The Efects of Feeding Fequency on Growth Performance and Carcass Composition of Nile Tilapia (*Oreochromis niloticus,* L.)*

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Abstract

In this study effects of four different feeding frequency (1, 2, 3 and 6 meals/day) on the growth performance, feed consumption, feed conversion ratio and carcass composition of Nile Tilapia (*Oreochromis niloticus*) were investigated.

The average live weight of 420 Nile tilapia used in this experiment were 9.39 ± 0.19 g. Four trial groups were tested in triplicate for 10 weeks and 35 fish were stocked in each tank. The fish were fed with the feed (350 g kg^{-1} CP; 11.7 MJ DE/kg) taken from a commercial feed company. At the end of the study, it was observed that there were important differences among the groups in terms of average live weight, live weight gain, feed consumption, feed conversion ratio (FCR) protein efficiency ratio (PER) and specific growth ratio (SGR) were found statistically significant (P<0.05). Moreover, the difference in the composition of carcass among the groups is found statistically significant (P< 0.05).

Consequently, it is understood that feeding frequency has an important effect on growth rate: there is a linear correlation in young fish, and there is a non- linear correlation in adult fish.

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Key words: Nile tilapia, feeding frequency, growth performance, feed consumption, carcass composition.

Introduction

Tilapias have become well-known among fish farmers because of the advantages of rapid growth, rusticity and easy industrialization due to their lack of lateral musculature spines. These qualities make tilapias the most adequate species for extensive and highly intensive cultivation, as the growing market has shown all over the world. Correct diet handling is absolutely necessary for fish growing performance without any sanitary risk. Besides metabolic-digestive alterations, excessive diet causes water quality deterioration and deficient diet results at a low growth rate and with great variations among individuals. Thus, the diet amount of feeding each time or feeding frequency may influence diet utilization (Sanches and Hayashi, 2001). This is due to the fact that diet is directly applied to water and the non-up taken portion will be dissolved and lixiviated. Feed conversion ratio increase and environmental pollution are the results. Since the main aim is that juvenile uptake a high daily diet ratio to meet their nutrition requirement and thus ingest adequate hormonal amounts, and since high feeding frequency results in high daily diet intake ratio and small amounts of diet per feeding (Meer *et al.*, 1997), a higher frequency may be the most adequate.

Triplicate groups of juvenile Nile tilapia (34.4 g) were fed with a commercial diet once, twice, three, or five times a day for 29 days. Consumption, growth, and feed utilization were evaluated. No significant differences in growth, feed efficiency, or protein utilization were detected among the fish fed 2, 3, or 5 times daily, but all were significantly better than fish fed once only (Riche *et al.*, 2004).

Siraj *et al.* (1988) compared five separate groups which were fed with 10 % ratio of their body weights and with the periods of 3 meals (R_1), 2 meals (R_2), 1 meal (R_3)/day, 1 meal (R_4) in 2 days and 5 meals (R_5)/day *ad libitum* respectively. They determined that the best feeding was achieved with 2 meals (R_2)/day feeding.

Tung & Shiau (1990) stated that FCR, protein and energy accumulation, like in the live weight gain, resulted better in the groups which are fed 6 meals (vs. 2 meals)/day.

Yousif (2004) has carried out to study the effects of feeding frequency on growth performance and feed utilization efficiency of Nile tilapia juveniles. Significantly higher (P<0.05) live weight gain, feed conversion ratio (FCR), protein efficiency ratio (PER) were achieved by receiving either 3 or 4 meals/day.

The objective of this study was to investigate the effects of feeding frequency of juvenile Nile tilapia. In this study, besides finding out the feeding frequency that could achieve optimum growth, the effects of feeding frequency on live weight gain; FCR, feed consumption, PER and feeding frequency on body compositions were aimed to be determined.

