invited panelists declined based on either conflict of time or interest. Eight accepted but six completed the assignment as detailed in Scheme 5.2 at the initial stage of the content validation. Four among the six experts were invited for the final content validation based on their availability. The number of panelists in this study measured up with the expert's recommendation as detailed in Table 5.2. After panel members accepted the position, they were sent the drafted flipbook and the accompanying multiple choice quiz questions for each module of the material. Panel members were provided with a content validation index (CVI) assessment form, as described in Table 5.3, and were asked to indicate their agreement on a five-Likert scale with the relevancy of the 10 item domains of the newly developed material.

The content validation assessment was in ten domains which include 1) objective 2) content, 3) relevance, 4) language, 5) infographics, 6) design, 7) motivation 8) culture, 9) methodology, 10) pre-and post-quiz test (Tavares et al., 2018). In this study, the expected minimum content validity index (CVI) value is between 0.83 and 1.0.

Table 5.2 The number of panelists and acceptable cut-off CVI score

Number of panelists	Min. Acceptable CVI values	Source
3-5	1.00	Lawshe (1975), Lynn (1986), Polit et al., (2007)
6-8	≥ 0.83	Lynn (1986), Polit et al, (2007)
9	0.78	Lawshe (1975), Lynn (1986)

The number of panelists and the corresponding degree of agreement acceptable for the cut-off CVI score



Scheme 5.2 Flowchart of expert's involvement in the initial content validation.

(n= Number of experts.)

Content Validation

Content validation is a rigorous assessment consisting of a two-stage process; the developmental stage and the judgment quantification stage (scheme 5.1). The developmental stage

consists of domain identification, item generation, and content development (Grant & Davis, 1997; Lynn, 1986). The second stage, judgment quantification, requires a specific number of experts to evaluate the validity of instrument items individually and as a whole (Lynn, 1986; Grant & Davis, 1997; Garcia et al., 2010). This study utilized the content validity procedure as described by Yusoff (2019). Content validation for relevance and appropriateness was initiated after completing the first version of the nutrition and food safety flipbook. Content validity was to determine the degree of agreement between performance on the material under investigation and the ability to function in the job performance domain (Lawshe, 1975). Six panelists completed the assignment representing an acceptable number of panelists recommended for validating a newly developed material (Polit et al., 2007).

Content Validity Index

The content validity index (CVI) assessment form is a self-administered five Likert scale and was sent to the experts via email. Each panelist completed seven CVI assessment forms, containing the 10 domains for each of the seven modules of the flipbook. The experts outside the United States sent their CVI reports through email, while experts within the university submitted their validation reports in person. The panelists' judgments were analyzed by computing the item-level content validity index (I-CVIs) and the scale-level content validity index (S-CVIs) to determine the relevancy of the items in the domains. I-CVI was also compared with the Modified Kappa Index (*k**); this is an index of agreement among the panelist that the item is relevant. *k** is categorized as fair, good, or excellent (Polit et al., 2007).

CVI was used to determine the relevancy or degree of usefulness of each component of the training material. The content validity ratio (CVR) is used in determining the rejection or

retention of specific items. Using a content validity panel of six members, a minimum value of 0.83 is required for the CVR at p = 0.05 (table 5.2). The panelists judged the relevancy or essentiality of each item on a five-point Likert scale. The higher the percentage of the panelist's agreement on the evaluated item, the greater the degree of its content validity.

Using the Content Validity Ratio (CVR) formula equation 3.1 *(ne* is the number of panelists perceiving the item as essential or relevant, *N* is the total number of panelists, and the CVR is the direct linear transformation of the percentage of panelists indicating essential or relevance (Lawshe, 1975)).

Likert rating and corresponding relevance rate
Items rated 4 and 5 (agree and strongly agree) = 4 relevant and essential
Items rated 3 (Neutral) = 3 item requires minimal further review
Items rated 2 (Disagree) = 2 item requires further review
Items rated 1 (Strongly disagree) = 1 item is not relevant and must be removed.

We calculated the Item-level CVI (I-CVI), or the number of experts indicating a rating of either 4 or 5 (relevant) divided by the total number of experts, and the scale-level CVI (S-CVI), an average of the I-CVIs to determine the relevancy and retention of the evaluated item. We also compared the CVI to alternative indexes by translating the I-CVIs into values of the modified kappa statistic. (Polit et al., 2007).

I-CVI = 0.67 when 4 out of 5, or 4 out of 6 of the panelists rated an item as 4, I-CVI = 0.83 when 5 out of 6 rated an item as relevant, I-CVI = 0.75 when 3 out of 4 rated an item as relevant, and I-CVI = 1 when all the experts rated an item as 4 as detailed in table 5.1.

To compute *k** in table 5, the probability of chance agreement, *Pc* was first computed. The formula for a binomial random variable was used:

$$Pc = \left[\frac{N!}{\mathrm{A!}\ (N - \mathrm{A})!}\right].5^{\mathrm{N}} \qquad (5.1)$$

N= number of experts and A= Number agreeing on good relevance.

After that, Modified Kappa Index (*k**) was computed using the proportion of agreements on relevance (I-CVI) and the probability of chance agreement, applying the formula:

$$k* = \frac{(\mathrm{I} - \mathrm{CVI}) - Pc}{1 - Pc} \quad (5.2)$$

Analysis of results and statistics

The content validation data collected were inputted into Microsoft Office Excel (Microsoft Corporation) and analyzed using the content validity index (Polit et al., 2007)**.** Results were tabularized in an excel file and word document (Microsoft Corporation). CVI was computed as the number of judges giving a rating of 4 and 5 (agree and strongly agree) divided by the total number of judges.

Results

Development of nutrition and food safety flipbook

A seven-module nutrition and food safety flipbook draft were successfully developed from the curriculum and shown in table 1 and presented to the panelist for content validation.

Content Validity Index

Table 5.3 presents the results of the initial and final validation by 6 and 4 experts respectively. The I-CVI value of all domains evaluated at the initial stage is 0.83 except the domain 5; infographic in module 1 with a value of 0.81 and domain 8; culture in module 2 with a value of 0.77. The S-CVI for the initial validation is 0.90 and increased to 0.983 at the final validation after making necessary adjustments based on the panelist's recommendation as summarized in table

5.4. The expert's recommendation helped to improve the cultural appropriateness of the newly developed material from the I-CVI value of 0.77 to 0.92.

Item-level content validity index (I-CVI) and Modified Kappa Index translation

Table 5.3 presents the I-CVI evaluation table and the number of experts agreement using 6 and 4 experts. It also shows the computed probability of chance occurrence (*Pc*), based on the number of experts (*N*) and the number of agreeing on relevance (A) to determine the kappa designating agreement on relevance (k^*); and compared with the evaluation criteria for kappa (E_K).

The minimum I-CVI in the final validation using 4 experts panel is 0.75, k^* value .67, and E_k evaluation description 'good'. The maximum content validity value = 1, k^* value 1.00 and E_k evaluation description as excellent.

Table 5.3 The initial and final content validity

	Scores (n=6)																	
	MODULE 1						MODULE 2						MODULE 3					
Evaluated Items	SA	A	N	D	SD	ICVI	SA	A	N	D	SD	ICVI	SA	A	N	D	SD	ICVI
1. Objective																		
1.1 Consistency with knowledge need on the module	6					1	5		1			1	6					1
1.2 Promotion of positive behavior and attitude changes	5	1				1	5	1				1	6					1
1.3 Promotion of thought on the topic	5	1				1	5		1			0.83	6					1
1.4 Practicability for the training	4	2				1	4	1	1			0.83	4	2				1
Subtotal	20	4	0	0	0		19	2	3	0	0		22	2	0	0	0	
Concordance rate						1.00						0.92						1.00
2. Content																		
2.1 Appropriateness for target audience	3	2	1			0.83	5		1			0.83	3	2	1			0.83
2.2 Clear and objective text	5	1				1	5		1			0.83	3	3				1
2.3 Highlights on subject matters	3	3				1	4	2				1	3	3				1
2.4 Informative	5	1				1	5	1				1	4	2				1
2.5 Logical sequence	3	3				1	3	2				1	2	3	1			0.83
2.6 Achievement of objective	4	2				1	4	1		1		0.83	3	3				1
2.7 Scientific correction	3	1	1			0.67	4	1		1		0.83	2	3				0.83
2.8 The content covered presents relevant information	4	2				1	5			1		0.83	3	3				0.83
Subtotal	30	15	2	0	0		35	7	2	3	0		23	22	2	0	0	
Concordance rate						0.94						0.89						0.92
3. Relevancy																		
3.1 Key points portrayed	5	1				1	5		1			0.83	5	1				1
3.2 Potential of knowledge transfer	4	2				1	4	1	1			0.83	4	2				1
3.3 Scope	5	1				1	5		1			0.83	5	1				1
3.4 Suitability for training	4	2				1	4	1	1			0.83	4	1	1			0.83
3.5 Applicability	4	2				1	5	1				1	4	2				1
Subtotal	22	8	0	0	0		23	3	4	0	0		22	7	1	0	0	
Concordance rate						1.00						0.86						0.97
4. Language																		
4.1 Literacy adequacy to the target group	3	2				1	2	3	1			0.83	2	4				1
4.2 Clearness and intelligible	3	2				1	4	1	1			0.83	4	2				1
4.3 Spelling Correctly	5					0.83	4	2				1	4	1	1			0.83
4.4 Well organized or structured	5					0.83	5		1			0.83	4	2				1
4.5 Comprehensible	3	2				0.83	4	1	1			0.83	2	4				1
Subtotal	19	6	0	0	0		19	7	4	0	0		16	13	1	0	0	
Concordance rate						0.90						0.86						0.97
5. Infographics																		
5.1 Relevance to content	5	1				1	5		1			0.83	4	2				1
5.2 Expression of needed information	2	3	1			0.83	3	2	1			0.83	4	2				1
5.3 Motivates understanding of the content	3	2	1			0.83	3	2	1			0.83	4	2				1
5.4 Appropriateness of Characters' charisma	3	2	1			0.83	3	1	2			0.83	4	1	1			0.83
5.5 Sufficiency	4	1	1			0.83	4	1	1			0.83	4	2				1
5.6 Similitude with real life	1	3	1			0.67	4	1	1			0.83	4	2				1
5.7 Suitable designs for adults	4		1			0.67	4	1	1			0.83	4	2				1
Subtotal	22	12	6	0	0		26	8	8	0	0		28	13	1	0	0	
Concordance rate						0.81						0.83						0.98
6. Design																		
6.1 Attractiveness	5	1				1	5		1			0.83	3	2	1			0.83
6.2 Color contrast	4	1		1		0.83	3	2	1			0.83	3	2	1			0.83
6.3 Font size	3	2	1			0.83	3	2	1			0.83	3	2	1			0.83
6.4 Number of pages	5	1				1	5		1			0.83	3	3				1
6.5 Style	5		1			0.83	5		1			0.83	3	3				1
6.6 Text wrapping	5			1		0.83	2	3	1			0.83	3	2				0.83
Subtotal	27	5	2	2	0		23	7	6	0	0		18	14	3	0	0	
Concordance rate						1.00						0.83						0.89
7. Motivation																		
7.1 Attractiveness of the content	5	1				1	4	1	1			0.83	3	2	1			0.83
7.2 Enthusiasm for readers	4	1	1			0.83	4	1	1			0.83	3	2	1			0.83
7.3 Sustain reader's interest	4	1	1			0.83	4	1	1			0.83	3	2	1			0.83
Subtotal	13	3	2	0	0		12	3	3	0	0		9	6	3	0	0	
Concordance rate						0.89						0.83						0.83
8. Culture																		
8.1 Appropriateness for sociocultural level of the target audience	2	4				1	3	2	1			0.83	3	3				1
8.2 Culturally appropriate and acceptable	2	2	2			0.67	2	1	2			0.67	3	1	2			0.67
8.3 Reflection of the cultural needs of the target audience.	1	5				0.83	2	3	1			0.83	2	3	1			0.83
Subtotal	5	11	2	0	0		7	6	4	0	0		8	7	3	0	0	
Concordance rate						0.83						0.78						0.83
9. Methodology																		
9.1 Appropriateness of teaching method to the target group	3	3				1	2	3	1			0.83	3	3				1
9.2 Relevant teaching aids	3	2	1			0.83	4		2			0.67	4	1	1			0.83
9.3 Appropriateness of key message	4	2				1	4	2				1	4	2				1
9.3 Duration; sufficient time allocation	4	2		1		0.83	2	3	1			0.83	4	2				1
Subtotal	14	9	1	1	0		12	8	4	0	0		15	8	1	0	0	
Concordance rate						0.92						0.83						0.96
10. Pre and post quizzes																		
10.1 Clearness & comprehensibility	2	4				1	3	2	1			0.83	2	4				1
10.2 Measures knowledge	3	2	1			0.83	4	1	1			0.83	3	1	2			0.67
10.3 Suitability for the target group	2	4				1	2	3				0.83	2	3	1			0.83
10.4 Well structured	4	2				1	4	2				1	3	2	1			0.83
10.5 Relevance	5	1				1	4	2				1	3	3				1
Subtotal	16	13	1	0	0		17	10	2	0	0		13	13	4	0	0	
Concordance rate						0.97						0.90						0.87
SCVI						0.81						0.85						0.92

	MODULE 4						MODULE 5						MODULE 6						MODULE 7							Scores (n=4) 7 Modules Flipbook					
Evaluated Items	SA	A	N	D	SD	ICVI	SA	A	N	D	SD	ICVI	SA	A	N	D	SD	ICVI	SA	A	N	D	SD	ICVI		SA	A	N	D	SD	CVI
1. Objective																															
1.1 Consistency with knowledge need on the module	5	1				1	5	1				1	5	1				1	5	1				1		4					1
1.2 Promotion of positive behavior and attitude changes	5	1				1	4	2				1	5	1				1	5	1				1		4					1
1.3 Promotion of thought on the topic	5	1				1	4	2				1	5	1				1	5	1				1		3	1				1
1.4 Practicability for the training	4	2				1	4	2				1	4	2				1	4	2				1		4					1
Subtotal	19	5	0	0	0		17	7	0	0	0		19	5	0	0	0		19	5	0	0	0			15	1	0	0	0	
Concordance rate						1.00						1.00						1.00						1.00				1			
2. Content																															
2.1 Appropriateness for target audience	5	1				1	5	1				1	5	1				1	4	2				1		3	1				1
2.2 Clear and objective text	4	1	1			0.83	5	1				1	3	2	1			0.83	4	2				1		3	1				1
2.3 Highlights on subject matters	4	2				1	4	2				1	4	2				1	4	2				1		3		1			0.75
2.4 Informative	4	2				1	5	1				1	4	2				1	4	2				1		4					1
2.5 Logical sequence	2	4				1	3	3				1	3	3				1	3	3				1		4					1
2.6 Achievement of objective	3	3				1	3	3				1	3	3				1	2	4				1		3	1				1
2.7 Scientific correction	1	3	2			0.67	4	2				1	3	2				1	4	1	1			0.83		2	2				1
2.8 The content covered presents relevant information	5		1			0.83	3	2				1	5	1				1	4	1				1		4					1
Subtotal	28	16	4	0	0		32	15	0	0	0		30	16	1	0	0		29	17	1	0	0			26	5	1			
Concordance rate						0.92						1.00						0.98						0.98				0.97			
3. Relevancy																															
3.1 Key points portrayed	5	1				1	5	1				1	5	1				1	5	1				1		4					1
3.2 Potential of knowledge transfer	3	3				1	4	2				1	4	2				1	4	2				1		4					1
3.3 Scope	5	1				1	5	1				1	5	1				1	5	1				1		4					1
3.4 Suitability for training	4	2				1	4	2				1	4	2				1	4	2				1		4					1
3.5 Applicability	3	3				1	4	2				1	3	3				1	4	2				1		4					1
Subtotal	20	10	0	0	0		22	8	0	0	0		21	9	0	0	0		22	8	0	0	0			20	0	0	0	0	
Concordance rate						1.00						1.00						1.00						1.00				1			
4. Language																															
4.1 Literacy adequacy to the target group	3	3				1	2	4				1	2	4				1	3	1	2			0.67		3		1			0.75
4.2 Clearness and intelligible	3	3				1	4	2				1	3	2				1	4	2				1		4					1
4.3 Spelling Correctly	3	1	1			0.83	4	2				1	3	3				1	4	1	1			0.83		4					1
4.4 Well organized or structured	3	2				1	4	2				1	3	2				1	4	2				1		3	1				1
4.5 Comprehensible	3	2	1			0.83	3	3				1	3	3				1	3	2	1			0.83		4					1
Subtotal	15	11	2	0	0		17	13	0	0	0		14	14	0	0	0		18	8	4	0	0			18	1	1	0	0	
Concordance rate						0.93						1.00						1.00						0.87				0.95			
5. Infographics																															
5.1 Relevance to content	4	2				1	4	2				1	4	2				1	5	1				1		3	1				1
5.2 Expression of needed information	4	1				1	3	3				1	4	2				1	4	1				1		2	2				1
5.3 Motivates understanding of the content	5	1				1	3	3				1	4	2				1	4	2				1		3	1				1
5.4 Appropriateness of Characters' charisma	3	2				1	4		1			0.67	4	1				1	3	1	1			0.67		3	1				1
5.5 Sufficiency	4	2				1	5	1				1	5	1				1	5		1			0.83		3	1				1
5.6 Similitude with real life	4	2				1	2	3	1			0.83	4	1	1			0.83	3	3				1		4					1
5.7 Suitable designs for adults	6					1	4	2				1	5	1				1	4	2				1		3	1				1
Subtotal	30	10	0	0	0		25	14	2	0	0		30	10	1	0	0		28	10	2	0	0			21	7	0	0	0	
Concordance rate						1.00						0.93						0.98						0.93				1			
6. Design																															
6.1 Attractiveness	4	2				1	3	3				1	4	2				1	5	1				1		4					1
6.2 Color contrast	4	2				1	3	3				1	4	1	1			0.83	3	1	2			0.67		4					1
6.3 Font size	4	2				1	4	2	1			0.83	3	1	2			0.67	3	1	1			0.67		3	1				1
6.4 Number of pages	5	1				1	5	1				1	5	1				1	5	1				0.83		4					1
6.5 Style	5	1				1	5	1				1	5	1				1	5		1			0.83		2	2				1
6.6 Text wrapping	5	1				1	5	1				1	4	1				0.83	5	1				0.83		3	1				1
Subtotal	27	9	0	0	0		25	11	1	0	0		25	7	3	0	0		26	5	4	0	0			20	4	0	0	0	
Concordance rate						1.00						0.97						0.89						0.81				1			
7. Motivation																															
7.1 Attractiveness of the content	3	3				1	3	3				1	5	1				1	3	3				1		4					1
7.2 Enthusiasm for readers	3	3				1	4	2				1	5	1				1	4	2				1		3	1				1
7.3 Sustain reader's interest	3	2				1	4	2				1	5		1			0.83	4	1	1			0.83		3	1				1
Subtotal	9	8	0	0	0		11	7	0	0	0		15	2	1	0	0		11	6	1	0	0			10	2	0	0	0	
Concordance rate						1.00						1.00						0.94						0.94				1			
8. Culture																															
8.1 Appropriateness for sociocultural level of the target audience	3	3				1	2	4				1	4	2				1	3	2	1			0.83		3	1				1
8.2 Culturally appropriate and acceptable	3	3				1	2	3	1			0.83	4	1	1			0.83	3	2	1			0.83		2	1	1			0.75
8.3 Reflection of the cultural needs of the target audience.	2	4				1	1	5				1	3	3				1	2	3	1			0.83		3	1				1
Subtotal	8	10	0	0	0		5	12	1	0	0		11	6	1	0	0		8	7	3	0	0			8	3	1	0	0	
Concordance rate						1.00						0.94						0.94						0.83				0.92			
9. Methodology																															
9.1 Appropriateness of teaching method to the target group	2	4				1	3	3				1	3	3				1	2	4				1		4					1
9.2 Relevant teaching aids	3	3				1	3	3				1	4	1	1			0.83	3	3				1		3	1				1
9.3 Appropriateness of key message	2	4				1	4	2				1	3	3				1	3	3				1		4					1
9.3 Duration; sufficient time allocation	3	3				1	3	3				1	1	4				0.83	4	2				1		4					1
Subtotal	10	14	0	0	0		13	11	0	0	0		11	11	1	0	0		12	12	0	0	0			15	1	0	0	0	
Concordance rate						1.00						1.00						0.92						1.00				1			
10. Pre and post quizzes																															
10.1 Clearness & comprehensibility	2	4				1	2	3	1			0.83	2	4				1	3	3				1		3					1
10.2 Measures knowledge	3	2	1			1	3	2	1			0.83	3	2	1			0.83	4	1		1		0.83		2	1				1
10.3 Suitability for the target group	2	4				1	2	3	1			0.83	2	4				1	3	2	1			0.83		3					1
10.4 Well structured	3	3				1	3	2	1			0.83	3	3				1	4	1		1		0.83		2	1				1
10.5 Relevance	3	3				1	3	3				1	4	2				1	5	1				1		3					1
Subtotal	13	16	1	0	0		13	13	4	0	0		14	15	1	0	0		19	8	1	2	0			13	2	0	0	0	
Concordance rate						1.00						0.86						0.97						0.90				1			
SCVI						0.98						0.87						0.96						0.93	0.9	SCVI= 0.983					

CVI of each module of the developed educational material according to the panelist's judgment regarding the ten domains; Objective, Content, Relevancy, Language, Infographics, Designs, Motivation, Culture, Methodology, Pre and Post quizzes, and subdomains.

