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Influence of Broodstock Size and Feeding Regime on Reproductive Performance and Seed Quality of Nile Tilapia *Oreochromis niloticus* under the Conditions of Hapa-in-Pond Hatchery System

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

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

THE OBJECTIVE of this study was to evaluate the effects of different broodstock sizes and feeding regime on seed production and quality of Nile tilapia *Oreochromis niloticus* broodstock reared under the conditions of hapa-in-pond tilapia hatchery system. 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 the1st feeding regime, broodstock were fed diet No.1 (25%CP/ 3434 Kcal ME/kg diet) throughout the whole experimental period (120 days) while, in the2nd feeding regime, broodstock were fed diet No.1 until spawning batch and thereafter fed diet No.2, which contained 30% CP/ 3533 Kcal/kg diet 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 Kcal/kg diet) 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 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 happas. There were significant (P≤0.05) differences among different feeding regimes and broodstock sizes throughout the subsequent clutches (4 seed collections). The 3rd feeding regime had the highest feeding regime followed by the 2nd (1145± 53.87) and the 1st (1048± 45.83 seeds) feeding regimes. The larger females produced more seeds (1255± 43.88) as compared to the smaller (1063±39.17) class. The absolute seed production (seed/ female/ day) and (seed/ day) were in favour of larger females fed according the third feeding regime, while the smaller female at the 1st feeding regime. Regardless of broodstock sizes, it was found that broodstock feeding regime affected the seed/ g female, seed/ female / day and seed/ day. They were (9.15± 0.91, 9.75±0.86 and 11.16± 1.19), (10.25± 0.53, 11.66± 0.68 and 13.40± 0.67) and (40.99± 2.13, 46.62± 2.67 and 53.60± 2.80 seeds), respectively for the1st, 2nd and 3rd feeding regimes. Fry growth performance, feed intake and feed conversion ratio were significantly ($P \leq 0.05$) affected by broodstock size and feeding regime. The larger females at the 3rd feeding regime recorded the highest fry growth performance while, the worst values were recorded for smaller females at the 1st feeding regime. The fry survival rates were significantly affected ($P \leq 0.05$) by the experimental treatments and ranged between 95.97± 1.20 (T6) and 92.33± 1.45 (T1). The previous results indicated that, there is a considerable difference in feed requirements before and after ovulation. Excellent egg and fry production can be obtained using the third feeding regime. Shortly, after ovulation a protein and energy rich diet should be used to accelerate the egg development.

Keywords: Nile tilapia, Broodstock size, Broodstock feeding regime, Reproductive performance and seed quality.

Broodstock nutrition is still poorly understood due to difficulties in conducting studies involving proper feeding and reproduction of broodstock (Izquierdo *et al.*, 2001, Chong *et al.*, 2004, Tahoun, 2007, Hammouda *et al.*, 2008 and Ibrahim *et al.*, 2008). Seed production in tilapia decreases with time (Behrends *et al.*, 1993) despite providing favorable environmental conditions for spawning (Mires, 1982 and Ridha & Cruz, 1998). To alleviate these problems, a number of broodstock management strategies were adopted by many workers to optimize seed production and breeding synchrony (Bhujel, 2000), such as broodstock density (Little, 1989 & Ridha & Cruz, 1999 and Tahoun, 2007), frequency of seed collection (Little *et al.*, 1993), brood fish age and size (Ridha & Cruz, 1989 and Smith *et al.*, 1991 and Tahoun, 2007) and broodstock exchange and conditioning technique (Abella & Batao, 1989 and Little *et al.*, 1993). for fish culture activities in Egypt as in many parts of the world, the necessity of dependable supply of Nile tilapia, *Oreochromis niloticus*, fry is therefore imperative, but the problem of mass production is still remains. There are many possible reasons for the low production of tilapia fry. These include too low density of broodstock, inappropriate sex ratios, inadequate spawning techniques, broodstock nutrition and high fry mortality (Salama, 1996). This experiment was undertaken to evaluate the influence of broodstock size and feeding regime on reproductive performance, seed out-put and the maternal effect on fry growth and quality of Nile tilapia.

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 – low energy)	25.0	4.0	75.0
Diet 2 (Intermediate-protein and energy)	30.0	6.0	85.0
Diet 3 (High protein -energy levels).	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. From 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. From 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. 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

Broodstock trial (105 dys)

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 to 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 approximately 10 females and 10 males from each size classes were taken, individually weighed and immediately killed and kept frozen at -18°C until proximate analysis at the end of experiment.

