Food Research 9 (4) : 309 - 314 (2025)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

RESEARCH PAPER

Effect of drying on physicochemical and textural characteristics of murrel fish (*Channa marulius*) powder and formulation of value-added soup premix

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Article history:
Received: 14 February 2025
Received in revised form: 20 March 2025
Accepted: 19 April 2025
Available Online: 27 August 2025

Keywords:
Murrel fish,
Drying,
Soup premix,
Fish powder,
Texture

DOI:
https://doi.org/10.26656/fr.2017.9(4).045

Abstract

An investigation was conducted to study the drying characteristics of murrel fish (*Channa marulius*) for powder production, enhancing shelf life and ease of handling. The dried fish powder was then used to prepare a nutrient-rich value-added fish soup premix. Freshwater murrel fish were cleaned, sliced into darne shapes, salted with NaCl for 2 hrs, and dried in a cabinet dryer at 60°C for 14 hrs under optimized conditions. The study evaluated the effects of drying on the fish's physicochemical and textural properties. Protein content increased from 20.71 g/100 g in raw whole fish and 22.76 g/100 g in fish without head to 42 g/100 g in dried fish powder. Fat content rose from 0.87 and 1.57 g/100 g to 2.96 g/100 g after drying. Ash content showed a substantial increase from 4.52 and 1.90 g/100 g to 40.86 g/100 g. Total energy went up from 114.97 and 108.03 to 194.54 Kcal/100 g. Calcium content was 82.34, 14.08, and 47.15 mg/100 g, respectively. Moisture content decreased drastically from 72.49% and 68.18% to 12.2%. Carbohydrates ranged from 3.87 and 4.62 to 2.21 g/100 g. Drying resulted in a 74% moisture loss over 14 hrs with moisture ratio reducing from 1 to 0.7. Textural analysis revealed increased hardness and chewiness in dried fish compared to raw. This study successfully optimized conditions to produce high-quality dried fish powder and soup premix, offering a nutritious, shelf-stable product.

1. Introduction

Fish are an important source of essential nutrients, including high-quality protein, omega-3 fatty acids, vitamins, and minerals, making them vital for human health. Freshwater fish, which live mainly in rivers and lakes with low salinity, represent about 41.24% of all known fish species due to rapid speciation enabled by isolated habitats (Mrad *et al.*, 2012). Their physiology differs from saltwater fish; they must carefully regulate salt and water balance to survive, relying on their scales to prevent excess water entry and on well-developed kidneys to retain salts (Rahman *et al.*, 2012).

Loss of scales, for instance, can be fatal to freshwater fish as it disrupts their ability to regulate water diffusion. This paper explores the use of dry murrel fish powder in preparing soup premixes. The study investigates how incorporating this innovative ingredient can improve the sensory qualities, nutritional value, and overall culinary experience of soups. Comprehensive sensory evaluations and nutritional analyses were conducted to determine the impact of dry murrel fish powder on various soup recipes. The research also examined the broader benefits of utilizing fish resources sustainably, such as enhancing food security and reducing waste (Chaudhry *et al.*, 2019).

Soups made with fish powder, especially when combined with vegetables, lean proteins, and whole grains, provide an array of essential nutrients, vitamins, and fiber while remaining low in calories. This makes them an ideal meal for health-conscious individuals or those aiming for weight management, as they can be both nutritious and satisfying (Mrad *et al.*, 2012). Present work was conducted to study the drying characteristics of murrel fish for powder production, enhancing shelf life and ease of handling.

2. Materials and methods

2.1 Procurement and pretreatment of fish

Fresh murrel fish (*Channa marulius*) were bought from Aurangabad, India, and transported with ice to the lab. They were cleaned, gutted, skinned, headed, and cut into 20 mm thick darne shapes. Pretreatment involved immersing the samples in 20% NaCl solution for 2 hrs,

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eISSN: 2550-2166
Published by Rynnye Lyan Resources

using a ratio of 1100 g fish to 2000 mL solution.

