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EFFECT OF FERTILIZATION AND SUPPLEMENTARY FEEDING ON GROWTH PERFORMAMNCE OF *LABEO ROHITA, CATLA CATLA* AND *CYPRINUS CARPIO*

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ABSTRACT

Studies were conducted to investigate the efficacy of inorganic and organic fertilizers on fish growth when applied individually and/or when combined with supplementary feed. Studies were designed and executed in earthen ponds and continued for one full growth period. Results revealed that organic manure is better than inorganic fertilizers and can independently handle nutritional requirements of fish to some extent of their growth period but inorganic fertilizers can not do this alone. These studies further exposed that administration of supplementary feed is mandatory for maximum yield though both fertilizers have been provided. Supplementary/artificial feed not only fulfills the nutrient deficiencies but also helps to exploit the maximum potential of manures added into the pond.

Key words: Organic manures; inorganic fertilizers; supplementary feed; Indian and Chinese carps.

INTRODUCTION

The population explosion is forecasting several challenges, the most important of them are food shortages and malnutrition. Aquaculture in general and fish culture in specific can significantly contribute and help in alleviation both qualitative and quantitative food shortages in provided in reasonable amounts. It has desirable nutrient profile and can afford high-quality animal protein with high biological value. Fis lipids are rich source of essential fatty acids, particularly omega-3 polyunsaturated fatty acids that are crucial for normal growth, cardiac functioning and mental development, especially during pregnancy and early childhood (FAO, 2003). Fish are also rich in vitamins (fat-soluble vitamins A, D and E, and water-soluble vitamins, B complex) and minerals (especially calcium, phosphorus, iron, selenium and iodine in marine products) (Choo and Williams, 2003; Sandhu, 2005; Razvi, 2006; Salim, 2006; Yildrim *et al*., 2008). Therefore, fish can provide an important source of nutrients, particularly for those whose diets are lacking these nutritional constituents (World Aquaculture, 2010).

Globally, slightly over half (54 %) of the total food fish supply is obtained from marine and inland capture fisheries and the remaining (46 %) is drawn from aquaculture. The contribution of capture fisheries to per capita food supply stabilized at 10–11 kg per capita in the period 1970–2000, and then declined to 9.3 kg per capita in 2008. Recent increases in per capita availability are attributed to inland aquaculture. Globally, aquaculture's contribution to per capita food availability grew from 0.7 kg in 1970 to 7.8 kg in 2008(World Aquaculture, 2010).

Aquaculture in Pakistan is semi-intensive in nature and is based on polyculture of three Indian major carps viz. rohu (*Labeo rohita*), thaila (*Catla catla*), mori (*Cirrhinus mrigala*) and two Chinese carps viz. grass carp (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys molitix).* Like India culture is quite successful. Pond quality dos not deteriorate and fish production is very high than single species culture system (Chakrabarti, 1998; Azim *et al*., 2001; Dhawan and Kaur, 2002a and b; Hossain *et al*., 2003; Keshavanath *et al.*, 2006; Sahu *et al*., 2007). Common carp (*Cyprinus carpio*) is normally avoided due to its frequent breeding habits and *Cirrhinus mrigala* is generally adopted as bottom feeding species to complete the stocking combination ratios. Introduction of *C. carpio* in current culture set-up is controversial. Jain (2002) opined that this fish species can withstand variable climatic conditions and also improves pond bottom by turning over bottom soil, releasing nutrients for micrscopic plants and exposing debris to sunlight (Ritvo *et al*., 2004; Milstein *et al*., 2003). Microscopic life get these nutrients from cowdung, poultry, pig, duck, goat, and sheep excreta, biogas slurry and artificial feed which are frequently added to fish ponds to augment pond productivity (Sehgal and Sehgal, 2002) and are available only when they are fully dispersed and suspended in water column which *Cyprinus carpio* can conveniently do if present in pond.

Other than manures artificial feed prepared from variety of plant and animal by-products also has a fabulous impact on fish production. Provision of artificial feed increased the fish growth and production in the fertilized ponds than those where supplementary feed was eliminated (Diana *et al.,* 1994). Azim *et al*. (2002) obtained higher grwoth rates in rohu when fed on combined feeding than those with solitary applications of fertilizers. Nandeesha *et al*., (2001) have also similar observations and found more growth in combined animal feeding than mere applications of organic and inorganic fertilizers. Common carp (*Cyprinus carpio*) and rohu (*Labeo rohita)* fed with fish meal, rice bran, mustard oil cake showed 1.5 and 2.1 times higher fish yield than in the treatments without supplementary feed (Rahman *et al*., 2006). The current project was therefore, designed to compare the growth performance of *Labeo rohita, Catla catla* and *Cyprinus carpio,* when cultured in graded levels of manure fed ponds and artificial feed supplemented ponds.