Fry nursing trial (43 days)

One hundred free-swimming fry were selected from the first seed collection from each broodstock spawning hapa and stocked in twelve fry rearing happas (2X1X1 m^3) at a density of 100 fry/ m^2 with two replicates/ treatment in order to asses the effects of different broodstock size and feeding regime (the six experimental treatments) on the fry growth performance, feeding efficiency and fry survival rates.

Experimental diets

Three diets were formulated for tilapia broodstock containing 25, 30 and 35%CP and had metabolizable energy of 3434, 3533 and 3760 Kcal to obtain three different protein/ energy ratio of 74.57, 85.77 and 92.55 mg protein/ Kcal ME for broodstock 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/ day (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. In fry nursery trial, fry were fed diet No. 4 (Table 1) which formulated to contain 40% CP and 3884 Kcal ME with protein energy ratio of 104.27 mg protein/ Kcal ME. The fry diet (diet No.4) was in powder form and rate of feeding was 20% of the total fry biomass at the first 20 days started from the 2nd day of collecting fry from the broodstock (spawning) hapas and decreased to 10 % in the 2nd growth interval which extended for 23 days with a whole experimental period of 43 days. Feed was introduced to fry at a feeding frequency of 10 times daily with amounts adjusted every week interval in response to fry weight gain in each nursing hapa. 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.

Analytical methods

At the end of the experiment, all broodstock and fry 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 diets 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.

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

Experimental diets	Diet 1 25%CP	Diet 2 30%CP	Diet 3 35%CP	Diet4 (Fry diet) 40%CP
Ingredients				
Fish meal (72 % CP)	7.00	11.50	14.50	30
Soybean meal (44 % CP)	25.00	27.00	35.00	35
Cotton seed meal	12.00	15.00	16.50	----
Corn gluten (62% CP)	----	----	----	10
Corn grain	12.00	15.00	16.50	22.5
Wheat bran	32.00	22.50	20.00	----
Vegetable oil	3.50	3.50	3.50	5
Di – Calcium phosphate	2.50	2.50	2.50	2.00
Molasses	2.50	2.50	2.50	----
Anti-aflatoxin[1]	0.10	0.10	0.10	0.10
Vitamin C.[2]	0.10	0.10	0.10	0.10
Min. & Vit mixture[2]	0.30	0.30	0.30	0.30
Proximate analysis				
Dry matter (%)	89.0	90.0	89.0	90.0
Crude protein (%)	25.600	30.300	34.800	40.50
Ether extract (%)	4.22	6.100	8.00	9.00
Crude fibre (%)[3]	4.97	5.45	3.50	3.30
Ash (%)	9.61	10.10	9.40	9.00
Nitrogen free extract (%)	55.60	48.00	44.30	38.20
Metabolizable energy (K Cal / Kg)[4]	3434.26	3532.80	3760.07	3884
Protein energy ratio (mg P/K Cal ME)	74.54	85.77	92.55	104.27

[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 broodstock and fry diets (Expressed as % of diet).

Diets Amino acid content	Diet 1 (25%, CP)	Diet 2 (30%, CP)	Diet 3 (35%, CP)	Diet 4 (Fry diet) 40% CP
Arginine	1.65	1.75	2.09	1.92
Histidine	0.75	0.80	0.82	0.88
Isoleucine	1.45	1.49	1.60	1.58
Leucine	1.73	2.02	1.97	2.53
Lysine	1.95	2.10	2.21	2.64
Methionin	0.85	0.94	1.15	1.20
Phenylalanine	1.12	1.42	1.39	1.47
Threonine	0.97	1.213	1.51	1.45
Tryptophan	0.36	0.43	0.49	0.38
Valine	1.82	1.80	1.72	1.70

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 (g) – Average initial weight (g)] / time (days).
- Specific Growth Rate (SGR %/day) = 100 [Ln Wt1 – Ln Wt 0 / t] Where: - 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.

Statistical analysis

Statistical analysis of the experiment was done using SAS Version 9 (SAS Institute, 2002) statistical package. Data were statistically analysed in factorial design procedure. Mean of treatments were compared by Duncan (1955) multiple range test. Duncan test ($p<0.05$) was used to compare means and ($F<0.05$) was considered for the variance analyses.

Results and Discusion

Seed production

The effect of broodsock size and feeding regime on seed output are presented in Table 3. The results indicate seed production at the subsequent clutches (seed collections). There were significant ($P\leq0.05$) differences among different feeding regime and broodstock sizes through the subsequent 4 clutches. T6 had the highest ($P\leq0.05$) over-all mean of total seed production (1392.00 ± 26.58) followed in descending order by treatments T5 (1249.67± 48.92), T3 (1175.0± 60.62), T4 (1122.67± 42.99), T2 (1039.67± 33.07) and finally T1 (973.33± 55.48), respectively.

