Effect of Protein Levels on Growth Performance, Feed Utilization and Economic Evaluation of Fingerlings Nile Tilapia Fingerlings under Biofloc System

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Abstract: The current experiment was designed to test the effect of crude protein content (19, 25 and 30% C.P.) on growth performance of monosex Nile tilapia (Oreochromis niloticus) fingerlings on clear and biofloc system. Three dietary protein levels (19, 25 and 30% CP) were used under biofloc system (no water exchange) in comparison with clear system three replicates for each treatment. The experiment was lasted for 84 days. The daily ration was 5% of the total stocked biomass divided into two equal amounts and offered two times a day (8.00 and 12.00). Fish in each treatment was weighed every 15 days and the amount of the daily allowance feed was readjusted accordingly. The C: N ratio was maintained at 15: 1 by daily addition of rice bean as an organic source of carbon. For biofloc treatments, rice bran was activated heterotrophic bacteria growth. Rice bran was dissolved in water at dry feed to molasses ratio of 1:1 on a daily basis in order to develop biofloc and nourish heterotrophic bacteria. The highest final body weight (FBW), weight gain (WG) and specific growth rate (SGR) values were recorded for fish fed 30% (DP). Biofloc system (BS) showed superiority over clear system (CS) for FBW, WG and SGR values. It could be concluded that 30% crude protein was the best in terms of growth performance, feed utilization and economic evaluation for monosex Nile tilapia fingerlings under this experimental conditions.

Keywords: Protein levels - monosex - Nile tilapia - Biofloc system - Growth

INTRODUCTION

Dietary protein is the most expensive ingredient in fish feed which is required to sustain normal growth of aquatic animals. In aquaculture feed accounts 40-60% of the production costs, with protein sources a significant proportion of this cost (Fotedar, 2004).

The use of rich protein diets above optimum levels, increases operating costs required to raise fish. Optimum protein levels in biofloc systems should be evaluated in terms of growth and feed performance as well as water quality parameters in culture units. Optimum levels of dietary protein not only reduce production costs, but also ameliorate water quality and fish growth conditions. Protein is main major dietary nutrient affecting performance of fish (Lovell, 1989). It provides the essential and non-essential amino acids which is necessary for muscle formation and enzymatic function and in part provides energy for maintenance (Yang et al., 2002). It is important to minimize the amount of protein used for energy, because protein is usually the most expensive constituents in the diet. Excess protein in fish diet may be wasteful and cause diets to be unnecessarily expensive (Ahmad, 2000). The protein requirement of Nile tilapia was estimated to be from 25% to 45% of diet (Swick, 2001). Monosex (males) Nile tilapia have been widely cultured in Egypt. Males are used for monosex culture because male tilapia grows faster than females (Bahnasawy, 2009).

It has been described that biofloc intake enhances the growth performance of aquatic organisms (Luo et al., 2014). However, there is little information on the recommended crude protein levels when using biofloc technology (BFT). For this reason, there is wide variation in the crude protein (CP) concentrations of Nile tilapia feeds used in studies with BFT. In the literature, crude protein in Nile tilapia juvenile represent 30%, with a range between 20-40% of the diet (Mansour and Esteban, 2017). However, there is little information on the recommended crude protein levels when using BFT. For this reason the present study aimed to investigate the effect of protein levels on growth performance, feed utilization and economical evaluation of fingerlings monosex Nile tilapia fingerlings under clear and biofloc system.

MATERIALS AND METHODS

The present study was carried out at the experimental fish laboratory of Suez National Institute of Oceanography and Fisheries (NIOF), experiments were designed to illustrate effect of biofloc and protein levels on growth response, feed utilization and body composition of mono-sex tilapia fingerlings.

Experimental fish and Culture techniques

Nile tilapia, O. niloticus fingerlings with an initial body weight of 8.00±0.05 g were obtained from the National Institute of Oceanography and Fisheries (NIOF). Prior to the start of the experiment, fish was acclimatized to laboratory conditions for two weeks. The fingerlings were stocked into 18 cylindrical fiberglass tanks (with water capacity of 500 Leach) at a rate of 50 fish tank-1, representing six experimental treatments in triplicate. The tanks were supplied with well water source. Aeration was continuously provided using an air blower.

