



DEVELOPMENT AND SENSORY EVALUATION OF FISH PROTEIN CONCENTRATE INCORPORATED PRODUCTS

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ABSTRACT

Fish Protein Concentrates are intended for human consumption, in which the protein is more concentrated than in the original fish. For the development of Fish Protein Concentrate (FPC), two fishes namely Tilapia fish (*Oreochromis niloticus*) and red snapper fish (*Lutjanus arjuntimaculatus*) were collected from farm and market. FPC was developed using physical method. After the preparation of FPC, four variations of crackers and soup mix were developed along with their control. Based on the organoleptic evaluation, the best ones selected were TC1 (80g Wheat flour: 20g Tilapia FPC), TS1 (80g Corn flour: 20g Tilapia FPC), RC1 (80g Wheat flour: 20g Red Snapper FPC) and RS1 (80g Corn flour: 20g Red Snapper FPC). The nutrient content like energy, protein, fat and calcium of selected products are 360kcal, 22g, 12g, and 30mg respectively for Red Snapper FPC cracker, 88kcal, 16g, 2g, and 26mg respectively for Red Snapper FPC soup mix, 350kcal, 21g, 16g, and 12mg respectively for Tilapia FPC cracker and 85kcal, 14g, 1.9g and 10mg respectively for Tilapia FPC soup mix.

KEYWORDS: Fish Protein Concentrate, Tilapia, Red Snapper, Organoleptic evaluation, Value-added products.

INTRODUCTION

The global demand for protein sources has been steadily rising due to increasing populations and changing dietary patterns. Among various protein sources, fish is particularly valued for its high-quality protein, essential amino acids, omega-3 fatty acids, and micronutrients. Despite its nutritional advantages, a substantial proportion of fish resources, including by-products and underutilized species, are often discarded, leading to environmental and economic inefficiencies. To address these issues and capitalize on the nutritional potential of fish, the development and evaluation of fish protein concentrate (FPC) incorporated value-added products represent a critical area of research.

Fish protein concentrate (FPC) is a refined product derived from fish or fish by-products through processes that eliminate water, fat, and other non-protein components, resulting in a high-protein powder. This concentrate has garnered attention due to its potential applications in various food products, aimed at enhancing their nutritional profiles and addressing global food security challenges (Khan et al., 2018). FPC is known for its excellent amino acid profile, comparable to that of animal proteins, and its rich content of bioactive compounds such as omega-3 fatty acids, which are

crucial for human health (Martínez et al., 2017). The development of FPC-incorporated value-added products offers an innovative approach to utilize fish resources more effectively and create food products that cater to both nutritional needs and consumer preferences.

Nutritional enhancement through FPC incorporation is a primary focus, as protein malnutrition remains a significant global issue. High-quality protein sources like FPC can help alleviate protein-energy malnutrition, particularly in regions where conventional protein sources are scarce or expensive (Hossain et al., 2020). FPC's high protein content and favourable amino acid profile make it a valuable ingredient for fortifying various food products, including snacks, baked goods, and ready-to-eat meals. By enriching these products with FPC, it is possible to address deficiencies in essential nutrients and contribute to improved health outcomes across diverse populations.

Economic impacts are another significant consideration in the development of FPC-incorporated products. The fish processing industry has the potential to generate economic benefits through the creation of new products and markets. Incorporating FPC into a range of food products can drive innovation and expand market

opportunities, particularly in the context of growing consumer interest in healthful and sustainable food options (Pérez-Jiménez *et al.*, 2016). Additionally, the production and commercialization of FPC-based products can stimulate job creation and economic growth within the fisheries sector, particularly in regions dependent on fishery resources.

OBJECTIVES

- To develop Fish Protein Concentrate by Physical Method
- To standardize and develop value added products incorporating Fish Protein Concentrate such as Crackers and Soup mix
- To assess the organoleptic characteristics of developed products
- To analyze the nutritional composition of products.

EXPERIMENTAL PROCEDURE

Two popular and economically viable fish were selected which Red Snapper (*Lutjanus arjuntimaculatus*) and Tilapia (*Oreochromis niloticus*). Among the selected fishes, one is marine fish and one is freshwater fish. These fishes are selected because of its high biological value, protein content, low fat and less odour.

