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Evaluation of different dietary protein levels on growth performance in the culture of Pearlspot, *Etroplus suratensis* (Bloch, 1790) in freshwater

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Abstract
Pearlspot (*Etroplus suratensis*) is an indigenous fish extensively found along the east and south-west coasts of Peninsular India and is an excellent table fish of delicacy, fetching a good demand and market price due to its taste and appearance. It can be farmed under extensive and intensive farming in freshwater and salt water eco-systems in ponds and cages. The growth of pearlspot in freshwater ecosystem is mainly influenced by dietary protein levels. The present study was conducted in the cement ponds to evaluate the growth performance of *E. suratensis* for a period of 8 months with four different protein diets *viz*., 35%, 30%, 25% and 20% as Treatment T_1, T_2, T_3 and T_4 respectively in triplicates. The fish fingerlings weighing an average weight of 6gm were stocked in cement tanks of 20.00 m^2 size. At the end of the feeding trial, the fishes were weighed to assess growth parameters in terms of weight gain percentage, feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER). The diet T_3 displayed significantly ($p<0.05$) higher rates of weight gain percentage, SGR, PER and lower FCR rates compared to other treatments. T_3 showed better growth when compared to other treatments. The study emphasized the need for species specific diets for application at the farm level for an effective profit in culture period.

Keywords: *Etroplus suratensis*, dietary protein, growth performance, freshwater aquaculture

Introduction
Aquaculture has become a cornerstone of global food production, addressing the increasing demand for sustainable and high-quality protein sources. Among the diverse species cultivated, *Etroplus suratensis*, commonly known as pearl spot. The pearl spot (*Etroplus suratensis*), belonging to the family Cichlidae, thrives in both freshwater and brackish water environments and is widely distributed across India and Sri Lanka (Hora and Pillay, 1962) [6]. This species is highly regarded for its vibrant coloration, making it a popular choice as an ornamental fish, while also being in high demand as a food source. Historically, pearl spot accounted for a substantial share (8-10%) of the total fish catch in backwater regions (George and Sebastian, 1970) [5]. However, overfishing has significantly diminished its population, pushing it toward potential extinction in its natural habitats (Padmakumar *et al*., 2002) [16].
In India, pearl spot is extensively found in the backwaters and freshwater ecosystems along the coastal regions, stretching from South Canara to Thiruvananthapuram on the west coast. It has also been introduced into eastern water bodies, including Chilka Lake, where it is traditionally cultured (Swaminathan *et al*., 2010) [21]. The species is highly favoured for its taste and superior flesh quality, making it a popular choice among consumers in regions where it is available. Due to its euryhaline nature and omnivorous diet, pearl spot is well-suited for polyculture systems, where it can be cultivated alongside both brackish water and freshwater fish and prawns (Jayaprakas *et al.*, 1990; Padmakumar *et al*., 2009b) [8, 17].
Karimeen is recognized as a highly nutritious fish. Along with being a rich source of meat, it contains notable amounts of fat, phosphorus, calcium, ash, iron, and water. The composition of these nutrients in Karimeen includes 17.5% fat, 1.65% phosphorus, 0.50% calcium, 1.08% ash, 4.90% iron and 79.70% water (Mukundan and James, 1978) [14].
Protein is a critical macronutrient in aquaculture diets, influencing fish growth, metabolism and health.

However, the effectiveness of protein feed varies based on its composition, digestibility and nutrient profile. Studies have demonstrated that optimizing protein levels in feed can significantly enhance growth and feed utilization in pearl spot (Marbade *et al*., 2023) [13]. Additionally, the inclusion of specific amino acids, such as lysine, has been shown to improve protein metabolism and growth efficiency (Wu, 2009) [23]. Understanding these dynamics is essential for developing cost-effective and sustainable feeding protocols. The findings are expected to contribute valuable insights toward improving feeding practices and promoting sustainable aquaculture development (Boyd *et al*., 2020) [2]. Despite its importance, optimal rearing conditions for pearl spot from the onset of exogenous feeding remain unclear, with one of the primary challenges being the provision of nutritionally suitable diets for grow out phase. Effective management of pearl spot culture, particularly during the growout phase, necessitates a thorough understanding of feeding strategies, as feed quality directly impacts growth performance, survival and overall productivity.