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In the tanks representing the control treatments (clear system); water was exchanged biweekly, while for experimental BFT tanks, no water exchange was done (zero water exchange) except for the added water to compensate the evaporation.

The dietary protein levels (19, 25 and 30% CP) under clear and biofloc system. The experiment lasted for 84 days; the fish was fed different experimental diets (19, 25 and 30%) under clear and biofloc systems. The daily ration of food was 5% of the total stocked biomass divided into two equal amounts and offered two times a day (8.00 and 12.00). Fish in each replicate aquarium was weighed every 15 days and the amount of the daily allowance feed was readjusted accordingly.

**Experimental design:**

| Feeding system       | % Crude protein |
|----------------------|----------------|
|                      | 19%  | 25%  | 30%  |
| Clear system (CS)    | T1   | T3   | T5   |
| Biofloc system (BS)  | T2   | T4   | T6   |

The C : N ratio was maintained at 15: 1 by daily addition of rice bran as an organic source of carbon. For biofloc treatments, rice bran was activated heterotrophic bacteria growth. For biofloc tanks, only a proper amount of fresh water was supplied to compensate water losses due to evaporation without any water exchange, whereas the control tanks were renewed weekly. At the beginning of the experiment, all tanks were filled with fresh water. No organic carbon was added to the tanks of the clear water groups, in which a daily water exchange rate of 20% was applied. For their part, each of the tanks containing the fish exposed to the BFT treatments was inoculated with 100 ml of concentrated biofloc from old biofloc tanks on the first day of the experiment. Furthermore, the BFT tanks were supplied daily with rice bran as a carbon source, two hours after feeding to maintain the C : N ratio of 15:1.

**Biofloc tanks preparation (stock / fermentation):**

The C : N ratio calculations are presented as followed. For examples, the carbon content of the feed will be considered 50% (based on dry matter). For the carbon source, rice bran was chosen and its content in such case is also 50%. In a practical way, dry matter of the feed will be 90%. Fish assimilation will be considered 25%. It was found that fish or shrimp in a pond (Avnimelech and Lacher, 1979; Boyd, 1990; Mathuwani and Lin, 1995) assimilate only about 25% of the nitrogen added in the feed (Avnimelech, 1999).

**Calculation C in the feed:**

\[1000 \text{ g feed} \times 0.9 \times 0.7 \times 0.3 \times (\text{30% of fish assimilation or 70% of waste that remains in water})/2 \times (\text{carbon content of the feed is ~50% based on dry matter}) = 315 \text{ g of C.} \]

**Calculation N in the water**

\[1000 \text{ g of feed} \times 0.9 \times 0.7 \times (\text{30% of fish assimilation or 70% of waste that remains in water}) \times 0.3 \times (\text{30% crude protein content of feed}) \times 0.16 (\text{constant}) = 30.24 \text{ g of N.} \]

**Adjusting the C : N ratio (15:1):**

If I want a C : N ratio of 15:1, 30.24 g of N in feed × 15 = I need 453.6 g of C. But I already have 315 g of C (calculated in feed). So 453.6 g–315 g of C = I really need 138.6 g of C.

If the rice bran has 50% of carbon content (based on dry matter), 1 kg of rice bran represents 500 g of carbon. So 138.6 g of carbon requirement will represent 277.2 g of rice bran.

The ingredients used in preparing the fermentation were 1000 g (30% crude protein content of feed), 15 g baker’s yeast and carbohydrate sources 277.2 g of rice bran. No carbohydrate source was added to the control group. All the ingredients were dissolved with 25 L of fish water, and aerated for 20 days until the aroma was odorless and flocs were formatted. After 20 days the floc was distributed to each aquarium as much as 2 liter and allowed to stand with continuous aeration. The fingerlings were stocked after seeding the tanks with flocs (Adipu et al., 2019). Carbon sources were completely mixed with water sample of the experimental tanks prior spreading into the whole water body.