Procurement of Raw Materials

The fresh Tilapia fish was collected from a nearby fish farm in Manjeri, Malappuram and the fresh Red Snapper is collected from the local market In Manjeri, Malappuram.

Selection of Processing Method

Various methods have been developed to prepare FPC for human consumption. They are physical, biological, chemical, and reduction methods used to develop FPC. Here FPC is developed using the physical method. It is selected due to its easy preparation procedure and to minimize chemical residues.

Processing of FPC

Fishes are cleaned by removing scales, gut, viscera and fins. Then the fishes are cooked to coagulate protein, followed by straining and the bones are separated. Then the fish meat is washed repeatedly with fresh water to remove more fat. Then it is filtered with cotton cloth and slurry is pressed to squeeze out water along with impurities. The solid matter is dried in a hot air oven at 90°C for 7 to 8 hours. After it is then powdered and sieved to reduce lumps.

Selection of Value-Added Products

The increase in preference for the intake of a high protein diet, especially among health-conscious consumers is promoting the rapid growth of developing countries. The selected recipes for the value-addition of FPC are crackers and soup mix powder. The recipes selected for the development were healthy and simple.

Development of Value-Added Products

Development Formulation

Four variations in each FPC cracker and soup mix were prepared to select the best acceptable one. Concentration of FPC in Crackers and Soup Mix are 20%, 40%, 60% and 80%.

Wheat flour cracker (TC₀ & RC₀) is used as control for both Tilapia and Red snapper crackers. The ingredients include in the cracker are wheat flour, sesame seeds, cumin seeds, baking powder, pepper powder, garlic powder, coriander leaves, butter, oil, salt and water. Four variations of crackers were developed by incorporating FPC which are represented as TC₁, TC₂, TC₃, and TC₄ and RC₁, RC₂, RC₃, and RC₄).

The Corn flour soup mix (TS₀ & RS₀) is used as control for both Tilapia and Red snapper crackers. The ingredients included in the soup mix are corn flour, onion powder, garlic powder, ginger powder, pepper, salt, parsley and dried carrot. Four variations of Soup mix were developed by incorporating FPC which are represented as (TS₁, TS₂, TS₃, and TS₄ and RS₁, RS₂, RS₃, and RS₄).

Preparation of Cracker

The ingredients used in crackers are wheat flour, pepper powder, baking powder, garlic powder, sesame seeds, cumin seeds, coriander leaves, butter, and sunflower oil and FPC. In the preparation of the control cracker, the ingredients except FPC are mixed in the selected proportions. The flour was kneaded with hot water and 5g of each sunflower oil and melted butter. After keeping it aside for 10 minutes, rolled it and cut it into thin rectangle shapes and pierced with a fork for baking evenly. Then they are placed in a tray and is covered by butter paper and kept in a 170-degree preheated hot air oven for 30 minutes. The baked crackers were allowed to cool for 5 to 10 minutes to make them crispier.

Preparations of soup mix and soup

Ingredients used for this product are corn flour onion powder, garlic powder, pepper powder ginger powder, and parsley purchased in the local market in Manjeri and the dried carrot used is sun dried in home. In preparation for the soup mix, all the ingredients are mixed. Using this soup mix makes soup, by taking 8g of prepared soup mix mixed with 200ml of water and this boil to 5 minutes to make soup consistency.

Organoleptic Evaluation

Sensory evaluation of Fish Protein Concentrate incorporated products were carried out in the Nutrition Lab of Dept. of Home Science, KAHM Unity Women's College, Manjeri, Malappuram. The samples were evaluated for their sensory attributes such as Appearance, Colour, Flavour, Texture, Taste and Overall Acceptability using a 9-point hedonic scale. Twenty semi trained panel members were selected for the

sensory evaluation and they are asked to assign scores for the sensory characteristics of Fish Protein Concentrate incorporated products.

Nutrient Analysis

The Energy, Protein, fat, and calcium content of the selected crackers and soup mix powder were analysed.

