Journal of Aquatic Biology & Fisheries | 2025 | 13(1) | pp. 12-18
ISSN 2321–340X
OPEN ACCESS
http://www.jabf.in/
University of Kerala, INDIA

Development and nutritional analysis of fish soup powder derived from *Amblypharyngodon melettinus* (Valenciennes, 1844): Enhancing nutritional value of an underutilized species

Rabea Naz H.[1*], Gopika P.J.[2], Divya K. Vijayan[2], Devika Pillai[1] and Srinivasa Gopal, T.K.[2]

[1]*Centre for Sustainable Aquaculture and Aquatic Animal Health Management, KUFOS, Cochin, Kerala-682506*
[2] *Centre of Excellence in Food Processing Technology, KUFOS, Cochin, Kerala-682506*
**E.mail: rabea.risam21@gmail.com*

ABSTRACT

The need for food, namely proteins, is projected to rise due to the anticipated global population expansion reaching 9.7 billion by 2050. The consumption of small-sized fish species as a whole, as well as the inclusion of big fish bones in the diet, has the potential to substantially contribute to alleviating vitamin deficiencies and protein malnutrition. The research aimed to investigate the nutritional advantages of the instant soup mix derived from *Amblypharyngodon melettinus*, often known as silver carplet, a low-value fish species that is recognised for its high content of micronutrients. The raw fish underwent a washing process using a 1% sodium bicarbonate solution, followed by steam cooking at a temperature of 100 degrees celsius for 15 to 20 minutes, to produce the fish soup powder. The proximate composition, mineral content, fatty acid composition, and amino acid composition of raw fish and soup powder were analyzed using nutritional profiling. The findings indicated that the Instant soup mix derived from fish exhibits elevated levels of protein, fat, and ash, while displaying a comparatively reduced moisture content. Additionally, it was discovered that the substance had significant levels of Fe, Zn, Ca, Mg, Na, and K. The use of indigenous underutilized low-value fish in an appropriate manner has been shown to provide a major contribution to meeting the nutritional needs of low-income populations.

ARTICLE HISTORY

Received on: 29-11-2024
Revised on: 27-06-2025
Accepted on: 01-07-2025

KEYWORDS

Low-value fish, Soup powder, *Amblypharyngodon melettinus*, Nutritional evaluation, Low-income groups, Food security

1. Introduction

Nutrient deficiencies impose an unfavourable weight not alone on people and the overall health of the nation, but also on the country's broader cultural, sociological, and economic fabric. In order to enhance the nutritional value of diets and address inadequacies, it is essential to adopt nutrition-sensitive strategies that prioritize food consumption, whether in its natural or processed form (Gibson et al., 2003). Fish is considered to be a precious protein source with a favourable composition of key amino acids, making it an ideal choice for meeting dietary protein needs. Calcium and phosphorus in fish bones make them a valuable natural resource, particularly for population groups with limited consumption of milk and dairy products (Larsen et al., 2000).

The demand for food, particularly proteins, is projected to rise due to the anticipated global population expansion, reaching 9.7 billion by the year 2050. In isolation, The agriculture sector cannot meet the pressing demand, thereby highlighting the significance of the fisheries industry. Small indigenous fish species are well recognized as valuable providers of critical micro and macro nutrients that play a crucial role in combating malnutrition. Fish is widely consumed in many developing nations and is considered a staple food due to its cultural and traditional significance. It is valued for its low-calorie content and is recognized as a rich source of high-quality animal proteins, vital fatty acids, vitamins, and minerals. Due to its inherent perishability, prompt consumption or processing into stable goods is necessary to ensure its long-term viability for future use. The transformation of inexpensive fish species into value-added food items is a significant area of focus within the field of food processing technology. The development of value-added products using fish species during periods of excess is an opportunity to prevent waste and maximise the utilisation of their calcium and protein sources, which are highly bioavailable. This approach may be achieved at a very cheap cost (Avens et al., 2002).

The silver carplet (*Amblypharyngodon melettinus*) is a diminutive autochthonous fish species that has a high nutritional value, characterized by its abundance of essential micronutrients like Fe, Zn, Ca, vitamin A, vitamin B12, as well as animal protein and fatty acids (Mohanty et al., 2013). The use of this intervention has the potential to serve as an effective solution for addressing malnutrition. According to Gopakumar, 2002, silver carplets possess the characteristic of yearly renewal. However, it is observed that during periods of plenty, significant amounts of these carplets are squandered because of imprudent use. This implies the use of the fish species in order to mitigate waste and guarantee the profitable exploitation of its mineral and protein content. Soup is a nourishing liquid-based meal that has a significant concentration of essential nutrients while containing a relatively low number of calories per unit volume. Fish soup is a viable and nutritious snack or appetizer that may be consumed by individuals of all age groups. Consequently, using entire fish to produce soup powder significantly enhances its value proposition, benefiting both farmers and customers. The present study aimed to evaluate the nutritional composition of fish soup powder obtained from *Amblypharyngodon melettinus* (Valenciennes, 1844), a fish species with little commercial potential. Additionally, a thorough nutritional assessment of the product was conducted.

