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EFFECTS OF DIETARY PROTEIN LEVELS AND SOURCES AS WELL AS TYPE OF SPAWNING CONTAINER ON MASS PRODUCTION OF NILE TILAPIA, OREOCHROMIS NILOTICUS, FRIES.

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ABSTRACT

Three experimental trials were conducted with Nile tilapia, Oreochromis niloticus, broodstock to test the effect of dietary protein levels (25% and 29%) and sources (fishmeal and soybean) on mass production of its fries. The effect of type of spawning container (hapas, concrete basins and fiberglass tanks) was also evaluated. The results indicate that highest fry production (80.7 fry/m^2/day) was achieved when broodstock fed on a mixture of animal and plant protein diet (1:1.5 animal to plant protein) containing 29% crude protei·· Also, the hapa system for Oreochromis niloticus fry production appears to be more productive (81 fry/m^2/day) than other tested systems, concrete basin (67 fry/m^2/day) or fiber glass tanks (45 fry/m^2/day).

ITRODUCTION

Reproduction and culture of Nile tilapia, *Oreochromis niloticus*, is an expanding industry in Egypt nowadays due to the following reasons: 1) ease of fry production (Pullin and Lowe-McConnel, 1982); 2) resistance to handling, disease and low dissolved oxygen levels (Mires, 1982 and Salama, 1994), and 3) response to feeds and manure fertilization to increase feed conversion ratio and yields (Hepher and Pruginin, 1981; Magouz, 1990; and Omar *et al.*, 1997). Abundance availability of fish fry is essential to establish prosperous aquaculture industry; especially tilapia female spawns in nature only about two to four eggs per gram of brood female (Thomas and Michael, 1999).

Therefore, fish fry should be intensively produced commercially to satisfy the needs of culturists at an economic cost that will permit financial administration to success. In tilapias extreme variability in broodstock reproductive performance and few information on their nutritional requirements are problems confronting fry producers and is an area meriting high priority in research. Among factors considered to be important in fry production are: brood fish age and size, brood fish nutritional requirements, frequency of removing brood fish and /or fry from the breeding unit, type of container, water quality and rate of water exchange (Hughes and Behrends, 1983; Mires, 1982; Essa, 1993 and Haroun, 1999).

Nutrition is one of three factors affect physiological condition (reproduction) of broodstock (Nickolsky, 1962), for that reason, the interaction between nutrition and reproduction of tilapias has recently attracted the attention of investigators (Santiago *et al.*, 1985; Chang *et al.*, 1988; Cisse, 1988; De Silva and Radampola, 1990; Essa and El-Ebiary, 1995). Previous results revealed that there is a positive relation between nutrition of broodstock and their reproductive efficiency. Also, most information on tilapia spawning potential is limited to studies in aquaria and fiberglass or concrete tanks (Rothbard, 1979; Mires, 1982; Santiago *et al.*, 1985; Salama, 1994 and Haroun, 1999).

Therefore, the present work aims to study the effect of various dietary protein levels and sources on fry production of Nile tilapia, *Oreochromis niloticus*, broodstock. The effect of different types of spawning containers (hapas, concrete basins and fiberglass tanks) on tilapia fry production were also studied.

MATERIALS AND METHODS

The present work was carried out at El-Maghrabbi Fish Farm, Sidi–Salem, Kafr El-Shiekh Governorate, Egypt for 108 days.

1- Evaluation of dietary protein levels:

Six concrete basins measured 3x2x1m each were prepared to test two dietary protein levels, 25% and 29% (diet 1 and 2), three replicates per each level, as shown in Table (1). Broodstock of *Oreochromis niloticus* with a mean weights of 81.20g (female) and 95.0g (male) were stocked in the basins at a density of 7 broodstock /m^2. The sex ratio of the fish was 5 females : 2 males. A total of 42 broodstock were stocked in each basin. The feeding rate was 1.5% of biomass, twice a day at 09:00 a.m and 15.00 p.m for six days a week.

