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Impact of Biofloc Technology on the Growth of Goldfish Young Ones

Mohamed Faizullah*, C. B. T. Rajagopalsamy, B. Ahilan and T. Francis

Fisheries College and Research Institute, TNFU, Thoothukudi, India; faizullahbfsc@gmail.com, lalithacbt@gmail.com, kamahilan@gmail.com, t_franciz2000@yahoo.com

Abstract

In the present study, the impact of biofloc technology on the growth of goldfish young ones was investigated. In the mean value of water temperature, pH, dissolved oxygen, ammonia-N, nitrite-N, nitrate-N and Floc Volume (FV) in biofloc treatment system where goldfish young ones were reared was 25.5°C, 7.9, 3.4 mg/l, 51.92 µg-at-N/l, 1.15 µg-at-N/l, 364.52 µg-at-N/l and 5.25 ml/l respectively. The control set registered the mean value of water temperature (28.6°C), pH (8.1), dissolved oxygen (3.9mg/l), ammonia-N (64.96µg-at-N/l), nitrite-N (2.42µg-at-N/l), nitrate-N (165.22 µg-at-N/l) and FV (0.24ml/l) more than the treatment excepting the nitrate-N and Floc volume. *Chlorella sp., Oscilatoria sp., Stephanodiscus sp., Coscinodiscus sp., Navicula sp., Amphiprora sp., Nitzschia sp., Chaetoceros sp., Cyclotella sp., Triceratium sp., Cymbella sp., Stentor sp, Paramecium sp, Cyclidium sp, Peranema sp, Petalomonas sp,* Rotifer, Nematode *or* round worm*, Chaetonotus sp.* and *Cyclops sp.* were observed in the biofloc treatment tank while the control tank had only *Chlorella sp., Coscinodiscus sp.* and *Chaetoceros sp.* The maximum SGR (25.78) was observed in biofloc treatment while in control the same was 22.87. 91.8 percent survival rate was registered in the young ones of Goldfish reared under biofloc treatment. 52.88 percent growth increment was recorded in goldfish young ones under biofloc treatment when compared with the control.

Keywords: Biofloc, Goldfish, Growth and Survival, Length Weight Relationship, Proximate Composition

1. Introduction

The goldfish, *C. auratus*[1] is the most popular variety of ornamental fish belonging to the family Cyprinidae and subfamily Cyprininae. It was first domesticated in China more than thousand years ago, and several distinct breeds have since been developed. Goldfish are basically omnivore and oviparous in breeding, and which may be extremely hardy so they make excellent aquarium species as well as good laboratory species. Ornamental fishes have traditionally been fed with live food, which in many cases can be nutritionally deficient and act as a source of diseases (parasitic, bacterial and viral). Sales and Janssens[2] investigated some nutritional requirements (protein and minerals) for growing freshwater ornamental species with emphasis on the provision of live feed during the early stages of life. The major portion (>80%) of artificial feed is lost in the aquaculture system as uneaten feed and faeces[3–5]. Artificial feed, which is lost in the rearing system, has a great effect on water quality through decomposition[6–10]. When aquaculture production becomes more intensive, the incidence of diseases including infectious diseases has increased and as a result of it, significant economic losses have been incurred. The use of antibiotics and other chemotherapeutics for controlling diseases has been criticized for their negative impacts.

Biofloc Technology (BFT) is an aquaculture system which focused on a more efficient use of nutrient input with limited or zero water exchange system. The main principle of BFT is to recycle nutrient by maintaining a high carbon/nitrogen (C/N) ratio in the water in order to stimulate heterotrophic bacterial growth that converts ammonia into microbial biomass[11]. In ornamental fish culture, rearing of young ones are the difficult-phase where the commercial ornamental fish farmer face a lot of difficulties due to low survival rate, right type of live feed

*Author for correspondence

availability, water quality management and incidence of disease etc., these problem could be easily averted through biofloc technology. The present study was undertaken to find out the impact of biofloc technology in the rearing of goldfish *C. auratus* young ones.