MATERIALS AND METHODS

Experimental Design: Studies were carried out in earthen ponds having an area of 0.02 ha each. There were 5 treatments and a control (Table 1) with two replicates in each. Experiment was designed following completely randomized design (CRD) with single factor (5 levels). Before stocking, all the ponds were sun dried till their bottom cracked. Quick lime was then sprinkled on pond bottom @ of 2.5 kg pond^{-1}(Wahab *et al.*, 2002). Pond water inlets were properly screened to control the entry of predators or escape of fish from ponds through incoming water. All the ponds were then filled with tubewell water upto 1.5 meter which was maintained through out the experimental period. Two weeks earlier than fish stocking all the ponds were manured with cowdung @ 66.66kg (3333.33kg ha^{-1}) (Javed *et al*., 1990) to promote natural food for incoming fish.

Fish Stocking: Well above of the required fish stock, was housed inside hatchery tanks for acclimatization before introduction into experimental ponds. After 5 days of acclimatization a random sample of 10 fish of each species was randomly withdrawn from the bulk stock, weighed and measured and recored for baseline data (Table 3). All the ponds were then stocked with *Labeo rohita, Catla catla* and *Cyprinus carpio* in the ratio of 20:15:15, respectively. Daily amount of organic manure, fertilizer and supplementary feed was calculated on N-equivalence of 0.2g N/100g body weight of fish. All the six treatments including control received the same quantity of N though sources differed from treatment to treatment (Table 1).

Feeding and Fertilization Schedule: Ponds were fertilized with organic and inorganic fertilizers where applicable on weekly basis. Thirty percent crude protein diet was formulated from fish meal, rice polish, sunflower meal, maize gluten meal, canola oil, vitamin and minerals premix (Table 2)for treatments T_4, T_5 and T_6 (Islam, 2008) following Pearson method (Rath, 2000) including. Quantity of feed and fertilizer was adjusted on monthly basis.

Fish Growth Studies: At the end of each month random fish samples were collected, weighed and measured and then released back into the pond. Monthly increments in weight were recorded for comparison among species and months of the year.

Condition factor (K): The value of condition factor (K) was determined by the formula given below;

$$K = \frac{W \times 10^5}{L^3}$$

Where W = Wet fish body weight (g)
L = Wet fish total length (mm)
Number 10^5 is the factor bringing the ponderal index or condition factor (K) near the unity (Carlander, 1970)

Statistical Analysis: The growth data thus obtained was subjected to ANOVA (Steel *et al*., 1997) to distinguish any difference in growth among different treatments using MSTAT and MICROSTAT packages. Differences among means were recognized by Duncan's Multiple Range Test (Duncan, 1955).

RESULTSAND DISCUSSION

Growth: *Labeo rohita* gained maximum average body weight (141.4g) in T_1 in May while T2, T_3, T_4 and T_6, showed the maximum weight gain of 140.5, 155.6, 148.9 and 219.1g in July. Same fish showed maximum increase in weight (156.8g) in T_5 in June (Table 3) however its weight was the highest in T_6 (Table 3).

Catla catla showed minimum increments of 24.0, 22.2, 23.5, 30.8, 28.3 and 28.7g in August in the start of the experiment from T_1 to T_6, respectively. Maximum increase in average body weight of *Catla catla* was observed as 149.9 and 145.5g in T_1 and T_3 during June, while in T_2, T_4 and T_6, 130.5, 170.5 and 186.4g in July (Table 3). In T_5 maximum increase (142.8g) in body weight was recorded in May (Table 3). Like *Labeo rohita*, *Catla catla* gained significantly higher weight in T_6 than rest of the treatments ($p<0.05$). The remaining treatments can be ranked in the order of weight increments as T_4, T_3, T_5, T_1 and T_2. Maximum growth was observed in June and July when weight increments were higher when compared on monthly basis (Table 3). Like *Catla catla Cyprinus carpio* showed minimum weight increments of 28.3, 22.3, 20.0, 30.5, 25.6 and 28.2g in August, in T_1-T_6, respectively (Table 3). The maximum increment in average body weight were observed as 138.7 (T_1) during June, while in T_2, T_3 and T_5, as 135.3, 135.5 and 129.5g in July. The maximum increment of 144.7 and 154g was recorded in T_4 and T_6 during April. *Cyprinus carpio* gained maximum weight of 1119.0g in T_6. T_6 differed significantly ($p<0.05$) from T_2, T_3 and T_4 but not from T_1 (Table 3).

