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Effect of *Carica Papaya* leaf powder supplementation on growth performance and survival rate of *Labeo Catla* (Worms, 2023)

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Abstract

The study investigated the effects of dietary *Carica papaya* leaf powder (PLP) on the growth, survival, and feed efficiency of *Labeo Catla* fry over a 60-day experimental period. Five dietary treatments were formulated, incorporating PLP at inclusion levels of 0% (control), 2.5%, 5%, 7.5%, and 10%, with all diets maintaining a consistent protein content of 30%. Growth parameters, including mean weight gain, specific growth rate (SGR), survival rate, feed conversion ratio (FCR), and protein efficiency ratio (PER), were evaluated. The results demonstrated that the treatment with 7.5% PLP (T3) exhibited the highest mean weight gain (2.263 ± 0.145 g), SGR ($3.225 \pm 0.099\%$ /day) and survival rate ($97.500 \pm 2.887\%$), while achieving the lowest FCR (1.923 ± 0.043) and the highest PER (1.734 ± 0.039). These findings indicate that PLP enhances protein digestion and nutrient absorption, likely due to bioactive compounds such as papain. However, higher inclusion levels ($>7.5\%$) showed diminishing returns, possibly due to anti-nutritional factors like alkaloids and saponins. The study highlights the potential of PLP as a natural growth promoter and survival enhancer for *Labeo Catla*, emphasizing the need for species-specific dietary formulations. The results suggest that a 7.5% inclusion level is optimal for this species.

Keywords: *Carica papaya*, *Labeo Catla*, growth performance, feed efficiency, papain

Introduction

The growing global demand for fish as a vital source of protein and essential nutrients has intensified the pursuit of sustainable and efficient aquaculture practices. Among various strategies to enhance aquaculture outcomes, dietary interventions using natural supplements have garnered significant interest. *Labeo Catla*, a freshwater fish species of considerable economic significance in India, plays a crucial role in aquaculture due to its rapid growth and strong consumer demand (Mohanty *et al.*, 2013) ^[13]. During 2022-23, India's total fish production was recorded at 17.545 million tonnes, with major carp accounting for approximately 6.736 million tonnes (DOF, 2023). Despite its importance, challenges such as disease outbreaks and suboptimal growth rates often limit its potential in aquaculture systems, underscoring the need for innovative approaches to improve fish health and overall productivity (Walker & Winton, 2010; Bondad-Reantaso *et al.*, 2005) ^[22, 23].

A promising approach to enhancing fish growth, health, and survival in aquaculture involves the use of bioactive compounds derived from plants. Among these, *Carica papaya* has gained attention for its wide range of bioactive properties, making it a natural alternative for promoting fish health and alleviating the impacts of disease and stress (Boshra & Tajul, 2013; Aravind *et al.*, 2013) ^[4, 2]. The leaves of the papaya plant contain bioactive components such as papain, flavonoids, and phenolics, which possess antioxidant, antimicrobial, and immune-boosting properties. These attributes hold potential for improving growth and survival rates in aquaculture species (Seigler *et al.*, 2002; Citarasu *et al.*, 1999) ^[6]. Papain, a proteolytic enzyme found in papaya, plays a particularly important role in enhancing protein digestion, which can significantly improve the growth performance of fish (Hitesh *et al.*, 2012) ^[9].

Materials and Methods

An experiment was conducted to evaluate the effects of *Carica papaya* leaf powder on the growth and survival of *Labeo Catla* fry. Rectangular tanks with a capacity of 56 liters were thoroughly cleaned, sun-dried, and arranged in a completely randomized design, comprising five treatments and four replications. The dietary treatments included a control (0% papaya leaf powder) and diets with papaya leaf powder at inclusion levels of 2.5%, 5%, 7.5%, and 10%, all formulated to maintain a protein content of 30%. Fish growth was monitored biweekly over 60-day period using an electronic balance, and average weights were calculated for analysis. Daily observations were made to assess survival, health status, and behavioral patterns. Survival rates were recorded every two weeks and again at the conclusion of the experiment.