2. Materials and Methods

2.1 Experimental Fish

Thousand numbers of common goldfish, *C. auratus* were procured from the commercial ornamental fish farm at Thoothukudi. All the goldfish were kept in the FRP tanks (250 litres capacity) with good aeration for one day for acclimatization. No feeding was done for 24 hours. Then the fishes were released in the control and biofloc treatment tanks equally i.e. 500 no's in each tank.

2.2 Experimental Setup

Outdoor circular cement tanks having a capacity of 14,000 litres were used for the present study. The rearing system consists of three circular cement tanks of same size. One tank was used as control, while the other two were used as biofloc treatment and reservoir tank. All the three tanks were filled with freshwater from nearby bore well. Then the culture water was disinfected with chlorine powder following standard norms[12]. One week time was allowed to get rid of all residual chlorine in the culture water. The reservoir tank was maintained to fill the control and treatment tank for making up the evaporation loss. The biofloc treatment tank was added with fertilizer and chemical as per the protocol described by Avnimelechi[13].

Day	Activity (Application in g/14,000 lit)
1	Urea - 22.4g, TSP - 2.8g, Shrimp pellet feed - 84g, dolomite - 140g
2	Tea seed cake - 15ppm (14mg)
4	Shrimp pellet feed - 84g, dolomite - 140g
6	Shrimp pellet feed - 84g, dolomite - 140g
8	Shrimp pellet feed - 140g, molasses - 22.4g, kaolin - 140g
10	Shrimp pellet feed - 140g
12	Kaolin - 140g

Water level in the culture tank was maintained at 1m depth throughout the culture period. The continuous aeration was provided with help of oil free compressor in biofloc experimental tank. A special water circulation system was designed and operated to keep the biofloc always in suspension with the help of 1.5 Hp high speed centrifugal motor pumps. Four green shade net (webbing) was suspended vertically with help of float on top and with help of sinker on the bottom in the biofloc tank (1m x 2m). This setup has been made for the development of periphyton as suggested by Avnimelechi[11]. The experiment was conducted for a period of 95 days.

2.3 Water Quality Parameters

During the experimental period, water quality parameters such as Temperature, Dissolved oxygen, pH, and Total alkalinity were recorded three times a day (morning, afternoon, evening) in the culture systems. Water temperature was measured using thermometer with an accuracy of 0.1°C. The pH of water was measured using the laboratory model Elico pH meter. Modified/Winkler's titration method APHA[14] was adopted to estimate the dissolved oxygen. Total alkalinity was determined as per the method described in APHA[14]. Total ammonia-N, nitrite-N, nitrate-N, water hardness, turbidity, and Floc Volume (FV) were assessed twice a week. Ammonia-N, nitrite-N, nitrate-N, water hardness were determined as per the standard methods APHA[14]. The floc volume was the measure of biofloc in treatment tank and which was determined by adopting the method explained by Avnimelech and Kochba[15] using imhoff cones.

2.4 Growth Parameters

Before stocking the goldfish, *C. auratus* in control and biofloc treatment tanks, a sample of 50 no's. of goldfish was used to assess the total length in mm and average body weight in gram. The control and biofloc treatment rearing tank were stocked with 500 numbers of goldfish young ones. Growth of goldfish was assessed by measuring the length and weight of ten numbers of goldfish from control and biofloc rearing experimental tanks by random sampling with scoop net during 13th, 26th, 36th, 51th, 65th, 75th and 95th days of culture. From the pooled growth data of goldfish, length and weight gain, mean length and mean weight gain, and Specific Growth Rate (SGR) were assessed using the following formula[16–18]. Further, the length weight relationship of goldfish reared in the control and biofloc treatment tanks were assessed using regression analysis[19].

2.5 Feeding

The goldfish as were fed with commercial pellet feed (32% Crude protein). Every day, the fishes were fed with 5% of their body weight. The feeding ration was divided into two equal quantities and given twice a day viz. morning and evening.