2.2 Drying of fish

The drying conditions were optimized using a cabinet tray dryer at 60°C for 14 hrs, with samples weighed every 2 hrs daily (Zhu *et al.*, 2022). After drying, the fish was stored in a deep freezer to prevent microbial activity. Weight analysis was conducted before and after drying each day. The dried fish was ground into fine powder using a grinder, then sieved through fine mesh sieves to obtain a consistent powder.

2.3 Formulation of instant soup premix

Soup was prepared using the ingredients given in Table 1. Three samples of soups, viz. S-1, S-2, and S-3 were prepared using different concentrations of dried fish powder (Rahman *et al.*, 2012). A total of 100 g of a mixture of ingredients was measured and used to prepare the soup.

Table 1. Formulation of instant soup premix.

Ingredients	S-1	S-2	S-3
Dried fish powder (g)	5.0	10.0	15.0
Corn flour (g)	39.0	34.0	29.0
Tomato powder (g)	17.5	17.5	17.5
Cauliflower powder (g)	17.5	17.5	17.5
Salt (g)	10.0	10.0	10.0
Sugar (g)	5.0	5.0	5.0
Spices powder (g)	5.0	5.0	5.0
Testing salt (MSG) (g)	1.0	1.0	1.0
Total (g)	100.0	100.0	100.0

2.4 Analysis of physico-chemical properties

2.4.1 Determination of moisture content

A mass of 5 g of each sample was transferred into a previously dried and weighed dish (W_1). The dish plus its content (W_2) was placed in an oven (Gallenkamp, model OV 880, England) which was thermostatically controlled at 105°C for 6 hrs. The dish was removed, placed in a desiccator and weighed, and subsequently put back into the oven, reheated, cooled, and weighed until a constant weight (W_3) was attained. The loss in weight was reported as the percentage of moisture content (AOAC Official Method, 967.21, 2016).

2.4.2 Determination of ash content

Ash content was estimated as per the standard procedure with slight modification, as under 5.00 g of each sample was transferred to a previously ignited and weighed crucible and placed in a preheated furnace (Muffle furnace size 2, England) at 525°C for 4 hrs (AOAC Official Method 950.49, 2016).

2.4.3 Estimation of protein content

The Kjeldahl method was used for protein estimation. Accurately weighed, 2 g of the sample was further digested by heating the same with a catalyst mixture, and 20 mL of concentrated sulfuric acid till it turned green. A cooled 40% sodium hydroxide solution was added to make it alkaline, and subsequent distillation was carried out. After completion of distillation, the solution was titrated against 0.1 M sodium hydroxide using methyl red as an indicator, the endpoint being red to yellow (AOAC Official Method 4.2.11, 1990).

2.4.4 Determination of carbohydrates

Carbohydrates was determined by difference with the following equation:

Percentage of Carbohydrates (w/w) = 100 - (% Moisture + % Ash + % Protein + % Fats + % Fiber).

2.4.5 Texture analysis

The hardness, chewiness, springiness, and resilience of the fillets were investigated using an A/MORS P/5S probe (Texture Pro CT V1.7 Build 28). The tests were performed with CT3 settings: mode: Normal, probe type**:** TA10 Perspex Cylinder, test type: TPA, target: 4.0 mm, trigger load: 5 g, test speed: 2.00 mm/s, return speed: 2.00 mm/s, pretest speed: 2.00 mm/s, load cell: 10000 g (Zhu *et al.*, 2022).

2.4.6 Rehydration ratio

Dry test samples were weighed with an electronic balance (Model BS124S, Sartorius Company, Germany). Dried samples were then put into 40°C of clean warm water to rehydrate for 30 min (Shang *et al.*, 2007), and they were removed from the water for weighing. The temperature of the water was maintained at 40±0.5°C by the temperature controller (Model 501, Shanghai Experiment Instrument Factory, China). The rehydration ratio was calculated as:

$$R_{reh} = (m - m_t)/m_t$$

Where R_{reh} is the rehydration ratio of the sample, m is the weight of the sample before rehydration

2.4.7 Moisture ratio

The moisture ratio (MR) was determined by using the following formula as per the method suggested by Rahman *et al.* (2012).

$$MR = M/M_o$$

Where M and M_o are the moisture content at the time t of the drying process (kg/kg dry solid), and the initial moisture content (kg/kg dry solid), respectively.