Produced fries in each basin were collected daily from April 24th to May 30th, 2002 with a dip net and counted. Fry production was quantified in 3 ways: number of fry or fry/m^2 of basin area, number of fry/m^2/day, number of fry/female brood fish and number of fry/g female/day.

2- Evaluation of dietary protein sources:

Three iso-nitrogenous (29% crude protein) diets were compared:

- Diet (2), with the supplemental protein composed of fishmeal and soybean meal,
- Diet (3), with all the supplemental protein composed of fishmeal, and
- Diet (4), with all the supplemental protein composed of soybean meal.

The composition and chemical analysis of the experimental pellets are presented in Table (1). The feeding rate was 1.5% of biomass for the three tested diets, twice a day, at 09.00 a.m and 15.00 p.m for six days a week.

Mean initial weights of *Oreochromis niloticus* broodstock were 81.20g (female) and 95.0g (male). The stocking density was 7 broodstock/m^2 with sex ratio 5:2 (female: male). Three basins for each diet were used. Fry production on the three tested diets were evaluated from April 24th to May 30th , 2002.

3- Evaluation of spawning container:

Three uniform spawning containers (each 2m^2), hapas (net-cages), concrete basins and fiberglass tanks, were compared during the experimental period, June, 25th to Sep., 6th , 2002 for fry production.

In El-Maghrebi Fish Farm, *Oreochromis niloticus* broodstock were stocked in the experimental hapas with small mesh nylon net placed in earthen fish pond (about 10 acres). This pond was fertilized regularly by organic and inorganic fertilizers to develop moderate plankton bloom. The hapas are suspended just above the pond bottom. Water level within the hapas was maintained at approximately 0.80 m depth.

Broodstock of *Oreochromis niloticus* with mean weights 81.20g (female) and 101.50g (male) were stocked in the three experimental spawning containers at a density of 7 broodstock/m^2. The sex ratio of the fish was 5:2 (female: male). Three replicates of each container were used. Broodstock were hand fed two times daily, with diet (2) with the supplemental protein composed of fish and soybean meal (Table 1) at a rate of 1.5% of biomass. Fish fry production of the three spawning containers were collected daily, counted and evaluated.

Analysis of variance and Duncan's multiple range test were used to evaluate the differences in fish fry or fry production due to treatment effects in the present three trials, according to Snedecor and Cochran (1967).

Table 1: Composition and proximate analysis of the dietary different protein levels and sources used for *Oreochromis niloticus* broodstock.

	Diet No.			
	1	2	3	4
<u>Ingredient</u>				
Soy bean meal	28.40	22.00	---	45.00
Fish meal	20.50	15.00	30.00	---
Yellow corn	3.00	10.00	11.00	10.00
Wheat milling by-product	47.10	52.00	58.00	44.00
Vitamins premix	0.30	0.30	0.30	0.30
Minerals premix	0.70	0.70	0.70	0.70
<u>Proximate analysis %:</u>				
Dry matter (DM)	91.70	87.12	91.80	90.75
<u>% on DM bases:</u>				
Protein	25.20	28.93	29.23	29.01
Lipid	3.80	2.90	4.42	3.29
Fiber	3.60	2.56	1.31	3.40
Ash	10.50	11.51	11.81	7.02
Nitrogen free extract	56.90	54.10	53.23	57.28
Total	100	100	100	100

RESULTS AND DISCUSSION

Water temperature in the study area and basins ranged from 20-31°C. Dissolved oxygen levels were 5.8-8.2 ppm, while pH values varied between 7.5-8.1. The unionized form of ammonia in the water study area were 0.023 - 0.101 mg/l, far below the toxic levels, i.e. between 0.6-2.0 mg/l (Emerson *et al.*, 1975).

1. Evaluation of dietary protein levels:

The effect of dietary protein levels on fish fry production and some reproductive traits of Nile tilapia (*Oreochromis niloticus*) broodstock shown in Tables (2) and (3).

