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The Use of Biochar in the Production of Tilapia (*Oreochromis niloticus*) in a Biofloc Technology System - BFT

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Introduction

One major water quality issue in aquaculture and specifically BFT systems is the accumulation of ammonia and its derivatives in the water, which in several ways affect the growth performance of the cultured fish. Biochar refers to the solid product of organic material pyrolysis, a process by which an organic material is heated to temperatures greater than or equal to 300°C under oxygen-limited conditions (Figure 1). Research shows that biochar is capable of removing ammonia from aquaculture water. It has also been reported to be a good adsorbent for environmental contaminants including heavy metals as well as nitrogenous compounds: ammonia, nitrates, nitrites etc . Biochar is said to be a stable and rich source of carbon, although a large part of this carbon is said to be recalcitrant and thus could be applied in BFT as a solid carbon source for water quality control.

Objective

Investigate the effects of biochar as a water quality control agent and an alternative carbon source in biofloc technology system

Experimental Set up

Two biochar treatments were employed, including one control i.e. B; only biochar, GB; biochar + glucose, while for the control (G) only glucose was added (Figure 1)

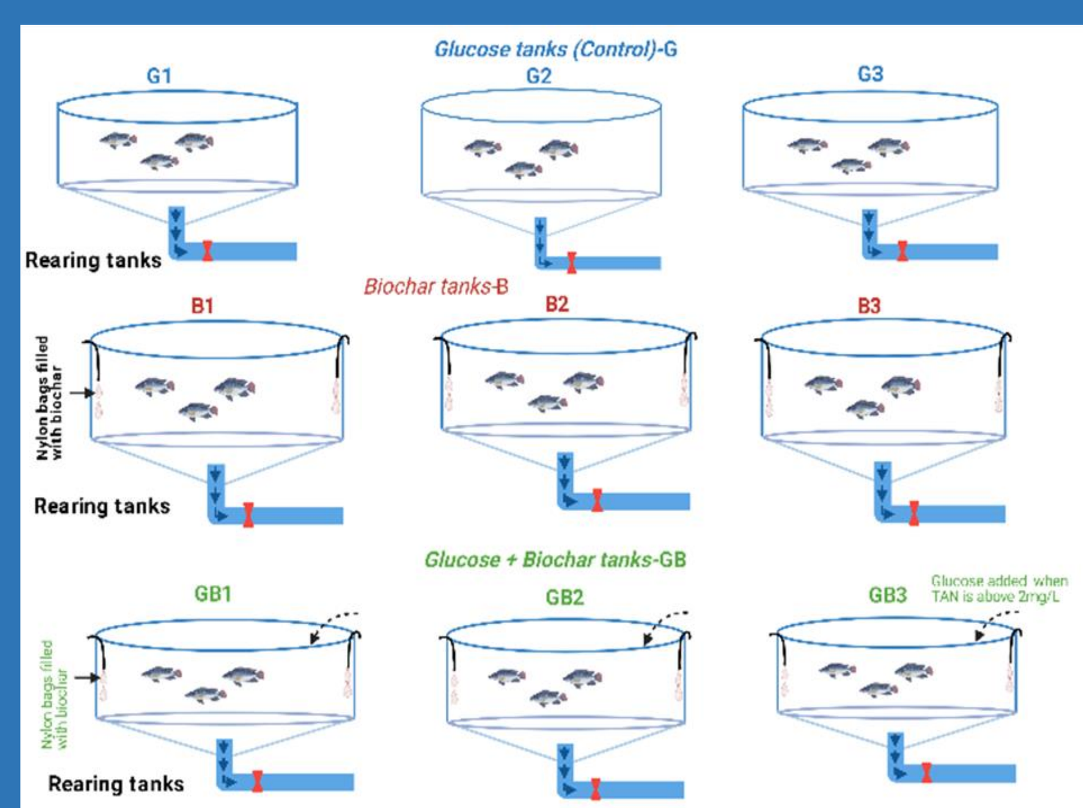

Figure 1. Schematic representation of the experimental set up.