Because the growth rate of heterotrophic bacteria is so much greater than that of nitrifying bacteria, ammonia control through immobilization by heterotrophic bacteria occurs rapidly, usually within hours or days if a sufficient quantity of simple organic carbon (e.g., sugar or starch) is added (Hargreaves, 2013).

Aeration was continuously provided using an air blower. More oxygen will be needed to support the respiratory demands of a greater bacterial load, and additional energy is needed to keep solids in suspension. High rates of water respiration (oxygen consumption) reduce response time in the event of system failure. Tanks were always covered with black plastic sheets. Water in the tanks never exchanged during the experimental period except for compensate for evaporated.

**Biofloc meal precipitation**

Imhoff cone was used daily to monitor the developing of biofloc. Imhoff or settling cones are a simple way to index suspended solids concentration. The cones have marked graduations on the outside that can be used to measure the volume of solids that settle from 1 liter of system water. The interval of time should be standardized and convenient, usually 10 to 20 minutes. Solids also can be measured with a turbidity meter. Maintaining a settleable solids concentration of 25 to 50 mL/L will provide good functionality in biofloc systems for tilapia (Hargreaves, 2013).

**Experimental diets**

All feed-grade ingredients including soybean meal, yellow corn, Rice bran, corn oil and starch were already purchased from local markets.

Experimental diets were processed by blending the dry ingredients into a homogenous mixture, and then the
mixture feed was passed through mill. The experimental diet, were then solar dried and stored.

Dietary gross energy (GE) contents were calculated according to gross caloric values of using the values of 5.6, 9.5 and 4.1 cal g⁻¹ for crude protein, crude fat, and total carbohydrate, respectively, according to (NRC, 1993). Table (1) showed the proximate composition of ingredients used in the Experimental diet.

Growth parameters

Growth parameters were calculated using the following equations:

\[ \text{WG} = \text{Final body weight (g) - Initial body weight (g)} \]

\[ \text{SGR\%} = \left( \frac{\ln \text{FBW} - \ln \text{IBW}}{t} \right) \times 100; \text{ where: FBW is final body weight (g); IBW is initial body weight (g); ln = natural logarithmic; t = time in days} \]

\[ \text{FCR} = \frac{\text{diet intake (g)}}{\text{weight gain (g)}} \]

\[ \text{PER} = \frac{\text{weight gain (g)}}{\text{protein intake (g)}} \]

Assessment of water quality parameters

Water quality parameters, such as temperature, pH, ammonia, Nitrite and Nitrate were monitored to follow the effect of biofloc system in comparison with clear system 30 cm water depth. Water temperature and dissolved oxygen was measured using a portable oxygen meter (HI9164 DO meter). pH was detected by sunflower paper test. Ammonia nitrogen (TAN), nitrite-nitrogen and nitrate-nitrogen using analytical kits (Lovebird®, Multidirect, co 210070 England).

Table (1): The proximate composition of ingredients used in the Experimental diet

| Chemical composition | Ingredients       | Dry mater | Protein % | Lipid % | Ash % | CF % | NFE % |
|----------------------|------------------|-----------|-----------|---------|-------|------|-------|
| Soya bean meal       |                  | 90.00     | 44.00     | 1.50    | 5.9   | 6.30 | 42.3  |
| Yellow corn          |                  | 90.85     | 7.70      | 3.80    | 0.86  | 2.30 | 85.34 |
| Rice bran            |                  | 86.2      | 12.8      | 13.7    | 15.7  | 29.0 | 28.8  |

Chemical analysis

At the beginning and the end of the each trial, a random pooled sample of fish was collected and sacrificed for determination of initial whole-body proximate composition. Fish sample were oven-dried, ground, and stored at -20°C for subsequent analysis. The chemical composition of fish and diet samples were determined according to the procedures of AOAC (2005). Dry matter was determined after drying the samples in an oven (105°C) for 24 h. Ash by incineration at 550°C for 12 h. Crude protein was determined by micro-Kjeldhal method, % N × 6.25 (using Kjeltechautoanalyzer, Model 1030, Tecator, Höganas, Sweden) and crude fat by Soxhlet extraction with diethyl ether (40-60°C). Table (2) presents the formulation and chemical composition of the experimental diets.

