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Growth Performance of Fingerlings of the Indian Major Carp, *Catla catla* (Ham.) Fed with Feeds Supplemented with Different Seaweeds

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ABSTRACT

The growth performance of Indian major carp (*Catla catla,* Ham.) was assessed over a period of six months through formulated feeds consisting of three seaweeds, namely *Chlorodesmis fastigiata*, *Padina tetrastomatica* and *Stoechospermum marginatum*. A relatively slow average growth rate (6.48 g/month) in fishes was observed in the control group. Meanwhile, the maximum and rapid growth rate (13.38 g/month) was observed with Feed-A supplemented with *C. fastigiata*. Similarly, a comparable growth rate was also observed with Feed-B (11.56 g/month) with *P. tetrastomatica*. However, the growth rate in fishes was relatively lower (9.05 g/month) with Feed-C containing seaweed *S. marginatum.* The growth rate in each month was also compared. The maximum attainable growth rate was found to be 12 g in the control group, whereas this was 30 g with Feed-A. The attainable growth was 20 g and 15 g with Feed-B and Feed-C, respectively. In the control group, the maximum increments in weight was recorded in the third (September) and fifth (November) months of rearing, and the increment was considerably reduced after that. The maximum increment in weight was in the second month (August) with Feed-A, and this was followed by a considerable decrease in subsequent months. A similar trend was observed with Feed-B and Feed-C. The biochemical composition of all the four feeds used in the present study showed approximately the same protein (0.45-0.50 mg/ml) and lipid contents (0.6 mg/ml). Carbohydrate was the only parameter which showed a relatively significant effect ($p<0.05$) on the growth rate (0.107 mg/ml). The average Food Conversion Ratio (FCR) calculated for all the different feeds showed the maximum value with control (2.54 ± 2.72), followed by Feed-C (1.77 ± 1.54) and Feed-B (0.67 ± 0.13). Meanwhile, the minimum value of FCR was obtained with Feed-A (0.57 ± 0.39) indicating its high efficiency. The data of the present study clearly demonstrated that seaweeds, such as *C. fastigiata* and *P. tetrastomatica*, could be used in commercial formulated feed to get better growth of the fingerlings of major carps.

Keywords: Growth performance, *Catla catla,* seaweeds

INTRODUCTION

Fish form one of the most important components of Asian diets (Ayyappan and Jana, 1997). In Bangladesh, Indonesia and Philippines, it comprises of 50% of animal protein intakes, while in Thailand and Vietnam, it contributes about 40% of the diets (Delagado *et al*., 2003). The demand for fish has increased worldwide with the growing population. It is estimated that by 2050, when world population will approximately increase to 9 billions, and the demand for fish and fish products will also increase to 130.1 million tones, in which aquaculture practices are expected to contribute 41% to the total production of fish (Delagado *et al*., 2003).

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The most essential and major operational input in successful aquaculture is the feed and hence cheap and nutritionally balanced effective artificial feeds need to be developed. From historical times, carrageen and alginates from seaweeds are used for medicinal purposes. In spite of their usefulness, unfortunately only a little work has been done on the incorporation of seaweed in formulated feeds of freshwater cultivable fishes. Therefore, an attempt has been made in this study to incorporate seaweed as one of the ingredients in pelleted feed and to evaluate the efficacy of the feeds on the growth of Indian major carp (*Catla catla,* Ham.). The main objective of this study was mainly to produce cost effective**,** cheap, and efficient feed for a better growth of carps. Since foraging carps readily accept artificial pelleted feeds under any culture conditions, *Catla catla* belonging to the same group was selected to study the performance of feed developed in his study.

MATERIALS AND METHODS

In the present study, small, healthy, disease-free fries (18-22 mm) of *Catla catla* (Ham.) were procured from the carp hatchery at Anjunam Dam of Goa (India). These live animals were brought to the laboratory in polythene bags filled with oxygen. The polythene bags were kept for 2-3 hours in the experimental tanks for acclimatization of the fries before commencement of the experiment. Initially, a static indoor rearing system, consisting of four rectangular glass aquarium tanks (capacity: 80 L), was used for the study. Before stocking the fish, the tanks were washed thoroughly with freshwater. All the tanks were kept on a cement platform to facilitate better observation and accessibility. These tanks were kept on thermocol sheets to avoid breakage. Adequate level of oxygen in each tank was maintained through aeration. A circular FRP tank of 800 L capacity was also kept separately for regular replenishing of the water. The water of the tank was aerated regularly to eliminate chlorine before it was used for the experiment.

