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Effect of Broodstock Size and Feeding Regime on Growth Performance and Feed Utilization of Nile Tilapia, *Oreochromis niloticus* (L.) Reared in Hapa-in-Pond Hatchery System

F.I. Magouz*, M.A.R. Ibrahim*, Y. A. F. Hammouda, M.M. Zaki El-Din**, A. S. Eid***and A.M. Tahoun****

**Animal Production Dept., Faculty of Agriculture, Kafr El-Sheikh University, **Animal Production Dept., Agric. Research Division, National Research Centre, Cairo and ***Animal Production and Fish Wealth Dept., Faculty of Agriculture, Sues Canal University, Ismailia, Egypt.*

IN 3X2 FACTORIAL design, three feeding regimes were tested in combination with two different Nile tilapia broodstock sizes (Small size:- ♂:87.17±1.81 and ♀: 69.31 ± 0.90g and large size:- ♂:166.28±1.49 and ♀: 143.81± 1.32g). In the 1st feeding regime, broodstock were fed diet No.1 (25%CP/ 3434 Kcal ME/ kg) throughout the whole experimental period (120 days) while, in the 2nd feeding regime, broodstock were fed diet No.1 until spawning batch and thereafter fed diet No.2, which contained (30%CP/ 3533 Kcal/ kg) for a period of 7 days. Form the 8th day after seed harvesting, brood-fish were fed again diet No.1 until the subsequent spawning and so on until the end of the experimental course. In the 3rd feeding regime, fish were fed diet No.2 until spawning batch and thereafter fed diet No.3, which contained (35%CP/ 3760 K cal kg) for 7 days. Form the 8th day after seed harvesting, the broodstock were fed again the diet No.2 until the subsequent spawning and so on throughout the whole experimental period. The three feeding regimes were tested in combination with the two sizes to obtain 6 experimental treatments. The treatments were assigned according to 3×2 factorial design with three replicates/ treatment giving total number of 18 spawning hapas. Growth performance of Nile tilapia broodstock found to be significantly (P≤0.05) affected by broodstock size and feeding regime, while broodstock survival rates did not significantly (p>0.05) affected. All treatments had 100% survival rates. Feed intake (g) and feed conversion ratio (FCR) did not significantly affected by the experimental treatments. The PER, PPV (%), and EU (%) were significantly (P≤0.05) affected by the experimental treatments. It was observed that, body DM%, CP% and EE% were significantly (P≤0.05) affected by broodstock feeding regime regardless of broodstock size. There is a considerable difference in feed requirements before and after ovulation. The best broodstock growth can be obtained by using the third feeding regime. Shortly, after ovulation a protein and energy rich diet should be used.

Keywords: Nile tilapia, Broodstock body size, Feeding Regime, Growth performance and Survival rates.

The nutrient requirements of broodstock may be different from growing juvenile animals. However, a full and comprehensive understanding of the reproduction mechanisms such as gonad maturation, fertilization success and larval quality is far from complete as these coordinated processes are very complex. Broodstock nutrition studies provide knowledge by determining if reproductive performance of a particular fish species can be improved by maternal dietary intake. However, broodstock nutrition is still poorly understood due to difficulties in conducting studies involving proper feeding and reproduction (Chong *et al.*, 2004). The quality of a particular food depends on its composition, and how the feed is stored and managed in a particular feeding regime. An improvement in broodstock nutrition and feeding has been shown to greatly improve not only egg and sperm quality but also seed production. Gonadal development and fecundity are affected by certain essential dietary nutrients, especially in continuous spawners with short vitellogenic periods. Thus, during the last two decades, more attention has been paid to the level of different nutrients in broodstock diets. However, studies on broodstock nutrition are limited and relatively expensive to conduct (Watanabe, 1997, Tahoun, 2007, Hammouda *et al.*, 2008 and Ibrahim *et al.*, 2008). The aim of the present study was to evaluate the effects of different broodstock sizes and feeding regime on growth performance and protein and feed utilization of Nile tilapia *Oreochromis niloticus* (L.) broodstock.

Material and Methods

Three experimental diets were formulated to contain low, intermediate and high dietary protein and energy levels as follows:

Experimental diets	Protein level (%)	Lipid level (%)	P/ E ratio*
Diet 1 (Low protein and energy)	25.0	4.0	75.0
Diet 2, Intermediate-protein an energy)	30.0	6.0	85.0
Diet 3 (High protein and energy).	35.0	8.0	93.0

* Expressed as mg protein/ Kcal Metabolizable energy).

Nile tilapia broodstock were fed accordingly three different feeding regimes, in the 1st feeding regime, the broodstock were fed diet No.1 throughout the whole experimental period (120 days) while, in the 2nd regime, fish were fed diet

No.1 until spawning batch and thereafter fed diet No.2 for 7 days. Form the 8th day after seed harvesting, the brood-fish were fed again the diet No.1 until the subsequent spawning and so on for the whole experimental course. In the 3rd regime, fish were fed diet No.2 until spawning batch and thereafter fed diet No.3 for 7 days. Form the 8th day after seed harvesting, the brood-fish were fed again the diet No.2 until the subsequent spawning and so on for the whole experimental course (120 days). The three experimental feeding regimes were tested in combination with two different broodstock size classes to obtain 6 treatments. The six experimental treatments were assigned according to 3X2 factorial design with three replicates/ treatment giving total number of 18 spawning hapas. The treatments were subjected to be studied as follows:

Symbol	Broodstock weight (g)*	Feeding regime
T 1	Small size: - ♂:87.17±1.81 and ♀: 69.31 ± 0.90g.	1st feeding regime.
T 2	Small size: - ♂:87.17±1.81 and ♀: 69.31 ± 0.90g.	2nd feeding regime.
T 3	Small size: - ♂:87.17±1.81 and ♀: 69.31 ± 0.90g.	3rd feeding regime.
T 4	Large size: - ♂:166.28±1.49 and ♀: 143.81± 1.32g.	1st feeding regime.
T 5	Large size: - ♂:166.28±1.49 and ♀: 143.81± 1.32g.	2nd feeding regime.
T 6	Large size: - ♂:166.28±1.49 and ♀: 143.81± 1.32g.	3rd feeding regime.