2.6 Carbon Addition

C: N ratio of the biofloc treatment tank was monitored regularly and adjusted by adding sugar at the rate of 15 times the ammonia-N content of culture water as and when the ammonia-N level crosses 150 µg-at-N per litre.

2.7 Proximate Composition of Biofloc

Biofloc samples were collected during 33rd, 49th and 70th days of culture. Concentrated floc were collected, dried at room temperature and then preserved in a refrigerator. The ash content of dried sample was determined after burning it in a muffle furnace at 550°C and afterwards the ash was cooled and weighed. The crude protein, lipid and moisture content were assessed following the method described by AOAC[20].

2.8 Collection and Identification of Living Organisms in Biofloc

Biofloc samples were collected using imhoff cone (1L capacity) once in a week both in control and biofloc treatment experimental tanks and the volume of the floc plug accumulated on the bottom of cone after 10–15 minutes for settlement was measured and recorded as described by Avnimelech and Kochba[15]. One ml of biofloc sample was taken by micropipette for further analysis using Leica LCD projection microscope (10x and 40x). All the samples were analysed immediately in live condition and were identified as per the description given by Edmondson[21] and Patterson[22].

2.9 Statistical Analysis

The results of the present study were analysed statistically using ANOVA test and regression analysis and the level of significant at $P<0.05$ and $P<0.01$ were considered for validation Snedecor and Cochran[23].

3. Results

3.1 Water Quality Parameters

The mean value of experimental biofloc treatment water temperature (28.6°C), pH (7.9), dissolved oxygen (3.4 mg/l), total alkalinity (183.93mg/l), ammonia-N (51.92µg-at N/l) nitrite-N (1.15 µg-at N/l), turbidity (23.3cm) and water hardness (606.66 mg/l) was lower than control nursery rearing tank while the mean value of nitrate (364.52 µg-at N/l) and floc volume (5.28 ml/l) was higher than control tank (Table 1).

Table 1. The water quality parameters of control and biofloc experimental rearing of goldfish, *Carassius auratus*

Water Quality Parameters	Control			Biofloc treatment		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Atmospheric Temperature (°C)	24 ± 0.48	31.8 ± 0.60	28.5 ± 0.57	24 ± 0.48	31.8 ± 0.60	28.5 ± 0.57
Water Temperature (°C)	24 ± 0.48	31.8 ± 0.60	28.5 ± 0.57	23.6 ± 0.47	29 ± 0.58	28.6 ± 0.57
P^H	7.7 ± 0.15	8.6 ± 0.17	8.1 ± 0.16	7.6 ± 0.15	8.4 ± 0.16	7.9 ± 0.15
Dissolved Oxygen (mg/l)	2.2 ± 0.04	6.2 ± 0.12	3.9 ± 0.07	2.0 ± 0.004	5.0 ± 0.1	3.4 ± 0.05
Total Alkalinity (mg/l)	140 ± 2.8	260 ± 4.2	198.58 ± 3.6	100 ± 2.0	240 ± 4.2	183.93 ± 3.6
Ammonia-N(µg-at N/l)	7.48 ± 0.14	109.48 ± 2.1	64.96 ± 1.2	9.96 ± 0.19	186.83 ± 3.7	51.92 ± 0.10
Nitrite-N (µg-at N/l)	0.06 ± 0.12	4.84 ± 0.09	2.42 ± 0.04	0.09 ± 0.05	5.52 ± 0.11	1.15 ± 0.02
Nitrate-N (µg-at N/l)	13.31 ± 0.26	452.72 ± 6.1	165.22 ± 3.3	154.25 ± 3.0	754.48 ± 8.12	364.52 ± 5.84
Turbidity (cm)	28.50 ± 0.57	60.0 ± 1.2	36.2 ± 0.7	19.50 ± 0.39	40.0 ± 0.80	23.3 ± 0.46
Water Hardness(mg/l)	300 ± 4.71	1850 ± 14.2	622.77 ± 6.6	300 ± 4.71	1250 ± 9.25	606.66 ± 6.4
Floc Volume (ml/l)	0.10 ± 0.002	0.60 ± 0.012	0.24 ± 0.005	0.80 ± 0.01	9.10 ± 0.18	5.28 ± 0.10

3.2 Proximate Composition of Biofloc

The proximate composition of dried biofloc sample contained the maximum value of crude protein (21.87 ± 0.43%) and crude lipid (0.98 ± 0.01%) was assessed during 70th days of culture period. The maximum value of moisture (5.85 ± 0.11%), carbohydrate (29.26 ± 0.73%) and total ash (53.037 ± 1.06%) in biofloc dried sample was assessed during 33rd days of culture period (Table 2).

