APPLIED RESEARCH

Development and Promotion of Consumption of Novel Nutrient-rich Fish Products for Food and Nutritional Security

A Climate-smart Method of Producing Nutritious Fish Products

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Cover page: ©2022 Preparation of fish-based products in KMFRI Kisumu Research Centre Food Processing Laboratory, Kisumu County. Courtesy of Cecilia Githukia. Used with permission.

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1.0 INTRODUCTION

Fish accounts for approximately 17% of animal protein consumed globally and provide nearly 20% of average per capita animal protein intake for approximately 3.2 billion people (FAO, 2018). Fish are nutritionally rich in quality protein, lipids, vitamins, minerals, and essential micronutrients that are required to address some of the most severe and widespread nutritional deficiencies, including iron, zinc, calcium, iodine, Vitamin A, B12 and D and omega-3 fatty acids (Golden et al., 2016; FAO, 2018). Fish consumption is linked to several health benefits, including a lower risk of coronary, heart and cardiovascular diseases, decreased inflammatory diseases e.g., arthritis and prevention of cancer (FAO, 2018; Srivastava and Srivastava, 2008; Victora, 2008). Fish contain a lower caloric density and high content of omega-3 long chain polyunsaturated fatty acids compared to terrestrial animals (Tacon and Metia, 2013). In recent decades, per capita consumption of aquatic foods has been influenced significantly by increased supplies, changing consumer preferences, advancements in technology and income growth (FAO, 2022).

Fish consumed in Kenya are predominantly provided by capture fisheries sourced from rivers, large inland lakes, coastal systems, and aquaculture (Munguti et al., 2021). The major fish species cultured in Kenya are Nile tilapia and African catfish while the main source of capture fisheries is Lake Victoria with three major species being Nile perch (*Lates niloticus*), Nile tilapia (*Oreochromis niloticus*) and silver cyprinid/*omena (Rastrineobola argentea)*. Other species such as lung fish, African catfish and *Haplochromines* form an important component of the local diet among the riparian communities. Despite the numerous benefits of fish consumption, utilization in Kenya remains low at 4 kg/year compared to the global average of 20.2 kg/year (FAO, 2022; Obiero *et al.*, 2019). Currently, Kenya's capture fisheries and aquaculture output are insufficient, and there is a significant gap between fish supplies and consumer demand (Obiero et al. 2019).

Furthermore, the fish supply gap is expected to widen because of rapid population and income growth, diet transformation due to urbanization, and changing consumer preferences (Obiero et al., 2019; Munguti et al., 2021). Consumers also have inadequate knowledge and skills to prepare value-added nutritious and tasty fish products (Cheserek *et al*, 2022). As a result of this growing disparity, pregnant and lactating women, and infants are at increased risk of morbidity, mortality, or suboptimal development. The first 1000 days between pregnancy and a child's second birthday are the most critical time for positive impact on a child's cognitive and physical development and is well recognized as a 'window

of opportunity'. These challenges, exacerbated by the unprecedented COVID-19 pandemic, have resulted in applied research to develop food products enriched with fish products, which offers a novel solution to major nutritional problems affecting young children and women in Kenya. This project developed three novel nutrient rich fish-based products namely fish soup, fish powder and fish gelatin for smart management of malnutrition and food security. In addition, it aimed to reduce post-harvest losses by preserving products designed to retain nutrients, increase shelf-life and thus be available for use at the family level whenever needed. Thus, the project expands the set of solutions available for addressing the growing problem of malnutrition nationally and globally, by utilizing aquatic foods, especially small fish species, which are a significantly underutilized yet transformative solution.

2.0 SAMPLE COLLECTION

Samples for Nile tilapia and African catfish were collected from fish farms in Siaya and Kakamega counties, while those for Nile perch, Lungfish, *Omena* and *Haplochromine spp*. were collected from Dunga beach of Lake Victoria. Upon harvesting, the fish were promptly placed on ice and transported in ice boxes to the fish processing laboratory at KMFRI Kisumu, Kenya.