Although several commercial diets are currently available for *Etroplus suratensis*, the precise nutritional requirements for different stages of its life cycle remain inadequately defined. Consequently, there is a pressing need to design a feed specifically tailored to the needs of *E. suratensis* juveniles to promote rapid growth while addressing the species' unique nutritional demands. This study focuses on an on-farm assessment to evaluate the impact of formulated feed of different proteins on the growth performance of *E. suratensis*, in growout culture. By analyzing growth metrics, feed conversion ratios and survival rates, this research seeks to identify the most effective protein feed strategies for pearl spot aquaculture.

Materials and Methods

Experimental Design

The present study was carried out at Fisheries Research and Information Centre, KVAFSU, Hesaraghatta, Bengaluru. The fishes were bred at the centre and reared upto fingerling size in ponds and fingerling weighing an average weight of 6 gm were used for the study purpose. The experiment was carried out in cement tanks of 20 m² size in four treatments in triplicates. The experimental tanks were stocked at 5 Nos/m^2 with pearl spot fingerlings and they were fed with four different protein diets *viz*., 35%, 30%, 25% and 20% as Treatment T_1, T_2, T_3 and T_4 respectively in triplicates for a period 8 months.

Growth and survival

The fishes were sampled at every 30 days intervals to record the growth and to calculate the feeding rate. The stocked fish were collected during each sampling and measured for length and weight. After the termination of the experiment, survived fishes were collected. Specific growth rate (SGR) and weight gain (WG %) were used as indicators for growth performance. The feed conversion ratio (FCR) was used as an indicator for feed utilization. The survival rate (%) after the completion of the experiment was recorded. The growth performances were calculated using standard formulae as follows.

$$\text{Weight gain} = \frac{\text{Final weight (g)-Initial weight (g)}}{\text{Initial weight (g)}} \times 100$$

$$\text{SGR (\%)} = \frac{\text{Ln (Final weight (g))-Ln (Initial weight (g))}}{\text{No. of days}} \times 100$$

$$\text{FCR} = \frac{\text{Dry weight of the feed given (g)}}{\text{Gain in wet weight of fish}} \times 100$$

$$\text{Survival (\%)} = \frac{\text{Final number of fish}}{\text{Initial number of fish}} \times 100$$

Statistical analysis

All statistical analysis were carried out using SPSS software (V 21.0). Comparison among different treatments was carried out by One-Way Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test at p<0.05. All data were expressed as mean±standard error (SE).

Results

The Growth performances and survival rate in Pearl spot fingerlings were determined (Table 1). During the experimental period, the different protein content showed improved feed conversion ratio, specific growth rate, weight gain, protein conversion ratio and survival, with significant differences in these parameters within the diets. Survivability in the experimental period is almost similar in all the treatments. For the Pearl spot fingerlings, after a 8 months feeding trial, the diets fed with 30% protein diet showed better growth performances, including SGR, weight gain and PER with high significance (p<0.05) and with that, the lowest FCR were seen in the treatments fed with 30% protein diet compared to other protein diets (p<0.05).

Table 1: Under various treatments and in the control group, FCR, SGR, PER, WG and survival were measured.

Parameters	Treatments			
	T_1	T_2	T_3	T_4
WG (%)	1236.53±2.247^a	1388.88±0.843^b	1776.28±7.913^d	1655.21±3.874^c
SGR (% per day)	1.82±0.001^a	1.87±0.001^b	1.96±0.002^d	1.94±0.000^c
FCR	2.95±0.004^c	2.85±0.005^b	2.72±0.012^a	2.74±0.005^a
PER	3.72±0.007^d	3.35±0.005^b	3.57±0.017^c	2.85±0.004^a
Survival (%)	95	96	96	95