3.3 Growth Parameters

The specific growth rate of goldfish (young ones) rearing in the biofloc treatment was from a minimum of 8.0 to 14.15 (Table 2). The specific growth rate (SGR) of goldfish (young ones) rearing in the control was from a minimum of 8.78 to 12.03 (Table 3). The growth parameters were significantly different (P<0.01) among the days of culture and control and biofloc treatment excepting the mean length and weight gain which was significant only at P<0.05 level between the days of culture. The length and weight gain in the control and biofloc treatment was not significant between the days of culture.

Table 2. The proximate composition of biofloc (dried) produced in the biofloc treatment experimental tank of gold fish *C. auratus*.

Days of Culture	Proximate Composition				
	Crude Protein (%)	Crude Lipid (%)	Moisture (%)	Carbo-hydrate (%)	Total Ash (%)
33	11.37 ± 0.22	0.48 ± 0.01	5.85 ± 0.11	29.26 ± 0.73	53.037 ± 1.06
49	20.12 ± 0.40	0.68 ± 0.01	4.27 ± 0.08	21.98 ± 0.72	52.941 ± 1.02
70	21.87 ± 0.43	0.98 ± 0.01	5.19 ± 0.10	20.51 ± 0.74	51.444 ± 1.02

3.4 Length Weight Relationship

The length weight relationship of goldfish young ones during harvest both in control W = 0.0001, L = 2.5305, R^2 = 0.874; biofloc treatment W = 0.00007 L = 2.6629, R^2 = 9.118. Both the regression coefficient are highly significant (P<0.01) and if the 'b' value when compared, the ('b' value 2.6629) recorded in the biofloc treatment was greater than that recorded in the control.

3.5 Survival Rate

The survival rate of goldfish young ones in experimental biofloc treatment was 91.8% and in control set, it was 88.8%.

4. Discussion

4.1 Water Quality Parameters

The entire study was undertaken in a tropical atmosphere (24° to 32°C) and the water temperature of the experimental setup ranged from 23.6° to 31.8°C. In BFT fish rearing system, the pH level may decrease due to reduction in alkalinity level and increase in dissolved carbon dioxide[24–27]. The result of the present experiment also revealed similar trend (Table 1.) in alkalinity and pH. In heterotrophic bacterial community biofloc fish culture system, normally the requirement of dissolved oxygen is very high since all the microbial community other than the target fish species

Table 3. Length, weight and other growth parameters during goldfish, *C. auratus*(youngones) rearing in biofloc treatment experimental tank

