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Enhancing Fish Feeding Methods and Formulating Nutritious Feed For The Growth Of *Labeo rohita*

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Abstract: The demand for effective and nutrient-rich fish meals has surged as aquaculture has spread internationally in recent decades. Nutritionally, inadequate diets can be detrimental to the health and productivity of fish. The formulation of fish feed requires precise measurements of various components, including protein, carbohydrates, vitamins, and minerals. To promote sustainable and economic growth in the aquaculture industry, it is crucial to produce and provide fish with the appropriate quality and quantity of feed. Therefore, the current work focuses on plant-based fish feed as a cost-effective and nutrient-rich substitute for traditional ingredients like fish meal and fish oil in fish feed formulations for the optimal growth of fish, *Labeo rohita*. The average body weight of *L. rohita* was 2.0 ±0.02 gm (n=100) on the first day, which progressed to 2.7 ±0.03 gm during the first week and reached 108.76 ±0.45 gm by the end of the 13th week. This increase in fish meal was a curvilinear increase with the weekly progression. The growth rate of *L. rohita* exhibited initial slow progression, which was followed by an exponential increase in the growth rate. The supplied fish food and fish body-weight ratio has increased from 1:1 to 1:6 from the first to the 13th week. We noticed a very low feed conversion ratio of 1.19 and a high Gross Food Conversion Efficiency of 84.03 % when the above fish meal was provided. We conclude that plant-based fish feed including soybean is highly nutritious for the growth of *L. rohita*.

Keywords: *labeo rohita* • aquaculture • fish meal • fish oil • plant-protein sources

Introduction

India is a diverse nation covering about an area of 3.287 million km^2. The region's climate varies from mild in the north to hot and muggy in the south. Generally, marine water sources are used for fisheries, although inland water bodies are often used for both culture and capture fisheries. Aquaculture includes, breeding, nursing, growing and harvesting aquatic fauna, such as fish and other aquatic flora. It contributes to healthier environments, rebuilds stocks of threatened or endangered species, and provides environmentally friendly sources of food and commercial goods (Ayyappan et al. 2006). The agricultural industry with the fastest global growth right now is aquaculture, which has undergone significant advancements in recent decades (Li et al. 2020; Sinha et al. 2023). Fish nutrition, feeds, and feeding management are crucial for enhancing aquaculture farm output and preventing nutritional disorders (Bhosale et al. 2010). Species prefer food with high in protein and energy (Castro et al. 2022).

Fish meal (FM) and fish oil (FO) are the main traditional food sources for carnivorous or omnivorous fish (Sarker et al. 2020). The biggest variable expense in the majority of fish production is feed. Fish feed must be developed to be cost-effective rather than just less expensive, even if there is unquestionably a demand for less-priced feeds (Albrektsen et al. 2022). This can be accomplished by carefully selecting and combining a variety of traditional and alternative feed ingredients that are suitable for use in fish diets (Tacon and Metian, 2008). When using less expensive alternative feedstuffs, the nutritional and physical quality of the feed, fish development, processed production, and product quality must not be compromised. Diseases present a substantial hindrance to the growth and long-term viability of aquaculture due to their impact on investment losses resulting from fish mortality, expenses associated with disease treatment, and reductions in both product quality and quantity (Egerton et al. 2020).

Aquaculture presently relies heavily on industrial coastal fisheries and processing trimmings to obtain 60% of FM and 85% of FO (Castro et al. 2022). However, this dependence on marine resources poses a significant challenge, as expanding production from these sources will inevitably result in increased environmental impact. While sustainably managed fisheries may currently yield approximately 5 million tons of FM and 1 million tons of FO (ICAR 2006), this falls short of both the existing and projected demand. Although there has been a six percent increase in total cumulative FM and FO production in 2021, it remains crucial for aquaculture to explore alternative means of meeting the growing fish demand.

