
**EFFECTS OF BIOFLOC TECHNOLOGY ON GROWTH PERFORMANCE OF NILE
TILAPIA (*Oreochromis Niloticus*)
FINGERLINGS AND MICROBIAL COLONIZATION IN THE SYSTEM.**

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ABSTRACT

Aquaculture intensification is characterized by high stocking density and need of high quality and quantity of artificial feed. Increased fish biomass and feed input brings about rapid deterioration of water quality hence a water quality management system need to be put in place in such systems. Biofloc technology has been developed as a viable option to recycle nutrient by maintaining a high carbon/nitrogen (C/N) ratio in the water in order to stimulate heterotrophic bacterial growth which converts ammonia into useful microbial biomass. This study investigated the effect of carbon source supplement in biofloc system on growth performance, water quality and microbial community in the system. The experimental research was conducted at the University of Eldoret from June - September 2017. A complete randomized design was used in triplicate treatments. The supplementation carbon source constituted molasses, wheat flour, potatoes flour and control respectively. At molasses carbon added treatments Nile tilapia indicated the highest significant growth at ($p < 0.05$) than other treatments with final mean weights (8.774 ± 0.394 g) and total length (7.956 ± 0.123 cm). The least growth of Nile tilapia fingerlings was at control treatments with final mean (3.784 ± 0.215 g, 5.827 ± 0.114 cm) weights and length respectively. Molasses added biofloc exhibited highest protozoan (520.13 ± 1.02), rotifers (200.6 ± 1.08), cyanobacteria (143.1 ± 1.22) and diatoms (60.033 ± 0.083) and improved water quality as compared to other treatments. The results revealed that molasses added in biofloc system improves Nile tilapia growth, microorganism colonization and water quality in the system than other carbon added treatment tested. The study recommends molasses carbon source for Nile tilapia fingerlings growth as it pertaining to the improved results of microorganism levels and water quality obtained in the system.

Keywords: Nile tilapia, Biofloc, Microorganism, Water quality

1. INTRODUCTION

Aquaculture intensification is characterized by high stocking density and need of high quality and quantity of artificial feed (1). Increased fish biomass and feed input brings about rapid deterioration of water quality hence a water quality management system need to be put in place in such systems. Authors (2) demonstrated the first option to solving this problem as Continuous replacement of culture water with fresh water but this needed large volume of water for aquaculture systems per day. Recalculating aquaculture systems became the second approach but again this technique is facing a challenge due to high costly in terms of capital investment and labour (3). Hence biofloc technology has been developed as a viable option. Biofloc technology focuses on an efficient use of nutrient input with no water exchange. The main principle of biofloc technology is to recycle nutrient by maintaining a high carbon/nitrogen (C/N) ratio in the water in order to stimulate heterotrophic bacterial growth which converts ammonia into microbial biomass (4).

The microbial biomass aggregates with other microorganisms and particles suspended in the water forming biofloc which eventually is consumed directly by the cultured fish or harvested and processed as a feed ingredient as was suggested by (5). According to (7), the feed efficiency of biofloc system increases hence the feed conversion ratio of the fish farmed using biofloc technology is better compared to conventional methods. The authors (8) also reported that addition of biofloc can reduce total feed cost and also improves the water quality resulting in accelerated growth of the cultured organisms (9).

The choice of an organic carbon source is dependent on the availability of a cheap carbohydrate near to where the BFT system is located (10). Different sources of locally produced carbohydrates has been used such as wheat bran (11), molasses (12), glucose (13), cellulose (14), potato flour and cassava meal, sorghum meal (15), wheat flour and corn/maize meal (16). Although some studies have been done on biofloc system using one carbon source at a time, according to 17), production of floc using different carbon sources needs further investigations hence this study was conducted to fill this gap. The study was aimed at investigating the effects of biofloc technology on growth performance of *Oreochromis niloticus*, water quality and the composition of biofloc organisms in fish rearing tanks.

2. MATERIALS AND METHODS

2.1 Experimental Design

The experiment was carried out using plastic tanks (100 L capacity each). Four treatments (each with 3 replicates) was compared. Biofloc produced using wheat flour as carbon source (Treatment TL 2), biofloc produced using potato flour as carbon source (Treatment TL 1), biofloc produced using molasses as carbon source (Treatment TL 3) and a plastic tank with no carbon added served as control. Systematic random design was employed in the arrangement of experimental tanks such that experimental tanks 1, 2, 3 and 4 were designated as Control, TL 1, TL 2 and TL 3 respectively while tanks 5, 6, 7 and 8 were assigned Control, TL 1, TL 2 and TL

3 in that order and tanks 9, 10, 11 and 12 were designated as Control, TL 1, TL 2 and TL 3 following similar sequence.

