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# PRELIMINARY INVESTIGATIONS IN THE INTENSIVE AND SEMI-INTENSIVE MARINE CAGE CULTURE OF FLORIDA RED TILAPIA UNDER DIFFERENT ENVIRONMENTAL CONDITIONS IN EGYPT.

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## ABSTRACT

Four groups of Florida Red tilapia were reared in marine cages in order to investigate the effect of water temperature and culture systems( intensive and semi-intensive) on their survival, growth, feed utilization parameters as well as production performance. Results of the study showed that: 1) 20-28°C may be near the optimal water temperature in cages; and 2) intensive and semi-intensive Florida Red tilapia mariculture did not affect the fish production inversely in floating cages. Intensive mariculture group had higher fish production (10.24 kg/m$^3$) than those of semi-intensive group (6.43 kg/m$^3$). This due to Florida red tilapia fingerlings could withstand conditions with high density, low content of dissolved oxygen and excess of organic matter.

**keywords:** Florida Red tilapia, Stocking density, Growth performance, Production, Culture systems.

## INTRODUCTION

Seafood is a desired source of protein for Egyptians, but domestic fisheries production does not meet demand. In year 2000, marine capture fisheries accounted for 18% only of production (Megapesca, 2001). If demand for seafood were better met by internal production, Egypt could benefit through enhanced nutrition, employment and personal incomes, and also reduced foreign exchange expenditures. Greater production is not likely to come from Egypt's marine fisheries, however, because traditional fishing grounds are already overexploited. It has been suggested that increased production could be achieved through development of marine fish culture. More attention must be focused on natural water resources, lagoons and lakes using its numerous marginal areas to find a new intensive or semi-intensive mariculture methods (Essa, 2001; El-Ebiary and Essa, 2002).

For the West-Northern Shore of the Mediterranean Sea areas, finfish mariculture in cages offers a number of advantages over freshwater and land-based aquaculture. It minimizes reliance on freshwater, which is often scarce or poor quality, and avoids competition with agriculture for limited land resources and land ownership. Scientific investigations concerning the possibility of culturing natural water resources, lagoons and lakes were made by many workers (Essa and Salama, 1989; Mckinley, 1994; Loverich, 1996; Essa, 2001; El-Ebiary and Essa, 2002 as well as Helal, 2003). This type of fish culture is practically well-developed in China. The current trend is to

convert the shallower zones of natural lakes into large pen fish farms and ponds, for more intensive fish culture (FAO, 1983).

Florida red tilapia (*Oreochromis uroplepis hornorum* female & *O. mossambicus* male) is well-adapted to saltwater and able to grown at high densities on artificial feeds (Ernst *et al.*, 1989 and Watanabe *et al.*, 1991). Therefore, the main objective of this study was to demonstrate the effect of intensive and semi-intensive floating marine cage culture of Florida red tilapia on their growth and production performance parameters under different rearing and environmental conditions.

## MATERIALS AND METHODS

Field trials were carried out in the West-Northern Shore of the Mediterranean Sea, West Lagoon, Mersi Matrouh City, Matrouh Governorate, Egypt, for 170 days.

Florida red tilapia (*Oreochromis urolepis hornorum* female & *O. massambicus* male) fingerlings at a inital weight and length of 0.52 to 0.61g and 2.95 to 2.96cm, respectively were introduced from the Marine Fish Hatchery General Authority for Fish Resources Development, km 21 West of Alexandria, Egypt.

Six floating net cages were used during the present study. Each cage had a frame made of 2 inch aluminium pipe with dimensions 4 x 3 x 2 meter(24 $m^3$) , with nylon netting bag of 6 mm mesh size and blocks of styrofoam protected against birds by thin aluminium foil and attached along two sides of the metal cage as floats (Fig. 1). Two cages were fastened together to form one unit. Cages were placed in West Lagoon, suspended at a water depth of 8 m.