Material and Method

Fish and diet

This study was performed in application unit of Aquaculture and Fishery Faculty, Mersin University with a total of 420 Nile tilapia (*Oreochromis niloticus,* L.). Fish were obtained from Çukurova University. They were counted, weighted and stocked randomly chosen into tanks at a rate of 35 fish/tank with 3 repetitions for each feeding frequency. Triplicate groups of juvenile (9.39 ± 0.19 g) were fed with a commercial diet (no 3 granule,

350 g/kg CP, 11.7 MJ DE/kg) once (**I**), twice (**II**), three (**III**), or six (**IV**) meals/day for 70 days. Table 1 shows nutritional composition of the feed.

The research was conducted in plastic tanks sized 200×50×60 cm. Water was distributed with PVC pipes for each tank. The water flow rate was fixed at 0.088 L/min for all treatments, thus 25% of total water volume was changed with fresh water daily. Values of pH (Hanna HI 8314), dissolved oxygen and water temperature (Schott Gerate CG 867) measured periodically, are presented in Table 2.

Feeding trial

Fish in all treatments were fed at a rate of 6% body weight per day during the first 2 weeks. This feeding level was reduced to 4% body weight per day during the rest of the study because there was feed waste of the bottom of the tanks. The same amount of feed was distributed among the group as 1, 2, 3 and 6 meals day^{-1} in the trial. Every two weeks, the whole fish starved before 24 h, was taken from each tank then weighed as a group and amount of feed was adjusted accordingly. It is supposed that all given feed was consumed by the fish. The amount of consumed feed was calculated by adding of amounts of daily feeds.

At the end of experiment, fish weight gain, FCR, PER[†] and SGR[‡] were estimated. Live weight gain was determined by the fish final weight - initial weight; the feed

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[†] $PER = \frac{Average\ Live\ Weight\ Gain\ In\ A\ Definited\ Period,\ g}{Consumed\ Crude\ Protein\ With\ The\ Diet\ In\ A\ Definited\ Period,\ g}$ (*Hepher* 1988)

[‡] $SGR = \left[\frac{lnW_t - lnW_0}{t - t_0}\right] \times 100$ (Wilson 1989)

conversion ratio was calculated as feed consumed/weight gain. No fish death was observed during the trial.

At the end of the experiment seven fish from each treatment were sacrificed and pooled for total body and carcass composition analyses. The chemical compositions of total body, carcass and feed were measured following by AOAC methods (Anonymous, 1995).

Table 1 Feed nutrition composition used in this study [a, b, c].

Item	**Diet (% as fed basis)**
Dry matter	91.0
Crude protein	35.0
Crude oil	7.0
Crude fibre	3.0
Ash	1.0
Digestible Energy, MJ DE/kg	11.7

[a] Vitamin premix (mg/kg dry feed): Vitamin A 3.6 mg, Vitamin D_3 0.45 mg, Vitamin E 0.015 mg, Vitamin K 10 mg, Vitamin C 70 mg, Thiamine 10 mg, Vitamin B_2 20 mg, Pantothenic acid 10 mg, Pyridoxine 5 mg, Vitamin B_{12} 20 mg, Niacine 100 mg, Biotine 0.25 mg, Folic acid 2 mg, Inositol 100 mg, Choline 1000 mg.

[b] Mineral premix (g/kg of dry feed): Calcium 25 g, Sodium 10 g, Phosphorus 6 g, Zinc 70 mg, Manganese 25 mg, Magnesium 25 mg, Ferrum 2 mg, Iodin 0.7 mg, Cupper 1 mg, Cobalt 0.2 mg, Selenium 0.03 mg.

[c] Essential amino acids (g/kg dry feed): L-Lysine 20 mg, DL-Methionine 10 mg, +Cystine 6 mg.

Table 2 Mean values of pH, dissolved oxygen and water temperature which is measured several times during trial periods.

Trial Periods, Day	Water Temperature, °C	Dis. Oxygene, mg/kg	pH
0-14	28.63 ± 1.88	5.14 ± 0.53	7.74 ± 0.25
15-28	27.91 ± 1.59	5.25 ± 0.93	7.61 ± 0.10
29-42	26.02 ± 1.70	5.74 ± 0.42	7.72 ± 0.22
43-56	26.04 ± 2.33	5.74 ± 0.33	7.66 ± 0.24
57-70	21.61 ± 2.19	5.62 ± 0.33	7.76 ± 0.15

Statistical Analyses

Random block experimental design was used to evaluate the differences between treatments. The mean final body weights in each treatment were subjected to statistical comparisons using ANOVA. All statistical analyses were carried out using the SPSS program (SPSS Inc. 1997). Results and Mean differences between treatments were tested for significance ($P<0.05$) by the help of Tukey's multiple range test. Results presented in Table 3 and 4 are reported as means ± SD (n=3 and 5 respectively).

