

ZOOLOGY

The Influence of Temperature on the Growth of the Nile Tilapia, *Oreochromis niloticus* reared in Glass Tanks

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Abstract. The effect of three water temperatures: 20, 25 and 30°C on the growth rate of Nile tilapia, *Oreochromis niloticus* was evaluated using a stocking density of 200 fish/m³. Fish were reared in glass tanks supplied with thermostatic heaters and biological filters. Fish were fed a local fish food (34% protein) in a dry form once daily for six days per week with 2% of fish body weight. The experiment covered a time period of 135 days from Nov. 1993 to Mar. 1994. The best growth rate was obtained at a temperature of 25°C followed by the temperature of 30°C, and the lowest growth rate was achieved at 20°C. The optimum temperature for these fish may be 25°C or slightly more but less than 30°C. The effect of the temperature on the growth rate of Nile tilapia was highly significant ($P < 0.001$).

Introduction

Aquaculture is rapidly growing in Saudi Arabia as a means to provide fishery product to consumers. The total catch of fish in the country provide only half of the demand for fish [1, p. 13]. Fish culture is thriving to fill the gap left by short production. Tilapias are widely used in fish culture in the country's interior which suffers the most from the shortage in the availability of fish.

Cuenco, *et al.* [2] has studied the interaction of five key variables affecting fish growth: body size, water temperature, dissolved oxygen, unionized ammonia, and amount of food available, and found that growth was more sensitive to change in water temperature than to changes in parameters for body size, dissolved oxygen or unionized ammonia, and that growth was more sensitive to change in food consumption parameters than to change in metabolic parameters.

The present work is aimed at determining the best water temperature suitable for the growth of Nile tilapia, *Oreochromis niloticus* under the same rearing conditions used

by the fish growers, such as fluctuating water temperature of the ground water with season, and the kind of fish food available to growers.

Materials and Methods

The fish were obtained from the fish hatchery project of King Abdulaziz City for Science and Technology in Riyadh. The initial weight of the fish was 16.20–16.90 g at the beginning of the experiment. Fish were reared for 135 days from November 1993 to March 1994 at a stocking density of 200 fish/m³ in glass tanks (100x30x35 cm) holding 90 l of water in each tank. Fish were fed with 2% of their body weight once per day for 6 days each week, on the seventh day no food was offered, the fish consumed all the quantity of food offered. Fish feed was obtained from a government establishment (Grain Silos and Flour Mills Organization in Riyadh). This feed is available and widely used by local fish growers. Feed has the following composition:

Formula of fish feed

Crude protein	34%
Crude fat	4.0%
Crude fiber	3.0%
Ash	10.0%
Calcium	1.8%
Salt	0.3%
Phosphorus	1.0%
Vitamin A	20.0 Iu/g
Vitamin D	6.0 Iu/g
Vitamin E	25.0 Iu/g

1. Trace elements added include:

Cobalt, copper, iodine, iron, manganese and zinc (no binder was used in this formula of fish feed).

2. The above formula is the only formula found in the market at the time.

Three temperature regimes were used (20, 25 and 30°C). Temperature was regulated and controlled by a thermostatically controlled electric heater in each tank. The water in the tanks did not flow continuously, but was renewed every two weeks using dechlorinated water.

The tanks were provided with biological filters (filters were 360 directional water outflow, filtered aeration, provided with high porosity filter sponge which was washed thoroughly and cleaned regularly). The tanks were held indoors inside a greenhouse and were exposed to the natural light during this season of the year.

The total weight of fish in each tank was recorded every two weeks and the

specific growth rate (SGR) was calculated according to the equation:

$$\text{SGR} = \left[\left(\ln w_t - \ln w_0 \right) / \text{days} \right] \times 100 \quad [3]$$

Where w_0 is the weight of fish at time 0, or initial weight, and w_t is the weight of fish at time t .

The differences between SGR for the three groups were tested by one-way analysis of variance (ANOVA) and by the standard F -test. Differences were considered significant at $P < 0.05$.

Results

In this study it was found that the highest growth rate was achieved at 25°C while the poorest growth was at 20°C and the growth rate of fish at 30°C was in between the two other temperatures. The data in Table 1 represents the mean weight of the fish and the SGR of fish is represented in Table 2. The relationship between the mean weight of fish and the experimental period is shown in Fig. 1 while the Fig. 2 represents the relationship between the SGR values of fish and the experimental period.

Table 1. Mean body weight of *O. niloticus* reared for 135 days at three different temperatures

Days of rearing	Mean body weight (g)		
	Water temperature °C		
	20°C	25°C	30°C
0	16.20	16.90	16.43
15	17.60	19.95	18.33
30	19.60	23.95	20.53
45	21.70	28.45	22.93
60	24.20	32.95	26.25
75	27.65	37.65	29.86
90	31.17	42.40	33.64
105	34.77	47.60	37.58
120	38.47	53.00	41.68
135	42.30	58.50	46.05
Mean ± SD	27.37 ± 9.06	36.14 ± 14.17	29.33 ± 10.19

Table 2. Specific growth rate (SGR) of *O. niloticus* reared for 135 days at three different temperatures

Days of rearing	SGR		
	Water temperature °C		
	20°C	25°C	30°C
15	0.553	1.106	0.730
30	0.635	1.162	0.743
45	0.650	1.157	0.741
60	0.669	1.113	0.781
75	0.713	1.068	0.797
90	0.727	1.022	0.797
105	0.727	0.986	0.788
120	0.721	0.952	0.776
135	0.711	0.920	0.763
Mean \pm SD	0.6783 \pm 0.059	1.0541 \pm .089	0.7685 \pm .0253

The effect of temperature on the specific growth rate of *O. niloticus* was highly significant ($P < 0.001$) at all the periods.