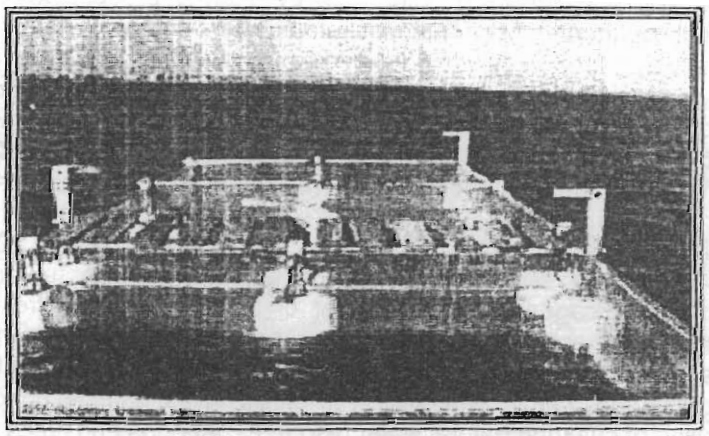

**Figure (1): Floating net - cages which were used for rearing Florida red tilapia fingerlings.**

**Experiment No.1:**

To examine the influence of water temperature on growth performance, survival rate and production of Florida red tilapia fingerlings reared in floating marine cages; two Florida red tilapia groups at a mean weight of 0.52 and 0.61g were stocked in cages at a density 1200 fish/cage (50 fish/$m^3$) .The first group was reared for 158 days, at 20-28 °C water temperature. The second group was reared for 170 days, at 15- 28 °C water temperature. The fish were fed a 22.92% protein supplementary diet (Table 1) twice daily at a rate of 5% of the total fish body weight during summer and autumn seasons and decreased to 3% during winter season.

Ten percent from the total fish stocked in each cage were weighed individually bi-weekly in order to determine fish growth and production parameters as described by Ballestrazzi *et al.* (1994).

**Experiment No.2:**

To examine the Effect of culture methods( intensive and semi-intensive) on growth, survival, feed utilization and production performance parameters of Florida red tilapia fingerlings reared in floating marine cages". Each cage was stocked with 2400 and 1200 fish of equal average initial weight, 0.52g (about 100 and 50 fish/$m^3$) for intensive and semi-intensive cultures, respectively, and reared for 158 days (from June 10 to November 15).

The fish were fed a 22.92% protein supplementary diet twice daily at a rate of 5% of the total fish body weight .Table (1) shows their feed ingredients and chemical analysis. The diet was offered in wet form on a plastic plate placed in the center of the cage.Ten percent from the total fish stocked in each cage were weighed individually every 14 days in order to determine fish growth performance parameters.

Some physico-chemical water quality parameters (temperature, salinity, pH, dissolved oxygen and ammonia) in cages area were determined bi-weekly according to APHA (1965).

Feed and fish samples were analysed for protein, fat, fiber and ash by standard methods of AOAC (1995).

The results of the present study were submitted to statistical analysis of variance and significant differences computed by Duncan's Multiple Range Test ( Snedecor and Cochran, 1967).

**Table (1): Composition (%) and proximate chemical analysis (%) of Florida red tilapia fingerlings diet.**

| Ingredient | (%) |
|---|---|
| Cotton seed cake | 25 |
| Soybean meal | 20 |
| Fish meal | 10 |
| wheat milling by- products | 42 |
| Cod oil | 2 |
| Vitamin and Mineral premix* | 1 |
| **Proximate chemical analysis (%as dry matter basis)** | |
| Dry matter(DM) | 88.96 |
| Crude protein( CP) | 22.92 |
| Ether extract(EE) | 9.92 |
| Crude fiber(CF) | 8.49 |
| Ash | 9.34 |
| Nitrogen free extract (NFE) | 49.33 |
| Calculated Gross energy Kcal (GE/100g DM) | 426.15 |

*** As described by Helal (2003)**

## RESULTS AND DISCUSSION

Water quality criteria of cages area (West Lagoon, Mersi Matrouh City) were presented in Table (2). The temperature exhibited a simple diurnal cycle, with the minimum at down or within an hour after dawn, and the maximum in early-mid after noon. Throughout the summer the temperature increased until August (the maximum 28.0°C) then decreased sharply in November and December to 17-19.5°C. It reached the lowest minimum value in January (15.0°C).