2.4.8 Color measurement

The effect of different drying methods and temperatures on color changes of dried fish fillets was determined at room temperature using a chroma meter (CR-10, KONICA MINOLTA, Japan) at five different edge spots on the surface of each sample before and after the drying treatment. The color evaluation procedure was based on the determination of Hunter values L* (whiteness/darkness), a* (redness/greenness), and b* (yellowness/blueness). To describe the change in the color values of samples, the total color difference (ΔE) value was calculated according to the following formula (Aksoy *et al.*, 2019).

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

2.5 Statistical analysis

All physicochemical analyses of fish with head and without head, and dried fish powder values were performed in triplicate, and the results are presented as mean value ± standard deviation (SD).

3. Results and discussion

3.1 Proximate analysis of Murrel fish with head, without head and dried fish powder

As shown in Table 2, proximate analysis of freshwater fish in dried powder form (without head), and raw fish with and without head reveals key nutritional differences. Protein content is highest in dried fish powder (42±0.942 g/100 g) due to moisture loss, concentrating nutrients. Raw fish with head contains 22.76±1.664 g/100 g protein, while raw fish without head has 20.71±0.858 g/100 g. Fat content is highest in dried powder (2.96±0.89 g/100 g), influenced by water loss and lipid oxidation during drying, compared to 0.87±0.262 g/100 g in raw fish with head and 1.57±0.468 g/100 g without head. Carbohydrates decrease with drying, highest in raw fish without head (4.62±0.586 g/100 g), followed by raw with head (3.87±1.035 g/100 g), and lowest in dried powder (2.21±0.383 g/100 g), indicating glycogen degradation during drying. Ash content, reflecting minerals, significantly increases in dried powder (40.86±1.130 g/100 g), while raw fish with head and without head have 4.52±0.591 and 1.90±0.287 g/100 g, respectively, due to mineral concentration after moisture removal.

Moisture content markedly decreases in dried powder (12.2±1.682 g/100 g) compared to raw forms (68.14±2.112 g/100 g with head, 72.49±1.573 g/100 g without head). Energy value is highest in dried powder (194.54±2.857 kcal) versus 114.97±1.540 and 108.03±2.090 kcal in raw fish with and without head, respectively, again attributable to nutrient concentration after drying. Calcium is notably higher in raw fish with head (82.34±2.541 mg/100 g) compared to dried powder (47.15±1.069 mg/100 g) and raw without head (14.08±1.255 mg/100 g), emphasizing the contribution of bones to mineral content. Overall, drying significantly reduces moisture but concentrates protein, energy, and minerals, making dried fish powder a nutrient-dense food, while the presence of the head in raw fish substantially influences mineral levels.

3.2 Textural analysis

The textural properties of fish fillets—including hardness, chewiness, stringiness, and resilience were measured using an A/MORS P/5S probe (Texture Pro CT V1.7 Build 28), as depicted in Figure 1. Dried fish fillets had significantly greater hardness (4566.0N) compared to raw fillets (110.0N), an effect attributed to the drying process. Cohesiveness, defined as the ratio of positive force areas during repeated compressions (second to first), indicates how well a product withstands repeated deformation. Adhesive force, a negative value, reflects the force required to separate the plunger from the sample. Chewiness was also markedly higher in dried fillets (148.10 mJ) versus raw fillets (2.20 mJ). Stringiness, measured as the distance the sample stretches during the plunger's withdrawal before breaking, was greater in dried fillets (3.85 mm) than in raw fillets (2.58 mm), suggesting improved muscle fiber integrity after drying. Resilience, indicating elastic recovery, was also higher in dried fillets (0.35) compared to raw ones (0.25), likely due to reduced moisture and

Table 2. Proximate analysis of murrel fish powder.