Days of Culture	Total Length (mm)	Body Weight (g)	Length Gain (mm)	Weight Gain (g)	Mean Length Gain (mm)	Mean Weight Gain (g)	Specific Growth Rate
1	45.74± 1.02^{a}	1.48± 0.08^{a}	--	--	--	--	--
13	54.20 ± 2.91b	2.83± 0.46^{ab}	8.46±0.16^{def}	1.35±0.02^{ab}	0.65±0.01^{de}	0.1±0.006^{a}	8.0±0.16^{a}
26	66.70 ± 1.73^{c}	5.05± 0.29^{abc}	12.5±0.25^{g}	2.22±0.04^{abc}	0.96±0.01^{g}	0.17±0.01^{a}	12.46±0.24^{b}
36	72.10 ± 4.32^{cd}	7.30± 0.90^{abcd}	5.4±0.10^{ab}	2.25±0.04^{abc}	0.54±0.01^{cd}	0.22±0.01^{a}	19.88±0.39^{e}
51	76.48± 1.26^{de}	9.19± 0.55^{bcde}	4.38±0.08^{a}	1.89±0.03^{abc}	0.29±0.005^{a}	0.12±0.01^{a}	14.79±0.29^{c}
65	82.50 ± 3.26^{ef}	10.38±0.72^{cdef}	6.02±0.12^{abc}	1.19±0.02^{a}	0.43±0.005^{abc}	0.08±0.01^{a}	16.71±0.33^{d}
75	89.00 ± 3.75^{ff}	13.17±1.27^{def}	6.5±0.13^{abcde}	2.79±0.05^{abc}	0.65±0.01^{def}	0.27±0.01^{a}	25.78±0.51^{f}
95	95.30 ± 0.83^{g}	16.97±1.45^{f}	6.3±0.12^{abcd}	3.8±0.07^{c}	0.31±0.005^{ab}	0.19±0.01^{a}	14.15±0.28^{c}

Values that have a different superscript letter (a,b,c,d,e,f,g) differ significantly P<0.05 and P<0.01 each other.

in the rearing system requires dissolved oxygen. Olah et al.[28] studied the oxygen consumption of bacteria in fish pond which contributed as much as 77% of the total oxygen consumption. Similar investigation was carried out by Visscher and Duerr[29]; Avnimelechet et al.[30] and Sun et al.[31] and they stated that heterotrophic microbial population consumed high level of dissolved oxygen in fish culture ponds. In the present study also the dissolved oxygen level (Table 1.) in biofloc experimental tank was always lower than the control tank although there was a continuous aeration. Tezuka[32] stated that the amount of nitrogen regenerated increased with low C: N level of organic substrate and there was no regeneration of ammonia when C: N ratio level of organic substrate was more than 15:1. Avnimelech et al.[11,30,33] documented that the ammonia-N generated from the faecal pellet and uneaten fish feed was more effectively removed by carbon addition than through the conventional water exchange method. In the present investigation the ammonia-N level in the biofloc treatment tank were less than that recorded in the control tanks (Table 1). The level of decrease in ammonia-N value was estimated around 20.7%. Liao et al.[34] and Kim et al.[35] studied the reduction in nitrite-N could be due to nitrification as corroborated by the rise in the level of nitrate-N as well as by denitrification. Aerobic denitrifiers significantly reduce nitrite-N by denitrification under aerobic and higher C: N conditions. The result of the present study is also in accordance with Liao et al.[34] and Kuhn et al.[36] that the nitrite-N level in biofloc rearing experimental tanks were lower when compared with control (Table 1). Similarly due to rise in the nitrification level, the higher concentration of nitrate-N was recorded in biofloc treatment than control (Table 1). The nitrification rate increase in biofloc treatment, than control experiment to the tune of 120.62%. The euphotic zone of any aquatic system extends upto 3.84 folds of secchi disc depth Parsons et al.[37] and which is very important in any autotrophic fish culture system where the phytoplankton are the only primary producers. The euphotic zone has little impact in BFT fish culture system[11,30,33,38–40]. The secchi disc reading (Turbidity) in the present study clearly revealed that control tank had higher mean and range value than the biofloc treatment tank (Table 1). However, the transparency reading in the autotrophic system recorded lower value than that of biofloc pond as stated by Avnimelech[13] and which contradicts the result of the present study. Avnimelech[41] calculated the feed available in the BFT system in terms of volume and according to him one cubic centimetre of floc volume contain 14mg floc on dry weight basis and a relatively low reading of 5 ml/l is equivalent to an amount of 700 kg dry matter per hectare. In the present study, the floc volume data showed that the mean and range values were always higher than the control tank. The potential dry matter from the floc available in the goldfish rearing (1.034 kg dry matter) were very significant feed equivalent as compared to the amount of feed rations in the control system (Table 1).