* Mean weight + standard error of mean.

Experimental fish

An over-wintered Nile tilapia *O. niloticus* broodstock were obtained from a commercial fish farm located in Kafr El-Sheikh Governorate. Broodstock were netted from earthen ponds, manually selected, sexed and transferred to conditioning happas, where they were held and kept separately for 25 days for adaptation to the new environment until starting the experiment. Two different broodstock size classes (small and large broodstock) were stocked at a rate of 2 females: 1 male. The mature brood-fish initial weights were as follows:

Broodstock size	Female broodstock weight (g)*	Male broodstock weight (g)*
Small size	67.08± 0.46 to 70.83± 1.01	86.0± 4.01 to 89.17± 4.41
Large size	140.60± 2.38 to 145.67± 2.80	163.83± 2.40 to 165.67± 0.93

* Mean weight + standard error of mean.

A total number of 72 females and 18 males were counted, batch weight and stocked in each hapa at a rate of 6 (2♂: 4♀) fish/ m^2. At the beginning of experiment, random samples of 10 females and 10 males from each size class were taken, individually weighed and immediately killed and kept frozen at-18°C until proximate analysis at the end of experiment.

Experimental diets-

Three diets were formulated for tilapia broodstock containing 25, 30 and 35 % CP and had metabolizable energies of 3434.26, 3532.80 and 3760.07 Kcal to obtain three different protein/ energy ratio of 74.57, 85.77 and 92.55 mg protein/ Kcal ME for diets 1, 2 and 3, respectively (Table 1). Broodstock fed the experimental diets at a feeding rate of 2% from the total broodstock biomass in each hapa daily (6 days/week) for 106 days. The feed was introduced to broodstock in spawning hapas two times daily (at 9.00 am and 4 pm) six days per week with amounts adjusted at approximately 15 days interval in response to their weight gain. Amino acids content of each experimental broodstock and fry diets were determined using a high performance amino acid analyzer as described by Moor *et al.* (1958). Amino acids content of experimental diets are shown in Table 2.

TABLE 1. Composition and proximate analysis of the experimental diets.

Experimental diets	Diet 1 25%CP	Diet 2 30%CP	Diet 3 35%CP
Ingredients			
Fish meal (72 % CP)	7.00	11.50	14.50
Soybean meal (44 % CP)	25.00	27.00	35.00
Cotton seed meal	12.00	15.00	16.50
Corn grain	12.00	15.00	16.50
Wheat bran	32.00	22.50	20.00
Vegetable oil	3.50	3.50	3.50
Di – Calcium phosphate	2.50	2.50	2.50
Molasses	2.50	2.50	2.50
Anti-aflatoxin[1]	0.10	0.10	0.10
Vitamin C.[2]	0.10	0.10	0.10
Min. & Vit mixture[2]	0.30	0.30	0.30
Proximate analysis			
Dry matter (%)	89.0	90.0	89.0
Crude protein (%)	25.60	30.30	34.800
Ether extract (%)	4.22	6.100	8.00
Crude fibre (%)[3]	4.97	5.45	3.50
Ash (%)	9.61	10.10	9.40
Nitrogen free extract (%)	55.60	48.00	44.30
Metabolizable energy (K Cal / Kg)[4]	3434.26	3532.80	3760.07
Protein energy ratio (mg P/K Cal ME)	74.54	85.77	92.55

[1]Produced by Egyptian – Holland Co. for veterinary products (SAE), Giza, Egypt

[2]Composition of the vitamin and mineral mixture produced by Pharma Trade Company, Egypt (calculated for each Kg):-

Vitamins: Vit. A: 5714286 IU; Vit. D3: 85.714 IU; Vit. E: 7.143 mg; Vit. B1: 571 mg; Vit. B2: 343 mg; Vit. B6: 571 mg; Vit. B12 7143 mg; Vit.C: 857 mg; Biotin: 2857 mg; folic acid: 86 mg and pantothenic acid 1143 mg.

Minerals: Phosphors: 28571 mg; Manganese: 68571mg; Zinc: 51429 mg; Iron: 34286 mg; Copper: 5714 mg; Cobalt: 229 mg; Selenium: 286 mg; Iodine: 114 mg.

[3]Crude fibre did not include in calculating ME of the diets.

[4]Metabolizable energy (ME) calculated using values of 4.50, 8.1 and 3.49 K Cal for protein, fat and carbohydrate, respectively according to Pantha (1982).

TABLE 2. Amino acid content of the experimental diets.

Amino acid	Diet 1 (25%, CP)	Diet 2 (30%, CP)	Diet 3 (35%, CP)	Requirements*
Arginine	1.65	1.75	2.09	1.18
Histidine	0.75	0.80	0.82	0.48
Isoleucine	1.45	1.49	1.60	0.87
Leucine	1.73	2.02	1.97	0.95
Lysine	1.95	2.10	2.21	1.43
Methionin	0.85	0.94	1.15	0.75
Phenylalanine	1.12	1.42	1.39	1.05
Threonine	0.97	1.213	1.51	1.05
Tryptophan	0.36	0.43	0.49	0.28
Valine	1.82	1.80	1.72	0.78

* Santiago and Lovell (1988).

Analytical methods

At the end of the experiment, all broodstock in each hapa were netted, weighed and finally frozen for final body composition analysis. Representative samples of the experimental fish were randomly taken at the beginning and at the end of the experiment. Fish samples were killed and kept frozen (-18°C) until performing the body chemical analysis. Samples of the experimental fish diets were taken, ground and stored in a deep freezer at -18°C until proximate analysis. All of chemical analyses of fish and fish feeds were determined according to A.O.A.C. (1990). Initial analyses were carried out on a pooled sample of fish, which were weighed and frozen prior to the experiment.

