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Effect of varying crude protein levels on spawning frequency and growth of *Sarotherodon niloticus* breeders

C.B. Santiago, M. Bañes Aldaba and M.A. Laron

Four-month old *Sarotherodon niloticus* (*Tilapia nilotica*) breeders were fed with dry pellets containing 20 to 50% crude protein in two separate experiments (Table 1). Frequency of spawning involving removal of egg⁻ from the mouthbrooding females and growth were determined over a 16-week period for each experiment.

All female fish in Experiment I spawned at least once. Females fed with diets containing 20 to 40% crude protein had two to four average spawnings in 16 weeks. The highest mean spawning frequency of six was obtained from females fed with 50% crude protein. However, spawning frequencies in all treatments were not significantly different ($P > 0.05$).

Eggs were collected from females in 21 instances out of the 90 total spawnings in 16 weeks. One explanation for the failure to recover eggs from some spawnings could be the disturbance caused by the daily cleaning of aquaria which threatened the brooders causing them to discard or swallow their eggs. Mean number of eggs produced per spawning ranged from 228 to 635.

Weight gains and increases in total weight of the females in Experiment I are presented in Table 2. A growth trend as a result of increasing dietary crude protein could not be established due to the state of reproduction of the females during sampling in which some of the replicates had just spawned or were about to spawn. Total growth, estimated by adding the body weight gain of a female and the total weight of eggs spawned by the female (Lee, 1979), could have been a better measure of growth, however, growth in terms of gonadal products could not be estimated for Experiment I inasmuch as spawned eggs were not weighed. Lee (1979) had shown that in a five-month period gonadal products of one-year-old *S. niloticus* and *S. aureus* females represent 35% and 39%, respectively, of total growth.

For the male tilapia, weight gains generally increased as crude protein increased up to 50% (Table 2). Mean weight gain of males fed with 50% crude protein was 48.7% greater than that of 20% crude protein. Increases in total length ranged from 3.5 to 4.5 cm and were not significantly different ($P > 0.05$) among treatments.

Since there were two females in each aquarium in Experiment II, a hierarchy was formed. Generally, females without tag appeared weaker or less aggressive and less responsive to the males compared with the females with tag. They stayed most of the time at the upper layer of the water column, and had darker coloration and vertical bands of the body as was observed by Lee (1979) and Rothbard (1979) among stressed females. Females without tag were often attacked by the males. Male aggression could be partly explained by size differences in sexes. Females with tag were dominant or stronger and they stayed at the lower layer of the water. Females with tag and the males which had co-existed in a cage four months prior to the experiment seemed more compatible.

Table 1. Percentage composition of diets containing varying amounts of crude protein

Ingredient	D I E T					
	1	2	3	4	5	6
Fish meal	22.22	27.78	33.33	38.89	44.44	55.56
Soybean oil meal	12.71	15.89	19.07	22.25	25.42	31.78
Dextrin	21.77	18.14	14.51	10.88	7.13	—
Fish oil	4.03	3.36	2.69	2.01	1.32	—
Vegetable oil	8.07	6.72	5.37	4.03	2.64	—
Starch	3.00	3.00	3.00	3.00	3.00	3.00
Mineral mix ¹	3.6	3.6	3.6	3.6	3.6	3.6
Vitamin mix ¹	0.73	0.73	0.73	0.73	0.73	0.73
Celite (filler)	23.87	20.78	17.70	14.61	11.72	5.33
Estimated crude protein (%)	20	25	30	35	40	50
Analyzed crude protein (%)	20.5	25.7	30.6	35.9	41.4	52.7
Estimated digestible energy (Kcal/100 g) ²	250	250	250	250	250	250

¹ For practical and complete diets (NRC, 1977).

² Adapted from values for channel catfish: 3.5 Kcal/g protein, 9.1 Kcal/g fat; 2.5 Kcal/g carbohydrates (NRC, 1977).

Spawnings of the females without tag were delayed, occurring mostly towards the end of the experimental period. The non-tagged females spawned only once on the average during the experimental period and the tagged females two to four times. Mean spawning frequencies of all females at the various crude protein levels were not significantly different ($P > 0.05$). Moreover, average number of eggs per spawning of females with tag, ranging from 310 to 592, were not significantly different among treatments (Table 3). Because of the low spawning frequency of the females without tag, the number of eggs per spawning was not considered.

There was an increasing mean total growth of all females as the dietary crude protein increased up to 50% (Table 4). Mean total growth of females without tag, however, were not significantly different. Total growth of females with tag fed with 20% CP was 32.67 g which was significantly different from all other treatments. Total growth of females fed with 50% crude protein was 57.95 g, representing a 72% increase over those fed with 20% crude protein.

There was a corresponding increase in mean weight gain of the males as the dietary crude protein increased up to 50% (Table 5). Mean weight gain at 50% crude protein was 73.8% higher than at 20% crude protein. However, weight gains (46.2 to 80.3 g) and increases in total length (3.2 to 4.7 cm) were not significantly different ($P > 0.05$) among treatments.