Table (2): Formulation and chemical composition of the basal diet

| Ingredients                  | Protein Levels % | Protein Levels % | Protein Levels % |
|------------------------------|------------------|------------------|------------------|
|                              | 19               | 25               | 30               |
| Soya bean meal               | 25              | 43               | 57               |
| Yellow corn                  | 20              | 20               | 15               |
| Rice bran                    | 45              | 27               | 18               |
| Soya oil                     | 6               | 6                | 6                |
| Vit. and Min. premix¹        | 3               | 3                | 3                |
| CMC (carboxy methyl cellulose)| 1              | 1                | 1                |

Proximate Analysis

|                   | Protein (%) | Lipid % | Total carbohydrate (%) | Ash % | Gross energy (Kcal/100g) |
|-------------------|-------------|---------|-------------------------|-------|--------------------------|
| Dry matter (%)    | 88          | 88.97   | 87.8                    | 87.8  | 416.477                  |
| Protein (%)       | 19.34       | 25      | 30.08                   | 4.87  | 437.11                   |
| Lipid %           | 12.35       | 11.65   | 10.49                   | 5.69  | 452.84                   |
| Total carbohydrate%| 46.35       | 45.20   | 44.71                   |       |                          |
| Ash %             | 3.60        | 4.87    |                         |       |                          |

1. Each Kg vitamin & mineral mixture premix contained Vitamin D3, 0.8 million IU; A, 4.8 million IU; E, 4 g; K, 0.8 g; B1, 0.4 g; Riboflavin, 1.6 g; B6, 0.6 g, B12, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin, 20 mg, Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.
2. Gross Energy based on protein (5.65 Kcal/g), fat (9.45 Kcal/g) and carbohydrate (4.11Kcal/g), according to (NRC, 1993).
Statistical analysis

All variables measured at harvest (fish growth performance and feed utilization) and various components in the nitrogen budgets were analyzed by two-way ANOVA to determine the effect of dietary protein level, culture technique and their interaction (EXPI). All the ANOVA were performed using the SAS v9.0.0 (2004) program. The ANOVA was followed by Duncan test (1955) at P < 0.05 level of significant. The data were statistically analyzed by 2x3 factorial designs according to the following model:

\[ Y_{ijk} = \mu + C_i + P_j + CP_{ij} + e_{ijk} \]

Where:
- \( \mu \) is the overall mean,
- \( C_i \) is the fixed effect of culture technique (i = 1 and 2),
- \( P_j \) is the fixed effect of protein levels (j = 1, 2 and 3),
- \( CP_{ij} \) is the interaction between effect of culture technique and protein levels and
- \( e_{ijk} \) is random error.

Table (3): Effect of protein levels on average* physico-chemical parameters of water quality (Mean ± SE) of monosex of Nile tilapia (O. niloticus) fingerlings under clear and biofloc system throughout the experimental period (84 days)