Growth performance parameters

The growth performance parameters are 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 – Average initial weight]/time (days).
- Specific Growth Rate (SGR %/day) = 100 [Ln Wt1 –Ln Wt 0 / t]

Where: - Ln: Natural log, Wt 0: initial weight (g), Wt 1: final weight (g) and T: time of days.

Feed and protein utilization parameters

Feed and protein utilization parameters are calculated according to the following equations

-Feed Conversion Ratio (FCR) = Total feed consumption/ weight gain.

-Protein efficiency ratio (PER) = body weight gain (g)/ protein intake (g).

-Protein -production value (PPV %) = 100 [Reta;ined protein (g)/ protein intake].
-Energy utilization (EU %) = 100 [Retained energy (Kcal)]/ energy intake (Kcal).

Water quality parameters

Air and water temperatures were determined four times weekly at 6.00 am and 2.00 pm by using a thermometer. Water dissolved oxygen (DO) content and water pH were measured weekly at 2.00 pm using a digital dissolved oxygen meter (Jenway model 9070) and a digital pH meter (model checker1 produced by Hanna Instrument Co.), respectively. Water salinity (mg/L) was determined biweekly using a digital conductivity meter (Jenway model 4075). Water alkalinity and total ammonia nitrogen (TAN mg/ L) were weekly determined following the methods described by Chattopadhyay (1998).

Statistical analysis

Statistical analysis of the experiment was done using statistical package SAS Version 9 (SAS Institute, 2002). Data were statistically analysed in a factorial design procedure. Mean of treatments were compared by Duncan (1955) multiple range test.

Results and Discusion

Water quality criteria

The average values of water quality parameters measured throughout the experimental period are summarized in Table 3. Concerning the pond's water temperatures in the present work, it is noted that, all values of pond's water temperature were closely suitable for the normal growth of warm-water fish. The results are in agreement with those of Dan & Little, 2000; El-Gamal & El-Greisy, 2005, Yi *et al.*, 2005 and Lamoureux *et al.* 2006, who reported that temperatures higher than 20 up to 32°C support tilapia to grow well. It can be observed that, the present pH values of the experimental pond water are within the acceptable range required for grow out of the fish culture (Popma and Masser, 1999).

TABLE 3 . Means of water quality criteria of the experimental earthen pond.

Month	Temperature (°C)			pH	DO (mg/L)		TAN (mg/L)	TA (mg/L)
	Air	Water (am)	Water (pm)		am	pm		
May 2004	25.9	24.3	22.2	7.90	1.33	7.50	0.010	145.0
June 2004	29.7	28.6	24.9	7.80	1.43	6.50	0.009	165.0
July 2004	32.5	29.0	27.3	8.45	1.44	6.90	0.120	179.0
August 2004	31.2	28.0	26.5	8.30	1.25	7.90	0.160	200.0
September 2004	29.1	26.7	22.9	7.80	1.09	8.00	0.015	168.0
October 2004	27.7	24.5	21.2	8.30	1.60	7.90	0.120	200.0

TAN= Total ammonia nitrogen, TA= Total alkalinity

The afternoon (pm) dissolved oxygen (DO) levels are within the optimum range and higher than 5 mg/ L which reported by Boyd (1979) as the minimum desirable DO level in fish ponds. Concerning pre-sunrise (am) DO levels, it can be say that tilapia routinely survive at dawn DO concentrations less than 0.5 mg/ L (Egna and Boyd, 1997 and Ridha and Cruz, 1998). The pre-sunrise DO levels in the present study were higher than the level of DO (0.3 mg/L) which reported by Lawson (1995) as a lethal level. Warm-water fish in ponds die after short-term exposure to less than this level, while 1.5 mg/ L DO is necessary to keep fish alive. Total ammonia nitrogen (TAN) values ranged between 0.009 and 0.160 mg/ L. were lower than the undesired maximum limit of TAN concentration (1.0 mg/L) as reported by Meade, 1989, Lawson, 1995 and Ridha and Cruz, 1998). Brunty *et al.* (1997) noted that, high levels of TAN could reduce fish vitality and/ or growth. Moreover, they can cause death in extreme cases. It is also found that, the total alkalinity (TA) concentrations remained within the levels (10-400 mg/ L as Ca Co_3) which reported by Meade as satisfactory TA for most aquaculture fish species. waters having a total alkalinity below 30 mg/ L are considered poorly buffered against rapid pH changes. Fish ponds having low total alkalinity often, have pH values of 5-7.5 at daybreak or sunrise time (Lawson 1995, Tahoun, 2002 and Tahoun, 2007).

Broodstock growth performance and survival rates

Growh performace of Nile tilapia broodstock as affected by broodstock size and feeding regime are given in Table 4. The data indicated that, there are significant (P≤0.05) differences among different broodstock groups in terms of average final weight (AFW), average weight gain (AWG), average daily gain (ADG) and specific growth rate (SGR) while, survival rates in all treatments were 100%. The highest AWG (64.83±1.17g) and ADG (0.69±0.01g) for male tilapia broodstock were observed in T6 (larger broodstock size and fed according to the 3rd feeding regime). The lowest male AWG (45.50±0.29g) and ADG (0.43±0g) were observed in T1 (smaller broodstock size at the1st feeding regime). The SGR values for male tilapia broodstock ranged between 0.29±0 and 0.52±0.07 % day for T1 and T2, respectively. The highest AWG (37.42±2.9g) and ADG (0.37±0.29 g) for female Nile tilapia broodstock were recorded for the T2 and T6, respectively while, the lowest female AWG (26.33±1.46g) and ADG (0.29±0.25g) were recorded for T5 and T1, respectively. It can be noted that, male tilapia growth rate was higher than that of female broodstock. In this connection, Toguyeni et *al.* (2002) cited that male tilapia grow faster than females, males start growing faster than females long before sexual maturity. This better growth in males could not be attributed only to higher allocation of metabolic energy into gameto-genesis in females as compared to males. The higher growth of males as compared to female tilapia broodstock was confirmed by the findings of Beardmore *et al.* (2001) who stated that, the use of male tilapia fish is intrinsically desirable in a variety of fish species in a range of aquaculture production systems. The potential advantages sought from their use may include one or more of the following features: achievement of higher average growth rate, elimination of reproduction, reduction of sexual territorial behavior, reduction of variation in harvest size, and reduction of risk of environmental impact resulting from escapes of exotic species.