Table 2. Mean weight gains and increases in total length of female and male tilapia fed with varying crude protein levels in Experiment 1

Treatment (% crude protein)	F E M A L E		M A L E	
	Increase in length (cm) ¹	Weight gain (g) ²	Increase in length (cm) ¹	Weight gain (g) ¹
20	3.2	51.5 ^b	3.5	74.6
25	4.2	81.5 ^{ab}	4.2	64.1
30	3.9	105.6 ^{ab}	4.2	79.2
35	4.9	92.2 ^{ab}	4.5	88.2
40	6.0	141.8 ^a	4.1	100.2
50	5.5	90.0 ^{ab}	4.0	110.9

¹Means are not significantly different ($P > 0.05$)

²Means followed by same superscript are not significantly different ($P > 0.05$)

Table 3. Spawning of female tilapia fed with varying crude protein levels in Experiment II

Treatment (% crude protein)	Spawning frequency of females without tag			Spawning frequency of females with tag			Number of eggs per spawning of females with tag	
	Total	Range	Mean ¹	Total	Range	Mean ¹	Range	Mean ¹
1 (20%)	3 (1) ²	1	1	8 (1) ²	2–4	3	355–714	592
2 (30%)	2 (0)	0–1	1	6 (4)	2	2	113–507	310
3 (40%)	3 (2)	0–3	1	12 (5)	3–5	4	100–867	485
4 (50%)	4 (0)	0–2	1	13 (0)	3–6	4	195–839	582

¹ Means are not significantly different ($P > 0.05$).

² Number in parentheses refers to number of spawnings where no eggs was recovered from the female.

Table 4. Estimated total growth of female tilapia fed with varying crude protein levels¹

Treatment (% CP)	Weight gain (g)	Total weight of eggs collected (g)	Total growth (g) ²	Weight gain (g)	Total weight of eggs collected (g)	Total growth (g) ³
1 (20%)	44.2	2.55	46.75	29.8	6.89	36.99
	46.5	0.00	46.50	20.5	9.74	30.24
	11.9	1.36	<u>13.26</u>	23.4	7.69	<u>31.09</u>
		mean	35.50		mean	32.67 ^b
2 (30%)	74.8	0.60	75.40	40.6	0.47	41.07
	15.9	0.00	15.90	54.9	2.51	57.41
	24.7	1.21	<u>25.91</u>	71.2	0.00	<u>71.20</u>
		mean	39.07		mean	56.56 ^a
3 (40%)	54.0	0.00	54.00	44.0	11.31	55.31
	14.6	0.00	14.60	33.5	0.98	34.48
	41.9	10.55	<u>52.45</u>	48.0	4.71	<u>52.70</u>
		mean	40.35		mean	47.50 ^a
4 (50%)	36.7	2.99	39.69	34.5	21.90	56.40
	60.0	0.00	60.00	42.2	12.97	55.17
	24.4	4.87	<u>29.27</u>	51.4	10.86	<u>62.26</u>
		mean	42.99		mean	57.94 ^a

¹Estimated total growth = Weight gain + total weight of eggs collected.

²Means are not significantly different ($P = 0.05$).

³Means followed by the same superscript are not significantly different ($P = 0.05$).

It appears that when the diets contain high quality proteins from fish meal and soybean oil meal and the amounts of daily food allowance are at satiation level, as in this present study, the influence of increasing dietary crude protein on spawning frequency, involving egg removal from the brooder, and growth may not be significant. Results have important economic implication because in the absence of information on nutrient requirements of the tilapia breeders, there is a tendency to offer high protein (over 30%) diets.

Table 5. Growth of male tilapia fed varying dietary crude protein levels in Experiment II

Treatment (% crude protein)	Total Length (cm)			Total Weight (g)		
	Initial	Final	Increase in TL (cm) ¹	Initial	Final	Weight gain (g) ¹
1 (20%)	17.8	20.6	2.8	97.5	128.5	31.0
	17.5	21.0	3.5	86.0	136.2	50.2
	16.5	20.4	<u>3.9</u>	82.0	139.4	<u>57.4</u>
		mean	3.4		mean	46.2
2 (30%)	17.8	20.5	2.7	88.0	143.1	55.1
	17.1	21.1	4.0	85.0	150.4	65.4
	17.5	21.9	<u>4.4</u>	84.0	163.7	<u>79.7</u>
		mean	3.7		mean	66.7
3 (40%)	18.0	20.1	2.1	95.0	163.8	83.3
	17.9	22.5	4.6	86.0	182.9	96.9
	17.0	19.6	<u>2.6</u>	82.0	127.9	<u>45.9</u>
		mean	3.1		mean	75.4
4 (50%)	17.8	21.5	3.7	92.5	145.0	52.5
	16.2	20.9	4.7	91.0	169.5	78.5
	17.6	23.2	<u>5.6</u>	91.0	200.8	<u>109.8</u>
		mean	4.7		mean	80.3

¹ Means are not significantly different (P = 0.05).

Literature cited:

- Lee, J.C., 1979. Reproduction and hybridization of the cichlid fishes, *Tilapia aurea* (Steindachner) *T. homorum* (Trewavas) and *T. nilotica* (Linnaeus) in aquaria and plastic pools. Ph.D. Dissertation. Auburn University, Auburn, Alabama. 84 p.
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