Fish is a nutrient-enriched food and a great source of animal proteins. Artificial feed must be provided so that fish can grow quickly and reach their optimum weight in the shortest amount of time in order to optimize fisheries and maximize yields from freshwater resources. Due to its compliance with the protein requirements of fish, FM is regarded as the best ingredient among regularly used feed ingredients (Pauly and Zeller, 2015). Fish feed has a lengthy and diverse history. The earliest form of feed was only a combination of several foods, but it wasn't until the early 1800s that more specific fish meals were created for various species of fish. Because of the escalating price and erratic supply of fish meal, fish feed must be replaced with less expensive elements of plant origin (Glencross et al. 2007). Rumsey (1993) suggested that fish meal costs might be decreased by using more plant protein supplements in fish feed. The work has concentrated on finding alternatives that can substitute fish meals that are less expensive and more readily accessible while maintaining the nutritional value of feed (Pauly and Zeller, 2015). When formulating fish feed, the apparent digestibility of protein, energy, and specific amino acids is taken into account as well as data on various raw materials, such as plant wastes that are frequently used in the feed manufacturing industry. For several decades, a variety of fish species have been the subject of numerous investigations, yielding digestibility data for the majority of nutrients. It is necessary to create a low-cost, balanced diet using locally accessible agricultural byproducts for fish commercial culture. Fish meal has recently risen to the top spot as the most expensive protein source in aquaculture diets. Numerous studies have demonstrated significant effectiveness when substituting soybean meal (SM) and other soybean products for fish meal in various fish species' diets (Drew et al. 2007). Fish feed plays a vital role in private and commercial aquaculture by providing nutritious diets for farmed fish. Typically, it is supplied in the form of pellets or granules, which offer concentrated and stable nutrition, facilitating optimal growth and development of the fish (Drew et al. 2007). Based on this distinction in food sources, fish food can be broadly categorized into two types: Natural feed which comprises phytoplankton (blue-green algae) and zooplankton (insect protein, housefly maggots) and supplementary

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feed. Fish supplements are also produced utilizing substances derived from animals, such as fish powder, silkworm pupa, animal, slaughter-house meat, and blood. Fish food is also made with plant-based ingredients such wheat flour, wheat bran, soybean meal, rice bran, mustard oil cake, coconut cake, and coconut cake (Khanna and Singh 2016).

At present, commercial fish meals primarily consist of FM and FO as the key ingredients. However, the production of these meals requires significant resources as wild fish need to be harvested for their manufacturing (Glencross et al. 2007). Consequently, overfishing has caused severe declines in populations of forage fish, such as anchovies and herring, which are crucial for the diet of larger fish and play a vital role in the marine food chain. The negative impact is evident as early as 2037, with the demand for fishmeal and fish oil projected to surpass the supply of small fish. This highlights the unsustainability of industrial feed production in the long term. Therefore, it is imperative to develop sustainable fish diets to protect marine ecosystems and mitigate the depletion of ocean resources. The present study is thus designed to study the impact of formulated fish feed on the growth parameters of *Labeo rohita* (Hamilton).

Materials and Methods

Study site: This work has been carried out at Sultan Fish Farm (SFSF) Butana, Nilokheri (Karnal), Haryana (Fig 1). The farm has been engaged in the breeding and culture of fresh water fish, including Indian Major Carps (IMCs), Chinese Major Carps (CMCs), freshwater prawns, and catfish. This study was carried out for about 3 months from 1st April 2023 to 30th June 2023 on Indian major carp, *Labeo rohita* (Hamilton).

Figure 1. Map of Study Site: Sultan Fish Seed Farm, 2.7km from Nilokheri, Haryana

To evaluate the daily feed requirements and growth rate of fish, around ten thousand individuals of fish, *L. rohita* (approximately based on their weight) were studied for 3 months. The fishes were supplied with supplementary plant-based feed by mixing and data was recorded based on the following calculations:

Feed Conversion Ratio (F.C.R.) is the relationship between the input of the feed that has been fed and the weight gain of a population, which is calculated as follows:

F.C.R. = Total Feed / Total Biomass

Total Biomass or Total Body Weigh*t* is derived from the total number of fish counted in a specific area of water multiplied by the average weight of fish sampled (*i.e.*, Number of Fishes / Average Body Weight of Sampled Fishes).

Daily Feeding Rate (D.F.R.): The total quantity of supplementary feeding to be given daily to the fish in a particular pond is usually expressed as a percentage of the total weight or biomass of fish present, which is calculated as follows:

D.F.R. = Total biomass / Percentage (%) Feed

Gross Food Conversion Efficiency (G.F.C.E.): It is the percentage of the inverse FCR calculated by following Stickeney and Hardy (1989).