For salinity, the values were found to be in the range of 32.96 to 36.11 ppt. Red tilapia are euryhaline and are able to survive and grow in sea water (Ernst *et al.*, 1989). Also, the dissolved oxygen, pH and ammonia values in cages area seemed to be suitable for tilapia culture(Table 2). The lowest tolerance limits of dissolved oxygen and pH for tilapias have been reported to range from 0.1-3.0 ppm and 6.5-7.0, respectively (Ng *et al.*, 1992). Also during the present study, ammonia values not more than 0.108 mg/l. Tudor *et al.* (1994) found that, concentrations of ammonia are usually be well below 1 mg/l in unpolluted water.

**Table (2): Water quality criteria in floating net cages area at the West Lagoon, Mersi Matrouh City, Matrouh Governorate .**

| Months | Water temperatures (C°) | pH | Dissolved oxygen (mg/l) | Salinity ppt | Ammonia $NH_3$ (mg/l) |
|---|---|---|---|---|---|
| June,10 | 26.10 | 8.09 | 7.79 | 32.96 | 0.087 |
| July | 27.00 | 7.79 | 7.72 | 34.20 | 0.088 |
| August | 28.00 | 7.76 | 6.88 | 34.90 | 0.091 |
| September | 27.50 | 7.75 | 6.92 | 34.81 | 0.099 |
| October | 23.00 | 7.70 | 7.26 | 36.05 | 0.099 |
| November | 19.50 | 7.68 | 7.75 | 36.07 | 0.092 |
| December | 17.00 | 7.68 | 7.77 | 36.11 | 0.091 |
| January,23 | 15.00 | 7.66 | 7.97 | 36.08 | 0.108 |

**Experiment No. 1:**

The performances of the two experimental groups of Florida red tilapia fingerlings semi-intensive mariculture in cages under different water temperature conditions, are presented in Tables (3) and (4).It was found that the incremental survival rate (%) and growth performance were nearly similar for the two Florida red tilapia groups during summer and start of autumn seasons. Throughout the late autumn and winter the water temperature decreased sharply the minimum was 15°C until the end of the present experiment in January, 23. Therefore, the survival and growth performances of the second fish group (reared at water temperature from 15-28°C) were decreased rapidly and the final means weight and survival reached only to 78.20g and 53.25%, respectively (Tables 3 and 4). Fish converted feed less efficiently (3.61:1) than those in the first fish group (1.65 : 1), reared at water temperature from 20-28°C, from June 10 to November 15 (Table 4).

Obviously, red tilapia production was too low in the second fish group (2.08 kg/$m^3$) comparing with those in the first fish group (6.34 kg/$m^3$) because of the opposite trend in individual survival and growth rates due to low water temperature in cages area especially during December and January months (15-17°C). Accordingly, means growth, survival and production performances were highest in the first fish group, 0.90 g/day, 89.30% and 152.16 kg / cage, respectively (Tables 3 and 4).

**Table (3): Monthly survival rate (%) of Florida red tilapia fingerlings which reared in semi-intensive mariculture in cages under different water temperature conditions.**

| Months | Water temperatures (C°) | | | |
|---|---|---|---|---|
| | 20-28 °C | | 15-28 °C | |
| | No. of fish per cage | % | No. of fish per cage | % |
| June,10 | 1200 | 100 | - | - |
| July | 1197 | 99.75 | - | - |
| August | 1184 | 98.67 | 1200 | 100 |
| September | 1169 | 97.42 | 1176 | 98.00 |
| October | 1138 | 94.83 | 1141 | 95.08 |
| November* | 1072 | 89.30 | 1090 | 90.83 |
| December | - | - | 853 | 71.08 |
| January 23 | - | - | 639 | 53.25 |

* Only to 15 November for the first fish group (20-28 °C).

These results agree with the previous results of Allanson *et al.* (1971), Pullin and McConnel (1982) as well as Dowindar and Essa (1988). They found that activity and feeding of tilapias become reduced below water temperature 20°C and feeding stops completely around 16°C.

The results from the first experiment strongly suggested that, 20-28°C may be near the optimal water temperature for Florida red tilapia survival and growth in Egypt.