2. Materials and Methods

2.1. Sample collection:

The research included acquiring recently caught fish from the aquaculture ponds at the Kerala University of Fisheries and Ocean Studies (KUFOS) in Cochin. The fish specimens were transported to the laboratory under controlled conditions, ensuring a low temperature was maintained by the use of ice. The species *Amblypharyngodon melettinus* was found to be the most abundant among the caught fish. The fish underwent the descaling and decapitation procedures, followed by a comprehensive washing using flowing tap water. The cleaned fish samples were partitioned into two distinct groups. Subsequently, the first cohort was pulverized with a mortar and pestle. The samples pertaining to the second group underwent a cleaning procedure using a solution of 1% sodium bicarbonate, followed by applying steam for cooking. The minced beef was carefully prepared and stored in a refrigerated setting to facilitate further examination.

2.2. Preparation of fish soup powder:

The fish cleaning procedure included the elimination of scales and the head, followed by a thorough rinsing using running tap water. The raw fish was then washed with a 1% sodium bicarbonate solution and then exposed to steam cooking at a temperature of 100 degrees Celsius for a period of 15 to 20 minutes. The ingredients, namely powdered pepper and coriander as indicated in Table 1, were mixed with the sautéed onions in butter. The cooked fish and the other components, except for milk powder, were amalgamated and subjected to processing in order to produce a compact and velvety mixture. The whole mass was put onto metal trays and underwent a drying process using a hot air dryer set at 55 degrees Celsius. The desiccated substance underwent a comprehensive pulverization process and was then filtered to provide a consistent outcome. The desiccated substance was mixed with powdered skim milk. The soup powder, intended for quick cooking, was enclosed in hermetically sealed pouches composed of a laminate material including polyester and polyethylene. The material can be stored at ambient temperature for a period of time, surpassing three months. The soup may be created by reconstituting the combination by boiling 5 grammes of powder in 100 millilitres of water for a period of 5 minutes.

Table 1. Ingredients used for the preparation of fish soup powder

Ingredients	Quantity (g)
Cooked fish	200
Onion	200
Coriander powder	3.2
Pepper powder	4
Butter	66.66
CMC	0.6
Milk powder	26.6
Ascorbic acid	0.4
Salt	34

2.3. Proximate analysis:

The chemical composition analysis was conducted using the procedures outlined in the Horwitz and Latimer, 2005 guidelines. In this study, the moisture content was assessed by measuring the decrease in weight after drying a powdered wet sample in a hot air oven set at a temperature of 105 ± 2 °C for 8-16 hours. The crude protein and fat levels were determined using the Kjeldahl and Soxhlet techniques, respectively, as outlined in the Horwitz and Latimer, 2005 guidelines. The ash was acquired by incinerating dry samples that were moisture-free in a muffle furnace, operating at a temperature of 550 °C for 4-5 hours, as specified by Horwitz and Latimer (2005). The findings were presented as the mean plus or minus the standard deviation of three separate measurements.

2.4. Physio-chemical analysis:

Water activity was measured using the Novasina (LabTouch - aw) water activity meter. The use of water activity is particularly valuable in the prediction of bacteria, yeast, and mould development. The colour profile of the product was assessed via the Hunter LabEZ colorimeter (Feili et al., 2013).

2.5. Amino acid and Fatty acid Profiling:

The amino acid content of fish soup powder was analyzed using HPLC using the methodology described by Ishida et al., (1981). Fish soup powder's fatty acid composition analysis was conducted using gas chromatography (specifically, the Trace 1310 gas chromatograph with flame ionisation detector). The technique used to extract the total lipid was based on the procedure developed by Folch et al., 1957. Next, the lipids underwent pre-column derivatization to convert them into fatty acid methyl esters (FAME) using the BF3-methanol method.

2.6. Estimation of Mineral:

After microwave digestion, the mineral compositions were analyzed by "inductively coupled plasma optical emission spectrometry" (ICP-OES) and flame photometry. The quantification process included the use of ICP-OES in conjunction with a multi-element standard solution. Prior to analysis, the standard solution was appropriately diluted. Flame photometry was used to evaluate the concentrations of Na and K inside the mineral samples, while ICP-OES was utilized to analyse the Mn, Fe, Zn, and Cu levels. The concentrations of Ca and Mg are determined using the titration technique.

