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# Water quality and growth of *Cyprinus carpio* at different stocking density in bio FLoC and non-bio FLoC system

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**Abstract**

A 60 days indoor trial was conducted at ICAR-RC for north eastern hill region, Umiam in glass aquaria (30L) without soil base. The performance of three stocking density @ 2.0 nos/$m^2$, 4.0 nos/$m^2$, 6.0 nos/$m^2$ with BFT and non BFT has been investigated using sweet potato powder as carbohydrate source. The water quality and growth performance of common carp (*Cyprinus carpio)* was access at different stocking density in bioFLoC and non biobloc system. The feeding rate was maintained @ 2% of body weight. The results show a significant difference ($p<0.05$) in total suspended solids (TSS), and FLoC volume among the treatments. The TSS, FLoC volume and total heterotrophic bacterial count (THB) was higher in 6 nos/$m^2$ in BFT system. The biological oxygen demand (BOD) load and *Aeromonas* count was found highest in non BFT system at 6 nos/$m^2$. The transparency and water exchange rate were lowest at 6 nos/$m^2$ stocking density in BFT system. The total ammonical nitrogen and phosphorus load also differs significantly in BFT and non BFT system at different stocking density. The survival was observed highest for 2 nos/$m^2$ in BFT system and lowest in 6 nos/$m^2$ in non BFT system. The daily growth rate (DWG) was not differing statistically among the treatments. The present study suggests that adding sweet potato as carbohydrate can increase the carrying capacity of culture system. Addition of sweet potato also reduce water demand by 20% at high stocking density culture.

**Keywords:** Bio FLoC, sweet potato, stocking density, water exchange, ammonical nitrogen

## Introduction

The increasing world population demand for more protein rich food across the globe. To increase the productivity intensive aquaculture with more feeding and high stocking density practiced to increase the productivity of water bodies. High stocking density and excessive feeding affects aquaculture industry negatively by accumulating residual feed, metabolites, toxic substances [4]. As a result, the disease emerges and reduce productivity due to mortalities. Bio FLoC technology is a system in which heterotrophic bacteria convert fish waste into microbial biomass (bio FLoC). BFT improving the water quality in the culture environment and subsequently reduces water use. It is a system that promotes continuous recycling and reuse of nutrients [5]. The bio FLoC technology continues to increase in the aquaculture industry worldwide for super intensive aquaculture system to reduce water consumption and increase fish production per unit. Aquaculturists shows their interest on bio FLoC which utilizes pond microbial community to improve water quality and maximize feed recycling by maintaining a high carbon/nitrogen (C: N) ratio in the water [3]. Bio FLoC stimulates heterotrophic bacterial biomass and reduce ammonical nitrogen load by utilizing nitrogenous waste [9].

In bio FLoC system, the total suspended solids of 200-300 mg/L and 100-300mg/L respectively for tilapia and shrimp are maintained. The total turbidity of 75-150 NTU is normally recommended for well-maintained bio FLoC system the solids are controlled with a clarifier at a flow rate of for every 3-4 days, in a settling tank [7].

Various fish species are cultured in a bio FLoC system like tilapia, catfish, shrimp prawn which can tolerate and survive in adverse environmental conditions. Different stocking density has different effects on water quality, growth performance and water re-use [7]. The study related to the effects of different stocking density are limited in bio FLoC system [10]. A few studies have been conducted using various stocking density to know the effects for tilapia, catfish, roux, shrimp, prawn [6]. The present study was conducted with an aim to observe the performance of common carp, at different stocking density in bio FLoC and non-bio FLoC system. The results may help for the optimization of stocking density in bio FLoC based culture system for common carp.

## Material and Methods

An indoor experiment, CRD was design in triplicates at ICAR-RC for north eastern hill region, Umami for 60 days. The eighteen numbers of glass aquaria having 30 liters capacity without soil base was used to conduct the trial during March- April 2015. All glass aquaria were disinfected with potassium permanganate @ 2 ppm and wash thoroughly and fill with ground water. The aquaria were treated with lime (Cao) to maintain the pH 7.5-8.0. Sweet potato powder contain 42% carbohydrate was used as carbohydrate source to maintain C: N ratio. Three stocking density of 2.0 nos/m$^2$, 4.0 nos/m$^2$, 6.0 nos/m$^2$ with BFT and Non BFT has been evaluated in glass aquaria.

