EFFECT OF STOCKING DENSITY AND DIET COMPOSITION ON GROWTH PERFORMANCE AND FEED UTILIZATION OF MONO-SEX NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FINGERLINGS

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Abstract

In 2x2 factorial designs, two different stocking densities of Nile tilapia, *Oreochromis niloticus* (2.5 and 4.5 g total biomass/L) were combined with two different diets (commercial or formulated) containing 25% crude protein to obtain 4 experimental treatments. The experimental treatments (T1, T2, T3 and T4) were subjected to be studied as the following: - T1 (commercial diet + 2.5 g / L stocking density), T2 (formulated diet + 2.5 g/L stocking density), T3 (commercial diet + 4.5 g/L stocking density) and T4 (formulated diet + 4.5 g/L stocking density). Fish were daily fed at a rate 3% of their biomass for 63 days. There were significant differences in AWG, ADG and SGR among treatments. The second treatment (T2) recorded the highest values for the above parameters, while the lowest level of these values were observed with T3. Feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV %) and energy utilization (EU %) were significantly affected by the experimental treatments. The formulated diet at the lowest stocking density recorded the best values of feed and protein utilization. Body dry matter (%) was not significantly affected by the experimental treatments, while CP%, EE% and ash% significantly differed among treatments. The formulated diet at the lower density recorded the highest CP and EE contents. The best economic efficiency (expressed as feed cost/Kg weight gain) was observed in T2, while the lowest efficiency was recorded for T3.

Key words: Nile tilapia, stocking density, feed type, growth performance and feed utilization.

INTRODUCTION

Nutrition is the most important factor of the culture process, it is often represent the major operating cost of aquaculture. Under intensive culture system, fish totally depend on complete balanced diets during their life stages. Aqua-culturist should know the optimum quality and quantity of feeds introduced to fish to avoid poor growth, health and reproduction. Fish cannot grow well without feeds and they should not be underfed. From the economical point of view, fish producers mostly use the cheaper and more balanced fish diets to cover the nutrient requirements of fish during the growing periods (Magouz *et al.*, 2002). The improvement in the efficiency of protein utilization at lower stocking densities was found in the work of many investigators (Zonneveld and Fadholi, 1991, Eid and El-Gamal, 1996, Sharma and Chakrabarti, 1998, El-Sagheer, 2001, Baumgarner *et al.*, 2005 and Ridha, 2006). There have been several reports indicating that rate of survival became reduced when fish are held at high stocking densities. This reverse relationship could be attributed to social stresses and stress-related disease (Esquivel *et al.*, 1997, Sharma and Chakrabarti, 1998, and Saoud *et al.*, 2005), aggressive behavior and cannibalism related with crowding among fish cultured (El-Sayed and El-Ghobashy, 1997), Increased mortality related with higher stocking density was frequently reported (Eid and Magouz, 1995, Eid and El-Gamal, 1996 and El-Sagheer, 2001).

The present experiment was carried out to study the influence of stocking density and diet composition on growth performance and efficiency of feed and protein utilization of mono-sex Nile tilapia (*Oreochromis niloticus*), fingerlings with average initial body weight of 10 g.

MATERIALS AND METHODS

Experimental design and feeding regime:

The present work was carried out in Fish Research Laboratory, Faculty of Agriculture, Kafr El-Sheikh University to study the influence of stocking density and diet composition on growth performance and efficiency of feed and protein utilization of mono-sex Nile tilapia *(Oreochromis niloticus)*, fingerlings. In 2x2 factorial designs, two stocking densities (2.5 and 4.5 g total biomass/L) were combined with two different diets (commercial and formulated) containing 25% crude protein (Table1) to obtain 4 experimental treatments. The experimental treatments (T1, T2, T3 and T4) were subjected to be studied as the following:

Symbol	Treatment
T_1	Commercial diet + Low stocking density (2.5 g/L).
T_2	Formulated diet + Low stocking density (2.5 g/L).
T_3	Commercial diet + High stocking density (4.5 g/L).
T_4	Formulated diet + High stocking density (4.5 g/L).