2.7. Microbiological quality evaluation:

2.7.1. Total Plate Count (TPC)

The homogenate was diluted using sterile physiological saline and then plated using the spread plate method. The agar medium used in this study was plate count agar. The petri dishes were incubated at ambient temperature for 48 hours.

2.7.2. Staphylococcus counts

The homogenate was used to generate suitable dilutions, which were then applied onto agar plates containing egg yolk-free Baired-Parker media. The plates were then incubated at a temperature of 37 °C for 48 hours.

2.8. Sensory analysis:

The sensory assessment of the soup powder that had been freshly made was conducted by a group of semi-trained

panellists consisting of 10 people. The use of a score card facilitated this evaluation. The panellists were requested to assess several characteristics of the soup powder, including its visual appearance, colour, taste, texture, and general acceptability. This evaluation was conducted using a 9-point hedonic scale. A score over 4 was deemed to be within the acceptable range.

2.9. Statistical analysis:

The trials were conducted in triplicate, with each trial being performed separately. The mean and standard deviation data were computed using the statistical software SPSS 26.

3. Results and Discussion

3.1. Proximate composition of fresh and steamed *Amblypharyngodon melettinus* and fish soup powder

In food systems, proximate analysis serves as a valuable tool for determining the quantitative composition of various macronutrients present in a given food product. Table 2 shows the proximate composition of raw fish, cooked fish, and fish soup powder, or *Amblypharyngodon melettinus.* The moisture content differs greatly across the three kinds. Some previous studies indicate that various cooking methods have a remarkable impact on the nutritional composition of a single fish species (Devi et al., 2012). Raw fish has 77.6% moisture, cooked fish 72.9%, and fish soup powder 3.07%. Statistically, these discrepancies indicate that heating and making fish soup powder have significantly decreased fish water content. The fish protein content shows notable changes across types. Steamed fish provides 5.28% protein, whereas raw fish has 14.2%. Fish soup powder has 41.5% protein, the most. These considerable protein differences show how cooking and processing affect fish protein content. This table shows the fat content of three fish types. Raw fish has 4.03% fat, steaming fish 1.40%, and fish soup powder 13.6%. Like the other metrics, these changes are statistically significant and imply that steaming and fish soup powder conversion affect fat levels. Ash, which represents fish inorganic minerals, is compared. Steamed fish contains 4.19% ash, whereas raw fish has 3.14%. The most ash is 13.0% in fish soup powder. Statistically significant differences show that fish ash content rises during boiling and processing.

The results of this study on the moisture, protein, lipid, and ash levels in raw *A. melettinus* are consistent with previous research. The findings of this research indicate that the increased concentration of nutrients seen in dried items may be attributed to their reduced moisture content. The moisture content of the dried fish, falling within the suggested range of 6-8%, is of significant relevance in terms of storage and shelf-life of dried items. The proximate values of raw silver carplet fish showed a substantial congruence with the findings of prior studies conducted by Wahengbam et al. (2012) and Rafikul et al. (2020). The research conducted by Jayasinghe et al. (2016) revealed that fish soup powder, when combined with carrageenan, exhibited a moisture content of 2.98%, protein content of 21.11%, fat content of 13.15%, and ash content of 22.53%. According to research conducted by Bothma et al. (2020), it was discovered that catfish with a substantial concentration of Saturated Fatty Acids have a fat level of 10.40%. Research findings indicate that soup powders enriched with seaweed, which is abundant in vitamins and minerals, exhibit a moisture content of 9.07%, protein content of 19.55%, carbohydrate content of 50.95%, fat content of 1.003%, ash content of 6.718%, and crude fibre content of 11.32%. According to Weerasuriya et al. (2015), fish soup cubes are composed of 3.5% moisture, 31% protein, 18.5% fat, and 46% ash.

3.2. Physio-chemical properties of fish soup powder:

The water activity (aw) of fish soup powder was determined to be 0.516 at a temperature of 31 °C. The water activity (aw) of the sample has shown a gradual rise over time. The water activity achieved a maximum value of 0.56 ± 0.12, as reported by Rockland et al. (1980). However, it did not exceed the threshold of unacceptability, which is defined as 0.6. The colour of the soup powder was represented by the L*, a*, and b* values, which were measured to be 65.24 ± 0.09, 4.66 ± 0.13, and 25.34 ± 0.06, respectively. The L* value was shown to be consistent with the findings reported in prior research conducted by Jeyakumari et al. (2016).

3.3. Amino acid and fatty acid profile of fish soup powder:

3.3.1. Amino acid

The analysis of the product's amino acid content was conducted, and the corresponding findings are shown in Table 3. The research findings indicate that the fish soup powder is a primary provider of essential amino acids, with a content of 7.65 g per 100 g sample. Notably, leucine and lysine are present in significant quantities, with respective amounts of 1.47 g and 1.29 g per 100 g sample. The essential amino acids with the lowest concentrations observed were histidine (0.38 g/100 g) and methionine (0.32 g/100 g). Similarly, the non-essential amino acids with the greatest levels were glutamic acid (3.14 g/100 g) and aspartic acid (1.53 g/100 g). Conversely, cystine was discovered to have the lowest concentration among the non-essential amino acids, measuring at 0.02 g/100 g.