Three different types of artificial feeds incorporated with commonly occurring seaweeds, namely *Chlorodesmis fastigiata* (Feed-A), *Padina tetrastomatica* (Feed-B) and *Stoechospermum marginatum* (Feed-C), were formulated. These seaweeds were collected from Marvel and Anjuna beaches of Goa (India) during low tides. After the collection, the seaweeds were immediately washed with freshwater to remove extraneous materials associated with them. These seaweeds were then allowed to dry under the sun for 6-8 hours and stored in polythene bags for further use. All the three species of seaweed were ground using a mixer and used according to the desired weight, as described in Table 1.

In the above formulation scheme, coconut oil cake was used as a fat substitute, while wheat flour was used as carbohydrate and protein sources. Similarly, rice bran was used as carbohydrate and protein sources whereas tapioca was used as a binder. The ingredients were mixed thoroughly in a mixer with sufficient quantity of water to get the required soft consistency. The material was then hand kneaded. Small pellets (2-3 mm) were prepared with the help of a hand pelletizer. These pellets were dried at 40 ^{o}C in an oven for 24 hours. Before use, these pellets were grounded to powder form in a mixture and preserved in airtight containers for further use.

The average weight of fry at the beginning of the experiment was recorded and 40 numbers of randomly selected fries in each experimental tank were transferred. Tank-1 was considered as a control tank where the artificial feed without seaweed was used. In Tank-2, artificial feed with seaweed (*C. fastigiata*), Tank-3 feed with seaweed (*P. tetrastomatica*) and Tank-4 feed with seaweed (*S. marginatum*) were given at the rate of 10% of the biomass. The feed was given twice every day at 0900 hrs and 1700 hrs.

Faeces and uneaten feed was removed from each tank by siphoning before introduction of fresh feed. About 20% of exchange of water was given every day by using freshwater from the circular FRP tanks. Feeding of the fish was done by hand as this method allowed regular inspection of the fish. In each month, a total of ten fish were taken out and their mean average weight was recorded separately for each group. Meanwhile, a monthly sampling was undertaken to record the growth of the fish and also for adjusting the appropriate feed ration. The specific growth rate "G" of the fishes was calculated separately for each group, as follows:

$$G = \frac{W_2 - W_1}{T_2 - T_1} \times 100 \qquad \text{(Chatterji } et\ al.\text{, 1979)}$$

where W_2 and W_1 are the weights of the juveniles at times, T_2 and T_1, respectively.

Crude protein, crude carbohydrate, and lipid contents in each formulated feed were determined following AOAC (1984). The feed conversion ratio (FCR) was determined as described by Chatterji (1976) to assess the performance of the formulated feed by a simple equation, as:

$$FCR = F/ (W_1-W_0)$$

where F is the weight of food supplied to the fish during the study period, W_0 is the weight of the fish at the beginning of the experimental period, and W_1 is the weight of the fish at the end of the experiment.

TABLE 1
Diet formulation and ingredients used for evaluating growth performance on *C. catla*

Ingredients (weight in gm)	Control (g/500 g)	Feed A (g/500 g)	Feed B (g/500 g)	Feed C (g/500 g)
Coconut oil cake	200	75	75	75
Wheat flour	100	100	100	100
Tapioca	50	50	50	50
Rice bran	150	200	200	200
Seaweed *(Chlorodesmis fastigiata)*	-	75	-	-
Seaweed *(Padina tetrastomatica)*	-	-	75	-
Seaweed *(Stoechospermum marginatum)*	-	-	-	75