TABLE 3. Effect of broodstock size and feeding regime on seed output at different seed collections (Mean ± SE).

Treatments	Clutch 1	Clutch 2	Clutch 3	Clutch 4	Total seed / F.
1	261.67 c ± 17.64	268.33 bc ± 11.67	248.33 c ± 29.20	195.00 c ± 14.43	973.33 d ± 55.48
2	251.00 c ± 18.50	271.67 bc ± 15.90	283.67 bc ± 22.10	233.33 bc ± 8.82	1039.67 cd ± 33.07
3	355.00 ab ± 31.23	256.67 c ±8.82	315.00 abc ± 22.55	248.33 abc ± 22.48	1175.00 bc ± 60.62
4	293.67 bc ± 15.41	266.67 ±14.81bc	333.33 ab ± 16.42	229.00 bc ± 24.38	1122.67 bc ± 42.99
5	341.33 ab ± 16.59	311.67 ab ±19.22	325.00 ab ± 25.66	271.67 ab ±36.55	1249.67 b ± 48.92
6	380.67 a ± 14.45	326.33 a ± 12.15	370.00 a ± 10.41	315.00 a ± 18.03	1392.00 a ± 26.58

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.

Based on the results of the present study it can be observed that, the considerable variability in clutch size produced by individual females may be due to the variability in the fecundity of individuals females even of the same group, even with constant prevailing environmental conditions and this may be attributed to a combination of factors include:- differences in spawning time of individual females and the relative asynchrony of spawning cycles among individual females (Essa, 1995). The effects of feeding regime without consideration of broodstock size on seed production are presented in Table 4 while, our results on the effects of broodstock size regardless of feeding regime on different seed collections are presented in Table 5. As shown in Table 4, there were significant (P≤0.05) differences among different feeding regimes at the 1st, 3rd, 4th and total seed number produced all over the 4 clutches, while no significant differences were observed in the second seed clutch among different experimental feeding regimes.

TABLE 4. Effect of broodstock feeding regime regardless of size on seed output at different seed collection (Mean ± SE).

Treatments	Clutch 1	Clutch 2	Clutch 3	Clutch 4	Total seed / Female
T1	277.67 a ±12.69	267.50 a ±8.44	290.83 b ±24.20	212.00 b ±14.78	1048.00 b ±45.83
T2	296.17 b ±23.05	291.67 a ±14.30	304.33 a b ±17.74	252.50 a b ±18.88	1144.67 b ±53.87
T3	367.83 b ±10.42	291.50 a ±16.96	342.50 a ±16.57	281.67 a ±19.61	1283.50 a ±50.84

Means in the same column having different letters are significantly different (P≤0.05).
-The first feeding regime:- broodstock fed diet 1 (25%CP) throughout the whole experimental period.
-The second feeding regime:- 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 third feeding regime:- 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

TABLE 5. Effect of broodstock size regardless of feeding regime on seed output at different seed collections (Mean ± SE).

Treatments	Clutch 1	Clutch 2	Clutch 3	Clutch 4	Total seed / Female
T1	289.22 b ±20.21	256.56 b ±6.64	282.33 b ±15.71	225.56 b ±11.29	1062.67 b ±39.17
T2	338.56 a ±14.77	301.56 a ±11.91	342.78 a ±11.58	271.89 a ±18.49	1254.78 a ±43.88

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 presented in Table 5 seed production at different seed collections was affected by different broodstock size regardless of feeding regime. There were significant (P≤0.05) differences in seeds obtained all over the 4 seed collections and the total seed number produced among different feeding regimes and the larger broodstock females produced more (P≤0.05) seed as compared by the smaller broodstock class.

As shown in Table 6, the highest relative fecundity (seed/g female,13.69 ± 0.78 seeds) was recorded for T3 (smaller broodstock fed on the 3rd feeding regime) followed by T2 (11.61 ± 0.46), T1 (11.05 ± 0.62), T6 (8.62 ± 0.16), T5 (7.89 ± 23.03), T4 (7.24 ± 0.32), respectively. The absolute seed production (seed/ female/ day) and (seed/ day) were in favor of T6 (larger broodstock size fed according the 3rd feeding regime followed in descending order by T5, T3, T4, T2 and finally T1. The importance of feed quality has been reported by many workers for enhancing the reproductive performance (Chang *et al.*, 1988, Cisse, 1988, Wee & Tuan, 1988, Creswell, 1993, NRC, 1993, Santiago & Reyes, 1993, Essa, 1995, Salama, 1996, Gunasekera *et al.*, 1996a, Gunasekera *et al.*, 1996b, Gunasekera & Lam, 1997, Gunasekera *et al.*, 1997, Abdelhamid *et al.*, 1999, Coward & Bromage, 2000 Santiago & Laron, 2002 and El-Sayed *et al.*, 2003 & 2005).