A set of 12 glass aquaria representing the four treatments in triplicates, each (80 x 40 x 35 cm) filled with dechlorinated tap water at constant level of 80 liters were used. Two thirds of the water in each aquarium was daily replaced after removing accumulated excreta and all water in the aquaria were totally replaced every week. Each aquarium was supplied with compressed air through a central air compressor (100 liters). Water temperature was thermostatically controlled using automatic electrical heaters and maintained at 25°C. Fish were exposed to 12 hr illumination: 12 hr darkness photoperiod using 40-watt fluorescent lamps. Fish were daily fed at a rate

3% of their biomass and weekly weighed for adjusting food amounts according to the new weights. The calculated amount of food was daily offered by hand to fish, in equal portions at 8.00 am and 2.00 pm and fed 7 days per week. Two diets were tested, the first one was commercial diet while the second diet was formulated from available ingredients in the local market to contain 25% crude protein according to recommended requirements needed for this stage of feeding (Jauncey, 2000). The formulated diet was prepared by mixing the dry ingredients in few amounts during the mixing process, water was gradually added with continuous mixing until clumping. Diet was passed through 3 mm sieve of an electric meat grinder, lasted in a forced oven at 60 °C until drying, and stored in a refrigerator (5 °C) until use. Amino acids content of experimental diets were determined by using a high performance amino acid analyzer as described by Moor *et al.* (1958). Composition and chemical analysis of the experimental fish feed (commercial and formulated diets) are presented in Table (1), while amino acid profile is given in Table (2).

Experimental fish:

Nile tilapia *(O. niloticus)* fingerlings with an average initial body weight of 10 g were obtained from a private mono-sex tilapia hatchery located in Kafr El-Sheikh Governorate. Fish were transported to Fish Research Laboratory and kept for two weeks in 600 L fiberglass tanks for adaptation to the new environment. Fish were stocked into aquaria at low and high stocking densities (2.5 or 4.5 g/L), respectively. Enough number of the same fish were immediately killed and kept in a deep freezer at −18oC until the chemical analysis at the end of the experiment.

Sampling and analytical methods:

Representative samples of fish were randomly taken at the beginning and at the end of the experiments. Fish samples were killed and kept frozen (-18°C) until performing the body chemical analysis. Samples of the experimental fish feed (commercial and formulated diets) were taken, ground and stored in a deep freezer at -18oC until proximate analysis. All of chemical analyses of fish and fish feed were determined according to A.O.A.C. (1990).

Growth performance parameters

The growth performance parameters were calculated according to the following equations:

- Average weight gain (AWG) = Average final weight (g)-Average initial weight (g).
- Average daily gain (ADG) =Average final weight (g)-Average initial weight (g)/Time (days).
- Specific growth rate (SGR%): = 100 [Lnwt1-Ln Wto/T].

Where: Ln: Natural log, Wto: Initial weight (g), Wt1: Final weight (g) and T: Time in days.

Feed and protein utilization parameters:

The feed utilization parameters were calculated according to the following equations:-

- Feed conversion ratio (FCR) = Total feed consumption (g) / Weight gain (g).
- Protein efficiency ratio (PER) = Body weight gain (g)/protein intake (g).
- Protein productive value (PPV%) = 100 [Retained protein (g)/protein intake]
- Energy utilization (EU %) = 100 [Retained energy (Kcal)/ Energy intake (Kcal).

Economic evaluation:

Economic evaluation of the experimental fish feeds (commercial and formulated diets) has been calculated by estimating the feed cost in Egyptian pound (LE) required to produce one unit of fresh fish, where feed cost/Kg fresh fish (LE) = Feed cost/Kg X Feed conversion ratio (FCR), according to Hassanen (1997).

Statistical analysis:

Statistical analysis was done according to Snedecor and Cochran (1980). The data were statistically analyzed in a factorial design. Means of treatments were compared following the method of Duncan (1955).