4.2 Biofloc Composition and Nutrition

Deschryver et al.[42] emphasised the importance of filamentous organisms helped in bridging the different floc farming components. In the present investigation, the biofloc treatment tank water consist of *Chlorella sp., Oscilatoria sp., Stephanodiscus sp., Coscinodiscus sp., Navicula sp. (*Pennate diatoms*) Amphiprora sp., Nitzschia sp. (*Pennate diatoms*), Chaetoceros sp., Cyclotella sp., Triceratium sp., Cymbella sp., Stentor sp., Paramecium sp., Cyclidium sp., Peranema sp., Petalomonas sp., Rotifer, Nematode or round worm, Chaetonotus sp. and Cyclops sp.* Similarly Azim and Little[43] recorded three groups of organisms consisting of Protozoa, Rotifer and Oligochaeta in the biofloc system. The most important aspect of biofloc nutrition is that all the nutrients it possesses are in biologically available form. In the present study, the proximate composition of biofloc was analysed during 33rd, 49th and 70th days of culture operation (Table 2). The crude protein content of biofloc ranged from 11.37% to 21.87%. Anand et al.[44] recorded more or less similar level (24.30%) of crude protein in biofloc. Further he has recorded higher level (3.53%) of crude lipid in biofloc than that recorded in the present investigation. The ash content recorded in the present study (53.44%) was much higher than that recorded (31.98%) by Anand et al[44]. In contrast to the results of present study, Rostika[45] recorded very high level (53.5%) of protein, moderate level of crude lipid (3.53%) and lower level of ash content (7.5%). Juet et al.[46] opined that the variation in the proximate composition of biofloc was usually based on the contributing or dominating living organisms present in the biofloc such as chlorophyll dominated biofloc (26.34%) and bacteria dominated biofloc (38%).

4.3 Growth and Survival

In the present study, the mean weight gain of goldfish in biofloc treatment always showed higher values than control (Table 3 and 4). Crab et al.[47] documented higher mean weight gain (0.29 ± 0.03g) in fish reared in biofloc

tanks than the control system. The Specific Growth Rate (SGR) is a good indicator among the different growth parameters used in the aquaculture research experiment. In the present experiment, SGR of goldfish young ones in biofloc treatment showed higher value (25.78) when compared with control (22.87). In line with the present investigation, Hari et al.[48] registered higher SGR value of fish in BFT system than that of control set of experiment. In contrary to the present study, the biofloc incorporated feed at 12% had resulted with only marginal SGR equal to that registered in control[44]. However he had documented increment in the SGR of fish when biofloc was fed at 4 and 8 % level in the feed. Through heterotrophic food web, microbial metabolism could contribute nutrition to fish as the cultivable fish directly and indirectly feed on the primary producers, bacteria and other vertebrates[49,50]. The higher fish production due to biofloc feeding by fish has been recorded by many authors[43,48,51,52]. However the results were highly variable i.e. from a low level of 13.8% to a higher level of 65.1% growth have been documented by researchers. In the present study, the growth increment of 52.88 % was observed in the goldfish young ones reared in biofloc system when compared to the control (Figure 1). Kuhn et al.[51] reported that microbial floc diet enhanced the fish growth by an average of 65.1 % over mean growth of control diet. Azim and Little[43] registered 45% higher net fish production in BFT tanks than in the control tanks. In contrary to the present study, a very low level of 13.8 present growth increment was documented by AndeloNaranjo[52] in biofloc fed fish culture system.

Karthikeyan[53] and Deepa Suman[54] assessed the length and weight of relationship in angel fish and rosy barb respectively

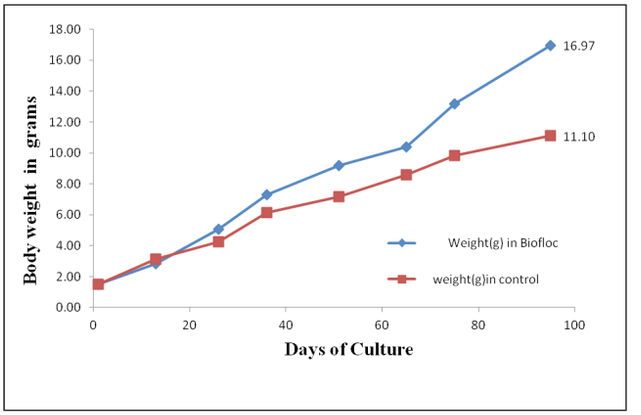

Figure 1. The average body weight of goldfish in control and biofloc treatment experimental tanks during goldfish, *C. auratus* (youngones) rearing.