TABLE 6. Effect of broodstock size and feeding regime on spawning performance of Nile tilapia females (Mean ± SE).

Treatments	IW	FW	Mean weight	Seed/ F	S/ g F	S/ F/ day	S/ day
T1	70.83 ± 1.104	105.27 ±0.96	88.05 ± 0.10	973.33 d ± 55.478	11.05 b ± 0.62	9.27 e ± 0.53	37.08 e ±2.11
T2	70.00 ± 2.17	107.43 ± 1.03	88.72 ± 0.85	1039.67 cd ± 33.067	11.61 b ±0.46	10.29 ed ±0.33	41.18 ed ±1.31
T3	67.08 ± 0.46	103.43 ± 0.27	85.26 ± 0.38	1175.0 bc ± 60.622	13.69 a ±0.78	11.99 bc ± 0.62	47.96 bc ±2.48
T4	140.60 ± 2.39	169.63 ±1.67	155.12 ±1.12	1122.67 bc ± 42.99	7.24 c ± 0.32	11.23 cd ±0.43	44.91 cd ±1.72
T5	145.17 ± 2.32	171.53 ±1.14	158.35 ±1.67	1249.67 b ±48.92	7.89 c ±0.23	13.02 b ±0.51	52.07 b ±2.04
T6	145.67 ± 1.45	177.53 ±0.72	177.53 ±0.72	1392.0 a ±26.58	8.617 c ±0.163	14.81 a ±0.28	59.23 a ±1.13

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+2 nd feeding regime. T5:-Large size + 2nd feeding regime
T3:-Small size +3 rd feeding regime. T6:-Large size + 3rd feeding regime.

Table 7 indicates the effect of different feeding regime without consideration of broodstock size on seed production, it can be observed that, there were significant (P≤0.05) differences among the three experimental feeding regimes. The highest seed production was recorded for T3 as compared with other two feeding regimes (T1 and T2). The seed/ g female, seed/ female/ day and seed/ day were 9.15± 0.91, 9.75± 0.86 and 11.16± 1.19; 10.25± 0.53, 11.66± 0.68 and 13.40± 0.67 and 40.99± 2.13, 46.62± 2.67 and 53.60± 2.80 seeds, respectively for T1, T2 and T3. The results revealed that feeding broodstock the diet No.2 (30% CP) until spawning batch and thereafter the diet No.3 (35%CP) for 7 days and from the 8th day after seed harvesting exclusively gave the better and the higher seed production in terms of seed/ female, seed/ female/ day and seed/ day (Fig. 1) than other experimental feeding regimes (T1 and T2). These results support the view that, feeding Nile tilapia broodstock high-quality diets can maintain good growth and high seed production and these are in a confirm with the results of Salama (1996). The findings of our work are also in parallel line with those of Essa (1995) who used two different feeding regimes to determine the nutrient requirements of tilapia broodstock and their effects on the reproductive performance and spawning success and found considerable differences in nutrient requirements of tilapia broodstock before and after ovulation. He found that, at the water temperature range of 24 to 28 °C female tilapia spawned 8 times intervals as short as two weeks within 112 days. In the broodfish of the first group (8 females and 4 males with sex ratio (2♀:1♂) [fed with feed 1 (25.7 %CP, 4.56 % fat and 46.83 % carbohydrate) before spawning activity- and with feed I, rich in fat (9.13%) and carbohydrate (49.52%) besides rich in dietary protein (25.20%), directly after spawning for 6-8 days]. Fish of the second group (8 females and 4 males), fed with feed II only all the time, were spawned in intervals longer, approximately 18 days, 6 times within the whole experimental period. The fish of the 1st group produced 30% more seeds/ female than those of the 2nd group. Therefore, the average seed production/g female (14.23± 107) was significantly (P≤0.05) higher than that of the second group (10.96± 119). Feed rich in fat and carbohydrate provide more efficient source of energy which might highly promote the vitello-genesis process of the fish with ovulated ovaries and also sparing protein for build-up of the sexual products (eggs and milt) in the gonads which start soon after the previous spawning.

TABLE 7. Effect of broodstock feeding regime regardless of broodstock size on spawning performance of Nile tilapia (Mean ± SE).

