

Review Article

Nutritional Composition of *Labeo rohita*: A Review

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Abstract

Labeo rohita (Hamilton, 1822), commonly known as Rohu, is one of the most important freshwater fish species cultured in South Asia. It forms a major component of inland aquaculture production and contributes significantly to the nutritional requirements of millions of people. The species is widely appreciated for its palatable flesh, rapid growth, and favorable nutritional profile. Scientific investigations have demonstrated that Rohu contains substantial amounts of high-quality protein, essential amino acids, beneficial fatty acids, vitamins, and minerals that are necessary for human growth, development, and physiological maintenance. The fish is characterized by moderate lipid content and a favorable fatty acid composition that includes nutritionally important polyunsaturated fatty acids. In addition, Rohu provides essential micronutrients such as calcium, phosphorus, iron, zinc, and potassium, along with fat-soluble vitamins that contribute to overall health. Variations in nutritional composition may occur due to factors such as feeding practices, environmental conditions, season, and culture systems. The present review summarizes the available scientific information on the nutritional composition of *Labeo rohita*, with particular emphasis on its proximate composition, protein quality, lipid profile, mineral content, and vitamin composition. Understanding these nutritional attributes is important for promoting the utilization of Rohu as a healthy and sustainable food resource.

Keywords: *Labeo rohita*, nutritional values, Protein, Lipid, Mineral and Vitamins.

1. Introduction

Fish is widely recognized as one of the most nutritious foods available for human consumption because it provides a balanced combination of proteins, lipids, vitamins, and minerals. In many

developing countries, fish serves as an important source of animal protein and contributes substantially to dietary quality and food security. Among freshwater fishes, *Labeo rohita* (Rohu) occupies a prominent position due to its extensive

cultivation, economic importance, and consumer preference. It is one of the three Indian major carps and forms the backbone of freshwater aquaculture systems throughout India, Bangladesh, Nepal, and several other Asian countries [9].

The popularity of Rohu extends beyond its commercial value. The species is highly regarded for its nutritional characteristics, which make it a valuable component of balanced diets. Scientific studies have consistently demonstrated that Rohu possesses an excellent nutrient profile characterized by high-quality protein, moderate lipid content, and significant quantities of essential micronutrients [10]. Unlike many terrestrial animal foods that contain high levels of saturated fats, Rohu provides beneficial fatty acids that contribute positively to human health. Its flesh is also highly digestible, making it suitable for consumption by individuals across different age groups.

With increasing awareness regarding the relationship between diet and health, there is growing interest in evaluating the nutritional composition of commonly consumed fish species. Understanding the nutrient profile of Rohu is important not only from a nutritional perspective but also for supporting aquaculture development and public health initiatives. This review examines the major nutritional components of *Labeo rohita* and highlights their significance in human nutrition.

2. Proximate Nutritional Composition

The proximate composition of fish provides a fundamental assessment of its nutritional quality and includes measurements of moisture, protein, lipid, ash, and carbohydrate contents. Numerous studies conducted on *Labeo rohita* have shown that the species possesses a well-balanced nutritional composition suitable for human consumption. Although slight variations occur among different geographical locations and

culture systems, the overall nutrient profile remains relatively consistent [3].

Moisture constitutes the largest proportion of Rohu flesh and generally ranges between 76 and 80 percent [14]. This high moisture content contributes to the soft texture, tenderness, and palatability of the fish. Protein is the second most abundant component and typically varies between 16 and 18 percent of fresh muscle weight. Such protein levels indicate that Rohu is an excellent source of animal-derived protein capable of meeting a substantial portion of daily nutritional requirements [8].

The lipid content of Rohu generally ranges from approximately 1.8 to 4.0 percent, classifying it as a lean to moderately fatty fish. Although the total fat content is relatively low, the lipids present possess considerable nutritional importance due to their fatty acid composition. Ash content usually ranges from 1 to 2.8 percent and reflects the presence of essential minerals within the muscle tissue. Carbohydrates occur only in trace amounts because fish primarily store energy as proteins and lipids rather than glycogen [5].