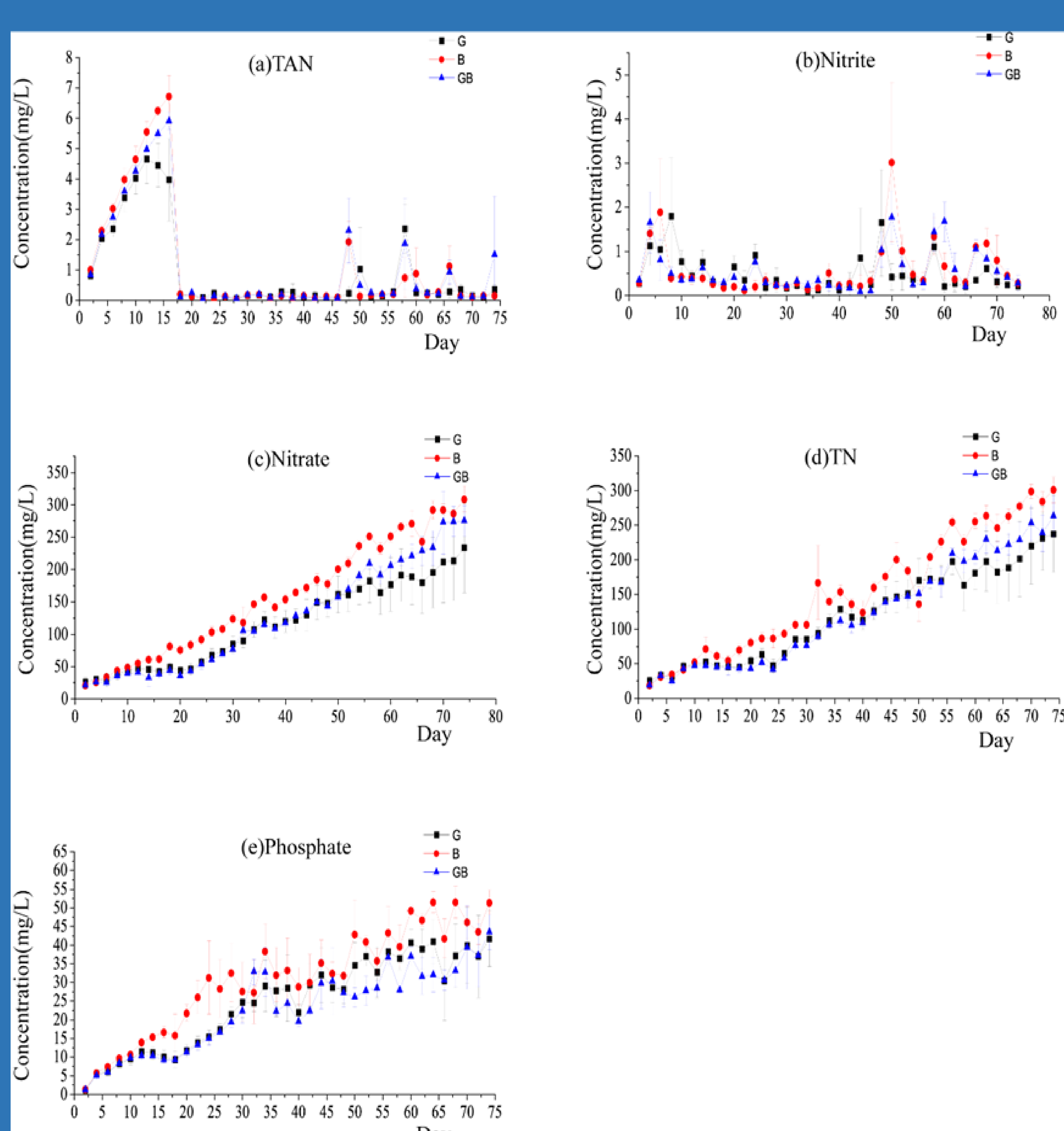

Figure 2. Changes in total ammonia nitrogen (TAN) (a), Nitrite nitrogen (NO_2^-) (b), Nitrate nitrogen (NO_3^-) (c), Total Nitrogen (TN)(d) and Phosphate (PO_4^{3-}) (e) during the 74 day experimental period.

