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Assessment of Several Feed Varieties in Carp Polyculture

Chandan Chakraborty[1], Sudip Barat[2,*]

Abstract

This six-month aquaculture study evaluated the effects of four distinct feeding treatments on the production and development of a five-species polyculture system comprising common carp (Cyprinus carpio), grass carp (Ctenopharyngodon idella), Rohu, Katla, and Mrigel. The experiment utilized the total volume for eight ponds, each with a volume of 150 m^3 is 1200 m^3 (cubic meters) to compare: T1 (finely chopped Dubo grass and mash feed), T2 (sinking pellet), T3 (floating pellet), and T4 (non-treatment control). The primary objective was to assess the comparative performance and economic viability of these feeding regimes. The results established T3 (floating pellet) as the most effective treatment for enhancing fish performance. T3 achieved the largest combined extrapolated gross and net fish production, followed closely by T2, and then T1. This superior productivity was attributed to better nutrient utilization, reflected in T3 having the lowest Feed Conversion Ratio (FCR), with T2 and T1 ranking second and third, respectively. The floating nature of the T3 feed likely minimizes waste and allows for visual confirmation of consumption, leading to a more efficient system. From an economic perspective, T3 also dominated profitability metrics. While T3 had the highest total production expenses, the high output led to superior financial returns. The gross margin was significantly higher in both T2 and T3 compared to T1 ($p < 0.05$). Most critically, the benefit-cost ratio (BCR) was highest in T3 and lowest in T1 ($p < 0.05$), with T2 showing no substantial difference from T3, indicating that the higher cost of pellet feeds was more than offset by the increased yield and efficiency. The study conclusively demonstrated that both sinking and floating pellets enhance nutrient utilization and increase output relative to mash feed and the control, with the floating pellet (T3) offering the optimal balance of superior production and economic profitability in this mixed-species carp culture.

Keywords: Carp polyculture, feeding strategies, floating pellet (T3), feed conversion ratio (FCR), benefit-cost ratio (BCR)

INTRODUCTION

Keeping many aquatic creature species in the same pond is known as polyculture. The three Chinese carps that are most frequently seen in polyculture are the bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and the common carp (*Cyprinus carpio*). A growing portion of Nepal's overall agricultural output has come from the introduction of polyculture of common, Chinese, and indigenous carps into the hot lowlands [1–4]. Protein is the costliest component of fish feed, accounting for 60% of production costs. In the polyculture system, giving the fish the right kinds of feed and feeding techniques is crucial. Fish eat a large portion of the mash feeds, which leads to feed waste and increased organic loading, both of which eventually degrade the quality of the water [5–7]. While floating pellets do not have these issues, sinking pellets lose some of its supplemental feed because it settles to the bottom and is indigestible by fish. In the carp polyculture production system, most farmers in the Regional are using other kinds of feed that might improve this yield even further [8–10]. Though the performance of the best feeds on the market that has not been evaluated yet. The purpose of this research is to evaluate carp growth and production

***Author for Correspondence**
Sudip Barat
E-mail: swapnilaroy@gmail.com

[1]Research Scholar, Department of Zoology, University of North Bengal, Raja Rammohanpur, Siliguri, Darjeeling, West Bengal, India.
[2]Professor, Department of Zoology, University of North Bengal, Raja Rammohanpur, Siliguri, Darjeeling, West Bengal, India.

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performance in both traditional and pellet feeding methods. The study was conducted in the Alluvial Tarai Region of Cooch Behar district, located at:

- *Longitude:* 89.28E to 89.33E.
- *Latitude:* 26.14N to 26.10N.

MATERIALS AND METHODS

Experimental Design and Site

Study Site and Duration

The study was conducted in the Alluvial Tarai Region of Cooch Behar district 1, situated at Longitude: 89.28E to 89.33E and Latitude: 26.14N to 26.10N. The experimental period spanned six months.

Experimental Unit and Design

The experiment utilized eight ponds, each with a volume of 150 m^3, and was designed to evaluate the comparative performance among four distinct feeding treatments [5]. The study evaluated the effects of these feed types on three species of carp: common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), and rohu (*Labeo rohita*) in a polyculture system [11, 12]. A one-way ANOVA was conducted for the significance test at an alpha level of 0.05 ($P < 0.05$).