RESULT AND DISCUSSION

Development of Fish Protein Concentrate

Fish Protein Concentrate is developed with Tilapia fish (*Oreochromis niloticus*) and Red Snapper fish (*Lutjanus arjuntimaculatus*) and was processed by using physical method. The developed Fish Protein Concentrate is used for the development of value-added

products. Two products were developed which are crackers and soup mix.

Wheat flour cracker and Corn flour soup mix are used as control (TC0, TS0, RC0, and RS0). Four variations of products are prepared incorporating two FPC. The variations of soup mix are, TS1, TS2, TS3, and TS4 (Tilapia FPC) and RS1, RS2, RS3, RS4 (Red Snapper FPC). The variations of crackers are TC1, TC2, TC3, and TC4 (Tilapia FPC) and RC1, RC2, RC3, and RC4 (Red Snapper FPC). The concentration of variations used in products are, 80:20, 60:40, 40:60, and 20:60. In control, 100% of Wheat flour used in crackers and 100% Corn flour is used in soup mix.

Organoleptic Evaluation of the Developed Products

Table 1: Mean Score for Organoleptic Evaluation of Tilapia FPC Crackers.

Crackers	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
TC0	8.5 (3.40)	8 (2.70)	7.8 (2.75)	8.2 (3.25)	8.1 (2.85)	8 (2.95)
TC1	8.6 (3.95)	8.4 (3.60)	8.2 (3.50)	8.5 (3.95)	8.6 (3.60)	8.5(3.70)
TC2	8.1 (3.10)	8.3 (3.45)	7.9 (3.05)	8.1 (3.10)	8.1 (2.55)	8.1 (3.10)
TC3	7.7 (2.30)	8 (2.80)	8.1 (3.25)	7.9 (2.75)	8.3 (3.05)	8.1 (3.05)
TC4	7.5 (2.25)	7.8 (2.45)	7.6 (2.45)	7.5 (1.95)	8.2 (2.95)	7.5 (2.20)
Kendall's (W) value	0.271**	0.149^{ns}	0.087^{ns}	0.342**	0.078^{ns}	0.144^{ns}

**= Highly significant at 1% level, ns = non-significant

TC0= control cracker 100% wheat flour, TC1= 80% wheat flour + 20%Tilapia FPC, TC2= 60% wheat flour +

40% Tilapia FPC, TC3= 40% wheat flour + 60% Tilapia FPC, TC4= 20% wheat flour + 80% Tilapia FPC.

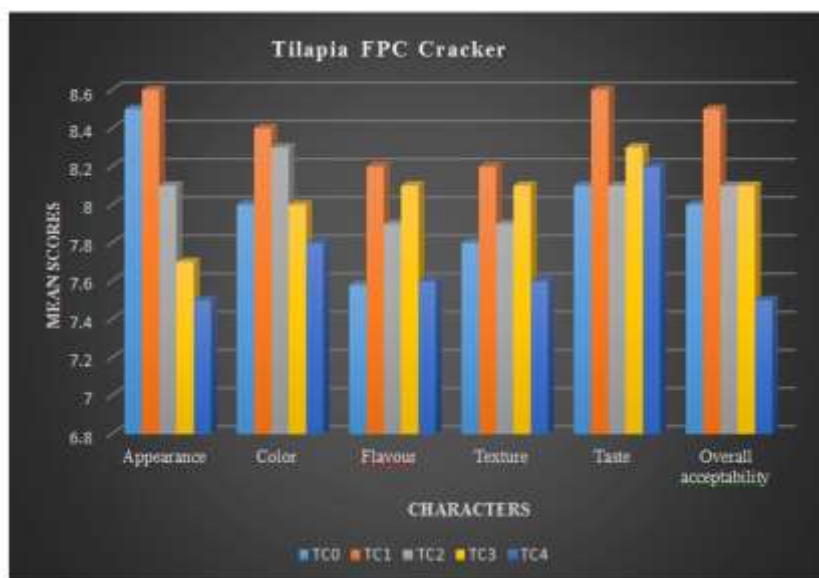


Figure 1: Mean Scores for Organoleptic Evaluation of Tilapia FPC cracker.