Experimental Diet Preparation

The experimental feed formulation was designed using the Pearson square method to maintain a consistent protein level of 30% across all diets. Five different experimental diets (T0 to T4) were created, incorporating *Carica papaya* leaf powder at varying concentrations of 0% (control), 2.5%, 5%, 7.5%, and 10%. Ingredients were precisely measured and mixed with water, followed by thermal processing at 121°C under 15 lbs of pressure for 15 minutes. After cooling, vitamins, minerals, and papaya leaf powder were added to the mixture and thoroughly blended. The feed was then pelletized using a mechanical pelletizer to form uniform pellets, which were sun-dried for 2-3 days until the moisture content fell below 12%. The dried pellets were stored in airtight containers. Nutritional analysis confirmed that the protein content remained consistent at 30% across all experimental diets.

Table 1: Composition of Experimental Diet (for 100 g diet)

Ingredients	Diet (30% protein)				
	T0 (0% PLP)	T1 (2.5% PLP)	T2 (5.0% PLP)	T3 (7.5% PLP)	T4 (10.0% PLP)
Papaya leaf powder	0.0	2.5	5.0	7.5	10.0
Sterilized fishmeal	27.2	26.6	26.0	25.0	24.0
GNOC	27.0	26.0	25.0	25.0	24.4
Wheat flour	27.0	26.0	25.0	25.0	24.4
Tapioca flour	13.8	12.9	12.0	13.0	11.6
Plant oil	2.0	2.0	2.0	2.0	2.0
Fish oil	2.0	2.0	2.0	2.0	2.0
Vitamin & minerals	2.0	2.0	2.0	2.0	2.0
Total	100.0	100.0	100.0	100.0	100.0

*PLP-papaya leaf powder

Assessment of Growth, Survival and Feed Efficiency

Every two weeks, all the fish in each treatment group were counted and weighed to assess their growth performance, feed efficiency, and survival rate. Prior to weighing, the fish were fasted overnight. The following formulas were used to determine growth parameters and feed utilization throughout the experiment.

Parameters

Growth Parameters

The following growth parameters were determined using the provided formula.

Mean Weight Gain = Final Average Body Weight - Initial Average Body Weight

Mean Weight Gain

The mean weight gain was computed utilizing the subsequent formula:

"Mean Weight Gain = " Final Weight (g) - Initial Weight (g)

Specific Growth Rate (SGR)

SGR was computed following the methodology outlined by Manivannan and Saravanan (2012) using the provided formula.

$$\text{SGR (\%/day)} = \frac{\ln(\text{Final Weight (g)}) - \ln(\text{Initial Weight (g)})}{\text{Experimental Period (days)}} \times 100$$

Survival Rate: The survival rate of *Labeo Catla* fry was computed utilizing the provided formula.

$$\text{Survival Rate (\%)} = \frac{\text{No. Of fish survived after rearing}}{\text{No. Of fish Stocked}} \times 100$$

Feed Conversion Ratio (FCR)

FCR was determined in accordance with the methodology described by Manivannan and Saravanan (2012), utilizing the formula provided.

$$\text{FCR} = \frac{\text{Feed Intake (g)}}{\text{Weight Gain (g)}}$$

Protein Efficiency Ratio

The PER calculation followed the formula provided by Nalawade & Bhilave (2011).

$$\text{PER} = \frac{\text{Weight Gain (g)}}{\text{Protein Intake (g)}}$$

Analysis of Water Quality Parameters

Water quality parameters such as temperature, pH, dissolved oxygen, and alkalinity were methodically assessed on a weekly basis throughout the entire duration of the experiment.

Results

The experiment's data regarding the impact of Papaya leaf powder (*Carica papaya*) in the diet of *Labeo Catla* fry over a 60-day experimental period is outlined below. The results encompass the mean weight (MW), specific growth rate (SGR), survival rate, feed conversion ratio (FCR) and

protein efficiency ratio (PER) observed across all five treatment groups at the end of the experiment.