Results

Performance of fish in feeding trial

Live weight, live weight gain, feed consumption, FCR, PER, SGR and survival rate data from different feeding frequencies over the experimental period are shown in Tables 3. The differences between the IV, III, II and I groups for final live weight were found as remarkable ($P<0.05$) at the end of the trial (Figure 1). The best live weight gain and SGR

were obtained in IV and significant differences for these features between I and II, III, IV were observed. The most feed was consumed by IV and the differences between I and II, III, IV; II, III and IV were found statistically significant (P<0.05). In the present study the best FCR was obtained by II during the trial. There were significant differences between I and II, IV; II, III and IV for FCR (P<0.05). The best PER value was obtained in II and the differences among all groups were found statistically significant (p<0.05).

Total body and carcass composition

At the end of the trial, average values of the effect of different feeding frequencies on total body and carcass composition are in Table 4.

IV has the highest total body and carcass moisture content, and the differences between I and II, III, IV; II, III and IV were remarkably important (P<0.05). Protein and fat content of total body and carcass have negative correlation with feeding frequency. The differences between I and II, III, IV; II and III, IV for total body and carcass protein content; I and II, IV; II and IV for total body fat content; I and II, III, IV for carcass fat content were found to be statistically significant (P<0.05).

Discussion

In the study, live weight gain was positively affected with the increase in feeding frequency. The best feeding frequency was found as 6 times day^{-1} for final live weight, live weight gain or SGR. But there is no significant difference between II, III and IV in these points. Extra feeding needs more manpower or expense.Thus, commercial farms must make a choice between manpower cost and income with extra crop obtained by 6 times /day

Table 3 Growth performances and feed efficiency of Nile tilapia fed experimental diets*

Item	Test Groups			
	I	II	III	IV
	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$	$\overline{X} \pm S_{\overline{X}}$
Trial period, day	70	70	70	70
Total fish number	105	105	105	105
Initial weight, g	9.52 ± 0.19	9.40 ± 0.19	9.30 ± 0.19	9.26 ± 0.19
Final weight, g	54.89 ± 0.84 [a]	63.62 ± 0.84 [b]	64.67 ± 0.84 [b]	65.48 ± 0.84[b]
Average live weight gain, g	45.37 ± 0.81 [a]	54.21 ± 0.81 [b]	55.36 ± 0.81 [b]	56.22 ± 0.81 [b]
Average feed consumption, g	58.38 1.39[a]	66.49 1.39[b]	69.42 ± 1.39[b]	74.19 1.39[c]
Feed conversion rate (FCR)	1.26 ± 0.01[a]	1.23 ± 0.01 [b]	1.25 ± 0.01 [ab]	1.32 ± 0.01 [c]
Protein efficiency rate (PER)	2.29 ± 0.02[a]	2.40 ± 0.02[b]	2.35 ± 0.02[c]	2.23 ± 0.02[d]
Specific growth rate (SGR)	2.50 ± 0.03[a]	2.73 ± 0.03[b]	2.77 ± 0.03[b]	2.79 ± 0.03[b]
Survival rate, %	100	100	100	100

*Results are means ± SD (n=3). Means in the same row that do not share a common superscript letter differ significantly (P<0.05).

