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Effect of carbon sources and water requirement in rearing of genetically improved farmed tilapia (*Oreochromis niloticus*) fry in biofloc system

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Abstract
A 90 days experiment with completely randomized design was carried out to evaluate the effect of different carbon sources on biomass production and water volume requirement in rearing of GIFT tilapia fry in biofloc system. Seven treatments *viz,* sugar cane molasses (T_1), sugar (T_2), jaggery (T_3), wheat flour (T_4), wheat bran (T_5), rice bran (T_6) and control (T_0) were used. Tilapia fry (initial biomass 14.27± 0.07g) were stocked in 110L capacity FRP tanks. Results showed that all the water quality parameters were within the acceptable range for tilapia fry rearing. A significantly higher biomass was found in T_6, but not significantly different from T_1 and T_2 after 90 days. At the end of experiment, a significantly lower water volume requirement was recorded in T_6. Therefore, it is suggested that rice bran can be a better source of carbon for rearing of GIFT tilapia fry in biofloc system.

Keywords: Carbon sources, biofloc, biomass, water requirement, GIFT tilapia

Introduction
Aquaculture is an important food-producing sector, which has the capacity along with agriculture to fulfil the demand of food of increasing population. The expansion of aquaculture is restricted due to scarcity of land and water, which can be resolved with the intensification of aquaculture.

However, intensified aquaculture systems are facing problems such as water quality issues like accumulation of ammonical products, high cost of feed and eutrophication of environment. The biofloc technology (BFT) was suggested as one of the efficient technology to overcome these problems; which uses minimum water, discharges less waste and minimises use of artificial feed [1, 2, 3]. Microbes play key role in the biofloc systems. Microbes associated with floc after consumption help to improve digestion, reduce FCR, reduces dietary protein level and heterotrophic bacteria, which together probiotic bacteria, inhibit the development of potential pathogen bacteria [4].

In the biofloc technology, finfishes such as rohu [5], common carp [6], cat fishes [7] and tilapia [8] are commonly cultured species. Among these, tilapia is one of the candidate species, which is a second largest cultivated group of fish next to carps [9]. There are about 100 species of tilapia, most of them are native to Western African rivers [10] of which, Nile tilapia (*Oreochromis niloticus*) is most widely cultured species in the world. Recently, the Genetically Improved Farmed Tilapia (GIFT) strain of Nile tilapia is an important species for aquaculture worldwide because of its better growth rate, high production, good disease resistance, high market value etc. However, the information on effect of carbon sources on biomass production and water requirement in rearing of GIFT fry using biofloc system is very limited.

BFT is a low or zero water exchange system. In BFT, heterotrophic microorganisms assimilate ammonium nitrogen and convert it into microbial protein [2, 11], which results into maintenance of the water quality. Volume of water requirement is relatively less in BFT. Therefore, the present study was undertaken to evaluate effect of different carbon sources on biomass production and water requirement for GIFT, *O. niloticus* fry in biofloc system.

Materials and Methods

Experimental fish

The fry of GIFT were procured from the Rajeev Gandhi Centre for Aquaculture, Andhra Pradesh. The fishes were acclimatized at laboratory condition for 15 days and fed with commercial feed containing 40% protein (Growel feeds Pvt. Ltd. Andhra Pradesh, India) twice a day [12].

Experimental design

The experiment was conducted for 90 days of duration.as per completely randomized design (CRD) with seven treatments *viz*, sugar cane molasses (T_1), sugar (T_2), jaggery (T_3), wheat flour (T_4), wheat bran (T_5) and rice bran (T_6) and control (T_0) with three replicates each. The fishes (Initial biomass 14.27± 0.07g) were stocked in FRP circular tanks of 110L capacity and fed @ 10% of body weight twice a day for first 15 days and @ 8% and 6% of body weight for next 30 days and for 45 days, respectively [13].

Development of biofloc

Biofloc was developed [11] separately using 2nos. of FRP tank of 110L capacity for each carbon source. Before the fishes were stocked, 60L of developed inoculum of biofloc and 40L freshwater were added in BFT treatments, whereas in control 100L of freshwater was added. The vigorous aeration was supplied in all experimental tanks. The daily amount of carbon sources were estimated [14].