The results showed that there were a significant differences ($P \leq 0.05$) in the fish fry production of Nile tilapia (*Oreochromis niloticus*) with the two tested dietary protein levels (25 and 29 CP%) (Table2). The results indicated that 29% dietary protein level produced highest fish fry production, expressed in terms of fish fry/m^2, fish fry/female and fish fry/g female/day: 2906, 581.20 and 0.17 fry, respectively, during the spawning period April 24 to May 30, 2002. Fish fry production criterions for 25% dietary protein level were less: 1786, 357.20 and 0.11 fry, respectively (Table 2). Similar results were obtained with Taiwanese red tilapia (*O. mossambicus* x *O. niloticus* hybrids) (Chang *et al.*, 1988), *O. niloticus* broodstock (De Silva and Radampola, 1990 and Gunasekera *et al.*, 1996) and *Sarotherodon melanotheron* (Cisse, 1988). These authors postulated that 20 to 30 % dietary protein is sufficient for tilapia broodstock, and it may be wasteful to use higher levels. The results of gonadosomatic index and relative fecundity of Nile tilapia females during the present study (Table 2) confirm these findings. These results demonstrated that female's gonadosomatic index or relative fecundity increased significantly ($P \leq 0.05$) by increasing the dietary protein level from 25% to 29% (3.26 vs. 3.86 and 19.00 vs. 21.00 eggs/ g female, respectively).

It was noted in the present trial (Table 3) that fry production of *O. niloticus* broodstock during the five weeks of study was markedly increased through the second harvest. The trend of production increasing was attributed to the natural increase in size associated with successive spawns due to a sudden rise in water temperature, reaching its high level of 28°C. Fish fry production appeared to be influenced by both water temperature and the dietary protein level in tilapia broodstock diets. It is highly recommended that high-protein (29% CP) diets could be given to Nile tilapia broodstock.

Table 2: Means for total number of *Oreochromis niloticus* fry per m^2, for female brood fish and per (g) of female weight/day, fed diets with different dietary protein levels during the spawning period, April 24 to May 30, 2002.

Item	Dietary protein	
	25%	29%
Fry / m^2*	1786.00^a	2906.00^b
Fry/m^2/day	49.61	80.72
Fry / female	357.20	581.20
Fry / g female/day**	0.11	0.17
Female gonadosomatic index	3.26 ± 1.49^a	3.86 ± 1.90^b
Female relative fecundity (No. of eggs / g female)	19.00 ± 2.20^a	21.00 ± 1.34^b

* ABC Duncan, s multiple range test ($P < 0.05$), horizontal comparison only.

**Based on the average of initial and final female weights.

Table 3: Means for total fry production per square meter (± standard error) of *Oreochromis niloticus*, fed diets with different dietary protein levels, collected during 3 harvest for the period April, 24 to May 30 (Each mean is the average of 3 replicates).

Harvest	Dietary protein level %	
	25	29
1	378 (±73)	627 (± 211)
2	759 (± 185)	1079 (± 445)
3	649 (± 196)	1200 (± 442)
Total fry	1786.00	2906.00

2. Evaluation of protein sources :

Table (4) shows that feeding of Nile tilapia (*O. niloticus*) broodstock fed diet (2) with the supplemental protein composed of fishmeal and soybean meal gave significantly ($P \leq 0.05$) better fry production than diet (3) with all the supplemental protein composed of fishmeal alone (animal protein), or diet (4) with all the supplemental protein composed of soybean meal alone (plant protein). It was noted also in this trial that the group of broodstock fed fishmeal diet alone possessed a significant ($P \leq 0.05$) higher fish fry production than those fed soybean meal diet alone (Table 4). These results may be attributed to one or more of the following factors: i) soybean meal contain indigestible polysaccharide (hemicelluloses, cellulose and oligosaccharides) that reduce the available energy to tilapia broodstock and thus reduce fish fry production, ii) fishmeal contains a high percentage of fish oil and protein that could be utilized by tilapia broodstock as source of energy and thus enhance the reproductive performance and thereby fry production, and iii) the digestive tract of *O. niloticus* broodstock is long, therefore the bacterial population of the tilapia gut is able to decompose part of the more complex carbohydrates of soybean meal and to derive energy from them. These assumptions were confirmed by many scientists, Viola and Arielli (1983) for tilapia hybrids, El-Sayed and Tacon (1997) for tilapias, Nour *et al.* (1989) for carp (*Cyprinus carpio*), and Alexis (1997) for Mediterranean marine fish.