Table 4 Nutritional composition of total body and carcass at the end of trial*

Item		Test Groups (g kg^{-1})			
		I	**II**	**III**	**IV**
		$X \pm S_{\bar{X}}$	$X \pm S_{\bar{X}}$	$X \pm S_{\bar{X}}$	$X \pm S_{\bar{X}}$
Final Total Body	Moisture	696.8 ± 3.17^{a}	708.4 ± 3.17^{b}	704.9± 3.17^{b}	711.9 ± 3.17^{c}
	Crude protein	173.1 ± 2.41^{a}	162.2 ± 2.41^{b}	157.5 ± 2.41^{c}	157.2 ± 2.41^{c}
	Fat	64.8 ± 7.00^{a}	77.2 ± 7.00^{ab}	86.0 ± 7.00^{bc}	94.7 ± 7.00^{c}
	Ash	42.3 ± 4.21^{a}	43.2 ± 4.21^{a}	35.4 ± 4.21^{a}	24.9 ± 4.21^{b}
Final Carcass	Moisture	755.0 ± 3.03^{a}	743.8 ± 3.03^{b}	746.8 ± 3.03^{b}	762.1 ± 3.03^{c}
	Crude protein	170.2 ± 2.27^{a}	176.9 ± 2.27^{b}	184.2 ± 2.27^{c}	184.8 ± 2.27^{c}
	Fat	47.2 ± 3.67^{a}	34.2 ± 3.67^{b}	31.8 ± 3.67^{b}	28.5 ± 3.67^{b}
	Ash	25.6 ± 3.24	28.7 ± 3.24	29.1 ± 3.24	27.4 ± 3.24

*Results are means ± SD (n=5). Means in the same row that do not share a common superscript letter differ significantly (P<0.05).