Comparative Growth rates: *Catla catla* gained significantly higher weight (1256.7g) than *Labeo rohita* and *Cyprinus carpio* but the later two did not differ significantly from each other($p<0.05$). *Cyprinus carpio* gained the maximum average body weight and performed better in T_1 while in T_2, *Labeo rohita* and *Cyprinus carpio* gained equal weight. The results are in accordance with the findings of Mahboob and Sheri, (1997) who obtained the fish production of 9400 kg $ha^{-1}yr^{-1}$ by the applications of broiler droppings as compared to 7400 $kg^{-1}ha^{-1}yr^{-1}$ by adding NPK fertilizer in ponds with major carps. Organic manuring is normally considered more beneficial for the farmer because it is economical and cuts down 50 % cost of inorganic fertilizer and supplementary feed (Yadava and Garg, 1992) and seems to have better nutrients balance than inorganic fertilizers. Contradictory to the above *Catla catla* attained the maximum average body weight in T_3, T_4 and T_6 but in contrast, *Labeo rohita* and *Catla catla* gained similar weight in T_5 when compared with *Cyprinus carpio* (Table 3). These differences might be due to their different feeding requirements and spatial locations in the water column.

Overall growth was best in T_6, in which cow manure, nitrophos and supplementary feed was added as compared to other treatments irrwespective of the type of fish cultured. Among three fish species, *Catla catla*, showed the maximum average body weight (1256.7g), followed by *Labeo rohita* (1215.0g) and *Cyprinus carpio* (1119.0g) in T_6. Highest growth performance of *Catla catla* was due to the higher growth potential than the other two species reared under semi-intensive culture system. These results are in line with the findings of Javed *et al.*, (1990) and Tahir (2008), who reported that *Catla catla* gained maximum body weight than *Labeo rohita* and *Cirrhinus mrigala*, when cultured under different treatments in polyculture system.

These results confirmed the findings of Liang *et al*., (1999) and Keshavanath *et al*., (2001), who reported that ground nut oil cake, cotton seed meal, deoiled rice bran and sunflower meal and additives in the feed such as salt and mineral mix along with organic manure (buffalo manure and poultry droppings), contributed to high yield in carp polyculture. Jena *et al*., (1999) and Islam *et al*., (2008) also reported that artificial diet comprising of rice bran, soybean meal, fish meal, vegetable oil, vitamin and mineral mixture (40:20:10:3:2) influenced the growth and survival of carp fingerlings. Mahboob *et al.*(1995) suggested that application of supplementary feed along with chemical fertilizers and organic manure is the best mean to obtain maximum fish production within the limited possible time in semi intensive culture system.

During the current studies, it was observed that higher fish production can be obtained in the warmer months than colder ones because fish is poikilothermic and there is considerable reduction in feed consumption and metabolism which is evident from the fact that *Labeo rohita*, *Catla catla* and *Cyprinus carpio* showed the maximum increment in average body weight in the month of July and minimum in February. Hassan *et al*., (1996) and Sahu *et al*., (2007) has similar findings which further support our observations that water temperature is the only variable that significantly affects the growth rate of major carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala)*, it accelerates growth in summer and retards in winter.

Condition Factor: The minimum value of condition factor (K) for *Labeo rohita* was observed as 1.1, 1.1, 1.0, 1.0, 1.0 and 1.0 in July for T_1 to T_6, respectively while the highest value of condition factor was observed in *Labeo rohita* in September in T_1 while values in remaining treatments were in the order of 2.4, 2.1, and 2.5, 2.1 and 2.4 for T_2, T_3, T_4, T_5 and T_6 respectively which were significantly lower than T_1 (Table 4). The lowest values of condition factor were observed for *Catla catla* in July and were 1.3, 1,5, 1.0, 1.4, 1.1 and 1.1 for T_1, T_2, T_3, T_4, T_5 and T_6 respectively. On the other hand values were quite higher in August in all the treatments except in T_1 which was slightly lower than others. It means that growth in both species was much better in July than August. It was same in August and April, from April it gradually declined and was minimum in July (Table 4). The minimum value of condition factor for *Cyprinus carpio* was observed in August in all the treatments. The maximum values of condition factor was observed to be 2.0 (October) in T_1, 1.9 (July) in T_2, 1.8 (May) in T_3, 1.6 (June) in T_4, 1.6 (May) in T_5 and 1.6 (April) in T_6 (Table 4). In the remaining months and treatments differences were quite minor meaning that this species is growing equally well in all the months as well as in all the treatments consuming all the feeds quite efficiently.

