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K Sarita
 Assistant Fisheries Officer,
 FARD, Govt. of Odisha,
 Odisha, India

NK Sial
 College of Fisheries (OUAT)
 Berhampur, Odisha, India

GC Kund
 College of Fisheries (OUAT)
 Berhampur, Odisha, India

SK Patra
 College of Fisheries (OUAT)
 Berhampur, Odisha, India

Effect of different carbon sources on growth performance and survival of *Cyprinus rubrofasciatus* in biofloc system

K Sarita, NK Sial, GC Kund and SK Patra

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Abstract

An experiment was conducted for a period of 90 days to evaluate the effect of carbon sources on growth and survival of *Cyprinus rubrofasciatus* in biofloc system. The experiment was designed following completely randomised design with one control and three treatments in triplicate viz., T₁ (tapioca starch), T₂ (jaggery), T₃ (cornstarch) along with T₀ (control: without carbon addition). The weight of *Cyprinus rubrofasciatus* ranged from 3.55 g to 3.59 g was distributed randomly to all 12 tanks at a stocking density of 10 nos. per 200-liter capacity tank. The carbon-nitrogen ratio was maintained 20:1 throughout the experimental period in biofloc tanks. No carbon source was added in control with periodical water exchange and siphoning. The mean body weight of fish during the stocking was 3.56±0.01 g, 3.57±0.02 g, 3.57±0.02 g and 3.56±0.02 g respectively in T₀, T₁, T₂ and T₃. At the end of the experiment, the highest growth reported in jaggery treated tank *i.e.* T₂ (19.87±0.54 g) and the lowest in control T₀ (10.26±0.59 g). The higher average daily growth was recorded from T₂ (0.18 g), followed by T₃ (0.17 g), T₁ (0.11 g) and T₀ (0.07 g) at 90 days of culture. Significant difference in weight gain was observed between the control and treatments during the experimental period ($p < 0.05$). The SGR showed, biofloc grown *Cyprinus rubrofasciatus* was significantly better than that of the control ($p < 0.05$). Feed conversion ratio and survival rate of all biofloc treated tank was significantly better than the control ($p < 0.05$). Among the different carbon sources used, the highest weight gain was observed in jaggery based biofloc treatment. So, the jaggery-based biofloc system is a better carbon source than the cornstarch and tapioca starch for rearing of *Cyprinus rubrofasciatus*.

Keywords: *Cyprinus rubrofasciatus*, biofloc, jaggery, tapioca starch, cornstarch

Introduction

In India, fish production has increased due to several developmental programs of Government in different states. Increased fish production in villages, tanks, and ponds is possible through scientific farming, which will help develop the rural population's socio-economic conditions by providing them employment opportunities in aquaculture.

Biofloc technology (BFT) is one practical alternative to the standard culture practice attempt to decrease or prevent effluents' emission from aquaculture farms by applying a source of organic carbon to the system to maintain the carbon-nitrogen (C: N) ratio. It abolishes inorganic nitrogen from culture environment, decreasing water pollution, and maintaining homeostasis in the ecosystem, unlike intensive aquaculture practices. Biofloc technology (BFT) depends on manipulating high levels of microbial floc dispersed through turbulent mixing and the addition of carbon sources to concede degradation of the animate matter. Biofloc system is for improving water quality parameter, providing nutrition and biosecurity, enriches fish health, growth and production in the culture tanks (Azim and Little, 2008) [5]. The nutritive value of bioflocs in addition to supplied feed would have contributed for higher growth and lower FCR in biofloc treatments (Karunaarachchi *et al.*, 2018) [12]. Several authors reported about the advantages of biofloc technology (BFT). It can improve water quality (Xu *et al.*, 2016) [22], improves digestive enzyme activity and growth performance (Zhang *et al.*, 2016) [24] and non-specific immunity and biosecurity (Xu and Pan, 2013) [23]. Biofloc can improve the growth and immunity of fish and shrimp (Khanjani and Sharifinia, 2020) [13]. BFT can improve growth performance in a variety of finfish species (Minabi *et al.*, 2020) [16].