Parameter	Fish without head	Fish with head	Dried fish powder
Protein content (g/100 g)	20.71±0.858	22.76±1.664	42±0.942
Fat content (g/100 g)	1.57±0.468	0.87±0.262	2.96±0.89
Carbohydrate content (g/100 g)	4.62±0.586	3.87±1.035	2.21±0.383
Ash (g/100 g)	1.90±0.287	4.52±0.591	40.86±1.130
Moisture (%)	72.49±1.573	68.14±2.112	12.2±1.682
Total energy value (kcal/100 g)	108.03±2.090	114.97±1.540	194.54±2.857
Calcium content (mg/100 g)	14.08±1.255	82.34±2.541	47.15±1.069

https://doi.org/10.26656/fr.2017.9(4).045

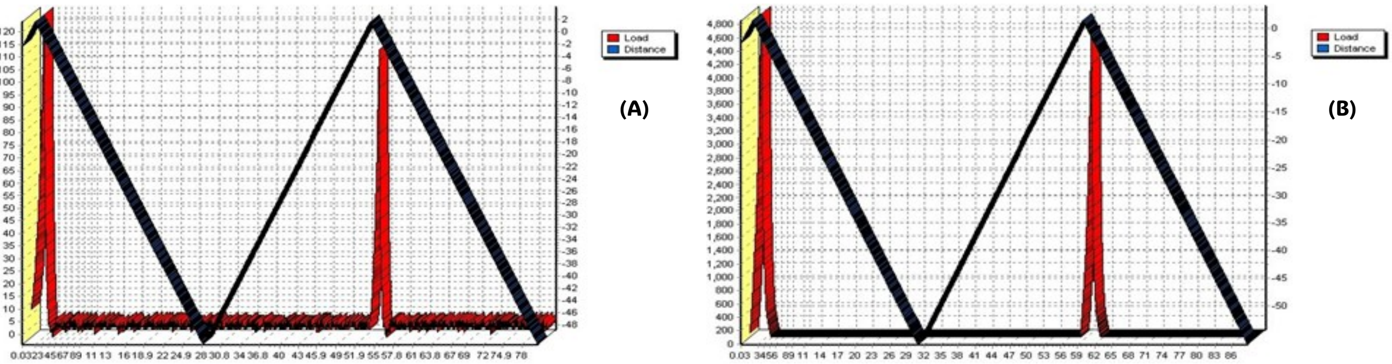

Figure 1. Textural analysis of (A) raw, and (B) dried fish fillets.

increased tissue rigidity. Overall, these findings demonstrate that drying substantially enhances the texture of fish fillets, resulting in a product that is firmer, chewier, and more elastic, in addition to improving shelf life and nutrient density.

3.3 Rehydration ratio

The rehydration ratio was calculated using the formula given by the method, using m as the rehydrated weight of the sample and 'mt' as the weight of the sample before rehydration. As shown in Figure 2(a), the comparison graph of the rehydration ratio of both samples at specific time intervals of 10 minutes was carried out, which was observed to be 0.26 and 0.19, respectively, for S-1 and S-2. Similar findings were also reported by Zhu *et al.* (2022). Factors such as drying methods, moisture retention ability, and material composition could have contributed to the variation in rehydration behavior between the two samples. Further investigation into the microstructural characteristics and drying conditions may provide deeper insights into the mechanisms influencing rehydration efficiency.

3.4 Moisture ratio

The obtained results indicate a consistent reduction in moisture ratio over time, as observed at specific two-hr intervals. This trend suggests a steady drying process, where the moisture content gradually decreases due to continuous evaporation. The downward curve presented in Figure 2(a) aligns with typical drying behavior, where the moisture removal rate is initially high and then gradually slows down as the material approaches equilibrium moisture content. The observed decline in moisture ratio highlights the effectiveness of the drying conditions used in the study. Additionally, factors such as temperature, airflow, and material properties may have influenced the rate of moisture loss, contributing to the overall drying kinetics.