Water quality parameters

Water quality parameters such as pH, temperature, dissolved oxygen, total alkalinity, total hardness, total ammonia-N, nitrite-N and nitrate-N were recorded during the experiment [15]. Floc volume was measured [16]. An amount of 100 ml of water sample was collected from each experimental tank and filtered through pre-dried and weighed Glass Fibre (GF/C) filter paper using Micropore vacuum filter.

Estimation of biomass

Before stocking, initial length and weight of fishes were recorded. After 30 days interval, 15 numbers of fishes were collected from each replicate and weight was recorded. At the same time, total numbers of fishes were recorded in each tank and biomass was calculated. The survival (%) was calculated [17].

Sludge removal and water volume requirement

For first 30 days, there was no removal of floc in all the experimental tanks. When uptake of biofloc by fish was insufficient, there was accumulation of floc in the tank. Therefore, regular removal of floc was carried out to maintain the TSS level. The excess floc was removed to maintain TSS level below 400mgL^{-1}. In control tank, daily siphoning was carried out and 10% water was replaced with fresh water. The quantity of water added was recorded in each replicate of treatments. Water volume requirement for biomass production in each treatment was estimated after 90 days.

Statistical analysis

The data such as biomass (g) and water volume requirement (L) were analysed by One-way Analysis of Variance (ANOVA). Differences were considered significant at $p< 0.05$. If difference was found significant, the means were compared by Tukey's test. The statistical analysis was performed [18].

Results

Water quality parameters

The temperature (°C) was found in the range of 22.7±0.00 to 27±0.00°C, while the pH (7.67±0.04 to 8.08±0.01), dissolved oxygen (5.20±0.23 to 7.60±0.23mgL^{-1}), total alkalinity (36.67±4.41 to 121.67±6.0mgL^{-1}), total hardness (72.00±2.00 to 91.00±5.20 mgL^{-1}), total ammonia-N (0.12±0.01 to 0.86±0.01mgL^{-1}), nitrite-N (0.05±0.02 to 0.27±0.02 mgL^{-1}) and nitrate-N (1.17±0.21 to 9.87±0.2mgL^{-1}) were within the acceptable range during the experimental period. The values of total suspended solids were ranged from 80.33±3.33 to 378.33±14.81 mgL^{-1} in the biofloc treatments. In control, total suspended solids were ranged from 0 to 3.00±0.01 mgL^{-1}. The floc volume was ranged from 12.00 ±1.15 to 24.00±1.76mlL^{-1} in the biofloc treatments while in control; it was below 0.5mlL^{-1}.

Biomass production

The average biomass (g) in a biofloc treatments and in control at the end of 30, 60 and 90 days is given in Table 1 and depicted in Fig. 1. One-way ANOVA revealed the significant difference ($p< 0.05$) in the biomass (g) by using different carbon sources and in control. Tukey's test showed a significantly higher ($p< 0.05$) biomass in T_6 than in T_0, but not significantly different than other treatments at the end of 30 and 60 days of experimental period. After 90 days, Tukey's test showed a significantly higher biomass in T_6, but not significantly different from T_1 and T_2 treatments. One-way ANOVA showed no significant difference (p>0.05) between the survival of fishes (88.00±0.00 - 96.00±0.00) in different treatments after 90 days.

Table 1: Average biomass after 30, 60 and 90 days

Days	Treatments						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6
30	58.42±0.46^b	66.42±0.17^a	65.87±0.87^a	66.28±0.92^a	66.25±1.98^a	66.00±0.76^a	69.67±2.83^a
60	213.17±10.08^b	281.60±6.55^a	283.17±8.28^a	274.27±8.34^a	276.00±5.54^a	275.87±8.20^a	284.00±3.49^a
90	345.84±13.78^c	461.76±1.03^{ab}	462.17±7.94^{ab}	453.31±7.64^b	459.52±10.84^b	456.55±13.10^b	504.80±3.97^a

The values are expressed as mean ± standard error (SE). Values in the same row with different superscripts are significantly different at $p< 0.05$.