Results

Based on the life cycle of fish feed is classified as starter feed, main-course feed and finisher. The average body weight (ABW) of small fish, *L. rohita* was 2.0 ±0.02 gm (n=100) on the first day, which increased gradually with the progression of each day with the decrease in the percentage of fish feed (Table-1).

Table 1: Feeding rate of fish, *Labeo rohita*

Average Body Weight (ABW) in gm	Feed %	Pellet size in mm
1gm	8-10%	1.4mm or below
10gm	6-8%	1.4-2mm
50gm	4-6%	2-3mm
100gm	2-4%	4mm
250gm and above	1.5-2%	4mm and above

The ABW gradually increased to 2.7 ±0.03 gm (n=100) by the end of the first week and reached 108.76 ±0.45 gm (n=100) by the end of the 13th week (Table-2). The feed conversion ratio (FCR) was found to be 1.19, as the total feed and total biomass for the three months were 1301.34kg and 1091.08kg, respectively. The Gross Food Conversion Efficiency (G.F.C.E.) was 84.03 %. There was a curvilinear increase in the feed with the weekly progression ($Y = -0.0967X^2 + 3.4187X - 3.537$; $r^2 = 0.8934$; $P<0.0001$), which reached an asymptote at the later phase of the fish life-history (Figure-2). The Growth rate of L. rohita in response to the weekly progression exhibited initial slow progression, which was followed by an exponential increase in the growth rate ($Y = 0.6307X^2 + 0.3923X - 0.1883$; $r^2 = 0.9969$; $P<0.0001$; Figure-3). A comparison between supplied fish feed and the body weight of *L. rohita* revealed that the supplied fish food and body-weight ratio has increased from 1:1 to 1:6 (Figure-4)

Table 2. Feeding rate of the fish, *Labeo rohita*

Week	ABW-gm	Fishes-Nos	Biomass-Kg	Feed %	Weekly feed-Kg	Feed Size
1	2.7	10000	27.00	10.00	2.70	1.40
2	4.4	10000	44.00	8.86	3.85	1.40
3	6.39	10000	63.86	7.71	4.90	1.40
4	8.86	10000	88.57	6.00	5.31	1.40
5	14.19	9800	139.09	5.14	7.11	1.83
6	23.29	9800	228.20	5.00	11.41	2.00
7	33.56	9800	328.86	5.00	16.44	2.00
8	44.85	9800	439.53	5.00	21.98	2.00
9	56.90	9800	557.62	4.14	22.81	2.00
10	69.26	9500	657.94	3.00	19.74	4.00
11	81.90	9500	778.05	3.00	23.34	4.00
12	94.79	9500	900.46	2.86	25.65	4.00
13	108.76	9500	1033.26	2.00	20.67	4.00

