The Bioscan 13(2): 549-552, 2018
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

GROWTH PERFORMANCE OF INDIAN MAJOR CARPS ON PERIPHYTON BASED AND SUPPLEMENTARY FEED IN AQUACULTURE SYSTEMS

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KEYWORDS
IMC
Growth
FCR
Periphyton
Feed

Received on :
11.03.2018

Accepted on :
24.05.2018

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ABSTRACT

An experimental study was conducted on growth performance of Indian major carps (IMC) in periphyton based aquaculture and supplementary feed for a period of 90 days w.e.f. February to May, 2017. Four treatments in triplicate were tried viz. only fertilization T0 (control), fertilization plus bamboo substrate (T1), fertilization plus bamboo substrate plus feed (T2) and fertilization plus feed (T3). Fishes showed significant (*p* Â0.05) weight gain and survivability in T2 as compared to other treatments. Improved FCR value was also observed in T2 as compared to T1. The objective of the study was to evaluate the growth of IMC based on substrate feeding and supplementary feeding.

INTRODUCTION

Periphyton based aquaculture is a method used to improve the natural productivity of a water body by providing food for the cultured aquatic organisms in the form of biofilms. Periphyton grows in the provided substrate inside the water column. Recent investigation showed that provision of substrates results in enhanced growth and production of fishes in freshwater as well as brackishwater ponds (Amish *et al*. 2008). Growth performance of *Oreochromis mossambicus* (Keshavanath *et al*. 2004), *Catla catla*, *Labeo rohita, Cirrhinus mrigala* and *Cyprinus carpio* (Gangadhar and Keshavanath, 2012; Keshavanath *et al*. 2015), have been evaluated with different substrates. Among these rohu, calbasu and tilapia grew better than others and the production ranged from 50 to 77% higher in substrate-based culture systems compared with control systems.

Periphyton based system showed higher nutrient utilization efficiency when compared to traditional substrate free system (Uddin, 2007). Studies conducted in fish ponds elucidates that the provision of substrates can reduce the need for artificial feed and can be an alternative to commercial feed in culture of herbivorous fishes (Azim *et al.,* 2002). The cost of feed constitutes one of the most expensive component of the recurring costs of aquaculture production. An alternative approach to this conventional system is to provide ponds with substrates for the growth of periphyton that can be eaten by herbivorous or planktivorous fish. To determine the significance of this culture system a study was undertaken to find out the growth performance of Indian Major Carps on periphyton substrate based and conventional aquaculture system.

MATERIALS AND METHODS

Experimental site, design and preparation

The experiment was performed using Completely Randomized Design (CRD) in 12 numbers of outdoor rectangular cement cisterns of size (5.5m x 4m x 1m). Liming and fertilization was done using quicklime (CaO), raw cow dung, urea and single super phosphate @ 250 , 10000, 100 and 50 kg ha^{-1} $year^{-1}$ respectively. The experimental tank was stocked with 30 fingerlings of *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* (average initial weight of 10.82 $\pm$ 0.05 gm, 10.78 $\pm$ 0.06 gm, 10.73 $\pm$ 0.07 gm and length of 11.43 $\pm$ 0.06 cm, 12.86 $\pm$ 1.74 cm and 11.35 $\pm$ 0.06 cm respectively) with a stocking density ratio of 10:10:10 (Catla:Rohu:Mrigal). Water depth was maintained at 80 $\pm$ 5 cm and bird fencing was provided during the entire experimental period.

Substrate selection and feeding schedule

Bamboo (*Bambusa tulda*) locally known as *Jati bah* was collected and used as substrate. Collected bamboo was cut and split into four pieces of size 1.2 m. These pieces were placed vertically in T1 and T2 treatments with a density of 45 pieces in each tank. After the installation, minimum of 30 days was taken for colonization of periphyton. Supplementary feed was prepared with locally available feed ingredients viz. rice bran and mustard oil cake in a ratio of 1:1 fortified with vitamin and mineral mixture (Agrimin forte) and fed @ 3% of the body weight of fishes.

Estimation of proximate composition

Proximate analysis of supplemental feed included estimation of moisture, dry matter, ash content, crude protein, crude fibre, crude fat and nitrogen free extract which were determined following AOAC (1995).

Stocking of Fish and growth studies and determination of periphyton biomass

A total of 360 nos. of stunted yearlings of Indian major carps were introduced into the experimental tanks at a density of 30 nos. per tank with a ratio of 10:10:10 of Catla, Rohu and Mrigal respectively. The growth parameters were calculated according to the formula given by Rahman *et al.* (2012).

Water quality monitoring

For analysis of different water quality parameters samples were collected from all tanks between 09:00 – 10:00 hours at 15 days interval following the standard methods APHA (2005).