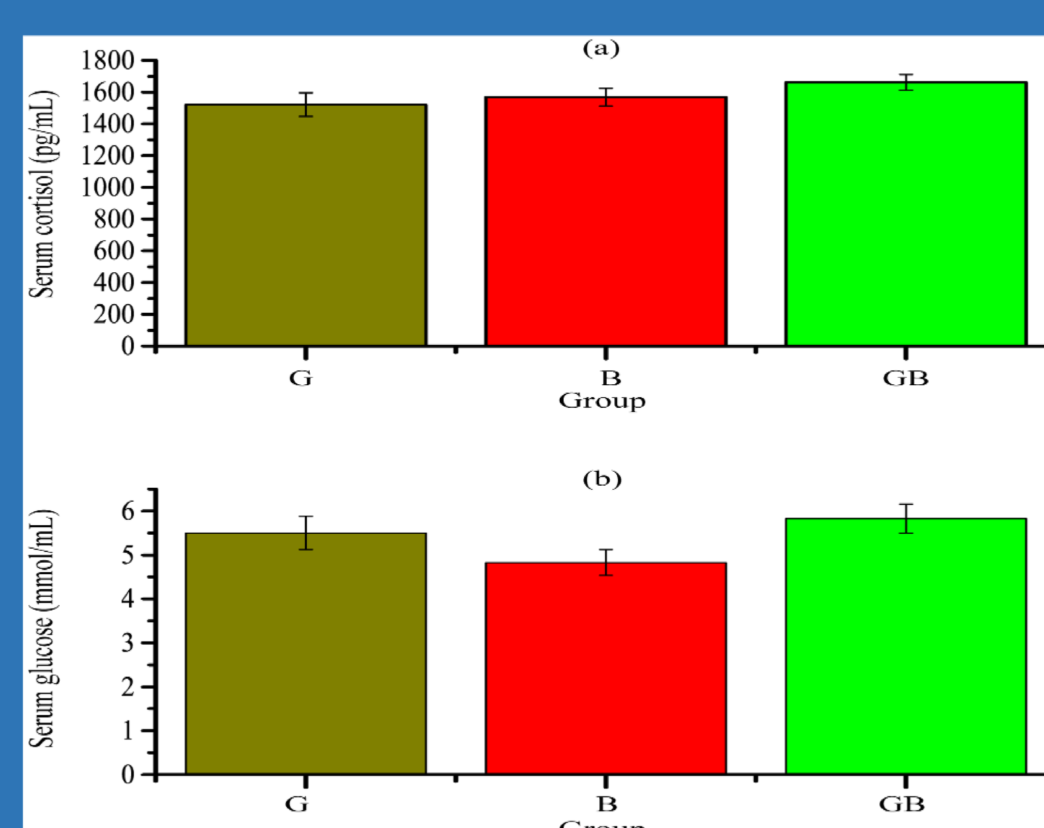

Figure 3. Concentrations of serum cortisol (a) and glucose (b) measured at the end of the experiment from tilapia serum samples from the three treatments (G, B and GB)..