All Carbon source were added at a rate of 50% of feed applied to each biofloc treatment to maintain an optimum C: N ratio for bacteria (18; 19). All the culturing tanks had central air diffuser to assure particle continuous movements and suspension.

2.2 Source of fish

300 sex reversed *Oreochromis niloticus* fingerlings were obtained from University of Eldoret Fish Farm. The fish were harvested using seine net and were counted by use of volumetric method. They were held in a plastic tanks for two days to empty their gut content. Sodium chloride (NaCl) was added to the plastic tanks by dissolving common table salt at a rate of 0.05% of water volume. Before stocking, fish were disinfected by bath treatment of 5ppm potassium permanganate (KMnO₄) for 30 minutes as was recommended by (20). The mean weight and length of fish recorded during stocking were 3.0156 ± 0.07 cm and 0.4489 ± 0.228 g respectively. Each tank was stocked with 45 fingerling of *Oreochromis niloticus*.

They were supplied with commercial food containing 40 % protein and a particle size of 0.6-0.8 mm (fish were initially fed at a rate of 10% of their total body weight) and adjusted every 10 days.

2.3 Sampling

2.3.1 Fish sampling

Each week, 20 fish from each aquarium were individually weighed and their total length measured. Fish was removed from each tank using a minnow seine, and returned to the tank following measurement. Electronic balance (readability 0.01 g) was used to record fish weight and a meter ruler to the nearest 0.1 cm used to estimate length.

2.3.2 Water physical-chemical parameters

The water quality parameters was measured according to the Standard Methods for American Public Health Association, (21). The water quality parameters that were observed are water temperature, dissolved oxygen, pH, ammonia, nitrite and nitrate. Sample Analysis of water quality variables was analysed during the experiment at an interval of 7 days. Sampling was conducted between 09:00hrs and 10:00hrs at each sampling date. The dissolved oxygen (mg/l) and temperature (^o c) were monitored using a Yellow Springs I (YSI) 550A hand held digital dissolved oxygen meter. The pH and electrical conductivity in micro Siemens per centimetre (μ S/cm) were measured with a pH meter and a Dist5EC/TDS Pen made by Hanna Instruments (Woonsocket, RI USA) respectively. While ammonia (NH₄⁺), nitrate (NO₃⁻) measured using YSI 9500 photometer. Chlorophyll-*a* in non-filtered water column samples was estimated following standard methods (22).

2.4 Fish Performance:

Survival rate (%), Food Conversion Ratio (FCR), Average final Body Weight (ABW), were estimate to assess dietary effects on fish performance. Survival rate (SR), weight gain (WG), and specific growth rate (SGR) were calculated using the following equations:

$$WG (\%) = 100 \times (\text{final weight} - \text{initial weight}) / \text{initial weight},$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{feed applied}}{\text{Live weight gain}}$$

$$\text{Specific growth rate (SGR)} = \frac{\ln \text{ final weight} - \ln \text{ initial weight} * 100}{\text{Days of experiment}}$$

$$\text{Survival \%} = \frac{\text{Total number of fish surviving} * 100}{\text{Total number of fish stocked}}$$

2.5 Assessment of plankton population

The density of phytoplankton and zooplankton was observed on the first, seventh, and last week of culture period. 10 L of water was pooled from the tanks and passed it through a plankton net (mesh size 45 µm). The concentrated samples were preserved in small plastic bottles with 5% buffered formalin.

Identification of the plankton was performed and categorized under several major classes based on (23). Plankton numbers were estimated using a Sedgewick-Rafter (S-R) cell and was left to stand for 15 minutes to allow plankton to settle. Then, the planktons in 10 randomly selected fields of the chamber were counted under a binocular microscope (Swift, M-4000).

Taxa were identified to genus level using keys from (24). Plankton abundance was calculated using the following formula

$$N = (P \times C \times 100) / L \quad (25)$$

Where,

N = the number of plankton cells or units per litre of original water;

P= the number of plankton counted in 10 fields;

C= the volume of final concentrate of the sample (ml); and

L= the volume (l) of the pond water sample.