The AFW, AWG, ADG and SGR of Nile tilapia broodstock as affected by feeding regime regardless of broodstock size are shown in Table 5. The results indicated that, there are significant ($P \leq 0.05$) differences among feeding regimes in AFW, AWG, ADG and SGR of male broodstock. No significant differences were observed among males in their survival rates (SR %). The highest AFW (187.0±21.19), AWG (57.75±4.59), ADG (0.60±0.05) and SGR (0.43±0.05) were recorded for T3 (the3[rd] feeding regime) while, the lowest values were 173.25±18.54, 47.25±0.82, 0.46±0.013 and 0.32±0.05, respectively for AFW, AWG, ADG and SGR which recorded for T1 (the first feeding regime).

TABLE 4. Effect of Nile tilapia, *Oreochromis niloticus* (L.) broodstock size and feeding regime on growth performance parameters (Mean ± SE).

Treat.	AIW (g)		AFW (g)		AWG (g)		ADG (g/ day)		SGR (%/ day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	86.33 b ±0.73	70.83 b ±1.014	131.83 e ±1.01	105.27 c ±0.96	45.50 c ± 0.29	34.42ab ± 1.95	0.43 ± 0 b	0.29 b ± 0.25	0.29 c ± 0	0.21 c ±0.20
T2	86.00b ±4.01	70.00 b ± 2.17	136.83ed ±2.20	107.43 ± 1.03 c	50.83bc ±5.93	37.42 a ± 2.92	0.50 b ±0.06	0.27 b ±0.02	0.36 bc ±0.02	0.19 c ±0.12
T3	89.167b ±4.41	67.08 b ± 0.464	139.83 ± 3.37 d	103.43 ±0.3 c	50.67 bc ±7.340	36.33 a ±0.17	0.52 b ±0.08	0.34ab ±0.21	0.36 bc ±0.01	0.22 c ±0.14
T4	165.67a ±0.93	140.60a ±2.39	214.67 c ±1.20	169.63 b ±1.67	49.0 bc ±00.50	29.0bc ±2.55	0.49b ±0.01	0.33ab ±0.19	0.47 ab ±0	0.44 b ±0.03
T5	163.83a ±2.40	145.17a ± 2.32	225.83 b ±0.60	171.53ab ±1.14	62.00 ab ±2.75	26.33 c ±1.46	0.65 a ±0.03	0.37 a ±0.29	0.52 a ±0.07	0.48 a ±0.04
T6	169.33a ±3.48	145.67a ±1.45	234.17 a ±2.84	177.53 a ±0.72	64.83 a ±1.17	31.83 b ±1.97	0.69 a ±0.01	0.37 a ±0	0.50 a ±0.08	0.48 a ±0.01

Means in the same column having different letters are significantly different ($P \leq 0.05$).

T1:-Small size +1[st] feeding regime. T4:-Large size+ 1[st] feeding regime.

T2:-Small size+2 [nd] feeding regime. T5:-Large size + 2[nd] feeding regime

T3:-Small size +3 [rd] feeding regime. T6:-Large size + 3[rd] feeding regime.

TABLE 5. Effect of Nile tilapia, *Oreochromis niloticus* broodstock feeding regime regardless of size on growth performance (Mean ± SE).

Treat.	AIW (g)		AFW (g)		AWG (g)		ADG (g/ day)		SGR (%/ day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	126.00ab ±17.75	105.72 b ±15.64	173.25c ±18.54	137.45 b ±14.40	47.25b ±0.82	31.71 b ±1.88	0.46b ±0.01	0.31 b ±0.02	0.38 b ±0.041	0.32b ±0.05
T2	124.92 b ±17.93	107.51 a ±16.87	181.33b ±19.93	139.48 a ±14.35	56.42 a ±3.84	31.88ab ±2.88	0.57 a ±0.04	0..32ab ±0.03	0.44 a ±0.047	0.33ab ±0.07
T3	129.25 a ±18.10	106.38 a ±17.59	187.00a ±21.19	140.48 a ±16.57	57.75 a ±4.59	34.08 a ±1.34	0.60 a ±0.05	0.36 a ±0.01	0.43 a ±0.05	0.35 a ±0.06

Means in the same column having different letters are significantly different ($P \leq 0.05$).

The 1[st] feeding regime (T1):- broodstock fed diet 1 (25%CP) throughout the whole experimental period.

The 2[nd] feeding regime (T2):- broodstock fed diet 1 until spawning batch and thereafter fed the intermediate feed (diet 2) for 7 days. Form the 8[th] day after seed harvesting, the brood-fish fed again the diet 1 until the subsequent spawning.

The 3[rd] feeding regime (T3):- broodstock fed diet 2 (30% CP) until spawning batch and thereafter fed diet 3 (35%CP) for 7 days. Form the 8[th] day, after seed harvesting, the broodstock fed again the diet 2 (25%CP) until the subsequent spawning and so on for the whole experimental course.

