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Acclimation Trial of *Liza aurata* Fingerlings To Fresh Water and To a Low Water Salinity

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□ ABSTRACT □

This study was conducted to investigate the effect of abrupt and gradual acclimation of *Liza aurata* fingerlings to fresh water and gradual acclimation to a selected salinity 3‰. *L.aurata* fingerlings were collected directly from the sea and duplicate groups of 30 fingerlings were distributed after rest to glass aquaria (100 liter capacity). The first group was acclimated abruptly to fresh water, the second gradually to fresh water, the third was acclimated gradually to 3‰ and the last group was left as control in sea water. The fingerlings were fed artificial diet (35% protein and 500 kcal GE/100g), twice a day to satiation for 75 days.

The results revealed that the first and the second group of fingerlings died gradually showing the same symptoms including stress, dark coloration, loss of appetite and abnormal swimming behavior.

While the fingerlings in the third aquarium stayed alive to the end, and even their growth rates and feed utilization efficiency were comparable (P>0.05) to those lived in sea water.

Keywords: *Liza aurata*, Fingerlings, Salinity, Fresh water.

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أقلمة اصبعيات البوري دهبان (*Liza aurata*)
للمياه العذبة و لدرجة ملوحة منخفضة

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□ ملخّص □

تم إجراء البحث لدراسة مدى تأثير الأقلمة الفورية و المتدرجة للمياه العذبة و كذلك الأقلمة المتدرجة عند درجة ملوحة3 ‰ على معاملات النمو عند اصبعيات البوري دهبان التي تم جمعها مباشرة من البحر و بعد استراحة قصيرة قمنا بتوزيع الاصبعيات الى أحواض زجاجية سعتها 100 ليتر و بمعدل 30 إصبعية لكل حوض. تم أقلمة اصبعيات الحوض الأول بشكل فوري مباشر للمياه العذبة, بينما أقلمت اصبعيات الحوض الثاني تدريجيا" للمياه العذبة, أما اصبعيات الحوض الثالث فتم أقلمتها بشكل تدريجي لدرجة ملوحة مختارة (3‰) و تركت اصبعيات الحوض الرابع كشاهد في مياه البحر. تم تغذية الاصبعيات بعليقه تحوي 35 % بروتين و 500 كح/100 غ عليقة بمعدل مرتين في اليوم حتى الشبع لمدة 75.يوما".

أشارت النتائج أن اصبعيات الحوضين الأول و الثاني نفقت كلها و بشكل تدريجي مظهرة نفس العوارض المرضية و المتضمنة الإجهاد و اللون الأسود و فقدان الشهية و السباحة غير الطبيعية.

بينما بقيت اصبعيات الحوض الثالث على قيد الحياة حتى نهاية التجربة و أظهرت معدلا ت نمو و معامل تحويل غذاء مقارباً ($P>0.05$) لتلك الاصبعيات المرباة في مياه البحر و كلاهما أظهرا معدل وفيات متقاربة ($P>0.05$).

الكلمات المفتاحية: البوري دهبان– إصبعيات – الملوحة – المياه العذبة

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Introduction:

Since long time, the mullets (Mugilidae) are considered among the most interesting coastal species for aquaculture (Pillia, 1975; Nash and Shehadeh, 1980). Global aquaculture production was approximately 121365 tons while capture production was 23927 tons for grey mullet of the world in 2002 (FAO, 2005). They are consumers of the low trophic layers, and can therefore be used in most economic and efficient way by culturing them extensively (Crosetti and Cataudella, 1995). They also possess osmoregulation abilities which appear early during the development (Nordlie *et al*., 1982) and allow them to maintain elevated growth rates also under hyposaline conditions (Cardona and Castello-Orvary, 1997).Thus, their production may be carried out in a variety of eco-systems like coastal lagoons with brackish to hyper saline waters (Hotos and Vlahos, 1998) ,reservoirs and ponds with fresh waters (Chervinski, 1977, 1982; Losse *et al*., 1991) or as supplementary crops in carp ponds (Crosetti and Cataudella, 1995).