2.6 Estimation of Biofloc Microbial Community

Total heterotrophic bacteria (THB), counts in water samples were recorded at fortnight intervals. Samples were processed as per the earlier described methods (26). In brief, 200 mL of water sample were collected from each tank and tenfold serial dilution prepared in normal sterilized saline solution. A 0.1 mL of appropriate dilution plated on tryptone soya agar (1.0% w/v NaCl) for THB, TCBS agar for cyanobacteria. The colony in the range of 30–300 counted and expressed as colony forming unit (CFU ml⁻¹). Total heterotrophic bacteria (THB) count in the water was estimated following the standard procedure (22) and expressed as colony forming units (cfu).

3. RESULTS

3.1 Fish growth performance in biofloc system

The growth parameters of fish at different levels treatments in biofloc system in terms of mean weight (g), total length (cm), % weight gain, SGR (%), FCR and survival (%) were calculated and as shown in Table 2. The final mean fish weight, in biofloc system treatments was 3.784±0.215g, 5.069±0.218g, 6.055±0.179g and 8.774±0.394g for Control, TL 1, TL 2, and TL 3 treatments respectively. Total length of the fingerling at the end of experiment was significantly different ($F_{0.05, 3} = 59.74$; p-value = 0.001) in all treatments. The highest was observed in TL 3 (7.956±0.123 cm) followed by TL 2 (6.9578±0.079 cm), TL 1 (6.6667±0.0974cm) and least in Control (5.827±0.114cm) treatment. Daily weight gain was significantly difference ($P < 0.05$) for the all treatment where TL 1 (8.3251g) had the highest and 0g Fe kg⁻¹ (3.3351g) had the lowest. The mean food conversion ratio (FCR) in all treatments was significantly ($p < 0.05$) higher in Control (2.5±1.5) and lower in TL 2 (1.6±0.2) as compared to other treatments (Table 2).

Table 2: Fish data from a biofloc experiment comparing the growth of (*O. niloticus*) at four difference treatments

Parameters		Treatments			
		Control	TL 1	TL 2	TL 3
Initial weight (g)	weight	0.4489±0.228 ^a	0.4489±0.228 ^a	0.4489±0.228 ^a	0.4489±0.228 ^a
Initial length (cm)	length	3.0156±0.07 ^a	3.0156±0.07 ^a	3.0156±0.07 ^a	3.0156±0.07 ^a
Final weight (g)		3.784±0.215 ^a	5.069±0.218 ^b	6.055±0.179 ^c	8.774±0.394 ^d
Final length (cm)	length	5.827±0.114 ^a	6.6667±0.0974 ^b	6.9578±0.079 ^c	7.956±0.123 ^c

Weight gain (g)	3.3351	4.6201	5.6061	8.3251
SGR	2.857143	4.761905	5.714286	7.619048
Survival	86±7.4 ^a	94±4.7 ^a	96±2.4 ^a	96±6.5 ^a
FCR	2.5±1.5 ^a	1.7±0.2 ^a	1.6±0.4 ^a	1.5±0.3 ^a

Superscript in the same row sharing a common letter were not statistically different

3.2 Fish growth trend

The treatment at TL 3 had the highest growth in terms of Total length and wet Weight throughout the experiment period followed by TL 2, TL 1 and last in Control treatment in the biofloc system. In the first weeks the growth were slower in all treatments but after two weeks fingerlings show significantly ($p < 0.05$) difference on length (Fig. 1) and weight (Fig. 2) up to the entire period of 15 weeks. Statistically analysis parametric One-Way ANOVA showed weights and length was ($F_{0.05, 3} = 59.74$; $p\text{-value} = 0.001$) and ($F_{0.05, 3} = 71.84$; $p\text{-value} = 0.001$) respectively.