**Table (4): Effects of water temperature on growth performance, condition factor, feed utilization and production of Florida red tilapia fingerlings which reared in semi-intensive mariculture (50 fish/ $m^3$ ) in floating cages (24 $m^3$ each).***

| Items | Water temperatures | |
|---|---|---|
| | 20-28 °C | 15-28 °C |
| -Av. Initial body weight (g) | 0.52 ± 0.06 | 0.61 ± 0.07 |
| -Av. Final body weight (g) | 141.94 ± 6.65 $^a$ | 78.20 ±8.04 $^b$ |
| -Av. Daily weight gain (g/fish/day) | 0.90 $^a$ | 0.46$^b$ |
| Specific growth rate (%/day) | 3.55$^a$ | 2.86$^b$ |
| Condition factor (k) | 2.94 ± 0.50 $^a$ | 2.14 ± 0.39 $^b$ |
| Feed conversion ratio (FCR) | 1.65 $^b$ | 3.61$^a$ |
| Protein efficiency ratio (PER) | 15.73 $^a$ | 7.20 $^b$ |
| Protein productive value (PPV)(%) | 47.98 $^a$ | 17.34 $^b$ |
| Energy utilization (EU)(%) | 26.98 $^a$ | 9.64 $^b$ |
| Total weight gain (kg fish/$m^3$) | 6.34$^a$ | 2.08 $^b$ |
| Total fish production (kg /cage) | 152.16$^a$ | 49.97$^b$ |

* Different superscript indicates significant differences ($p<0.05$).

**Experiment No. 2:**

The results in Table (5) showed that, red tilapia reared in semi-intensive mariculture (50 fish/$m^3$, about 1200 fish per cage 24$m^3$ water capacity) (L50) had the heaviest body weight (141.9 g) and longest body length (17.0 cm) comparing with those reared in intensive mariculture (100 fish/$m^3$, about 2400 fish per cage) (H100), 119.7 ± 5.89g and 16.1± 037 cm, respectively.

The condition factor (k) of cultured Florida red tilapia after 158 days in marine cages was also affected by culture methods. L50 fish group had higher condition factor (2.94) than H100 fish group (2.86), but the differences

were insignificant (Table5). This lead to concluded that the marine cages conditions were suitable for rearing Florida red tilapia. In the same trend, Lagler (1956) demonstrated that, high values of condition factor indicated the suitability of the environment to the fish.

The total and individual daily gain in weight and length were significantly higher in L50 fish group than in H100 fish group. Similarly, the highest survival rate was recorded in L50 group (89.33%), while the lowest value was in H100 fish group (85.75%) and the differences were significant (Table5).

**Table (5): The effect of two different culture systems (intensive and semi-intensive) on growth performance, condition factor (k) and survival rate of Florida red tilapia mariculture in floating net cages***

| Items | Culture systems | |
|---|---|---|
| | Intensive (100 fish / $m^3$) | Semi-intensive (50 fish / $m^3$) |
| 1) Stocking data: | | |
| -Av. Initial body weight (g) | 0.52±0.06 | 0.52±0.06 |
| -Av. Initial body length (cm) | 2.95±0.12 | 2.95±0.12 |
| No. of fish stocked /cage | 2400 | 1200 |
| 2) Harvesting data: | | |
| -Av. Final body weight (g) | 119.68±5.89 $^a$ | 141.94±6.06 $^b$ |
| -Av. Final body total length (cm) | 16.12±0.37 $^a$ | 17.03±0.44 $^b$ |
| No. of fish harvested/cage | 2058 $^a$ | 1072 $^b$ |
| -Av. Individ. daily weight gain (g/fish/day) | 0.75 $^a$ | 0.90 $^b$ |
| -Av. Individ. daily length gain (mm/fish/day) | 0.83 $^a$ | 0.89 $^b$ |
| Specific growth rate (%/day) | 3.44 | 3.55 |
| Condition factor (k) | 2.86±0.14 $^a$ | 2.94±0.50 $^b$ |
| Survival rate (%) | 85.75 $^a$ | 89.33 $^a$ |

* Different superscript indicates significant differences ($p<0.05$).