RESULTS AND DISCUSSION

Growth performance and survival rates:

Table (3) summarizes average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR) and survival rate (SR %) of tilapia fingerlings. The growth of tilapia was affected by stocking density and diet composition. Tilapia fingerlings reared at the lower density (2.5 g/L) and fed the formulated diet (25% CP) grew better than those reared at higher density (4.5 g/L) and fed the commercial diet (22.5% CP). This may be due to the increased stresses caused by crowding and social interactions among fish groups. Barcellos *et al.* (1999) suggested that stocking densities of 1.0 and 2.0 g/L reflected a stress for Nile tilapia under laboratory conditions. The authors emphasized on the importance of adjusting the stocking density to avoid the detrimental effects related to highly intensive densities. Inversely, Eid and Magouz (1995) suggested a higher stocking density of 5 g/L as an optimum stocking density for Nile tilapia to obtain higher growth and survival rates. On the other side, Cruz and Ridha (1995) recommended a stocking density of 1000 fish/m3 (equivalent to 2 g/L) at a feeding rate of 2.5 % for the optimum production of *O. spilurus* fingerlings (2 g average body weight) grown in tanks during winter using underground seawater. Many reports indicated the adverse relationship between weight gain and socking density in many warm-water fish species, i.e. Nile tilapia (Essa, 1990, Eid and El-Gamal, 1996 and El-Sagheer, 2001), *O. spilurus* (Cruz and

Ridha, 1995), sea bass (El-Sayed and El-Ghobashy, 1997 and Papoutsoglou *et al.*, 1998), channel catfish (Esquivel *et al.*, 1997), mullet (Essa, 1990) and carp (Sharma and Chakrabarti, 1998).

The effects of stocking density regardless of feed types on fish growth in the present work are shown in Table (4).The results of SGR in the present study are in accordance with those indicated by Moustafa (1993) who found that SGR of caged tilapia (30 g BW) decreased linearly as the stocking density increased from 80 to 140 fish/m2. Comparable results were obtained in many fish species reared under different culture systems as follows: Nile tilapia held in glass aquaria (Eid and Magouz, 1995), Nile tilapia reared in tanks, floating cages and concrete ponds (Eid and El-Gamal, 1996), Nile tilapia reared in earthen ponds (El-Sagheer, 2001), *O. spilurus* in tanks (Cruz and Ridha, 1995), grass carp held in re-circulating systems (Sharma and Chakrabarti, 1998), sea bass in tanks (Papoutsoglou *et al.* 1998). It could be concluded that conclusions derived from stocking density experiments could be varied widely according to the variations in experimental conditions (e.g., species, culture systems, initial fish size, differences in biomass attained, feed quality, water current speed, etc. Therefore, generalization of such conclusions could be very erroneous (Eid and El-Gamal, 1996).

Irrespective of stocking density, it was observed that the diet type significantly influenced the AWG, ADG and SGR. AWG, ADG and SGR values were 8.03 and 11.49 g/fish, 0.128 and 0.19 g/fish/day, 0.79 and 1.06 %/day for commercial and formulated diets, respectively (Table 5). The differences found in growth measurements may be also due to the difference in dietary protein level and crude fat, In addition, increasing fishmeal amount was effective for covering the essential amino acid profile required for higher growth. Egna and Boyd (1997) showed that 7-15% animal protein source (fishmeal, meat meal ...etc.) is necessary to avoid the shortage in amino acid requirements in channel catfish.

The dietary protein level of the commercial (22.5%) and formulated diet (25%) lied within the range indicated by Wannigama *et al.* (1985), who stated that 19-29% as the level required for maximum growth of tilapia (20-30 g). Comparable results were obtained by Wang et al. (1985), who suggested 25% CP as the dietary protein level required for higher growth of Nile tilapia (9-17 g) and Shiau and Huang (1989) who recommended a 24% as the optimum dietary protein for *O. niloticus X O. aureus* (3-8 g). Jauncey (2000) emphasized on the fact that fish do not really have higher dietary protein requirements than terrestrial mono-gastric animals in terms of absolute quantity of protein required for producing one unit weight gain. The author recommended a dietary protein level of 25-30% for tilapia (10 g to marketable size).

The dietary lipid level (4%) of the commercial diet was lower than that reported by Wilson (1991), who stated that dietary lipid levels of 5 to 6% as the lipid requirements for tilapia. Accordingly, the formulated diet (6.25 % lipid) was more efficient to supply the lipid requirements of fish. In this connection, Hanley (1991) found no significant differences in terms of growth rate, feed conversion efficiency and protein gain as the dietary lipid level increased from 5 to 12% and concluded that the protein rather than energy was of greater significance in such feeds. On the other side, many workers reported that tilapia require 8% lipid in their diet to obtain higher growth (Siddiqui *et al.*, 1988, Jauncey, 2000 and Magouz *et al.*, 2002).