SA, strongly agree, A, agree, N, neutral/neither agree nor disagree, D, disagree, SD, strongly disagree, CVI content Validity Index, n= number of experts. I-CVI, Item-level content validity index, S-CVI, Scale-level content validity index; averaging method (I-CVI/Ave) = .90 (initial). Scale-level content validity index; averaging method (I-CVI/Ave) = .983 (final).

Table 5.4 Summary of the qualitative analysis of the Expert's recommendations.

	Recommendations of the Experts
Module 1	Increase the text font size and sizes of the pictures. Use appropriate colors Replace dairy with milk, and use meals or plates instead of diet Replace milk in the suggested MyPlate for Nigeria with another source like soy products, or available substitutes
Module 2	Include a picture of a well-nourished mother with a healthy child Use a clear image to show the benefits of the fish Use appropriate child images and words, change child to infants or baby Move the "Benefits of breastfeeding to infants and mothers to Module 1,
Module 3	Use more visible, culturally appropriate, and relatable pictures Quiz #2 What are safe practices? Change TV series to Watching TV Quiz #3 Option A is too long, keep the answers or options brief and precise.
Module 4	Number the items on the slides rather than bullets. It makes it easier for reference. On slide 5, remove the statement "excess salt intake may increase the risk of high blood pressure because it is not relevant to the module. Reorder slides on fish processing and procedures (15-17) Quiz #2 keep options brief and concise. Do not trick the participants
Module 5	Increase the eligibility on slide 1, increase the spacing and the font size Label the pictures on slides 4-7. This will enhance learning faster Create separate slides for the biological contaminants and biological carriers of diseases. Replace iodine with antiseptics. With open wounds on your hands, consider using forks and a spoon.
Module 6	Generally, font size should be increased. Separate sanitary requirements of fish processing premises from health requirements for fish processors Check the dilution formula and change the chlorine to water volume Quiz #1 Remove the word 'except' from the question, provide one correct option, and do not try to trick your audience with low literacy.
Module 7	Emphasize the economic benefit of a quality fish product Use a brighter color to enhance the readability of the content Slide 8 content is more relevant to food safety. Reconstruct Quiz 1 to health benefits of quality and safe fish products Change Quiz 2 to Economic benefits of quality and safe fish products include Quiz # 3 You can save money by reducing the fish waste generated a.) Yes b.) Maybe c.) I do not think so. The options are relative and subjective. Use options Yes, No, and I don't know instead.
Cover	Use culturally appropriate images to enhance acceptability and inclusiveness

Table 5.5 I-CVI evaluation table and number of experts in agreement

Number of experts	The number giving 4 or 5 rating	**I-CVI**	P_c	K^*	E_K
3	3	1.00	.125	1.00	Excellent
3	2	.67	.375	.47	Fair
4	4	1.00	.063	1.00	Excellent
4	3	.75	.25	.67	Good
5	5	1.00	.031	1.00	Excellent
5	4	.80	.156	.76	Excellent
6	6	1.00	.016	1.00	Excellent
6	5	.83	.094	.81	Excellent
6	4**	.67	.234	.57	fair

I-CVI, Item-level content validity index. P_c = [N! /A! (N - A) !] *.5^N, probability of chance occurrence, where N= number of experts and A= Number of agreeing on relevance. K*= (I-CVI -P_c) / (1- P_c). kappa designating agreement on relevance; E_K, evaluation criteria for kappa, described guideline by Cicchetti and Sparrow (1981). Fair = *K* of .40 -.59. Good =*K* of .60 -.74, Excellent = *K* of >.74, ** binomial variable. (Polit et al., 2007)

Discussion

Content development

Development and validation of a new training material is a multistage process that involves curriculum development, objective formulation, review of literature, use of sufficient, clear, and appropriate infographics, understandable and easy to read words preferably at or below 8-grade reading level (Plimpton & Root, 1994; Ip, 2010).

Initial content validation

The CVI for each item of the seven modules was evaluated individually by the six-panel experts at the initial stage, and the degree of agreement and relevancy of each item among the experts was computed with an average CVI of 0.9. Table 5.3 details the concordance rate of 10

domains for each module 1-7 met the minimum recommended CVI value of 0.83 for at least six experts (Polit and Beck 2006; Polit et al., 2007) except the item 5; infographic in module 1 and item 8; culture in module 2 that have a lower value based on the level of agreement among the panelists. Although, CVI of 0.78 or higher for a minimum of three experts could be considered evidence of good content validity (Polit et al., 2007).

Experts' recommendation and Final content validation

The experts' recommendations were instrumental in improving the overall content, language, and cultural appropriateness of the nutrition and food safety flipbook. The S-CVI value of the entire validated nutrition and food safety flipbook increased by 0.083 after adding, editing, and adjusting based on the expert's recommendations. The material was finally validated with CVI 0.983. This value is considered to have met the minimum CVI required to satisfy the 5% level of significance, at $p = 0.05$, and satisfy the expected minimum CVI value for this study (CVI ≥ 0.83) with the consideration to the number of panelists and the corresponding degree of agreement acceptable for the cut-off CVI score; table 5.2 (Lawshe, 1975; Polit & Beck, 2006; Polit et al., 2007).

The CVI value for the newly developed nutrition and food safety flipbook also satisfies Davis (1992) recommendation that a new content valid instrument should have a minimum S-CVI of .80. Also, Polit & Beck recommended that an overall scale could be judged as having excellent content validity if it would be composed of items with I-CVIs that meet Lynn's (1986) criteria (I-CVI = 1.00 with 3 to 5 experts and a minimum of I-CVI of .78 for 6 to 10 experts: and an S-CVI/Ave of .90 or higher.

I-CVIs evaluation and the Kappa modified index

Table 5.5 presents the I-CVI evaluation and the number of experts in agreement. It shows the overall evaluation description of the newly developed and validated flipbook as excellent (Polit

et al., 2007). Our result in this study is consistent with the result on the table 4; *'Evaluation of I-CVIs with different numbers of experts and agreement', page 465* of Polit et al., (2007); there is almost no need to compute the table except for the difference in the probability of chance (*Pc)* of occurrence for the 5-experts panel, with all giving 4 or 5 ratings. In this study, *Pc* = 0.031 (table 5.5) compared with 0.041 (Polit et al., (2007). Although both values are still within the kappa range for excellence. The I-CVI comparison with the modified kappa index and the evaluation criteria described guideline by Cicchetti and Sparrow (1981) shows that the content validity using 6 and 4 experts was Good when *K is between* .60 -.74, and Excellent when *K* is >.74.

Strength and limitations of the study

The strength of the study includes the dynamism of the right mix of disciplines of the panelist, whose areas of expertise and recommendation were found essential in the development of the material. Also, the right mix of cultural backgrounds reduces cultural biases and improves the cultural appropriateness of the newly developed nutrition and food safety flipbook to the target population. The number of panelists at the initial and final validation is within the recommended value to achieve the minimum acceptable CVI values for a newly developed material. A limitation in the development of the flipbook is the westernized graphics and pictures where culturally familiar photo illustrations were not available.

Finally, the newly developed and validated flipbook will be available to the public in a printable and downloadable form for improving the knowledge of nutrition, safe fish handling, and processing.

Conclusion

Creating education material involves writing key points and easy-to-read words, high-quality graphic aids, and contributions of experts or relevant professionals. Content validity of the

newly developed low literacy seven-module flipbook on nutrition and safe fish handling and processing for fish processors was successfully validated and considered suitable and culturally appropriate for the target population. The flipbook has the potential to contribute to improving nutritional status and food handling practices among women fish processors in Nigeria.

CHAPTER VI

EVALUATING THE NEWLY DEVELOPED AND VALIDATED LOW LITERACY EDUCATIONAL MATERIAL IN IMPROVING KNOWLEDGE OF WOMEN FISH PROCESSORS ON NUTRITION AND FOOD SAFETY

Abstract:

Introduction: To improve the knowledge of the nutritional value of fish, food safety, and fish processing techniques, training was developed for low literacy women and youth fish processors. This study aimed to evaluate the training comprehensibility, material delivery or methodology, and training evaluation.

Methodology: A 3-day workshop was implemented in Delta State, Nigeria. The comprehensibility of the training material was evaluated with a cloze procedure, and the participatory teaching methodology in the pyramid of learning was used for material delivery. Knowledge acquisition was measured using pre and post quizzes, and the delivery of the training program was evaluated using a 5-point Likert scale training evaluation survey and self-knowledge evaluation.

Results: The paired sample t-tests showed a significant difference in knowledge change ($p \leq 0.05$) and the comprehensibility score was > 60%.

Discussion: The result showed a knowledge increase. However, there is a need for additional nutrition and food safety education to address food contamination.

Conclusion: The newly developed material and training were effective. Overall, the nutrition and food safety training program significantly improved the participants' knowledge of nutrition and food safety.

Keywords: evaluation, training, knowledge acquisition, nutrition, food safety, low literacy, fish processors, Nigeria.

Introduction

The UNICEF office of research recommended that evaluative reasoning should be used throughout an evaluation process to synthesize information necessary to draw evaluative conclusions. Evaluation is defined as finding answers to evaluative questions about the quality and value of a program, process, or material (Davidson, 2012). The efficacy of newly developed materials can be determined through experimental trials, pilot studies, and training using the pre- and post-evaluation methods (*Guidance for pre and post-test)*. Literature has established that testing newly developed and validated instructional material is crucial to evaluate its efficacy and appropriateness to the target audience (Mosby et al., 2015). A pre and post-training performance assessment were used in determining the efficacy of a word-based auditory-training procedure for use with older adults with hearing impairment (Humes et al., 2009). A study revealed that a food safety education (Alimentación) booklet was effective in improving the knowledge of low-literacy caregivers of children with leukemia in El Salvador and Guatemala (Mosby et al., 2015). Basic numerical cognition training was tested for efficacy in improving children's math achievements using a pre and post-test evaluation (Kim et al., 2018). Several researchers have tested the efficacy

of training material, products, procedures, or processes using the pretest and posttest methods(Hemingway et al., 2015; Michelazzo et al., 2015; Shivaraju et al., 2017).

Teaching materials and aids are vital to the teaching-learning processes (Bajrami & Ismaili, 2016; Olayinka, 2016). A study conducted in a secondary school in Nigeria shows the essentiality of the teaching aid in enhancing students' achievement (Olayinka, 2016). As found in the literature, incorporating an engaging and modern teaching method like using digital devices, and audiovisuals such as computers, projectors, and blogs have been proven to be successful (Normand-Marconnet & Cordella, 2012; Silk et al., 2008) in education and training programs. Education booklets were found efficient in teaching the low-literacy population about food safety (Mosby et al., 2015). Another study shows that culturally appropriate nutrition education pamphlet was effective for caregivers (Garcia et al., 2010). The instrument used for this study was designed for use with adults and considered suitable and culturally appropriate for our audience.

The objective of this study focuses on evaluating the newly developed and validated low literacy nutrition and food safety instructional material by evaluating the knowledge acquisition and the overall outcome of the training program. The quality and value of the material were scrutinized through evaluative methods. Quality in this context refers to the appropriateness and the comprehensibility of the instructional material to the target group; value refers to how good it is in terms of the training program, in particular considering the needs it was supposed to address (Davidson, 2012) that is improving knowledge on nutrition and food safety.

Methods

Study Design

This is an evaluation study design. This study is the evaluation of a training program conducted in the "train the trainer" approach to improving the knowledge of women and youth fish processors on nutrition and food safety, using participatory or active teaching methodology. This involves a four-stage evaluation that includes the comprehensibility evaluation of the material, delivery or training methodology evaluation using pre and post-test, the overall training evaluation, and the self-knowledge evaluation of the participants using retrospective pre and post-test.

This study was submitted, reviewed, and approved by the Institution Review Board for Human Studies at the Mississippi State University (IRB number IRB-20-072).

Setting

A three-day training was conducted within the Delta State study area, situated in the South-South geopolitical zone in Nigeria. Delta State is known for aquaculture and fish farming because of its geographical location in the coaster zone, and its intrinsic ecological features (WorldFish, 2018; Lo et al., 2019). This area is one of the World's largest wetlands, with an incredibly biologically diversified freshwater swamp and forest, and contributes to massive fish production. It also has established fish markets accommodating women as fish processors (WorldFish, 2018) which are the target population for this study.

Participants

Participants were recruited in collaboration with the Delta State Rural and Agricultural Development Agency (DARDA) under the Ministry of Agriculture in Delta State, Nigeria. Inclusion criteria were women aged 19-49 years and youth (means and include young adult men

within 19-35 years of age), who rely on fish processing as a source of livelihood. Exclusion criteria include children aged 18 years and below, and non-fish processors. Recruited subjects were asked to give their consent to participate before enrolment in the study. They were also informed that their consents may be withdrawn at any point if they are not willing to continue.

Data Collection

The data for this study were collected using print-out surveys administered during, and after the training. Three different collection tools were used to collect data. 1) Comprehensibility test 2) Pre and Post quizzes (test) to assess learning and 3) Training evaluation survey which contain self-knowledge assessment survey. The comprehensibility test was conducted before the use of the material for training, to determine the comprehensibility or understandability of the material. A pre-test was done before each module and a post-test after the completion of each module to evaluate the knowledge acquisition. Training and self-knowledge evaluation was done after the overall completion of the training.

Data analysis

The quantitative data were evaluated and analyzed by using descriptive statistics; percentages, frequencies, mean and standard deviations, pre and post quiz for knowledge acquisition were entered in Microsoft Excel (Microsoft Corporation) and exported into SPSS Version 27 (IBM). A paired sample t-test was utilized to determine if there were differences between the pre and post quizzes scores on each of the 7 modules. The training and self-knowledge evaluation survey was analyzed on a 5-score Likert scale and presented in percentages and bar charts.

Comprehensibility

A comprehensibility test was used to determine the understandability of the newly developed and validated training material (flipbook; *Nutrition Education, food safety and safe fish handling practice guide for fish processors*) using the cloze procedure (Bastable, 2014).

The comprehensibility test was performed by administering fill-in-the-gap questions to the five non-participants of the target group as described in the literature (Bastable, 2014). The test consisted of two questions from each of the training modules of the nutrition and food safety curriculum. A total of 14 fill-in-the-blank questions were generated from the validated material and quiz questions. This paper-type test was administered a week before the training to determine the comprehensibility of the newly developed and validated flipbook on nutrition and food safety for fish processors. ***The Cloze Procedure*** is designed so that every fifth word in a sentence extracted from the educational material is deleted and the respondent is to fill in the blank gaps with the *exact* word as much as they can. The total correctly filled blanks are the final cloze score of the reader. The pass mark for the test is a cloze score ≥ 60%. This indicates the understandability of the educational material (Bastable, 2014). The comprehensibility score for each participant was converted into percentages for the ease of data analysis and interpretation using Microsoft excel.

Cloze score formula using equation 3.2

A Score ≥ of 60% indicates that the training material is better understood.

40 – 59% indicates a moderate difficulty and supplementary teaching will be needed, and a score of < 40% indicates the difficulty and unsuitability of the training material (Bastable, 2014).

Learning

The trainer's or facilitator's guide*; "Nutrition education, food safety, and safe fish handling practice guide for fish processors"* is a step-by-step instructional material on nutrition and food safety for low literacy educators (see supplementary list). It includes a training guide for the facilitators and a flipbook on nutrition and food safety for women fish processors with low literacy to facilitate participatory training. The developed nutrition and food safety flipbook is a seven-curricular module instructional material and validated by experts with high content validity index value of .983 and considered suitable for training the target population. Literature established that the success of educational activities relies on well-designed and effective printed educational communication material (Birhanu et al., 2011).

Training materials used for the train-the-trainer included a training manual (flipbook), facilitator's guide, PowerPoints slides, teaching aids; flipcharts, food cards/models, and promotional materials. It also includes evaluation materials; pre, and post-tests, and a training evaluation survey.

The trainer's or facilitator's guide also contains seven curricular modules, that cover (1) Nutrition education, focusing on healthy eating (2) Animal source foods, (3) Food safety, (4) Fish processing techniques, (5) Food poisoning and contamination, (6) Hygiene rules and good practices, and (7) Economic benefits of quality and safe fish products. The guide contains complementary lesson plans which contain learning objectives, teaching methodology, instructional materials, teaching aids, icebreakers/group activities/exercise, instructions for group activities, discussion points, time frames, and key messages. Other quick reference training aid were explored e.g. USAID MyPlate.org

Training Methodology

A participatory or active method was predominantly used in this training program. However, passive methods were explored for efficient training delivery as recommended by the

National Training Laboratories (NTL) Institute for Applied Behavioral Science as detailed in figure 6.1. The participants were actively involved in the training process in form of games, group activities, discussion, debates, reverse teaching, or teaching others. Facilitators and co-facilitators conveyed the training instruction in the English language with simple and jargon-free sentences (Plimpton & Root, 1994). Time allocation for each module was 1 hour 20 mins with 15 minutes of tea and lunch breaks in between. An average of 3 modules were taught in a day. The whole training took three days and included about 10 hours of training altogether. The training environment was well illuminated and ventilated, conducive for learning, and supported active participation (Guskey, 2005). Module slides were presented using an alternately powered projector and public address system.