| Protein levels % | C.S | B.S | C.S | B.S | C.S | B.S |
|------------------|-----|-----|-----|-----|-----|-----|
| DO               | 7.48±1.10 | 6.52±1.10 | 7.44±1.10 | 6.52±1.10 | 7.39±1.10 | 6.63±1.10 |
| Temp. ⁰C         | 25.54±1.20 | 25.85±1.01 | 26.66±1.0 | 26.68±1.10 | 26.40±1.10 | 26.50±1.10 |
| pH               | 7.00±1.10 | 8.00±0.50 | 7.00±0.50 | 8.00±0.50 | 7.00±0.50 | 8.00±0.50 |
| TAN mg⁻¹         | 0.43±0.10⁵ | 0.35±0.10⁶ | 0.56±0.10⁷ | 0.41±0.10⁷ | 0.60±0.10⁴ | 0.45±0.10⁶ |
| NO₂ mg⁻¹         | 0.33±0.10³ | 0.11±0.10⁶ | 0.22±0.10⁴ | 0.13±0.10⁶ | 0.25±0.10⁴ | 0.15±0.10⁴ |
| NO₃ mg⁻¹         | 11.3±1.10⁶ | 10.8±1.10⁶ | 11.8±0.10⁶ | 10.33±0.10⁷ | 13.83±0.10⁶ | 11.6±0.10⁷ |

* Means in the same row having the same superscript letter are not significantly different (P<0.05)

RESULTS AND DISCUSSION

Water quality Parameters

Table (3) present water quality criteria of monosex tilapia as affected by protein levels which reared in tanks under clear and biofloc system. As apparent difference in water quality parameters were found among treatments; the data for each experiment for the whole experimental period were pooled. Water quality was found to be within the acceptable range for tilapia growth (Crab et al., 2009). Temperature and pH concentration did not differ significantly among treatments, while the increase in protein levels resulted in lower dissolved oxygen and an increase in TAN, NH₃ and NH₄ with biofloc (Table 3). Generally, the average water temperature during the experimental period ranged between 25.54 and 26.60 ⁰C, while pH ranged from 7.00 to 8.00, respectively. Dissolved oxygen 6.52±0.4 and 7.48 mg⁻¹, NO₂ 0.11± 0.01 to 0.25±0.01 NO₃ 10.33±0.10 to 13.83±0.10 mg⁻¹ measured during the study period were all within the optimum range for rearing O. niloticus (Marcos et al., 2018).

Under biofloc (no water exchange), addition of carbohydrate kept water quality (TAN and NO₂) within the normal ranges as (CS) where, water in (CS) was biweekly exchanged. There are three principal pathways to remove hazardous N species in aquaculture: (1) phototrophic removal by algae, (2) immobilization by heterotrophic bacteria as protein acetic microbial biomass and (3) chemo-autotrophic oxidation to nitrate by nitrifying bacteria (Ebeling et al., 2006). When the C/N ratio of feed is adjusted to about 20 by adding rice bran, the water quality could be controlled by the bioflocs growing in the tanks. At this C/N ratio, the inorganic nitrogen was converted into organic nitrogen, due to assimilation by the dense floc cultures (heterotrophic bacteria) (Crab et al., 2009). This corresponds with the theoretical predictions made by Avnimelech (1999). Carbohydrate addition to the water column under extensive shrimp culture conditions reduced the concentration of both TAN and NO₂. Meanwhile, nutrient discharge was reduced also making extensive shrimp farming more ecologically sustainable and economically viable, by high rates of nitrification, indicated by constant nitrate accumulation coupled with ammonia immobilization into bacteria (Azim et al., 2007). Similar results were suggested by Crab et al. (2009) for tilapia fish. Additionally, Kuhn et al. (2009) reported that no differences were observed between any water quality parameters, by confirming system uniformity. Water quality levels were within safe levels for normal fish health, growth, and survival under biofloc system.

Temperature is suitable for all chemical, physical and biological processes in ponds water as cited by Boyd (1979). The results indicate that there are significant differences (p<0.05) in water quality, TAN, DO, and pH due to different culture system types (CS and BFT) without any significant effect on water temperature. Total ammonia nitrogen (TAN) values used to calculate unionized ammonia NH₃ changed numerically within the normal range (0.35-0.15 mg⁻¹)
for both (CS) and (BFT). In the same context normal nitrate (NO$_3$) concentration (0.42-0.45 mg$^{-1}$) was observed for both CS and BFT during the experimental period. The weekly data for NO$_3$ showed numerically decrease for BFT tanks compared to CS. The result of nitrate (NO$_3$) was noticed at the normal range (5-9 mg$^{-1}$) for both BFT system and CS system during the experimental period. These values were beneficial for fish culture (Boyd, 1979 and 1990). Under biofloc system BFT (zero exchange water), addition of rice bean as a carbohydrate source kept water quality (TAN and NO$_2$) within the normal ranges as change water system (CS) where ,water in (CS) were daily changed.