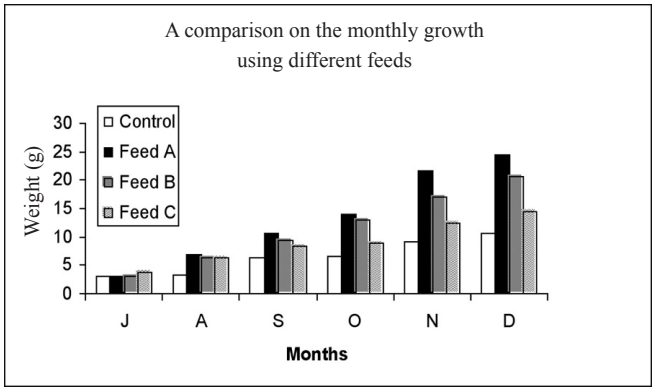

Fig. 1: A comparison on the monthly weight gained using different feeds

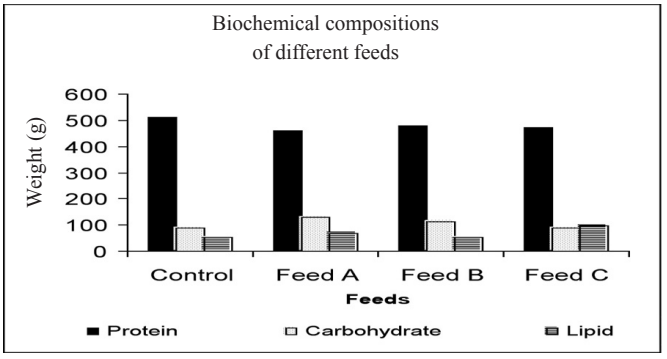

Fig. 2: Biochemical compositions of different feeds

RESULTS

Monthly weights (i.e. from July to December 2005) gained by *C. catla* with different feeds are presented in *Fig. 1*. In the control group, the weight was 6.48 g, whereas the maximum with Feed-A was 13.38 g. With Feed-B and Feed-C, the average growths were 11.56 and 9.05 g, respectively *(Fig. 1)*. In the control group (feed without seaweed), the weight gain of the fish was relatively very low for all the months as compared to the other feed types. The growth rate in terms of weight gain was the maximum and rapid when the fish was fed with Feed- A which was supplemented with seaweed *C. fastigiata*. A more or less similar growth trend was observed with Feed-B supplemented with *P. tetrastomatica*. However, the growth was relatively lower with Feed-C which contained seaweed (*S. marginatum*). In all the groups, except for the control, the growth gained was higher (*Fig. 1*).

The specific growth rate for each group was calculated separately for each month (*see* Table 2). In the control and with Feed-C, the specific growth rate was relatively low with the maximum values in December (10.62 and 14.50%, respectively). The higher SGR values with Feed-A (24.50%) and Feed-B (20.54%) showed consistent growth increments (*see* Table 2). The monthly increment in the weight was also compared in all the four groups. The growth rate in each month was also compared. The maximum attainable growth rate was 12 g in the control group, whereas this was 30 g with Feed-A. The attainable growth was 20 g and 15 g with Feed-B and Feed-C, respectively. In

TABLE 2
Growth performance in *Catla catla* when fed with different feeds

Months	Control		Feed-A *C. fastigiata*		Feed-B *P. tetrastomatica*		Feed-C *St. marginatum*	
	Monthly weight increment (g)	Specific growth rate (%/ month)	Monthly weight increment (g)	Specific growth rate (%/ month)	Monthly weight increment (g)	Specific growth rate (%/ month)	Monthly weight increment (g)	Specific growth rate (%/ month)
July	-	2.96	-	2.98	-	2.96	-	3.84
Aug.	8.35	3.23	56.24	6.81	53.01	6.30	13.43	6.34
Sept.	48.20	6.36	35.57	10.57	33.26	9.44	24.16	6.36
Oct.	2.15	6.50	24.28	13.96	27.49	13.02	5.10	8.81
Nov.	53.00	9.25	35.06	21.50	23.85	17.10	29.52	12.50
Dec.	12.71	10.62	12.24	24.50	16.74	20.54	13.79	14.50

TABLE 3
Food Conversion Ratio (FCR) values using different feeds during the experimental periods

Group	Aug	Sept	Oct	Nov	Dec	Average
Control	7.40	0.63	1.41	1.09	2.18	2.54±2.72
Feed-A	0.52	0.53	1.51	0.39	0.18	0.57±0.39
Feed-B	0.59	0.63	0.55	0.73	0.87	0.67±0.13
Feed-C	0.80	0.99	4.41	0.81	1.50	1.77±1.54

the control group, the maximum increment in the weight was recorded in the third (September) and fifth (November) months of rearing and after that the growth increment was reduced considerably. The maximum increment in the weight was recorded in the second month (August) with Feed-A, which was followed by a considerable decrease in the subsequent months. This showed that in all the experimental groups where seaweeds were incorporated in the feeds, the growth followed the normal trend (*see* Table 2).

The biochemical composition of all the four feeds used for the present study showed that the protein contents of all the feeds were similar (0.45-0.50 mg/ml), as illustrated in *Fig. 2*. Similarly, the lipid content (0.6 mg/ml) of the all the four feeds did not show any significant effect on the growth rate of the juveniles (see *Fig. 2*). Carbohydrate (0.107 mg/ml) was the only parameter which showed a significant effect ($p<0.05$) on the growth, as it was evident with Feed-A.

The average FCR calculated for all the different feeds showed the maximum value with the control (2.54±2.72), whereas the minimum was with Feed-A (0.57±0.39), and this was followed by Feed-B (0.67±0.13). The data presented in Table 3 showed that Feed-A and Feed-B were definitely better as compared to the control and Feed-C (1.77±1.54).