3.0 FISH SPECIES USED FOR PRODUCT DEVELOPMENT

Plate 1: *Fish species used for product development. A-Catfish, B-Haplochromine spp., C-Omena, D-Nile tilapia, E-Nile perch, F-Lungfish*

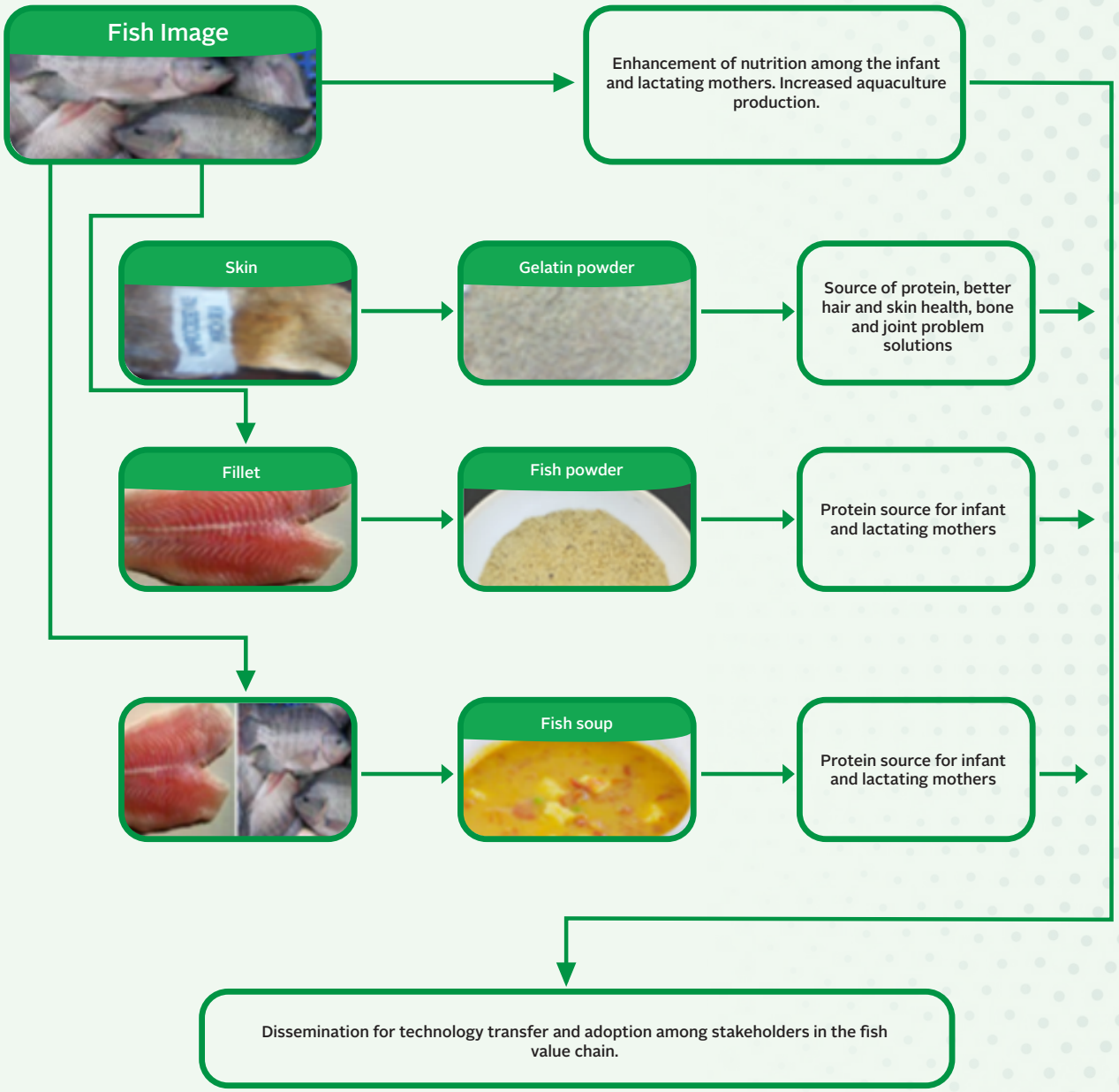

Fig. 1 *Process diagram showing the production of fish gelatin, powder and soup from different fish species.*