**Effect of protein levels on growth performance of monosex Nile Tilapia fingerlings under clear and biofloc system**

Growth performances of Nile tilapia fed three dietary protein (DP) levels 19, 25% and 30% under clear (CS) or biofloc system (BS) are presented in Table (4). The two-factorial analysis of variance indicates overall significant effects of dietary protein levels and management conditions (CS, BS) effects of dietary protein levels and management conditions (CS, BS) (p<0.05). The highest final body weight (FBW), weight gain (WG) and specific growth rate (SGR) values recorded for fish fed 30% (DP). Biofloc system (BS) showed superiority over clear system (CS) for FBW, WG and SGR values. Regards interaction results, fish showed superiority over clear system (CS) for FBW, recorded for fish feeding 30% (DP). Biofloc system (BS) improved and it contributed 43% of growth compared with system without BFT. Dan and Little (2000) found that, SGR of Nile tilapia was significantly increased as diet protein level increased from 25-45% (with increment of 5%). Also, Ogunji and Wirth (2002) with the same fish species found that, SGR increased with increasing dietary protein level from 7.3 to 44.24%.

These results revealed that, increasing dietary protein level for tilapia *O. niloticus* significantly (P<0.05) increased body weight (El-Saiedy and Gaber, 2005). The optimum protein requirement for tilapia has been determined by several investigators and the results are not consistent. For instance, estimates of 30% (Wang et al. 1985), 32% (Shiau et al., 1987), 29-38% (Cruz and Laudencia, 1976), 30-35% (Mazid et al., 1979), 36% (Davis and Stickney, 1979) and 40% (Jauncey, 1982) have been reported. In the present study, the growth performance had a significant increase (P<0.05) with increasing dietary protein levels.

**Table (4): Effect of protein levels on growth performance, feed utilization and survival rate of monosex Nile tilapia (*O. niloticus*) fingerlings under biofloc and clear water throughout the experimental period (84 days)**

| Items                | 19%       | 25%       | 30%       |
|----------------------|-----------|-----------|-----------|
|                      | T1 (C.S)  | T2 (B.S)  | T3 (C.S)  | T4 (B.S)  | T5 (C.S)  | T (B.S)   |
| Initial weight g     | 8.00 ± 0.10 | 8.00 ± 0.10 | 8.00 ± 0.10 | 8.00 ± 0.10 | 8.00 ± 0.10 | 8.00 ± 0.10 |
| Final weight g       | 25.79±0.20 | 28.11±0.20 | 31.75±0.20 | 34.47±0.20 | 40.25±0.20 | 43.97±0.20 |
| WG(g)                | 17.79±0.10 | 20.11±0.10 | 23.75±0.10 | 26.47±0.10 | 32.25±0.10 | 35.47±0.10 |
| WG %                 | 222.37±1.20 | 251.37±1.20 | 296.87±1.20 | 330.87±1.20 | 403.13±1.20 | 443.37±1.20 |
| SGR                  | 1.39±0.10 | 1.49±0.10 | 1.64±0.10 | 1.73±0.10 | 1.92±0.10 | 2.02±0.10 |
| Survival rate%       | 78.00±1.00 | 80.00±1.00 | 85.00±1.00 | 86.00±1.00 | 92.00±1.00 | 94.00±1.00 |

* Means in the same row having the same superscript letter are not significantly different (P<0.05)

In many fish including tilapia, it has been reported that the protein requirement of fish decreased with increasing size and age of fish Wilson (1989). Considerable variation has been reported in the optimum dietary protein requirement for maximum growth. This variation could be the result of different experimental conditions, which include species, size and age of fish, stocking density, protein quality and environmental conditions, particularly temperature, all of which influence the dietary protein requirement in tilapia (Jauncey and Ross, 1982) and in other fish species (Wilson, 1989).