3.3.2. Fatty acid

Table 4 shows fish soup powder's fatty acids. Fatty acid amounts per 100 grammes of lipid extract are shown. Three primary fatty acid categories are saturated, monounsaturated, and polyunsaturated. The SFA group includes butyric acid, caproic acid, and palmitic acid. Within the lipid extract, total saturated fatty acids comprise 74.98 grammes per 100 grammes. Monounsaturated fatty acids like oleic acid and myristoleic acid are MUFAs. MUFA total 21.33 grammes per 100 grammes of lipid extract. polyunsaturated fatty acids include linoleic acid and EPA). Lipid extract contains 3.71 grammes of total polyunsaturated fatty acids (PUFA) per 100 grammes. Fish soup powder contains 0.91 and 2.80 grammes of omega-3 fatty acids (ω3), as shown in the table. Saturated fatty acids (SFAs) accounted for approximately 70-80% of the total fatty acids in the muscle tissues of all carp species (Dey et al., 2015). Functionally significant fatty acids in the muscle triacylglycerols, such as 18:2ω-6 and 18:3 ω-3, each constituted around 5% (Mishra et al., 2020). This higher SFA content serves as both an energy reserve for fish muscle and a fundamental component of

Table 2. Proximate composition of fresh and steamed *Amblypharyngodon melettinus* and fish soup powder

Parameters	Raw Fish	Steamed Fish	Fish Soup Powder
Moisture %	77.6 ± 0.33^{c}	72.9 ± 0.18^{b}	3.07 ± 006^{a}
Protein %	14.2 ± 016^{b}	5.28 ± 0.30^{a}	41.5 ± 0.33^{c}
Fat %	4.03 ± 0.20^{b}	1.40 ± 0.13^{a}	13.6 ± 0.02^{c}
Ash %	3.14 ± 0.15^{a}	4.19 ± 0.63^{b}	13.0 ± 0.20^{c}

* All values are represented as Mean value ± standard deviation. Values that have different superscript letters differ significantly ($P \leq 0.05$) with each other.

Table 3. Amino acid content of fish soup powder

Sl. No.	Amino acids	Quantity (g amino acid)
1.	Aspartic acid	1.53
2.	Glutamic acid	3.14
3.	Serine	0.68
4.	Histidine*	0.38
5.	Glycine	0.66
6.	Threonine*	0.83
7.	Arginine*	1.11
8.	Alanine	0.90
9.	Tyrosine	0.55
10.	Cystine	0.02
11.	Valine*	0.82
12.	Methionine*	0.32
13.	Phenylalanine*	0.65
14.	Isoleucine*	0.78
15.	Leucine*	1.47
16.	Lysine*	1.29
17.	Proline	0.69
Total EAA		**7.65**
Total NEAA		**8.17**
Total		**15.82**

* Essential Amino Acids (EAA), Non Essential Amino Acids (NEAA)

Table 4. Fatty acid profile of fish soup powder

Peak Number	Component name	Amount (g/100g lipid extract)
Saturated fatty acids (SFA)		
1	Butyric acid (C4:0)	3.31
2	Caproic acid (C6:0)	5.47
3	Caprylic acid (C8:0)	4.60
4	Decanoic acid (C10:0)	8.26
5	Undecanoic acid (C11:0)	0.05
6	Dodecanoic acid (C12:0)	5.45
7	Tridecanoic acid (C13:0)	0.14
8	Myristic acid (C14:0)	11.16
10	Pentadecanoic acid (C15:0)	0.97
12	Palmitic acid (C16:0)	25.8
14	Heptadecanoic acid (C17:0)	0.56
16	Stearic acid (C18:0)	8.78
20	Arachidic acid (C20:0)	0.06
25	Behenic acid (C22:0)	0.13
28	Tricosanoic acid (C23:0)	0.15
Total SFA		**74.98**
Unsaturated fatty acids		
Monounsaturated fatty acids (MUFA)		
9	Myristoleic acid (C14:1 [cis-9])	1.22
11	Pentadenoic acid (C15:1 [cis-10])	0.22
13	Palmitoleic acid (C16:1 [cis-9])	1.36
15	Heptadenoic acid (C17:1 [cis-10])	0.20
17	Octadecenoic acid (C18:1 [trans-9])	1.06
18	Oleic acid (C18:1 [cis-9])	17.09
22	Eicosenoic acid (C20:1 [cis-11])	0.18
Total MUFA		**21.33**
Polyunsaturated fatty acids (PUFA)		
19	Linoleic acid (C18:2 [cis-9,12] w6)	1.90
21	Linolenic acid (C18:3 [cis-6,9,12] w6)	0.42
23	Linolenic acid (C18:3 [cis-9,12,15] w3)	0.07
25	Eicosatrienoic acid (C20:3 [cis-8,11,14] w6)	0.27
26	Eicosatrienoic acid (C20:3 [cis-11,14,17] w3)	0.29
27	Arachidonic acid (C20:4 [cis-5,8,77,14] w6)	0.21
29	Eicosapentaenoic acid (C20:5 [cis-5,8,11,14,17] w3)	0.29
30	Docosahexenoic acid (C22:6 [cis-4,7,10,13,16, 19] w3)	0.34
Total PUFA		**3.71**
Σ ω3		**0.91**
Σ ω3		**2.80**