Statistical analysis

The data obtained from experimental groups were subjected to one way Analysis of variance with Statistical Package for Social Sciences (SPSS version 16.0 for windows, 2013) to determine the level of significance.

RESULTS AND DISCUSSION

Proximate composition of supplementary feed was found to be 10.72 ± 0.23 % moisture, 9.98 ± 0.04 % ash, 24.97 ± 0.33 % crude protein, 11.04 ± 0.52% crude fat, 6.92 ± 0.40 and 36.14 ± 0.67 nitrogen-free-extract. Though slightly lower temperature was observed in tanks due to substrate but it did not showed significant (pÂ0.05) difference among other treatments. Lower temperature in substrate tanks could be attributed to the shading effect of substrates (Keshavanath *et al.* 2002, Lende *et al.* 2015, Begum *et. al.* 2016).

Addition of substrate showed significant (pÂ0.05) difference in transparency value with only feeding treatment. It might be due to entrapping of organic detritus and dissolved suspended solids, removal of nutrients from water column, organic matter breakdown by periphyton assemblage as stated by Haque *et. al.* (2014).

The pH values were slightly in alkaline range (6.7 to 9.3) in all the tanks which indicated good pH conditions for biological production. Treatment with substrate was found to be significantly (pÂ0.05) higher in DO concentration than the control tanks which might be due to the effect of photosynthetic activity of periphyton. Water turbulence induced by the grazing activity of the fishes have also increased during the recent study.

Average Dissolved oxygen concentrations were found to be in desirable (5.07 to 6.95 mgl^{-1}) range for carp culture in the all treatment groups. Treatment with substrate was found to be significantly (pÂ0.05) higher DO concentration than the control tanks. It might be due to the effect of photosynthetic

Table 1: Average water quality parameters (mean ± SE) of different treatments during the 3 months of experiment (Feb-May)

Treatments	Parameters Temperature (ºC)	Transparency (cm)	pH	DO (mgl^{-1})	Total Alkalinity (mgl^{-1})	Total Hardness (mgl^{-1})	Nitrate-Nitrogen (μgl^{-1})	Ammonia-Nitrogen(μgl^{-1})	Phosphate (μgl^{-1})	Chlorophyll-a (μgl^{-1})
T0 (Control)	29.74 ± 0.77	30.69 ± 0.75	7.34 ± 0.09	5.07 ± 0.10^a	139.80 ± 3.37	126.45 ± 2.08	4.64 ± 0.09^a	14.44 ± 0.40^a	0.08 ± 0.004^b	96.30 ± 1.43
T1(Fertilization + Bamboo Substrate)	28.59 ± 0.72	37.04 ± 1.47^b	8.02 ± 0.14	6.95 ± 0.04^b	152.22 ± 3.81	122.78 ± 3.04	8.96 ± 0.06^c	8.96 ± 0.25^b	0.22 ± 0.01^a	88.41 ± 1.42
T2 (Fertilization + Bamboo Substrate + Feed)	28.86 ± 0.74	36.11 ± 0.91^b	7.63 ± 0.10	6.14 ± 0.04^c	156.92 ± 4.73	127.45 ± 2.23	8.91 ± 0.16^c	11.84 ± 0.16^c	0.23 ± 0.009^a	96.06 ± 2.08
T3 (Fertilization + Feed)	29.04 ± 0.80	24.53 ± 1.29^a	7.67 ± 0.13	5.43 ± 0.13^a	138.50 ± 3.73	129.25 ± 2.43	6.02 ± 0.15^b	15.86 ± 0.29^a	0.14 ± 0.005^c	101.53 ± 1.73

Values are given as mean ± SE. (n = 63). The means in a column with different superscripts are significantly different (P < 0.05, Tukey-HSDtest).

Table 2: Average growth, survival and production of fishes in different treatments

Treatments	Average weight gain(g)	Average length gain (cm)	SGR(%/day)	FCR	Average survival (%)	Net Yield (g/22m^2)	Gross Yield) (tone/ha/90 days	Net yield(tone/ ha/90 days)	Increase in production over control (%)
T0 (Control)	36.18 ± 0.78	4.21 ± 0.23	1.63 ± 0.01	-	76.66 ± 2.88	832.06 ± 13.54	0.49	0.37	-
T1(Fertilization + Bamboo Substrate)	54.86 ± 2.45	5.96 ± 0.33	1.99 ± 0.04	-	85.55 ± 2.93	1407.98 ± 36.55	0.76	0.63	69.11
T2 (Fertilization + Bamboo Substrate + Feed)	125.08 ± 3.57	9.53 ± 0.42	2.80 ± 0.02	1.34	87.77 ± 3.23	3291.37 ± 89.03	1.62	1.49	283.71
T3 (Fertilization + Feed)	66.60 ± 1.04	7.47 ± 0.34	2.19 ± 0.02	1.85	72.22 ± 3.23	1442.95 ± 26.57	0.77	0.65	71.30

The means in a column with different superscripts are significantly different (P < 0.05, Tukey-HSD test and pair t test) activity of periphyton in tanks with substrates led to higher DO concentration. Water turbulence induced by the grazing activity of the fishes might have also increase dissolved oxygen diffusion, particularly at the uppermost area of the water column (Jiwyam, 2013).

