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Influence of Probiotic Food on the Growth Performance and Survival Rate of Gold Fish (*Carassius auratus)*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted at the Postgraduate Department of Zoology, Sree Narayana College, Nattika, Insia. Twenty juvenile goldfish were randomly placed in two groups: a control group (n = 10) and an experimental group (n = 10), and acclimatized in the laboratory for one week prior to the experiment. The control group were fed a basal diet of fish meal, soybean meal, wheat flour, and rice flour., while the experimental group were fed a combination of the basal diet and probiotic food (curd) at a dosage of 4 g per day. The fish were kept in aerated and dechlorinated freshwater at a temperature range of 20-25°C and a pH of 7.4, and fed once daily in the morning, over an 8-week period. Mean Initial weight (MIW) for the Control fishes was 2.18g while the Mean Final weights (MFW) for the Control fishes were 2.88g. The MIW for the Experimental fishes fed with probiotics was 2.73g while the MFW was 4.1g. Survival rate was 50% for the Control fishes and 100% for the Experimental fishes fed.

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Keywords: Probiotics; curd; Carassius auratus; protein.

1. INTRODUCTION

A Probiotic is a microorganism which when consumed as a dietary supplement, maintains or restores beneficial bacteria in host (Martínez Cruz et al., 2012). Kozasa was a pioneer in the empirical application of probiotics in aquaculture, drawing inspiration from the positive effects observed in humans and poultry (Kozasa, 1986). The aquaculture industry has emerged as a vital sector in meeting the global demand for seafood, with a growing emphasis on enhancing the growth and health of cultured species (FAO, 2020). *Carassius auratus,* commonly known as goldfish, is a popular ornamental fish that has garnered significant interest in aquaculture due to its adaptability, economic value, and growing demand in the market (Herrera-Castillo et al., 2024). Ensuring optimal growth performance and survival rates of goldfish in aquaculture systems is crucial for maximizing productivity and profitability (Rahmatullah et al., 2015; Mellisa et al., 2018). Several factors, including water quality, nutrition, and disease management, play a critical role in determining the growth and survival of goldfish in aquaculture systems (Yoshitomi et al., 2002; Bandyopadhyay, 2005; Elshafey et al., 2023). Studies have shown that goldfish are capable of adapting to a wide range of water temperatures and quality conditions, making them an ideal species for aquaculture (Ford & Beitinger, 2005; Filice et al., 2021). In addition to water quality management, nutrition also plays a critical role in determining the growth and survival of goldfish in aquaculture systems. Studies have shown that goldfish require a balanced diet that includes a mix of protein, carbohydrates, and lipids (Bandyopadhyay, 2005; Belsare et al., 2017). Furthermore, the use of probiotics and prebiotics have been shown to improve the growth and survival of goldfish by enhancing their immune system and gut health (Hoseinifar et al., 2014; Ahire et al., 2018. Torres-Maravilla et al., 2024).