cell bio-membranes (Tocher., 2003). Among SFAs, palmitic acid stood out as the most abundant, comprising 35-40% of the total SFA content. Some unique odd-chain fatty acids, including pentadecanoic acid (15:0), heptadecanoic acid (17:0), and their monoenes 15:1 and 17:1, were identified in A. melettinus. Generally, freshwater fishes primarily feature monounsaturated fatty acids (MUFAs) (Muhamed et al., 2012). These MUFAs play a crucial role in enhancing the fish's physical activity and provide the necessary energy for migration during spawning.

3.4. Mineral composition of fish soup powder

Table 5 provides information about the mineral composition of fish soup powder that has undergone a process involving $NaHCO_3$ washing and steam cooking. The minerals are measured and expressed in different units depending on the element. Calcium is significant, with a concentration of 2000 mg per kilogram of wet weight. Magnesium is also abundant, measuring 1215 mg per kilogram. Iron is present in smaller but still notable quantities, with a concentration of 1.089 µg per liter. Similarly, zinc is present at 1.359 µg per liter. Sodium, an essential mineral, is found at 169.4 mg per kilogram of wet weight, while potassium, another important mineral, is present at 29.1 mg per kilogram of wet weight. Copper is present at 0.102 µg per liter, and manganese is measured at 0.415 µg per liter.