Treatments	IW	FW	Mean weight	Seed/ F	S/ g F	S/ F/ day	S/ day
T1	105.72 ±15.64	137.45 ±14.40	121.54 ±15.01	1048.0 b ±45.83	9.15 ±0.91b	10.25 c ±0.53	40.99 c ±2.13
T2	107.58 ±16.87	139.48 ±14.35	123.53 ±15.59	1144.67 b ±53.87	9.75 b ±0.86	11.66 b ±0.68	46.62 b ±2.67
T3	106.38 ±17.59	140.48 ±16.57	123.43 ±17.07	1283.50 a ±50.84	11.16 a ±1.19	13.40 a ±0.67	53.60 a ±2.80

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

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

-The second feeding regime:- 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 third feeding regime:- 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.

Based on the results of the present work and those of Essa (1995), it can be concluded that, tilapia seed production was affected by feeding regime and spawning frequency.

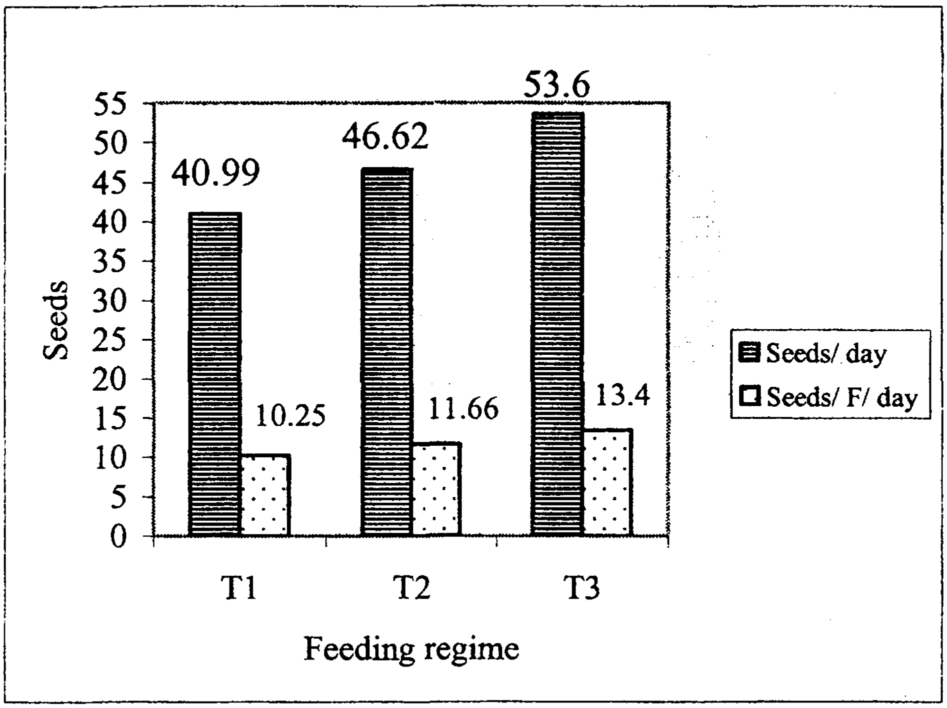

Fig. 1. Effect broodstock feeding regime regardless of broodstock size on reproductive performance of Nile tilapia.

Data on the spawning performance of Nile tilapia broodstock as affected by broodstock size regardless of feeding regime are presented in Table 8 and Fig. 2. There were significant ($P \leq 0.05$) differences between two broodstock size tested in terms of seed/ g female, seed/ female/ day and seed/ day. The higher measurments of these parameters were recorded for the smaller class of broodstock size, while the larger class showed the better results in terms of seed/ female/ day and seed/ day as compared by the smaller class.

TABLE 8. Effect of broodstock size regardless of feeding regime on spawning performance of Nile tilapia (Mean ± SE).

Treatments	IW	FW	Mean weight	Seed/ F	S/g F	S/ F/ day	S/ day
T1	69.3 b ±0.90	105.38 b ±0.71	87.34 b ±0.59	1062.67b ±39.17	12.12 a ±0.51	10.52 b ±0.47	42.07 b ±1.88
T2	143.a ±1.32	172.90 a ±1.25	158.36 a ±1.11	1254.78a ±43.88	7.92 b ±0.23	13.02 a ±0.56	52.07 a ±2.23

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).