Dietary protein/energy (P/E) ratios of the experimental diets ranged from 69.55 to 70.1 for commercial and formulated diet, respectively. It could be said that they were similar to those reported by Siddiqui *et al.* (1988) and Shiau and Huang (1990) who recommended 70-75 and 67.78 mg protein/K Cal, as the optimum P/E ratio for Nile and hybrid tilapia fingerlings. Many workers recommended much higher P/E ratios ranged from 104-137 mg protein/K Cal (El-Waly, 1999). It can easily note that there are great discrepancies among investigators even for fish of the same species and size and this may be attributed to differences in feeding husbandry, limitations in experimental design and other prevailing culture conditions. Eid *et al.* (1995) attributed the positive correlation between weight gain and the amount of fishmeal incorporated in the diet of tilapia to the presence of all essential amino acids in the protein. Many reports focused on the importance of fishmeal as the main protein source in the commercial fish diets, because it is especially rich in essential amino acids and minerals, highly digestible for fish and greatly improve the nutritional value of the entire diet (Viola *et al.*, 1988). El-Waly (1999) worked on Nile tilapia and found that AWG, ADG and SGR significantly improved with increasing fishmeal protein in the diet and this was supported by the results of Eid *et al.* (1995) who stated the fact that fishmeal has approximately similar amino acid profile as in fish tissues themselves. De Silva *et al.* (1991) found that increasing the dietary lipid content is needed for meeting the energy requirements and to spare the protein for tissues synthesis and growth. It must be a goal in tilapia nutrition to maximize the use of protein for growth via minimizing its use for energy by supplying adequate amounts of alternative dietary energy sources (Jauncey, 2000).

Table (3) indicates that there were not significant differences were observed in survival rates among fish groups as affected by stocking density and diet type, favoring lower stocking densities. No clear trend was observed in survival rates among the experimental treatments. It is obviously noted that the survival rates lied within the range reported by Bardach *et al.* (1972), who mentioned that 80-90% survival rates as a normal survival rate for tilapia. Over the recent years, many evidences have been accumulated to support the negative relationship between fish stocking densities and their survival rates (Eid and Magouz, 1995, Eid and El-Gamal, 1996 and El-Sagheer, 2001). On the other hand, Cruz and Ridha (1995) observed no significant differences among fish groups reared under different stocking densities. El-Saidy *et al.*

(1999) and Magouz (2002) did not found any significant effects in survival rates among tilapia groups fed different dietary protein levels.

Protein and feed utilization:

As presented in Table (6), the best FCR value was 2.11 for group T2, but the worst value was 3.56 for group T3. Averages of protein efficiency ratio (PER) and protein productive value (PPV) were 1.28, 1.97, 1.20 and 1.61, 25.64, 41.06, 22.72 and 29.67% for T1, T2, T3 and T4, respectively. The differences among treatments were significant, favoring the lower density with formulated diet. Energy utilization also reflected some significant differences among fish groups. The best EU (20.7%) was recorded for T2 followed by 14.73% (T4), 12.2% (T1) and 11.33% (T3). No significant differences were detected in feed intake among fish groups as affected by stocking rate and diet type, although the amount of feed consumption in T3 was somewhat lower than those in the other treatments. Many reports indicated that FCR became worst at the higher densities (Cruz and Ridha, 1995, Eid and Magouz, 1995, Eid and El-Gamal, 1996, El-Sayed and El-Ghobashy, 1997, Esquivel *et al.*, 1997, Sharma and Chakrabarti, 1998 and El-Sagheer, 2001).

As shown in Table (7) reduced feed intake associated with higher stocking rate may be explained by the aggressive behavior of tilapia (Huang and Chiu, 1997) and their competition for their food. Similar results were reported by Zonneveld and Fadholi (1991), Moustafa (1993), and El-Sagheer *et al.* (2001). However, no significant differences in PER values were detected between different stocking densities under the conditions of this study. Eid and Magouz (1995) found that PER was significantly improved with increasing the stocking density from 5 to 10 g. /L. This disagreed with the findings of Eid and El-Gamal (1996), who observed an adverse relationship between both of PPV and PER on one side and stocking density on the other side under several types of culture systems. El-Sagheer (2001) found that all of the measurements of protein and feed utilization became worse with increasing fish stocking density.