Members of this family (11 genera and 220 species, Demirsoy, 1997) are found in all tropical and subtropical regions. Because of being euryhaline and eurytherm, mullets can tolerate salinity degrees between 0‰ and 60-70‰ and live in water temperature between 0 C ° and 38 C ° and they can live long time in 0.32 ppm dissolved oxygen level and pollute water with H_2S (Cardona, 2000; Bozkurt and Secer, 2001).

Approximately, 20 mullet species have been cultured in many regions of the world (Lee, 1997). Extensive culture of the mullets is fairly old and still common (Agiragac and Kalma, 1998).

Golden mullet (*Liza aurata)* is one the mullet species which is a coastal migratory fish and important for food and roe (Hedayatifard, 2009). *Liza aurata* , like other mullets, usually live in sea and durable to ecological factors (such as salinity, oxygen, etc.) except cold water ((Hedayatifard, 2009). *Liza aurata* with other mullets are cosmopolitan fish inhabiting all tropical and temperate seas. Utilized as food fish in many tropical and subtropical regions, they play an important role in world fishery and aquaculture (Boglione *et al*., 2006).

Aim of Research:

Mullets are extremely important fishes which are cultured in many countries due to the former reasons. But in Syria the total production of mullets comes from the wild and they form a major part of the total catches of fisheries. Unfortunately, despite the great amount of mullets in our coast, they are undesirable by citizens due to the fact that most of these species live in harbors and polluted areas which make them unpalatable. In Syria, as far as we know, there are no trials to culture mullets either in cages in sea water or in the brackish and even fresh water.

Considering the euryhaline aptitude of mullets, the present study is the first in Syria trying to make an attempt to manifest the ability to culture one of the most popular and common mullet in our country (*Liza aurata*) in fresh water and at very low water salinity (3‰) and hence we try to make a contribution to sustain national effort on fresh water aquaculture and to assure the ability to culture mullets as mono culture or polyculture with other species such as Tilapias either by the governmental or private farms.

Materials and Methods:

This experiment was achieved at Culture Laboratory, High Institute of Marine Researches, Tishreen University, Lattakia, Syrian Arab Republic. *Liza aurata* fingerlings (3.28g mean weight) were brought directly from the coast near by the Institute using a mosquito net provided with some bread dough in the middle and spread near the shore waiting for the fingerlings to come close to eat, then the net is folded and gathered them. The fingerlings were left a day to rest in plastic containers(1000 liter capacity), then duplicate groups of the fingerlings were distributed into glass aquaria (100 liter capacity) which were previously filled with sea water (39.9‰). 30 fingerlings were put in each aquarium, and left unfed for 2-3 days.

We submitted the fingerlings of the first group directly (abruptly) to fresh water by replacing sea water by another fresh water, while the fingerlings of the second group were acclimated gradually to fresh water by removing saline water with fresh water within 45 days, the third group was acclimated gradually to a chosen point of salinity 3‰ by removing sea water with fresh one within 30 days, it is worth to mention that we selected this degree of salinity depending on some references which considered this degree as the lethal salinity point for *L.aurata* and *C.labrosus* (Chervinski, 1977), finally we left the fingerlings of the fourth group in sea water and used as control. The fingerlings were fed diet with 35% protein and 500 kcal GE/100g diet, the composition of the used diet was given in table (1), the diet was prepared as described by El-Sayed (1990). The fingerlings were fed the diet two times a day (at 9 am and 4 pm), seven days a week for 75 days (from 25-8-2009 to 8-11-2009). The aquaria were cleaned every day in order to remove the feces and expelled water was replaced by another one of the same salinity. The aquaria were provided with special filters (for more Oxygen). The values of salinity, temperature and dissolved Oxygen were monitored daily by using special apparatus (Dissolved Oxygen Kit-WTW milti 34oi) to check the salinity to keep it as described previously, the temperature was ranged from 23.1-28.4 °C, while water was almost saturated with dissolved Oxygen and the values ranged from 5.39 to 6.11 mg/liter.