Corresponding Author:
NK Sial
 College of Fisheries (OUAT)
 Berhampur, Odisha, India

Wasave *et al.* (2020)^[21] reported that the rice bran is a better source of carbon for rearing of GIFT tilapia fry in biofloc systems. Jackquelinwino *et al.* (2024)^[11] suggested that the jaggery based biofloc could enhance the growth performance, survival rate, digestive enzymes and resistance against pathogenic bacterial infection activity in RAS based system. Susitharan *et al.* (2022)^[19] suggested that the experimental biofloc treatment with Jaggery can improve the quality of culture water and results in better growth of pearl spots compared to Sugar, Corn flour and Cassava flour treatments as carbon sources. The higher fish production due to biofloc recorded by (Azim and Little, 2008)^[5] and Kuhn *et al.* (2009)^[14]. *Cyprinus rubrofasciatus* is the most popular and valuable ornamental fish with a high market demand (Aries *et al.*, 2022)^[3]. Therefore, the present study was designed to evaluate the effect of carbon sources such as tapioca starch, jaggery and cornstarch on growth and survival of *Cyprinus rubrofasciatus* in biofloc based rearing units.

Materials and methods

Experiment design: The experiment was conducted in the Aquaculture Laboratory, College of Fisheries (OUAT), Odisha, India. The seeds procured and acclimatized under the aerated condition for 15 days. In between adaptation phase, fish were given with commercial fish feed twice a day. After 15 days, the experiment was designed following completely randomised design with one control and three treatments in triplicate viz., T₁ (tapioca starch), T₂ (jaggery), T₃ (cornstarch) along with T₀ (control: without carbon addition). The weight of *Cyprinus rubrofasciatus* ranged from 3.55 g to 3.59 g was distributed randomly to all 12 tanks at a stocking density of 10 nos. per 200-liter capacity tank. The FRP tanks were initially washed, sun-dried, and then filled with potassium permanganate (KMnO₄) solution and were left overnight. The tanks were flushed out the very next day and washed thoroughly with clean water. Then the clean water was filled in the tanks for stocking of the experimental fishes. From the day of the experiment's initiation, the fishes were sampled periodically to check any abnormality with a particular reference to diseases' onset. As a prophylactic measure, the fishes were treated with Oxytetracycline, vitamin-E supplement, common salt, turmeric powder to keep the fishes disease-free. Every day the fishes were fed with commercial pellet feed. Feeding ration will be divided into two equal quantities and given twice a day, i.e., morning and evening. The protein content of the feed was around 23%.

Inoculum making process: For initial inoculum making, soil of pond bottom was taken from the stocking pond of the College of Fisheries (OUAT) were formed in a plastic bucket (10L) by adding 20 g/L of pond bottom soil in well-aerated water containing 10 mg/L ammonium sulfate and 200mg/L of carbon sources to their respective treatments by following the procedure of Avnimelech (1999)^[4]. Nitrogen and carbon sources were added regularly to the treatment tanks to maintain the C:N ratio of 20:1 (Chamberlain *et al.*, 2001)^[7]. The suspension was incubated for 3-5 days to develop microbial growth, and the microbial floc development was observed.

Transfer of inoculum to experimental tank: The inoculum was transferred to the experimental tank in the

ratio of 1L of inoculum: 50L of water under vigorous aeration. Before this, the cleaned and dried treatment tanks were filled with fresh water and the inocula were added to their respective treatment group.

The tank was well aerated for 15 days to ensure optimum floc production. After 15 days, when floc volume reached >25 ml/l in Imhoff cone reading, the flocs were fully matured and ready for stocking.

Fish biomass sampling: For observation of growth and fish species, periodic sampling was carried out at 15 days interval. From random sampling, fishes were taken for estimating mean length and mean weight. The harvesting of fish was done after of 3 months of trial days. Total biomass was recorded from each tank and also calculated the survivability.

Water quality monitoring: The physico-chemical parameters of water, viz., water temperature, pH, dissolved oxygen, total alkalinity, ammonia-nitrogen, nitrite and nitrate were analysed twice in a week following standard methods (APHA, 2005)^[2].