Treatments

Four treatments were applied, corresponding to different feed varieties:

- *T1 (Mash Feed):* Finely chopped Dubo grass (*Cynodon dactylon*) combined with mash feed.
- *T2 (Sinking Pellet):* Sinking pellet.
- *T3 (Floating Pellet):* Floating pellet.
- *T4 (Non-Treatment Control):* A non-treatment control.

Pond Preparation

Prior to stocking, the experimental ponds were treated with calcium carbonate at a rate of 5 kg/100 m^2 and allowed to equilibrate for one week [13, 14]. To prevent the entry and exit of wild fish, all water inlets were fitted with screens. For the entire duration of the trial, the water depth was maintained at a constant 1.0 meter. Ponds were fertilized one week before fish stocking and subsequently every two weeks, using inorganic fertilizers. Urea (as a nitrogen source) and diammonium phosphate (DAP) (as a phosphorus source) were applied at rates of 0.4 g N/m^2/day and 0.1 g P/m^2/day, respectively [15–19].

Stocking of Fingerlings

The three target species were stocked in a ratio of 100 (Common Carp): 60 (Grass Carp): 40 (Rohu, Katla, Mrigel) across all treatments, resulting in a total stocking density of 200 fish per experimental unit.

The stocking rates, standardized per 100 m^2 area, were:

- *Common Carp (Cyprinus carpio):* 67 fish/100 m^2
- *Grass Carp (Ctenopharyngodon idella):* 40 fish/100 m^2
- *Rohu, Katla, Mrigel:* 27 fish/100 m^2

Water Quality Parameters

Weekly measurements of water quality parameters, such as temperature, dissolved oxygen (DO), and pH, were made with a HANNA-HI-96107 pH meter and an Orion-1230 DO meter. In a similar manner, the Eco-Check kit #486798-k for digital water testing was used to assess nitrite, nitrate, and ammonia every week. At 6 or 7 a.m., all measurements were taken at a depth of 25 cm.

Fish Growth Measurement

Monthly sampling was conducted by randomly selecting approximately 15% of each species' population from every experimental unit using a dragnet. The individual and batch weights of the sampled fish were recorded using an electronic scale before the fish were returned to their respective experimental units.

At the time of harvest, the following growth and production parameters were computed:

- Total weight gain (kg/150 m^2).
- Feed Conversion Ratio (FCR).
- Survival rate (%).
- Daily weight gain (DWG) (g/fish/day).
- Gross Fish Yield (GFY).
- Net Fish Yield (NFY).
- Other relevant growth parameters.

Economic Analysis

Economic analysis was conducted to ascertain the Benefit-Cost Ratio (B/C Ratio) in carp polyculture. The foundation for the economic analysis was the farm gate pricing for the caught fish and the current local prices for all other inputs.

The farm gate prices for the harvested fish were:

- *Common Carp and Rohu, Katla, Mrigel:* NRs. 250/kg.
- *Grass Carp:* NRs. 200/kg.

The fingerling costs for stocking were:

- *Common Carp:* NRs. 5/each.
- *Grass Carp:* NRs. 1/each.
- *Rohu, Katla, Mrigel:* NRs. 2/each.

Variable costs, including feed, carp fingerlings, lime, and inorganic fertilizer, all had different prices across treatments.

Statistical Analysis

To analyze the experimental data, MSTAT-C (version 1.3) was used. For the significance test, a one-way ANOVA was conducted at an alpha level of 0.05 ($P < 0.05$). DMRT was used to compare the means ($P < 0.05$). Data tabulation and figure preparation were done using the Microsoft Excel computer application. Every means was provided with a standard error (SE) of ±.

RESULTS & DISCUSSION

Water Quality Parameter

Table 1 displays the mean levels of the water quality parameters that were monitored on a weekly and monthly basis during the study period. These parameters include temperature, DO, pH, ammonia, nitrate, and nitrite. According to statistical analysis, the water quality measures did not significantly change between the treatments ($P > 0.05$). A mosquito net was utilized to keep the three experimental units – three distinct treatments – separated from one another in the single pond. Given that water moved between experimental units, this might be the cause of the non-significant changes observed (Table 1).