The fish were feed with sinking pelleted feed 20% CP prepared with hand pelletizer at Fisheries division, Umami. The feeding rate was maintained at the rate of 2% body weight. The feed was prepared, dried and stored in polythene bags at low temperature. The sweet potato was procured from Barnihat, cut into pieces, dried powdered and stored in polythene bags at low temperature for further use.

The total initial biomass as well as individual weight were recorded for all the treatments. All the fishes were harvested after 60 days from aquaria. The fish were counted, individual weight and final biomass recorded after harvest. The survival, daily weight gain (DWG) was calculated by using the following formula:

1. Survival (%) = Final number of fish/Initial number of fish x 100.
2. DWG (g/ day) = (final mean weight-initial mean weight)/ culture days.

All water quality parameters were estimated by following APHA (1998) method. The statistical analysis of all data for water quality and growth parameter were performed with SPSS 16 software. Difference between mean were subject to one way ANOVA and duncan's multiple range test was considered as significant differences at $P < 0.05$.

## Results and discussion

### Water quality parameters in BFT and Non BFT system

The all-water quality parameters are presented in Table 1. There was a significant reduction ($p$<0.05) in total suspended solids (TSS), and FLoC volume among treatments. The TSS, FLoC volume and total heterotrophic bacterial count (THB) was higher in 6 nos/m$^2$ in BFT system. The biological oxygen demand (BOD) load and  count was highest in 6 nos/m$^2$ non BFT system. The transparency and water exchange rate were found lowest in 6 nos/m$^2$ in BFT system. The total ammonical nitrogen and phosphorus load was higher in non BFT compare to BFT at different stocking density. Periodic water exchange 10-30% was performed for all the stocking density in non BFT system. But for BFT system there was no water exchange in case of 2 and 4 nos/m$^2$ stocking density and for 6 nos/m$^2$ stocking density 10% water exchange performed.

Bio FLoC technology can increase stocking density and reduce water demand but periodic water change may require when TSS and BOD value cross the culture limit [13]. A clarifier is required for removal of total solids from bio FLoC system when TSS reach beyond 50ml/L. A vigorous aeration also required to keep the FLoC s in suspension, otherwise accumulation of sludge creates off flavor and water quality deteriorate [9].

Bio FLoC also reduces harmful bacterial growth and increases beneficial heterotrophic bacterial growth for shrimp [1]. Bio FLoC boost immune system against *Vibrio* species [14, 15]. The optimum stocking density with better survival was reported for tilapia 20-25 nos/m$^3$, shrimp 200PL/m$^3$ [8, 9] and prawn 6 PL/liter [11, 12].

In the study results suggest better performance of BFT at optimum stocking density (SD) of 4 nos/m$^2$ without any water exchange. A periodic water exchange and removal of total solids from culture system is required when SD increased beyond 4 nos/m$^2$ for common carp in indoor system.

### Growth parameters in BFT and Non BFT system

The survival was highest for 2 nos/m$^2$ in BFT system and lowest in 6 nos/m$^2$ in non BFT system (Table1). The daily growth rate (DWG) was not differing statistically among the treatments (Fig1).

The survival rate increases in BFT with high stocking density compare to non BFT system [1]. BioFLoC increase immunity against *Aeromononas hydrophila* in *Labeo rohita* [2]. The survival rate generally inversely proportional with stocking density. However, application of BFT, improves water parameter, therefore increase survival in medium stocking density without any water exchange [9]. In high stocking density (>500 nos/m$^3$) culture, the antioxidant, immunity and digestive enzyme depressed in shrimp, results low survival and slow growth [15].

The present study also described low survival with increasing stocking density both non BFT and BFT system. But the stocking density can be increased in double and survival rate by 10% with BFT for common carp without any adverse effect on growth rate.

