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Effect of Different Levels of Feeding During Acclimatization in High Salinities on Gonadosomatic Index and Survival Rate of Adult Red Hybrid Tilapia, *Oreochromis sp.*

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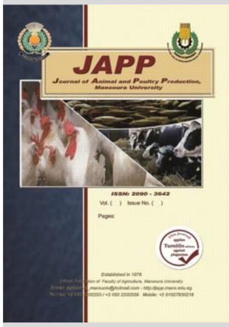

ABSTRACT

A 15 day acclimation experiment was conducted to determine the optimum feeding level during an acclimatization period to marine water for improving survival rate and gonadosomatic index (GSI) of adult red hybrid tilapia in high salinities. This experiment examined four levels of feeding as the follows; treatment (T_1) the control group, which was acclimated without feeding, T_2, T_3 and T_4 were fed at feeding rates 0.5, 1, and 2% of brood-fish weight, respectively. Using mixed sex stocks of adult red tilapia, fish were randomly stocked at rate of one fish / 10 liters in 8 plastic tanks (60 liters) with an average initial weight of 48.75g. Mediterranean Sea water was used to gradually raise the salinity. The statistical analyses appeared significant differences among treatments and confirmed that the growth and GSI indicators are affected by different feeding levels. 0.5% (T_2) and 1% (T_1) as feeding rates for adult red hybrid tilapia during the acclimatization period had the best and highest in theses indicators in comparison with the control treatment and T_4.

Keywords: Acclimatization, Red hybrid tilapia, Marine water, Gonad somatic index

INTRODUCTION

Feeding habit of red hybrid tilapia similar to that of one common mouth-brood Nile tilapia this fish has many economic, omnivores, reproductive in captivity, highly resistant to diseases and ability to grow in brackish and high salinities water (Liao and Chang, 1983**).** Red tilapia is a good commodity to be developed because it has a high nutritional value composition, with a protein content 17.8%, fat 2.8% and 1.2%, others composition. Therefore, the consumption rate of red tilapia is increasingly and the fish become one of the export commodities. It is known, red hybrid tilapia produced in Taiwan in the late 1960s, through hybridization between orange female *Oreochronis mossambicus* and a normal male *O. nilotics*. It was called the Taiwanese red tilapia. Tilapia is well known for their readjustment of several physiological and biochemical processes (Jürss *et al*., 1984). Although red tilapia can grow and productive in a wide range of salinity water, the direct transfer from fresh water to marine water or vice versa results in fish died because severe dehydration which might impair the function of NaK-ATPase activity and is not enough to compensate for ionic exchange requirements at high salinity (Weng *et al*., 2002). Additionally, the direct transfer increases the osmolality and Na ions of blood. Moreover, salinity is known to act directly on several physiological mechanisms of fish such as fish osmoregulatory problems associated with changes in salinities (Altinok and Grizzle, 2003). Thus, fish acclimatization has a great role to reduce these physiological changes, metabolisms rates and improve the osmoregulatory mechanisms. Also, brood-stock acclimatization and feeding has been to greatly improve in their reproductive performance **(**Fontainhas-Fernandes *et al.*, 2000). The acclimatization success from fresh to marine water relates with many factor such as methods of acclimatization, temperature, fish age, salinity level and feeding. Feeding and their system during acclimatization periods of fish are considered unknown factors. Feeding during acclimated fish is an energy source to compensate for the energy consumed in osmoregulatory mechanisms and modifying the physiological case. Therefore, it is believed that optimum feeding level has a vital role to raise the quality acclimatization and survival rate of fish. In general, brood-fish acclimation and the factors that relate with it is without doubt one of the most unknown. Consequently, the current study aimed to improve the acclimatization quality and then fish weight, survival rate and gonadosomatic index of adult red hybrid tilapia, which is transported from fresh water to the marine hatcheries through determination the optimum feeding level during the acclimatization period to marine water.