The overall growth and survival results demonstrated that, intensification of red tilapia mariculture in cages resulted in decreased significantly fish growth and survival rates. This agrees with the previous results of Essa (1996) for Nile tilapia, *Oreochromis niloticus*, cage culture, El-Sayed and Ghobashy (1997) as well as Helal (2003)and Abd El-Rhman *et al.*,(2003) for marine fish, sea bass *(Dicentrarchus labrax)*, in cage. This results could be explained the observation that the fish at moderate density (semi-intensive culture) consume maximum amount of feed available and growing faster. In the other side , the fish at high density (intensive culture) disturbing each other during feeding and normal activity. Holm *et al.* (1990) attributed the decrease in growth rate with increasing density to the reduced food consumption and thereby the feed efficiency ratio. The results of feed utilization parameters during the present experiment (Table 6) confirm these findings. These results demonstrated that increase Florida red tilapia density from 50 to 100 fingerlings /$m^3$ significantly decreased feed utilization parameters (protein efficiency ratio, protein productive value and energy utilization). Thereby, Florida red tilapia marine semi-intensive cage culture used less feed (1.79 unit) to produce one unit of gain in weight (Table 6) as compared to that in case of intensive cage culture (3.86: 1).

**Table (6): The effect of two different culture systems on feed utilization parameters of Florida red tilapia mariculture in floating cages, 24 $m^3$ each. ***

| Items | Culture systems | |
|---|---|---|
| | Intensive (100 fish / $m^3$) | Semi-intensive (50 fish / $m^3$) |
| Feed intake (kg) | 460[b] | 254[a] |
| Feed conversion ratio (FCR)** | 3.86 | 1.79 |
| Protein efficiency ratio (PER) | 1.13[a] | 2.45[b] |
| Protein productive value (PPV)(%) | 19.73[a] | 47.98[b] |
| Energy utilization (EU)(%) | 10.57[a] | 26.00[b] |

*** Different superscript indicates significant differences ($p<0.05$).**
**** Insignificant ($p<0.05$)**

On the other hand, it may be of interest to note from Fig. (2) that, intensive Florida red tilapia marine cage culture group had significantly ($p < 0.05$) higher fish production (10.24 kg/$m^3$) than those of semi-intensive cage culture group (6.43 kg/$m^3$). This might be due to Florida red tilapia fingerlings could reflect well performance withstand conditions with high density, low content of dissolved oxygen and excess of organic matter (Huet, 1972; Pullin and Lowe-McConnell, 1982). Therefore ,intensive red tilapia group possessed a good growth and survival rates during the present experiment (0.75 g/day and 85.75%, respectively).

Based on the above results, culture systems (intensive and semi-intensive mariculture) did not affect the total Florida red tilapia production inversely in floating net cages.

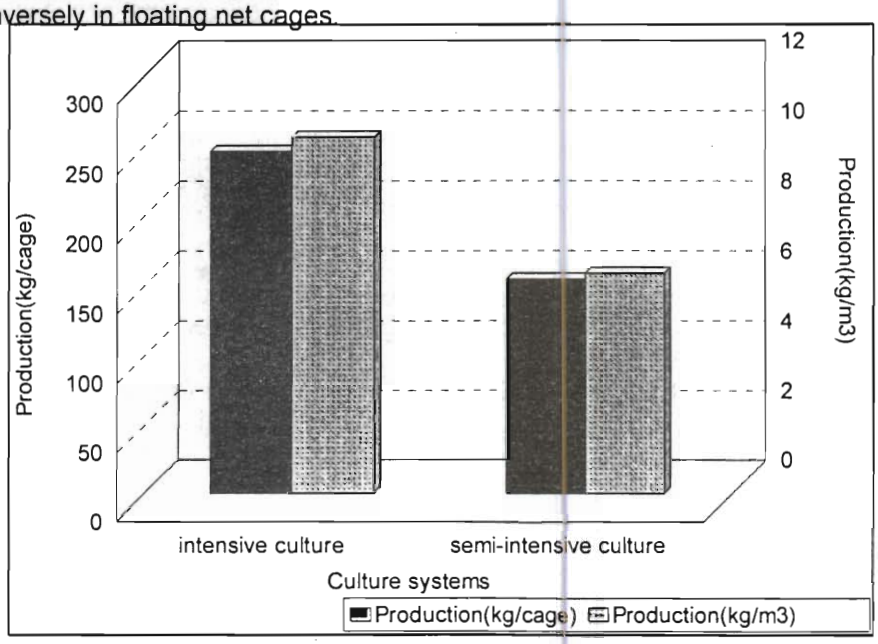


**Figure (2): Total Florida red tilapia production for the different mariculture systems in cages, Matrouh Governorate.**