From Table (8) it is clear that FCR, PER, PPV and EU were significantly affected by diet type regardless of the stock density. They were poorer in fish fed commercial diet than those fed the formulated diet. The decline in protein and feed utilization efficiency may be due to the reduction in dietary protein and lipid levels as well as reduced animal protein percent and in turn, the levels of essential amino acids (Table 2). In this context, Eid et al. (1995) observed a relatively poorer FCR and PER related to plant protein as compared with fishmeal based-diet and the probable consequence of either amino acid imbalance or lower digestibility or both of them. On the other hand, Pantha (1982) observed no significant differences in feed utilization efficiency of Nile tilapia fry fed diet containing 40% CP, when all of the dietary protein was supplied either from fish meal or from fish meal and full-fat soybean at a ratio of 1:3 as well as the supplementation of DL-methionine. Viola *et al.* (1988) who developed an animal protein-free diet of nutritional value equal to a standard commercial fishmeal based-diet confirmed this. A diet based on soybean meal and supplemented with amino acids resulted in growth performance and body composition equal to those on a fish meal-based diet. Jauncey (2000) stated that, however essential amino acids that may be chemically measurable in the dietary protein, this dose not necessarily mean that they will be biologically available and this should be taken into account when considering the protein requirements.

The increased ability of fish fed the formulated diet to utilize the feed and protein as compared with those fed the commercial diet may be attributed to the addition of vitamins and minerals premix to the formulated diet. The use of vitamin and mineral premix, even in very low levels was proven to improve the feed utilization and in turn, fish growth as well as to avoid deficiency signs (Wilson, 1991, NRC, 1993 and Jauncey, 2000). In this respect, Lim (1989) emphasized on the importance of supplementing vitamins mixture to feeds in the intensive culture systems, especially when the feeding of fish depends only on the artificial diets as a result for inadequate or absent natural food.

Body chemical composition:

Table (9) illustrates that there are significant differences in the whole body composition among the experimental treatments except for DM. Crude protein, EE, ash and DM values ranged from 60.4 to 55.1%, 19.5 to 16.2%, 19.5 to 16.20% and 27.33 to 25.33%, respectively. Carcass DM tended to decrease with increasing stocking density. Zonneveld and Fadholi (1991) found no significant differences in DM and CP contents in red tilapia reared in earthen ponds at different stocking densities. Whole body composition including DM, CP, EE and Ash are shown in Table (10), as affected by stocking density irrespective of the type of diet. The data indicated that there were no significant differences in the whole body composition among fish groups reared on different stocking densities.

The data on carcass composition of the experimental fish as affected by the diet type regardless of the level of stocking are given in Table (11). It was found that the CP and EE contents of the whole body increased significantly in fish groups fed the formulated diet as compared with those fed on the commercial diet, while the opposite trend was recorded for the ash content. These results are in a partial agreement with those reported by Magouz (2002), who found that the CP% content of Nile tilapia significantly improved as the dietary protein level increased from 20 to 30%, but the EE content showed the opposite trend. The findings of the present work were confirmed by those obtained by Shiau and Huang (1989) who found that the protein content of hybrid tilapia increased with increasing the level of dietary protein. Hassanen *et al.* (1998), found that EE% of mullet body increased with increasing the dietary lipid level. Although De Silva *et al.* (1991) and Magouz *et al.* (2002) reported comparable results, Viola *et al.* (1988) found that body fat content of tilapia did not appreciably increased by the addition of fish oil to the diet. This positive relationship between body CP% and EE% in our study was confirmed by the findings of El-Saidy *et al.* (1999). Body ash content decreased in fish fed the formulated diet (had the higher dietary protein level) as compared with those fed the commercial diet (had lower dietary protein level) and this disagreed with the findings of El-Saidy *et al.* (1999). The incorporation of higher amounts of bone meal (4%), di-calcium phosphate (3.5%) and limestone (3% of the diet), may be the reason for increased ash content in fish fed on the commercial diet.