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MATERIALS AND METHODS

This study was done in fish feeding laboratory, faculty of aquaculture and marine fisheries, Arish University. Adult red hybrid tilapia were obtained from the Fish Research Center, Arish University, Egypt, and transported in freshwater to the experimental site. Water of Mediterranean Sea was used to raise the salinity in the rearing tanks as shown in Table 1.

Table 1. Content of Mediterranean Sea water of live food (zooplankton, organism/m^3)

Groups	Mean No./m^3	%
Copepoda	5083	55
Cladocera	23	0.6
Cirripedia	264	2.9
Ostracoda	59	0.9
Protozoa	1440	15.6
Cnidaria	94	1.2
Rotifera	1077	11.7
Nematode	30	0.7
Annelida	332	3.9
Molluse	196	2.1
Chaetognatha	11	0.5
Chordata	259	2.9
Porifera	100	1.1

According to Hamdy *et al*. (2018)

Experimental design and conditions:

Red tilapia were randomly distributed into 8 square plastic tanks with dimensions of (55 cm × 38 cm × 29 cm; L×W×H) and water volume 60 liter. Fish with an average initial weight 48.75±2.39g were stoked at 6 fish/ tank (3 male + 3 female). All tanks were provided with continuous aeration. Red tilapia were reared under natural photoperiod conditions. Fresh water was replaced with marine water for raising the salinity rate of 3.8 g/l every day for 12 day. After this period the salinity of water was equal the salinity of Mediterranean Sea (38 g/L). This trial tested four different levels of feeding rates during fish adaptation from fresh water to marine water. The first treatment (T_1) was a control group and their fish did not feed, the second treatment (T_2) fish fed with feeding rate 0.5% of their biomass, while the third treatment (T_3) and the fourth treatment (T_4) fish fed with feeding rates 1% and 2% of their body weight, respectively.

Experimental diet and Feeding:

Fish fed a commercial diet containing 27% crude protein (floating pellets 3mm) Table (2) Feed was offered by hand in two meals/day (9:00 a.m. and 16:00 p.m.).

Table 2. Chemical composition of the experimental diet (% on dry matter basis)

Items	%
Dry matter	7.80
Crude protein	27.10
Ether extract	6.55
Crude fiber	6.74
Ash	12.94
Nitrogen free extract (NFE)	46.67
Gross energy (Kj/g)	18.36

NFE calculated by differences
Gross energy calculated according to NRC 1993

Water quality and samples collection:

Water temperature, dissolved oxygen (DO) and pH, were recorded daily before adding the marine water and measured by multi parameter water quality analyzer (MULP-8C). At the end of the experimental period, all fish were collected and the lengths and weights of the fish were taken and gonads of male and female in each treatment were individually weighted to calculate the gonadosomatic index (GSI).

Growth and morphological indicates:

Growth and morphological indicates were calculated according to the following equations;

Weight gain (WG; g) = Final weight (FW) – initial weight (IW).
Average daily gain (ADG; g) = WG/t. Where, t is the experimental period (day).
Relative growth rate (RGR; %) = (WG/IW) ×100.
Specific growth rate (SGR; %/day) = [(ln FW- ln IW)/t] × 100.
Feed intake (FI; g/fish) = Feed offered during the experimental period/number of fish at the end.
Condition factor (CF; %) = FW/(TL)^3.
Where, TL is the total length (cm).
Survival rate (SR; %) = (Number of fish at the end/ number of fish at the start) ×100
Gonadosomatic index (GSI; %) = (A paired of gonads weight/ FW) ×100.
Where, GSI was calculated for both male and female in each treatment.

Chemical analyses:

Chemical analyses of diet were analyzed as the methods described by (AOAC, 2010). Gross energy of the used diet were calculated by using factors of 23.62, 17.56 and 39.5 Kj/g of crude protein, total carbohydrate and crude fat level, respectively (NRC, 1993).

Statistical analysis:

The data were analyzed by one-way ANOVA and significant differences were determined by Duncan Waller multiple range test at 5% level using SPSS statistical package program version17.