The organoleptic evaluation of Tilapia FPC crackers showed that TC1 had the highest mean scores for appearance (8.6), color (8.4), flavor (8.2), texture (8.5), taste (8.6), and overall acceptability (8.5). TC0, TC2, and TC3 displayed moderate scores across these attributes, with TC0 scoring 8.5 in appearance and 8 in overall acceptability, TC2 scoring 8.3 in color and 8.1 in overall acceptability, and TC3 scoring 8.1 in flavor and overall

acceptability. TC4 had the lowest scores, particularly in appearance (7.5) and overall acceptability (7.5). Significant Kendall's W values for appearance (0.271) and texture (0.342) indicated strong agreement between the judges.

Table 2: Mean Scores for Organoleptic Evaluation of Tilapia FPC Soup Mix.

Crackers	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
TS0	8.5 (3.95)	8.4 (3.70)	8.1 (3.65)	8.2 (3.70)	7.7 (3.65)	8 (3.55)
TS1	8.4 (4.00)	8.2 (3.85)	8.5 (4.30)	8.3 (4.00)	8.1 (4.15)	8.4 (4.25)
TS2	7.7 (2.90)	7.7 (2.70)	7.3 (2.80)	7.7 (3.00)	7 (3.00)	7.7 (3.05)
TS3	7.6 (2.60)	7.5 (2.40)	6.7 (2.35)	7 (2.40)	6.5 (2.65)	6.6 (2.40)
TS4	6 (1.55)	7.4 (2.35)	5.4 (1.90)	5.7 (1.90)	5.3 (1.55)	5.6 (1.75)
Kendall's (W) value	0.528***	0.318*	0.435**	0.362**	0.439**	0.474**

***= very highly significant at 0.1% level, **= highly significant at 1% level, *= Significant at 5% level

TS0= control soup mix 100% corn flour, TS1= 80% corn flour + 20% Tilapia FPC, TS2= 60% corn flour + 40%

Tilapia FPC, TS3= 40% corn flour + 60% Tilapia FPC, TS4= 20% corn flour + 80% Tilapia FPC.

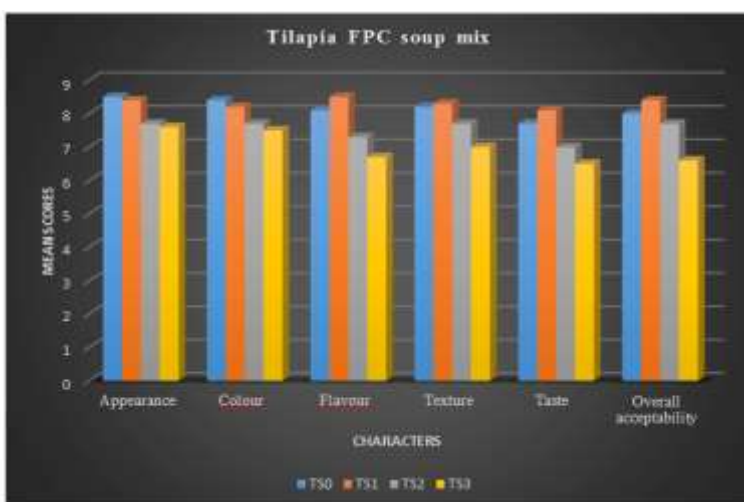


Figure 2: Mean Scores for Organoleptic Evaluation of Tilapia FPC Soup Mix.

TS0 scored highest in appearance (8.5) and color (8.4), with a very high significance level (Kendall's W = 0.528***). TS1 excelled in flavor (8.5), texture (8.3), taste (8.1), and overall acceptability (8.4), showing strong agreement between the judges (Kendall's W values

ranging from 0.362** to 0.474**). TS2 received moderate scores, while TS3 and TS4 had the lowest organoleptic characteristics, particularly TS4, which scored poorly in flavor (5.4) and overall acceptability (5.6).

Table 3: Mean Scores for Organoleptic Evaluation of Red Snapper FPC Crackers.