Significant effect of substrate density on dissolved oxygen concentration observed by Keshavanath *et al.* (2002) and Azim *et al.* (2004) also recorded higher DO concentration in treatment with substrate surface area of 75 % of tanks water surface area than control tanks.

The higher alkalinity value indicated higher nutrient turn over and productivity in tanks with substrates (Shit and Ghosh, 2015).

Nitrate-nitrogen in the treatments with substrate showed an increasing trend indicating enough nitrifying activities and oxidation process of nitrite to nitrate. In tanks with substrates, nitrifying bacteria could colonize on provided substrate that were located in water column, which resulted in enhanced nitrification.

The provision of substrate had significant effect on lowering ammonia concentration in T1 and T2. This might be due to higher nitrification rates by periphyton assemblage. Langis *et al.* (1988) and Ramesh *et al.* (1999) reported that the bacterial biofilms (periphyton) on the substrates reduced ammonia levels through promotion of nitrification. Nitrifying bacteria are known to improve water quality by converting highly nitrogenous toxins such as ammonia and nitrite into nitrate (Rajkumar *et al.* 2015). Lower ammonia nitrogen value in substrate tanks might be attributed to the establishment of nitrifying bacteria in the systems.

A higher phosphate value was recorded in treatment with substrate which was significantly (pÂ0.05) higher from T3 and control. Higher phosphate indicated higher nutrient turn over and productivity in tanks with substrates (Keshavanath *et al.* 2012).

Growth performance of fish

Data on growth, survival and yield of experimental fishes are summarized in Table 2. In the present study, administration of fertilization along with feed (T3) resulted in 71.30 % increase in production and fertilization along with bamboo substrate (T2) resulted in 69.11 % higher production over control. Keshavanath *et al.* (2002) observed significant effect of feeding on combined culture of mahseer and fringe-lipped carp which resulted in 30- 59 % higher production compared to without feeding and without substrate treatment. Similar results were also observed by Azim *et al.* (2002b) who recorded 60 % higher production of rohu, catla and calbasu in only feed treatment compared to control.

In the present study, the percentage production of rohu in treatment T1 was significantly (pÂ0.05) higher than control which was also comparatively higher than treatment (T3) where rohu production was 78.89 % higher compared to control (Table 3). Thus, it indicated that rohu could efficiently utilize periphyton assemblage as food source. Similar observations were also obtained by Ramesh *et al.* (1999); Wahab *et al.* (1999a); Azim *et al.* (2001). But in the case of catla and mrigal production percentage was more in T3 (66.56 and 67.42 %) than T1 (51.87 and 52.48 %) when compared to control. Thus it could be assumed that catla and mrigal could not utilize periphyton as food as effectively as rohu.

However, growth and yield of catla, rohu and mrigal were significantly ($P < 0.05$) higher in T2 as compared to all other treatments. The average specific growth rate of rohu was found to be the highest in T2 (2.80 ± 0.02 % /day) which was significantly (pÂ0.05) higher than all other treatments. This indicated that when substrates were provided, rohu mainly depended on periphyton for food leaving supplemental feed for efficient utilization by other species. From the present findings it may be concluded that catla and mrigal probably got indirect benefit when poly cultured with rohu under periphyton along with supplemental feed. Rohu might have depended on periphyton assemblage for food and leaving the supplemental feeds to other species when reared under periphyton along with supplemental feed. The provision of substrates might have helped in better utilization and conversion of available feed into fish biomass. Thus provision of substrate can reduce the need for artificial feed and can be considered as an alternative method of conventional fish culture system. These findings showed that introduction of substrate in conventional aquaculture system was suitable for the production of Indian major carps, while providing same amount of input in carp polyculture system.

Survivability

Provision of substrate increased fish survival in both T1 and T2, which might be due to additional shelter and natural food in the form of periphyton colonized on bamboo substrates along with improvements of environmental conditions through a range of ecological and biological processes (Tidwell *et al.* 2002). In addition to increasing food supply, the presence of substrate appears to reduce stress by acting as a shelter or hiding place (Schveitzer *et al.,* 2013).

ACKNOWLEDGEMENT

The authors are thankful to the authority of College of Fisheries, Assam Agricultural University for providing the necessary facilities to carry out the research work.

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