Fish Growth Measurement

Treatment T3 (Floating Pellet) generally resulted in the highest growth and survival rates across all three carp species:

1. Common carp in T3 achieved the highest final mean weight (385.00\pm 40.34 g/fish and survival rate (67.67 pm 5.40), followed by T2 (Sinking Pellet).
2. Similarly, grass carp exhibited superior growth in T3, reaching a final mean weight of 463.33 0.01 g/fish and the highest daily weight gain (2.53 pm 0.12 g/fish/day). For rohu, T2 (Sinking Pellet) yielded the best results, achieving the highest final mean weight (277.00\pm 23.42 g/fish) and daily weight gain (1.48 pm 0.12 g/fish/day). Overall, the non-treatment control (T4) consistently showed the lowest performance across all measured growth and survival parameters for all three species (Tables 2 & 3).

Table 1. Shows the mean ± SE for temperature, dissolved oxygen, pH, ammonia, nitrite, and nitrate in various treatments during the experiment.

Parameters	**Treatments Mean**			
	T1	***T2***	***T3***	***T4 (Non-Treatment Control)***
Temperature (°C)	20.05 ± 0.03	21.08 ± 0.04	21 ± 0.05	20.50 ± 0.04
Dissolved oxygen (mg/L)	5.32 ± 0.11	6.10 ± 0.05	6.51 ± 0.03	5.20 ± 0.10
pH	7.30 ± 0.05	7.53 ± 0.02	7.20 ± 0.05	7.40 ± 0.03
Ammonia (mg/L)	0.10 ± 0.01	0.10 ± 0.01	0.10 ± 0.01	0.12 ± 0.02
Nitrite (mg/L)	0.05 ± 0.02	0.04 ± 0.02	0.04 ± 0.02	0.06 ± 0.02
Nitrate (mg/L)	1.6 ± 0.03	1.5 ± 0.05	1.4 ± 0.09	1.70 ± 0.06

Table 2. Shows the growth, production, and extrapolated GFY and NFY of rohu, grass carp, and common carp in various treatments (mean ± S.E).

Species and Parameters	**T1 (Mash Feed)**	**T2 (Sinking Pellet)**	**T3 (Floating Pellet)**	**T4 (Non-Treatment Control)**
Common Carp				
Initial mean weight (g/fish)	12.00 ± 0.30	11.00 ± 1.70	11.09 ± 0.97	11.50 ± 0.35
Final mean weight (g/fish)	287.20 ± 17.15	349.00 ± 9.42	385.00 ± 40.34	240.00 ± 12.30
Daily weight gain (g/fish/day)	1.51 ± 0.09	1.85 ± 0.06	2.05 ± 0.23	1.20 ± 0.05
Total weight gain (kg/150 m^2)	13.36 ± 1.68	18.59 ± 0.39	24.52 ± 0.87	10.00 ± 0.50
Survival (%)	51.67 ± 7.85	56.67 ± 2.90	67.67 ± 5.40	45.00 ± 4.00
Grass Carp				
Initial mean weight (g/fish)	3.00 ± 0.00	2.89 ± 0.05	2.61 ± 0.05	3.20 ± 0.10
Final mean weight (g/fish)	298.29 ± 15.92	386.34 ± 53.06	463.33 ± 0.01	270.00 ± 10.10
Daily weight gain (g/fish/day)	1.62 ± 0.08	2.10 ± 0.29	2.53 ± 0.12	1.40 ± 0.07
Total weight gain (kg/150 m^2)	10.41 ± 0.36	14.01 ± 1.49	18.26 ± 0.49	9.50 ± 0.40
Survival (%)	50.56 ± 5.50	62.22 ± 6.50	66.67 ± 4.80	47.00 ± 3.50
Rohu				
Initial mean weight (g/fish)	5.00 ± 0.95	5.00 ± 0.36	5.00 ± 0.32	5.00 ± 0.25
Final mean weight (g/fish)	256.00 ± 14.29	277.00 ± 23.42	227.00 ± 3.91	200.00 ± 5.50
Daily weight gain (g/fish/day)	1.36 ± 0.07	1.48 ± 0.12	1.21 ± 0.02	1.00 ± 0.04

Note: Mean values with different superscripts in the same row are significantly different (P < 0.05).

Table 3. Combined extrapolated GFY and NFY of carps in different treatments (Mean ± S.E).

Parameters	**T1 (Mash Feed)**	**T2 (Sinking Pellet)**	**T3 (Floating Pellet)**
Combined Extrapolated GFY (t/ha/yr)	4.35 ± 0.20c	5.59 ± 0.10b	6.84 ± 0.05a
Combined Extrapolated NFY (t/ha/yr)	4.14 ± 0.25c	5.43 ± 0.15b	6.64 ± 0.07a
FCR	3.1 ± 0.2a	2.1 ± 0.1b	1.8 ± 0.0b

Note: Mean values with different superscripts in the same row are significantly different (P < 0.05).