Crackers	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
RC0	8.5 (3.70)	8.1 (3.30)	8.3 (4.00)	8.5 (3.85)	8.5 (4.05)	8.5 (4.25)
RC1	8.4 (3.60)	8.2 (3.55)	7.6 (4.30)	8.3 (3.65)	8.5 (4.15)	8.4 (4.00)
RC2	8.2 (3.45)	7.7 (3.10)	7.7 (3.65)	8 (3.20)	7.5 (3.45)	7 (3.35)
RC3	7.5 (2.40)	6.2 (2.95)	6.2 (1.70)	7.4 (2.40)	6.5 (2.00)	6.2 (2.25)
RC4	7.1 (1.85)	5.2 (2.10)	5.2 (1.35)	7 (1.90)	5.9 (1.35)	5.4 (1.15)
Kendall's (W) value	0.427**	0.160ns	0.841***	0.421**	0.751***	0.758***

*** = very highly significant at 0.1% level, ** = highly significant at 1% level, ns = non-significant

RC0= control cracker 100% wheat flour, RC1= 80% wheat flour + 20% Red Snapper FPC, RC2= 60% wheat flour + 40% Red Snapper FPC, RC3= 40% wheat flour + 60% Red Snapper FPC, RC4= 20% wheat flour + 80% Red Snapper FPC.

The organoleptic evaluation of red snapper FPC crackers revealed that the control sample, RC0, received the highest scores in all attributes, indicating superior quality. RC1 maintained high scores but showed a

notable drop in flavour (7.6). RC2 exhibited further declines, particularly in overall acceptability (7.0) and taste (7.5). RC3 and RC4 had the lowest scores, with RC4's overall acceptability at 5.4. Kendall's W value analysis showed significant agreement among evaluators in appearance, texture, taste, and overall acceptability, while colour was non-significant, indicating inconsistent evaluation, and flavour was very highly significant, indicating strong consensus.

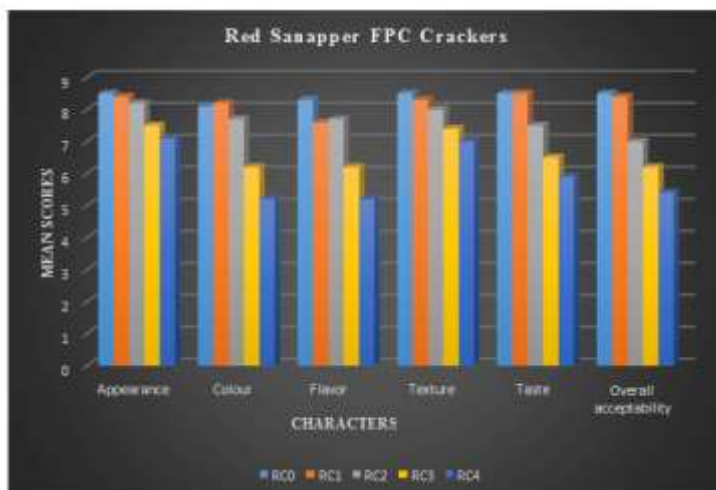


Figure 3: Mean Scores for Organoleptic Evaluation of Red Snapper FPC Crackers.

Table 4: Mean Scores for Organoleptic Evaluation of Red Snapper FPC Soup Mix.

Crackers	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
RS0	8.1 (3.70)	8.1 (3.90)	8 (3.75)	8.4 (4.25)	8.2 (3.90)	7.9 (3.80)
RS1	7.9 (3.70)	7.8 (3.55)	7.6 (3.45)	7.8 (3.50)	7.6 (3.35)	7.6 (3.55)
RS2	7.8 (3.45)	7.5 (3.45)	7.6 (3.65)	7.7 (3.80)	7.6 (3.75)	7.5 (3.80)
RS3	6.8 (2.30)	6.8 (2.45)	6 (2.40)	5.6 (2.25)	5.7 (2.45)	5.3 (2.35)
RS4	5.7 (1.85)	5.8 (1.65)	4.8 (1.75)	4.3 (1.20)	4.5 (1.55)	4.6 (1.50)
Kendall's (W) value	0.447**	0.525***	0.366**	0.749***	0.441**	0.478**

*** = very highly significant at 0.1% level, ** = highly significant at 1% level

RC0= control soup mix 100% corn flour, RS1= 80% corn flour + 20%Red Snapper FPC, RS2= 60% corn flour + 40% Red Snapper FPC, RS3= 40% corn flour + 60% Red

Snapper FPC, RS4= 20% corn flour + 80% Red Snapper FPC.