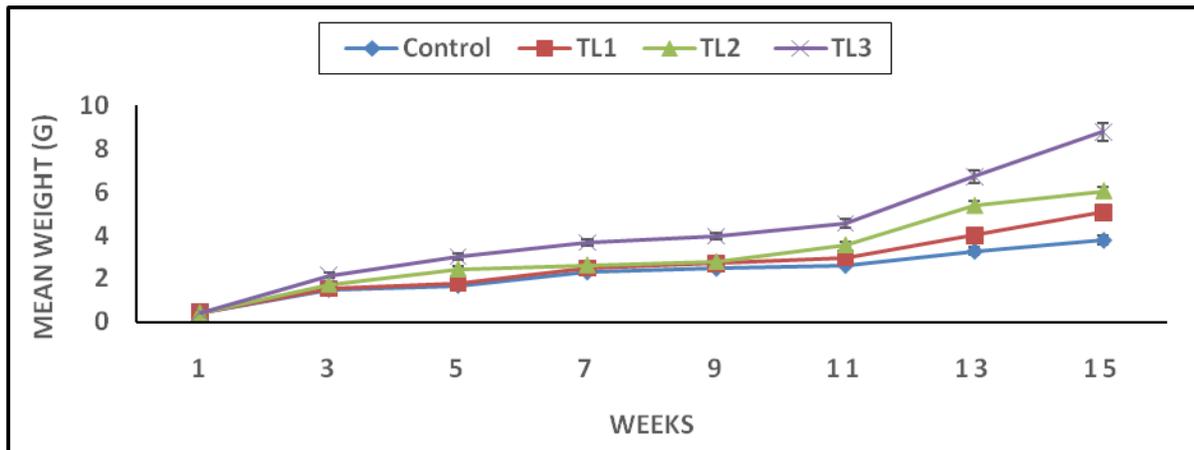


Figure 1: Mean Weight ± SE of *O. niloticus* fingerlings for 4 treatments over the experimental period of 15 weeks

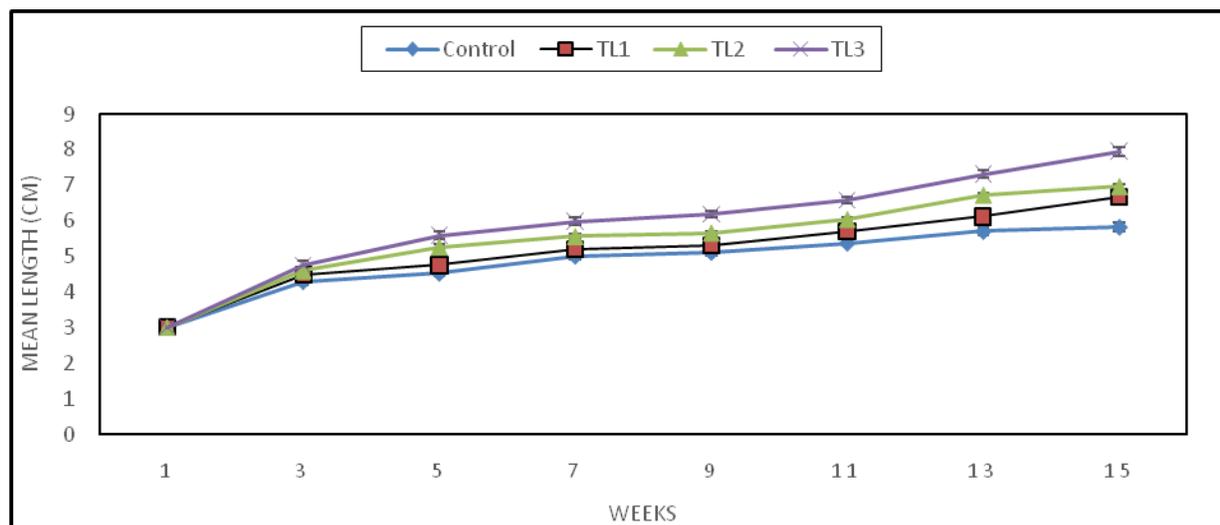


Figure 2: Mean length \pm SE of *O. niloticus* fingerlings for 4 treatments over the experimental period of 15 weeks

3.3 Microorganism community biofloc system

Summary for microorganism in the biofloc system (Protozoans, rotifers, cyanobacteria and diatoms) levels are presented in Table 4. Significant variation in colony of protozoan in the system was observed among all four treatments ($F_{0.05, 3} = 8878.64$; P- value = 0.0001), the TL 2 (560.47 ± 1.80) treatment having the highest protozoan colony and control treatment (48.067 ± 0.571) had the lowest colony. On the number of rotifers the values were significantly ($F_{0.05, 3} = 8878.64$; P- value = 0.0001) difference among all the treatments. The values (means \pm SE) of rotifers in the treatments control, TL 1, TL 2, and TL 3 were 42.167 ± 0.791 , 240.07 ± 0.952 , 210.43 ± 0.934 and 200.60 ± 1.08 , respectively. Cyanobacteria community was found to be high in treatment and low in control ponds and significantly ($F_{0.05, 3} = 3120.22$; P- value = 0.0001) difference was exhibited in all treatments.