and Karthikayan[53] observed 'b' value above 2 for angel fishes whereas Deepa Suman[54] recorded 'b' value less than 2 for rosy barb during rearing experiment. In line with Karthikeyan[53] the present study also showed the b value above 2 for the length weight relationship of goldfish both in control and biofloc treatment. By comparing 'b' value of control and biofloc treatment, the latter had higher value. Azim and Little[43] observed the survival rate as high as 100% in Tilapia BFT system. However, Suresh and Lin[55] and Rostika[45] recorded 93.56% and 94% survival in Tilapia and Vannamei biofloc culture system respectively. In line with Suresh and Lin[55] and Rostika[45] survival rate of 91.8% was registered in the rearing of goldfish *C. auratus* young ones in biofloc treatment and 88.8% survival was recorded in the control. From the present investigation it is possible to conclude that the rearing young ones of goldfish could be undertaken using

Table 4. Length, weight and other growth parameters during goldfish, *C. auratus* (young ones) rearing in control experimental tank

Days of Culture	Total Length (mm)	Body Weight (g)	Length Gain (mm)	Weight Gain (g)	Mean Length Gain (mm)	Mean Weight Gain (g)	Specific Growth Rate
1	45.74 ± 1.02^{a}	1.48 ± 0.08^{a}	--	--	--	--	--
13	55.60 ± 3.40^{b}	3.13 ± 0.41^{ab}	9.86 ± 0.17^{f}	1.65 ± 0.03^{a}	0.75 ± 0.01^{f}	0.12 ± 0.01^{a}	8.78 ± 0.17^{a}
26	56.70 ± 4.03^{bc}	4.23 ± 0.74^{abc}	1.1 ± 0.02^{g}	1.1 ± 0.02^{a}	0.08 ± 0.01^{a}	0.08 ± 0.01^{a}	11.09 ± 0.22^{b}
36	66.20 ± 4.31^{d}	6.14 ± 1.16^{abcd}	9.5 ± 0.19^{f}	1.91 ± 0.03^{a}	0.95 ± 0.01^{f}	0.19 ± 0.01^{a}	18.15 ± 0.36^{e}
51	69.90 ± 2.56^{dc}	7.18 ± 0.32^{abcd}	3.7 ± 0.07^{bc}	1.04 ± 0.02^{a}	0.24 ± 0.01^{abc}	0.06 ± 0.01^{a}	13.14 ± 0.26^{c}
65	73.64 ± 1.75^{ef}	8.60 ± 0.39^{bcd}	3.74 ± 0.07^{bcd}	1.42 ± 0.02^{a}	0.26 ± 0.01^{abcd}	0.10 ± 0.01^{a}	15.37 ± 0.30^{d}
75	77.12 ± 1.00^{fg}	9.85 ± 0.29^{cd}	3.48 ± 0.06^{ab}	1.25 ± 0.02^{a}	0.34 ± 0.01^{bcde}	0.12 ± 0.01^{a}	22.87 ± 0.45^{f}
95	81.20 ± 1.90^{g}	11.10 ± 0.60^{d}	4.08 ± 0.08^{bcde}	1.25 ± 0.02^{a}	0.20 ± 0.01^{ab}	0.06 ± 0.01^{a}	12.03 ± 0.24^{b}

Value that have a different superscript letter (a,b,c,d,e,f,g) differ significantly $P<0.05$ and $P<0.01$ each other.

biofloc technology for better survival rate and higher growth rate. This technology of goldfish larvae rearing could be made as a cutting edge technology for the benefit of ornamental fish farmers so as to increase aquarium fish production.

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