4.0 DEVELOPMENT OF THE THREE NOVEL PRODUCTS: FISH POWDER, FISH GELATIN AND FISH SOUP

4.1 Fish powder

Fish powder was obtained from each of the six fish species. Whole fish were processed for *omena* and *haplochromines* powder, whereas fillets were used for Nile perch, African catfish, lungfish, and Nile tilapia. *Omena* and *haplochromines* were sorted, cleaned, blended, dried and milled to make the powder.

The remaining fish were partially boiled and deboned to obtain the fillet. The fillet was then dried and milled to obtain powder. The powder, rich in protein, fat and minerals, can be used in a variety of food products for the intended population. It is especially useful for inclusion in the diets of young children during the complementary period beginning at 9 months of age. Fish powder can be added to children's food to enrich and improve nutrition quality.

Fig 2A. Sorting and cleaning of the fish

Fig. 2B. Final fish powder.

4.2 Fish gelatin

Gelatin is a protein product derived from collagen. It has important health benefits due to its unique combination of amino acids. Skins from Nile perch and Nile tilapia were used to make gelatin through heat hydrolysis, sap concentration, drying and milling. The most gelatin is found in Nile perch, which is easily amenable for industrial processing. Addition of gelatin to food products helps integrate valuable nutrients from the skin and scales, which are typically discarded.

Figure 3. Dried gelatin.

4.3 Fish soup

Fish soup was made by boiling the head, frames and skeletons of Nile perch, catfish and lungfish (these parts are usually thrown away). These fish components produce soup that is high in oils, omega-3 fatty acids, and polyunsaturated fatty acids (Okoth *et al.*, 2015). Fish soup is nutritionally important for infants aged nine months to two years, pregnant women, and breastfeeding women. Utilizing head, frames, and skeletons to produce soup is crucial in lowering post-harvest losses and boosting revenue for all parties involved in the value chain.

Figure 4. Cooking of the fish soup

5.0 Nutritional significance of the novel fish products

The novel fish products have the potential to help prevent malnutrition. The laboratory testing revealed that all critical nutrients, including minerals, fatty acids, and essential amino acids, are abundant in the three novel products. There were a total of seventeen amino acids found in the products. There was an abundance of essential amino acids such as lysine, histidine, isoleucine, leucine, methionine, and phenylalanine. These amino acids are especially important for normal growth and development of young children. Because the body cannot produce these amino acids, they must be obtained through diet. The amino acid concentrations determined in this study were within the standard amino acid values of FAO/WHO (1991) and of FAO (2013).

Fish contains long-chain polyunsaturated fatty acids, micronutrients such as vitamins A, B12, and D, and minerals that are essential for both children's and adults' health and cognitive development (Golden et al., 2016; FAO, 2018). Among the long chain polyunsaturated fatty acids found in fish, oleic acid and palmitic acid were the most abundant in the fish powder. According to the results, *omena* and *haplochromines* had the highest concentrations of calcium and potassium; followed by fish powder and gelatin. When eaten whole, small fish are an excellent source of bioavailable micronutrients such as calcium, iron, and zinc. Calcium and potassium are both important for pregnant and nursing women, as well as for the formation of a baby's bones. The finished products had a moisture content ranging from 5% to 9%. This was low enough to prevent microbial growth, extending the shelf life of the products.

6.0 CONCLUSIONS

- The three products (fish powder, soup, and gelatin) contain nutrients that are beneficial to human health at desired concentrations and are recommended for inclusion in the diets of vulnerable groups in order to create a healthy society free from hunger and malnutrition.
- Utilizing previously discarded fish body parts (skin, bones, and skeletons) reduces post-harvest losses while increasing productivity and income.
- The standardized production technology developed by the research team is simple and adaptable for technological diffusion and adoption among smallholder farmer's households.

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