Growth performance

The mean weight of *L. catla* fry was monitored every 15 days over a 60-day experimental period for each treatment group, as detailed in Table 2 and illustrated graphically in Figure 1. At the start of the experiment, the initial mean weights of the fry were recorded as 0.380 ± 0.006 g, 0.381 ± 0.006 g, 0.379 ± 0.006 g, 0.382 ± 0.006 g, and

0.383 ± 0.006 g for treatments T_0 , T_1 , T_2 , T_3 , and T_4 , respectively. By the conclusion of the study, the final mean weights had increased to 1.346 ± 0.036 g, 1.832 ± 0.057 g, 2.198 ± 0.132 g, 2.644 ± 0.144 g, and 1.614 ± 0.037 g for the respective treatments. Statistical analysis conducted at the end of the 60-day period indicated a significant difference ($p<0.05$) in mean weights across the treatment groups. The highest mean weight was observed in the T_3 group (2.644 ± 0.144 g), while the lowest was recorded in the T_0 group (1.346 ± 0.036 g).

Table 2: Mean weight (g) of *Labeo Catla* fry recorded in different treatments during the culture period (Mean $\pm$ SD)

Treatment	Experimental Period				
	Initial	15 th DAY	30 th DAY	45 th DAY	60 th DAY
T_0	0.380 ± 0.006^a	0.659 ± 0.028^b	0.784 ± 0.063^d	1.005 ± 0.046^d	1.346 ± 0.036^e
T_1	0.381 ± 0.006^a	0.635 ± 0.181^b	1.078 ± 0.048^c	1.469 ± 0.066^b	1.832 ± 0.057^c
T_2	0.379 ± 0.006^a	0.753 ± 0.039^b	1.209 ± 0.091^b	1.547 ± 0.100^b	2.198 ± 0.132^b
T_3	0.382 ± 0.006^a	1.003 ± 0.029^a	1.350 ± 0.091^a	1.773 ± 0.098^a	2.644 ± 0.144^a
T_4	0.383 ± 0.006^a	0.682 ± 0.030^b	0.776 ± 0.032^d	1.119 ± 0.050^c	1.614 ± 0.037^d

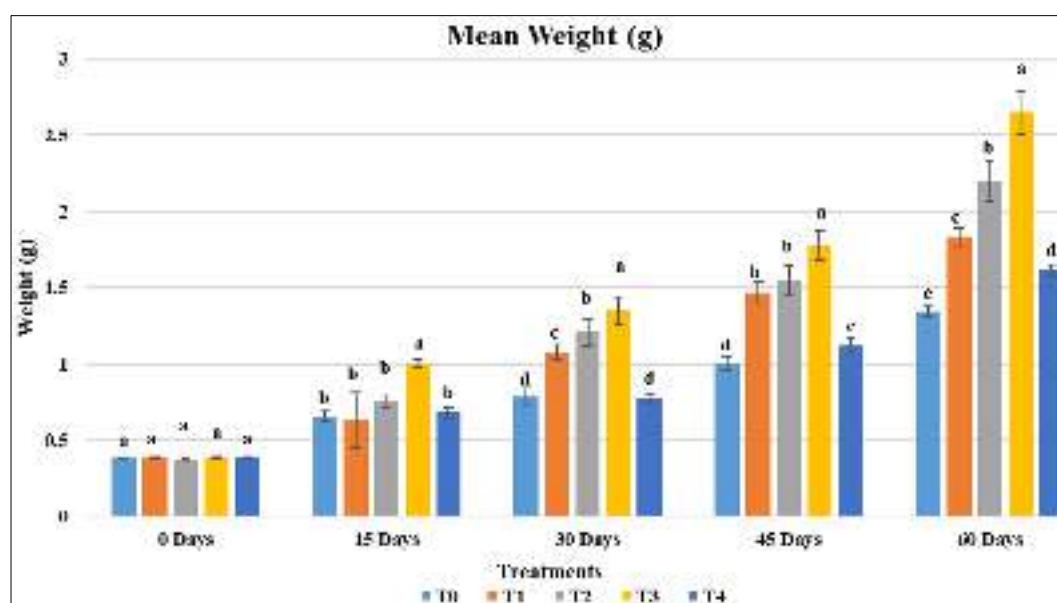


Fig 1: Mean weight (g) of *Labeo Catla* fry recorded in different treatments during the culture period.