Statistically T_6 differed significantly from T_1 and T_2 but no significant difference ($p< 0.05$) was noted among T_3, T_4, T_5 and T_6, respectively. *Catla catla* showed the significant variation in T_6 that differed from T_1 and T_3 while other treatments differed slightly from each other except T_3 . In case of *Cyprinus carpio*, there was a highly significant variation ($p<0.05$) among T_2, T_3 and T_4 whereas significant difference ($p<0.05$) was noted in T_1, T_2 and T_3 while not among T_4, T_5 and T_6. The highest average value of condition factor was 2.9 in September for T_6 for *Catla catla* followed by *Labeo rohita* (2.9) in T_1 during the same month (Table 4)

Condition factor (relationship of weight and length) shows the variation which may be allometric or isometric. These variations in condition factor are attributed to the feeding opportunities, age, size, seasons, stocking density and feeding rates (Baumgarner *et al*., 2005; Sangun *et al*., 2007; Balik *et al*., 2006). The data on condition factor of *Labeo rohita*, *Catla catla* and *Cyprinus carpio* exhibited an isometric growth pattern between the body weight and total length during the current experimental trial. Contradictory to *Cyprinus carpio*, *Labeo rohit* and *Catla catla* showed the seasonal variations, refelecting decline in condition factor. This might be due to seasonal variation in the growth rate with respect to the difffernt months of the year, however prominent growth was observed from Feburay to November. Secondly major carps depicted the linear trend between the average body weight and total length showing continuous increase in length and weight. However, *Cyprinus carpio* with the constant growth rate showed the increment in morphometric parameters through out the year. That is why there is an increasing trend in the values of condition factor in Cyprinus *carpio* when compared with major carps which showed decreasing trends. Findings of Yildiz *et al*., (2006) further substantiate our results, who observed that condition factor is influenced by seasonal changes and is lower in winter than summer. Doria and Leonhardt (1993b) in their studies concluded that seasonal variations in temperature significantly affect the length-weight relationship and condition factor (K) of fish which is quite in line with our studies.

Therefore it can be concluded that organic fertilizers of any type and form can not suffice the nutritional requirements of fish for reasonable growth though much cheaper, supplementation of artifical feed in one form or the other is inevitable for satisfactory fish growth and higher yields. These studies have further revealed that minor changes in inputs either in quality or quantity do not have any significant effect on overall water quality of fish ponds.

Table 1: Composition of experimental treatments

Treatment	Source of Nitrogen	Nitrogen %
T_1	Cow manure	100%
T_2	Nitrophos	100%
T_3	Cow manure	50%
	Nitrophos	50%
T_4	Cow manure	50%
	Supplementary feed	50%
T_5	Nitrophos	50%
	Supplementary feed	50%
T_6	Cow manure	25%
	Nitrophos	25%
	Supplementary feed	50%

Table 2: Feed formulation and proximate composition of diet and ingredients.

Ingredient or diet /composition	Contribution in feed formula (%)	Moisture %	Crude proteinz%	Ether extract %	Crude fiber %	Total ash %	NFE %
Fish meal	47	7.6±1.3	51.95±4.7	7.95±0.7	0.96±0.2	22.7±3.2	8.84±1.5
Rice polish	19	4.7±0.9	7.11±0.8	0.9±0.1	20.3±2.9	20.9±2.5	37.97±4.1
Sunflower meal	13	5.3±0.8	22.42±3.1	0.50±0.01	34.05±3.5	7.11±1.1	30.62±3.3
Maize gluten meal	15	7.1±0.9	20.23±2.6	0.5±0.01	9.82±1.3	7.24±0.9	55.11±5.7
Canola oil	4	6.5±1.1	36.5±3.7	3.5±0.5	20±3.1	7.9±1.0	25.1±2.9
Vitamin and mineral premixses	2	-	-	-	-	-	-
Formulated feed		5.2±0.6	30.07±3.4	5.48±1.0	0.96±0.2	22.7±3.4	40.85±5.1

Table 3: Monthly increase in average body weight (g) of *Labeo rohita, Catla catla* and Common carp (*Cyprinus carpio*) under different treatments.