3.5 Color measurement

The results indicate that drying at 60°C leads to significant color changes in the fillet sample, as evidenced by the highest ΔE value in Table 3. This

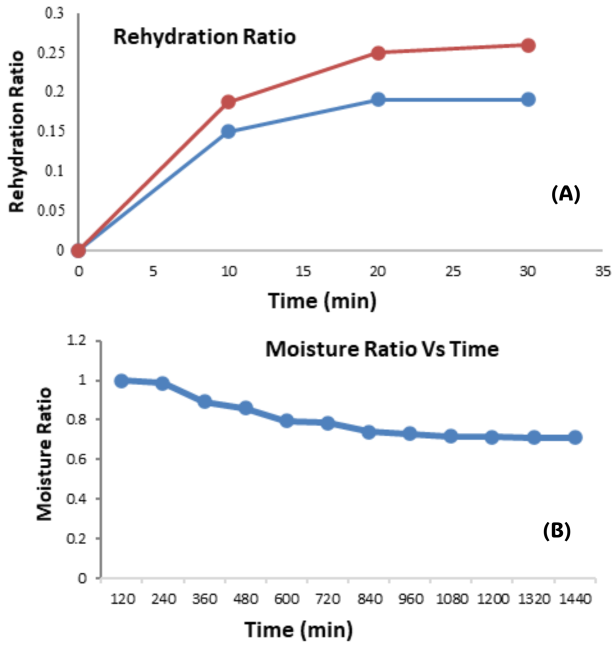

Figure 2. (a) Rehydration ratio of S-1 and S-2 and (b) Moisture ratio of dried fish.

suggests that elevated temperatures and prolonged drying times contribute to more pronounced alterations in appearance, likely due to oxidative reactions and structural modifications. The darkening effect observed aligns with previous studies, which attribute such changes to pigment degradation, Maillard reactions, and caramelization. Additionally, the increased color difference may impact consumer perception and product quality, emphasizing the need to optimize drying conditions to minimize undesirable visual changes while ensuring effective preservation.

Table 3. Color measurements of raw as well as dried fish fillets.

$(\Delta L)^2$	$(\Delta a)^2$	$(\Delta b)^2$	ΔE
9.61±0.8	12.96±0.2	144.00±2.5	12.9062±0.2
4.41±0.5	79.21±0.5	187.69±1.2	16.4714±0.5
324±2.3	81.00±0.3	225.00±1.6	25.0998±0.8
82.8±1.1	60.84±0.4	123.21±2.3	16.3358±0.7
27.0±0.6	75.69±0.6	237.16±1.6	18.4361±0.5

3.6 Sensory evaluation of dried fish powder soup

Sensory evaluation was done using a 9-point hedonic

https://doi.org/10.26656/fr.2017.9(4).045

scale to rate colour, appearance flavour, taste, aroma, and overall acceptability. The developed dried fish powder soup samples, S-1, S-2, and S-3 were served in food-grade bowls to the panel members for sensory evaluation. In terms of all the quality aspects of the sensory evaluation, sample S-3 with 15 g of fish powder performed the best when compared to S-1, and S-2, as shown in Table 4. The findings suggest that the concentration of fish powder plays a crucial role in consumer acceptability, with higher concentrations leading to better sensory perception. Additionally, investigating consumer preferences across different demographic groups could provide more insights into market acceptability.

Table 3. Color measurements of raw and dried fish fillets.

Quality attribute	E1	E2	E3	E4	E5	E6
Color	9	9	8	9	9	8
Appearance	8	9	8	9	9	9
Flavor	6	8	7	9	8	8
Taste	8	8	8	9	8	9
Aroma	7	8	7	7	9	8
Overall acceptability	8	8	8	9	9	8

E1 to E6 denotes responses of individuals.