DISCUSSION

In the traditional carp culture, a mixture of rice bran and groundnut oil cake (1:1) is generally used (Mukhopadhyay, 1997). However, studies pertaining to nutrition in freshwater aquaculture in the recent years have led to the development of new feed formulations for Indian carp (Mohanty *et al*., 1990; Ayyappan and Jana, 1997; Paul *et al*., 1998). However, due to the escalating cost of groundnut oil cake and its increasing demand for aquaculture industry and poultry, there is an urgent need to search alternative sources to replace groundnut oil cake in the carp feeds (Mishra and Samantaray, 2004).

Feeds from plant origin have been reported to be effective and less expensive ingredients to fish diets (Dorsa *et al*., 1982; Robinson *et al*., 1984a, b; Ofojekwu and Ejike, 1984). These feeds are known to have an excellent amino acid profile (Jackson *et al*., 1982). In the recent years, feeds from plant origin have been accepted for Indian major carps as the growth in fishes has been reported to be as good as the traditional feed (Patnaik and Das, 1979). In some cases, aquatic and terrestrial macrophytes have been used as unconventional source of plant proteins to develop suitable fish feeds (Edwards *et al*., 1985; Devaraj *et al*., 1986). In tropical developing countries, where algal production rates are high, algae have been receiving increasing attention as an alternate protein possess relatively high protein contents (50-65%) that may be included in balanced fish feeds (Devaraj *et al*., 1986).

There is a paucity of information concerning the incorporation of seaweeds in fish diets. However, there have always been contradictory results obtained. For examples, inclusion of the brown seaweeds known as *Undaria pinnatifida* and *Ascophyllum nodosum* in the formulated feeds has been found to improve the growth and feed efficiency of red sea bream (Yone *et al*., 1986). The use of red seaweeds (*Eucheuma cottonii*) and *Gracilaria lichenoides* in the diet of juvenile of spotted rabbitfish (*Siganus canaliculatus*) resulted in a negative growth rate (Tacon *et al*., 1990). Hashim and Mat-Saat (1992) investigated the utilization of several seaweed meals by snakehead fry, where a relatively higher growth performance was reported. Considering the above mentioned studies, three species of commonly occurring seaweeds were used to study the growth pattern in *catla* in the present investigation. In this study involving feed with seaweed (*C. fastigiata*), better results were shown as compared to the feed without the seaweeds supporting the fact that the fingerlings of catla preferred food consisting of more carbohydrates as compared to protein. Low FCR value for Feed-A (0.57 ± 0.39) and Feed-C (0.67 ± 0.13) shows a better efficiency of the feeds as compared to the control and other feed.

An attempt was also done by Basudha and Vishwanath (1997) to study the growth performance, feed conversion ratio, and protein efficiency ratio of a formulated feed containing *Azolla* powder, fish meal, mineral, vitamin supplements and feed containing rice bran, mustard oil cake in a feeding trial on *O. belangeri*. The growth of fish in the manured ponds, where no supplementary feed was given, was considered as a control group. The growth was compared in all these groups, which showed that the percentage of weight gained by the fish fed with *Azolla* powder was highest. A better growth in the fries in these studies could be attributed to the presence of both plant and animal proteins and probable balance of amino acid composition (Saavedra *et al*., 2008). In the present study, Feed-A, which was formulated with rice bran, groundnut oil cake, tapioca, and seaweeds showed better results. This shows that the incorporation of carbohydrate in feed relatively gives a better growth in common carps as compared to animal proteins. The findings by Keshavnath *et al*. (2002) on common carps have shown that these animals are capable of utilizing high level of dietary carbohydrates, especially when the protein content in the diet is low, and this further supports the findings obtained in the present study.

Krishnanidhi and Shell (1965) recommended 20% carbohydrates as the most efficient level for the feed of channel cat fish. Their study proved that larger carbohydrate contents have also been found to yield a better growth of channel cat fish. In the continuation of other experiments, a 26% carbohydrate in the diet yielded the best growth in carps (Krishnanidhi and Shell, 1965). *Piaractus mesopotamicus* has been reported to use carbohydrates as effectively as lipids and grow better as compared to feeds containing protein (Abimorad and Carneiro, 2007). The specific growth rate and weight gained in juvenile Asian seabass (*Lates calcarifer*) fed with feed containing 20% carbohydrate were higher with better feed conversion ratios as compared to the ones which were fed with feeds containing higher protein and lipid (Catacutan and Coloso, 1997). These observations support the findings of the present study which used carbohydrate-based feed for the juveniles of common carps.

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