The favorable balance among these nutritional components makes Rohu an attractive food source. Its high protein concentration, moderate fat levels, and significant mineral content collectively contribute to its nutritional significance and support its widespread consumption across South Asia.

3. Protein Quality and Amino Acid Profile

Protein is one of the most important nutrients required for human growth, maintenance, and physiological functioning. The nutritional significance of *Labeo rohita* is largely attributed to its high-quality protein content and balanced amino acid composition. Studies have consistently reported protein concentrations ranging from 16 to 18 percent in fresh muscle tissue, making Rohu a valuable source of dietary protein for populations that depend on fish as a primary animal food source.

The quality of a protein source depends not only on the amount of protein present but also on its amino acid profile. Rohu contains all essential amino acids required for human nutrition, including lysine, leucine, isoleucine, valine, methionine, threonine, phenylalanine, tryptophan, and histidine. These amino acids play critical roles in growth, tissue repair, enzyme production, hormone synthesis, and immune function. Since the human body cannot synthesize essential amino acids in sufficient quantities, they must be obtained through dietary sources [2].

An important characteristic of Rohu protein is its high digestibility. Fish muscle contains relatively low levels of connective tissue compared with terrestrial meats, allowing digestive enzymes to break down proteins more efficiently. Consequently, amino acids are absorbed and utilized effectively by the body. This characteristic makes Rohu particularly beneficial for children, elderly individuals, pregnant women, and people recovering from illness. The combination of high protein content, balanced amino acid composition, and excellent digestibility establishes Rohu as an important nutritional resource capable of supporting growth, health, and overall well-being [4].

4. Lipid Composition and Fatty Acid Profile

The lipid fraction of *Labeo rohita* contributes significantly to its nutritional value despite the relatively low total fat content. Fish lipids are recognized as important sources of essential fatty acids that participate in numerous physiological processes and support long-term health. In Rohu, total lipid content generally ranges between 1.8 and 4.0 percent, although variations may occur depending on environmental conditions, feeding practices, and seasonal changes [11].

The fatty acid profile of Rohu includes saturated, monounsaturated, and polyunsaturated fatty acids. Among these, polyunsaturated fatty acids are of particular nutritional importance because they include omega-3 fatty acids such as

eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fatty acids are associated with several beneficial health effects, including support for cardiovascular function, brain development, visual health, and regulation of inflammatory responses. DHA is especially important for the structural development of the brain and retina, whereas EPA contributes to cardiovascular protection and immune regulation [13].

Studies have also reported a favorable omega-6 to omega-3 fatty acid ratio in Rohu. This balance is considered beneficial because excessive dietary omega-6 fatty acids relative to omega-3 fatty acids may contribute to inflammatory disorders and chronic diseases [12]. Furthermore, lipid health indices such as atherogenicity and thrombogenicity indices indicate that the fatty acid composition of Rohu is compatible with heart-healthy dietary recommendations. Therefore, the lipid profile of Rohu enhances its value as a nutritious freshwater fish suitable for regular consumption.

5. Mineral Composition

Minerals are essential nutrients that participate in numerous physiological and biochemical processes necessary for maintaining human health. Although required in relatively small quantities, their deficiency can lead to serious health complications. *Labeo rohita* is recognized as a valuable source of several important minerals and therefore contributes significantly to dietary micronutrient intake. The mineral composition of Rohu reflects its nutritional quality and enhances its importance as a food fish.

Among the minerals present in Rohu, calcium and phosphorus are particularly significant because of their roles in the formation and maintenance of bones and teeth. These minerals also participate in muscle contraction, nerve transmission, and energy metabolism [1]. Regular consumption of Rohu can therefore contribute to skeletal development and maintenance throughout life. Iron is another important mineral found in Rohu

and is essential for the synthesis of hemoglobin, which transports oxygen throughout the body. Adequate iron intake helps prevent anemia and supports normal physical and cognitive performance.