Also Among the different treatment groups, there was a significant difference ($F_{0.05, 3} = 116.98$; P- value = 0.0001) in the community of diatoms. The values (means \pm ES) of diatoms were 36.03 ± 1.02 , 53.033 ± 0.823 , 48.03 ± 1.04 and 60.033 ± 0.835 in Control, TL 1, TL 2 and TL 3 treatment respectively (Table 4). Control ponds showed low levels of microorganism as compared to treatment ponds.

Table 4: Microorganism levels from a biofloc system treatments and control experiment at four difference treatments

Microorganism	Treatments			
	Control	TL 1	TL 2	TL 3
Protozoans	48.067 ± 0.571 ^a	560.47 ± 1.80 ^b	480.60 ± 1.36 ^a	520.13 ± 1.02 ^c
Rotifers	42.167 ± 0.791 ^a	240.07 ± 0.952 ^b	210.43 ± 0.934 ^c	200.60 ± 1.08 ^d
Cyanobacteria	27.067 ± 0.881 ^a	150.07 ± 1.04 ^b	165.13 ± 1.35 ^c	143.10 ± 1.22 ^d
Diatoms	36.03 ± 1.02 ^a	53.033 ± 0.823 ^b	48.03 ± 1.04 ^c	60.033 ± 0.835 ^d

Superscript in the same row sharing a common letter were not statistically different

3.4 Water quality

The average values recorded for the various physiochemical parameters like temperature, pH and dissolved oxygen are given in Table 5. The nitrite value between treatments was significant difference ($F_{0.05, 3} = 149.24$; P- value = 0.0001). The mean nitrite in biofloc treatment and control was 0.028 ± 0.0004 mg/L, 0.018 ± 0.0003 mg/l, 0.021 ± 0.0004 mg/l and 0.019 ± 0.0004 mg/l (Table 5) for Control, TL 1, TL 2, TL3 treatment respectively. The highest mean nitrate concentration was recorded in Control (0.036 ± 0.0007 mg L⁻¹) followed by TL 1 (0.017 ± 0.0005 mg L⁻¹), TL 3 (0.015 ± 0.0005 mg L⁻¹) and TL 2 treatment (0.009 ± 0.0007 mg L⁻¹), nitrate in all treatments showed significantly ($F_{0.05, 3} = 312.82$; P- value = 0.0001) different.

The mean chlorophyll a concentration on fish aquaria was significant ($F_{0.05, 3} = 78.77$; P- value = 0.0001) different. The highest mean chlorophyll a concentration was recorded in control (20.50 ± 0.309) followed by TL 2 (14.53 ± 0.436), TL 3 (13.89 ± 0.382) and TL 1 treatment (12.53 ± 0.460).

The results further showed that dissolved oxygen was statistically significant ($F_{0.05, 3} = 426.76$; P- value = 0.0001) differences between the treatment but there was no significant ($p > 0.05$) difference in treatment TL 2 (4.63 ± 0.0447 mg/l) and TL 3 (4.58 ± 0.0353 mg/l). However temperature indicated no significant difference ($F_{0.05, 3} = 426.76$; P- value = 0.071) between the treatment.

Table 5: Mean water chemistry parameters for the four treatments (control, TL1, TL 2, and TL 3) biofloc system carbohydrate supplement system

Parameters	Treatment			
	Control	TL 1	TL 2	TL 3
Nitrate (mg/l)	0.036±0.0007 ^a	0.017±0.0005 ^b	0.009±0.0007 ^c	0.015±0.0005 ^d
Nitrite (mg/l)	0.028±0.0004 ^a	0.018±0.0003 ^b	0.021±0.0004 ^c	0.019±0.0004 ^d
chlorophyl a	20.50±0.30 ^a	12.53±0.460 ^b	14.53±0.436 ^c	13.89±0.382 ^d
D.O mg/l	6.66±0.0955 ^a	3.88±0.0291 ^b	4.63±0.0447 ^c	4.58±0.0353 ^d
Temperature (o ^c)	24.33±0.140 ^a	23.82±0.814 ^a	24.26±0.0614 ^a	24.47±0.0665 ^a