Growth parameters: The growth parameters, such as mean body weight, daily weight gain, weight gain, specific growth rate, feed conversion ratio and survival rate of *Cyprinus rubrofasciatus* were calculated using standard methods.

Statistical Analysis: The experiment was designed following the statistical tools "completely randomised design (CRD)". CRD and Duncan's multiple range test were used for comparison of mean ($p < 0.05$) between different groups.

Results and Discussion

In the present study, the important water quality parameters in all the treated tanks were within the suitable range. Biofloc technology could enhance water quality and enhance the efficiency of nutrient utilization reported by Azim and Little (2008)^[5], Xu *et al.* (2016)^[22] and Susitharan *et al.* (2022)^[19] confirms the present study. The Growth performance of *Cyprinus rubrofasciatus* is given in table 1. The mean body weight of *Cyprinus rubrofasciatus* during the stocking were 3.56 ± 0.01 g, 3.57 ± 0.02 g, 3.57 ± 0.02 g and 3.56 ± 0.02 g respectively in T₀, T₁, T₂ and T₃. After completion of 90 days, the species grow relatively higher in T₂ (19.87 ± 0.54 g) followed by T₃ (18.61 ± 0.53 g), T₁ (13.65 ± 0.16 g) and T₀ (10.26 ± 0.59 g). The significant of weight gain of *Cyprinus rubrofasciatus* between the control and treatments is tested through the statistical design "completely randomized design". It is concluded that weight gain in T₂ is significantly higher than the control as well as other treatments ($p < 0.05$). The higher average daily growth was recorded from T₂ (0.18 ± 0.01 g) followed by T₃ (0.17 ± 0.01 g), T₁ (0.11 ± 0.00 g), and T₀ (0.07 ± 0.01 g) at 90 days of culture. T₂ revealed higher average daily growth followed by T₃ and T₁, while T₀ performed low among trial days.

The result indicates the control grow significantly lower than the treated tanks ($p < 0.05$). The specific growth rate (SGR) is one of the best growth indexes among the different growth indicating parameters used in aquaculture.

Significant difference ($p < 0.05$) was observed in the specific growth rate among the control and biofloc treated systems. The mean SGR of the species at 90 days of culture was higher in the T₂ ($1.91 \pm 0.03\%$) followed by T₃ ($1.84 \pm 0.03\%$), T₁ ($1.49 \pm 0.02\%$) and T₀ ($1.18 \pm 0.06\%$) throughout the culture period.

In the present experiment, the mean body weight and daily weight gain of *Cyprinus rubrofasciatus* in all treated tank was significantly higher than the control ($p < 0.05$). Similarly, in earlier studies higher weight gain was observed in biofloc raised tilapia (Azim and little 2008) [5], *Carassius auratus* (Wang *et al.*, 2015) [20], *Cyprinus carpio* (Najdegerami *et al.*, 2016) [17] and *Labeo rohita* (Ahmad *et al.*, 2016) [1]. The result of the present study revealed that all biofloc treatments enhanced the growth performance of *Cyprinus rubrofasciatus* than that of control. Further, *Cyprinus rubrofasciatus* cultured in jaggery biofloc treatment showed a significant result in terms of mean body weight and daily weight gain compared to other treatments. Mali *et al.* (2024) [15] evaluated the effects of various C:N ratios in a jaggery-based BFT system on water quality, growth, feed efficiency, and the well-being of *Heteropneustes fossilis*. They suggested that a C:N ratio of 12:1 was optimal for biofloc systems used in cultivating *H. fossilis*, enhancing both microbial growth and water quality. Durigon *et al.* (2023) [8] reported that jaggery is an alternative carbon source to improve biofloc in tropical aquaculture. Hassan *et al.* (2022) [10] suggested that jaggery improved the water quality, immune response, and growth performance in *O. niloticus* and *P. vannamei*. Elayaraja *et al.* (2020) [9] reported that jaggery showed best growth performance and survival of fish. Sakkaravarthi and Sankar (2015) [18] observed higher weight gain in shrimp growth performance on jaggery based carbon source. So similar results also obtained in the present study that jaggery supplementation enhanced body weight gain and specific growth rate in biofloc system compared to control group. In the present study, it is also found that jaggery produced comparatively more nutritive biofloc than cornstarch and tapioca starch. That indicates jaggery as a better source of carbon for rearing of *Cyprinus rubrofasciatus* in biofloc systems.