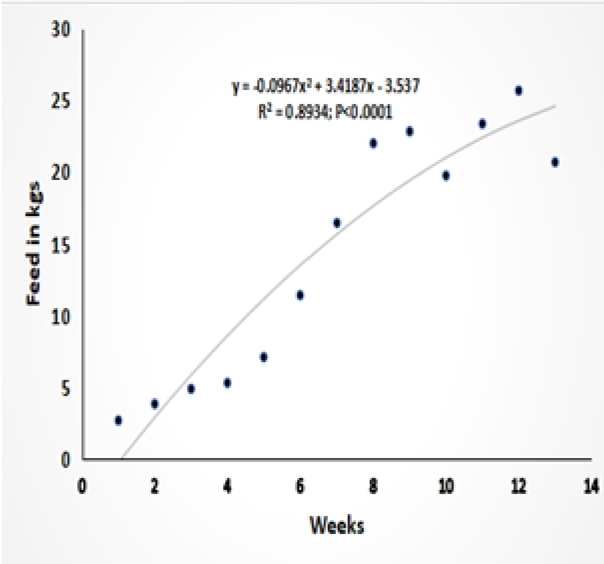

Fig 2. Feed requirement of the fish, *Labeo rohita*

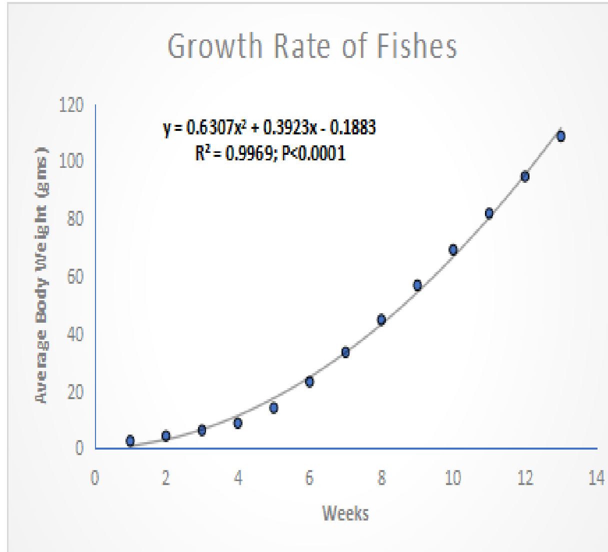

Fig 3. The Growth Rate of *Labeo rohita* in response to the weekly progression

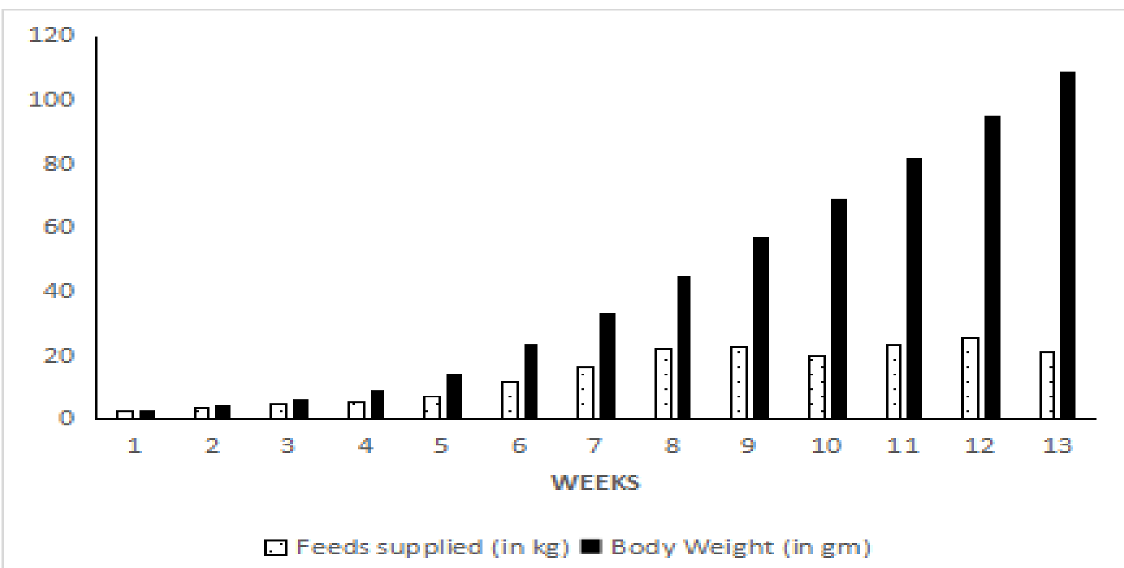

Fig 4. Feed Supplied vs Body Weight of fish, *Labeo rohita*

Discussion

The results revealed a low Feed Conversion Ratio (FCR), which indicates that less feed is required to produce 1kg of fish, *L. rohita* compared to a higher FCR. This implies that the feed has a higher efficiency and is considered of superior quality. A low FCR is a positive indicator of feed performance. A very high Gross Food Conversion Efficiency (%) in the present study indicates the high suitability of the fish meal, which was supplemented with plant products including plant proteins, soybeans, and carbohydrates.

To safeguard marine ecosystems and lessen the loss of ocean resources, sustainable fish diets are required. However, there is a rising need for commercial fish feed. This is because as the human population grows, so does the demand for protein, and fish is greatly sought after because it is a superior source of protein. A "protein challenge" has emerged as a result of an increasing world population and increased protein demand (Bhosale et al.2010). Presently used aquafeed plant proteins include: Soybean [*Glycine max* Linnaeus] which is a highly important oilseed crop, that was a substantial global production of around 254 million tons during 2009-11. The process of oil extraction from soybeans results in a protein-rich cake, which serves as a valuable resource. When compared to FM, SPC (soy protein concentrate) raises additional concerns due to its high quantity of carbohydrates, with a significant portion being oligosaccharides. Some of these carbohydrates are not available to aquatic species, posing a potential issue. SPC is known to offer a well-balanced amino acid profile for fish (Glencross et al. 2007). However, it may lack certain essential amino acids, specifically methionine. As a result, methionine supplementation in crystalline form is necessary to ensure the proper dietary balance (Khanna and Singh, 2016). Wheat gluten (WG) is an interesting alternative to FM as a protein source in diets. While primarily used in bovine feed, WG is occasionally utilized by baking companies (less than 1% concentration) for quality control or nutritional marketing purposes (Glencross et al. 2007) WG exhibits high overall protein digestibility, with particularly high digestibility of cysteine when included in diets (Fresco et al. 2000).