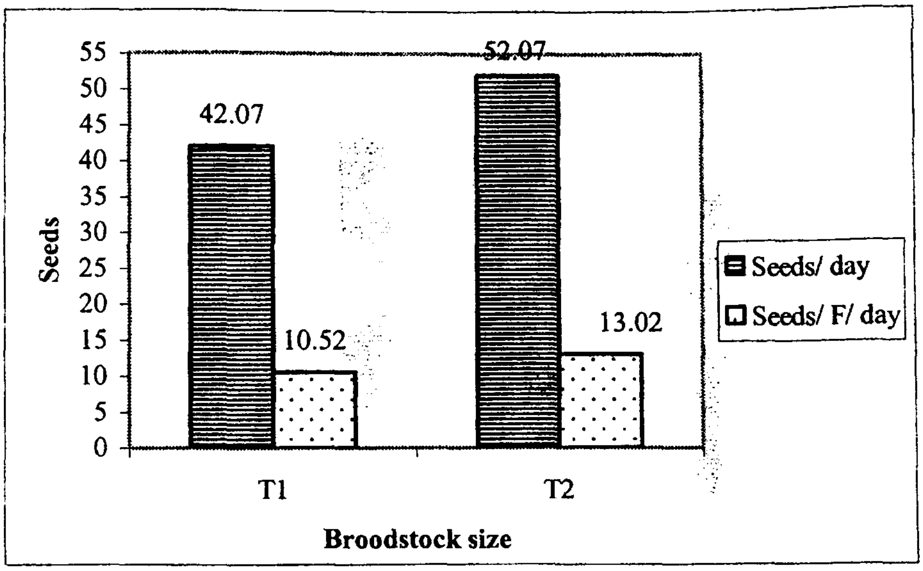

Fig. 2. Effect of broodstock size regardless of feeding regime on reproductive performance of Nile tilapia.

The results of the present study are in agrrement with those reported by Siraj *et al.* (1983) who found that, the range of *O. niloticus* fecundity was as low as 580 eggs/ clutch for year class one (44g) females to as high as 1820 eggs/ clutch for year class three (280 g) females. These results are also in accordance with the findings of Bhujel (2000) who cited that, absolute fecundity number of eggs per spawning increases up to a certain age then declines; but relative fecundity number of eggs per unit weight of female , which is highest at younger ages, declines before absolute fecundity. Moreover, older females spawn less frequently or may stop completely. In a commercial seed production, medium-size tilapia broodfish 150–250 g are preferred. However, many broodfish can start to breed when they are as small as 60 g, which can be achieved within a maturation period of 6 months after hatching. Broodfish are usually discarded after attaining more than 300 g as bigger or larger fish are difficult to handle during harvesting of seed.

Fry nursing trial

As shown in Table 9 fry growth performance was affected by the experimental treatments. The T6 recorded the highest fry growth performance, while the worst values were recorded for T1. The fry survival rates were significantly ($P \leq 0.05$) affected by the experimental treatments and ranged between 95.97± 1.20 (T6) and 92.33± 1.45 (T1). Feed intake and feed conversion ratio were also affected by different broodstock sizes and feeding regime. The average initial weight (AIW), AFW, ADG, SGR, feed intake and survival rates are summarized in Table 10. The above parameters were significantly reflected the effect of broodstock feeding regime regardless of broodsock size. The best measurements were in favor of T 3.

TABLE 9. Effect of broodstock size and feeding regime on fry growth performance, feed conversion ratio and survival rates (Mean± SE).

Treat.	AIW (g)	AFW (g)	AWG	ADG (mg/ day)	SGR (%/day)	Feed intake	FCR	SR (%)
T1	0.11 c ± 0.00	3.97 b ±0.07	3.85 c ±0.07	89.61 e ±1.59	8.27 a ±0.09	6.91e ±0.14	1.79 a ±0.03	92.33 c ±1.45
T2	0.12 c ±0.00	4.31 b ±0.07	4.19 bc ±0.07	97.36 d ±1.56	8.27 a ±0.07	7.93 bc ±0.07	1.90 a ±0.04	95.33 a ±0.33
T3	0.13 b ±0.00	4.63 b ±0.14	4.50 b ±0.14	104.57 c ±3.18	8.25 a ±0.11	6.86 e ±0.37	1.53 b ±0.11	94.67 b ±0.88
T4	0.13 b ±0.00	5.03 ab ±0.09	4.91 ab ±0.09	114.11 b ±2.12	8.54 a ±0.10	7.04 c ±0.23	1.43 b ±0.02	94.67 ±0.88
T°	0.13 b ±0.01	4.95 ab ±0.33	4.82 ab ±0.33	112.02 b ±7.76	8.22 a ±0.25	8.40 ab ±0.31	1.31c ±0.14	95.00 a ±0.58
T6	0.16 a ±0.00	6.20 a ±0.12	6.04 a ±0.12	140.54 a ±2.69	8.55 a ±0.07	9.00 a ±0.29	1.49c ±0.07	95.67 a ±1.20

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

TABLE 10. Effect of broodstock feeding regime regardless of broodstock size on fry growth performance, feed conversion ratio and survival rates (Mean± SE).