Economic analysis:

Table (12) indicated that fish fed the formulated diet and reared at 2.5 g/L (T2) had the highest economic efficiency as compared with the other treatments. This may be due to the superiority of this diet to satisfy nutrient requirements of fish and consequently resulted in much higher growth when compared with the commercial diet. Moreover, the lower density was more efficient, in terms of feed utilization and growth performance as compared with those of the higher stocking density.

Table 1. Composition and proximate analysis of formulated and commercial diets.

Ingredients (%)	Formulated diet	Commercial diet
Fishmeal (72%)	10.0	-
Fishmeal (65%)	-	5.0
Soybean meal (44%)	34.0	27.0
Corn gluten (60%)	-	10.0
Wheat bran	20.0	15.0
Yellow corn	30.0	30.0
Sunflower oil	5.0	-
Bone meal	-	4.0
Dicalcium phosphate	0.5	3.5
Lime stone	-	3.0
Molasses	-	2.0
Table salt	-	0.5
Min. and vit. Mix. @	0.5	-
Total	100%	
Proximate analysis (%)		
Dry matter	89	89
Crude protein (%)	25	22.5
Ether Extract (%)	6.25	4
Crude fiber (%)*	3.95	4.5
Ash (%)	11.33	15.5
NFE (%)	54.47	54.5
ME (kcal/kg)**	3532	3239
Protein/energy ratio (mg protein/kcal ME)	70.1	69.55

@ Produced by Pharma Trade Company, Egypt. *Vitamins*:-Vit. A: 5,714,286 IU, Vit.B1: 571 Mg, Vit. B2: 343 mg, Vit,C : 7,143 µg, Vit B6: 571 mg , Vit B12: 7.143 µg, Vit K_3: 1.429mg. Vit D3: 85,714 IU, Biotin: 2.857 mg, folic acid: 86 mg, pantothenic acid: 1.143 mg. *Minerals:* - Iodine 114 gm, Cobalt 229 gm, Phosphorus: 28.571 mg, Manganese: 68.571 , Iron: 34.286 mg, Zinc: 51.429mg, Selenium: 286gm, Copper: 5.714 mg. Inert essential agents:- Starch 57 gm, Natural H 29 gm, Ca Co_3 : 1000 gm.

* Crude fiber did not include in calculating ME of the diets.

** Metabolizable energy (ME) calculated using values of 4.50, 8.1 and 3.49 kcal/kg for protein, fat and carbohydrate, respectively according to Pantha (1982).

Table 2. Amino acid contents of the experimental diets.

Amino acid (mg/100 mg)	Commercial diet	Formulated diet
Essential amino acids		
Argenine	1.55	2.2
Histidine	0.57	1.24
Isoleucine	0.88	2.05
Leucine	1.78	2.46
Lysine	1.26	2.07
Methionine	0.32	0.56
Phenylalanine	1.1	1.45
Threonine	0.77	1.43
Tryptophan	ND*	ND
Valine	1.03	2.3
Non-essential amino acids		
Alanine	1.12	1.57
Aspartic	2.22	3.3
Cystine	0.31	0.3
Glutamic	4.22	3.73
Glycine	1.04	1.33
Proline	1.26	2.3
Serine	0.96	1.21
Tyrosine	0.86	0.95

*ND (Not determined)

Table 3. Effect of stocking rate and diet type on growth performance of Nile tilapia.

Treatments	Diet type	Stocking density (g/L)	AIW (g/fish)	AFW (g/fish)	AWG (g/fish)	ADG (g/fish/day)	SGR (%/day)	SR %
1	Commercial	Low (2.5)	10.07a	18.57b	8.50b	0.14bc	0.91b	90a
2	Formulated	Low (2.5)	10.07a	23.53a	13.43a	0.21a	1.22a	91.67a
3	Commercial	High (4.5)	9.95a	17.53b	7.57b	0.12c	0.68c	85.0a
4	Formulated	High (4.5)	10.07a	20.50b	10.45ab	0.17b	0.90b	86.67a

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 4. Effect of stocking density, regardless of diet type on growth performance of Nile tilapia.

Stocking density (g/L)	AIW g/fish	AFW (g/fish)	AWG (g/fish)	ADG (g/fish/day)	SGR (%/day)	SR %
Low (2.5 g/L)	10.01a	21.02a	10.97a	0.17a	1.07a	90.83a
High (4.5 g/L)	10.07a	19.02a	9.01a	0.14a	0.79b	85.83b

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 5. Effect of diet type, regardless of stocking density on growth performance of mono-sex Nile tilapia.