The training was conducted with adherence to the facilitator's guide, containing the participatory methodology with high knowledge retention capacity as detailed in figure 6.1. Participants were also given a copy of the newly developed and validated training material; flipbook; "*Nutrition education, food safety, and safe fish handling practice guide for fish processors*" to facilitate the learning process.

The researcher also integrated reinforcement as a training strategy to sustain participation. Low literacy tool or materials; apron, foldable fabric hand fan, and silicon wristband containing nutrition and food safety promotional information were also given to the participants for a dual purpose; to serve as a reward for participating in the training and as a reminder of what they've learned. Ultimately a certificate of completion was awarded at the end of the training program giving the participants a sense of accomplishment.

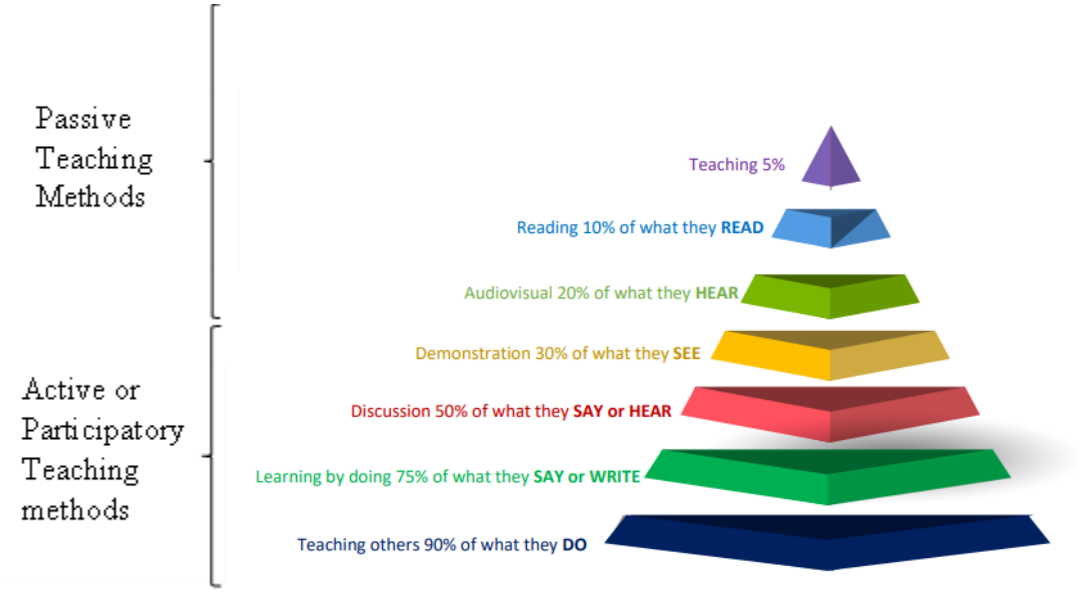


Figure 6.1 Pyramid of learning.

Percentage of average knowledge retention. Adapted from National Training Laboratories (NTL) Institute for Applied Behavioral Science.

Table 6.1 The summarized pedagogical description of the teaching methodology and activities

Module	Training Activities	Teaching Methods	Description
Module 1 **Nutrition education** ***Healthy eating habits***	Ask participants to **draw** a large circle representing a plate on a cardboard or paper to represent the serving bowls. **Shade** the plate, serving bowl, or tray with the appropriate colors and portions of the rainbow, brown, and white foods as taught with USAID Myplate. Figures 2a and b **Discuss** with participants why packaged, fatty, salty, or sugary foods should be consumed in moderation.	Learning by doing (75%) Discussion (50%)	Active or Participatory
Module 2 **Animal source food.** ***Fish nutrition***	Ask a group of two groups, to **present your views** or experience on the topic. "A mother's feeding habits and nutrition can affect a child's growth and development during pregnancy and after birth". Ask each group to **mention** specific foods including fish they ate during pregnancy. Give each team about 5 mins to prepare their discussion. Each team will present two spokespeople to **discuss** their views, 3 mins each of the lead speakers and 2 mins for the seconder from each group.	Group activity; Debate (75%) Discussion (50%) Teaching others (90%)	Active or Participatory

Table 6.1 (continued)

Module	Training Activities	Teaching Methods	Description
Module 3. **Food safety:** ***Fish safety and handling***	Ask the fish processors to form a group of 5-10 people and ask them to **identify** all possible unsafe conditions and practices in the group activity. After five minutes, have some groups **share** what they discovered with the larger group.	Learning by doing (75%) Teaching others (90%)	Active
	Demonstrate to the participants the steps to handwashing and ask the participants to repeat the demonstration.	Demonstration Learning by doing (75%)	Active or participatory
	Discuss with the fish processors why they should wash their hands and when and ask participants how handwashing can be encouraged.	Discussion (50%)	
Module 4 **Fish processing** ***Fish processing techniques***	Ask 2-3 volunteers to **tell** the larger group about the type of fish and fish processing methods they are using, their experiences, advantages, and challenges encountered with the method.	Teaching others (90%)	Active or participatory
	Ask another volunteer to **write** down the challenges for further discussion.	Listening and writing	Active
	Brainstorm with fish processors ways that they can reduce or eliminate the challenges associated with the identified processing methods and ensure the production of nutritious and safe fish products all year long to facilitate a healthy diet.	Discussion (50%)	

Table 6.1 (continued)

Module	Training Activities	Teaching Methods	Description
Module 5 **Food poisoning** ***Fish poisoning and contamination***	Ask the participants to **mention** substances or objects they have seen in their fish products before that could be harmful to human health, and **discuss** with them why these contaminants are present in our fish and "what can we do about it?"	Teaching and discussion (50%)	Active or participatory
	Ask the fish processors to split up into 4 groups and ask them to **identify** and **classify** different contaminants in the picture provided and have each group report their answers to the larger group.	Learning by doing (75%) Teaching others (90%)	
Module 6 **Hygiene rules and good practices** ***Hygiene rules for fish handlers***	Ask the participants to form a small group of 5-10 people. Ask them to **create** a checklist of sanitary and good practices. Ask the small group to **present** back to the larger group.	Learning by doing (75%) Teaching others	Active or participatory
	Discuss with participants why hygiene and good practices are important in ensuring food safety, quality, and sound fish product.	Discussion (50%)	

Table 6.1 (continued)

Module	Training Activities	Teaching Methods	Description
Module 7 **Economic and nutrition benefits of quality and safe fish products.**	Ask participants if anyone can **share** how quality fish products could reduce fish waste generation and how it could help increase the income or economy. **Brainstorm** with fish processors ways that they can produce quality nutritious and safe fish products all year long to contribute to a healthy diet.	Teaching others (50%) Discussion (50%)	Active or participatory Active
Revision **Module 1-7**	Ask one volunteer each to **recap** what was learned in each module. Encourage the participant to **teach** other fish processors about what they've learned	Teach back Teaching others (90%)	Passive
Evaluation	Administer the pre and post quizzes-3 multiple-choice questions on each module Ask the participants to **evaluate** the training program	Reading, (10%) Audiovisual (reading), Learning by doing (75%)	Active

See the supplementary list for the details of activities.

Figure 6.2 a. Suggested MyPlate for Nigeria.

Figure 6.2 b. Food color and portion size,

Figure 6.2 a and b; adapted from USAID MyPlate and Home Garden toolkit World Garden Center.

Learning Evaluation

The researcher conducted a formative assessment (Guskey, 2005) (pre-test) using short paper-pencil quizzes to evaluate the knowledge of the participants on each module before initiating the training, followed by feedback in form of a lecture, with corrective activities accompanied by group activities after which another (post) test is given. Pre and post-test evaluation methods were implemented to measure the knowledge acquired during the training using the newly developed and validated nutrition and food safety material. The pre-and post-quizzes consist of three multiple-choice questions with the content validity index (CVI) value ≥ .83.

Training Evaluation

The training program was evaluated in terms of its impact and usefulness using the participant's responses to the evaluative questions (Davidson, 2012) on a 5-point Likert scale as detailed in the training evaluation survey (see appendix F), where 1= Not useful at all and 5= Very useful. The quality of i) the overall content of the training, ii) PowerPoints slides, iii) low literacy materials and tools, iv) presentation of the material and training methodology, v) participant/group activities, and vi) facilitation activities by the trainers were rated on a 5-point Likert scale; 1= poor, 2=fair, 3=good, 4= very good and 5= excellent. Also, the training evaluation survey includes a self-assessment of knowledge before and after training on the seven modules taught to evaluate the training impact and immediate outcomes.

Self-knowledge assessment

A retrospective before and after training knowledge evaluation was conducted for the training, using a self-administered 5-point Likert scale survey. This method was adopted to reduce

the knowledge shift bias in pre-and-post-test (Clyne & Clyne, 1991). Participants were to rate their knowledge confidence level before and after the training retrospectively on each module taught during the training.

Results

The participants were mainly women (79.5%) and youth (20.5%) fish processors from the three senatorial districts (Delta North, Delta South, and Delta Central) of the Delta State in Nigeria. The program goal was to recruit forty fish processors from each of the senatorial districts for a total of 120 expected participants, at an estimate of approximately 20% dropout rate. Upon recruitment, a total of 122 participants enrolled in the training, accounting for a 0.17% increase with a zero percent dropout.

Comprehensibility Evaluation

The result shows that the average cloze score was 72.1 percent with a mean and standard deviation (10.1 ± 0.55) as detailed in table 6.2. The comprehensibility result of the newly validated material met the recommended cut-off cloze score; above 60 percent (Bastable, 2014), which is an indicator that the training material is better understood.

Table 6.2 Cloze score for the training material

Number of participants	Score out of 14	% Score
1	10	71.4
2	11	78.6
3	10	71.4
4	10	71.4
5	9.5	67.9
Mean	**10.1**	**72.1**

Comprehensibility test of the newly developed and validated low-literacy educational material on nutrition and food safety for women fish processors, n =5.

Learning Evaluation

True Pre and post-test:

The average number of participants that took the pre and post quizzes was n = 80. The quizzes consisted of three multiple-choice questions with a score ranging from 0 - 3 points, 1 point for each correctly answered question. Table 6.3 shows the mean, standard deviation, and variance of the pre-and post-quizzes at $p \leq .05$. Table 6.4 shows the paired sample difference of the pre and post quizzes on each module. The result shows that the knowledge of the participants significantly improve after each module that was taught. It is noteworthy to mention that participants with literacy skills assisted a few others with low or no literacy skills to understand the material and training instruction. However, approximately thirty-four percent (n=42) of the participants did not participate in the pre and post quizzes due to either a fear of failure or a lack of literacy skills (read and understand instructions without external assistance). Oral questioning was an alternative means used to evaluate this category of participants but there was no recorded data for the evaluation.

Training Evaluation:

The overall training evaluation survey reveals that the training was highly significant and relevant to the target population. The training program, the overall content of the material, low literacy tools, PowerPoint presentations, group activities, the presentation and delivery of the material, and the facilitator's performances were generally rated 4 and 5 on the 5-point Likert scale. 99.1 % indicated the usefulness and relevancy of the training program. Other variables were rated on a similar scale 4; very good, and 5; excellent as detailed in figure 6.4.

Table 6.3 Frequency table for pre and post quizzes

	M1 Pre quiz	M1 Post quiz	M2 Pre quiz	M2 Post quiz	M3 Pre quiz	M3 Post quiz	M4 Pre quiz	M4 Post quiz	M5 Pre quiz	M5 Post quiz	M6 Pre quiz	M6 Post quiz	M7 Pre quiz	M7 Post quiz
n	79	81	81	81	81	80	81	81	81	79	80	80	80	80
Missing	2	0	0	0	0	1	0	0	0	3	1	1	1	1
Mean	1.91	2.54	2.74	2.91	2.54	2.78	2.04	2.49	1.14	1.83	2.46	2.76	1.98	2.41
S.D	.701	.775	.628	.394	.708	.595	.872	.709	.787	.859	.711	.484	.993	.837
Var.	.492	.601	.394	.155	.501	.354	.761	.503	.619	.738	.505	.234	.987	.701

Frequency table showing the average scores of participants pre- and post-quiz on the seven-module curricular nutrition and food safety training for women and youth fish processors.
M= Module, n=number of quiz participants, S.D = standard deviation, Var. = variance.

Table 6.4 Paired differences in the mean, standard deviation of the pre and post quizzes

Pair	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Module 1 Pre quiz Module 1 Post quiz	-.620	.584	.066	-9.439	78	.000
Module 2 Pre quiz Module 2 Post quiz	-.173	.519	.058	-2.995	80	.004
Module 3 Pre quiz Module 3 Post quiz	-.212	.758	.085	-2.508	79	.014
Module 4 Pre quiz Module 4 Post quiz	-0.457	.807	.090	-5.094	80	.000
Module 5 Pre quiz Module 5 Post quiz	-.718	.952	.108	-6.660	77	.000
Module 6 Pre quiz Module 6 Post quiz	-.300	.863	.096	-3.110	79	.003
Module 7 Pre quiz Module 7 Post quiz	-.437	.824	.092	-4.747	79	.000

Paired samples test with the paired differences in the mean, standard deviation of the pre and post quiz of modules 1-7, at 95 % confidence intervals.

Self-Knowledge Evaluation

The result of the retrospective pre and post a self-knowledge evaluation was rated on a 5-point Likert scale indicating a rate of 1 as not knowledgeable, and 5 as very knowledgeable on the seven modules taught in the training program. The self-rated knowledge curve suggested that most of the participants were knowledgeable before the training across the seven modules and more knowledgeable with the evidence of a right-skewed knowledge curve after the training (figure 6.5b).

Self-evaluated knowledge after the training shows a positive shift in the knowledge of the participants across the training modules. Almost all the respondents indicated that they feel more knowledgeable about the seven curricular modules with 5 level ratings 93, 87, 95, 93, 86, 92, 97 representing 86.1, 80.6, 88, 86, 79.6, 85.2, 89.8 percent respectively (figure 6.4). This indicates that the nutrition and food safety training was impactful and effective in improving the confidence in the knowledge of the target population.

Figure 6.3 Summary of the training evaluation

Figure 6.3, Summary evaluation of the nutrition and food safety training by 108 respondents, on a five-point Likert scale. Likert scale for the training program: 1= Not useful or relevant 5= Very useful and relevant. Other variables are rated as 1=poor, 2= fair, 3= good, 4= very good, and 5=Excellent.

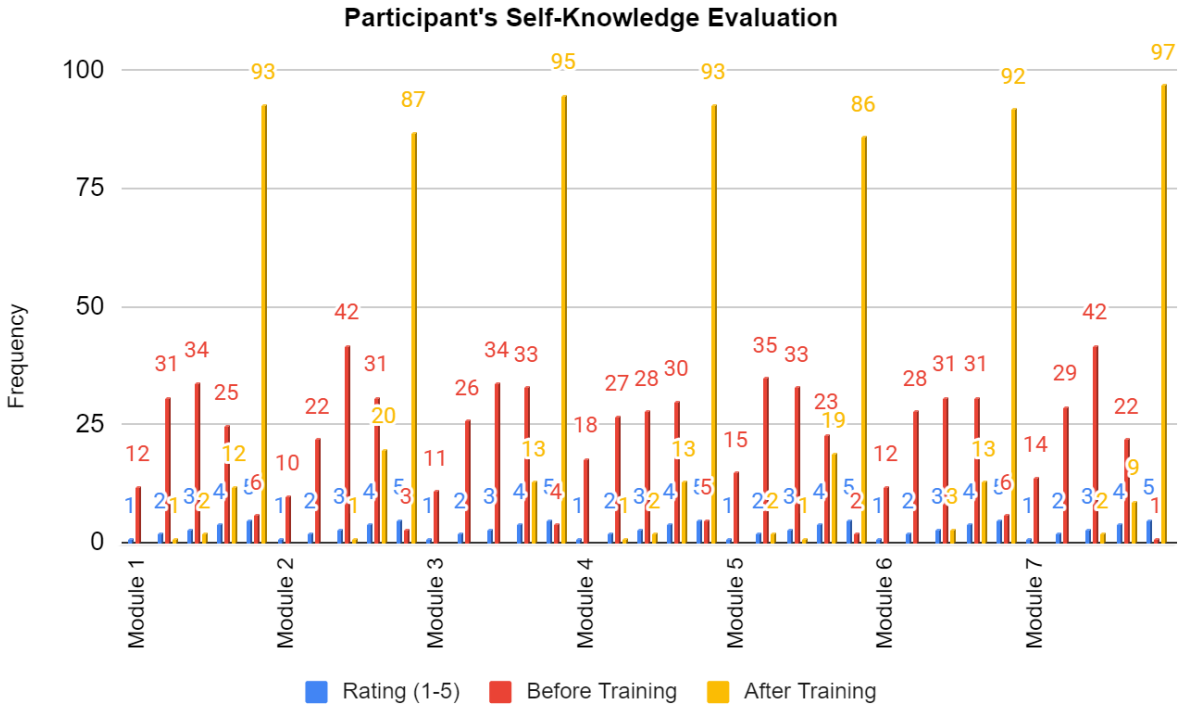


Figure 6.4 Retrospective self-knowledge evaluation

Figure 6.4, Self-knowledge evaluation of 108 respondents on their knowledge of the seven curricular modules on a scale of 1-5 before and after the nutrition and food safety training. Comparison between knowledge curve from true pre and post-test versus retrospective before-and-after training self-knowledge evaluation.

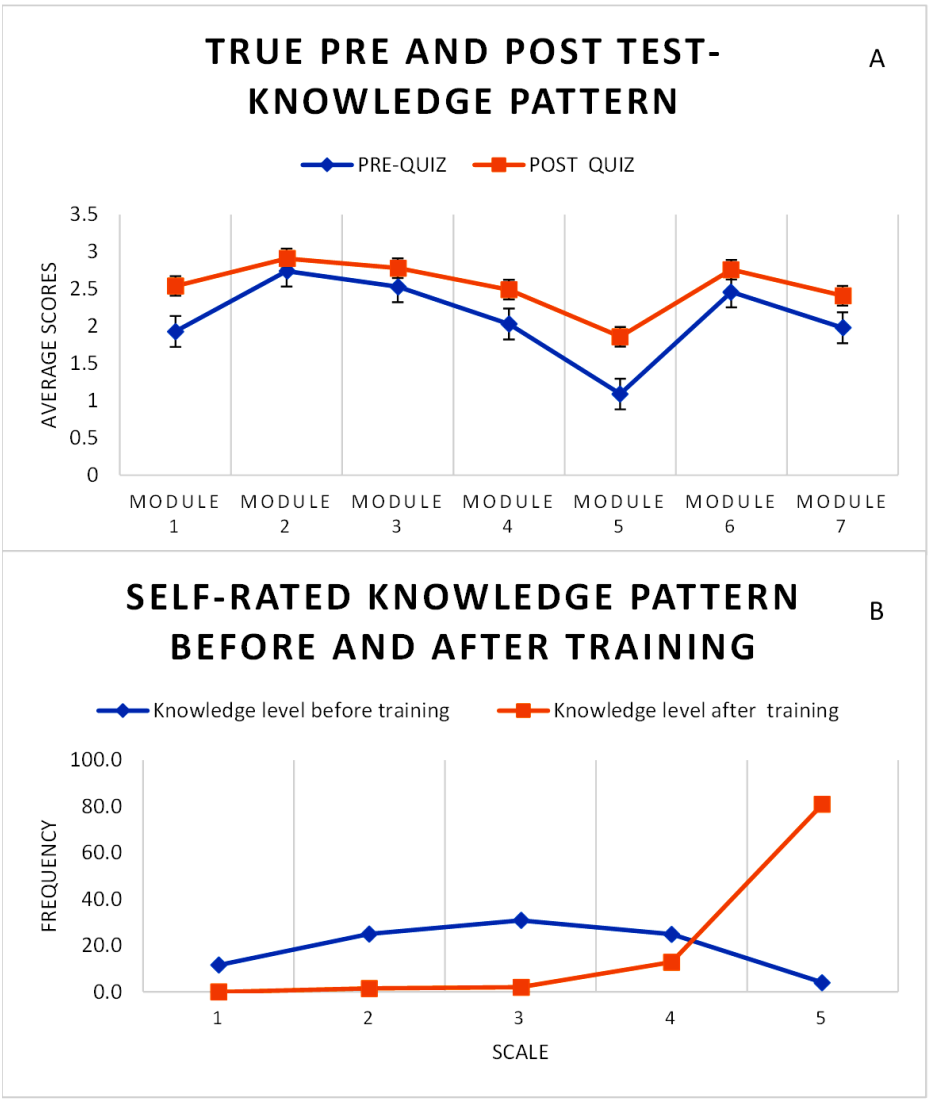


Figure 6.5 Comparison of true test with self-knowledge evaluation

Figure 6.5 A presents a linear representation of the Mean scores of the nutrition and food safety training participants on seven curricular modules, where n = 80 ±1; and B presents the frequency of participants' self-rated knowledge on seven curricular modules on the scale of 1-5.