The differences found in growth measurements as affected by the experimental feeding regimes may be due to the differences in diet composition as the 3rd feeding regime (Diets No.2 and No.3) had much higher dietary protein and lipid levels as compared to the st (Diet1) and the 2nd (Diets No.1 and No.2) feeding regimes. In addition, increasing fish meal amount may be more effective for covering the essential amino acid profile required for higher growth (Tables 1 & 2). Robinson *et al.* (2001) cited that, the requirements for proteins and their structural components, amino acids, have been studied for several years. Yet, there is still a debate as to which level of dietary protein provides for cost-effective growth. The level of dietary protein and amino acids needed for the most economical gain may differ as the cost of feed ingredients varies. In addition, it is difficult to set a level of protein that is optimum for all situations because of the factors that affect the dietary protein requirements. These include water temperature, feed allowance, fish size and amount of non-protein energy in the diet, protein quality, natural food availability, and management practices. In this connection, 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 above author recommended a dietary protein level of 25-30% for tilapia (from10g to marketable size). The increased male AFW, AWG and ADG of the third feeding regime as compared to the 1st and the2nd feeding regimes may be attributed to increasing the level of dietary lipid level from 4.22% (diet No.1) and 6.10 % (diet No.2) to 8.0 (diet No.3) and this was confirmed by the results of Siddiqui *et al.*, 1988; Jauncey, 2000 and Magouz *et al.*, 2002 who indicated that tilapia require 8% lipid in their diet to obtain higher growth. On the other side, Wilson (1991) stated much lower dietary lipid levels of 5 to 6% as the lipid requirements for tilapia. Furthermore, 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.

The AIW, AFW, AWG, ADG and SGR of Nile tilapia broodstock as affected by broodstock size without consideration of feeding regime are given in Table 6. The data revealed that, there are significant ($P \leq 0.05$) differences between broodstock size classes in AFW, AWG, ADG and SGR and they were in favour of the larger broodstock class.

In this study, it was observed that, growth performance parameters of Nile tilapia broodstock were found to be significantly ($P \leq 0.05$) affected by initial broodstock stocking size and this is in accordance with the results of Ahmed *et al.* (2004) who found that growth performance was significantly ($P \leq 0.05$) affected by protein level and fish initial size, however the interaction among the two studied factors was insignificant. Comparable results were obtained by Akbulut *et al.* (2003) who found that, the growth rate and final biomass of rainbow trout were significantly affected by initial stocking size. In addition, Duston *et al.* (2004) found that, the final biomass of juvenile stripped bass was significantly affected by the initial stocking size.

TABLE 6. Effect of Nile tilapia *Oreochromis niloticus* (L.) broodstock size regardless of feeding regime on growth performance (Mean ± SE).

Treat.	AIW (g)		AFW (g)		AWG (g)		ADG (g/ day)		SGR (%/ day)	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
T1	87.17 b ±1.80	69.32 b ±0.904	136.17b ±1.67	105.3b ±0.71	49.0 b ±2.86	29.06b ±1.29	0.49b ±0.03	0.30b ±0.01	0.34 b ±0.01	0.21b ±0.01
T2	166.28a ±1.49	143.8a ±1.32	224.89a ±2.96	172.9a ±1.25	58.61a ±2.59	36.06a ±1.11	0.61a ±0.03	0.37a ±0.01	0.50a ±0.03	0.47a ±0.17

Means in the same column having different letters are significantly different ($P \leq 0.05$).
T1:- Class1, Small size (♂:87.17±1.81 and ♀: 69.31 ±0.90).
T2:- Class2, Large size (♂:166.28±1.49 and ♀:143.81±1.32).

Broodstock protein and feed utilization

As shown in Tables 7 & 8 it can be noted that, there were significant ($P \leq 0.05$) differences among the treatments in terms of feed intake, feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV%) and energy utilization (EU%) as affected by different broodstock sizes and feeding regimes. In this experiment, an attempt was made to establish a relationship between the feeding regime of broodstock sizes on one side and the efficiency to utilize the feed on the other side in order to assess the best broodstock feeding practice.

The effects of Nile tilapia broodstock feeding regime regardless of broodstock size on protein and feed utilization parameters are shown in Table 8. Protein feed and utilization measurements were significantly ($P \leq 0.05$) influenced by broodstock feeding regime. The best measurements were in favour of T3 followed by T2 and T1, respectively.

TABLE 7. Feed and protein utilization of Nile tilapia, *Oreochromis niloticus* broodstock (both sexes) as affected by tilapia broodstock size and feeding regime (Mean ± SE).

Treat.	Feed intake (g)	Feed conversion ratio	Protein efficiency ratio	Protein productive value (%)	Energy utilization (%)
T1	175.34 a ±10.36	2.19 a ±0.09	1.47 b ±0.05	24.31 c ±0.78	12.50 d ±0.02
T2	189.65 a ±13.14	2.16 a ±0.08	1.58 c ±0.06	28.84 b ± 0.47	13.50cd ±0.69
T3	186.59 a ±6.82	2.16 a ±0.11	1.62 b ±0.01	28.14 b ± 0.86	15.19 bc ± 0.27
T4	170.34 a ±1.37	2.19 a ±0.10	1.47 c ±0.02	28.63 b ± 0.84	14.56 bc ± 0.52
T5	175.10 a ±20.04	1.98 a ±0.18	1.65 b ±0.02	29.42 b ± 0.40	15.90 b ±0.06
T6	184.97 a ±3.38	1.92 a ±0.06	1.83 a ±0.01	34.54 a ± 0.06	18.39 a ± 0.28

Means in the same column having different letters are significantly different ($P \leq 0.05$).

T1:-Small size +1st feeding regime. T4:-Large size+ 1st feeding regime.

T2:-Small size+2nd feeding regime. T5:-Large size + 2nd feeding regime

T3:-Small size +3rd feeding regime. T6:-Large size + 3rd feeding regime.

TABLE 8. Feed and protein utilization of Nile tilapia broodstock as affected by feeding regime regardless of broodstock size (Mean ± SE).