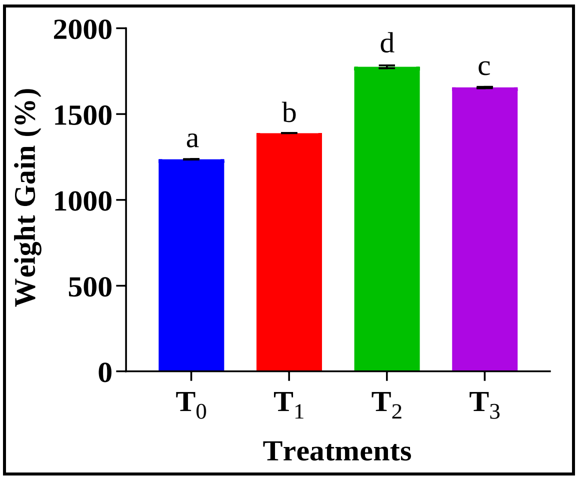

Fig 1: Influence of different protein on Pearl spot weight gain

Figure 1 depicts the influence different protein on Pearl spot weight increase. T_1 has the least amount of protein influence on fish weight. Compared to the other treatment groups, T_2 had the largest effect of protein on fish weight gain.

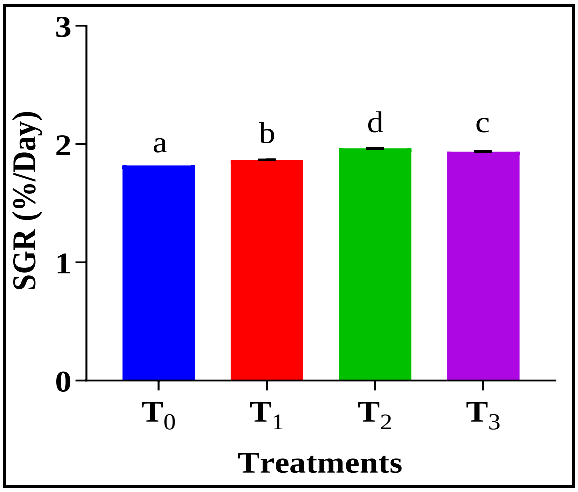

Fig 2: Influence of different protein on Pearl spot specific growth rate

Figure 2 shows the impact of different protein on Pearl spot specific growth rate. T_3 had the highest influence of protein on fish-specific growth rate compared to other treatment groups T_4, followed by T_2 and T_1.

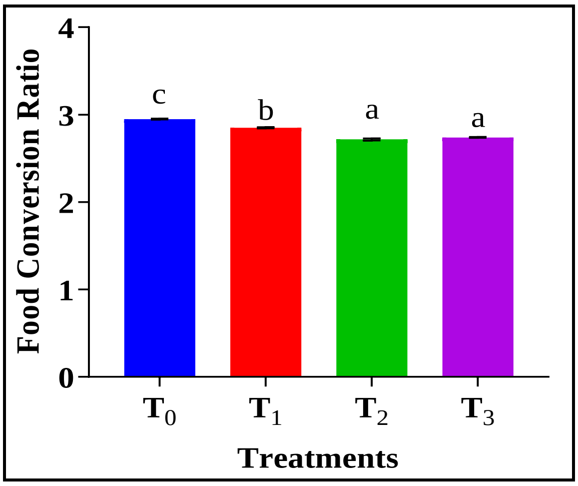

Fig 3: Influence of different protein on Pearl spot food conversion ratio

Figure 3 depicts the impact of different protein on Pearl spot food conversion ratio. T_3 had the highest influence of protein on fish-food conversion ratio with low FCR values compared to other treatment groups T_4, followed by T_2 and T_1.