To study the effect of the tested diets on fingerlings performances, a series of measurements were accomplished including the initial weight (g/fish), the final weight (g/fish) and the amount of food given (g/fish). To determine the effect of the acclimation trials on the growth rates and feed utilization efficiency of the tested fingerlings, we made up the following measurements:

a- Average daily gain (ADG) = W_2-W_1/t

b- Percent weight gain (%) = W_2-W_1/W_1×100

c- Specific growth rate (SGR) = $\log_e W_2 - \log_e W_1 / t \times 100$

d- Feed conversion (FC) = dry feed intake (g) /fish live weight gain (g)

Where: W1 = initial weight (g), W2 = final weight (g), t = time of the experiment (days).

At the end of the experiment, the fingerlings in each aquarium were netted and weighed to estimate the final weight (g/fish). The statistical analysis was performed by using a two-way analysis of variance (ANOVA) to test the effect of the diets on the fingerlings growth performance.

Table (1): Composition of the experimental diet.

Ingredients	Amounts used (g)
Soy bean(44.8% protein)	75
Corn (9.6% protein)	5
Wheat bran (15.2% protein)	10
Plant oil	3
Fish oil	7
Total	100

Results and Discussion:

-Results:

The results of this experiment will be discussed for each salinity degree:

The first group: the fingerlings stopped eating by day 5-6 of the abrupt acclimation to fresh water, later they began to swim near water surface and total death occurred within 20-25 days. It is interesting to mention that the death happened gradually, so we got 2-3 fingerlings struggle to survive. The fingerlings revealed the same symptoms which include stress, dark coloration, loss of appetite and abnormal swimming behavior.

The second group: no mortality had been noticed during the acclimation period (45 days), and the fingerlings were eating and staying alive. The death began 7-8 days after reaching fresh water salinity, as the former group the death happened gradually, the complete death was at 10-13 days. Again, the fingerlings manifested the same mentioned symptoms. A very important notice that pays our attention is that we kept the fingerlings in this aquarium for about 20 day at 3‰, within this time the fingerlings were doing well and no mortality was noticed, the withdraw started at fresh water point.

The third group: the fingerlings still alive till the end of the experiment. Also we started with 30 fingerlings and we got at the end 26 fingerlings which mean that we lost only 4 fingerlings which may died for many reasons including salinity causes. The fingerlings were in good health and we did not record any symptoms relating the acclimation to 3‰. The growth of this group was even comparable ($P>0.05$) to that of control (forth group).

The forth group: we lost 3 fingerlings and they were good and healthy, and revealed the best growth rates and feed utilization efficiency.

Table 2 shows the growth rates and feed utilization efficiency of the third and forth groups of the fingerlings and graphically represented in figure (1).

Table (2): Growth rates and feed conversion efficiency of *L.aurata* fingerlings reared at 3‰ and sea water for 75 days.

Parameters	3‰	Sea water
Initial weight (g/fish)	3.51	3.50
Final weight (g/fish)	6.37	6.49
Food given (g/fish)	7.23	7.42
Weight gain (g/fish)	2.86	2.99

Daily weight gain (g/fish)	0.038	0.039
%Weight gain	81.48	85.42
Specific growth rate %	0.34	0.36
Feed conversion	2.52	2.48