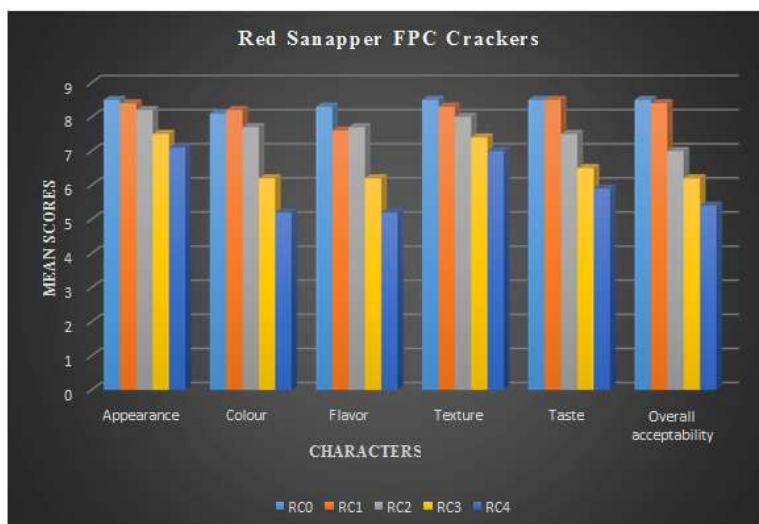


Figure 4: Mean Scores for Organoleptic Evaluation of Red Snapper FPC Soup Mix.

The organoleptic evaluation of Red Snapper Fish Protein Concentrate (FPC) soup mix revealed a decline in mean scores across various attributes (appearance, color, flavor, texture, taste, and overall acceptability) from RS0 to RS4. RS0 received the highest scores, notably 8.1 for appearance and color, 8 for flavor, 8.4 for texture, 8.2 for taste, and 7.9 for overall acceptability. In contrast, RS4

had the lowest scores, with 5.7 for appearance, 5.8 for color, 4.8 for flavor, 4.3 for texture, 4.5 for taste, and 4.6 for overall acceptability. Kendall's W values ranged from 0.366 to 0.749, indicating significant agreement among panelists, with the highest consistency in texture evaluation (0.749).

Selection of Most Acceptable Products

Among the variations of Tilapia FPC crackers, TC₁ (60% wheat flour +20% Tilapia FPC) and from the variations of Tilapia soup mix TS₁ (60% corn flour +20% Tilapia FPC) were selected. RC₁ (60% wheat flour + 20% Red Snapper FPC) is selected as a highly acceptable red snapper crackers and RS₁ (60% corn flour + 20% Red Snapper FPC) is selected as a highly acceptable red

snapper soup mix. These for variations used for the further study.

Nutrient Analysis of the Selected Products

The nutrient content of selected products like energy, protein, fat and calcium were analysed in the laboratory and is presented in Table 5.

Table 5: Nutrient Content of Selected Value-Added Products.

SINO	Parameters	TC1	TS1	RC1	RS1
1	Energy (kcal)	350	85	360	88
2	Protein (g)	21	14	22	16
3	Fat (g)	16	19	12	12
4	Calcium (mg)	12	10	30	26

Table 5 shows the nutrient content of Tilapia and Red Snapper Cracker and Soup mix. It shows that energy content of tilapia and red snapper cracker were 350kcal and 360kcal respectively. The energy content of Tilapia and Red snapper soup mix were 85kcal and 88kcal respectively.

The protein, fat and calcium content of tilapia and red snapper cracker were 21g (Protein), 16g (Fat), 12mg (Calcium) and 22g (Protein), 12g (Fat), 30mg (Calcium).

The protein, fat and calcium content of tilapia and red snapper soup mix were 14g (Protein), 19g (Fat), 10mg (Calcium) and 16g (Protein), 12g (Fat), 26mg (Calcium).