RESULTS And DISCUSSION

Result

Physiochemical variables of water were presented in Table (3) temperature degree ranged between 25.05 and 27.5 ºC with an average was 26.07 ºC, the maximum and the minimum pH value was 6.9 and 8.6 with mean was 7.3. While, DO was ranged between 6.0 mg/L at the end and 7.5 mg/L and an average was 6.9 mg/L.

Table 3. Water physiochemical indicators and salinity gradient during the acclimatization period

Day	Temperature ºC	Ph	Dissolved oxygen (mg/L)	Salinity (g/L)
1st	25.1	6.9	7.5	0.0
2nd	25.05	6.9	7.5	3.8
3rd	25.1	6.9	7.4	7.6
5th	25.2	7.0	7.4	11.4
6th	25.5	7.3	7.1	15.2
7th	25.7	7.5	7.1	19.0
8th	25.9	7.6	7.1	22.8
9th	26.1	7.7	7.0	26.6
10th	26.3	7.8	6.8	30.4
11th	26.7	8.0	6.5	34.2
12th	26.5	8.2	6.5	38.0
13th	27.0	8.4	6.3	38.0
14th	27.3	8.5	6.4	38.0
15th	27.5	8.6	6.0	38.0
Mean (± SE)	26.07 ± 0.23	7.33 ± 0.17	6.9 ± 0.13	

Growth performance parameters are shown in Table (4) an average of FW, WG, ADG, RGR, SGR and FI were significantly affected ($P \leq 0.05$) by feeding rate under the acclimatization conditions from fresh water to marine water. There no significant between fish fed with feeding rate 0.5% (T_2) and 1% of biomass (T_3) and they were significantly higher than T_4 and T_1 in FW and ADG. Whereas, fish in T_2 had the highest FW (53.65g) and ADG (0.33g) followed by T_3 (52.77g and 0.28g), T4 (50.50g and 0.12g) and the lowest FW and ADG was obtained by T_1 (50.25g and 0.10g). Fish fed with feeding rate 0.5% of their body weight (T_2) had the highest WG, 4.90g; RGR, 10.04%; SGR, 0.63% followed by T_3 (4.02g; 8.22%, and 0.53%, respectively) and T_4 (1.75g; 3.60%, and 0.23%, respectively), while the control group (T_1) had the lowest values in these parameters. Final length (FL, cm) of fish did not significantly change among groups and T_2 and T_3 had the highest FL (15.5 cm) and 14.50, 14.4 cm for T_4 and T_1, respectively.

Table 4. Effect of different feeding rates on the growth performance measurements of hybrid red tilapia under the salinity acclimatization conditions

Items	Feeding rates				*P*-value	± SE
	Without feeding (T_1)	0.5% of biomass (T_2)	1% of biomass (T_3)	2% of biomass (T_4)		
FW (g)	50.25^b	53.65^a	52.77^a	50.50^b	0.030	0.816
FL (cm)	14.4	15.5	15.5	14.5	0.318	0.674
WG (g)	1.50^c	4.90^a	4.02^{ab}	1.75^{bc}	0.030	8.16
ADG (g)	0.10^b	0.33^a	0.28^a	0.12^b	0.034	0.56
RGR (%)	3.07^c	10.04^a	8.22^{ab}	3.60^{bc}	0.031	1.67
SGR (%/day)	0.20^c	0.63^a	0.53^{ab}	0.23^{bc}	0.037	0.107
FI (g/fish)	0.00	2.87^c	6.56^b	14.19^a	0.001	0.088

Means of treatments in the same row with different superscripts letters are significantly differ (*P*<0.05). SE = Standard error.

Table 5. Effect of different feeding rates on morphological indicates of hybrid red tilapia under the salinity acclimatization conditions

Items	Start	Feeding rates				P-value	± SE
		Without feeding (T1)	0.5% of biomass (T2)	1% of biomass (T3)	2% of biomass (T4)		
SR (%)	100	58.00	74.00	75.00	66.00	0.416	10.422
CF (%)	1.52	1.68	1.44	1.42	1.66	0.366	0.158
GSI (%)	0.83	0.86ab	0.97a	1.16a	0.40b	0.049	0.178

Means of treatments in the same row with different superscripts letters are significantly differ (*P*<0.05).
SE = Standard error.