Discussion

This study evaluates the comprehensibility of the training material, to ensure that the user can understand and utilize the information even after the training is completed. As found in the literature, educational materials can be read at home, and the information can be shared with friends and family members (Tavares et al., 2018). A study shows that well-written materials with easy-to-understand information improve the reader's knowledge and satisfaction (Tavares et al., 2018). The result of the comprehensibility test; a cloze score of 72.1%, shows that the material is understandable and users could read and understand the material by themselves without assistance (Bastable, 2014).

Training delivery also involves judicious use of measurable verbs generally referring to actions associated with the intended cognitive process and objectives described by the Bloom taxonomy (Bloom, 1956) as emphasized in training activities in Table 6.1 to achieve our specific goal. The result of this study shows that learning occurs and is evident with a significant improvement in participants' knowledge as evidenced in Tables 6.3 and 6.4 at p-value $\leq .05$. The average mean of pre and post-test indicates a significant increase in the knowledge level of the participants in the seven modules taught. The average mean of the pre-test is 1.93, 2.74, 2.53, 2.03, 1.09, 2.46, and 1.98 as presented in Table 6.3. The results show that participants had the least knowledge in Module 5; food contamination with an average of 1.09, and low knowledge in Module 1; healthy eating, and module 7; the economic importance of quality and safe fish products. However, the result of the post-quiz also shows that there was an improvement in the knowledge level of the modules (Table 6.3). A significant shift in participants' knowledge was observed in modules 1, 5, and 7, as the post quiz mean values increased from 1.93,1.09, and 1.98

to 2.54, 1.86, and 2.41 respectively. Although the mean value on module 5; food contamination, remains low compared to other modules. Knowledge increased steadily with the training intervention. Knowledge before all the modules was relatively high except for Module 5; fish processors seem to have limited knowledge of food contamination with a pre-quiz score average mean of = 1.09 and post quiz score of 1.86 respectively. This suggests that nutrition and food safety educators need to focus on food contamination in future training programs as this is paramount to food safety, food, and nutrition security.

This study also analyses the self-rated confidence in the knowledge of the training participants. It was evident that participants hype their level of knowledge of the different curricular modules before the training. Figure 6.4 shows a knowledge curve indicating that more than half of the training participants overrated their knowledge level before training. In comparison with the self-knowledge evaluation after the training, a spontaneous shift and upward swing in knowledge level were observed, with left-skewed data; suggesting that the training might have influenced the level of participant's knowledge positively. This result also suggests the efficacy of the training material and program in improving the knowledge of nutrition and food safety. Our findings were consistent with the other nutrition and food safety training studies; food safety training education improves the knowledge and health behavior of training participants (Blackburn et al., 2014; Kendall et al., 2017; Losasso et al., 2012; Reicks et al., 1994) and promotes food security and food literacy (West et al., 2020).

Figure 6.5a shows a similar trend in knowledge acquisition comparing the pre and post quizzes. The researcher observed during the grading of the test or quizzes, that some of the participants choose the same answer they chose in the pre-test, or before the training, which is

more of a reflex response and was suspected to have influenced the knowledge curve. This could be because an individual selects one response instead of another because of prior conditioning and psychological drives existing at the moment of action (Yusuf & Yusuf, 2015). This study holds a proposition that adults may likely stick to their old way of doing things or methods when they are either afraid of failure or have been protective of their self-esteem. It also suggests it may be challenging for an adult to change their perspective on certain issues. Nevertheless, they may likely change when they understand the consequences or benefits of some of their decisions or actions.

Training evaluations: Overall, nutrition, and food safety training significantly improve knowledge acquisition. The training program was rated useful and relevant by 99% of the participants. Responses to evaluative questions on the training evaluation survey about the overall content, PowerPoints slides, low literacy tools, presentation of the material and training method, group activities, and the facilitation of the activities by the trainers validated that the training methodology was effective.

The participatory or collaborative learning explored in this study showcases the strength and impact of active training over the autonomous or spoon-feeding methodologies (Gregory et al., 2006; Vakil et al. 1998; Romoser & Fisher, 2009). The National Training Laboratory, which experimented with group relations directed toward the adult learner, highly recommends active training. Participants in this study were enthusiastic and willing to contribute their knowledge and share opinions with others, making the training more interactive and engaging. This study proposes that adults may prefer to learn from their peers rather than in a traditional classroom teacher-learners setting and methodology.

In this study, the researchers have utilized the participatory training methodology and their corresponding knowledge retention rates in the pyramid of learning with measurable action verbs

and the targeted levels of cognition to stimulate specific outcomes. The researchers targeted all the levels of cognition; remember, understand, apply, analyze, evaluate, and create categorized by Benjamin Blooms (Bloom, 1956) to achieve the overall objective of the training. This study combined all the training methodologies for efficacy including passive methods like demonstration, audiovisuals, and teaching where necessary. Bloom recommends the combination of all methods or variations in teaching methodology, for instruction to be optimally effective to increase the retention rate (Guskey, 2005).

Strength and Limitation.

The strength of this study is the multiple evaluation methods applied. Also, the mixed education status of the participants presents a diversified trained group that is necessary for productivity. However, 34% of the participants with low literacy did not take the pre and post quizzes. Also, most of the participants including the literates were unable to fully understand the concept of food contamination, most especially in identifying the different categories of contaminants and their effects on human health. Biological and chemical contaminants are difficult to explain in a "community language". For instance, the fish processors had difficulty comprehending the chemical contaminants from wood-burning during fish smoking, such as dioxin, polycyclic aromatic hydrocarbons (PAH), and carbon monoxide but they are accustomed to the physical effect such as eye irritation, heat, burn, and other associated physical risks. In like manner, participants could not differentiate the mechanism of foodborne disease transmission by biological carriers of diseases (host) and pathogens (disease-causing organisms). We recommend that nutrition and food safety educators should pay more attention to food contamination to improve food safety and nutrition security.

Conclusion

The researchers rely on the validity of the newly developed flipbook, the cloze score or the comprehensibility, and the delivery methodology, to determine its efficacy in improving the participant's knowledge of nutrition and food safety. The efficacy of training material is a function of its validity for cultural appropriateness and suitability for the target population, comprehensibility, teaching methodology (active), trainer's experience, and participant's interest. It may be difficult to evaluate the efficacy of training material independent of this context. There is an increase in knowledge acquisition throughout the seven modules. In conclusion, the improvement in the participants' knowledge is an outcome of several components of a strategically organized, methodological, and goal-oriented training program.

CHAPTER VII

NUTRITION AND FOOD SAFETY TRAINING AND DIETARY DIVERSITY OF WOMEN FISH PROCESSORS OF REPRODUCTIVE AGE IN DELTA STATE NIGERIA

Abstract

Introduction: Animal source foods are rich in macronutrients that serve as a source of energy and readily digestible protein. They also contain bioavailable micronutrients in sufficient quantity to meet the recommended nutritional requirements.

Aim: To evaluate the consumption of the food groups and determine the dietary diversity score of women fish processors of reproductive age.

Study design: A prospective evaluative study design was used

Place and duration of study: the study was conducted among women fish processors in Delta State, Nigeria, between August to December 2021.

Methodology: A baseline survey, training, and end-line survey were conducted to determine the dietary diversity of women and youth fish processors. The MDD-W survey containing 10 items was used to collect data on the variety of foods consumed within the past 24 hours. SPSS was used for analysis to determine the mean, frequencies, and standard deviations.

Results: A paired sample test was used to determine the paired differences between the baseline and end-line DDS at 95% CI. The result shows no significant difference, $t = -1.832$; $p > .05$. However, the mean DDS appeared to slightly increase from $5.8 \pm .22$ to $6.4 \pm .20$. The number of women that consumed at least 6 out of the 10 food groups increased by 9.8% ($p \leq 05$), after 12 weeks of training intervention.

Conclusion: Women and youth fish processors in Delta State, Nigeria consumed an average of 5-6 food groups per day. There is an improvement in food groups' consumption. Further study on food security is recommended to determine access to nutritious food.

Keywords: malnutrition, dietary diversity, nutrition training, women of reproductive age, restricted foods, Nigeria.

Introduction

Dietary diversity is a validated indicator of dietary quality and nutrient intake in low-income countries (Workicho et al., 2016; FANTA, 2006), especially among women of reproductive age (FAO & 360, 2016). Consumption of animal source food (ASF) is also one of the major indicators to measure dietary intake and quality in low and middle-income countries (LMICs). A research study confirmed a link between dietary diversity and quality and ASF consumption (Gittelsohn & Vastine, 2003). Animal source food provides proteins and micronutrients essential for maximum growth and development (Black, 2003). Various studies reported that lack or insufficient intake of ASFs in childhood is strongly associated with stunting (Kaimila et al., 2019), poor cognition, mortality, and morbidity (Black, 2003; James & Palmer, 2015). Therefore the inclusion of ASF such as fish and seafood in the diet is imperative to improve the diet quality of the household but most importantly of women and children under the age of 2 years (James & Palmer, 2015; Mohanty et al., 2019; Obiero et al., 2019). In this study, women and youth fish processors were trained to improve their knowledge of nutrition and safe food handling but also about the importance of protein, especially fish, in their diet.

Why do we train women?

Pregnant and lactating women are more nutritionally vulnerable because of the physiological demands of their condition (Iqbal et al., 2019; Mousa et al., 2019; Thayer et al., 2020). Inadequate nutrient intakes during the prenatal and antenatal period and lactation can negatively impact both women and the child (Gebre et al., 2018; Oot et al., 2016; Belkacemi et al., 2010; Che et al., 2017; Kavle & Landry, 2018; Wu et al., 2004)

Secondly, women are the primary caregivers to a child, and they are responsible for preparing food in the household. Nevertheless, women are marginalized globally, especially in developing countries, and often engaged in unpaid domestic labor (UN women's report). Compared with their male counterparts and due to cultural norms and barriers many women are neglected and underpaid. Many women in low-income countries experience extreme poverty because they often channel all their income into domestic upkeep and childcare (*Department of Economic and Social Affairs*, 2020). Research shows that women are vulnerable to malnutrition and other nutrition-related problems due to economic incapacity and burdens (Delisle, 2008; Hanandita & Tampubolon, 2015).

Malnutrition remains one of the leading causes of infant mortality and morbidity in LMICs. Globally, about one-third of children under the age of five years are malnourished (WHO, 2009). Children from LMICs remain vulnerable to severe acute malnutrition (SAM) (Fagbamigbe et al., 2020). According to the United Nations Children's Fund (UNICEF), the national prevalence of stunting in Nigeria was estimated at 32% of children under the age of five, which conscripted the country as the second-highest burden of stunted children in the world. In addition, an estimated 2 million children in Nigeria suffer from SAM. The National Nutrition and Health Survey reported that 6.9 percent of Nigerian women of reproductive age (WRA) were acutely malnourished and

3.8 percent were severely malnourished (NBS, 2015). This current nutritional status of WRA and children in Nigeria has drawn the attention of the United Nations Children's Fund (UNICEF), United States Agency for International Development (USAID), Department for International Development (DFID), and other international agencies working towards achieving the Sustainable Development Goals (SDGs) on zero hunger, eradicating malnutrition, poverty, illiteracy, and promoting gender equity in middle and low-income countries. These organizations have also shown commitment to eradicate discrimination against women and promote nutrition and wellbeing among the vulnerable population (WHO & UNICEF, 2015).

Fish is one of the ASF that provides micronutrients and macronutrients needed for growth and maximizing health potentials in both women and children (Balami et al., 2020; Mohanty et al., 2019a; Tacon & Metian, 2013). Fish has the potential of mitigating malnutrition due to their nutritional value. However, these nutrients are compromised as a result of poor fish handling and processing, which largely accounted for the traditional methods of fish processing, particularly, smoking, and sun-drying (Abraha et al., 2018; Adeyeye, 2016). Those practices remain dominant among artisanal fish processors in Nigeria, the majority of whom are women (Akintola & Fakoya, 2017; Ike-Obasi & Ogubunka, 2019). A preliminary study revealed that women fish processors are important stakeholders in the food system capable of producing and supplying fish and other fish products as a contribution toward improving malnutrition and hunger (Ike-Obasi & Ogubunka, 2019). Literature documented the impact of nutrition and food safety training on reducing malnutrition, food insecurity, and food safety issues such as food contamination (Cailliau, 2013). A study in Madagascar shows that interventions through nutrition education, food safety training, and women empowerment could improve a child's growth (Rabaoarisoa et al., 2017). Training interventions have been proven viable in improving knowledge of nutrition, food choices and

preparation, food safety, and product quality improvement (Blackburn et al., 2014; Medeiros et al., 2001; Losasso et al., 2012). Therefore, the USAID Feed the Future Innovation Lab for Fish (FTF FIL), through the Nourishing Nations project embarked on training women and youths fish processors in Delta State, Nigeria on the nutritional benefits of animal source foods including fish, and safe handling. Delta State is one of the USAID Zone of Influence (ZOI). It is known for aquaculture and fish farming because of its geographical location at the coaster zone, and its intrinsic ecological features (WorldFish, 2018; Lo et al., 2019). This area is one of the World's largest wetlands, with an incredibly biologically diversified freshwater swamp and forest, and contributes to massive fish production. It also has established fish markets accommodating women as fish processors which are the target population for this study (WorldFish, 2018).

The three objectives formulated by USAID FIL, Nourishing Nation to complete this project are:

i. Develop cost per nutrient guides by analyzing the nutrient and contaminant profile of selected processed fish products in the Delta State of Nigeria.
ii. Build capacity among women and youth fish processors in the Delta State to produce high-quality, safe, and nutritious processed fish products for local consumption.
iii. Educate women and youth fish processors in the Delta State about the benefit of fish in the human diet and develop low literacy tools to help them better market their products

In this study, we implemented nutrition and food safety training in Delta State, Nigeria to achieve the second and third objectives of the Nourishing Nations project with the overall goal of improving nutrition, food safety, food security, and women empowerment. We anticipated that the training intervention will contribute to reducing malnutrition prevalence among children under the age of five, and improve the nutritional status and dietary diversity among WRA (Hanandita & Tampubolon, 2015; Ishikawa et al., 2018; Thilsted et al., 2014).

Methods

Study Design

This was a prospective evaluation study by design. This study was submitted, reviewed, and approved by the Institution Review Board (IRB) for human studies at the Mississippi State University (IRB number IRB-20-072). This study is of an intervention approach to improve the knowledge of women and youth fish processors in nutrition and food safety including the benefits of ASF consumption (fish), using the participatory training method.

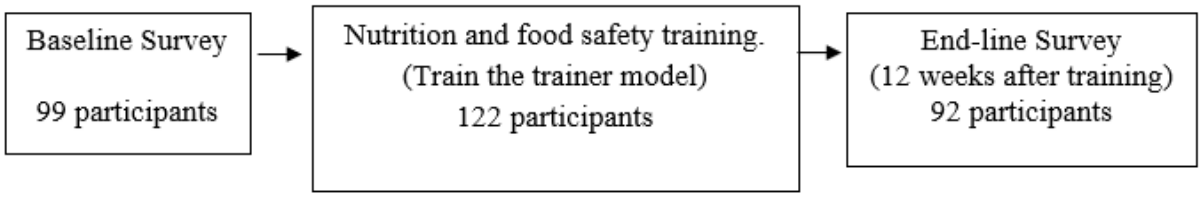
Training

The training was overseen and facilitated by the Feed the Future Innovation lab for fish, the Nourishing Nations team. The training was conducted in August 2021, in two separate designated training centers; Delta Agriculture and Rural Development Agency (DARDA) building facilities in Asaba and Warri respectively. Training participants were 122 women and youth fish processors enrolled from the three senatorial districts in Delta State, Nigeria.

Training Material

A newly developed and expert validated training material title; *Nutrition education, food safety, and safe fish handling practice guide for fish processors* was used during the training in a train the trainer model. The training material consists of seven modules that cover 3 major areas, Nutrition, Food Safety, and Quality. Module 1 and 2 addressed healthy eating and animal source food consumption. Module 3-6 covers food safety, safe fish processing and handling, food contamination, hygiene, and good practices, while module 7 covers the economic benefits of quality fish products.

Data collection



Scheme 7.1 flow chart showing the data collection

A baseline survey was conducted by three trained enumerators who administered the 60 minutes questionnaire to the participants before training in August 2021, and the end-line (post) survey in December 2021. The participants provided demographic and socioeconomic information and completed other sections of the comprehensive survey that ask about fish business income-related activities, nutrition knowledge and hygiene practice, nutrition information and communication, fish preparation and processing, fish business accessibility, fish safety, and after-purchase handling, and the minimum dietary diversity for women or the MDD-W survey and child dietary recall.

MDD-W survey is a validated proxy for social-economic status. Information on the food consumed by the respondent was collected from the baseline and end-line survey after the signing of the informed consent. The MDD-W method assumes that the participant would know the meals she cooks, serves, and eats. The women were asked to recall and mention all food, and drinks consumed during the day (24-hour recall) and night. These include all meals, snacks, and drinks. They were encouraged to remember every food consumed per meal and in-between meals. Women who do most of the cooking for themselves or the household were asked to name or describe all ingredients and condiments used for the meal preparation. This study assessed the Dietary

diversity in women fish processors using the 10-point women dietary diversity (WDDS-10 survey). The 10-point WDDS-10 survey is a list-based instrument consisting of 10 food groups from which dietary diversity scores (DDS) or Minimum Dietary Diversity for Women (MDD-W) were being generated *(International Dietary Data Expansion*).