Rohu also contains zinc, a micronutrient involved in immune function, wound healing, protein synthesis, and cellular growth. Potassium contributes to the maintenance of fluid balance, nerve impulse transmission, and blood pressure regulation [7]. In addition, magnesium and other trace minerals present in Rohu support numerous enzymatic reactions associated with energy production and metabolic regulation. The presence of these minerals in biologically available forms enhances their nutritional effectiveness. Consequently, the regular inclusion of Rohu in the diet can contribute significantly to meeting daily mineral requirements and supporting overall physiological health.

6. Vitamin Composition and Nutritional Implications

Vitamins are indispensable organic compounds required for normal growth, development, and maintenance of health. Fish are widely recognized as important dietary sources of several vitamins, particularly fat-soluble vitamins that are often deficient in many populations. *Labeo rohita* contributes to human nutrition through the presence of vitamins A, D, E, and K, each of which performs specific physiological functions essential for maintaining health [7].

Vitamin A is necessary for vision, immune competence, cellular differentiation, and the maintenance of epithelial tissues. Adequate intake of vitamin A is particularly important for preventing visual disorders and enhancing resistance to infections. Rohu also provides vitamin D, which plays a central role in calcium and phosphorus metabolism. This vitamin facilitates calcium absorption from the intestine and contributes to bone formation and skeletal integrity. Given the increasing prevalence of

vitamin D deficiency worldwide, fish consumption remains an important dietary strategy for improving vitamin D status.

Vitamin E functions primarily as an antioxidant that protects cellular membranes from oxidative damage caused by free radicals. Through this action, it contributes to cellular stability and may reduce the risk of certain chronic diseases associated with oxidative stress. Vitamin K, another fat-soluble vitamin present in fish tissues, is involved in blood clotting mechanisms and bone metabolism. The combined presence of these vitamins enhances the nutritional value of Rohu and contributes to various aspects of human health. Consequently, regular consumption of Rohu can assist in meeting vitamin requirements and support the maintenance of normal physiological functions [6].

7. Factors Influencing Nutritional Composition

The nutritional composition of *Labeo rohita* is influenced by a variety of biological, environmental, and management-related factors. Although the species generally exhibits a stable nutrient profile, variations in protein, lipid, mineral, and vitamin contents may occur depending on specific conditions. Understanding these factors is important for improving fish quality and maximizing its nutritional benefits.

Diet is one of the most important determinants of nutritional composition. The quality and quantity of feed consumed by Rohu directly influence growth performance and nutrient deposition within muscle tissues. Fish receiving balanced diets rich in essential nutrients often exhibit improved protein levels and more favorable fatty acid profiles. Environmental conditions such as water temperature, dissolved oxygen concentration, pH, and water quality also affect metabolic activity and nutrient accumulation. Adverse environmental conditions can influence growth and alter the biochemical composition of the fish.

Seasonal variation represents another important factor affecting nutritional quality. Changes in temperature, reproductive activity, and natural food availability can result in fluctuations in moisture, protein, and lipid contents throughout the year. Age and size of the fish may also contribute to differences in nutrient composition, as physiological requirements change during

growth and maturation. Furthermore, culture practices such as stocking density, pond management, and production systems can influence nutritional characteristics. These factors collectively determine the final nutrient profile of Rohu and highlight the importance of appropriate aquaculture management in maintaining high nutritional quality.