Month	T_1			T_2			T_3			T_4			T_5			T_6		
	Labeo rohita	*Catla catla*	C.carp	*Labeo rohita*	*Catla catla*	C.carp	*Labeo rohita*	*Catla catla*	C. carp	*Labeo rohita*	*Catla catla*	C. carp	*Labeo rohita*	*Catla catla*	C. carp	*Labeo rohita*	*Catla catla*	C. carp
Initial	16.3 ±1.9a	18.6 ± 1.7a	24.5 ±2.3a	16.5 ±2.0a	19.1a ±1.5	24.5 ±2.7a	17.1 ±1.5a	18.7 ±0.9b	24.7± 2.3a	16.5 ±1.5a	18.9 ±0.8a	24.7 ±3.0a	16.1 ±3.1a	18.3 ±2.1a	24.3 ±2.1a	16.4 ±2.1a	19.1 ±2.1a	24.3 ±2.2a
Aug	28.8 ±2.4^{bA}	24.0 ±2.1^{bA}	28.3 ±3.0^{aA}	20.8 ±2.1^{aB}	22.2 ±1.9^{aB}	22.3 ±2.5^{aB}	18.3 ±1.9^{aB}	23.5 ±2.0^{aB}	20.0 ±2.4^{aB}	21.2 ±2.4^{aB}	30.8 ±3.9^{bC}	30.5 ±4.1^{aC}	23.1 ±2.5^{bB}	28.3 ±3.3^{bA}	25.6 ±3.1^{aB}	30.3 ±3.1^{bC}	28.7 ±3.1^{bA}	28.2 ±3.1^{aA}
Sept	46.5 ±3.7^{cA}	40.9 ±2.9^{cA}	46.2 ±3.1^{bA}	39.9 ±3.5^{bA}	41.2 ±2.7^{bA}	45.2 ±3.9^{bA}	35.2 ±4.1^{bB}	58.3 ±3.5^{bC}	47.5± 3.9^{bA}	42.8 ±3.9^{bA}	50.3 ±4.1^{cA}	54.9 ±4.9^{bC}	38.5 ±3.3^{cA}	51.3 ±3.4^{cA}	47.8 ±3.2^{bA}	54.5 ±3.4^{cC}	64.9 ±3.1^{cD}	59.9 ±5.6^{bE}
Oct	53.8 ±3.9^{cA}	65.8 ±3.1^{dB}	58.5 ±2.9^{cA}	49.8 ±2.8^{cA}	52.4 ±2.5^{cA}	50 ±3.7^{bA}	55.3 ±3.9^{cA}	64.5 ±4.0^{bC}	64.5 ±4.1^{cC}	49.4 ±4.1^{bA}	85.9 ±4.9^{dD}	77.5 ±5.1^{cD}	65.8 ±2.3^{dC}	64.4 ±4.5^{cC}	68.9 ±3.1^{cC}	77.5 ±3.5^{dD}	74.8 ±4.1^{cD}	80.7 ±6.7^{cD}
Nov	45.5 ±3.4^{cA}	45.2 ±3.5^{cA}	48.5 ±2.7^{bA}	54.5 ±3.2^{cB}	56.5 ±3.7^{cB}	43.7 ±3.0^{bA}	64.2 ±4.7^{cC}	80.3 ±4.9^{cD}	40.9 ±3.5^{bA}	39.8 ±3.9^{bA}	64.5 ±5.1^{eE}	59.8 ±6.0^{dE}	48.3 ±3.0^{eA}	74.8 ±4.8^{dF}	60.0 ±5.6^{cE}	85.3 ±4.9^{dD}	88.3 ±3.2^{dD}	58.8 ±6.1^{bB}
Dec	29.3 ±2.9^{bA}	30.3 ±3.1^{bA}	36.3 ±3.5^{aA}	26.3 ±2.6^{aA}	36.3 ±3.1^{bA}	30.1 ±2.8^{aA}	28.3 ±2.3^{bA}	30.3 ±2.1^{aA}	33.9± 1.8^{dA}±	19.2 ±1.9^{aB}	36.3 ±3.4^{bA}	40.5 ±5.7^{eC}	26.2 ±3.2^{aA}	30.3 ±3.1^{bA}	35.3 ±5.0^{dA}	38.3 ±3.9^{bC}	36.3 ±3.1^{bA}	36.3 ±3.2^{aA}