The results of the feed conversion ratio is depicted in figure-1. The feed conversion ratio is a good indicator of how efficient a feed or a feeding strategy can be. FCR is a simple index which implies the requirement of feed amount for calculating aquaculture enterprise's profitability. The FCR of at T₀ was 1.87 ± 0.04 , followed by T₁ (1.35 ± 0.02), T₃ (1.22 ± 0.02) and T₂ (1.12 ± 0.01). The FCR between the control and treated tanks varied significantly during the experimental period ($p < 0.05$). Similar results were earlier reported in biofloc based system for rearing different species like tilapia (Caldini *et al.*, 2015) [6] and Rohu (Ahmad *et al.*, 2016) [1].

A previous study on jaggery based biofloc system revealed that the technology could reduce the FCR more effectively (Sakkaravarthi and Sankar, 2015) [18]. It is observed that the application of bio-floc technology in fish farming systems can reduce FCR values. The survival rate is depicted in figure-2. The survival at control (T₀) was 87% where as 100% in treated tanks. Significantly better results were observed in biofloc grown *Cyprinus rubrofasciatus* than the control ($p < 0.05$).

Table 1: Growth performance of *Cyprinus rubrofasciatus*

Parameter	T ₀	T ₁	T ₂	T ₃
Initial weight (g)	3.56±0.01	3.57±0.02	3.57±0.02	3.56±0.02
Final weight(g)	10.26±0.59	13.65±0.16	19.87±0.54	18.61±0.53
Weight gain (g)	6.70±0.60	10.09±0.18	16.30±0.54	15.05±0.51
Daily wt. gain(g)	0.07±0.01	0.11±0.00	0.18±0.01	0.17±0.01
SGR (%)	1.18±0.06	1.49±0.02	1.91±0.03	1.84±0.03

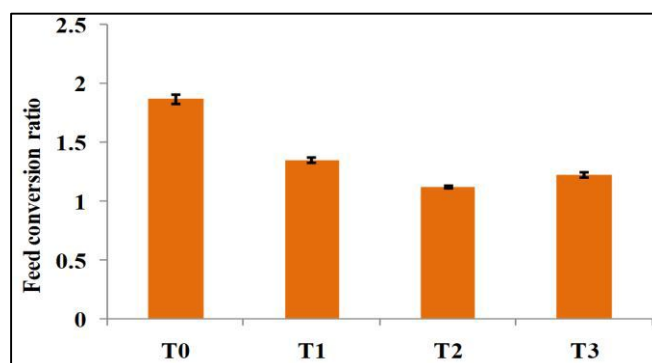


Fig 1: Feed Conversion ratio (FCR)

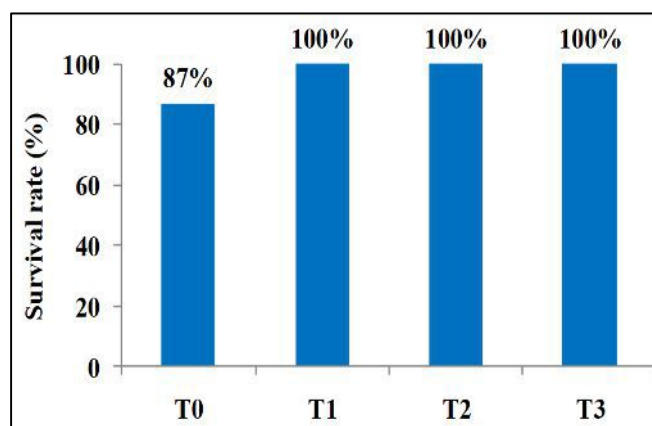


Fig 2: Survival rate (%) of *Cyprinus rubrofasciatus*

Conclusion

In the present study, all the important water quality parameter falls within the suitable range. The growth performance of *Cyprinus rubrofasciatus* was better in all biofloc treatment than that of control. Among the carbon sources used, highest growth showed in jaggery based on biofloc treatment compared to cornstarch and tapioca starch.

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