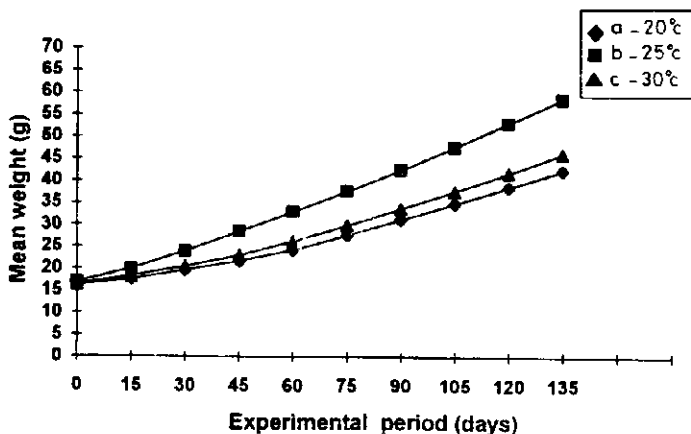


Fig. 1. Effect of temperature on *O. niloticus* reared for 135 days at three different temperatures.

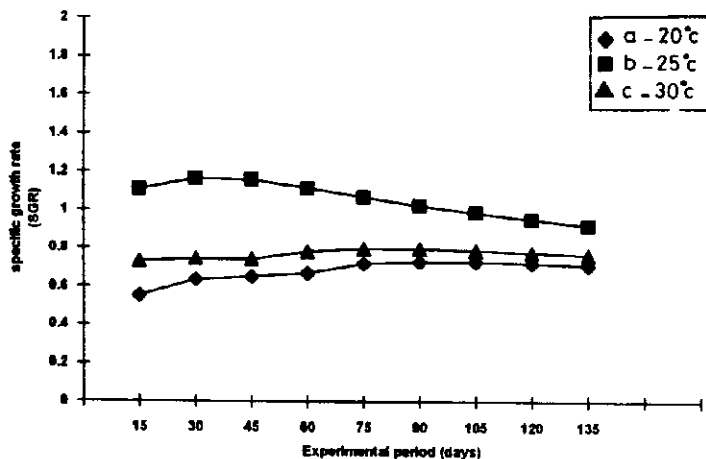


Fig. 2. Specific growth rate of *O. niloticus* reared for 135 days at three different temperatures.

Discussion

It is evident that this species of tilapia being a warm water fish grows best at 25°C. It has shown poor growth at 20°C. The growth rate at 30°C was better than that at 20°C but lower than that at 25°C which indicates that the growth rate of this species of tilapia increases with the increase of water temperature until certain degree above which the growth declines. This certain degree is called the optimum temperature.

In this study it can be expected that the optimum temperature may be 25°C or slightly more but less than 30°C. These results were influenced by the rearing conditions such as the nature of the water, type of fish feed, amount of fish diet, the period of light, body size and dissolved oxygen.

Reproduction in tilapia does not occur below 20°C and tilapia become inactive at 16°C which is considered to be the minimal temperature for normal growth, [4, p. 435; 5, pp. 119-128]. Disorientation of movement, disequilibrium or death occurs at 12°C or lower depending on the species of tilapia [6; 7].

Our results differ with those obtained by Job [8], working on another species of tilapia, *Oreochromis mossambicus*, it is suggested that the growth rate increases up to 30°C and declines at higher temperature. Variation in results also exists between [9] and

[3] where [9] found that the optimum temperature for small African catfish, *Clarias gariepinus* (between 0.5 and 5 g) was 30°C and for large fish (125 g) it was 25°C, while [3] concluded that for the same fish the best temperature was 27°C for fish which ranged in size from 10 to 12 g at the beginning of the experiment.

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تأثير درجة الحرارة على نمو أسماك البلطي *Oreochromis niloticus* المربأة في أحواض زجاجية

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(استلم في ١٤١٦/٥/٩ هـ، وقبل للنشر في ١٤١٧/١١/٩ هـ)

ملخص البحث. تم في هذا البحث دراسة نمو أسماك النيلبي *O. niloticus* عند درجات الحرارة الثلاث (٢٠، ٢٥ و ٣٠م). ربيت هذه الأسماك في أحواض زجاجية بكثافة تربية تعادل ٢٠٠ سمكة/م^٣، ولقد زودت هذه الأحواض بسخانات حرارية ثرموستاتيكية لتسخين المياه وضبط حرارتها عند الدرجات المطلوبة، كما زودت الأحواض أيضاً بمرشحات بيولوجية.

استخدم في هذا البحث غذاء محلي مجروش وجاف (٣٤٪ بروتين) وكانت تغذية الأسماك مرة واحدة يومياً لمدة ٦ أيام من كل أسبوع بنسبة تغذية تساوي ٢٪ من وزن الأسماك. استغرق البحث ١٣٥ يوماً (من نوفمبر ١٩٩٣م حتى مارس ١٩٩٤م). ودلت النتائج النهائية على أن أفضل معدل للنمو قد تحقق عند ٢٠م. ومن خلال النتائج نستطيع أن نتوقع أن درجة الحرارة المثلى لنمو هذه الأسماك قد تكون ٢٥م أو قد تزيد قليلاً إلا أنها وبكل تأكيد أقل من ٣٠م. كان تأثير الحرارة على معدل نمو البلطي النيلبي ملموساً بدرجة عالية ($P < 0.001$).