3.7 Proximate analysis of soup prepared from dried fish powder

The nutritional and sensory values of soup prepared from dried fish powder were measured and analyzed for various measurements. The physicochemical properties and the sensory evaluation of the soup were done as shown in Table 5. The protein content was found to be 44.56%, the fat content was 4.97%, the carbohydrate content was 32.89%, the ash content was 14.10%, the moisture % was 3.48%, and the total energy value was found to be 341.12. From a sensory perspective, the soup's physicochemical properties, along with its nutrient composition, suggest that it has the potential to be both nutritious and acceptable in terms of taste, texture, and overall consumer appeal. The balance of macronutrients, particularly protein and carbohydrates, combined with a low-fat profile, indicates that this soup formulation can be a valuable dietary addition, particularly in regions where protein malnutrition is a concern.

4. Conclusion

The present investigation with respect to the drying study of murrel fish helped in optimizing the parameters for obtaining good-quality dried fish powder. The dried fish powder was subsequently utilized for the development of a novel fish soup premix. The protein content of fish soup premix was found to be 20.71, 22.76 and 42 g/100 g, respectively, in S-1, S-2, and S-3. Calcium content was found to be 82.34, 14.08 and 47.15 mg/100 g, respectively. A moisture loss of 74% was observed in dried fish after optimized drying time of 14 hrs. The textural properties, like hardness and chewiness of dried fish, were higher than raw fish. The result indicated that the concentrated form of freshwater fish was used in various value-added convenience products like fish soup premix, which improves the keeping quality of fish and provides ease of handling.

Conflict of interest

The authors confirm that they have no conflicts of interest with respect to the work described in this manuscript.

Acknowledgements

This work was supported by the Mahatma Jyotiba Phule Research and Training Institute (Mahajyoti) Fellowship under the state Government of Maharashtra, India.

References

Aksoy, A., Karasu, S., Akcicek, A. and Kayacan, S. (2019). Effects of different drying methods on drying kinetics, microstructure, color, and the rehydration ratio of minced meat. *Foods*, 8(6), 216. https://doi.org/10.3390/foods8060216

AOAC INTERNATIONAL. (2016). Moisture analysis (AOAC Official Method 967.21). Official Methods of the Analysis of AOAC INTERNATIONAL. 20th ed. Gaithersburg, USA: AOAC INTERNATIONAL.

AOAC INTERNATIONAL. (2016). Ash analysis (AOAC Official Method 950.49). Official Methods of the Analysis of AOAC INTERNATIONAL. 20th ed. Gaithersburg, USA: AOAC INTERNATIONAL.

AOAC INTERNATIONAL. (2016). Protein analysis (AOAC Official Method 4.2.11). Official Methods of the Analysis of AOAC INTERNATIONAL. 20th ed. Gaithersburg, USA: AOAC INTERNATIONAL.

Chaudhry, S., de, Alwis Goonatilake, S., Fernado, M. and Kotagama, O. (2019). Channa striata, snakehead *murrel*. *The IUCN Red List of Threatened Species*, 2019, e.T166563A60591113. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T166563A60591113.en

Mrad, N.D., Boudhrioua, N., Kechaou, N., Courtois, F. and Bonazzi, C. (2012). Influence of air-drying temperature on kinetics, physicochemical properties, total phenolic content and ascorbic acid of pears. *Food and Bioproducts Processing*, 90(3), 433-41. https://doi.org/10.1016/j.fbp.2011.11.009

https://doi.org/10.26656/fr.2017.9(4).045

Rahman, M.A., Saifullah, M. and Islam, M.N. (2012). Fish powder in instant fish soup mix. *Journal of the Bangladesh Agricultural University*, 10, 145-148. http://dx.doi.org/10.22004/ag.econ.209310

Shang, J., Duan, Z.H. and Feng, A.G. (2007). Effect of pre-treatment of low-concentration salt on the drying of *tilapia* fillets with hot air. *Food Science and Technology*, 32(4), 111–114. https://doi.org/10.1016/j.fbp.2010.11.005

Zhu, Y., Chen, X., Pan, N., Liu, S., Su, Y., Xiao, M., Shi, W. and Liu, Z. (2022). The effects of five different drying methods on the quality of semi-dried *Takifugu obscurus* fillets. *LWT Food Science and Technology*, 161,113340. https://doi.org/10.1016/j.lwt.2022.113340