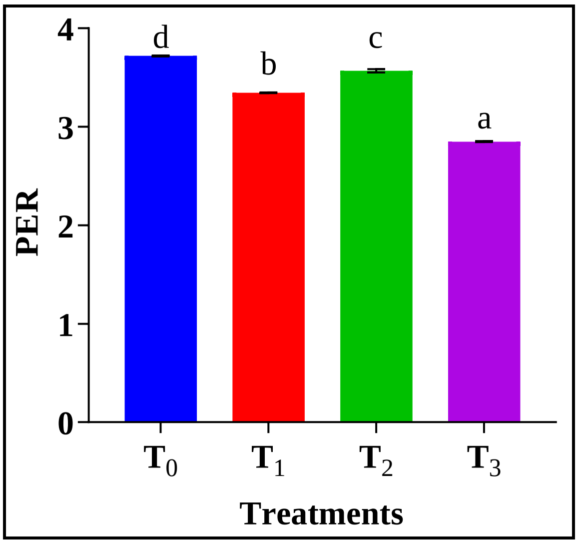

Fig 4: Influence of different protein on Pearl spot protein efficiency ratio

Figure 4 depicts the impact of different protein on Pearl spot protein efficiency ratio. T_3 had the highest influence of protein on fish-food conversion ratio compared to other treatment groups T_1, followed by T_1 and T_4.

Discussion

The research highlights that enhancing the nutritional composition of diets, beyond the standard used in commercial grow-out feeding, can significantly boost the growth outcomes of *Etroplus suratensis*. Among the tested diets, Diet T_3 comprising 30% crude protein demonstrated superior growth performance. In contrast, diets with lower protein levels exhibited higher feed conversion ratios and less optimal energy profiles. Additionally, the study aligns with findings by Kaushik and Médale (1994) [10], suggesting that fish adjust their feed consumption to satisfy their energy requirements. Sayeed *et al*. (2008) [20] observed that the final weight and specific growth rate of Thai pangus (*Pangasius hypophthalmus*) improved with increasing dietary protein levels. While their findings were consistent with the current study, the protein range they examined spanned from 26% to 40%, reinforcing that higher protein concentrations are essential for enhanced growth and production. Similarly, Abdel-Tawwab *et al.* (2010) [1] reported analogous outcomes in Nile tilapia (*Oreochromis niloticus*), where fry exhibited optimal growth with a 45% protein diet, whereas the lowest growth was observed with a 25% protein diet. The study revealed that *Etroplus suratensis* exhibited optimal growth efficiency with a diet containing 30% protein, alongside a higher survival rate for the T_3 diet. The relative feed intake of *Etroplus* varied depending on dietary protein levels, suggesting that feed intake is influenced not only by energy requirements but also by specific nutrient demands, particularly protein. The research underscores that dietary protein is crucial in aquaculture for promoting rapid growth, as noted by Jauncey and Ross (1982) [7] and Lovell (1989) [11].

Juvenile *E. suratensis* showed notable improvements in specific growth rate (SGR) and weight gain (WG) with increased dietary protein, achieving peak results at a protein level of 30%. Similar findings were reported by El-Dahhar *et al*. (2000) [3] and Prabu *et al.* (2020) [18] for Nile tilapia and snub nose pompano juveniles. Protein levels of 40-38% produced significantly better body weight gain compared to 37%, aligning with previous studies on other species like yellow snapper (*Lutjanus argentiventris*, Maldonado-Garcia *et al*., 2012) [12], Senegalese sole (*Solea senegalensis*, Rema *et al*., 2008) [19], common dentex (*Dentex dentex*, Espinos *et al*., 2003) [14], and Mediterranean yellowtail (*Seriola dumerilii*, Jover *et al*., 1999; Wilson, 2002; NRC, 2011) [9, 22, 15], which typically require higher protein levels for optimal growth observed with a 25% protein diet.

Survival rates in fish are typically impacted by favorable factors such as adequate nutrition and optimal environmental conditions. When these conditions are insufficient, fish health deteriorates, leading to reduced survival rates. Ensuring higher survival rates is crucial for achieving successful growth. The findings of this study align with this principle, demonstrating improved survival outcomes in fish fed with the high protein diet.

Conclusion

Juvenile *E. suratensis* demonstrated optimal growth, survival, and feed conversion efficiency when provided with a diet containing around 30% crude protein administered at a specific ration with three daily feedings. These results hold substantial practical importance, marking a significant advancement in formulating a comprehensive farming practice framework for *E. suratensis*, with direct benefits for farm-level operations.

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