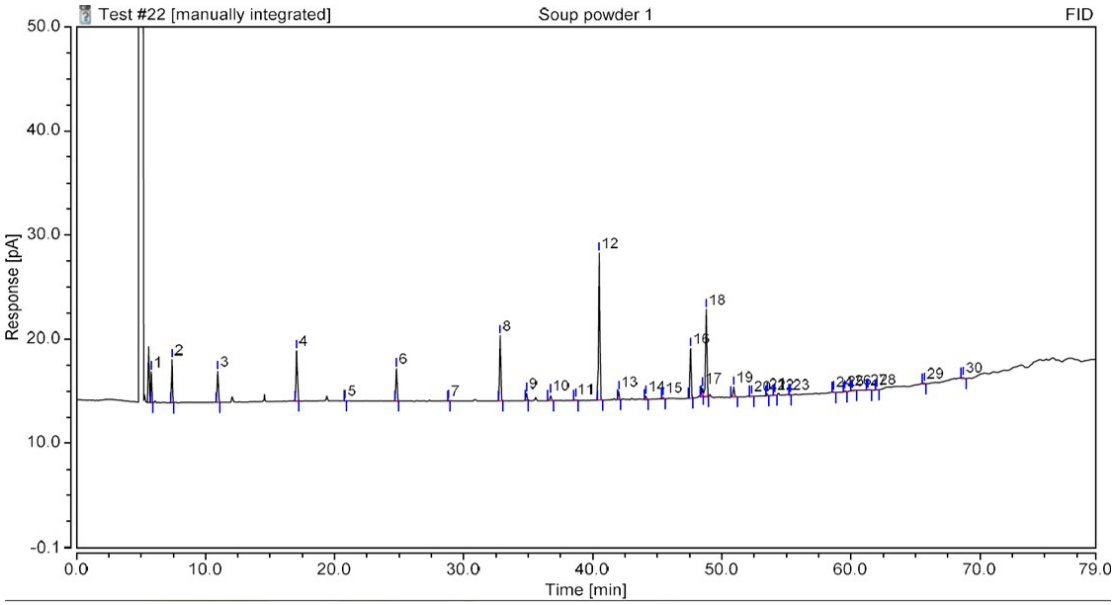


Fig. 1. Fatty acid profile of fish soup powder

3.5. Lipid quality indices of instant fish soup powder:

3.5.1. PUFA/SFA ratio:

Fatty acids (FAs) are organic acids having at least one carboxyl (–C(=O) OH, –COOH, or –CO_2H) group and a long carbon chain whose links might be double bonds, as in unsaturated fatty acids, or single bonds, as in saturated fatty acids (Henderson and Tocher, 1987). FAs are primarily produced from triglycerides and phospholipids and are the major components of dietary fats. Most naturally occurring FAs contain an unbranched chain of an even number (4–28) of carbon atoms. According to the quantity of double bonds, the FA catalogue contains saturated fatty acids (SFAs), monounsaturated fatty acid (MUFA), and polyunsaturated fatty acid (PUFA). SFAs may increase the likelihood of developing multiple sclerosis (MS) as well as disease progression, while PUFAs may have positive benefits for MS patients. Total PUFA/ Total SFA of the soup powder was 0.05 (3.71/74.98). The minimal value advised for PUFA/ SFA is 0.45 (HMSO 1994). Since the value of fish soup powder was lower than the required minimum value it might be claimed that the soup includes fewer quantity of health beneficial PUFAs (Table 4). According to Calder (2015), seafood and fish oils contain considerable levels of SFAs. From Table 4, it is obvious that the SFAs were in the largest quantity.

3.5.2. n6/n3 ratio:

The ratio of total n6 polyunsaturated fatty acids (PUFA) to total n3 PUFA is 3.07 (2.80/0.91). According to Moreira et al. (2001), it is widely acknowledged that an optimal mix of polyunsaturated fatty acids (PUFA) is desirable. In this regard, the recommended maximum ratio of n6/n3 is believed to be 5. Given that the obtained value was below 5, it may be inferred that the soup formulation exhibits a satisfactory mix of polyunsaturated fatty acids (PUFAs**).**

3.6. Mineral analysis:

Microminerals, such as iron, copper, zinc, manganese, selenium, and others, are essential elements that are necessary for the proper physiological functioning of the human body (Mohanty et al., 2016). Current research provides evidence suggesting that tiny fish containing bones may serve as a significant dietary supply of calcium for humans, but perhaps less bioavailable compared to calcium derived from milk. The variations in calcium concentration seen in different soup powders may be attributed to the significant bioavailability of calcium derived from silver carp fish (Larsen et al., 2000). Despite being recognised as a source of vitamins and minerals, the calcium content of *C. gariepinus* is within the range of 708 mg/100 g (Bothma et al., 2020). According to Mohanty et al. (2016), an analysis of zinc content in various fish species revealed that *Stolephorus waitei* had the highest concentration of zinc at 26.0 mg/100 g, followed by *Stolephorus commersonii* at 21.0 mg/100 g. In contrast, indigenous freshwater fish species such as *Ailia coila* had a lower zinc concentration of 10.2 mg/100 g, while *Sperata seenghala* and *Tenualosa ilisha* had even lower concentrations of 0.4 mg/100 g and 0.9 mg/100 g, respectively. In recent research done by Mohanty et al. (2019), it was shown that some fish species, such as *Gudusia chapra, Penaeus monodon, Amblypharyngodon mola, Mugil cephalus*, and *Lates calcarifer*, had high levels of iron. These iron-rich fish species have the potential to play a significant role in addressing iron deficiency

Table 5. Mineral composition of fish soup powder

Parameters	**Fish Soup Powder** (with $NaHCO_3$ wash & steam cooking) *(mg/kg)
Calcium	2000
Magnesium	1215
Iron	1.089
Zinc	1.359
Sodium	169.4
Potassium	29.1
Copper	0.102
Manganese	0.415

* Ca, Mg, Na and K values were expressed as mg/ kg wet weight; Fe, Zn, Cu and Mn were expressed as µg/L.

illnesses. The mineral content of the fresh silver carplet fish and soup powder derived from *Amblypharyngodon melettinus* exhibits notable variance (Kongsbak et al., 2008). The soup powder exhibited a higher calcium content compared to the fresh fish, whereas the concentration of other components in the soup powder was comparatively low. The soup samples showed an absence of hazardous components, namely Co, Ni, and Cr.

3.7. Microbiological analysis:

Since using fish bones along with meat can influence microbial stability and nutrient levels, previous studies may provide insights into how such inclusion affects the overall product quality during storage (Sarah et al., 2017). The maximum allowable limit for Total Plate Count (TPC) in fresh/chilled/frozen fishing products is $5x10^5$ colony forming units per gramme (cfu/g), as stated by the Environmental Impact Assessment (EIA) in 1995. For cooked/boiled fishery products, the limit for TPC is $1x10^5$ cfu/g. The total plate count (TPC) of soup powder produced using *Amblypharyngodon melettinus* fish was determined to be $2.05x10^4$ colony-forming units per gramme (cfu/g). The maximum allowable *Staphylococcus* count for powdered fish-based products is $1x10^2$ colony-forming units per gramme (cfu/g). The *Staphylococcus* count of soup powder produced from *Amblypharyngodon melettinus* fish was determined to be $1.04x10^2$ colony-forming units per gramme (cfu/g). *Escherichia coli* is unable to survive when the water activity is below 0.5. Given that soup powder falls within the category of dried products, it may be inferred that the presence of E. coli is unlikely.