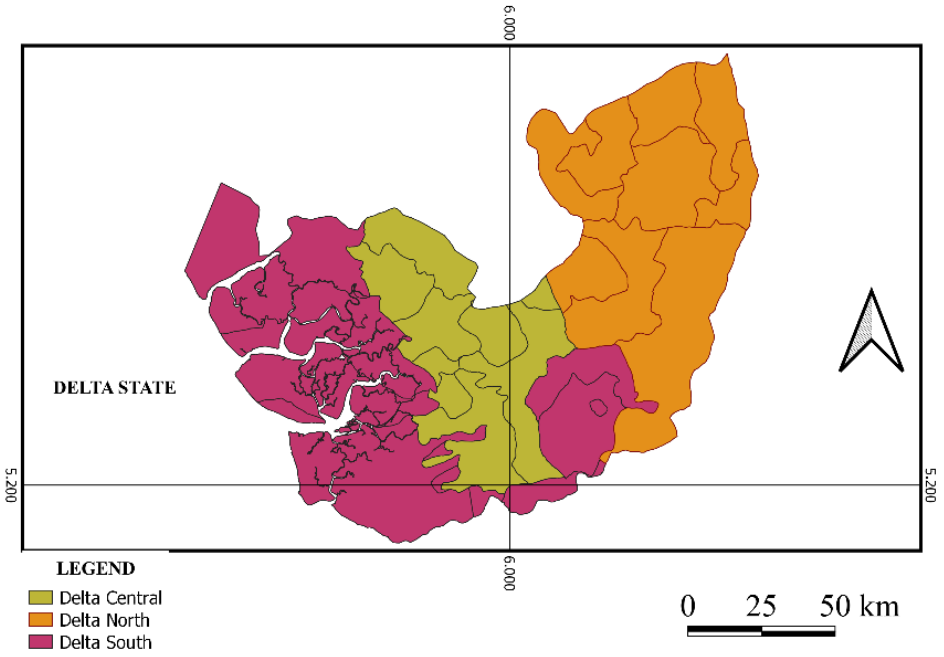


Figure 7.1 Map of Delta State, Nigeria the three senatorial districts.

Statistical analysis

The quantitative data were evaluated and analyzed by using descriptive statistics; percentages, frequencies, means and standard deviations, baseline and end-line WDD-M survey were collated and inputted in Microsoft Excel (Microsoft Corporation) and transferred in SPSS Version 27 (IBM) for statistical analysis using the paired sample t-test to determine the significant paired differences mean.

Minimum Dietary Diversity for Women (MDD-W) was computed as the summation of food groups consumed by a woman from a total of the ten food groups available. The ten food groups include 1) Grains, roots, and tubers; 2) Legumes/Pulse; 3) Nuts and seeds; 4) Dairy products; 5) Meats or poultry, fish, seafood, and snails; 6) Eggs; 7) Dark leafy green vegetables; 8) Vitamin A-rich vegetables, Vitamin A-rich fruits, and red palm oil; 9) Other vegetables; 10) Other fruits. (*All the food groups have been adjusted to reflect the social and cultural diet of Nigerians.)* See Appendix B, part C.

The MDD-W is a dichotomous indicator considered the standard for measuring population-level dietary diversity of women of reproductive age (FAO & 360, 2016). According to the recommended guidelines, an indicator of the probability of micronutrient adequacy for 11 micronutrients in a woman's diet is ≥ 5 of the 10 food groups represented. It is considered high and portrays the likeliness that the woman consumes animal source foods, nuts or seeds, pulses, fruits, and vegetables. Women who consume ≤ 4 food groups are considered to have low dietary diversity and have a greater probability of micronutrient inadequacy (FAO & 360, 2016). The dietary diversity score has been an efficient validated indicator to determine the possibility of meeting the dietary requirements (Adubra et al., 2019). In this study, we used the WDDS-10 score as a continuous variable and the MDD-W cut-off 6 food groups as an indicator of minimum dietary diversity.

Women's Dietary Diversity Score = *Continuous variable from 0-10*
Minimum Dietary Diversity for Women (Population-level indicator) =*Dichotomous variable*
Women who have MDD score ≥ 6 food groups, from 10 food groups
Women who have MDD score <6 food groups, from 10 food groups
MDD Score for Women of Reproduction Age 15-49 years old was calculated using the formula: (equation 3.3)

Results

Demographic information of the participants.

Table 7.1 presents the demographic characteristics of the fish processors who participated in this study. The mean age of the study participants was 30.8 (± 8.78 SD) years. Predominantly spoken languages are the Ijaw, Igbo, and Urhobo languages. More than half of the participants had a family size of between 4- 6 people, while 30.1% had between 1-3 people. Approximately 69% of the participants had completed at least secondary school education, while 4.1% had no formal education. Seventy-eight percent of the study participants were married, 8.2% were never married while 6.8% were widowed.

Restricted foods for pregnant women and children

Table 7.2 presents the participant's knowledge of restricted foods. Meat, chicken, and egg are among commonly identified restricted foods for pregnant women and children.

Food group consumption.

Figure 7.2 shows the baseline information of the food groups consumed by the participants over 24 hours. ‘Grain, roots, and tubers’ are the commonly consumed food group accounting for 65 (89%) respondents, 78% consumed ‘other fruits’, (75%) consumed foods in the ‘meat, fish, seafood, and insect’ group. Eggs are the least consumed (12%) among the food groups, followed by 26%, ‘dark leafy green vegetables, and 40% of the respondents consumed ‘dairy products. A 59% of the respondents reported having consumed ‘vitamin A-rich vegetables’, 59% consumed ‘other vegetables’, 53% respondents consumed ‘pulse or legumes’ and 48% consumed ‘nut/seeds’ food groups each within the past 24 hours.

Also, figure 7.2 presents the information about the food consumption pattern of the respondents 12 weeks after the training intervention. The end-line data of the food groups consumed by

participants over 24 hours shows that the majority representing 82% of respondents consumed ‘grain, root & tubers’, and 84% consumed ‘meats, chicken, fish, seafood, and insect’ within the past 24 hours. Sixty-two percent consumed food group ‘dairy products, 59% consumed ‘Eggs’, 48% consumed ‘dark leafy vegetables, 62% consumed ‘pulse & legumes’, and 66% consumed ‘other vegetables’ in the past 24 hours.

Dietary diversity score

The baseline MDD score shows that almost half, 47.9% of the women consumed at least 6 out of 10 food groups, and 52.1% consumed less than 6 food groups. However, the End-line survey showed that 57.7% of the women consumed at least 6 food groups out of 10 while 42.3% consumed less than 6. There is a 9.8% increase in the dietary diversity of the target population at 12 weeks post-training evaluation.

We found that the average minimum dietary diversity of women score (MDDW) for baseline and end-line was 5.8 ± 0.22 and 6.4 ± 0.20 respectively (Table 7.4). There was no significant difference between baseline and end-line MDD (p= 0.07)

Table 7.1 Demographic information of the respondents

Characteristic	Frequency	Total (%)
Age (years)		
15-18	4	5.5
19-29	13	17.8
30-39	25	34.2
40-49	31	42.5
Language		
Igbo	19	26.0
Ijaw	32	43.8
Uhrobo	16	21.9
Itsekeri	2	2.7
Others	4	5.5
Number of Households		
1-3	22	30.1
4-6	42	57.5
7-9	9	12.3
Religion		
Christian	72	98.6
No response	1	1.4
Education		
Preschool or no formal education	3	4.1
Some primary	2	2.7
Complete primary	10	13.7
Some secondary	8	11.0
Complete secondary	31	42.5
College or higher	18	24.7
Other	1	1.4
Reproductive status		
Pregnant	2	2.7
Lactating	11	15.1
NPNL (not pregnant not lactating)	59	80.8
No response	1	1.4
Marital Status		
Single never married	6	8.2
Widowed	5	6.8
Divorced	1	1.4
Married	57	78.1
Separated	3	4.1
No response	1	1.4

(Only female, n=73).

Table 7.2 Restricted foods for pregnant women and children in Delta State, Nigeria

	Responses	**Frequency**	**Percent**
Are there restricted foods for pregnant women?	Yes	38	52.1
	No	21	28.8
	I don't know	13	17.8
	No response	1	1.4
	Total	73	100
Are there restricted foods for children?	Yes	9	12.3
	No	46	63.0
	I don't know	16	21.9
	No response	2	2.7
	Total	73	100

List of commonly identified restricted foods in Delta State Nigeria

Pregnant women	Children
Pounded yam/yam	Pounded yam/yam
Eba/gaari/fufu	Eba/gaari/fufu
Pepper soup/stew	Noodles?
Vegetable soup/akpu	Vegetable soup and akpu
Tea/beverages	
Meat/chicken	
Eggs	

Table 7.3 Minimum dietary diversity of women before and after training

MDD Score	Percentage of women that consumes at least 6 out of 10 food groups (%)	Percentage of women that consumes less than 6 out of 10 food groups (%)
Baseline	47.9	52.1
Endline	57.7	42.3

(n =73)

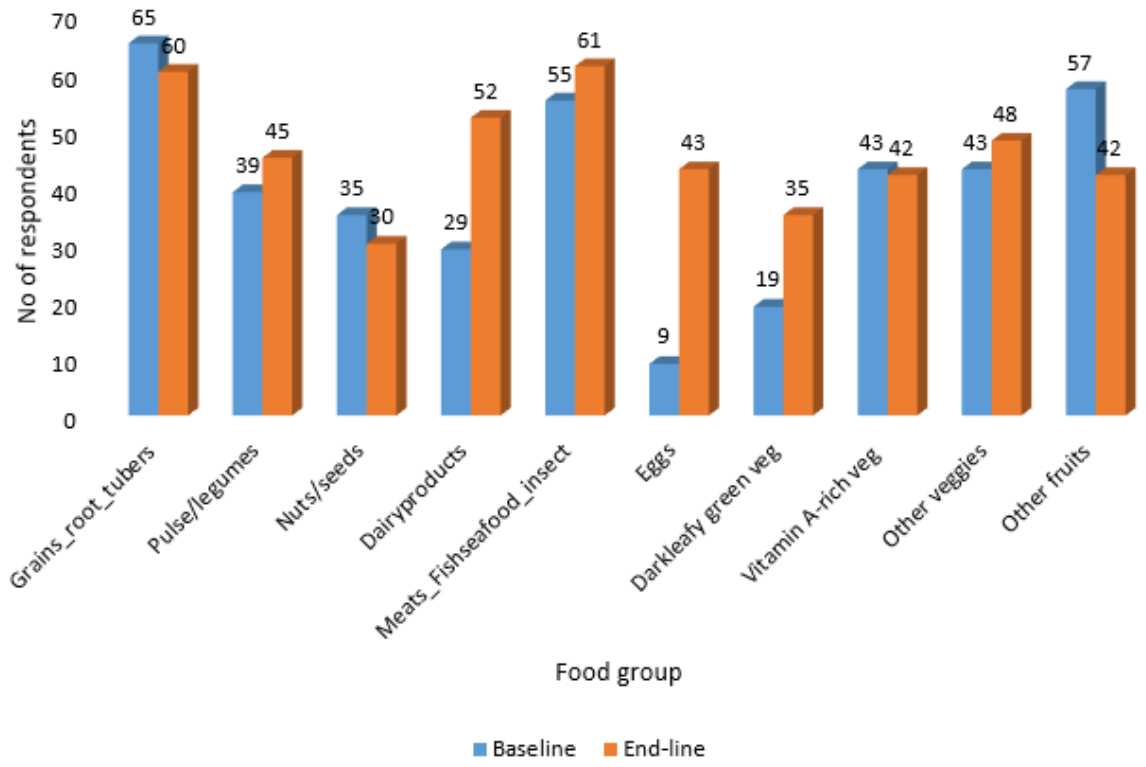


Figure 7.2 Respondent's consumption of food groups over 24 hours

Data from baseline and end-line survey

Table 7.4 Paired differences of mean DDS at baseline and end-line

MDDW score	Mean	Paired difference Mean	Std Dev.	Std Error Mean	t	Sig. (2 tailed)
Baseline (pre-survey)	5.775±0.22	-0.5915	0.2734	0.3244	-1.8230	.0730
End-line (post-survey)	6.366±0.20					

Pair samples T-test, at 95% CI., n=73

Evaluating low literacy tools

Table 7.5 Use and suitability of low-literacy tools as nutrition promotional materials

Variables		
Frequency of use	**n**	**%**
Occasionally	23	25.0
Always	69	75.0
Comfortability of wristband use		
Indifferent	14	15.2
Comfortable	78	84.8
Attractiveness of tools		
Attractive	23	25.0
Very attractive	69	75.0
Usefulness/suitability of tools		
Neutral	22	23.9
Very useful	70	76.1
The frequency that tools served as reminders on fish nutrition and food safety training		
Occasionally	18	19.6
Often	74	80.4
The tools initiate a conversation on the benefits of fish consumption and food safety		
Neutral	22	23.9
Agree	70	76.1

Fish processor's perceptions of the low-literacy tools, including wristbands and hand fans (n=92)

Table 7.5 above shows the qualitative result of the usefulness and acceptance of the low literacy tools, hand fans, and wristbands. This study shows that the fish processors find the tools useful, comfortable, and attractive. A higher percentage 80.4% said that the tools often remind them of the nutrition and food safety training, while 76.1% agreed that the tools are a conversation starter on the nutritional benefits of fish consumption.

Discussion

Participant's demographic characteristics

The results of this study laid the premise for a better understanding of the dynamics of food consumption, nutrition, and dietary diversity among women fish processors in Delta State, Nigeria. The demographic information shows that majority of the participants have a post-primary education which seems to be advantageous in terms of their ability to utilize the nutrition information provided through the training intervention to improve their dietary patterns thereafter. In this study 68.6% of the women had completed secondary education, this is commensurate with the result of the Nigeria Demographic and Health Survey (NDHS) shows that educational attainment is fairly high in Nigeria; 45% of women and 62% of men have completed secondary education (National Population Commission of Nigeria, 2014).

Literature shows that women with low or no literacy may not utilize nutritional information and are less likely to meet the required dietary intake for improved nutritional status (Ickes et al., 2015). Another study in Uganda, East Africa, shows that women with low literacy and no formal education or skills are more likely to have malnourished children (Ickes et al., 2018; Ickes et al., 2017). Limited education has a significant association with lower micronutrients (iron, folate, and vitamin D) intake (Rippin et al., 2020; Ickes et al., 2015; Iftikhar et al., 2017). In addition, women's knowledge of nutritional needs during pregnancy and food safety can help in reducing the non-communicable disease (NCDs) prevalence (Thandar et al., 2019).

In this study, many of the participants have a family size of between 4 and 9 people. A study in Nigeria shows that family sizes of 5 and 8 members are vulnerable to food insecurity (Olayemi, 2012). Several other studies confirm the relationship between household size, food security, and dietary diversity (Aidoo et al., 2013; Mango et al., 2014).

Animal source food consumption

ASF are food groups from animal source which includes dairy products, meats, fish, seafood, insects, and eggs. Meat or chicken and eggs are identified as restricted foods for pregnant women. This study demonstrated that the consumption of animal-source foods was improved among women after the training. As shown in figure 7.2, Egg was one of the identified restricted foods and the least consumed only by 17% of the respondent followed by 28% that consumed 'dark leafy green vegetable' food groups within the past 24 hours. A recent study posted that choice of food allocation is influenced by the economy, social value, and other factors which sometimes limit the animal source food intake by children and women (Gittelsohn & Vastine, 2003). The result of this study reflected the improvement in the participant's knowledge of a healthy and diversified diet including the importance of consumption of animal food sources, and dairy products. This showed that participants have had a paradigm shift in perceptions about some restricted foods after the training intervention. The result aligns with the literature that access to nutrition education and information is an indicator of higher consumption of fruit, vegetable, milk, and fish consumption (Moreira & Padra, 2004).

Consumption of other food groups

Other identified restricted food for pregnant women and children includes pounded yam or yam, eba or gaari, fufu, and akpu which are part of the typical Nigerian diet and are mostly starchy foods from plant sources. However, consumption of these food groups; grains, roots, and tubers remain relatively high post-training, even though there is a 4% reduction in the consumption. Research has shown that women of reproductive age (WRA), due to low dietary intake dominated

by starchy foods commonly suffer micronutrient deficiency (Chakona & Shackleton, 2017). However, food restrictions in addition to seasonal variations may affect food consumption and be a barrier to dietary diversity and adequate maternal nutrition (Kavle & Landry, 2018; Ravaoarisoa et al., 2019).

There was an increase in fruit and vegetable consumption among the participants. Fruits are one of the main food groups that are nutritionally dense and contribute significantly to under-consumed nutrients. Evidence suggests that they reduce the risk of several chronic diseases, and their intake is generally considered an indicator of a healthy diet. A recent study shows that women that consume ASF, fruits, and vitamin A-rich vegetables reached the MDDW (Adubra et al., 2019).

Tea and beverages are another identified restricted food in this study. Consumption of beverages, sugary, and sweet foods have long been under surveillance globally for its associated risks such as obesity, diabetes, and other chronic diseases (Otto & Anderson, 2018; Karimbeiki et al., 2018).

Dietary diversity status

Dietary Diversity Score (DDS***)*** is an identified vital surveillance indicator for determining the effectiveness of intentions to resolve food insecurity and nutrient deficient related risk (FAO & 360, 2016). The observation of this study suggests that there is more dietary adjustment than increased dietary diversity among the participating women. In table 7.4, the mean DDS at the baseline was already relatively high 5.8 ± .22, and slightly increased at the end-line 6.4 ± .20, $p = 0.07$, but there is no statistical difference. Also, the percentage of women that consumed at least 6 of the ten food groups in this study increased by 9.8% after 12 weeks of the nutrition and food safety training intervention (table 7. 3). The food group consumption seems to be more evenly

distributed in figure 7.3, which presents evidence of a dietary adjustment. However, there is a need for a more diversified diet among the population, because dietary diversity deficit is one of the sinister problems eroding quality of life, especially among the poor in LMICs (Chakona & Shackleton, 2017).

Low literacy tools as nutrition promotional material

We found that the low literacy tools were suitable and useful to women and youth fish processors. It also serves as a reminder about nutrition and food safety values. The quality of attractiveness of the tools may make them suitable for promoting the fish business. Therefore, we are hopeful that the use of promotional low literacy tools like hand fans and wristbands will help the fish processors in marketing their fish products better and reach more customers.

Impact of Covid-19

Fish is a recognized source of economy and nutrition in developing countries, especially among the poor population (Ayoola, 2010; Selig et al., 2019; Tacon & Metian, 2013). Covid-19 has been responsible for economic regression in different parts of the world and has negatively impacted food security, and distribution, and influenced dietary patterns at the individual level. This study also suggests that fisheries and aquaculture might be a prospective career for both skilled and educated individuals in low-income countries like Nigeria. All the participants in this study were artisan women fish processors who depend on fisheries as a source of income. The unemployment rate has been worsened by the impact of COVID-19 in the past two years; *Unemployment rates during the COVID-19 pandemic* (Falk, 2020) and has been perceived as the

cause of increasing small-scale businesses and small-scale farming including fish production and processing in Nigeria.

Strength and limitations of the study

The instrument used in data collection is a dietary diversity survey that has been proven as a valid instrument in determining and monitoring the nutritional need and dietary intake, especially for women of reproductive age (FANTA, 2006; FAO & 360, 2016). However, the DDS for the children between 0-23 months collected from the study participants were exempted from analysis because of the small sample size which does not give an accurate representation of the study population.