Treat.	Feed intake	Feed conversion ratio	Protein efficiency ratio	Protein productive value (%)	Energy Utilization (%)
T1	172.93b ± 4.80	2.19 a ±0.06	1.47 a ±0.02	26.47 b ± 1.10	13.53b ±0.61
T2	182.38 a ±11.20	2.07 ab ±0.01	1.62 a ±0.03	29.13 ab ± 0.30	14.70 b ±0.66
T3	185.0 a ±3.43	2.04 b ±0.08	1.72 a ±0.05	31.34a ±0.05	16.79 a ±0.73

Means in the same column having different letters are significantly different (P≤0.05).
The 1st feeding regime (T1):- broodstock fed diet 1 (25%CP) throughout the whole experimental period.
The 2nd feeding regime (T2):- broodstock fed diet 1 until spawning batch and thereafter fed the intermediate feed (diet 2) for 7 days. Fonn the 8th day after seed harvesting, the brood-fish fed again the diet 1 until the subsequent spawning.
The 3rd feeding regime (T3):- broodstock fed diet 2 (30% CP) until spawning batch and thereafter fed diet 3 (35%CP) for 7 days. Form the 8th day, after seed harvesting, the broodstock fed again the diet 2 (25%CP) until the subsequent spawning and so on for the whole experimental course.

Feed and protein utilization of Nile tilapia broodstock as affected by broodstock size without consideration of feeding regime are shown in Table 9. It can say that feed intake (g/fish), feed conversion ratio (FCR) did not significantly affected by broodstock size while, the statistical analysis revealed that larger (T2) broodstock significantly (P≤0.05) utilized protein and feed in terms of PER, PPV (%) and EU (%) more efficiently than smaller broodstock.

TABLE 9. Feed and protein utilization parameters of Nile tilapia, *Oreochromis niloticus* broodstock as affected by size regardless of feeding regime (Mean ± SE).

Treat.	Feed intake (g)	Feed conversion ratio	Protein efficiency ratio	Protein productive value (%)	Energy Utilization (%)
T1	183.86 a ± 5.65	2.17 a ± 0.05	1.55 b ± 0.03	27.10 b ± 0.791	13.7 b ±0.45
T2	176.87 a ±6.25	2.03 a ± 0.08	1.65 a ± 0.05	30.86 a ± 0.96	16.28 ± 0.64

Means in the same column having different letters are significantly different (P≤0.05).
T1:- Class1, Small size (♂:87.17±1.81 and ♀: 69.31 ±0.90).
T2:- Class2, Large size (♂:166.28±1.49 and ♀:143.81±1.32).

Ahmed *et al.* (2004) found significant (P≤0.05) effects of dietary protein levels and initial stoking sizes. The above authors found that, interaction between both factors (dietary protein and initial stocking size) did not affect the feed intake and feed conversion ratio. Feed conversion ratio was declined with increasing the initial fish size. From our results on FCR, it can say that FCR declined with increasing the level of dietary protein and the protein to energy (P/E) ratio. This was confirmed by the findings of Ahmed *et al.* (2004). Al-Hafedh (1999) and Khattab *et al.* (2000) obtained comparable results. The present results are in a parallel line with those reported by Akbulut *et al.* (2003) who found that the FCR and daily feeding rate of rainbow tout were significantly (P≤0.05) influenced by initial stocking size. Duston *et al.* (2004) found that FCR of juvenile stripped bass was significantly (P≤0.05) affected by initial stocking size. In this study, protein efficiency ratio (PER) and protein productive value (PPV%) were significantly (P≤0.05) affected by dietary protein levels and reflected that, protein utilization increased by increasing the level of dietary protein from 25 to 25-30 and 30-35% CP which are in disagreement with the results obtained by Ahmed *et al.* (2004) on PER and PPV% which used as indicators of protein quality and quantity in fish feeds and amino acid balance. These fore-mentioned parameters are used to assess protein utilization and turnover where they are related to dietary protein intake and its conversion into fish gain and protein gain. They added that, protein growth rate (PGR) inversely influenced by fish size indicating that protein utilization decreased by increasing fish size. These results may be attributed to the fact that, the major part of the weight gain is related to the deposition of protein and the protein accretion is a balance between protein anabolism and catabolism.

Broodstock chemical composition

As shown in Table 10 the differences among treatments were significant (P≤0.05) in body dry matter, crude protein, ether extract while, the body ash content did not significantly affected by different broodstock sizes and feeding regimes. The data of the effects of Nile tilapia broodstock feeding regime regardless of broodstock size on body chemical composition (both sexes) are shown in Table 11. It can be note that, there were significant (P≤0.05) differences in body chemical composition among different feeding regimes except for body ash content. The insignificant differences of body ash content as acffected by diffferent feeding regime in our study disagreed with the findings of El-Saidy *et al.* (1999), who found that ash content of Nile tilapia increased with increasing the dietary protein level.

TABLE 10. Body chemical composition of Nile tilapia, *Oreochromis niloticus* broodstock (both sexes) as affected by broodstok size and feeding regime (Mean ± SE).

Treat.	Moisture (%)	Dry matter (%)	On dry matter (%)		
			CP	EE	Ash
T1	73.56 b ± 0.07	26.03 b ± 0.37	61.16 b ± 0.70	13.57 b ± 0.27	22.70 a ± 0.38
T2	73.77 b ± 0.48	26.80 a ± 0.153	61.44 b ± 0.728	14.56 ab ± 0.80	22.40 a ± 0.513
T3	75.18 a ± 0.25	25.08 c ± 0.22	59.97 b ± 0.38	12.63 c ± 0.20	23.37 a ± 0.28
T4	73.60 b ± 0.32	25.73 b ± 0.69	60.73 ab ± 1.45	14.57 ab ± 0.70	22.87 a ± 0.29
T5	74.99 a ± 0.28	25.413 bc ± 0.58	60.10 b ± 1.039	13.56 b ± 0.615	23.30 a ± 0.44
T6	73.00 c ± 0.23	27.00 a ± 0.23	63.23 a ± 0.29	15.48 a ± 0.36	21.63 a ± 0.20

Means in the same column having different letters are significantly different (P≤0.05).