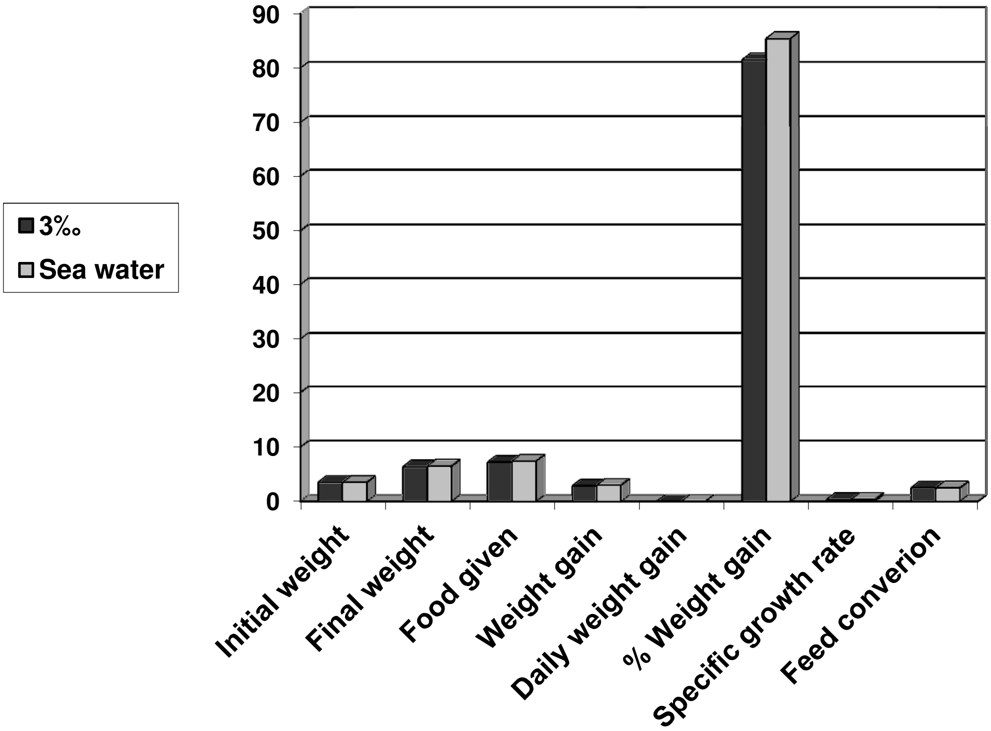

Figure (1): Growth rates and feed conversion of *L.aurata* fingerlings reared at 3‰ and sea water.

- Discussion:

Members of the family Mugilidae are euryhaline being tolerate of a wide range of salinities (Thomson, 1996). However, this ability is not the same for all the species.

This experiment revealed that fresh water salinity was vital for the fingerlings which were acclimated gradually or abruptly to it. It was interesting that the death did not include the whole fingerlings, indeed, some of them stayed alive longer than the others. This may due to the condition of each fingerling and hence the ability to overcome stress was different, but eventually, they all died showing severe symptoms.

There were no significant differences (P>0.05) in the growth rates and feed utilization efficiency of the fingerlings reared at 3‰ and at sea water.

The most important notice facing us in this experiment is the fact that we might consider 3‰ as the lethal salinity degree that *Liza aurata* fingerlings can resist and live successfully. The results obtained indicated that the fingerlings died at fresh water whether they were transferred to it abruptly or directly, but they lived at 3‰. So, we may recommend that a further work most be done to define accurately the lethal salinity point, which should rang according to the present work, from 3‰, to fresh water (0.1-0.3‰) and consequently, knowing the exact killing salinity degree for this species.

Several studies were conducted to investigate the effect of water salinities on many species of mullets in many countries of the world which depend on mullets for providing a good quality protein to the people.

Chervinski (1977) subjected Li*za aurata* (20 mm total length) to abrupt and gradual changes from sea water to fresh water media and found that no mortality occurred with salinity decrease, even with an abrupt change from 100% sea water to 10% sea water (3.9‰). All fish died with an abrupt salinity decrease from sea water to fresh water whish is in agreement with the present study. With a gradual decrease from 3.9‰ to fresh water, all the fish survived (Chervinski, 1977).

The growth performance of *Liza ramada* fry (0.13 g) reread at sea water was better than those reared in brackish and fresh water, fry reared at fresh water exhibited poor growth and feed efficiency concomitant with high mortality (El-Sayed, 1991). This pattern is in agreement with our study and with the results of De Silva and Perera (1976) on grey mullet *Mugil cephalus*. Those authors reported that groups of fish reared at 30‰ consumed more food and exhibited an improved feed conversion compared with those reared at 10‰ or in fresh water. It appears, therefore, that the growth rates and food utilization of mullets are salinity-dependent. Coccotti *et al*. (1995) found high survival rate and tissue osmolality regulation with a gradual transfer of *M.cephalus* (3.54 mm) to fresh water in 48 hours.