The research assessed the impact of various treatments (T_0 , T_1 , T_2 , T_3 , and T_4) on mean weight gain, survival and specific growth rate over a span of 60 days as detailed in Table 3. Among all treatments, T_3 exhibited the highest mean weight gain at 2.263 ± 0.145 g, with T_2 , T_1 , T_4 , and T_0 following in descending order (1.819 ± 0.126 g, 1.451 ± 0.052 g, 1.231 ± 0.031 g, and 0.966 ± 0.040 g, respectively). The specific growth rate (SGR) was also greatest in T_3 , reaching

3.225 ± 0.099 , followed by T_2 (2.929 ± 0.076), T_1 (2.619 ± 0.031), T_4 (2.399 ± 0.018), and T_0 (2.109 ± 0.065). In terms of survival rates, T_3 again led with $97.500\pm2.887\%$, ahead of T_2 ($88.750\pm6.292\%$), T_1 ($86.250\pm4.787\%$), T_4 ($81.250\pm6.292\%$), and T_0 ($78.750\pm4.787\%$). Collectively, T_3 outperformed all other treatments across every measured parameter, highlighting its effectiveness in promoting growth and ensuring survival.

Table 3: Mean Weight Gain, Specific Growth Rate & Survival Rate of *Labeo Catla* fry recorded in different treatments after 60 days

Treatment	Mean $\pm$ SD		
	Mean weight gain (g)	Specific growth rate (SGR)	Survival Rate (%)
T_0	0.966 ± 0.040^e	2.109 ± 0.065^e	78.750 ± 4.787^c
T_1	1.451 ± 0.052^c	2.619 ± 0.031^c	86.250 ± 4.787^{bc}
T_2	1.819 ± 0.126^b	2.929 ± 0.076^b	88.750 ± 6.292^b
T_3	2.263 ± 0.145^a	3.225 ± 0.099^a	97.500 ± 2.887^a
T_4	1.231 ± 0.031^d	2.399 ± 0.018^d	81.250 ± 6.292^{bc}

Feed Utilization

The Feed Conversion Ratio (FCR) is a key metric for evaluating feed efficiency in aquaculture, where lower values signify more effective conversion of feed into fish

biomass. In this study, *Labeo Catla* fry were fed up to 10% of their body weight daily over a 60-day period. The Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER) were evaluated after 60 days across different treatments (T_0 ,

T₁, T₂, T₃, and T₄). The FCR values indicated significant variation among the treatments, with T₃ showing the lowest and most efficient FCR at 1.923±0.043, followed by T₂ (2.117±0.012), T₁ (2.367±0.062), T₄ (2.553±0.142), and T₀ exhibiting the highest FCR at 3.003±0.211. In contrast, the PER values demonstrated the opposite trend, with higher

values indicating better protein utilization. T₃ recorded the highest PER at 1.734±0.039, followed by T₂ (1.575±0.009), T₁ (1.409±0.037), T₄ (1.309±0.073), and T₀ with the lowest PER at 1.114±0.080. Overall, T₃ emerged as the most efficient treatment in terms of both feed conversion and protein utilization (Table 4).

Table 4: Feed Conversion Ratio & Protein Efficiency Ratio of *Labeo Catla* fry recorded in different treatments after 60 days

Treatment	Mean ±SD	
	Feed Conversion Ratio (FCR)	Protein Efficiency Ratio (PER)
T ₀	3.003±0.211 ^a	1.114±0.080 ^e
T ₁	2.367±0.062 ^c	1.409±0.037 ^c
T ₂	2.117±0.012 ^d	1.575±0.009 ^b
T ₃	1.923±0.043 ^e	1.734±0.039 ^a
T ₄	2.553±0.142 ^b	1.309±0.073 ^d

Discussion

The present study investigated the effects of incorporating Papaya leaf powder into the diet of *Labeo Catla*, revealing significant improvements in growth performance, survival rates, and feed utilization. Treatment T₃, which included 7.5% *Carica papaya* leaf powder, demonstrated the highest mean weight, mean weight gain, and specific growth rate (SGR), underscoring its potential as an effective dietary supplement for this species. These findings align with previous research highlighting the growth-enhancing properties of Papaya leaf powder in various fish species, although optimal inclusion levels appear to vary depending on the species.