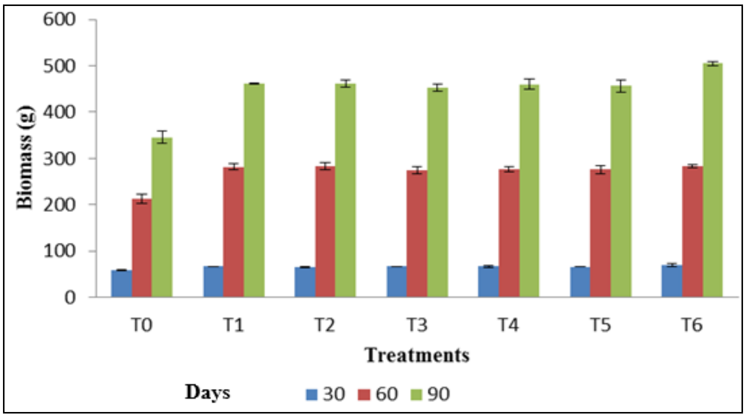

Fig 1: The average biomass (g) in a biofloc treatments and in control at the end of 30, 60and 90days

Water requirement

The volume of water required for production of tilapia biomass is given in Table 2. One-way ANOVA revealed the significant difference ($p< 0.05$) in water volume requirement by using different carbon sources and control. Tukey's test showed a significantly lower water volume requirement in T_6 than other treatments, but it was not significantly different than T_4 and T_5 treatments.

Table 2: Water requirement (L) at the end of experiment

Sr. No.	Treatments	Vol. of water required (L) for biomass production
1	Control (T_0)	1000.00 ± 0.00^{a}
2	Molasses (T_1)	126.67 ± 1.67^{b}
3	Sugar (T_2)	126.67 ± 1.67^{b}
4	Jaggery (T_3)	123.33 ± 1.67^{bc}
5	Wheat flour (T_4)	118.33 ± 1.67^{cd}
6	Wheat bran (T_5)	116.67 ± 1.67^{cd}
7	Rice bran (T_6)	113.33 ± 1.67^{d}

The values are expressed as mean ± standard error (SE). Values in the same column with different superscripts are significantly different at $p< 0.05$.

Discussion

Water quality parameters

The pH values (7.67±0.01-8.08±0.01) and the dissolved oxygen values (5.20±0.23-7.60±0.23) reported in the present study were within the acceptable range for tank culture of tilapia [19]. The alkalinity values reported in present study was suitable for tilapia rearing [20]. The total hardness values were in the suitable range for culture of tropical fish [15]. The total ammonia values reported in the present study were suitable for tilapia culture [20]. The ammonia concentration found in present study was within the range reported earlier for Nile tilapia fry (0.13 to 2.4 mgL^{-1}) in biofloc systems [21]. The desired concentration of nitrite and nitrate in the water was less than 0.3 mgL^{-1} and 0.2 to 10 mgL^{-1}, respectively in aquaculture [22]. The similar range of nitrite and nitrate were reported in the present study. The values of TSS reported in present study were within the range reported earlier for Nile tilapia fry [21]. The floc volume range was similar to reported earlier for rearing tilapia fry in biofloc system [21].

Biomass production

In the present study, after 90 days a significantly higher biomass was recorded in rice bran biofloc treatment than other BFT treatments and control, but did not significantly differ from molasses and sugar based biofloc treatments. The higher nutritional value especially protein content in rice bran based biofloc was reported earlier, but it was not significantly different than molasses based biofloc treatment [23]. The biofloc was utilized as a feed by fishes [2] in addition to supplied feed in BFT treatments, which might have contributed for higher growth as well as higher biomass of fishes. Similar to present study, the higher biomass of *O. niloticus* fish in biofloc treatments as compared to fish reared in clear water were reported [24] and the two different carbon sources rice bran and wheat meal based by-product were significantly better for rearing of *O. niloticus* fingerlings compared to clear water rearing [25].

Water requirement

The amount of water in BFT treatments was between 113.33 and 126.67 L for biomass production, with a significantly lower water volume requirement in T_6 treatment. In the control, it was 1000L for biomass production. The simple carbohydrates such as molasses, sugar and jaggery degraded fastly as compared to wheat flour, wheat bran and rice bran, which are more complex carbohydrates. Faster degradation of simple carbohydrate (molasses, sugar and jaggery) might have provided higher levels of carbon as a substrate for heterotrophic bacteria [26], which resulted into increase in TSS and floc level earlier than wheat flour, wheat bran and rice bran based treatments. Therefore, floc was removed regularly in these treatments and the volume of water required was more as compared to wheat flour, wheat bran, and rice bran based biofloc treatments. Similar to these findings, the higher amount of water reported in sugar based biofloc treatments than wheat flour and corn flour based biofloc treatment for tilapia fingerling production [27]. In control group, 10% of water exchange was carried out daily, which resulted into higher volume of water requirement. At least 10-15% water exchange was required in well-aerated tanks to maintain the optimum water quality in intensive tank culture of tilapia [28]. Similar to findings of present study, less water requirement for rearing of tilapia and rohu fry in biofloc treatment than control was reported earlier [27, 29].