Jan	30.3 ±2.7^{bA}	28.7 ±2.9^{bA}	33.9 ±3.1^{aA}	27.5 ±2.7^{aA}	34.2 ±3.0^{bA}	33.8 ±1.8^{aA}	18.5 ±^{aB}	26.2 ±3.1^{aA}	35.0 ±2.9^{dA}	20.3 ±1.7^{aB}	30.5 ±4.0^{bA}	42.0 ±5.0^{eC}	25.9 ±3.1^{aA}	29.4 ±3.7^{bA}	33.7 ±5.1^{dA}	21.4 ±2.1^{bB}	26.5 ±3.2^{bA}	33.3 ±3.1^{aA}
Feb	58.8 ±4.2^{cA}	67.3 ±4.6^{dA}	66.5 ±3.6^{cA}	64.5 ±4.5^{dA}	60.3 ±5.1^{cA}	61.3 ±3.9^{cA}	59.9 ±3.8^{cA}	88.4 ±3.9^{cB}	70.7 ±4.1^{cA}	65.9 ±3.9^{cA}	74.2 ±4.5^{eC}	79.3 ±6.2^{cC}	75.7 ±3.2^{dC}	85.3 ±8.1^{eB}	80.0 ±3.2^{eC}	70.3 ±3.9^{dA}	88.3 ±4.2^{dB}	89.6 ±5.1^{cB}
Mar	91.3 ±4.9^{dA}	90.7 ±5.9^{eA}	78.8 ±4.7^{dB}	101.9 ±5.0^{eC}	88.5 ±4.7^{dA}	125.4 ±3.5^{dD}	120.6 ±4.1^{dD}	120.9 ±4.7^{dD}	135.3 ±5.6^{eE}	100.5 ±6.1^{dC}	132.8 ±3.9^{fE}	129.0 ±7.0^{fE}	105.3 ±4.9^{fC}	115.9 ±9.3^{fC}	123.0 ±3.1^{fD}	125.2 ±4.1^{eD}	120.4 ±4.1^{eD}	147.7 ±5.2^{dF}
Apr	120.2 ±6.1^{eA}	127.3 ±5.9^{fA}	135.9 ±4.8^{eA}	131.3 ±4.9^{fA}	99.8 ±4.3^{eB}	111.5 ±3.8^{eA}	135.8 ±4.2^{eA}	131.3 ±5.1^{dA}	128.2 ±5.9^{eA}	123.8 ±6.9^{eA}	164.3 ±3.5^{gC}	144.7 ±7.1^{gA}	136.5 ±4.6^{gA}	120.8 ±6.9^{fA}	120.8 ±6.8^{fA}	124.3 ±4.8^{eA}	174.3 ±5.1^{fD}	154.0 ±5.9^{dC}
May	141.4± 7.9^{fA}±	142.9 ±6.7^{gA}	116.8 ±6.9^{eB}	120.9 ±3.9^{fB}	121.3 ±4.1^{fB}	118.3 ±5.8^{fB}	125.7 ±4.9^{dB}	144.5 ±4.5^{eA}	125.6 ±6.0^{eB}	145.3 ±6.1^{fA}	160.5 ±4.9^{gC}	139.8 ±6.7^{fA}	155.9 ±5.1^{hC}	142.8 ±6.9^{gA}	123.2 ±7.6^{fB}	168.1 ±9.1^{fD}	170.3 ±5.2^{fD}	150.0 ±5.1^{dA}
June	139.0 ±8.9^{fA}	149.9 ±6.8^{gA}	129.8 ±5.8^{eB}	128.7 ±4.1^{fB}	128.3 ±3.9^{gB}	119.5 ±4.7^{fC}	140.3 ±4.6^{fA}	145.5 ±4.5^{fA}	130.8 ±6.1^{fB}	138.3 ±6.7^{fA}	161.5 ±4.1^{gD}	142.6 ±6.9^{fA}	156.8 ±3.5^{hA}	136.3 ±5.3^{gA}	120.3 ±8.1^{fC}	184.3 ±9.2^{gE}	178.4 ±7.1^{gE}	133.5 ±5.6^{eB}
July	132.5 ±7.6^{fA}	140.5 ±6.3^{gA}	138.7 ±5.2^{eA}	140.5 ±4.7^{gA}	130.5 ±4.6^{gA}	135.3 ±3.4^{gA}	155.6 ±6.8^{gB}	140.6 ±5.9^{eA}	135.5 ±5.9^{fA}	148.9 ±5.9^{fB}	170.5 ±5.1^{gC}	140.5 ±5.9^{gB}	150.5 ±4.9^{hB}	140.8 ±5.9^{gA}	129.5 ±5.9^{fA}	219.1 ±5.1^{hC}	186.4 ±7.9^{gD}	122.5 ±5.6^{fA}