T1:-Small size +1st feeding regime. T4:-Large size+ 1st feeding regime.

T2:-Small size+2nd feeding regime. T5:-Large size + 2nd feeding regime

T3:-Small size +3rd feeding regime. T6:-Large size + 3rd feeding regime.

In support, Essa (1995) who found that, the least fat content of Nile tilapia breeders was recorded for the feeding regime which had the minimum fat content as compared with the other feeding regime and this are in accordance with our results and may be attributed for the significant (P≤0.05) decline in feed intake and FCR of that group. Lie (2001) reported that fish nutrition has an immportant impact on several parameters directly influencing the quality of the fish such as, color and appearance, smell, taste, texture, nutritional quality, shelf life and level. Although, there are several studies showing that the deposition of fat is dependent on the level of dietary level of lipids in diets for the different farmed fish species regarding fillet quality has not yet been clearly defined. Further more, there is a need for a more understanding of the lipid metabolism in fish. Regarding the whole body composition of Nile tilapia broodstock (both sexes) as affected by broodstock size without respect to feeding regimes (Table 12), It was observed that, the whole body composition of Nile tilapia broodstock (both sexes) significantly (P≤0.05) affected by initial broodstock size except for body ash content. Ahmed *et al.* (2004) investigated the relationship between the dietary protein level and chemical composition of the whole body of fry, fingerlings and mature Nile tilapia and found that, fish fed 25%CP diet had lower (P≤0.05) protein content and higher (P≤0.05) content of lipid than fish fed 35%CP or 45%CP diets which are in a agreement with our results on body protein and in a disagreement with our results on body lipid content.

TABLE 11. Body chemical composition of Nile tilapia broodstock (both sexes) as affected by broodstock feeding regimes regardless of size ((Mean ± SE).

Treat.	Moisture (%)	Dry matter (%)	On dry matter (%)		
			CP	EE	Ash
T1	74.38a ±0.38	25.56 b ±0.29	60.57 b ±0.44	13.10 b ±0.26	23.04 a ±0.258
T2	74.38 a ±0.36	26.11 b ±0.409	60.77 b ±0.642	14.11 a b ±0.51	22.85 a ±0.36
T3	73.300 b ±0.22	26.37 a ±0.43	61.98 a ±0.88	15.01a ±0.40	22.25 a ±0.32

Means in the same column having different letters are significantly different (P≤0.05).
The 1st feeding regime (T1):- broodstock fed diet 1 (25%CP) throughout the whole experimental period.
The 2nd feeding regime (T2):- broodstock fed diet 1 until spawning batch and thereafter fed the intermediate feed (diet 2) for 7 days. Form the 8th day after seed harvesting, the brood-fish fed again the diet 1 until the subsequent spawning.
The 3 rd feeding regime (T3):- broodstock fed diet 2 (30% CP) until spawning batch and thereafter fed diet 3 (35%CP) for 7 days. Form the 8th day, after seed harvesting, the broodstock fed again the diet 2 (25%CP) until the subsequent spawning and so on for the whole experimental course.

In support, Al-Hafedh (1999) and Ibrahim *et al.* (2008) and found that, dietary protein content of the diets (P≤0.05) influenced the protein content of the fish body. Fish fed 40–45% dietary protein had significantly (P≤0.05) higher body protein content than the fish fed low protein diets (25–35%). For the lipid content of the fish body in relation to dietary protein level, no definite trend was noted, but generally, the lipid level decreased with the increasing dietary protein level. The present results on body ash content as affected by the dietary protein level were confirmed by those of Khattab *et al.* (2000) and Ahmed *et al.* (2004) who reported that body ash content was unaffected by the dietary protein level in Nile tilapia and this is in a complete accordance with the findings of the present results.

TABLE 12. Chemical composition of Nile tilapia broodstock (both sexes) as affected by broodstock size regardless of feeding regime (Mean ± SE).

Treat.	Moisture(%)	Dry matter(%)	On dry matter%		
			CP	EE	Ash
T1	74.05 a ±0.262	25.73 b ±0.295	60.07b ±0.575	13.88 b ±0.318	22.96 a ±0.21
T2	73.98 b ±0.36	26.92 a ±0.32	61.55 a ±0.53	14.25 ±0.50a	22.47 a ±0.31

Means in the same column having different letters are significantly different (P≤0.05).
T1:- Class1, Small size (♂:87.17±1.81 and ♀: 69.31 ±0.90).
T2:- Class2, Large size (♂:166.28±1.49 and ♀:143.81±1.32).

From the results of the present study, it can be concluded that, there is a considerable difference in feed requirements before and after ovulation. Shortly, after ovulation a protein and energy rich diet should be used.

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تأثير حجم قطيع التفريخ و النظام الغذائى علي كل من النمو وكفاءة الاستفادة من الغذاء لأسماك البلطي النيلي

فوزي إبراهيم معجوز*، مصطفي عبد الرحمن ابراهيم* ياسر أحمد فتحي حمودة، ، منال محمد علي زكي الدين** ، عبد الحميد صلاح عيد*** والعزب محمد طاحون****

* قسم الإنتاج الحيواني، كلية الزراعة- جامعة كفر الشيخ**، قسم الإنتاج الحيواني- شعبة البحوث الزراعية والبيولوجية، المركز القومي للبحوث- القاهرة و*** قسم الإنتاج الحيواني والثروة السمكية - كلية الزراعة - جامعة قناة السويس- الإسماعيلية – مصر.