Table 1. **Summary table for temperature, pH, dissolved oxygen (DO), total suspended solids (TSS) and alkalinity monitored over the experimental period for the three biofloc systems (G, B and GB).**

Parameter		G	B	GB
Temperature (°C)	means	26.22 ± 0.23	26.40 ± 0.23	27.12 ± 0.27
	min, max	22.70, 28.83	23.23, 29.20	23.40, 29.93
PH	means	7.42 ± 0.56	7.33 ± 0.56	7.44 ± 0.50
	min, max	6.74, 8.02	6.62, 8.14	6.79, 8.11
DO (mg/L)	means	5.99 ± 0.10^b	6.66 ± 0.12^a	6.53 ± 0.56^a
	min, max	4.46, 7.28	5.36, 7.79	5.07, 7.60
TSS (mg/L)	means	665.18 ± 54.46^a	597.16 ± 49.62^b	505.27 ± 37.44^c
	Min, max	156.00, 1621.67	110.67, 1399.00	129.67, 964.33
Alkalinity (mg/L)	means	156.47 ± 5.17^a	137.92 ± 3.83^b	146.44 ± 3.87^b
	Min, max	93.80, 219.43	92.13, 200.20	91.29, 190.19
BFV (mL/L)	means	53.64 ± 5.18^a	25.74 ± 3.01^b	35.58 ± 2.81^b
	min, max	2.25, 104	1.20, 68.67	6.13, 74.67

Table 2. Tilapia growth performance and utilization of feed in the three (3) biofloc systems considered in the study determined at the end of the trial

Parameter	G	B	GB
Initial mean weight (g)	36.2	36.2	36.2
Initial number (fish/ tank)	100	100	100
Survival (%)	86.33 ± 3.06	93.50 ± 4.95	88.67 ± 3.06
Specific growth rate (%/day)	1.09 ± 0.01	0.83 ± 0.13	0.98 ± 0.14
Weight gain (%)	186.65 ± 7.63	167.10 ± 6.37	176.04 ± 17.14
Total weight gain (kg/ m^3)	22.40 ± 0.92	20.16 ± 0.77	21.24 ± 2.07
Food conversion rate (FCR)	1.26 ± 0.01	1.32 ± 0.03	1.30 ± 0.13
Mean Weight Gain (g)	77.83 ± 0.45	64.85 ± 5.90	71.89 ± 7.00

Results and Discussion

Biochar application to the biofloc system resulted in the following effects:

- Levels of $NO3^-$ and total nitrogen (TN) were significantly higher in group B compared to G and GB. Also, significant difference was observed in PO_4^{3-} levels between B (30.81 ± 2.28 mg/L) and GB (22.70 ± 1.84 mg/L). The dynamics of the water quality parameters revealed that heterotrophic assimilation and nitrification were active in maintaining the water quality (Figure 2).
- Significant reduction ($p < 0.05$) in dissolved oxygen (DO) level was observed in group G (5.99 ± 0.10 mg/L) compared to B (6.66 ± 0.12 mg/L) and GB (6.53 ± 0.56 mg/L). Notably, concentrations of total suspended solids (TSS) were signficantly lower in the biochar treatments (B and GB) compared to the control (G). Additionally, alkalinity was significantly higher in G (156.47 ± 5.17 mg/L) compared to B (137.92 ± 3.83 mg/L) and GB (146.44 ± 3.87 mg/L) (Table 1).
- Overall, the result showed no significant differences ($p > 0.05$) in all the fish growth parameters (Table 2).
- Notably, no significant difference were detected in serum cortisol in tilapia among all the treatment groups (Figure 3a). Similarly, for the serum glucose levels, there was no significant difference among all groups (Figure 3 b).
- Due to the slow carbon releasing ability of biochar, and the higher solubility associated with glucose, in which both properties could be advantages and disadvantages at certain times, strategies to explore the effects of their combined application is promising.

Concussion:

The study demonstrated that biochar is suitable for application in tilapia-based BFT systems as a solid carbon for controlling the toxic effects of nitrogen compounds.

Biochar application will promote infrequent supervision observed for the biochar treatment and the positive effect on TSS accumulation

Generally, there were no notable detrimental effects of biochar application on fish growth and physiological performance.

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Further Research:

Further, future studies should focus on establishing the optimal application strategy of biochar in BFT systems.

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