Treatments	AIW (g)	AFW (g)	AWG	ADG (mg/ day)	SGR (%/day)	Feed intake	FCR	SR (%)
T1	0.12 b ±0.00	4.50 b ± 0.24	4.38 b ±0.24	101.86b ±5.60	8.34 b ±0.14	6.98 b ±0.12	1.61 a ±0.08	93.50 a ±0.92
T2	0.13 b ± 0.00	4.63 b ± 0.21	4.50 b ±0.21	104.69b ±4.82	8.40 a ±0.09	7.08 b ±0.40	1.60 a ±0.15	95.17 a ±0.31
T3	0.15 a ± 0.01	5.42 a ± 0.36	5.27 a ±0.35	122.56a ±8.26	8.42 a ± 0.09	7.93 a ±0.52	1.51 a ±0.06	95.50 a ±0.56

Means in the same column having different letters are significantly different (P≤0.05).
-The first feeding regime:- broodstock fed diet 1 (25%CP) throughout the whole experimental period.
-The second feeding regime:- 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 third feeding regime:- 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.

The fry growth parameters, feed intake, FCR and survival rates as affected by the broodstock size regardless of feeding regime are summarized in Table 11. The best (P≤0.05) fry AIW, AWG, ADG were recorded for T2 (the larger Nile tilapia broodstock). It can easily note that, there were no significant differences between the two broodstock sizes in SGR (%/ day) and survival rates (%).

TABLE 11. Effect of broodstock size regardless of broodstock feeding regime on fry growth performance, feed conversion ratio and survival rates. (Mean ± SE).

Treat.	AIW (g)	AFW (g)	AWG	ADG (mg/ day)	SGR (%/day)	Feed intake	FCR	SR (%)
T1	0.12 b ±0.00	4.30 b ±0.17	4.18 b ±0.10	97.18 b ±2.43	8.26 a ±0.05	7.23 a ±0.21	1.71 a ±0.03	94.33 a ±0.67
T2	0.14 a ±0.01	5.39 a ±0.23	5.26 a ±0.22	122.22 a ±5.20	8.51 a ±0.10	7.42 a ±0.43	1.41 b ±0.0	95.11 a ±0.48

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 ±0.90g).
T2:- Class2, Large size (♂:166.28±1.49 and ♀:143.81±1.32g).

It is important to know that, the mortality rate which considered a good index for determining the success of stocking programs. The fry survival rates in the present work are quite satisfactory and within the range reported by Bardach *et al.* (1972) and Langton & Wilson (1998) who mentioned that survival rate ranged from 80 to 90% for tilapia and valued 80% for marine fish as a normal survival rate (Tahoun, 2002). In this connection, Siddiqui & Al-Harbi (1995) stated that survival rates during the fry stage were significantly lower than the fingerlings, sub-adult and adult stages of tilapia.

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تأثير النظام الغذائى وحجم قطيع التفريخ علي النمو وكفاءة الاستفادة من الغذاء والأداء التناسلي وإنتاج القطيع من الزريعة لأسماك البلطي النيلي

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

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

أجريت هذه التجربة فى مفرخ ومزرعة تجارية بمحافظة كفر الشيخ فى موسم التفريخ سنة ٢٠٠٣ واستخدم في هذه التجربة حجمين من ذكور وإناث أسماك البلطي النيلي حيث كانت متوسطات الوزن الابتدائي للإناث (0.90 ± 69.31 و 1.32 ±143.81) بينما كانت أوزان الذكور (1.32 ±143.81 و 166.28 ± 1.49) للحجم الأصغر والأكبر على الترتيب، كما استخدمت ثلاثة أنظمة غذائية مختلفة فى النظام الغذائي الأول تمت تغذية قطيع التفريخ على العليقة 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 تمت 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 الأولى : اسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الأول.
- المعاملة الثانية : اسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الثاني
- المعاملة الثالثة : اسماك القطيع الأصغر حجما والمغذاة طبقا للنظام الغذائي الثالث.
- المعاملة الرابعة : اسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الأول.
- المعاملة الخامسة : اسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الثاني
- المعاملة السادسة: اسماك القطيع الأكبر حجما والمغذاة طبقا للنظام الغذائي الثالث.