Conclusion

The nutrition and food safety training may have improved the dietary diversity of women fish processors of reproductive age. Although there was no difference ($p > 0.05$) in the paired mean dietary diversity score (DDS) However, the number of participants meeting MDD increased by 10%. in addition, there was an increase in the consumption of animal source proteins including eggs, green leafy vegetables, dairy products, nuts, and legumes. Increased intake of animal source foods contributed to the increase in dietary diversity score (DDS). We suggest further longitudinal study to evaluate the food security determinants of dietary diversity among the target population using the food security survey. Emphasis should be placed on raising awareness of dietary diversification and its importance for children and women of reproductive age.

CHAPTER VIII

DISCUSSION

This project presents an evaluation of nutrition and food safety knowledge on small-scale women fish processors in Delta State, Nigeria, and an overview of a public health intervention to identify needs. This study was a public health nutrition education project, first and foremost with an evaluation component. Training materials with low literacy were created, then validated by experts and evaluated for comprehensibility by a sample of the target audience. The purpose of this study was to analyze if these newly validated materials together with the training helped to increase knowledge in nutrition and food safety among women fish processors in Nigeria. The findings support an increase in knowledge in the short term. The study also evaluated if the dietary diversity of women changed after going to the training. There is some indication of behavior changes though the difference was not statistically significant.

Understanding the sociodemographic characteristics, attitudes, and food handling practices in a study population is paramount in diagnosing the need and filling the knowledge gaps among the targeted group. The findings from the baseline survey presented in Chapter 4 were instrumental in providing a specific safe handling practice guide and sustainable recommendations to improve the quality and safety of processed fish products in Delta State, Nigeria.

This study also presents the methodological process of developing and validating low literacy nutrition and food safety training material, including low literacy tools (chapter 5). The

process requires a proper understanding of the target audience or foundational knowledge, which could be acquired through formative assessment, interviews or preliminary stakeholder's meeting report, and literature review. Developing relevant and culturally acceptable training material involves the use of appropriate language, high-quality graphics, and the involvement of experts for content validation (Conceicao et al., 2007; Ip, 2010; Sharma et al., 2019). The newly developed seven-module nutrition and food safety flipbook was considered relevant and suitable for the use of adult low-literate low-income women fish processors.

We found that the use of culturally appropriate, understandable, and validated low literacy nutrition, and food safety training material, *"Nutrition education, food safety, and safe fish handling practice guide"* is suitable for training the fish processors. Knowledge acquired was significant throughout the seven modules taught at a p-value < 0.05 (Chapter 6). Our finding was consistent with other studies that show that training interventions improve knowledge of nutrition and food safety. Literature show that nutrition and food safety training stimulate behavioral change toward safe food handling, preservation, and processing (Bailey et al., 2019; Losasso et al., 2012; West et al., 2020). However, the result of our end-line survey does not provide a measurable variable in the attitude and practice domain needed for determining behavioral change. Therefore, we recommend a review of the survey used in this study for future use.

Chapter 7 of this study presents that the consumption of animal-source foods and other food groups improves among the women fish processors three months after the training. A study shows that factors like economic and cultural factors may influence ASF consumption (Gittelsohn & Vastine, 2003). In addition, the minimum dietary diversity score of the women slightly increased with no significant difference at a p-value > 0.05. We observed a dietary adjustment in the food group consumption among the women and youth fish processors. Therefore, we recommend a

continuous campaign and promotion of dietary diversification. However, data on the child's dietary diversity was statistically insignificant based on the few numbers of respondents with children under 24 months at the time of data collection. We opined that the food security evaluation of the study group would be more appropriate in determining their nutrition and food security status.

Strengths and limitations of the study

The instruments and materials used in this study were validated. The involvement of experts from different fields contributed significantly to the improvement of newly developed training material; *"Nutrition education, food safety and safe fish handling guide for fish processors"* The training material were considered culturally appropriate, and understandable by the audience. This shows that they can understand and use the information after the training without external or extra help. However, knowledge acquisition using the pre and post quizzes seems not to be appropriate for participants with low literacy who couldn't participate in the true knowledge evaluation process. Although self-knowledge evaluation seems to be appropriate for this group, it may not give the true representation of the knowledge acquired.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The study involved the pre-assessment of the target population in respect of the knowledge about nutrition and safe fish handling practices. To fill the knowledge gap as an intervention to improve the quality and safety of processed fish products for local consumption, a low literacy training material was developed and validated for suitability and relevance by a group of experts. The training material was also subjected to validation by the target population by testing its comprehensibility. A 3-day participatory training was implemented in three senatorial districts in Delta State Nigeria, 122 fish processors were trained in a “Train the trainer model”. There was an improvement in knowledge acquisition using pre and post quizzes and retrospective self-knowledge evaluations. A post-assessment was conducted with an end-line survey at 12 weeks post-training. The minimum dietary diversity of women fish processors of reproductive age was relatively high before and after assessment. However, there is a need for a continuous dietary diversity campaign for an improved nutritional status.

In conclusion, nutrition and food safety education improved the knowledge of women and youth fish processors on healthy eating, benefits of fish and other animal source foods consumption, safe handling, and processing of fish for quality and safe products. The newly developed low literacy training material was suitable and culturally appropriate for the target population. The comprehensibility of the material suggests that the women can access, process, and understand it without the help of others after the training while they train their peers

subsequently. Low literacy nutrition and food safety promotional materials were considered suitable and effective in promoting fish business, nutrition, and safe fish products among the fish processors. However, nutrition and food safety literacy educators should give attention to the prevention of fish contamination as one of the sustainable interventions to improve the quality and safety of processed fish products.

Implications of research for practice

The nutrition and food safety training material *"Nutrition education, food safety, and safe fish handling practice guide for fish processors"* is a suitable validated nutrition and food safety literacy (NFSL) tool that could be used with adult fish processors in other low-income countries with similar socio-demographic characteristics and practices. There is a need for more research in nutrition and food safety literacy. We suggest that future research efforts should focus on low nutrition or food safety literacy instead of low literacy and education. Although, existing records show an association between education, literacy, and utilization of nutrition information for optimal health. However, in this study, we found that literacy is not synonymous with nutrition literacy or food safety literacy, even though literacy help facilitates nutrition and food safety literacy processes, especially in a peer-to-peer collaborative or participatory training model.

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APPENDIX A

INFORMED CONSENT FORM

Informed Consent Form for Participation in Research for Exempt Research*

IRB Approval Number: Number IRB-20-072
Title of Research Study: Nourishing Nations: Improving the Quality and Safety of Processed Fish Products in Nigeria.
Researcher(s):
US PI**:** Dr. Terezie Tolar-Peterson, Mississippi State University.
Nigeria Co-PI: Prof. Henrietta Ene-Obong, University of Calabar, Calabar, Nigeria.
WorldFish PI: Dr. Lauren Pincus, WorldFish or International Center for Living Aquatic Resources Management (ICLARM).
Procedures: If you participate in this study, you will be asked to complete a survey that will take about 60 minutes to complete after a nutrition and food safety training section.

1. The researcher participant will be informed about the study, and a consent form will be signed.
2. The participant will complete a survey with the help of an enumerator, which would be a master's student in Nutrition at the host university, the University of Calabar, Nigeria.
3. The participant will provide demographic, and socioeconomic information, and complete other sections of the survey that ask about fish business income-related activities, nutrition knowledge and hygiene practice, nutrition information and communication, fish preparation and processing, fish business accessibility, fish safety, and after-purchase handling, and measuring dietary diversity using woman's dietary recall and child dietary recall

Questions: If you have any questions about this research project, please feel free to contact Dr. Terezie Tolar-Peterson ***at*** (662) 325-3200 terezie.mosby@msstate.edu ***or*** Prof. Henrietta Ene-Obong, University of Calabar, Calabar, Nigeria. +2348036754151 henriettaeneobong@unical.edu.ng
Voluntary Participation: **Please understand that your** participation is voluntary**.** Your refusal to participate will involve no penalty or loss of benefits **to which you are otherwise entitled.** You may discontinue your participation **at any time without penalty or loss of benefits.**

Please take all the time you need to read through this document and decide whether you would like to participate in this research study.
If you agree to participate in this research study, please sign below. You will be given a copy of this form for your records.

_____ _____
Participant Signature Date

_____ _____
Investigator Signature Date

APPENDIX B

NOURISHING NATIONS BASELINE/END-LINE SURVEY

Code: _____

Version: 2021

Introduction

Before starting the interview, read aloud the following paragraph and ensure that the respondents understand before asking for their consent:

"Good morning/afternoon. We are coming from the University of Calabar (UC) and Mississippi State University (MSU). The purpose of this survey is to understand the level of knowledge of women and youth fish processors about the benefit of fish, the preferences influencing fish consumption, and the challenges encountered by the female fish processors and youth in the fish business regarding fish processing, production, and economy. We would like to share some of this information widely so that more people understand the benefits of fish in the human diet.

This study is funded by the USAID Feed the Future Innovation Lab for fish, the US Government's Global Hunger and Food Security Initiative. This survey has two parts, the second part will be administered at the end of the training workshop. If you indicate your willingness to participate in this survey, your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Your participation in the survey is voluntary and you do not have to participate if you don't want to. You may withdraw from the study at any time, and if there are questions that you would prefer not to answer then we respect your right not to answer them. You may ask questions at any time, and if after the survey/interview you have any questions, you can contact Prof. Henrietta Ene-Obong of the Human Nutrition and Dietetics Units, University of Calabar, Calabar, Nigeria at +2348036754151. This interview will take about 60 min.

i. Do you agree to provide the information? _____

(If the participant consent to take this pre-knowledge survey mark yes to this

question)

1 = Yes

2 = No - skip to terminate the survey

Code: _____

A. Demographic and Socioeconomic information

Instructions to the enumerator: *Record the following information for all the participants. The number of children in a household is the number of children 18 years below who are normally living in the same residence, eat together, and depend on their parents. A child that is based elsewhere*
(for work or school) should be included if they do NOT have another household:

A1. Age of respondent: _____

A2. The primary language is spoken by the respondent or participant.

1 = Hausa

2 = Yoruba

3 = Igbo

4 = Pidgin

5 = Ijaw

6 = Urhobo

7 = English

99 = Other, specify

A3. How many members does the household have? _____ (please list all household members in column

Participant ID: _____

	A4	A5	A6	A7	A8	A9	A10
Household member number	Name	Sex Children 1 = male 0 = female	Age For, under two children, list age in months	Religion *Record only for the woman or the mother* 1=Christian 2=Islam 3=Traditional 99=Others	The highest level of schooling obtained *Record only for the mother or participant* 1=Preschool/no formal education 2=some primary 3=complete primary 4=some secondary 5=complete secondary 6=university or higher 7 = other	Physiological status of women of reproductive age (15-49 years old) 1=pregnant 2=lactating 3=NPNL	Marital Status *Record only for those over 18* 1=single/never married 2=widowed 3=divorced 4=married 5=separated 99=other *If the respondent is below 18years and married* *97 = Child marriage*
	Name	**Code**	**Years**	**Code**	**Code**	**Code**	**Code**
1							
2							

3							
4							
5							
6							
7							

A11	A12	A13	A14	A15	A16	A17
Does your household own a TV set in working condition? 1 = yes 2 = no	Do you have an internet-enabled phone (smartphones e.g. iPhone, Android)? 1=Yes 2=No	Does the household have stable electricity? 1=Yes 2=No	What is your main source of energy for cooking? ***Read answers out loud*** *(select one)* 1 = electricity 2 = gas 3 = kerosene/paraffin 4 = coal (mined from the mines) 5 = charcoal (made from trees) 6 = solar 7 = sawdust 8 = firewood 9 = cow dung 99 = other, specify	What kind of toilet facility does the household use, primarily? ***Do not read answers out loud*** 1 = flush toilet or water closet 2 = pit latrine with slab 3 = pit latrine without a slab 4 = ventilated improved pit latrine 5 = composting toilet 6 = bucket 7 = use bush or field 8 = stream 99 = other, specify	What is the main source of water supply to the household, primarily? R***ead answers out loud*** (select one) 1= Stream, river, spring 2= borehole, well 3= Tap (pipe-borne) 4= purchased 99= other, specify	How do you get to the market most of the time (**choose only the most commonly used mode)?** 1 = walk 2 = bicycle 3 = motorcycle (okada) 4 = tricycle (keke) 5 = shared vehicle 6 = private vehicle 7 = canoe or boat 8 = animal or donkey 99 = other, specify
	Code	**Code**	**Code**	**Code**	**Code**	**Code**

A17b. How many minutes (one-way) does it take from your house to get to the fish market by the identified mode of transportation? _____

Participant ID: _____

A1. Fish business and income-related activities

A1.1	A1.2	A1.3
Which fish activities do your family members participate in? (Multiple options) 1= Fisherfolk/fishing 2= Fish farming 3= Fish business or trading (wholesale, retail) 4= Fish processing 99= others, please specify	What are your other sources of income? (Multiple options) ***Do not read answers out loud*** 1=Crop production 2=Poultry keeping 3=Livestock production 4=Trading 5=Support from husband, children/relatives 6= Labor on other farms 7= labor, not on a farm 8= Work in local business 9=Remittances (receive money) 10= Work for the government or public institution 11=Rent out land or house to others 12=Skilled salaried employment 13=Unskilled salaried employment 14=Petty trading and services 15=Pension/government allowance 16=Wholesale/retail trade (Business) 17=Manufacturing /handicraft 18 =none 99 =Others, specify	How long have you been in the fish processing business? ***Read answers out loud*** (select one) 1= < 1 yr. 2= 1 - 2 yrs. 3= 3 - 5 yrs. 4= 6 -10 yrs. 5= > 10 yrs.
Code	**Code**	**Code**

Participant ID: _____

Instruction: *Enter the amount in Nigerian currency (**Naira**)* ***Read answers out loud***

A1.4 During the low season of fish supply, how much do you make on average from the fish processing business in a week? _____

A1.5 During the high season (peak) of fish supply, how much do you make on average from a fish processing business in a week? _____

A1.6 Do you think that trying a new fish product could improve your business and income?

1 = Yes

2 = No

99 = Don't know

A1.7 How likely are you to accept and sell a new fish product? (Select one)

1 = Most likely

2 = likely

3 = Less Likely

4 = Not likely

99 = Don't know

Participant ID: _____

A2. Nutrition knowledge and hygiene practices

Food nutrition knowledge, practices, and dietary habits

Food code

1= Rice/bread/cereal	8= Fruits	15 = Plantains	21 = Eba/Gaari/fufu
2=Milk	9= Beans/moinmoin	16 = Ojuju soup	22 = Soybean cake
3=Fish/seafood/fish stew	10= Pepper soup/stew	17= Pounded yam/yam	23 = Pap
4= Meat/chicken	11= Vegetable soup and akpu	18 =Tea/beverages	24 = Noddles (indomie)
5= Eggs	12= Banga soup	19 = Amala	25 = Breastmilk
6= Snail &Grasscutter meat	13= Semolina/wheat	20 = Ewedu/okra	97 = Don't know
7=Vegetables	14= Ogbono soup		

A2.1a	A2.1b	A2.2a	A2.2b	A2.3a	A2.3b	A2.4
Are there foods that are particularly important for a pregnant woman to eat for good health during pregnancy? 1 = Yes 2 = No 98 = Don't know	If yes, which foods are the most important? (Enter codes, don't read responses out loud, allow respondents up to 4 answers) 99= others, specify	Are there any restricted foods for pregnant women? 1 = Yes 2 = No 98 = Don't know	If yes, mention them (enter codes if the responses are in the listed food and specify if not)	Are there any restricted foods for children? 1 = Yes 2 = No 98 = Don't know	If yes, mention them (enter codes if the responses are in the listed food and specify if not)	What foods does a young child (from 6 to 23 months) need to grow and develop healthily? (Allow respondents up to 4 answers)
Code	**Code**	**Code**	**Code**	**Code**	**Code**	**Code**

A2.5a Do you know the health and nutrition benefits of eating fish and fish products?

1 = Yes

2 = No

98 = I don't know

A2.5b If yes, mention some of the health and nutrition benefits? (Allow respondents up to 4 answers)

a. _____
b. _____
c. _____
d. _____

A2.6 Do you know any specific problem(s) associated with smoked fish consumption?

1= Yes

2= No

98= I don't know

A2.6b If yes, mention some of the problems (open response)

a. _____
b. _____
c. _____

A2.7 Do you know of any specific problem associated with Sundried fish consumption?
1= Yes

2= No

98= I don't know

A2.7b If yes, mention some of the problems

a. _____
b. _____
c. _____

Participant ID: _____

A2.8 Hygiene knowledge, practices, and outcomes

A2.8a	A2.8b	A2.8c	A2.8d
When do you wash your hands? (Choose as many as you want) ***Do not read answers out loud*** (Select all that apply) 1= Before eating 2= After going to the toilet 3= Before feeding your child 4= After cleaning a child who has defecated 99= Other 98= Don't know	Do you have the option to wash your hands under running water with soap? 1= Yes 2=No	Did your child or any member of your family had diarrhea, typhoid, cholera, etc. within the last 30 days? 1= Yes 2=No	How do you think food can get contaminated? ***Do not read options loud*** (Select all that apply) 1= Dirty Water 2= Dirty hands and fingers 3= Dirty dishes, cutlery, and utensils 4= Flies 5= Fecal matter from birds, animals, and human 6= Contaminated air 7= Dirty surroundings and waste 98= Don't know
Code	**Code**	**Code**	**Code**

Participant ID: _____

A3 Nutrition information and communication

Do not read answers out loud

A3.0 Source of nutrition information and communication code
1= Passed down from family and friends
2= Formal Education/ school
3=Books including textbooks, magazine, newspaper
4= Booklet, pamphlet, stickers, flipchart,
5=Media (TV or radio)
6= Social media/internet (Facebook, WhatsApp, YouTube, text messages etc.)
7= Religion leaders
8= Health worker /antenatal visit
9=Nutritionist/ Dietitian
10= Consultation, Lecture, training, workshop
99= Other, specify
98= Don't know

A3.1	**A3.2**	**A3.3**	**A3.4**
What is your main source of nutrition and food safety information? (Select one) *Refer to the code above*	Which of these means do you prefer most in receiving nutrition information? (Select one) *Refer to the code above*	Why did you choose your option in **A3.2**? 1= Physically accessible/easy to get 2= financially affordable 3= easy to understand 4= other, specify 98= I don't know (Multiple options)	Have you received nutrition education and food safety information from any of the sources in **A3.0** in the past month? 1= Yes 2= No
Code	**Code**	**Code**	**Code**

Instruction: *Place an X in one box that best describes your answer to each question.* ***Read answers out loud***

A3.5 On a scale of 1-5, how would you rank the **effectiveness** of these sources and communication means in receiving nutrition information?