Conclusion

Fish feeds, crucial in aquaculture, come as pellets or granules, providing concentrated nutrition for optimal fish growth. Conventional feeds heavily rely on animal ingredients, depleting forage fish stocks and disrupting ecosystems. Sustainable alternatives are imperative. This disruption affects larger fish dependent on forage fish. Sustainable feed production is vital for quality, with soybean emerging as a promising protein substitute. Plant-based feeds, especially soybean-based ones, offer cost-effective, nutritionally equivalent options. Consequently, plant-based feed manufacturing units are globally establishing, ensuring sustainable aquaculture practices and Ecosystem Preservation.

References

Albrektsen S, Kortet R, Skov PV, Ytteborg E, Gitlesen S, Kleinegris D and Overland M (2022) Future feed resources in sustainable salmonid production: A review. Rev. Aqua. 14(4): 1790-1812.

Ayyappan S, Jena JK, Gopalakrishnan A, and Pandey AK (2006) Handbook of fisheries and aquaculture.

Bhosale SV, Bhilave MP and Nadaf SB (2010). Formulation of fish feed using ingredients from plant sources. Res. J. Agric. Sci. 1(3): 284-287.

Castro PL, Torrecillas S, Montero D, Izquierdo MS and Ginés R (2022) Effect of combined fishmeal and fish oil replacement on growth performance, flesh quality and shelf life of European sea bass (*Dicentrarchus labrax*). Aquac. 560: 738452.

Drew MD, Borgeson TL and Thiessen DL (2007) A review of processing of feed ingredients to enhance diet digestibility in finfish. Anim. Feed Sci. Technol., 138(2), 118-136.

Egerton S, Wan A, Murphy K, Collins F, Ahern G, Sugrue I and Stanton C (2020) Replacing FM with plant protein in Atlantic salmon (*Salmo salar*) diets by supplementation with fish protein hydrolysate. Sci. Rep., 10(1), 4194.

Fresco J, Meadows R, Economy RB and Cities C (2010) Growing fish feed: protecting our health and the oceans. FAO (SOFIA). 3.

Glencross BD, Booth M and Allan GL (2007) A feed is only as good as its ingredients–a review of ingredient evaluation strategies for Aquaculture feeds. Aquac. Nutrit. 13(1): 17-34.

ICAR (2006). Handbook of fisheries and aquaculture. pp. 307-319.

Khanna SS and Singh HR (2016) A textbook of Fish Biol. Fish. Narendra Publishing House.

Li D, Wang Z, Wu S, Miao Z, Du L and Duan Y (2020) Automatic recognition methods of fish feeding behavior in aquaculture: A review. Aquac. 528: 735508.

Pauly D and Zeller D (2017) Comments on FAOs (SOFIA 2016). Marine Policy. 77: 176-181.

Rumsey GL (1993). Fish meal and alternate sources of protein in fish feeds update 1993. Fisheries 18(7): 14-19.

Sarker PK, Kapuscinski AR, McKuin B, Fitzgerald D S, Nash HM and Greenwood C (2020) Microalgae-blend tilapia feed eliminates FM and FO, improves growth, and is cost viable. Sci. Rep. 10(1): 19328.

Sinha A, Kumar S and Kumar K (Eds.) (2023) Outlook of Climate Change and Fish Nutrition. Springer Nature.

Stickeney RR and Hardy RW (1989) Lipid Requirement of some warm water species. Aquac. 79: 145-146.

Tacon AG and Metian M (2008) Global overview on the use of FM and FO in industrially compounded aquafeeds: Trends and future prospects. Aquac. 285(1-4): 146-158.