**Table 1:** Water quality and growth parameters at stocking density

| Parameter | Non BFT | | | BFT | | |
|---|---|---|---|---|---|---|
| | **2.0 nos/m$^2$** | **4.0 nos/m$^2$** | **6.0 nos/m$^2$** | **2.0 nos/m$^2$** | **4.0 nos/m$^2$** | **6.0 nos/m$^2$** |
| **Water quality parameters** | | | | | | |
| TSS (mg/L) | 110.0±10.0$^a$ | 150.0±5.77$^b$ | 210.0±5.77$^c$ | 156.67±6.67$^b$ | 260.0±10.0$^d$ | 348.33±1.67$^e$ |
| FV (ml/L) | 4.5± 0.5$^a$ | 7.8± 0.17$^b$ | 12.67± 0.67$^c$ | 10.17± 0.17$^d$ | 17.83± 0.17$^e$ | 29.83± 0.44$^f$ |
| BOD (mg/L) | 12.0± 2.0$^b$ | 18.0± 1.15$^c$ | 39.33± 0.67$^e$ | 5.0± 0.58$^a$ | 9.67± 0.88$^b$ | 21.0± 0.58$^d$ |
| Transparency (cm) | 27.5± 2.50$^b$ | 15.0± 2.89$^a$ | 14.0± 1.0$^a$ | 15.33± 2.0$^a$ | 12.0± 1.15$^a$ | 10.0± 1.15$^a$ |
| Water exchange (%) | 11.0± 1.0$^b$ | 21.67± 1.67$^c$ | 29.33±0.67$^d$ | 0±0$^a$ | 0±0$^a$ | 10.0± 0.01$^b$ |
| TAN (µg/ml) | 1.3±0.20b | 2.2±0.12$^c$ | 3.23±0.15$^d$ | 0.5±0.06$^a$ | 0.8±0.12$^a$ | 2.33±0.18$^c$ |
| $PO_4$-P (µg/ml) | 0.35±0.15$^a$ | 2.1±0.10$^c$ | 3.07±0.18$^d$ | 1.27±0.18$^b$ | 1.83±0.38$^{bc}$ | 3.2±0.12$^d$ |
| THB (cfu/ml) | 37.50±2.50$^a$ | 89.20±2.08$^b$ | 150.67±0.67$^d$ | 42.33±1.45$^a$ | 111.00±2.08c | 204.20±3.05$^e$ |
| *Aeromonas* (cfu/ml) | 0.35±0.15$^a$ | 0.67±0.07$^b$ | 1.83±0.17$^c$ | 0.11±0.006$^a$ | 0.17±0.02$^a$ | 0.21±0.006$^a$ |
| **Growth parameters** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Initial mean weight (g) | 9.5±0.5[a] | 10.67±0.33[a] | 9.67±1.20[a] | 10.0±0.58[a] | 10.68±0.88[a] | 10.33±0.33[a] |
| Final mean weight (g) | 11.50±0.5[a] | 12.33±0.88[ab] | 12.67±0.67[b] | 14.67±0.33[ab] | 15.0±0.58[b] | 14.33±1.20[b] |
| DWG | 0.21±0.12[a] | 0.06±0.02[a] | 0.12±0.04[a] | 0.11±0.06[a] | 0.14±0.03[a] | 0.13±0.04[a] |
| Survival (%) | 90.00±0.01[d] | 71.33±0.67[c] | 60.00±0.01[a] | 100.00±0.01[f] | 95.00±0.01[e] | 70.00±0.01[b] |

**Fig1:** Common carp grown non bioFLoC (a) and bioFLoC (b) system

## Conclusion

The result concludes that bio FLoC system can reduces the water consumption by purifying water through nutrient recycling. The present study indicates that the addition of sweet potato produces good quality bio FLoC, improves water quality as well as reduces water exchange rate. The stocking density can be increase by three times and water consumption reduces by 20% by applying bio FLoC system compared to non-bio FLoC system. The optimum stocking density found 4 no's/m$^2$ with 95% survival and zero water exchange.

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