Conclusions

The biomass obtained in rice bran based biofloc treatment was similar with molasses and sugar based biofloc treatments, but there is a significant saving in water in rice bran based biofloc treatment as compared to control (886.67L), molasses, and sugar based biofloc treatments (13.34L). Therefore, the results suggested that rice bran as a better source of carbon for rearing of GIFT tilapia fry in biofloc system.

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References

1. Wasielesky W, Atwood H, Stokes A, Browdy CL. Effect of natural production in a zero exchange suspended microbial floc based super-intensive culture system for white shrimp *Litopenaeus vannamei*. Aquaculture. 2006; 258:396-403. https://doi.org/10.1016/j.aquaculture.2006.04.030.
2. Avnimelech Y. Feeding with microbial floc by tilapia in minimal discharge bioflocs technology ponds. Aquaculture. 2007; 264:140-147. https://doi.org/10.1016/j.aquaculture.2006.11.025
3. Mishra JK, Samocha TM, Patnaik S, Speed M, Gandy RL, Ali AM *et al*. Performance of an intensive nursery system for the Pacific white shrimp, *Litopenaeus vannamei*, under limited discharge condition. Aquacultural Engineering. 2008; 38:2-15. https://doi.org/10.1016/j.aquaeng.2007.10.003
4. Wasave SS, Chavan BR, Naik SD, Wasave SM, Pawase AS, Tibile RM *et al.* Role of microbes in biofloc systems: a review. Journal of Experimental Zoology in India. 2020; 23(1):903-906.
5. Irshad Ahmad H, Verma AK, Babitha Rani AM, Rathore G, Saharan N, Gora AH *et al*. Growth, non-specific immunity and disease resistance of *Labeo rohita* against *Aeromonas hydrophila* in biofloc systems using different carbon sources. Aquaculture. 2016; 457:61-67.
6. Bakhshi F, Najdegerami EH, Manaffar R, Tokmechi A, Farah KR, Jalali AS *et al*. Growth performance, haematology, antioxidant status, immune response and histology of common carp (*Cyprinus carpio* L.) fed biofloc grown on different carbon sources - Bakhshi - 2018 - Aquaculture Research - Wiley Online Library [WWW Document]. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/are.13469 (accessed 6.20.20)
7. Romano N, Dauda A, Ikhsan N, Karim M, Kamarudin M. Fermenting rice bran as a carbon source for biofloc technology improved the water quality, growth, feeding efficiencies, and biochemical composition of African catfish *Clarias gariepinus* juveniles. Aquaculture, 2018. Research. https://doi.org/10.1111/are.13837
8. Azim E, Little D. The biofloc technology (BFT) in indoor tanks: Water quality, biofloc composition, and growth and welfare of Nile tilapia (*Oreochromis niloticus*). Aquaculture. 2008; 283:29-35. https://doi.org/10.1016/j.aquaculture.2008.06.036
9. Bhujel RC. A Manual for Tilapia Business Management - Ram C. Bhujel - Google Books [WWW Document]. 2014. URL https://books.google.co.in/books/about/A_Manual_for_Tilapia_Business_Management.html?id=p8aWBAAAQBAJ&redir_esc=y (accessed 6.20.20).
10. Avnimelech Y. C/N ratio as a control element in aquaculture systems. Aquaculture. 1999; 176:227–235.
11. Hargreaves JA. Photosynthetic suspended-growth systems in aquaculture. Aquacultural Engineering, Design and Selection of Biological Filters for Freshwater and Marine Applications. 2006; 34:344-363. https://doi.org/10.1016/j.aquaeng.2005.08.009
12. Hafedh YSA. Effects of dietary protein on growth and body composition of Nile tilapia, *Oreochromis niloticus* L. Aquaculture Research. 1999; 30:385-393. https://doi.org/10.1046/j.1365-2109.1999.00343.x
13. Chowdhury DK. Optimal feeding rate for Nile tilapia (*Oreochromis niloticus*). MScThesis. Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences, 2011, 76.