For instance, Simanjuntak *et al.* (2022) [20] reported that a 2% inclusion of Papaya leaf powder significantly improved growth metrics in Nile tilapia, while Firdaus and Mukti (2021) [8] observed similar benefits in catfish (*Clarias sp.*) with a 2.5% inclusion level. Likewise, Mic Salomiya *et al.* (2023) [12] noted enhanced growth in rohu (*Labeo rohita*) when fed a diet containing 10% Papaya leaf meal. These variations suggest that different species may require tailored dietary formulations to achieve optimal growth outcomes. In the case of *Labeo Catla*, the higher inclusion level of 7.5% appears necessary to maximize growth performance, likely due to species-specific differences in nutrient metabolism and enzyme activity.

The growth-promoting effects of Papaya leaf powder can be attributed to its bioactive compounds, including protease, chymopapain, and papain, which facilitate protein digestion by breaking down complex proteins into absorbable amino acids (Alorkpa *et al.*, 2016) [1]. Singh *et al.* (2011) [21] reported that Papaya leaves contain approximately 5.3% papain, a proteolytic enzyme known to enhance protein utilization efficiency. This enzymatic activity likely contributed to the improved Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER) observed in the current study, as supported by earlier findings from Citarasu (2010) [5], Rinna Hamlin *et al.* (2013) [16], and Safrida *et al.* (2020) [18]. However, discrepancies in results across studies, such as those reported by Simanjuntak *et al.* (2012) and Mic Salomiya *et al.* (2023) [12], may stem from differences in preparation methods, leaf maturity, or the specific part of the leaf used (Dinajpur, 2023).

In terms of survival rates, the current study found that a 7.5% inclusion of Papaya leaf powder improved fish viability. This contrasts with earlier studies, where lower inclusion levels (e.g., 2-4.5%) were deemed optimal for enhancing survival in Nile tilapia (Simanjuntak *et al.*, 2022;

Munguti *et al.*, 2014) [20] and catfish (Firdaus and Mukti, 2021) [8]. Conversely, Kasiati *et al.* (2016) [10] and Rosmawaty *et al.* (2016) [17] reported adverse effects at higher inclusion levels, attributing these outcomes to the presence of anti-nutritional factors such as alkaloids and saponins, which may negatively impact fish health when present in excessive amounts. This highlights the importance of balancing dietary supplementation to avoid potential drawbacks.

The findings of this study emphasize the dual role of Papaya leaf powder as both a growth promoter and a survival enhancer, albeit with species-specific variations in optimal inclusion levels. For *Labeo Catla*, a higher inclusion level of 7.5% appears to be beneficial, whereas other species like Nile tilapia and catfish respond better to lower concentrations (2-4.5%). These variations underscore the need for further research to refine dietary formulations for different aquaculture species, ensuring maximum growth, survival, and feed efficiency while minimizing the risks associated with anti-nutritional factors.

The study demonstrates that incorporating 7.5% Papaya leaf powder into the diet of *Labeo Catla* significantly enhances growth performance, survival rates, and feed utilization. These effects are likely due to bioactive compounds like papain, which improve protein digestion and nutrient absorption. However, optimal inclusion levels vary across fish species, with lower concentrations (2-4.5%) being effective for Nile tilapia and catfish, while higher levels benefit *Labeo Catla*. The presence of anti-nutritional factors such as alkaloids and saponins at elevated doses may negatively impact survival, emphasizing the need for species-specific dietary formulations. Tailored approaches are essential to maximize growth and health outcomes in aquaculture.

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