Table 4: Condition factor of different fish species fed on different dietary treatments

	Control			T_1			T_2			T_3			T_4			T_5		
Mos	Labeo	Catla	C.Carp	Labeo	Catla	C. carp	Labeo	Catla	C. carp	Labeo	Catla	C. carp	Labeo	Catla	C. carp	Labeo	Catla	C. carp
Initial	1.6±0.3^{aA}	1.4±0.2^{aA}	1.3±0.2^{aA}	1.5±0.2^{aA}	1.4±0.2^{aA}	1.2±0.2^{aA}	1.5±0.2^{aA}	1.1±0.2^{aB}	1.2±0.1^{aB}	1.6±0.1^{aA}	1.4±0.1^{aA}	1.1±0.1^{aB}	1.4±0.2^{aA}	1.4±0.2^{aA}	1.2±0.2^{aB}	1.5±0.2^{aA}	1.4±0.1^{aA}	1.2±0.3^{aA}
Aug	2.6±0.1^{bA}	1.8± 0.4^{aB}	1.4±0.2^{aB}	2.2±0.3^{bA}	1.8±0.3^{aB}	1.3±0.3^{aB}	1.9±0.4^{aA}	1.4±0.2^{aB}	1.3±0.2^{aB}	2.2±0.5^{bA}	2.0±0.3^{aB}	1.3±0.1^{aB}	2.0±0.2^{bA}	2.4±0.3^{bA}	1.4±0.2^{aB}	2.0±0.2^{bA}	2.3±0.2^{bA}	1.4±0.3^{aB}
Sep	2.9±0.4^{bA}	2.1± 0.5^{bA}	1.7±0.3^{bA}	2.4±0.3^{bA}	1.9±0.3^{bA}	1.5±0.3^{aA}	2.1±0.3^{bA}	2.1±0.2^{bB}	1.4±0.3^{aB}	2.5±0.2^{bA}	2.2±0.2^{bA}	1.3±0.2^{aB}	2.1±0.3^{bA}	2.8±0.3^{bA}	1.5±0.1^{aB}	2.4±0.2^{bA}	2.9±0.2^{bA}	1.5±0.2^{aB}
Oct	2.8±0.3^{bA}	2.2±0.4^{bA}	2.0±0.2^{bA}	2.2±0.4^{bA}	2.1±0.3^{bA}	1.6±0.3^{aB}	2.1±0.4^{bB}	2.1±0.3^{bB}	1.6±0.2^{aB}	2.2±0.3^{bA}	2.3±0.2^{bA}	1.5±0.2^{aB}	2.1±0.2^{bA}	2.8±0.3^{bA}	1.5±0.2^{aB}	2.4±0.2^{bA}	2.7±0.2^{bA}	1.5±0.2^{aB}
Nov	2.7±0.4^{bA}	2.1±0.4^{bA}	1.7±0.4^{bA}	2.1±0.3^{bA}	2.3±0.3^{bA}	1.6±0.1^{aA}	2.1±0.3^{bA}	2.1±0.2^{bA}	1.5±0.3^{aB}	2.1±0.2^{bA}	2.4±0.3^{bA}	1.5±0.2^{aB}	2.1±0.3^{bA}	2.8±0.2^{bA}	1.4±0.2^{aB}	2.2±0.2^{aA}	2.7±0.3^{bA}	1.5±0.3^{aB}
Dec	2.5±0.5^{bA}	2.2±0.4^{bA}	1.7±0.4^{bA}	2.1±0.3^{bA}	2.4±0.3^{bA}	1.7±0.2^{aB}	2.1±0.3^{bA}	2.1±0.3^{bA}	1.6±0.2^{aB}	2.0±0.2^{bA}	2.4±0.3^{bA}	1.5±0.2^{aB}	2.0±0.2^{bA}	2.7±0.3^{bA}	1.4±0.2^{aB}	2.2±0.2^{bA}	2.7±0.3^{bA}	1.5±0.2^{aB}