CONCLUSION

The development and evaluation of Fish Protein Concentrate (FPC)-incorporated products, such as crackers and soup mixes, demonstrated that FPC is a valuable nutritional addition, particularly in enhancing protein content in food products. Among the products tested, the most acceptable were those with 20% FPC incorporation, confirming that moderate levels of FPC can improve organoleptic properties without compromising consumer acceptability. The nutritional analysis revealed that these products are rich in essential nutrients, including protein and calcium, with minimal fat content, making them ideal for health-conscious consumers.

This study contributes to the growing body of knowledge on the utilization of underutilized fish species for value-added product development. The incorporation of FPC into popular food items highlights its potential for addressing global nutritional challenges, especially in regions facing protein malnutrition. Additionally, FPC-based products offer economic benefits by reducing fish waste and generating new market opportunities in the food industry.

REFERENCES

1. Apostolidis, A., Yeo, S. K., & Hong, J. H. (2022). *Sustainable fishery practices: Waste management*

- and by-product utilization*. Journal of Cleaner Production, 2022; 371: 133737.
2. Arias, C. R., García, M. C., & Martín, C. M. (2021). *Economic evaluation of fish protein concentrate production: Cost-effectiveness and scalability*. Food Science and Technology, 2021; 42(9): 1623-1632.
3. Bardach, J. E., Ryther, J. H., & McLarney, W. O. (1972). *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. Wiley.
4. Beveridge, M. C. M., Thilsted, S. H., Phillips, M. J., Metian, M., van der Zijpp, A. J., & Pomeroy, R. (2010). *Meeting the food security needs of the poor in the developing world: The role of aquaculture*. Food Security, 2010; 2(2): 155-171.
5. FAO (2018). *The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals*. Food and Agriculture Organization of the United Nations.
6. FAO (2021). *The State of World Fisheries and Aquaculture 2020*. Food and Agriculture Organization of the United Nations.
7. Hossain, M. B., Yusof, Y., & Hoque, M. N. (2020). *Nutritional benefits and applications of fish protein concentrate*. Journal of Food Science and Technology, 2020; 57(5): 1863-1875.
8. Khan, M. I., Singh, S., & Siddiqui, N. A. (2018). *Fish protein concentrate: A review on its applications and health benefits*. Trends in Food Science & Technology, 2018; 77: 21-31.
9. Martínez, M. M., Torres, J. A., & Díaz, M. A. (2017). *Bioactive compounds in fish protein concentrate and their health benefits*. Nutrients, 2017; 9(9): 934.
10. N (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations.
11. Pérez-Jiménez, J., López-Miranda, J., & Ros, E. (2016). *Health benefits of incorporating fish protein concentrate in the diet*. Clinical Nutrition, 2016; 35(6): 1263-1271.
12. Sánchez-González, M. Á., Vargas, M., & Martínez-Castro, I. (2020). *Functional properties of fish protein concentrate and its applications in food*

- products*. Journal of Food Engineering, 2020; 280: 109918.
13. UN (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations.
 14. Vaz, M., Goh, C., & Hossain, M. M. (2018). *Utilization of fish by-products for sustainable aquaculture*. Marine Pollution Bulletin, 2018; 127: 339-346.
 15. Wang, X., Sun, J., & Liu, Y. (2019). *Consumer perceptions and acceptance of fish protein concentrate-enriched food products*. Food Quality and Preference, 2019; 74: 124-134.
 16. Aberoumand, A. (2012). "Nutritional and Sensory Properties of Fish Soup Fortified with Fish Protein Concentrate." *Food Science and Technology International*.
 17. Gokoglu, N., Yerlikaya, P., & Cengiz, E. (2004). "Effects of fish protein concentrate on sensory properties of fish snacks." *European Food Research and Technology*.
 18. Balachandran, K. K., George, J. P., & Thomas, M. (2007). "Development of fish balls with fish protein concentrate and their sensory evaluation." *Journal of Food Science and Technology*.
 19. Kristinsson, H.G., & Rasco, B. A. (2000). "Fish protein hydrolysates: Production, biochemical, and functional properties." *Critical Reviews in Food Science and Nutrition*.