As shown in Table (5) SR and CF did not significantly vary among the treatments but T_3 and T_2 had the highest SR (75 and 74%) followed by T_4, while T_1 had lowest SR. However, the highest CF was recorded by T_1 (1.68%) and T_4 (1.66%), thereafter T_2 (1.44%) and T_3 (1.44%). GSI (%) was significantly affected by different feeding rates, where T_3 and T_2 had the highest GSI followed by the control group. While, T_4 had the lowest GSI not only among all different groups, but also lower than GSI at the beginning.

Discussion

A gradual increase of salinity level with feeding resulted in increasing pH values from 6.9 to 8.6 with decreasing DO level from 7.5 to 6 mg/L but means of temperature , pH and DO, mg/L were within optimal limits and without lethal effects on red tilapia fish according to many research works such as (El-Sayed, 2006; Tsuzuk *et al*., 2007; Tsadik and Bart, 2007; Sarma *et al*., 2013**).** Moreover, the acclimatization from fresh water to high salinities was gradually done as shown in Table (3) the salinity was increased at rate 3.8g/L daily to maintain SR of fish as it has been suggested by Al-Amodi (1987) the gradually pre-acclimatization of tilapia to salt water have a significantly effect on growth and survival rate.

Results in Table 4 confirmed that the feeding of adult red tilapia during the adaptation from fresh to marine water has a vital role to improve their performance, stability of body weight and GSI and decrease of the mortality rate. This result corroborates that, observed by Cioni *et al*. (1991**)** the adaptation capacity of tilapia to high salinities depended on the digestive tract and kidney. Fish need a lot of energy to counteract the stress resulting from the changes of physiological and environmental associated with marine acclimatization. El-Sayed (2006) found that physiological changes associated with acclimatization of tilapia in marine water require energy may account for much as 20% of total body metabolism after four days. Payne *et al*. (1988) reported that the diverted metabolic energy into osmoregulation of *O. mussambicus* and *O. spilurus* enhanced with increasing salinity level of water during the acclimatization period. This observation was conformity with the suggest of Boeuf and Payan (2001) mentioned that, water salinity can effect on growth, metabolic rates and osmoregulation which consume about 20-30% of total energy. The freshwater fish acclimatization to high salinities negatively effect on fish performance as a result of some functional changes in gills epithelium chloride cell and Na-K-ATPase activity (Perry, 1997).

Al-Amodi *et al*. (1996) also noted that Na, CL of plasma elevated directly after the once day of transfer to sea water but returned to levels of fresh water on the fourth day. In the same trend, Sardella and Brauner (2008) reported osmotic water loss and diffusive ion gains for maintaining their hypo-osmotic environment when fresh water fish are acclimated to marine water. It has added that fish trend to drink a lot of water causing Na^+ exchange and net outward transport of NaCL at the level of the branchial mitochondria–rich cells. This process lead to increase the excretion urea and ammonia content along with their urine. Thus increasing the levels of ammonia in water can cause impairment of cerebral energy metabolism and then there are damages in gill, spleen and kidney (El-Sherif and El-Feky, 2008). In addition to these observations, Besra and Sharma (2004) and Pradeep e*t al*. (2011**)** said that when freshwater fish are acclimated to salt water their metabolism activity was always altered and greater demand of salt excretion along with ammonia and urea. In the light of this discussion, it can be affirmed that, feeding the acclimated tilapia to marine water is very important to compensate for the energy consumed in these physiological activities but over feeding lead to an adverse result as it was occurred in T_4. Fish fed at a feeding rate 2% of their biomass (T_4) had a lowest values of the growth performance parameters compared with those fed 0.5 and 1% as feeding rate during the acclimatization period to marine water, in addition to GSI of T_4 was the lowest among all treatments. This is interpreted that when fish reared under stressful conditions such as the acclimatization to slain water, high temperature, high density, decreased water quality and also reproductive, they need to feed at the rate which compensates the lost energy to face these conditions, additionally fish did not trend to growth or muscles formation until removing the stressful factors. Accordingly, increasing level of feeding can cause load and burden on fish. Furthermore, as a result of increasing feeding rate of fish reared under acclimatization conditions to marine water uneaten of feed, uneaten feed increase the deterioration of water quality in addition to the acclimatization to marine water increases the excretion urea and ammonia as aforementioned. A similar statement of Chowdhury (2011**)** increasing feeding rate would add feces in the water therefore influence DO depletion and increase ammonia level. Similar trends agreed with our findings such as Abou-Zied (2006) found that, a feeding rate 1% and 0.5% of tilapia brood-stock weight was the best on reproductive performance during the season spawning. In the same context El-Dahhar *et al*. (2015) who found that, 1% as feeding rate for tilapia brood-stock was considered to be the best for improving the reproductive efficiency.