Table1: Comprehensive Nutrient Profile and Dynamics of *Labeo rohita*

Nutritional Category	Key Component(s)	Specific Values / Metrics	Physiological Significance & Human Health Benefits	Key Influencing Factors (Causes of Variation)
Proximate Composition	Moisture	76% – 80% [14]	* Provides soft texture, tenderness, and high palatability. * Acts as an excellent source of premium animal protein. * Classified as a lean to moderately fatty fish. * Reflects a solid presence of essential mineral matter. * Energy is primarily stored as proteins and lipids rather than glycogen.	* Geographical location & culture system variations [3]. * Seasonal fluctuations [11]. * Age and structural size of the fish.
	Protein	16% – 18% [8]		
	Lipids	1.8% – 4.0%		
	Ash	1% – 2.8%		
	Carbohydrates	Trace amounts [5]		
Protein Quality & Amino Acids	Lysine, leucine, isoleucine, valine, methionine, threonine, phenylalanine, tryptophan, and histidine.	16% – 18% concentration in fresh muscle. High digestibility due to low connective tissue.	* Essential for tissue repair, growth, enzyme/hormone synthesis, and immune defense [2]. * Highly digestible muscle structure is ideally suited for children, elderly, pregnant women, and convalescing individuals [4].	* Quality and quantity of dietary feed. * Metabolic shifts during growth and seasonal maturation.
Lipid & Fatty Acid Profile	Saturated, Monounsaturated, and Polyunsaturated Fatty Acids (PUFAs) including Omega-3 (EPA & DHA) and Omega-6.	1.8% – 4.0% total fat [11]. Features a highly favorable Omega-6 to Omega-3 ratio.	* DHA: Critical for brain and retina structural development [13]. * EPA: Promotes cardiovascular health and immune regulation [13]. * Low atherogenicity and thrombogenicity indices support heart-healthy diets	* Dietary oil/fat sources in feed. * Water temperature and environmental changes. * Reproductive

			and lower inflammation [12].	cycles and seasonal shifts.
Mineral Composition	Calcium (Ca), Phosphorus (P), Iron (Fe), Zinc (Zn), Potassium (K), and Magnesium (Mg).	Present in highly bioavailable forms within muscle tissues.	<p>* Ca & P: Crucial for bone/teeth formation, nerve transmission, and energy metabolism [1].</p> <p>* Fe: Essential for hemoglobin synthesis to prevent anemia.</p> <p>* Zn & K: Enhances immune response, cellular growth, fluid balance, and blood pressure regulation [7].</p>	<p>* Environmental water chemistry and pH.</p> <p>* Pond management and fertilizer regimes.</p> <p>* Feed formulation mineral density.</p>
Vitamin Composition	Fat-soluble Vitamins A, D, E, and K.	Synthesized or stored effectively in fish tissues [7].	<p>* Vitamin A: Supports vision, immunity, and epithelial integrity.</p> <p>* Vitamin D: Facilitates calcium absorption for bone health.</p> <p>* Vitamin E: Acts as an antioxidant protecting cell membranes [6].</p> <p>* Vitamin K: Drives proper blood clotting and bone metabolism [6].</p>	<p>* Natural food availability in ponds.</p> <p>* Vitamin-precursor levels in commercial feed.</p> <p>* Seasonal water quality variations.</p>

Conclusion

Labeo rohita is one of the most nutritionally valuable freshwater fish species cultivated in South Asia and serves as an important source of essential nutrients for human populations. Scientific investigations have consistently demonstrated that Rohu possesses a favorable nutritional profile characterized by high-quality protein, moderate lipid content, essential fatty acids, vitamins, and minerals. Its protein is highly digestible and contains all essential amino acids required for growth, tissue maintenance, and metabolic functions. The lipid fraction, although relatively low in quantity, contains nutritionally important polyunsaturated fatty acids that contribute to cardiovascular and neurological health.

In addition to macronutrients, Rohu provides several essential minerals, including calcium, phosphorus, iron, zinc, and potassium, which support skeletal development, oxygen transport, immune function, and metabolic regulation. The presence of vitamins A, D, E, and K further enhances its nutritional significance by contributing to vision, bone health, antioxidant defense, and normal physiological functioning. Variations in nutritional composition may occur due to factors such as feeding practices, environmental conditions, seasonal changes, and culture systems, but the overall nutritional value of the species remains consistently high. The combination of nutrient density, affordability, and widespread availability makes Rohu an important component of balanced diets and a

valuable resource for improving nutritional status. Continued research and sustainable aquaculture practices will further strengthen its role in supporting human nutrition and food security.

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