أجريت هذه التجربة في مفرخ مزرعة تجارية بمحافظة كفر الشيخ في موسم التفريخ سنة ٢٠٠٣ واستخدم في فيها حجمين من ذكور وإناث أسماك البلطي النيلي حيث كانت متوسطات الوزن الابتدائي للإناث (٦٩,٣١ ±٠,٩٠) بينما كانت أوزان الذكور (١٤٣,٨١±١,٢٣ و١٠٤٩± ١٦٦,٢٨) للحجم الأصغر والأكبر على الترتيب، كما استخدمت ثلاثة أنظمة غذائية مختلفة في النظام الغذائي الأول تمت تغذية قطيع التفريخ على العليقه رقم ١ (٢٥ ٪ بروتين خام) خلال الفترة التجريبية، بينما فى النظام الغذائي الثاني تمت تغذية الأسماك على العليقه الأولى (٢٥٪) بروتين خام من بداية التجربة حتى حدوث التفريخ الأول ثم تغذيتها من اليوم التالي لحدوث التفريخ على العليقه الثانية (٣٠ ٪ بروتين خام) لمدة (أسبوع) ومن اليوم الثامن يتم تغذية الأسماك على العليقه رقم (١) مرة أخرى وحتى حدوث التفريخ التالي وهكذا حتى نهاية التجربة، أما النظام الغذائي الثالث تمت تغذية الأسماك فيه على العليقه رقم ٢ (٣٠ ٪) بروتين خام من بداية التجربة وحتى حدوث أول تفريخ ، ثم تمت تغذية الأسماك من اليوم التالي لحدوث التفريخ على العليقه رقم ٣ (٣٥ ٪) بروتين خام لمدة سبعة أيام ثم إعادة تغذيتها على العليقه رقم ٢ مرة أخرى إلى حدوث التفريخ التالي وهكذا . وتم اختبار الثلاث أنظمة الغذائية مع حجمي قطيع التفريخ في تجربة عاملية وكان ترتيب المعاملات كما يلي:

- المعاملة الأولي : أسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الأول.
- المعاملة الثانية : أسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الثاني
- المعاملة الثالثة : أسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الثالث.
- المعاملة الرابعة : أسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الأول.
- المعاملة الخامسة : أسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الثاني
- المعاملة السادسة: أسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الثالث.

أظهرت نتائج التجربة الأولى ما يلي :

معايير جودة المياه

بينت قياسات معايير جودة المياه خلال الفترة التجريبية (شهر يونيو إلى شهر سبتمبر) والتي اشتملت على كل من درجة حرارة المياه و pH والأكسجين الذائب

في الماء والقلوية الكلية للمياه أن جميعها داخل المدى الملائم لحياة ونمو وتناسل قطعان التفريخ في أسماك البلطي النيلي.

معايير أداء النمو و معدلات الحياة لقطعان التفريخ

تأثرت معنويا متوسطات الوزن النهائي AFW والزيادة في وزن الجسم AWG ومعدل النمو اليومي ADG ومعدل النمو النوعي SGR في كل من ذكور وإناث قطيع التفريخ المستخدم في التجربة بالمعاملات التجريبية بينما لم تتأثر قيم معدلات الحياة بالمعاملات التجريبية والتي كانت جميعها إلى 100 ٪، و قد سجلت المعاملة السادسة (حجم القطيع الأكبر و النظام الغذائي الثالث) أعلى قيم لمقاييس أداء النمو مقارنة بالمعاملات التجريبية الأخرى وتأثرت معنويا قيم معايير النمو بالنظام الغذائي لقطيع التفريخ (بغض النظر عن حجم قطيع التفريخ) بينما لم تتأثر معنويا معدلات الحياة (100 ٪) وقد سجلت المعاملة الثالثة أعلى قيم لمتوسطات الوزن النهائي والزيادة الحادثة في وزن الجسم ومعدل النمو اليومي ومعدل النمو النوعي مقارنة بالنظام الغذائي الأول والثاني .تفوقت أسماك المجموعة الثانية الأكبر حجما على مجموعة الأسماك الأصغر حجما في قيم كل من معايير النمو السابقة (بغض النظر عن النظام الغذائي) بينما لم تسجل أية فروق معنوية بين كلا من الحجمين في معدلات الحياة والتي كانت جميعها (100٪).

كفاءة قطيع التفريخ في الاستفادة من البروتين والغذاء

سجلت المعاملة السادسة أفضل قيم للغذاء المأكول ومعامل التحويل الغذائي والكفاءة النسبية للبروتين والقيمة الإنتاجية للبروتين وكفاءة الاستفادة من الطاقة مقارنة بالمعاملات الأخرى .لوحظ تأثر معايير كفاءة الاستفادة من البروتين والغذاء باختلاف النظام الغذائي (بغض النظر عن حجم قطيع التفريخ) حيث سجلت المعاملة الثالثة أفضل قيم لهذه المقاييس مقارنة بكل من النظام الغذائي الأول والثاني .تأثرت معنويات قيم مقاييس الاستفادة من البروتين والغذاء باختلاف حجم قطيع التفريخ حيث تفوقت أسماك المجموعة الثانية (القطيع الأكبر حجماً) على المجموعة الأولى في الاستفادة من البروتين والغذاء.

التحليل الكيماوي لأسماك قطعان التفريخ

تأثرت معنويا قيم كل من محتوى المادة الجافة والبروتين والمستخلص الإثيرى باختلاف المعاملات التجريبية فقد تفوقت أسماك المعاملة السادسة على باقي المجموعات حيث سجلت أعلى قيمة لمحتوى الجسم من المادة الجافة والبروتين الخام والمستخلص الإثيرى . تأثرت معنويا قيم محتوى الجسم من المادة الجافة والبروتين الخام والمستخلص الإثيرى باختلاف النظام الغذائي(بغض النظر عن حجم قطيع التفريخ) حيث سجلت مجموعة الأسماك التي غذيت على للنظام الثالث أعلى قيم للمعايير السابقة يليها أسماك المجموعة الثانية و أسماك المجموعة الأولى على الترتيب.