	1	**2**	**3**	**4**	**5**
Nutrition information and communication sources and tools.	strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. Passed down from family, friends, and neighbors					
2. Formal Education/ school; university, college, high school					
3. Written material including textbooks, magazines, newspaper					
4. The nutrition information presented in Picture, charts, stickers, pamphlet					
5. Media (Television or radio)					
6. Social media and the internet; Facebook, WhatsApp, YouTube, text messages, etc.					
7. Religion leaders					
8. Health worker /antenatal visit					
9. Nutritionist/ Dietitian					
10. Consultation, Lecture, training, workshop					
11. Other, specify					

A3.6 If you are to introduce a new fish product to your customers, which of the media would you use to pass the information to them? (Select one of the nutrition information source code in **A3**) _____

A3.7 As a fish processor, if you are upgrading your fish business to include a new fish product, how would you encourage your customers to purchase the products? ***Open response***

1. _____
2._____
3._____
4. I don't know

A3.8 Are there nutritionists or dietitians in your community?

1 = Yes

2 = No

98 = I don't know

Participant ID: _____

Instruction: administer this part ONLY at the Post-survey

A3.9 Appearance, Acceptance, and Efficacy of the low literacy tools.

1. How often do you wear the wristband or use a hand fan?

    1= I do not remember to wear it, 2= Occasionally, 3= Always

2. How comfortable is the wristband?

    1= Not comfortable, 2= indifferent, 3= Comfortable

3. How attractive are the wristbands and hand fans?

    1= Not attractive 2= Attractive 3= Very attractive

4. How useful are these tools?

    1= Not useful, 2= useful, 3= very useful

5. How often do they remind you of the training on fish nutrition and food safety?

    1= Never 2= Occasionally 3= Often

6. It is a good way to initiate a conversation with others about the benefits of fish consumption and food safety.

    1= Disagree 2= Agree 3= Strongly agree

Participant ID: _____

Instructions to the enumerator: *Thank the participant for her time. However, the woman is free to discontinue the survey at any time.*

B1. Fish Preparation and Processing

B1.0 Preparation and processing behavior

Instructions to the enumerator. *Ask fish processors to list all the types of fish they purchase for resale. Allow for free-response. Probe for all types of fish and seafood: fresh, dried, bivalves, etc. When the participant is finished listing all fish types, repeat the list back to them and ask if it is complete. Then proceed to ask the following questions for each fish type one at a time*

Fish Code

1 = Nile Perch	7 = Bony Tongue Fish or African Bony Tongue Fish or African Arowana	12 = Threadfin	19 = Mormyrids - Elephant Snout Fish	25 = Freshwater Sardines (Clupeids)	32 = Bivalves
2 = Tilapia		13 = Grouper		26 = Shad	33 = Crayfish
3 = Catfish		14 = Hake		27 = Common Sole	34 = Crabs
4 = African Carp		15 = Cod/stockfish		28 = Barracuda	35 = Prawns/Shrimp
5 = African Tigerfish		15a = Cod Head		29 = shinynose	36 = Tuna
6 = Pike		16 = Atlantic Bumpers		30 = Mangrove oyster	37 = Snail
					38=unknown
	8 = African Knife fish/Aba Aba	17 = Common Carp	20 = Mudskipper	31 = Periwinkles	39=crumbles/ broken fish
	9 = Croakers	18 = Mackerel/Titus	21 = Moonfish		40=none
	10 = Snakehead		22 = Longfin Crevalle Jack		99 = Other
	11 = Snapper		23 = Bonga		
			24 = Saltwater Sardines		

Processing Codes

1 = Remove viscera (the organs)	8= Cut into large pieces (Chunks)	14 = Wash with water and lime
2= Remove intestines and stomach content	9= Cut into small pieces (Chunks)	15 = Wash with water (hot or cold)
3= Remove head	10= Keep whole and cut slits	16 = Soak
4= Remove scales	11 = Wash with fresh water	17 = drying
5= Cut into fillet	12 = Wash with salt water	18 = grinding 19 = remove shell
6= Remove gills	13 = Remove bones	99 = other, specify 20 = sieve/strain

B1.1a	B1.1b	B1.2	B1.3	B1.4	B1.5	B1.6	B1.7

Participant ID: _____

Which fish do you purchase? (Refer to fish code above)	**Fish form (s)** (When purchased) 1 = fresh 2 = dried 3 = smoked 4 = salted 5 = canned 6 = paste/ mashed 7 = powder 8 = frozen 9 = fried 10 = barbecued 99 = other, specify	**What is the price per kg of the fish** (when purchased)? (Naira/kg)	**How did you preserve this fish after purchase?** (Select all that apply) 1=cold storage 2=basket over fireplace 3= Air-tight container/ bag 4=Kiln, oven or over charcoal 5= Sundry 6= Add salt 97 = not applicable 98 = don't know Fish are cooked immediately	*Only ask if the participant chooses **B1.1a** for tilapia, catfish, croaker, mackerel, or sardines* 1= Imported 2= Produced domestically 97 =NA 98 =don't know	**If fish was reported to be produced in Nigeria, which of the following applies?** 2 = farmed in Nigeria 3 = caught from capture fisheries in Nigeria 97 = not applicable 98 = don't know (Select one)	**Fish form** (When sold) 1 = fresh 2 = dried 3 = smoked 4 = salted 5 = canned 6 = made into paste or mash 7 = powdered 9 = fried 10 = Barbecued 11 = boiled 13 = other, specify (Select all that apply)	**What is the price per kg of the fish** (when sold)? (Naira/kg)
Code	**Code**	**Code**	**Code**	**Code**	**Code**	**Code**	

Participant ID: _____

B1.8 Instruction: Indicate the processing methods you are using in processing your fish products and mention specific challenges associated with the method(s).

B1.8a	**B1.8b**	**B1.8c**	**B1.8d**
Which method do you use in processing your fish for sale? *(Select all that apply)* 1= Cooking/boiling 2= Smoking 3= Sun drying 4= Frying 99= other, specify	Do you add any chemicals to preserve fish offered for sale? 1 = Yes 2= No	What do you use for smoking the fish? Ask, If the respondent selected smoking in **B1.8a** 1 = wood 2 = charcoal 3= rubbish/waste 4= traditional Kiln 5= modernized kiln 99 = others, specify *(Select all that apply)*	What specific challenge(s) do you encounter with the fish processing method you selected in **B1.8a**? open response *(Allow multiple responses)* 1= exposure to pests, and microorganisms 2= exposure to sand, grit, dust, and grit 3= smoke, soot 4= foul odor due to fermentation 5= burn 6= loss of nutrients 7= chemical contamination e.g., PAHs 98= I don't know 99= others, specify
Enter Code above	**Code**	**Code**	**Code**

Participant ID: _____

B2. Fish business and Accessibility

(Accessibility means available for purchase for a resale)

B2.0 Which of these options best describe your access to fish? I can access it: (select one)

Instruction: *Place an **X** in one box that best describes your answer to each fish code selected.*

Read the options out loud.

Type of fish	Always	Most of the time	Sometimes	Occasionally	Never
Refer to fish code (B1.0)	**1**	**2**	**3**	**4**	**5**

Read the options out loud.

B2.1 Have you had any formal training in the past year to learn about new fish processing methods or fish products to expand your business?

1 = Yes

2 = No

B2.1b If yes, mention the processing method(s) you learned *(open response)*

a. _____
b. _____
c. _____

B2.1c Mention new fish products that were introduced during the training in the past year. *(Open response)*

a. _____
b. _____
c. _____

B2.2 What could be a possible reason(s) for you not to sell a new fish product? (Allow multiple answers)

1= Past negative experience trying a new product

2= Lack of money to buy and expand the business to include new fish products

3= Afraid consumers will reject the product because of the taste or some other preference

4= Afraid of trying a new product that people are not familiar with

98 = Others, specify_____

B2.3 Fish products business potentials (*Read answers out loud)*

	B2.3a	**B2.3b**	**B2.3c**
Fish form code 1 = fresh 2 = dried 3 = smoked 4 = salted 5 = canned 6 = paste/ mashed 7 = powder 8 = frozen	Which of the fish form is always available regardless? ***(Enter code)***	Which of the fish form do you think your customer prefers? ***(Enter code)***	Which of the fish form is cheaper to process? ***(Enter code)***

9 = fried 10 = barbecued 99 = other, specify			
Code			

Instruction: *Place an X in one box that best describes your answer to each question.*

Read answers out loud

B2.3d How would you rank the likelihood of the fish forms being exposed to the contamination? (Flies, dust, smoke, dirt, rodents' droppings, etc.)

	1	**2**	**3**
Fish form code	Least Likely	More Likely	Most Likely
1 = fresh			
2 = dried			
3 = smoked			
4 = salted			
5 = canned			
6 = paste/ mashed			

7 = powder			
8 = frozen			
9 = fried			
10 = barbecued			
99 = other, specify			

B2.4a What can you do to improve the quality (nutrient) and safety of the fish product you currently offer for sale? ***Read out loud (open response)***

1. _____

2._____

3. I don't know

B2.4b What fish products are you interested in learning more about through this program? (Select from the fish form code) _____

Participant ID: _____

B3. Fish safety and the post-harvest handling

B3.0 **Fish handling and sanitation during processing**

B3.1a	**B3.1b**	**B3.1c**	**B3.1d**	**B3.1e**	**B3.1f**	**B3.1g**
What is the typical time lapse between when you purchase the fish to when you sell it? State number of hours; or 99= Don't know	Are fish transported to your business site or shop kept on ice or in a refrigerated container? ***read answers out loud*** 1= Ice container 2= refrigerated container 99= don't know	Do you practice handwashing before handling fish using clean water and soap? 1= Yes 2= No 3= sometimes 99= don't know	Do you use gloves on your hands when you handle fish? 1= Yes 2= No 3= sometimes 99= don't know	Is access to clean water available at your site of business? 1= Yes 2= No 3= sometimes 99= don't know	If answered yes to B3.1d, what type of water? ***Do not read answers out loud*** 1= Pipe water 2= River water 3= Groundwater 4=borehole 5=rain catch	What kind of toilet facility is present at your site of business? ***Do not read answers out loud*** (select one 1 = flush toilet or water closet 2 = pit latrine with slab 3 = pit latrine without a slab 4 = ventilated improved pit latrine 5 = composting toilet 6 = bucket 7 = use bush or field 8 = stream 99 = other, specify
Hours	**Code**	**Code**	**Code**	**Code**	**Code**	**Code**

B3.2 Fish safety knowledge, behavior, and challenges

B3.2a. On a scale of 1-5 how good (regarding spoilage) are the fish you purchase for sale (select one)

1	2	3	4	5
Very bad	**Bad**	**Fair**	**Good**	**Very Good**

Do not read answers out loud

B3.2b	**B3.2c**	**B3.2d**
How do you recognize a bad or spoilt frozen fish? (Select all that apply) ***Do not read answers out loud*** 1= smell/ odor 2= dark or dull brown operculum/gill 3= fallen scale 4= wounds or cuts 5= presence of parasites or flies 6= dull grey or faded color 7= flabby & soft skin 8= sunken, dull eye 99= other specify 97= Don't know	How do you identify a deteriorating dried fish? (Select all that apply) ***Do not read answers out loud*** 1 = presence of mold 2 = worms or insect larva 3 = loss of nutrients 4 = Change in taste 98 = don't know 99 = others (specify)	How do you identify a deteriorating smoked or fried fish? (Select all that apply) ***Do not read answers out loud*** 1 = presence of mold 2 = worms or insect larva 3 = loss of nutrients 4 = Change in taste 98 = don't know 99 = others (specify)

Enter code	Code	Code

B3. 2d	B3.2e	B3.2f	B3.2g
How often does the fish you purchase to resell go bad before you can resell it? (Select one) ***Read answers out loud*** 1= Always 2= Most of the time 3= sometimes 4= occasionally 5= Never	What is the reason for spoilage after purchase? (Select all that apply) ***Do not read answers out loud*** 1 = weather conditions 2 = loss of access to appropriate home storage 3 = electrical outage 4 = fish had some injuries or deformities 5 = poor handling during processing 6= pests (insects, rats, etc.) 99 = other, specify	What do you do with the spoiled fish that you could not sell? (Select all that apply) ***Do not read answers out loud*** 1=feed to other animals 2=compost (use to fertilize other crops) 3=throw away 4= eat 99=other, specify	What are your major challenges or barriers as a fish processor to producing fish-based products? (Select all that apply) ***Do not read answers out loud*** 1= lack of access to credit and other forms of financial support 2= electricity outage 3= Pest e.g., insects, flies, rodents, etc. 4= Lack of storage facilities 5= lack of knowledge on better fish processing and preservation 6= financial loss from spoilage 7= Lack of motivation 8= Health hazards e.g. smoke, odor, injuries, or cuts 9= Seasonal lack of availability of fish 10= Distance from the fish market or farm 11= Competition in the marketplace

			12= high cost of equipment needed for processing fish. 13= low consumer willingness to pay price for fish products. 99= others, specify
Code	**Code**	**Code**	**Code**

Instructions to the enumerator: *Thank the participant for her time. However, the woman is free to discontinue the survey at any time*

Participant ID: _____

C. Measuring dietary diversity among women and children

Section C1: Woman's Dietary Recall

Yesterday during the day or last night, did you eat or drink any of the following items? Note: food eaten today should not be included. This section is for the wife (or head of household if she is female) who is under 50 years old.

Instructions to enumerator: *List the foods from each group one by one. As soon as the respondent says yes to one food group, you can stop listing from that group. Be careful with the groups to avoid miscategorization. For example, ripe papaya goes in a different group than the other fruits group.*

	Food categories	**Locally available foods**	**Consumed** 1=Yes 2=No
C01	**Grains** **Roots & tubers**	Wheat, oats, maize, rice, sorghum (guinea corn or *dawa*), millet (*gero/jero*), fonio(*acha), pate*, *doro*, couscous, spaghetti (*talia*), macaroni, noodles, bread, *tuwo shinkafa*, *tuwo masara*, semo, *masa*, *pap*, *agidi*, *egbo*, other foods made from cereal grains Yam, three-leaf yam (*ona/esuru/enem*), *amala*, water yam, aeriel yam (*adu*), cocoyam, taro, irish potato, *garri*, *fufu*, *lafun*, cassava, *abacha*, tapioca, tiger nut flour, white or yellow fleshed sweet potato, native potato, plantain	
C02	**Pulse/legumes**	Brown beans, white beans, all kinds of cowpea (iron beans, *aloka*, *akidi*), chickpeas, soya beans, bambara nut (*ebi-abo*), mucuna beans/velvet beans, pigeon pea (*fiofio*, *agbugbu*), African yam bean (*azama*, *opkodudu*, *igirigi*), kidney bean, lima bean, Jack bean (*egbekpen*), winged bean (*okwe*), ground bean (*akidi ani*)	
C03	**Nuts and Seeds**	Sesame seed/beniseed (*ridi/okpa odudu*), gourd/melon seed (*egusi*), pumpkin seeds (*mkpuru anyu/ugboguru*), sunflower seeds, walnuts, groundnuts, shea nut, cashew nuts, bush mango seeds (*ogbono*), african oil bean seed (*ugba/ukpaka*), bread fruit seed (*ukwa*), *ibaba/ukpo*, *achi*, *ofor*, *akparata*	
C04	**Dairy Products**	Milk, sour milk (*nono*), yogurt (*kindirmo*), cheese (*wara*), powdered milk, condensed milk, evaporated milk, goat milk, camel milk	

	Food categories	Locally available foods	Consumed 1=Yes 2=No
C05	**Meats or poultry** **Fish, seafood, and snails** **Insects**	Beef, mutton, goat, rabbit, chicken, goose, turkey, quail, pork, lamb, grass cutter, guinea fowl, hawk, pigeon, small kangaroo, dove, squirrel, guinea pig, deer, alligator lizard, crocodile, camel, antelope, bat, bush rat, and other bushmeat/bird, *kundi, kilishi, dambu nama*, horse, camel, duck, ox tail, cow leg, lung, stomach, intestines, tongue, brain, spleen, frog (*konko/ankere*, liver, kidney, heart, gizzard Fresh fish, frozen fish (e.g. mackerel/Titus, *kote*), canned fish (sardine, Geisha), smoked fish, dried fish, crab, lobster, shrimp, stock fish (*okporoko*), bonga fish, mudfish, tilapia, catfish, barracuda, any other type of fish or snail Pallid Emperor moth (Yoruba: *Kanni, Munimuni*), Palm weevil (Yoruba*: Ipe, Itun*), Snout beetle (Yoruba: *Ogongo*), Rhinocerus beetle (Ibo: *Ebe*), Caterpillar (Yoruba: *Ekuku*), Yam beetle, Grasshopper (Yoruba: *Tata;* Ibo: *abuzu, Ukpana),* Honeybee (Yoruba: *Oyin),* Termites (Yoruba: *Esunsun;* Ibo: *Aku*), Cricket (Yoruba: *Ire*), Green stink bug, other insects	
C06	**Eggs**	Quail eggs, chicken eggs, duck eggs, guinea fowl eggs	
C07	**Dark leafy green vegetables**	Lagos Spinach (*efo shoko),* Wild Lettuce *(Efo Yanrin),* Bitter leaves (*efo ewuro),* African Spinach *(Efo Tete),* Water leaf (*Gbure),* Eggplant leaves *(efo igbo),* Malabar spinach (*Amunututu),* African basil/scent leaf (*Efinrin*), Yoruban bologi (*Ebolo Yoruba)*, a*fang/okazi*, Fluted pumpkin leaf (*Ugu), zogale* (moringa), *yakuwa* (sorrel leaves), *soko*, *ewedu/ayoyo*, sweet potato leaves, cassava leaves, cocoyam leaves, amaranthus/spinach (green/*tete*), *oha* leaf, *karkashi*, *kuka* (baobab, luru), *lansir, yadiya, rama, tafasa*, *kanya*, cress, *eku gogoro, eku petere, ilasa* (young okro leaves), *igbagba, atama, editan*, scent leaf (*ntong/nchuawu/ arigbe/aluluisi*), *chaya* (*iyana paja*), other green leaves eaten	
C08	**Vitamin A-rich vegetables (remember Vitamin A-rich veggies are orange!) Vitamin A-rich fruits and Red Palm oil**	Squash that is orange inside, pumpkin, carrot, red sweet pepper (*tatase*), a sweet potato that is orange inside (orange sweet potatoes) Ripe pawpaw (*gwanda/ibeppe/okwuru oru/bobo*), ripe mango, ripe passion fruit, *dorowa* (locust bean fruit), red palm fruit, hog plum (*tsadan gida, iyeye, ngulungu*), ripe cantaloupe, musk melon, monkey cola (*ndiya*), bush mango fruit (*ugili/ogbono/mbupauyo*), Red oil added to any food	
C09	**Other vegetables**	Cabbage, cucumber, cauliflower, fresh tomato, onion, green beans, green pepper, radish, okro, garden egg, eggplant, green peas, boiled or roasted fresh corn, beets, mushroom, *ujuju*	

	Food categories	Locally available foods	Consumed 1=Yes 2=No
C10	**Other fruits**	Apple, banana, watermelon, tangerine, avocado pear, oranges, pears, dates (*dabino*), guava, pineapple, grapefruit, coconut, African cherry/African star apple (*agbalumo/udara/udala*), breadfruit, cashew fruit, soursop, golden melon, baobab fruit (*ose/nonkuku*), figs, shea fruit, doum palm fruit (*goruba*)	

Section C2: Child Dietary Recall

Instructions to enumerator:

Ask the participant again if she has or is a caretaker of a child under two years old. If there is no child in that range or if there are no children in the household between 6 and 24 months, skip to section E.

C11. Child Name:

C12. Can you tell me everything that [child] ate yesterday, from the morning he or she woke up to when he or she went to sleep?