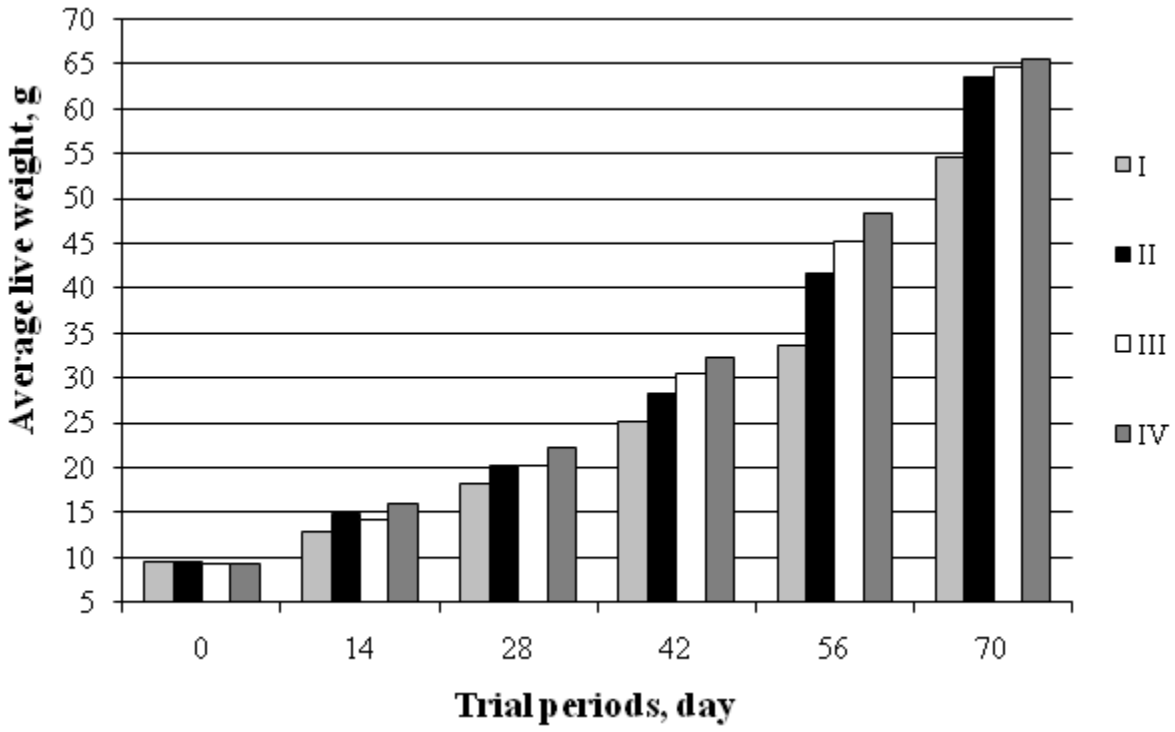

Figure 1 Average live weight in several trial periods

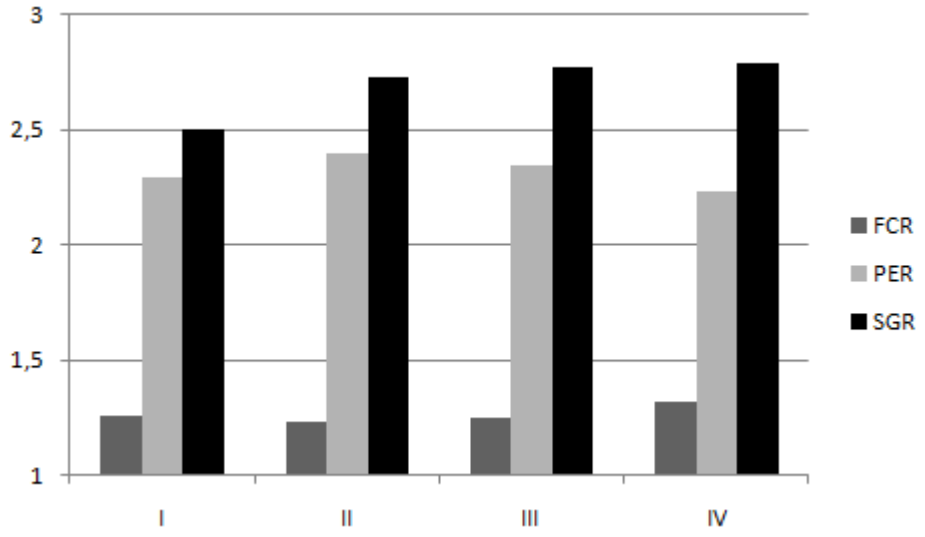

Figure 2 The relationship between FCR and diets. Bars show the means and bars with different letters are different (P<0.05)

High live weight gain with feeding 6 times/day confirmed the results obtained by Tung & Shiau (1990). The results of the current study are also supported with the results of Kubaryk (1980), Siraj *et al.* (1988), Yousif (2004), Ferrari and Hayashi (2001) and Lovell (1998) indicated that live weight gain was positively affected by the increase in the feeding frequency.

The trial showed that there is a positive correlation between the feed consumption and feeding frequency; so, the more fish fed frequently, the more feed consumed. FCR was non linear with feeding frequency and the worst FCR was obtained with 6 meals/day. This situation can be explained by passing more rapidly of ingested food from digestive track, so digestibility of the feed decreases. The present study was supported by Siraj *et al.* (1988) found out that the best FCR results were achieved when they were fed 2 meals/day. On the other hand, Tung and Shiau (1990) stated that the best FCR was achieved with 6 meals/day feeding, which is not supported by the current study.

When total body and carcass compositions are taken into account, it is seen that lipid accumulation was occurred in the body cavities and around the viscera in contrast to carcass, while protein accumulation was found especially in carcass due to the increasing feeding frequency.

The factors affecting the feed consumption in fish show variations depending on lots of parameters such as feeding level, feeding frequency, size of fish, the water temperature, live weight gain and feed quality. Feeding frequency and amount of feed given with the meal should be regular and accepted as one of the basic principles in rearing fish. The feed which is not consumed by the fish is broken into pieces after staying sometime in the water and some of the feed pieces dissolves and affects the water quality negatively besides causing feed loss. As a result, feed efficiency decreases.

Recording to the results of the study; it is understood that the effect of feeding frequency on tilapia culture is important. So, while feeding frequency shows parallelism with the growth in larval period, it is deduced that the mentioned relationship is in negative correlation when they were adult. In

the regions where especially manpower is very expensive, the gradual decrease in feeding frequency can provide economical benefit. Furthermore, as feed cost which approximately 2/3 of the management cost, will decrease in the next periods resulting from the decrease in feeding frequency, it is obvious that this will provide extra benefit to the management

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