The present trial recommended that animal and plant protein mixture diet advised to be given to *O. niloticus* broodstock to enhance its ripe gonads and thereby increase fish fry production.

Table (4): Means for total fry production of *Oreochromis niloticus* broodstock fed experimental diets containing various protein sources during the spawning period, April 24 to May 30, 2002.

Treatment	Diet No.		
	2	3	4
Fry / m^2*	2906.00^a	2046.06^b	1487.00^c
Fry / female	587.20	409.20	297.40
Fry / g female**	0.17	0.12	0.09

* ABC Duncan's multiple range test ($P < 0.05$), horizontal comparison only.
**Based on the average of initial and final female weights.

3. Evaluation of spawning container:

Three types of containers, hapas (net-cages), concrete basins and fiberglass tanks, were compared for fish fry production of Nile tilapia (*O. niloticus*) and the results are shown in Tables (5) and (6).

There were significant differences ($P \leq 0.05$) in fish fry production of *O. niloticus* in the three types of spawning containers. Hapas produced highest fry production expressed in terms of fry/m^2, fry/female and fry/g female/day: 5832, 1166.40, and 0.19 fry, respectively (Table 5). Fish fry production in fiberglass tanks is less efficient than in the concrete basins, 3246 vs. 4822 fry/m^2.

Preliminary observations collected from the present study showed that, *O. niloticus* broodstock spawned five times at intervals of 12-14 days in hapas and concrete basins during the period June, 25 to September, 6, 2002 (Table 6). While in case of fiberglass tanks the fish spawned four times only at intervals of 17-19 days.

The hapa system for *O. niloticus* fry production appears to be more productive than most other tested systems. Fish fry production levels of 8-23/m^2/day are reported in tanks (Berrios-Hernands, 1979; Salama, 1994 and Haroun, 1999). Only in cages and hapas (73 total fry/m^2/day) (Table 6).

The adaptability of the hapa system to a wide variety of culture environments, such as reservoirs, River Nile and its tributaries, food-fish production ponds is an important asset. Also, the ease of installing and relocating hapas make the system an ideal choice for a variety of fry producers. The hapa unit, manageable by one person, is highly adaptable to small-scale, owner-operated enterprises which require a minimum investment.

Table 5: Mean fry production of *Oreochromis niloticus* broodstock with three spawning containers after 72 days, June 25 to Sept. 6, 2002 (Each mean is the average of 3 replicates).

Spawning system	Hapas	Concrete Basins	Fiberglass tanks
Fry / m^2*	5832.00[a]	4822.00[b]	3246.00[c]
Fry/m^2/day	81.00	67.00	45.00
Fry / female	1166.40	964.00	619.20
Fry / g female/day	0.19	0.17	0.11

* abc Duncan, s multiple range test ($P < 0.05$).

Table 6: Means for total fish fry per square meter (± standard error) of *Oreochromis niloticus* collected during 5 harvest for the period June, 25 to Sept., 6, 2001 (Each mean is the average of 3 replicates).

Harvest	Spawning method		
	Hapas	Concrete basins	Fiberglass tanks
1	479 (± 175)	330 (± 149)	283 (± 185)
2	1614 (± 494)	1292 (±357)	797 (± 316)
3	1786 (± 762)	1310 (± 537)	1007 (± 614)
4	675 (± 189)	594 (± 271)	----------------*
5	1178 (± 435)	1296 (± 476)	1159 (± 631)
Total fry	5832	4822	3246

* not spawned

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