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# دراسات فى الاستزراع السمكى البحرى المكثف و شبه المكثف للبلطى الأحمر من سلالة فلوريدا تحت ظروف بيئية مختلفة فى جمهورية مصر العربية

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المعهد القومى لعلوم البحار و المصايد-الاتفوشى – الإسكندرية

أجريت هذه الدراسة بمنطقة الساحل الشمالى الغربى للبحر الأبيض المتوسط – اللاجون الغربى بمدينة مرسى مطروح بغرض التعرف على إمكانية استزراع البلطى الأحمر من سلالة فلوريدا فى أقفاص شبكية عائمة (٢٤ متر مكعب للوحدة) بالنظام المكثف (١٠٠ وحدة زريعة /م$^{٣}$ ) و شبه المكثف (٥٠ وحدة زريعة/م$^{٣}$) و أيضاً للتعرف على درجات حرارة الماء المثلى اللازمة لنمو و معيشة البلطى الأحمر . أظهرت النتائج ما يلى:

١) حقق الاستزراع السمكى شبه المكثف للبلطى الأحمر تحت ظروف درجات حرارة الماء المعتدلة(٢٠-٢٥ °م ) أعلى معدلات للنمو (٠,٩٠ جرام/يوميا) و أعلى قيمة لمعامل الحالة(٢.٩٤) دلالة على مناسبة الظروف البيئية و الغذائية و المعيشية , وعليه حققت أسماك هذه المجموعة إنتاجية كلية قدرها٦,٤٣ كجم/م$^{٣}$ .

٢) بزيادة تكثيف زريعة أسماك البلطى الأحمر (١٠٠وحدة/م$^{٣}$ ) تحت ظروف درجات الحرارة المعتدلة حققت أسماك هذه المجموعة المرتبة الثانية من حيث معدلات النمو (٠,٧٥ جرام/ يوميا) و معامل الحالة(٢,٨٦) . ولكن أظهرت أسماك البلطى الأحمر تحملاً كبيراً لظروف التكثيف حيث كانت نسبة الإعاشة ٨٥,٧٥ % و عليه حققت أسماك هذه المجموعة أعلى معدل للإنتاج بلغ ١٠,٢٤ كجم/م$^{٣}$ .

٣) حقق الاستزراع السمكى البحرى شبه المكثف للبلطى الأحمر تحت ظروف درجات الحرارة المعتدلة ثم المنخفضة(١٥-٢٨ °م) معدلات نمو متباينة خلال فترة التربية المستمرة من ١٠ يونيو حتى ٢٣ يناير (١٧٠يوما). فى خلال الفترة من أغسطس حتى أكتوبر حيث كانت درجات حرارة الماء أعلى من ٢٠ °م تماثل معدلات النمو و الإعاشة لأسماك هذه المجموعة مع نظيرها فى المجموعة المرباة تحت ظروف درجات الحرارة المعتدلة . اعتباراً من نهاية نوفمبر و حتى ٢٣ يناير انخفضت درجات حرارة الماء بشدة حتى وصلت إلى ١٥ °م مما أدى إلى انخفاض معدل النمو لأسماك هذه المجموعة (٠,٤٦ جرام/يوميا) و أيضا زادت نسبة الموت حيث بلغت نسبة الإعاشة فى النهاية ٥٣,٢٥ % و بالتالى لم تزد الإنتاجية الكلية لأسماك هذه المجموعة عن ٢,٠٨ كيلوجرام/م$^{٣}$ دلالة على أن المدى الحرارى المناسب لنمو و معيشة أسماك البلطى الأحمر سلالة فلوريدا فى مصر هو ٢٠-٢٨°م.