1 = Yes

2 = No

Cc. *Now I would like to ask you about liquids or foods that (NAME) ate yesterday during the day or at night. I am interested in whether your child had the item even if it was combined with other foods. For example, if (NAME) ate a millet porridge made with a mixed vegetable sauce, you should reply yes to any food I ask about that was an ingredient in the porridge or sauce. Please do not include any food used in a small amount for seasoning or condiments (like chilies, spices, herbs), I will ask you about those foods separately. Yesterday during the day or at night, did (NAME) drink/eat:*

	Food categories	Locally available foods	Consumed 1=yes 2=no
C13	**Breastmilk**	From mother or foster mother	
C14	**Grains,** **Roots and tubers**	Wheat, oats, maize, rice, sorghum (guinea corn or *dawa*), millet (*gero/jero*), fonio(*acha), pate, doro*, couscous, spaghetti (*talia*), macaroni, noodles, bread, *tuwo shinkafa*, *tuwo masara*, semo, *masa*, *pap*, *agidi*, *egbo,* other foods made from cereal grains Yam, three leaf yam (*ona/esuru/enem*), *amala*, water yam, aeriel yam (*adu*), cocoyam, taro, irish potato, *garri, fufu, lafun*, cassava, *abacha*, tapioca, tigernut flour, white or yellow fleshed sweet potato, native potato, plantain	
C15	**Legumes,** **Seeds and Nuts**	Brown beans, white beans, all kinds of cowpea (iron beans, *aloka, akidi*), chickpeas, soya beans, bambara nut (*ebi-abo*), mucuna beans/velvet beans, pigeon pea (*fiofio, agbugbu*), African yam bean (*azama, opkodudu, igirigi*), kidney bean, lima bean, Jack bean (*egbekpen*), winged bean (*okwe*), ground bean (*akidi ani*) Sesame seed/beniseed (*ridi/okpa odudu*), gourd/melon seed (*egusi*), pumpkin seeds (*mkpuru anyu/ugboguru*), sunflower seeds, walnuts, groundnuts, shea nut, cashew nuts, bush mango seeds (*ogbono*), african oil bean seed (*ugba/ukpaka*), bread fruit seed (*ukwa*), *ibaba/ukpo, achi, ofor, akparata*	
C16	**Dairy products**	Milk, sour milk (*nono*), yogurt (*kindirmo*), cheese (*wara*), powdered milk, condensed milk, evaporated milk, goat milk, camel milk	
C17	**Flesh Foods: Meats or poultry** **Fish, seafood, and snails** **Insects**	Beef, mutton, goat, rabbit, chicken, goose, turkey, quail, pork, lamb, grass cutter, guinea fowl, hawk, pigeon, small kangaroo, dove, squirrel, guinea pig, deer, alligator lizard, crocodile, camel, antelope, bat, bush rat, and other bushmeat/bird, *kundi, kilishi, dambu nama*, horse, camel, duck, ox tail, cow leg, lung, stomach, intestines, tongue, brain, spleen, frog (*konko/ankere*, liver, kidney, heart, gizzard Fresh fish, frozen fish (e.g., mackerel/Titus, *kote*), canned fish (sardine, Geisha), smoked fish, dried fish, crab, lobster, shrimp, stock fish (*okporoko*), bonga fish, mudfish, tilapia, catfish, barracuda, any other type of fish or snail Pallid Emperor moth (Yoruba: *Kanni, Munimuni*), Palm weevil (Yoruba*: Ipe, Itun*), Snout beetle (Yoruba: *Ogongo*), Rhinoceros beetle (Ibo: *Ebe*), Caterpillar (Yoruba: *Ekuku*), Yam beetle, Grasshopper (Yoruba: *Tata;* Ibo: *abuzu, Ukpana),* Honeybee (Yoruba: *Oyin),* Termites (Yoruba: *Esunsun;* Ibo: *Aku*), Cricket (Yoruba: *Ire*), Green stink bug, other insects	
C18	**Eggs**	Quail eggs, chicken eggs, duck eggs, guinea fowl eggs	
C19	**Dark leafy green vegetables**	Lagos Spinach (*efo shoko),* Wild Lettuce *(Efo Yanrin),* Bitter leaves (*efo ewuro),* African Spinach *(Efo Tete),* Water leaf (*Gbure),* Eggplant leaves *(efo igbo),* Malabar spinach (*Amunututu),* African basil/scent leaf (*Efinrin*), Yoruban bologi (*Ebolo Yoruba),* a*fang/okazi,* Fluted pumpkin	

	Food categories	Locally available foods	Consumed 1=yes 2=no
		leaf (*Ugu), zogale* (moringa), *yakuwa* (sorrel leaves), *soko*, *ewedu/ayoyo*, sweet potato leaves, cassava leaves, cocoyam leaves, amaranthus/spinach (green/*tete*), *oha* leaf, *karkashi*, *kuka* (baobab, luru), *lansir*, *yadiya*, *rama*, *tafasa*, *kanya*, cress, *eku gogoro, eku petere, ilasa* (young okro leaves), *igbagba*, *atama*, *editan*, scent leaf (*ntong/nchuawu/ arigbe/aluluisi*), *chaya* (*iyana paja*), other green leaves eaten	
C20	**Vitamin A rich vegetables and fruits** **Red palm oil**	Squash that is orange inside, pumpkin, carrot, red sweet pepper (*tatase*), sweet potato that is orange inside (orange sweet potatoes) Ripe pawpaw (*gwanda/ibeppe/okwuru oru/bobo*), ripe mango, ripe passion fruit, *dorowa* (locust bean fruit), red palm fruit, hog plum (*tsadan gida, iyeye, ngulungu*), ripe cantaloupe, musk melon, monkey cola (*ndiya*), bush mango fruit (*ugili/ogbono/mbupauyo*) Added to any food	
C21	**Other vegetables**	Cabbage, cucumber, cauliflower, fresh tomato, onion, green beans, green pepper, radish, okro, garden egg, eggplant, green peas, boiled or roasted fresh corn, beets, mushroom, *ujuju*	
C22	**Other fruits**	Apple, banana, watermelon, tangerine, avocado pear, oranges, pears, dates (*dabino*), guava, pineapple, grapefruit, coconut, African cherry/African star apple (*agbalumo/udara/udala*), breadfruit, cashew fruit, soursop, golden melon, baobab fruit (*ose/nonkuku*), figs, shea fruit, doum palm fruit (*goruba*)	

Participant ID: _____

D. Fish consumption and cooking behaviors

D1.0 Did your family eat fish in the past 7 days?

1=yes

2=no

Skip pattern: If yes, Fill in **D01.1 to D01.4.** If no, skip to **D2.1**

Instructions to the enumerator. *Ask which fish the family has consumed in the past 7 days. Allow for free response. Probe for types of fish and seafood: fresh, dried, bivalves, other aquatic animals, etc. Also probe for fish forms such as canned, fish powder, etc. Ask the questions for each fish one at a time*

D1.1	**D1.2**	**D1.3**	**D1.4**
Which fish? (Refer to fish code above)	**Where was the fish obtained?** 1 = open market 6 = fish market 2 = store 3 = home production 4 = gift 5 = bartered 7 = supermarket 8 = farmgate 9= left over from business or procured from fellow fish processors 98 = don't know 99 = other	**Which fish form do you prepare this fish for your family's consumption?** (Select all that apply from the processing code above) **98 = don't know**	**When this fish was consumed, which parts were left behind as plate waste?** 1 = tail 2 = flesh 3 = skin 4 = head 5 = bones 6 = nothing is left behind 7 = shell 98 = don't know
Code	**Code**	**Code**	**Parts**

D2. Fish in Complementary Foods

		Months
D2.1	At what age do you think children should begin eating fish?	
D2.2	At what age do you think children should begin eating eggs?	
D2.3	At what age do you think children should begin eating meat?	
D2.4	At what age do you think children should begin drinking animal milk?	
D2.5	For the youngest child in the household: at what age did you start feeding the child fish?	

D2.6	**D2.7a**	**D2.7b**
When your children were babies, did you add any fish or fish products to the pap? 1 = yes 2 = no 3 = not applicable	If yes, which fish and do you add? Type of fish (use codes above)	What form of fish do you add? Form of fish (use codes above)
Code	**Code**	**Code**

E. Observations

E1 Enumerator comments about this survey: _____

E2. Survey status:

1 = complete

2 = terminated

If **E2** = 2, continue to **E3**. Otherwise, save and upload.

E3. Reason for termination:

1 = respondent fatigue

2 = respondent refused

3 = respondent had to leave

4 = nature (rain, etc.)

99 = other, specify.

APPENDIX C

CVI RESULTS

Project's Comprehensive Workplan

(Research Proposal Workplan and Timeframe.xlsx)

CVI Result

https://docs.google.com/spreadsheets/d/1YEek7SwV9EhR7MmqvTnLYTL3ZffCNs8a/edit#gid=511369385

APPENDIX D

PRE AND POST QUIZ

Module 1 Healthy Eating

1. What is healthy eating? (a) Eating all food colors (b) Eating yam, rice, and corn (c) Eating vegetables, and multivitamins

2. Eating varieties of food is important because it will make us (a) look robust and very fat (b) hungry and eat more (c) grow well

3. Choose the correct MyPlate from the list of good foods

(a) Vegetables, juice, and tubers (b) Fruits, vegetables, proteins, grains, dairy, root, and tubers (c) Water, diet coke, tubers, and vegetables.

Module 2 Animal Source Protein

1. Fish is an animal source of protein.

   It is good for (a) only infants and children (b) Pregnant women only (c) Children, young children, women, and adults.

2. One of the options is **not** a benefit of eating fish

   (a) good for the eye (b) good for brain development in children (c) good for treating malaria.

3. Fish contains (a) fruits and veggies (b) salt and sweets (c) Omega 3 and Vitamin A.

Module 3 Food Safety

1. Food safety is (a) making food free from harmful substances (b) making food look nice and smell good (c) making food taste delicious

2. What are safe practices? (a) Watching TV (b) Actions taken to ensure safe and quality food production (c) helping others.

3. What will you do to keep fish from harmful germs and substances that can affect humans? (a) use pesticides to kill germs and flies (b) call the Delta State government for help (c) wash your hands with soap and clean water.

Module 4 Fish Processing and preservation

1. Modern fish processing methods are? (a) Oven baking and solar drying (b) smoking, and sun drying. (c) Salting and frying.

2. The method used for fish preparation or processing can affect

(a) the level of fish exposure to harmful substances (b) its quality (c) Both a and b

3. Which of these is not a safe and hygienic method of fish drying? (a) Air drying by hanging or spreading on a net table (b) solar or oven drying (c) Spread on the ground and cover it with a nylon or transparent plastic

Module 5 Food Contamination

1. Choose one of these options that do not make fish unsafe for eating.

(a) germs, chemicals, and harmful substances (b) witchcraft and evil eye (c) unclean water and expired ingredients.

2. How can you prevent or stop harmful substances from getting into product fish?

(a) Cover the fish products with your wrapper of cloth, (b) do not spray pesticides on fish (c) store the fish in a covered paint container to protect it from rats, cats, and insect attacks.

3. Why do we need to prevent fish and other foods from these harmful agents?

(a) to promote our business (b) to maintain a good name in the community (c) to prevent foodborne diseases.

Module 6 Hygiene rules and good practices

1. Sanitary requirements of fish processing premises are the following except

   (a) Adequate lighting, space, and fresh air (b) clean water, and handwashing facility (c) located close to a latrine or dumpsite.

2. Which one does not describe good practices? (a) good makeup and customer service.

   (b) good hygiene and processing practices. (c) good fish handling and packaging practices.

3. You can store processed fish in a chemical container if you wash it properly with water?

   (a) True (b) False

Module 7 Economic benefits of a quality and safe fish product

1. Health benefits of quality and safe fish products to an individual is: (a) improve nutrition status, and healthy eating habits (b) prevent foodborne diseases (c) a and b is correct.

2. Economic benefits of quality and safe fish products include (a) create job opportunities and reduce poverty. (b) improve income and prevent fish loss (c) b and a is correct.

3. You can save more money by reducing the fish waste generated (a) Yes (b) No (c) I don't know.

APPENDIX E

COMPREHENSIBILITY TEST MATERIAL

Marking guide

Each question contains 7.1 points, participants must answer 9 questions correctly to meet the pass mark. A score ≥ 60% is a pass mark. *The respondent is to fill in the blank gaps with the exact word as much as they can. The participants will be i.) encourage to answer all the questions as accurately as possible, ii.) read through the sentence before answering, iii.) never mind the spelling errors, iv.) write only one word, v.) It is okay to guess, and vi.) reassure them that it is not a timed test.*

1. Heathy diet is eating _____, brown, and rainbow foods (white)
2. Rainbow food contains fruits and _____ (vegetables), brown food contains proteins and white food contains grains, tubers, and roots.
3. Fish is good for _____ and pregnant women (children)
4. Fish nutrients improve the _____, heart and bone health (Eye)
5. Dirty hands, water, and soil, contains _____ (Germs)
6. Wash your hands before _____fish or after using the toilet (handling or touching)
7. Don't cough or sneeze into your _____ (hand, palm)
8. Visit the hospital when _____ (sick)
9. Food-borne illnesses are caused by _____ (germs)
10. Fish is exposed to _____ during smoking (hazard, smoke, dioxin, PAHs)
11. Do not store cooked _____ with uncooked or raw foods (fish, meat, or food)
12. Biological hazards include germs, and _____ (flies, pests, body fluid, feces)
13. _____ improves the quality and safety of processed fish products (proper handling, good practices)
14. Quality and safe processing _____ fish waste and loss (prevents, reduces)

Comprehensibility Test

Instructions: Please, fill in the blank gaps with the exact word as much as you can.

i)Answer all the questions as accurately as possible, ii.) Read through the sentence before answering, iii.) Do not worry about the spelling errors, iv.) Write only one word, and it is okay to guess if you are not sure of the answer.

1. Heathy diet is eating _____, brown, and rainbow foods
2. Rainbow food contains fruits and _____, brown food contains proteins and milk products, white food contains grains, tubers, and roots.
3. Fish is good for _____ and pregnant women
4. Fish nutrients improve the _____, heart and bone health
5. Dirty hands, water, and soil, contains _____
6. Wash your hands before _____fish or after using the toilet
7. Don't cough or sneeze into your _____
8. Visit the hospital when _____
9. Food-borne illnesses are caused by _____
10. Fish is exposed to _____ during smoking
11. Do not store cooked _____ with uncooked or raw foods
12. Biological hazards include germs, and _____
13. _____ improves the quality and safety of processed fish products
14. Quality and safe processing _____ fish waste and loss

APPENDIX F

TRAINING EVALUATION SURVEY

1. Please rate the training in terms of its impact and usefulness in your business using the scale below. Circle the numbers that apply to your opinions

1= Not useful at all 5= Very useful

	1	2	3	4	5
Training program					

2. Please complete the following by checking the column of your choice

Rate the quality of the following	Poor	Fair	Good	Very good	Excellent
The overall content of the training					
PowerPoints slides					
Low literacy material and tools					
Presentation of the material & training method					
Participant/group activities					
Facilitation activities by trainers					

SELF-KNOWLEDGE EVALUATION

3. Think about what you knew and what you learned during this training about nutrition and food safety instructions. Evaluate your knowledge in each topic area related to nutrition and food safety ***Before and After*** this training.

Before Training					Self -Assessment of your knowledge and skills related to:	After Training				
1	2	3	4	5	Module 1: Healthy Eating Habits	1	2	3	4	5
1	2	3	4	5	Module 2: Animal Source Protein	1	2	3	4	5
1	2	3	4	5	Module 3: Food Safety	1	2	3	4	5
1	2	3	4	5	Module 4: Fish Processing and preservation	1	2	3	4	5
1	2	3	4	5	Module 5: Food Poisoning	1	2	3	4	5
1	2	3	4	5	Module 6: Hygiene and good practices	1	2	3	4	5
1	2	3	4	5	Module 7: Economic benefits of a quality & safe fish product	1	2	3	4	5

APPENDIX G

ACRONYMS

Agricultural Development Program (ADP)

Animal-Source Food (ASF)

Bisphenol A (BPA)

Bone Mineral Density (BMD)

Center for Disease Control and Prevention (CDC)

Chronic Obstructive Pulmonary Diseases (COPD)

Co-Principal Investigator (Co-PI)

Critical Control Points (CPP)

Delta Agricultural and Rural Development Agency (DARDA)

Dietary Diversity Score (DDS)

Disability-Adjusted Life-Years (DALYs)

Docosahexaenoic acid (DHA

Eicosapentaenoic acid (EPA)

Essential fatty acids (EFAs)

Feed the Future Innovation Lab for Fish (FTT FIL)

Food and Agricultural Organization (FAO)

Foodborne Disease Burden Epidemiology Reference Group (FERG)

Foodborne diseases (FBD)

Foodborne infectious Diseases (FID)

Good Aquaculture Practice (GAQP)

Good Handling and Packaging Practices (GHPP),

Good Hygiene practices (GHP),

Good Manufacturing Practices (GMP),

Good Storage Practices (GSP)

Good Transport Practices (GTP),

Hazard Analysis Critical Control Point (HACCP)

High-Density Lipoprotein (HDP),

Item-Level Content Validity Index (I-CVI)

Infant and young child feeding (IYCF)

Institutional Review Board (IRB)

Knowledge, Attitude and Practice (KAP)

Long-chain n-3 polyunsaturated fatty acids (LC n-3PUFAs)

Low literacy tools (LLT)

Low triglycerides (TGL)

Low-and middle- income countries (LMICs)

Low-density lipoprotein (LDL)

Millennium Development Goals (MDGs)

Minimum Acceptable Diet (MAD)

Minimum Dietary Diversity for Women (MDD-W

Minimum dietary diversity for a child (MDD)

Ministry of Agriculture (MOA)

Ministry of Agriculture and Natural Resources (MANR)

Ministry of Health (MOH)

Mississippi State University MSU

National Training Laboratories (NTL)

Non-Communicable Diseases (NDCs)

Non-lactating-Non-pregnant (NLNP)

Nutrition Education and Skills Training (NEST)

Nutrition and Food Safety Literacy (NFSL)

Persistent Organic Pollutants (POPs)

Poly Aliphatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs)

Post-Harvest Loss (PHL)

Pregnant and Lactating Women (PLW)

Principal Investigator (PI)

Protein-energy malnutrition (PEM)

Recommended Dietary Intake (RDI)

Scale-Level Content Validity Index (S-CVI)

Sanitation Standard Operating Procedures (SSOPs)

Severe Acute Malnutrition (SAM)

Simplified Measure of Gobbledygook (SMOG)

Small Indigenous Species (SIS)

Social cognitive theory (SCT)

State Nutrition Officer (SNO)

United Nations International Children's Emergency Fund UNICEF

United States Agency for International Development (USAID)

University of Calabar (UC)

Very Low-Density Lipoprotein (VLDL)

Vitamin A Deficiency (VAD

Water, Sanitation, and Hygiene (WASH)

Women of Reproductive Age (WRA).

World Bank Group (WBG)

World Food Production WFP

World Health Organization (WHO)

WorldFish or International Centre for Living Aquatic Resources Management (ICLARM)

Zone of Influence (ZOI)

APPENDIX H

FINDINGS FROM BUSINESS SITE VISITATION (PROCESSING SITES AND MARKETS)