Superscript in the same row sharing a common letter were not statistically different

4. DISCUSSION

4.1 Fish Growth performance

Growth performance of Nile tilapia fingerlings was significance difference in all the treatments ($P < 0.05$) and treatments with carbon supplement of molasses exhibited higher growth and non-carbon supplement control treatments exhibited low growth performances. This could be attributed to the fact that Biofloc produced is a medium rich in organic matter made of friendly and useful microorganisms such as bacteria, phytoplankton, protozoa, filamentous bacteria, nematodes, ciliates, flagellates and rotifers which serve as natural food and contains a high protein level for *O. niloticus* and thus improving growth performance and survival for the cultured fish in the system. The treatments resulted in increased growth rate and lower FCR compared to control tanks, suggesting that fish culture in the carbon supplement biofloc system increases utilization of protein and convert most of the diet to the body mass in these treatments. Similar finding conquers with (9) result which demonstrated that biofloc can enhance the digestion and utilization of artificial feeds as well as improving the growth performance of aquatic animals. Molasses containing sucrose, a disaccharide, which is more effective compared to wheat flour and potato flour that contain starch, which is a polysaccharide. Authors such as (10) and (27) pointed out that molasses carbon source is most used to produce biofloc, because it constituted simple carbohydrates that can easily be assimilated for microorganisms founded in biofloc, so this system can promote better growth results in aquatic cultured species

Highest growth performance was recorded in treatments with molasses supplemented system, which might be due to the high load of microorganism, traces of some of the molasses in the system which can bind some of suspended particles and make them useful and available source of food for the cultured species. Authors (28) showed that biofloc is a good food, low cost strategy which is better than traditional culture system because the formed flocs have high protein, lipids, carbohydrates and ashes content and can be used as food in aquaculture industry. It is possible that biofloc stimulate digestive enzyme activity as shown in other studies by (29) and (16). This could contribute to increased growth of Nile tilapia, as was observed in this study with the three different carbon sources, with respect to control diet without carbon supplement.

Higher survival was recorded in carbon supplemented biofloc system, where molasses carbon supplemented system exhibited highest survival of Nile tilapia and control exhibited lowest survival percentage. These might be as a result of good water quality parameter in the system with carbon supplement as compared to control with no carbon supplement. The authors (30) indicated that biofloc system may provide a sustainable method to maintain water quality within an acceptable range for *Oreochromis niloticus*. The present study record the lower survival percentage in control tank, because, it did not receive any carbon and hence, biofloc formation was limited.

4.2 Biofloc Composition

The microorganism in the biofloc system was significant difference among all the treatments where system with molasses added exhibiting high levels of protozoan, rotifers, cyanobacteria and diatoms. Similar trend was observed by (25) as well as (31). The total micro-organism counts in the carbon added groups were higher than the control throughout the duration of the experiment. These might be as a results of the carbon sources added in the system as compared in the control treatment. The authors (32) stated that the increased in bacteria population growth in the biofloc system resulted from the carbon sources added to the system. Similar results were also obtained in an earlier study using wheat and corn flour as carbon sources for biofloc production in freshwater tilapia. High number of protozoan, rotifers, cyanobacteria and diatom was recorded in the system with the carbon source added group, highest number was recorded in molasses treatment, followed by wheat flour, potatoes flour, and last control treatment respectively. The higher number of microorganism recorded in molasses added group might be because the high level starch, cellulose, fructose, sucrose content and other constituent elements molasses composition which could be exploited by bacteria as indicated by (33).

4.3 Water Quality

Results of the present study proved that biofloc helps in improving water quality in the system thus maintaining conducive culture environment for the aquatic life.