Diet	AIW (g/fish)	AFW (g/fish)	AWG (g/fish)	ADG (g/fish/day)	SGR (%/day)	SR %
Commercial	10.01a	18.05a	8.03a	0.128a	0.79a	87.50a
Formulated	10.07a	21.98b	11.49b	0.190b	1.06b	89.17a

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 6. Effect of stocking density and diet composition on feed and protein utilization in mono-sex Nile tilapia.

Treatments	Diet type	Stocking density (g/L)	Feed intake (g/fish)	FCR	PER	PPV (%)	EU (%)
1	Commercial	Low (2.5)	28.6a	3.42b	1.28b	25.64b	12.2b
2	Formulated	Low (2.5)	28.32a	2.11a	1.97a	41.06a	20.7a
3	Commercial	High (4.5)	26.09a	3.56b	1.20b	22.72b	11.33b
4	Formulated	High (4.5)	27.82a	2.67a	1.61ab	29.76b	14.73b

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 7. Effect of stocking density, regardless of diet type on feed and protein utilization in mono-sex Nile tilapia.

Stocking density	Feed intake (g/fish)	FCR	PER	PPV (%)	EU (%)
Low (2.5 g/L)	28.46	2.77	1.63	33.35	16.45
High (4.5 g/L)	26.96	3.11	1.41	26.24	13.03

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 8. Effect of diet type, regardless of stocking density on feed and protein utilization in Nile tilapia.

Diet	Feed intake (g/fish)	FCR	PER	PPV (%)	EU (%)
Commercial	27.35a	3.49a	1.24a	24.18a	11.7a
Formulated	28.07a	2.38b	1.79b	35.4b	17.72b

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 9. Body chemical composition of mono-sex Nile tilapia as affected by stocking density and diet type.

Treatments	Diet type	Stocking density (g/L)	DM (%)	% On dry matter basis		
				CP	EE	Ash
1	Commercial	Low (2.5)	26.0 a	56.83 bc	16.9b	19.5 a
2	Formulated	Low (2.5)	27.33 a	60.4 a	19.50a	17.3 b
3	Commercial	High (4.5)	25.67 a	55.1c	16.20 b	18.70 a
4	Formulated	High (4.5)	25.33 a	58.4 ab	18.70 a	16.20 b

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 10. Body chemical composition of Nile tilapia as affected by stocking density, regardless of diet type.

Stocking density	DM (%)	% On dry matter basis		
		CP	EE	Ash
Low (2.5 g/L)	26.76	58.62 a	18.2 a	16.57 a
High (4.5 g/L)	25.50	56.75 a	17.45 a	17.32 a

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 11. Effect of diet type, regardless of stocking density on bod chemical composition of Nile tilapia.

Diet type	DM %	%On dry matter basis		
		CP	EE	Ash
Commercial	25.83 a	56.0 a	16.55 a	17.8 a
Formulated	26.33 a	59.4 b	19.1 b	16.94 b

a, b,....etc., mean in the same column bearing different letters are significantly different (P≤0.05)

Table 12. Effect of different stocking densities and feed type on the economic efficiency of Nile tilapia fingerlings.

Treatments	Diet type	Stocking density (g/L)	Feed cost/Kg diet (LE)	Feed cost/Kg fresh fish (LE)	Relative feed cost/Kg fresh fish (%)
1	Commercial	Low (2.5)	1.5	5.13	164.28
2	Formulated	Low (2.5)	1.48	3.1228	100.00
3	Commercial	High (4.5)	1.5	5.34	171.00
4	Formulated	High (4.5)	1.48	3.9516	126.54

* Relative feed cost/Kg fresh fish

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تأثير كثافة التخزين ونوع الغذاء علي أداء النمو والكفاءة الغذائية لإصبعيات أسماك البلطي النيلي وحيد الجنس