Probiotics, which are live microorganisms that confer health benefits to the host when administered in adequate amounts, have gained considerable attention in aquaculture due to their potential to improve growth performance, enhance immune responses, and increase resistance to diseases in various aquatic species (El-Saadony et al., 2021). The use of probiotics in aquaculture has been shown to have several benefits, including improved feed utilization, enhanced nutrient absorption, and increased production of beneficial enzymes (Gatesoupe, 2008; Amenyogbe et al., 2024; El-Saadony et al., 2021). Among the various forms of probiotic administration, probiotic-enriched food has shown promise in delivering consistent and beneficial effects on fish health and growth it involves the incorporation of probiotic microorganisms into commercial fish feeds, which are then consumed by the fish (Gatesoupe, 2008; Ljubobratovic et al., 2017). This method of probiotic administration is effective in improving growth performance, enhancing immune responses, and reducing disease susceptibility in various aquatic species (Fuchs et al., 2017; Mohammadi et al., 2022). Previous studies have reported that the use of probiotics results in improved growth and feed utilization across various fish species, including Nile tilapia (*Oreochromis niloticus*) (Lara-Flores et al., 2017), Indian major carp (*Labeo rohita*) (Sinha & Pandey, 2013), and rainbow trout (*Oncorhynchus mykiss*) (Bagheri, 2008). Similarly, the study by Opio et al., (2019) found that the use of probiotic-enriched food improved growth and enhanced body composition in Nile tilapia. In addition to improving growth performance, probiotic-enriched food has also been shown to enhance immune responses in fish. Single-strain probiotics have been shown to enhance growth, boost anti-pathogen immunity, and increase resistance to *Nocardia seriolae* in grey mullet (*Mugil cephalus*) by modulating the gut microbiota (Chan et al., 2024). *Lactobacillus rhamnosus* enhanced the immune response in rainbow trout *Oncorhynchus mykiss* by increasing the production of immune-related enzymes and proteins (Panigrahi et al., 2004).

Curd as a probiotic in aquaculture has gained attention due to its potential to enhance fish health and improve water quality. Curd, a fermented dairy product, contains beneficial lactic acid bacteria (LAB) such as *Lactobacillus* species, which can act as probiotics by promoting gut health, enhancing immune responses, and inhibiting pathogenic bacteria in aquatic species (Fu et al., 2019). *Lactobacillus basilus* has been studied for its positive effects on the growth of fishes. Specific studies have demonstrated that supplementing *Labeo rohita* diets with *Lactobacillus basilus* can improve growth performance, enhance immune responses, and increase disease resistance. For example, a study by Sinha & Pandey, (2013)

showed that *Labeo rohita* with a diet enriched with *Lactobacillus basilus* exhibited significantly higher growth rates and better feed utilization efficiency compared to those on a standard diet (Sinha & Pandey, 2013). The benefits of using Lactobacillus as a probiotic in aquaculture include improved growth and survival rates, enhanced immune system function, increased resistance to disease, and improved water quality. Different strains of Lactobacillus, such as *Lactobacillus plantarum*, *Lactobacillus rhamnosus*, and *Lactobacillus acidophilus*, have been isolated and characterized for their probiotic properties. The mechanisms of action of Lactobacillus as a probiotic include adhesion to the intestinal mucosa, production of antimicrobial compounds, modulation of the immune system, and improvement of nutrient absorption and utilization (Sinha & Pandey, 2013).

This study aims to investigate the effects of probiotic-enriched curd on the growth rate and survival rate of *Carassius auratus*. By comparing the growth performance, survival rates, and protein content between probiotic-supplemented and control groups, this research seeks to provide valuable insights into the potential benefits of probiotic supplementation for enhancing the growth and health of goldfish in aquaculture.

2. MATERIALS AND METHODS

An indoor experiment was conducted at the Postgraduate Department of Zoology, Sree Narayana College, Nattika, to investigate the effects of probiotic supplementation on the growth performance of goldfish (*Carassius auratus*). Twenty juvenile goldfish were randomly assigned to two groups: a control group (n = 10) and an experimental group (n = 10), and acclimatized to laboratory conditions for one week prior to the experiment. The control group received a basal diet consisting of fish meal, soybean meal, wheat flour, and rice flour, while the experimental group received a combination of the basal diet and probiotic food (curd) at a dosage of 4 g per day. The fish were maintained in aerated and dechlorinated freshwater at a temperature range of 20-25°C and a pH of 7.4, and fed once daily in the morning, with growth parameters, including initial and final length and weight, recorded over an 8-week period. The growth parameters such as live weight gain, percentage increase in biomass, specific growth rate, feed conversion ratio and survival rate percentage were calculated as follows.