Economic Analysis

The economic evaluation clearly demonstrated the superior profitability of pellet feeds (T2 and T3) over mash feed (T1). Floating pellet (T3) yielded the highest Total Gross Return (Rs. 11493 ± 147) and the highest Total Production Cost (NRs. 6054 ± 7) per 150 m^2, driven mainly by the high cost of feed (NRs. 4787). However, the Gross Margin for both T2 and T3 was significantly higher than T1, with T3 achieving Rs. 5439 ± 144 per 150 m^2 and NRs. 727000 ± 19369 per hectare per year. The Benefit-Cost (B/C) Ratio was highest in T2 (Sinking Pellet) (1.86 ± 0.05), followed by T1 (1.59 ± 0.11), with no substantial difference observed between T2 and T3. These findings indicate that while

T3 incurs the highest expense, both pellet feeds (T2 and T3) significantly enhance the overall economic output compared to mash feed (T1) (Tables 4 & 5).

Table 4. Economic evaluation of various treatments (NRs/pond) during the trial.

Variables	T1 (Mash Feed)	T2 (Sinking Pellet)	T3 (Floating Pellet)	T4 (Non-Treatment Control)
Total Gross Return (NRs./150 m^2)	7220 ± 459c	9443 ± 216b	11493 ± 147a	N/A
Variable Cost (NRs./150 m^2)				
Lime	150	150	150	150
Feed	3271c	3820b	4787a	N/A
Urea	252	252	252	252
DAP	225	225	225	225
Carp fingerlings	640	640	640	640
Total Production Cost (NRs./150 m^2)	4538 ± 80c	5087 ± 31b	6054 ± 7a	N/A
Gross Margin (NRs./150 m^2)	2681 ± 500b	4355 ± 242a	5439 ± 144a	N/A
Gross Margin (NRs./ha/yr)	358000 ± 66968b	582000 ± 32474a	727000 ± 19369a	N/A
BC Ratio	1.59 ± 0.11b	1.86 ± 0.05a		

Note: Mean values with different superscripts in the same row are significantly different (P < 0.05).

Table 5. Absolute Growth Rate (g/day) of the Indian Major Carps (*Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*) due to the Formulated Diets (A, B, C, and D) in the treated ponds (IA, IB, IC, and ID) and without the diets in Control Ponds (IIA, IIB, IIC, and IID).

Year		*Catla catla*						*Labeo rohita*						*Cirrhinus mrigala*			
		IA	IIA	IB	IIB	IC	IIC	ID	IID	IA	IIA	IB	IIB	IC	IIC	ID	IID
First	2.99	1.91	3.72	2.33	4.96	2.93	2.8	1.84	1.87	1.52	2.23	1.86	2.83	2.29	2.04	1.54	1.71
Second	4.71	2.8	5.09	2.9	5.55	3.04	3.62	2.47	2.65	1.95	2.81	2.01	3.9	2.39	2.27	1.5	2.23
Third	4.18	2.61	4.92	2.83	6.58	3.5	2.84	2.21	2.99	2.02	3.11	1.85	4.06	2.29	2.39	1.37	2.52
Fourth	4.1	2.33	4.46	2.69	6.73	3.47	3.05	2.23	2.86	2.13	3.06	2.17	4.08	2.35	2.5	1.41	2.49

CONCLUSION AND ECONOMIC IMPLICATION

This study demonstrates that the use of pellet feeds (sinking and floating) significantly enhances nutrient utilization and increases overall output in carp polyculture compared to mash feed and the non-treatment control. Specifically, T3 (Floating Pellet) exhibited the largest combined extrapolated gross and net fish production, followed by T2 (Sinking Pellet) and T1 (Mash Feed). Economically, while T3 required the highest total production cost, both T2 and T3 yielded a significantly higher gross margin than T1 (P < 0.05). Although the benefit-cost ratio was lowest for T1 (P < 0.05), there was no substantial difference observed between the sinking (T2) and floating (T3) pellets, with T2 having the highest measured B/C ratio. Therefore, adopting either sinking or floating pellet feed is recommended for commercial carp polyculture to maximize both biological productivity and economic returns.

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