Dissolved oxygen was relatively higher in the control experiment than in the biofloc treatments, which might be attributed to higher total heterotrophic bacteria in the biofloc treatment which utilizes dissolved oxygen for their microbial metabolism. The present results demonstrated that supplementation of carbohydrate in the biofloc system reduces the dissolved oxygen levels with

lower oxygen level being recorded in molasses supplemented treatment. According to (34), the oxygen budget in aquaculture system is affected by the autotrophic and heterotrophic processes. Heterotrophic bacteria (HB) constitute an important factor in terms of oxygen consumption, metabolic by-products they release after cellular lysis, for the competition they may have with autotrophic bacteria for oxygen and space (34). The higher microbial load was recorded in molasses added treatment compared to wheat flour treatment, potato flour treatment and control which might have resulted in lower dissolved oxygen level and faster rate of dissolved oxygen reduction in this treatment. Moreover, molasses added groups recorded lower chlorophyll-a level compared to other treatments. This indicates the dominance of heterotrophs over autotrophs and may have influenced the dissolved oxygen level (35)

Temperatures recorded were no significant difference in all the treatment ($P > 0.05$). This was possible because temperatures were controlled by using thermostat heaters to control and maintain water temperature. The suggested suitable temperature for an aquaculture facility for rearing Nile tilapia is varied and sometimes controversial. The current results was with an average of 25°C which is the optimal range recommended for tilapia production (36). However, the results of this research differed with a study by (37), who suggested temperatures ranging between 31 to 36°C as optimum for food consumption and growth of *Oreochromis niloticus*.

pH levels recorded significant difference among the treatments. The pH in control treatment declined followed by potato flour treatment wheat flour treatment and molasses treatment respectively. Similar result were obtained by (34). This downward trend might resulted from the association action of nitrifying bacteria which encourage production of weak concentrations of nitric acid from the nitrification process as the bacteria liberate hydrogen ions during the conversion of ammonia to nitrate. Over time, the aquaculture system gradually become more acidic primarily as a result of this bacterial activity (38). The dissolution of carbon dioxide in tank water to form carbonic acid might also have contributed to this reduced PH. The average PH recorded in the experiment were 6.8 ± 0.31 , 7.94 ± 0.34 , 8.23 ± 0.22 and 7.88 ± 0.11 for Control, molasses, wheat flour and potato flour respectively. Higher PH values were recorded in biofloc treatment than the Control ($P < 0.05$). This was attributed to the amount of nitrogen uptake by heterotrophic processes. Similarly, (36) also suggested that nitrogen uptake by heterotrophic process that likely to dominate biofloc system consumes alkalinity half than nitrification.

Nitrite levels exhibited a significant different in levels between all the treatments ($P < 0.05$). From the Present study, it is possible that the addition of carbohydrate source was useful to reduce the concentration of nitrogenous compounds in water. This findings were in agreement with other studies such as (35; 39). The results further supports results of a series of experiments conducted by (40) which proved that addition of carbohydrate reduce the need of dietary protein while reducing ammonia concentration in the fish rearing unit.

Fish exposure to high ammonium concentrations seems to reduce their resistance to diseases, hence addition of carbon may have played a key role in elimination of nitrogenous compounds.

The authors (35) reported that autotrophic nitrifying bacteria remove ammonia at a sufficient rate that can maintain water quality at a level adequate to prevent ammonia toxicity to the fish.

In the present experiment, the toxic ammonia was converted into the less toxic nitrite and nitrate. The results of (38) demonstrated that nitrate induces extremely low toxic to aquatic organisms. The presence of nitrite and nitrate in both control and other treatments indicates the occurrence of nitrification processes in both culture systems. While nitrite concentration in all with carbon supplemented treatments seems to be relatively stable which might be due to the higher rate of nitrification processes as compared control treatments with no carbon supplement. Therefore, the carbon supplement in the biofloc technology in aquaculture can be environmentally beneficial by producing cleaner effluents, especially less ammonia. The authors (41) report that biofloc are capable of treating aquaculture effluents by recycling nutrients, turning them in situ into fish food.

5. CONCLUSION

Carbon source supplemented in the biofloc system have the ability to reduce the inorganic nitrogen accumulation hence improving water quality. Molasses carbon source exhibited the highest fish growth and survival as compared to the three treatments. Microorganism colony was recorded highest in molasses carbon source added treatments and lowest in potato flour added carbon. Improved water quality was recorded in molasses added carbon source as compared to the other treatments. This is an indicator that molasses carbon source added improved growth of Nile tilapia and increasing the essential microorganism in the biofloc technology.

6. RECOMMENDATIONS

This study recommends the adoption of molasses carbon source in biofloc technology in aquaculture so as to improve water quality and cut the cost of feeds while improving fish performance.

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