- Increase in biomass= $\text{final weight} - \text{initial weight}$ (Ayim et al., 2002)
- Increase in biomass (%) =

$$\frac{(\text{final weight} - \text{initial weight})}{\text{initial weight}} \times 100$$ (Ayim et al., 2002)

- FCR = $\frac{\text{Total feed consumed by fish (g)}}{\text{Total weight gain by fish(g)}}$ (Bethke et al., 2013)
- Survival rate (%) =

$$\frac{(\text{Initial number of fishes} - \text{final number of fishes})}{\text{initial number of fishes}} \times 100$$

- SGR= $\frac{(\text{In w(t)} - \text{In w(i)}}{T} \times 100$ (Arshad, 2024)

Where,

Wt was the final weight, Wi was the initial weight and T was the experimental duration.
Total body protein estimation was done by Lowry's method (Lowry et al., 1951).

3. RESULTS

At the end of the experimental period probiotic supplemented diets revealed that a significant increase in the body weight and length. The study revealed that a significant relationship between body length and body weight of experiment and control. The final body weight gain, percentage of weight gain, specific growth rate, food conversion ratio and survival rate of gold fish increased significantly in experiment than control, when fed a diet containing probiotic food (Tables 1, 2). Concerning the proximate chemical analysis of whole fish body shows that the protein content in experiment was significantly increased compared to that of control (Table 3).

Table 1. Weight of gold fish

Group	Initial weight (g)	Final weight (g)	MEAN ±SD	p
Control	2.18	2.88	2.88 ± 0.13	0.01
Experiment	2.73	4.1	4.1 ± 0.12	0.001

Table 2. Growth parameters of gold fish (8 week)

Group	Initial weight (g)	Final weight (g)	BWI	PWI (%)	SGR	FCR	SR (%)
Control	2.18	2.88	0.7	32.11	1.25	0.57	50
Experiment	2.73	4.1	1.37	50.18	2.44	2.91	100

Table 3. Protein estimation (Lowry method)

Group	MEAN ±SD	p
Control	1.51± 0.003	0.01
Experiment	2.17±0.005	

4. DISCUSSION AND CONCLUSION

The present study demonstrates the beneficial effects of probiotic supplementation on the growth performance and survival rate of goldfish. The results show that the probiotic-treated group had a significant increase in body weight, length, specific growth rate, feed conversion ratio, and protein efficiency ratio compared to the control group. These findings are consistent with previous studies that have reported the positive effects of probiotics on fish growth and performance (Gatesoupe, 1999; Pirarat et al., 2011; Standen et al., 2016; Ramos et al., 2015; Ramos et al., 2017). Research has shown that probiotics promote growth by enhancing fish appetite and stimulating the production of vitamins, fatty acids, and additional digestive enzymes. This process helps break down indigestible feed components and improves overall digestion (Rengpipat et al., 2008; Merrifield et al., 2010).

The probiotic food used in this study, curd, contains various beneficial microorganisms, including lactic acid bacteria, which have been shown to improve growth performance and feed utilization in fish (Madhankumar et al.,2024). The presence of these microorganisms in the probiotic food may have contributed to the improved growth performance and survival rate observed in the probiotic-treated group. The results of this study also suggest that the probiotic supplementation had a positive effect on the protein content of the fish body. The combined effect of probiotic bacteria with the basal diet showed a significant increase in protein content in the experimental group. This finding is consistent with previous studies that have reported the positive effects of probiotics on protein synthesis and deposition in fish (Dall & Moriarty, 1983). The non-specific immune system of the fish was also stimulated by the probiotic treatment, providing protection from diseases by activating both cellular and humoral immune defenses to pathogens. (Rengpipat, 2000).

In conclusion, the results of this study demonstrate the beneficial effects of probiotic supplementation on the growth performance and survival rate of goldfish. The use of probiotic food, such as curd, as a feed additive can improve feed utilization, growth performance, and protein content in goldfish *Carassius auratus*. These findings have important implications for the development of sustainable and effective feeding strategies in aquaculture.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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