Jan	2.5±0.7^{bA}	2.2±0.3^{bA}	1.6±0.4^{bA}	2.0±0.2^{bA}	2.5±0.3^{bA}	1.7±0.3^{aA}	2.0±0.4^{bA}	2.1±0.4^{bA}	1.6±0.3^{aB}	1.9±0.3^{bA}	2.4±0.2^{bA}	1.5±0.2^{aB}	2.0±0.1^{bA}	2.7±0.2^{bA}	1.4±0.2^{aB}	2.0±0.2^{bA}	2.6±0.2^{bA}	1.5±0.2^{aB}
Feb	2.2±0.4^{bA}	2.2±0.4^{bA}	1.6±0.4^{bA}	1.9±0.2^{aA}	2.6±0.4^{bA}	1.6±0.4^{aA}	1.9±0.3^{bA}	2.2±0.3^{bA}	1.6±0.2^{aA}	1.8±0.1^{aA}	2.2±0.2^{bA}	1.5±0.2^{aB}	1.7±0.2^{bA}	2.5±0.2^{bA}	1.5±0.1^{aB}	1.2±0.2^{aB}	2.4±0.3^{bA}	1.5±0.3^{aB}
Mar	2.1±0.4^{bA}	2.1±0.3^{bA}	1.7±0.4^{bA}	1.8±0.3^{aA}	2.5±0.3^{bA}	1.8±0.3^{aA}	1.8±0.4^{bA}	1.8±0.1^{aA}	1.7±0.2^{aA}	1.7±0.2^{aA}	2.0±0.3^{bA}	1.5±0.1^{aB}	1.6±0.2^{bA}	2.0±0.3^{bA}	1.6±0.1^{aA}	1.5±0.2^{aB}	1.9±0.3^{bA}	1.6±0.2^{aA}
Apr	1.8±0.5^{aA}	1.8±0.2^{aA}	1.7±0.4^{bA}	1.7±0.3^{aA}	2.2±0.4^{bA}	1.8±0.4^{aA}	1.6±0.2^{aA}	1.6±0.3^{aA}	1.8±0.5^{aA}	1.6±0.2^{aA}	1.8±0.2^{bA}	1.5±0.2^{aB}	1.4±0.1^{aB}	1.8±01^{aA}	1.6±0.2^{aA}	1.3±0.1^{aB}	1.8±0.3^{bA}	1.6±0.2^{aA}
May	1.5±0.6^{aA}	1.6±0.4^{aA}	1.6±0.4^{bA}	1.4±0.30.4^{aA}	1.9±0.0.1^{aA}	1.9±0.2^{aA}	1.4±0.4^{aA}	1.3±0.2^{aB}	1.8±0.3^{bA}	1.4±0.2^{aB}	1.7±0.2^{aA}	1.6±0.3^{aA}	1.3±0.3^{aB}	1.5±0.2^{aB}	1.6±0.2^{aA}	1.1±0.1^{aB}	1.6±0.3^{aA}	1.6±0.2^{aA}
June	1.3±0.3^{aA}	1.5±0.3^{aB}	1.6±0.4^{bB}	1.2±0.40.2^{aA}	1.7±0.5^{aB}	1.9±0.4^{aB}	1.2±0.3^{aA}	1.2±0.2^{aA}	1.7±0.3^{aB}	1.2±0.1^{aB}	1.5±0.3^{aA}	1.6±0.2^{aA}	1.2±0.2^{aB}	1.3±0.2^{aB}	1.6±0.1^{aA}	1.1±0.2^{aA}	1.3±0.2^{aA}	1.6±0.1^{aB}
July	1.1±0.1^{aA}	1.3±0.2 aA	1.6±0.4^{bB}	1.0±0.30.3^{aA}	1.5±0.4^{aB}	1.9±0.3^{aB}	1.0±0.2 aA	1.0±0.1^{aA}	1.7±0.4^{aB}	1.0±0.2 aA	1.4±0.3^{aA}	1.6±0.2 aB	1.0±0.2^{aA}	1.1±0.1^{aA}	1.6±0.4^{bB}	1.0±0.2^{aA}	1.1±0.2^{aA}	1.5±0.3^{aB}

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