In view of Table (4) it can be noted that WG of the control group increased slightly this may be due to content of Mediterranean Sea water of live food as showed in Table (2) and these results are in agreement with those obtained by Abdel-Aziz *et al*. (2019) who reported natural food in marine water of Qaroun lake contributed about 35% from the growth rate of hybrid red tilapia fry, which were fasted. Additionally, GSI was higher at feeding rates 1 and 0.5% of fish body weight than the control and feeding rate 2% of biomass (T_4). This may be due to overfeeding was a load and multiplied the stress with stress of acclimatization resulted in decreased GSI. Haddy and Pankhurst (2000) found that high salinity had the negative effect on fish weight and cause harmful changes on the reproductive performance. However, Neves *et al*. (2019) environmental salinity effects growth and sexual maturation and they reported salinity level from 24.0 to 26.0 g/L can activity aromatase, which result in producing estrogens.

CONCLUSION

It could be conclude that the determination of feeding rate of the acclimated fish is very important to improve the acclimatization quality of adult-red tilapia. Where, the feeding rates 0.5% and 1% are suitable to mitigate the stressful conditions that accompany the acclimatization to high salinities. Also, a higher feeding level than 1% for the acclimated adult red tilapia leads to the adverse results.

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تأثير مستويات مختلفة من التغذية خلال فترة الاقلمة لتحمل الملوحة العالية على مؤشر الغدد التناسلية ومعدل البقاء للبلطى الاحمر

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أجريت هذه الدراسة لتحديد معدل التغذية الأمثل اثناء أقلمة أسماك البلطى الأحمر الهجين البالغة على الملوحات العالية لتحسين معدل البقاء ودليل الغدد التناسلية .في الدراسة الحالية تم اختبار أربع معدلات تغذية كالتالى، المعاملة الاولى الأسماك أُقلمت دون تغذية (كنترول)، المعاملة الثانية، الثالثة والرابعة غُذيت فيها الأسماك بمعدلات 0,5 و1٪ و2٪ من وزن الأسماك الحى على التوالى. استخدمت عدد 8 تانكات بلاستيكية (60لتر) وزعت الأسماك عشوائيا بمعدل تسكين 6 اسماك (3 ذكور: 3 إناث) / تانك. متوسط الوزن الأبتدائى للأسماك 48,75جرام، الأقلمة تمت تدريجيا لمدة 15 يوم برفع مستوى الملوحة 3,8 جزء فى الألف يوميا باستخدام مياه البحر المتوسط. التحليل الإحصائي للنتائج المتحصل عليها أظهر اختلافات معنوية بين المعاملات وأكد أن التغذية بمعدلات 0,5 و1٪ لأسماك البلطي الأحمر الهجين البالغة كانت الأفضل فى تحسين جوده الأقلمة مقارنة بالمعاملة الكنترول أو التغذية بمعدل 2٪ من وزن الأسماك الحى.

الكلمات الدالة: الاقلمة، البلطى الاحمر، المياه البحرية،مؤشر الغدد التناسلية