3.8. Sensory evaluation of fish soup powder

The sensory characteristics of fish soup powder were assessed with a 9-point hedonic scale measurement. The attributes evaluated in this study were appearance, colour, taste, flavour, texture, and overall acceptability (Wichchukit and Mahony, 2015). The mean values for these attributes were 8.7 ± 0.42, 7.68 ± 0.31, 8.30 ± 0.48, 7.90 ± 0.45, 8.10 ± 0.52, and 8.50 ± 0.41, respectively. These results are shown as the mean value ± standard deviation. The sensory evaluations indicate that all the results for the characteristics were within the acceptable range.

4. Conclusion

Based on the provided information, it can be inferred that *A.melettinus* has a considerable nutritional content, making it a potentially viable therapeutic dietary option. Consequently, *A.melettinus* may be regarded as a potential alternative to conventional intervention methods for managing IMCs. There is an urgent need to prioritize the protection of this fish species, while also focusing on developing an economically viable farming protocol for the broad cultivation of *A. melettinus* inside our nation. The creation of fish soup powder derived from silver carp is a promising and financially rewarding business opportunity for female entrepreneurs and self-help organizations. The establishment of a company might start at a home-based level, or alternatively, as a cottage industry or on a bigger scale. Given the continuously expanding demand for pre-packaged meals, this potential business proposition seems to have significant promise within the Indian market, provided that it is executed with strict adherence to hygiene standards. Future research should prioritize the analysis of the bioaccessibility and bioavailability of marine bioactive compounds, particularly when these constituents are integrated into various food matrices. This aspect is crucial in understanding the significant nutritional and health advantages associated with these substances.

Acknowledgements

This work was supported by Centre of Excellence in Food Processing Technology of Kerala University of Fisheries and Ocean Studies. The authors acknowledge the Vice-Chancellor, Kerala University of Fisheries and Ocean Studies for providing facilities to carry out this research work and for granting permission to publish the data acquired from this work.

5. References

Avens, J. S., Albright, S. N., Morton, A. S., Prewitt, B. E., Kendall, P. A., & Sofos, J. N. (2002). Destruction of microorganisms on chicken carcasses by steam and boiling water immersion. *Food Control*, 13(6–7), 445–450. https://doi.org/10.1016/S0956-7135(02)00053-4

Bothma, C., Cronjé, N., Koen, M., & Hugo, A. (2020). Product development and consumer acceptability of soup made from Clarias gariepinus. *CyTA-Journal of Food, 18* (1), 572–579. https://doi.org/10.1080/19476337.2020.1781309

Calder, P. C. (2015). Functional roles of fatty acids and their effects on human health. *Journal of Parenteral and Enteral Nutrition*, 39(1 Suppl), 18S–32S. https://doi.org/10.1177/0148607115595979

Devi, W. S., & Sarojnalini, C. (2012). Impact of different cooking methods on proximate and mineral composition of Amblypharyngodon mola of Manipur. *International Journal of Advanced Biological Research*, 2(4), 641–645.

Dey, S., Misra, K. K., & Homechoudhuri, S. (2015). Lipid classes and fatty acids of a freshwater Indian minor carp, Amblypharyngodon mola. *International Journal of Research in Fisheries and Aquaculture*, 5(1), 5–18.

Feili, R., Zzaman, W., Abdullah, W. N. W., & Yang, T. A. (2013). Physical and sensory analysis of high fiber bread incorporated with jackfruit rind flour. *Food Science and Technology,* 1(2), 30–36. https://doi.org/10.1007/s13197-013-1233-2

Folch, J., Lees, M., & Stanley, G. S. (1957). A simple method for the isolation and purification of total lipides from animal tissues. *Journal of Biological Chemistry*, 226(1), 497–509.

Gibson, R. S., Yeudall, F., Drost, N., Mtitimuni, B. M., & Cullinan, T. R. (2003). Experiences of a community-based dietary intervention to enhance micronutrient adequacy of diets low in animal source foods and high in phytate: A case study in rural Malawian children. *The Journal of Nutrition*, 133(11), 3992S–3999S. https://doi.org/10.1093/jn/133.11.3992S

Gopakumar, K. (2002). Fish processing technology. Directorate of Information and Publication of Agriculture, ICAR.