14. De Schryver P, Crab R, Defoirdt T, Boon N, Verstraete W. The basics of bio-flocs technology: the added value for aquaculture. Aquaculture. 2008**; 277**:125-137.
15. Boyd CE. Water Quality in Warmwater Fish Ponds. Auburn University, Agricultural Experiment Station, 1979.
16. Avnimelech Y, Kochba M. Evaluation of nitrogen uptake and excretion by tilapia in biofloc tanks, using N-15 tracing. Aquaculture. 2009; 287:163-168.
17. Long L, Yang J, Li Y, Guan C, Wu F. Effect of biofloc technology on growth, digestive enzyme activity, hematology, and immune response of genetically improved farmed tilapia (*Oreochromis niloticus*). Aquaculture. 2015; 448:135–141. https://doi.org/10.1016/j.aquaculture.2015.05.017
18. SAS 9.3. Statistical Analysis System. Users Guide Statistics, SAS Institute Inc. Cary, North Carolina, USA, 2002.
19. De Long DP, Losordo TM, Rakocy JE. Tank Culture of Tilapia, 2009. SRAC Publication No. 282
20. Lucas JS, Southgate PS. Aquaculture: Farming Aquatic Animals and Plants, 3rd Edition, 2012. https://www.wiley.com/enus/Aquaculture%3A+Farming+Aquatic+Animals+and+Plants%2C+3rd+Edition-p-9781119230861 (accessed 6.21.20).
21. Liu G, Ye Z, Liu D, Zhao J, Sivaramasamy E, Deng Y *et al.* Influence of stocking density on growth, digestive enzyme activities, immune responses, antioxidant of *Oreochromis niloticus* fingerlings in biofloc systems. Fish & Shellfish Immunology. 2018; 81:416-422.
22. Boyd CE. Water quality in ponds for aquaculture. Research and Development Series. Number 43. International Centre for Aquaculture and Aquatic Environments. Alabama Agricultural Experimental Station, Auburn University, Alabama, 1998.
23. Becerril-Cortés D, Monroy-Dosta MDC, Emerenciano MGC, Castro-Mejía G, Bermúdez BSS, Correa GV *et al.* Effect on nutritional composition of produced bioflocs with different carbon sources (Molasses, coffee waste and rice bran) in Biofloc system. International Journal of Fisheries and Aquatic Studies. 2018; 6(2):541-547.
24. Haridas H, Verma AK, Rathore G, Prakash C, Bannerjee Sawant P, Babitha Rani AM *et al*. Enhanced growth and immuno-physiological response of Genetically Improved Farmed Tilapia in indoor biofloc units at different stocking densities, 2017. |Request PDF [WWW Document]. ResearchGate. http://dx.doi.org/10.1111/are.13256
25. Mansour AT, Esteban MÁ. Effects of carbon sources and plant protein levels in a biofloc system on growth performance, and the immune and antioxidant status of Nile tilapia (*Oreochromis niloticus*), 2017. |Request PDF [WWW Document].URL https://www.researchgate.net/publication/314981105_Effects_of_carbon_sources_and_plant_protein_levels_in_a_biofloc_system_on_growth_performance_and_the_immu

ne_and_antioxidant_status_of Nile_tilapia_*Oreochromis_niloticus*

26. Khanjani MH, Mir Masoud Sajjadi MM, Morteza Alizadeh M, Sourinejad I. Nursery performance of Pacific white shrimp (*Litopenaeus vannamei* Boone, 1931) cultivated in a biofloc system: the effect of adding different carbon sources. Aquaculture Research. 2017; 48:1491-1501.
27. García-Ríos L, Miranda-Baeza A, Coelho-Emerenciano MG, Huerta-Rábago JA, Osuna-Amarillas P. Biofloc technology (BFT) applied to tilapia fingerlings production using different carbon sources: Emphasis on commercial applications. Aquaculture. 2019; 502:26-31. https://doi.org/10.1016/j.aquaculture.2018.11.057
28. Rakocy JE. Tank culture of tilapia. SRAC Publication No. 282, 1989.
29. Sawant KS. Production of *Labeo rohita* (Hamilton) fingerling in biofloc system using various dietary protein levels. M.F.Sc. Thesis. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, India, 45pp (unpublished), 2018.