In the same context, Megahed (2010) reported that *Penaeus semisulcatus* fed dietary protein 16.25% with...
bioflocs could even show better growth rate than shrimp fed 42.95% CP without bioflocs. The development and regeneration of the bioflocs in the culture tanks can recycle residual feeds and associated wastes, resulting in the recycling and reutilization of feed nutrients and eventually improving overall feed assimilation, especially under zero exchange water (Avnimelech, 2006, 2007). Similar results were suggested by Zhao et al. (2012) who reported that the bioflocs technology significantly increased the individual shrimp weight at harvest. Similar results were obtained by Azim and Little (2008) and Mishra et al. (2008). Contrastively, some other studies suggest that biofloc led to the level of production well below commercially viable levels (Little et al., 2008). Same phenomena was confirmed for shrimp as Xu et al. (2012) reported that shrimp in both dietary protein level 30% and 35% under (BFT) gained better growth performance (in terms of final weight, weight gain and specific growth rate) than that in the control (under clear system) (P<0.05). Wasielasky et al. (2006) demonstrated that, shrimp (L. vannamei) juveniles grown in a bioflocs-based system had higher growth rates compared to juveniles grown in a clear water system. Generally the group of monosex Nile tilapia fingerlings on biofloc system had as significantly highest (P<0.05) weight gain SGR, FE and PER than the group of fish on clear water system. These results are in agreement with Azim and Little (2008) and Xu et al. (2012).

The interaction between protein levels and biofloc system was significant (P<0.05). In agreement with Azim and Little (2008) and Xu et al. (2012). There were a significant (P<0.05) differences in survival rate between experiment group (Table 4). The lower survival rate (78%) in the control of T1 (19% CP) and the highest survival rate was found (96%) in T6 biofloc 30% crude protein. It is possible that survival is related to minimum CP requirements, as optimum CP levels found for final weight and daily weight gain. Biofloc has been proving itself to be an option to control mortality in aquaculture (Ekasari et al., 2015; Perez-Fuentes et al., 2016).

**Feed utilization.**

Feed utilization of different treatment is presented in Table (5). Regards of dietary protein, tilapia fed 30% CP showed the highest values for Feed intake (FI), the best feed conservation ratio (FCR). While the highest protein efficiency ratio (PER) noticed for tilapia fed (T2) 20% protein. Regards the interaction, tilapia fed 30% CP under biofloc system recorded the highest feed intake, the best FCR values. With increasing dietary protein under biofloc system a decrease in PER values were noticed. Despite that increasing dietary protein causes significant improvement in tilapia weight gain, PER results suggested that protein intake did not efficiently utilized for both 25 and 30% diets under clear and biofloc system.

**Table (5):** Effect of protein levels on growth performance, feed utilization and survival rat of mono Nile tilapia (O. niloticus) fingerlings under clear and biofloc system throughout the experimental period (84 days).

| Items     | 19%          | 25%          | 30%          |
|-----------|--------------|--------------|--------------|
|           | C.S          | B.S          | C.S          | B.S          | C.S          | B.S          |
| Feed intake | 42.7±1.10a  | 37.74±1.10a  | 47.92±1.10c  | 42.92±1.10d  | 55.45±1.10a  | 50.45±1.10b  |
| FCR       | 2.40±0.10a  | 1.87±0.10c  | 2.01±0.10b  | 1.62±0.10c  | 1.71±0.10d  | 1.42±0.10f  |
| FE        | 0.41±0.10f  | 0.53±0.10d  | 0.49±0.10c  | 0.61±0.10b  | 0.58±0.10e  | 0.70±0.10a  |
| PER       | 2.19±0.20d  | 2.80±0.20a  | 1.98±0.20c  | 2.46±0.20b  | 1.93±0.20f  | 2.34±0.20c  |

* Data are presented as means ± standard error (SE)
** Means followed by different letters in each row are significantly (P<0.05) different.