It is obvious from the previous discussion that tolerance of the mullets to fresh water or salt water during acclimation is limited by species, fish size (Cardona, 2000) and water temperature and salinity (Atay, 1994).

Altun, (2005) revealed that *M.aurata* (7.16 g) could acclimate to fresh water in two days with no mortality (0%) and begin to feed in a short time. We may owe the differences between the present study and that of Altun to the differences in fish sizes, and also Altun used hormone known as testosteroneundeconoate at a rate 10 mg/kg feed, and was found to be useful to increase the golden grey mullet growth in fresh water.

Some researches concerning with the aspect of the acclimation of different mullet species to fresh water are dealing with the effect of applied water salinity on lipids content. For example, El Cafsi *et al*. (2003) attempted to explain the effect of decreasing water salinity on triacylglycerols and phospholipids concentrations of *M.cephalus* fry. They found that after 4 weeks, the fry acclimated to fresh water were less rich in triacylglycerols than those in sea water. Similar results have been reported for wild *L.aurata* acclimated to fresh water in comparison with sea water species (El Cafsi *et al*., 2002).The same conclusion was got from European sea bass in a low salinity 4‰ (Roche *et a*l., 1983). Mourente and Tocher (1994) found that in gilthead sea bream reared at 32‰ and at 20 C °, an important reduction of neutral lipids occurred especially in the triacylglycerol fraction. Comparing phospholipids concentration in *M.cephalus* fry acclimated to fresh water and sea water, El Cafsi *et al*. (2003) found significant differences after 4 weeks of acclimation. A similar result has been recorded in the white muscle of the mullet species *L. aurata* acclimated to a low salinity (5‰) in comparison to marine fishes (35‰) (El Cafsi *et al*., 2002). Roche *et al*. (1983) noted a reduction of phospholipids in *Dicentrarchus labrax* reared at 4‰ in comparison with sea water species. El Cafsi *et al*. (2003) recommended that grey mullet fry acclimated to fresh water use their lipids reserves, especially the triacylglycerols, as an energy source to maintain their internal osmotic pressure as they osmoregulate to prevent water invasion and salt loss from their bodies. Against the former studies, Hotos and Vlahos (1998) acclimated *Chelon labrosus* and *Mugil cephalus* fry well to the conditions of gradual increase of salinity up to a level of 116 and 126‰, respectively, showing no sign of stress or decreases in appetite with no mortality occurred until the above levels of salinity were reached. After which the fish became stressed. Mortality escalated rapidly and after 1-4 days all fish had died. Based on these results, salinities of 116 and 126‰ are the maximum levels of salinity tolerated by fry of these two species. Both species can withstand abrupt salinity changes from 20‰ to slightly more saline water up to 40‰, direct transfer to higher salinities causes mortality (Hotos and Vlahos, 1998). On contrast, if salinity is increased gradually the two species can be acclimated to salinities exceeding 100‰. Ben-Yami (1981) states that *C.labrosus* fry (18-32 mm) acclimated to sea water exhibited a 100% survival following abrupt transfer from full sea water to fresh water and vice versa. For *M. cephalus*, according to Mires *et al.*(1974), the situation is completely different, as sudden transfer of the fry from 35 to 11‰ gave 100% survival, but sudden transfer from 4‰ to fresh water resulted in the death of all fry.

In the future, mullet's culture has been thought to increase such as cultures of gilthead sea bream, sea bass, turbot and shrimps because of increasing demand but decreasing of mullet's populations in lagoon and sea due to excessive fishing and other factors (Altun, 2005).

Finally, at the end of this local study, we recommended the great needs of further investigation concerning the acclimation of local mullet's species to different water salinities in order to establish a base to the ability of future culture in brackish and fresh water ponds and thus give a push by applying such methods to overcome the depression of fisheries in Syria.

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