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أجريت هذه التجربة بمعمل بحوث الأسماك بكلية الزراعة بكفر الشيخ تم استخدام أصبعيات البلطي النيلي وحيد الجنس بمتوسط وزن ابتدائي قدره ١٠ جم/سمكة وتم توزيع الأسماك في أحواض زجاجية مقاس ٨٠×٤٠×٣٥سم بمعدلات تخزين ٢,٥ ، ٤,٥ جم/لتر وتم تغذية الأسماك في كل كثافة إما على عليقه تجارية جاهزة أو عليقه مصنعة في المعمل تحتوى كل منهما على ٢٥% بروتين حيث غذيت الأسماك بمعدل ٣% من وزن الجسم يومياً لمدة ٦٣ يوماً وكان ترتيب المعاملات كالآتي:- المعاملة الأولي: عليقه تجارية + معدل تخزين ٢,٥ جم/لتر، المعاملة الثانية: عليقه مصنعة معملياً + معدل تخزين ٢,٥ جم/لتر، المعاملة الثالثة: عليقه تجارية + معدل تخزين ٤,٥ جم/لتر بينما كانت المعاملة الرابعة:عليقه مصنعة معملياً + معدل تخزين ٤,٥ جم/لترا. ولقد أظهرت نتائج التجربة ما يلي :-

١. تأثرت معنويا قيم كل من الزيادة في الوزن (AWG) و معدل النمو اليومي (ADG) ومعدل النمو النوعي (SGR) باختلاف المعاملات التجريبية حيث سجلت المعاملة الثانية أعلى قيم لهذه المقاييس بينما لوحظت أقل قيمة لهذه المقاييس في المعاملة الثالثة.
٢. تأثرت معنوياً قيم معامل التحويل الغذائي (FCR) والكفاءة النسبية للبروتين (PER) والقيمة الإنتاجية للبروتين (PPV %) وكذلك كفاءة استخدام الطاقة (EU %) باختلاف المعاملات التجريبية حيث سجلت المعاملة الثانية (العليقة المصنعة معملياً مع كثافة تخزين ٢,٥ جم/لتر) أفضل قيمة لهذه المقاييس.
٣. لم يتأثر معنويا محتوى الجسم من المادة الجافة باختلاف المعاملات التجريبية. بينما تأثر محتوى الجسم من كل من البروتين الخام والمستخلص الإثيري والرماد باختلاف هذه المعاملات. وسجلت المعاملة الثانية أعلى قيمة لمحتوى الجسم من البروتين الخام والمستخلص الأثيري.
٤. بغض النظر عن تأثير نوع العليقة لم تتأثر معنوياً قيمة ADG ، AWG بينما تأثرت معنويا قيم معدل النمو النوعي SGR باختلاف كثافة التخزين و لم تختلف معنوياً قيمة FCR وPER،PPV%، EU% باختلاف كثافة التخزين ولوحظ أن أفضل قيم لهذه المعايير السابقة كان مع كثافة التخزين المنخفضة (٢,٥ جرام /لتر).

٥. لم تسجل أية فروق معنوية في محتوى الجسم من كل من المادة الجافة والبروتين الخام والمستخلص الأثيري والرماد بين كثافتي التخزين، كما أظهرت النتائج أن معدل الحياة قد انخفض معنوياً بزيادة كثافة التخزين.

٦. بغض النظر عن تأثير كثافة التخزين زادت معنويا قيم AWG ، ADG ، SGR في الأسماك التي تغذت علي العليقة المصنعة معملياً، ولوحظ أيضا انخفاض FCR و زيادة كل من PER وقيمة PPV% وEU% في الأسماك التي تغذت علي العليقة المصنعة معملياً ، كما تأثر معنوياً محتوي جسم الأسماك من البروتين الخام والمستخلص الإثيري والرماد باختلاف نوع العليقة ، بينما لم تلاحظ أية فروق معنوية في محتوي جسم الأسماك من المادة الجافة و لم يتأثر معنويا معدل الحياة باختلاف نوع العليقة.

٧. أظهرت بيانات التقييم الاقتصادي (تكلفة الغذاء/ كجم زيادة في الوزن) أن المعاملة الثانية (العليقة المصنعة معمليا وكثافة تخزين ٢,٥ جم / لتر) هي الأفضـــل اقتصاديا بينما كانت المعاملة الثالثة (العليقة التجارية وكثافة تخزين ٤,٥ جم/ لتر) هي الأقل اقتصادياً .