أظهرت نتائج التجربة الأولى ما يلي :

- تأثرت معنوياً أعداد الزريعة الناتجة باختلاف المعاملات التجريبية (حجم القطيع والنظام الغذائي) ، حيث تفوقت مجموعة اسماك المعاملة السادسة على باقي مجموعات الأسماك فى المعاملات الأخرى فى عدد الزريعة الناتجة على مستوى التجميعات (أربع تجميعات) وبالتالي فى عدد الزريعة الإجمالى بينما سجلت المعاملة الأولى أقل قيمة لعدد الزريعة الناتجة وبالتالى عدد الزريعة الإجمالى .

- تفوقت مجموعة الأسماك التي غذيت على النظام الغذائى الثالث (بغض النظر عن حجم قطيع التفريخ) عن مثيلاتها فى النظام الأولى والثانية في عدد الزريعة الناتجة سواء على مستوى التجميعات أو الرقم الكلى للزريعة الناتجة / أم ماعدا التجميعة الثانية والتي كانت الفروق الإحصائية بينها و بين مجموعات الأسماك الأخرى غير معنوية . وكانت أعداد الزريعة الناتجة / أم هي 54.83 ± 1048 و 53.87 ± 1144.67 و 50.84 ± 1284 لأسماك المجموعة الأولى والثانية والثالثة على الترتيب ولم تسجل أية فروق معنوية بين كلاً من النظامين الغذائيين الأول والثاني (على مستوى احتمال ٠,٠٥٪) .
- تأثرت معنوياً قيمة الزريعة الناتجة (سواء على مستوى التجميعات المتعاقبة أو في العدد الكلى الناتج لكل أم) بحجم القطيع (بغض النظر عن النظام الغذائي لقطعان التفريخ) حيث تفوقت مجموعة الأسماك الأكبر حجماً في إنتاج الزريعة 43.88 ± 1225 زريعة / أنثى على أسماك المجموعة الأصغر حجما ± 1027 . 39.17
- كما أظهرت نتائج التجربة أن المعاملة السادسة تفوقت على باقى مجموعات الأسماك في عدد الزريعة/ أنثى/ يوم وعدد الزريعة/ م٢/ يوم ، بينما سجلت المعاملة الثالثة أعلى قيمة للخصوبة النسبية (عدد الزريعة / جم من وزن الإناث) ، وذلك نتيجة لتأثير حجم القطيع والنظام الغذائي المتبع .
- أوضحت نتائج هذه التجربة تفوق مجموعة الأسماك التى تمت تغذيتها طبقاً للنظام الغذائي الثالث (بغض النظر عن حجم قطيع التفريخ)على كل من أسماك المعاملة الثانية والأولى فى قيم كل من عدد الزريعة / أنثى / يوم وعدد الزريعة/ م٢ / يوم والتي كانت 0.67 ± 13.40 و2.80 ± 53.6 على الترتيب .
- تأثرت معنوياً قيم الخصوبة النسبية للقطيع بحجم قطيع التفريخ (بغض النظر عن النظام الغذائي للقطيع) حيث سجلت المعاملة الأولى (0.51 ± 12.12 زريعة/ حجم وزن الأنثى) بينما تفوقت أسماك المجموعة الثانية على أسماك المجموعة الأولى فى قيم كل من عدد الزريعة الناتجة / أنثى / يوم ، وعدد الزريعة الناتجة/ م٢ / يوم فتراوحت قيم الزريعة الناتجة/ أنثى/ يوم بين 10.52 ± 0.47 و 0.56 ± 13.02 للمعاملة الأولى والثانية على الترتيب بينما تراوحت قيمة عدد الزريعة الناتجة/ م٢/ يوم بين 1.88 ± 42.07 و 2.33 ± 52.07 وذلك للمعاملة الأولى والثانية على الترتيب .
- أوضحت نتائج تجربة نمو الزريعة أن الزريعة الناتجة من أسماك المجموعة السادسة قد تفوقت على مثيلاتها في المجموعات التجريبية الأخرى في متوسط الوزن الابتدائى AIW والنهائي AFW والزيادة فى وزن الجسم AWG ومعدل النمو اليومى ADG بينما لم تسجل أية فروق معنوية بين مجموعات الزريعة المختلفة في قيمة المعدل النوعي للنمو SGR بإختلاف حجم قطيع التفريخ والنظام الغذائى المتبع ، كما دلت النتائج أيضاً على تفوق المعاملة السادسة على باقي المعاملات فى قيمة كل من الغذاء المأكول ومعامل التحويل الغذائي كما كان للزريعة الناتجة من هذه المعاملة أعلى نسبة حياة مقارنة بباقى المجموعات التجريبية .