Henderson, R. J., & Tocher, D. R. (1987). The lipid composition and biochemistry of freshwater fish. *Progress in Lipid Research*, 26(4), 281–347. https://doi.org/10.1016/0163-7827(87)90002-4

HMSO. (1994). Nutritional aspects of cardiovascular disease (Report on Health and Social Subjects No. 46). London: HMSO. https://doi.org/10.77044-2

Horwitz, W., & Latimer, G. W. (Eds.). (2005). Official methods of analysis of AOAC International (18th ed.). *AOAC International*.
Ishida, Y., Fujita, T., & Arai, K. (1981). New detection and separation method for amino acid by high performance liquid chromatography. *Journal of Chromatography* A, 204, 143–148. https://doi.org/10.1016/S0021-9673(00)81643-6
Islam, R., Hossain, M. B., Islam, M. N., Islam, M. M., & Islam, M. T. (2020). Nutrient composition of small indigenous fish species (SIS) from homestead ponds of Noakhali Coast, Bangladesh. *Egyptian Journal of Aquatic Biology and Fisheries*, 24(7S), 943–954. https://doi.org/10.21608/ejabf.2020.135572
Jeyakumari, A., Joseph, C., Zynudheen, A. A., & Anandan, R. (2016). Quality evaluation of fish soup powder supplemented with carrageenan. *International Journal of Environmental Science and Technology*, 5(6), 4362–4369. https://doi.org/10.1007/s13762-016-1070-8
Kongsbak, K., Thilsted, S. H., & Wahed, M. A. (2008). Effect of consumption of the nutrient-dense, freshwater small fish Amblypharyngodon mola on biochemical indicators of vitamin A status in Bangladeshi children: A randomised, controlled study of efficacy. *British Journal of Nutrition*, 99(3), 581–597. https://doi.org/10.1017/S0007114507819144
Larsen, T., Thilsted, S. H., Kongsbak, K., & Hansen, M. (2000). Whole small fish as a rich calcium source. *British Journal of Nutrition*, 83(2), 191–196. https://doi.org/10.1017/S0007114500000246
Mishra, V., Chugh, V., Dwivedi, S. V., & Sharma, K. D. (2020). Food and nutraceuticals value of purslane (Portulaca oleracea L.): An overview. *The Pharma Innovation Journal*, 9(7), 419–424. https://doi.org/10.22271/tpi.2020.v9.i7f.4961
Mohanty, B. P., Pati, M. K., Bhattacharjee, S., Hajra, A., & Sharma, A. P. (2013). Small indigenous fishes and their importance in human health. *Advances in Fish Research*, 5, 257–278.
Mohanty, B. P., Sankar, T. V., Ganguly, S., Mahanty, A., Anandan, R., Chakraborty, K., ... Sridhar, N. (2016). Micronutrient composition of 35 food fishes from India and their significance in human nutrition. *Biological Trace Element Research*, 174, 448–458. https://doi.org/10.1007/s12011-016-0714-3
Moreira, A. B., Visentainer, J. V., de Souza, N. E., & Matsushita, M. (2001). Fatty acids profile and cholesterol contents of three Brazilian Brycon freshwater fishes. *Journal of Food Composition and Analysis*, 14(1), 65–574. https://doi.org/10.1006/jfca.2000.0962
Muhamad, N. A., & Mohamad, J. (2012). Fatty acids composition of selected Malaysian fishes. *Sains Malaysiana*, 41(1), 81–94. https://doi.org/10.17576/jsm-2012-4101-08
Yadav, R. P., Sharangdhar, S. T., Sharangdhar, M. T., Wasawe, S. M., Wasawe, S. S., & Patil, H. S. (2010). Utilization of brown seaweed Sargassum for preparation of soup from seaweed soup powder. *Ecology, Environment and Conservation*, 16(2), 163–168.
Rockland, L. B., & Nishi, S. K. (1980). Influence of water activity on food product quality and stability. *Food Technology*, 34(4), 42–59.
Sarah Priscilla, S., & Vigasini, N. (2017). Microbial and biochemical quality of fish soup powder prepared using white bait (*Stolephorous spp*.) with bones. *International Journal of Home Science*, 3(1), 316–318.
Tocher, D. R. (2003). Metabolism and functions of lipids and fatty acids in teleost fish. *Reviews in Fisheries Science*, 11(2), 107–184. https://doi.org/10.1080/713610925
Weerasuriya, H. M. C. P., Ariyarathn, S., & Abeyrathne, E. D. N. S. (2015, June). Production of fish soup cube using Yellow fin Tuna (*Thunnus albacares*) fish powder. *Proceedings of the NARA Conference*, Sri Lanka.
Wichchukit, S., & O'Mahony, M. (2015). The 9-point hedonic scale and hedonic ranking in food science: Some reappraisals and alternatives. *Journal of the Science of Food and Agriculture*, 95(11), 2167–2178. https://doi.org/10.1002/jsfa.6993