Otherwise, biofloc system improved tilapia feed utilization compared with clear system. Avnimelech et al. (1995) estimated that feed utilization is higher under biofloc system. For Tilapia better values for feed conversion ratio, protein efficiency ratio and protein productive value were observed in all the bioflocs treatments compared to those treatments without biofloc (Avnimelech, 2007). Same trend was noticed for tilapia feed utilization under biofloc system by Azim and Little (2008). These observations were suggested also for shrimps by Zhao et al. (2012) who reported that the biofloc treatment for shrimp resulted in 12.0% higher protein efficiency ratio, and 7.22% lower feed conversion rate comparing with treatments without biofloc. Also, Hari et al. (2006) reported that shrimp in treatments supplemented with dietary protein 25% and carbohydrate recorded lower FCR and highest PER (P ≤ 0.05) than treatment without carbohydrate supplementation. Similar result was suggested by Xu et al. (2012) who showed that the feed conversion ratio of the shrimp in dietary protein level 35% under (BFT) was significantly lower than that in the control (treatment without biofloc) (P<0.05). Additionally, Hari et al. (2004) demonstrated that carbohydrate addition in extensive shrimp ponds improved the nitrogen retention efficiency and had a positive effect on production. Under biofloc system addition of carbohydrate enhances the total heterotrophic bacteria in the pond, which in turn result further 35 reductions in inorganic nitrogen (Wahab et al., 2003). Low toxic inorganic nitrogen levels and utilization of microbial cells are demonstrated to be an effective potential food source for...
Effect of Protein Levels on Fingerlings Nile Tilapia Fingerlings under Biofloc System

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تأثير مستويات البروتين الغذائي على أداء النمو والاستفادة الغذائية والتقييم الاقتصادي لاصبعيات أسماك البلطي النيلي (Oreochromis niloticus) وحيد الجنس تحت نظام البيروفلك

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صممت هذه الدراسة تأثير مستوى البروتينات الخام (12.6، 20.3)٪ على أداء نمو واستفادة الغذائية والتقييم الاقتصادي لاصبعيات أسماك البلطي النيلي وحيد الجنس تحت نظام البيروفلك والإمداد الفعلي. كن متوسط وزن الأسماك 8.00 ج/سمكة (كل عاملة 3 مكرات) واستمرت التجربة لمدة 84 يوماً. كان معدل التغذية الوراثية 5٪ من إجمالي وزن الأسماك المخزنة مخصصة على مرتين متساويين في اليوم الساعة (06:00 و12:00). وكان وزن الأسماك في كل حوض مكروك كل 15 يومًا، لذلك، تم الحفاظ على نسبة C:N عند 1:10 عن طريق إضافة رجع الكرون يوميًا كمضاد عضوي للكراتين. بالنسبة للمعاملة بالبيروفلك، كان رجع الكرون ينشط نمو البكتيريا غير ذاتية التغذية. حيث تم إضافة رجع الكرون في الماء مع المولasses بنسبة 1:1 يوميًا من أجل تطوير الكتلة الحيوية والغذائية البكتيريا غير ذاتية التغذية. معالج معامل البيروفلك وحيد الجنس وزن 12.78 ج/سمكة. كان أعلى قيمة لوزن الجسم النهائي (FBW) لفصيلة الأسماك غير ذاتية التغذية وقائمة معدل النمو النوعي (WSGR) والارتداد في الوراثات (WG) في سلسلة الأسماك التي تتغذى على عينة تحت 30٪ بروتين خام تحت نظام البيروفلك. ويستنتج من هذه الدراسة أن 20٪ من البروتينات الخام في نظام البيروفلك كان الأفضل من حيث أداء النمو والاستفادة الغذائية والتقييم الاقتصادي لاصبيعيات سمك البلطي النيلي وحيد الجنس تحت هذه الظروف التجريبية.