

## The Effect of Gradual Acclimatization to Different Salinity Levels on Growth and Survival Rate of Cultured *Cyprinus carpio*

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### □ ABSTRACT □

This study describes the gradual acclimation of 90 *Cyprinus carpio* individuals to different levels of salinity ( $\leq 0.5$ , 3, 6, 9 and 12ppt) for 46 days during the period 2February-21March 2022, and its effect on the growth and survival rate. The juveniles ( $15.92 \pm 1.50$  g,  $13.25 \pm 1.2$  cm) were brought from Al-Sen Research Center of the General Establishment of Fisheries in Jableh and then transferred directly to the Marine Science Laboratory at the Faculty of Agriculture- Latakia University, kept in fresh water for two weeks for acclimatization, then fed a diet of 35% protein. The survival rate of juveniles was 100% at  $\leq 0.5$ , 3, 6, 9 and 12ppt salinities respectively. The fish remained alive for 17 and 9 hours at 15ppt and 18ppt, but only lived for five minutes at 24ppt. The survival rate was significantly higher in lower salinities than other acclimation salinities.

**Keywords:** Common carp, Salinity, Growth, Survival rate

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## تأثير الأقلمة التدريجية لمستويات ملوحة مختلفة على نمو وبقاء إصبغيات الكارب الشائع *Cyprinus carpio* المستزرعة

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### □ ملخص □

بينت هذه الدراسة تأثير الأقلمة التدريجية 90 فرد من إصبغيات الكارب الشائع المستزرعة على مستويات ملوحة مختلفة (3, 6, 9, 12, 15, 18, 21, 24ppt) لمدة 46 يوماً خلال الفترة (2 شباط - 21 أيلول) 2022، وتأثير ذلك على نموها وبقائها. تم جلب الإصبغيات ( $1.50 \pm 15.92$  غ،  $1.2 \pm 13.25$  سم) من مركز بحوث السن التابع للمؤسسة العامة للأسماك في جبلة، ثم نقلت مباشرة إلى مخبر علوم البحار في كلية الزراعة - جامعة اللاذقية، وحفظت في مياه عذبة لمدة أسبوعين للتأقلم، وغذيت بعدها على علف يحتوي على 35% بروتين. بلغت نسبة بقاء الإصبغيات 100% عند ملوحة  $0.5 \leq$ ، 3، 6، 9، 12ppt. بقيت الأصبغيات حية لمدة 17، 9 ساعات عند ملوحة 15 ppt و 18ppt على التوالي، لكنها لم تعش سوى خمس دقائق عند ملوحة 24 ppt. كان معدل البقاء أعلى بكثير في درجة الملوحة المنخفضة منه في درجات الملوحة الأعلى.

الكلمات المفتاحية: الكارب الشائع، الملوحة، النمو، معدل البقاء.

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## Introduction:

Common carp is generally considered to be a stenohaline freshwater fish, but can tolerate a wide range of salinities and is therefore a good candidate for rearing in brackish water.

The aquaculture is the fastest growing sector in the food industry and thereby provides nutritional security worldwide [1]. Rapid coastal and inland aquaculture development is facilitated by growing demand for aquatic food products in conjunction with limited production from capture fisheries. The salinization of freshwater resources near coastline reduces the area available for freshwater fish production 9.38 million hectares of salt-affected land comes under the hot semiarid and arid eco-region of northern plains and central high lands. Agricultural sectors have been affected and therefore it is essential to find alternatives.

Livelihood Common carp, *Cyprinus carpio* (L. 1758) is one of the most commercially important and widely cultivated freshwater fish in the world, contributing to 11% of the total world freshwater aquaculture production [2]. More than 90% of this production comes from Asia [2], where common carp is cultured in various pond systems. In recent times a concentration of soluble salt in terrestrial and/or aquatic environments has been increasing and causes salinization of lands or fresh water area, which mainly occur due to natural or anthropogenic activities [3].

Abiotic factors have a direct role in the success of aquaculture operations [4] and juveniles are very sensitive to environmental changes [5]. However, salinity was considered as one of the most important ecological factors that strongly influences our inland water environments [6]. Temperature and salinity are among the most important environmental variables governing the distribution and development of aquatic organisms [7, 8]. However, our understanding of the response of thermal tolerance to salinity gradients is limited, and it is unknown whether these responses differ systematically among different groups. Changes in temperature and salinity can jointly act on aquatic organisms as thermal and osmotic stressors by activating the same cellular responses and triggering the expression of the same genes in aquatic organisms [9, 10]. In addition, these metabolic parameters were suggested to be related to fish adaptations to environmental stresses, mostly temperature and hypoxia [11]. Salinity tolerance could have stronger energetic mechanisms comparing to temperature and oxygen tolerance [12].

The present study aims to evaluate the growth and survival rate of the common carp juveniles reared in different salinity levels.

## Material and Methods:

### 1.Common Carp

Common carp (*Cyprinus carpio*) belongs to the order Cypriniformes and the family Cyprinidae, which is considered as the largest family of freshwater fish. It generally lives in ponds, lakes, rivers, and rarely brackish-water environments [13]. It is distributed world wide but is very popular in Asia and some European countries [14]. Because of its high popularity, its distribution has been extended by human introductions. Common carp is the third most frequently introduced species worldwide. As it has a very high adaptive capability to both environment and food [15], it is considered as a potential candidate for commercial aquaculture.



**Fig.1.Cyprinus carpio (15.6 cm)**

## **2- Fish material and acclimatization**

Ninety fingerlings introduced from Al-Sen Research Center of the General Establishment of Fisheries were transferred directly to the Marine Science Laboratory at the Faculty of Agriculture and kept in fresh water glass tanks (70\*40\*50cm capacity) for two weeks to rest under controlled laboratory conditions. Fingerlings were fed a commercial diet (35% protein) twice a day at 5% of their body weight. Water hydrological parameters such as pH, dissolved oxygen DO, and temperature were monitored daily by the methods described by [16] using PDO-408 and PCT-407 devices.

The juveniles were reared under laboratory condition at salinity levels of  $\leq 0.5$ , 3, 6, 9, 12, 15, 18, 21 and 24ppt to evaluate the effect of salinity on growth and survival rates. Salinity was gradually increased in the tanks (10 fish each) by 3 ppt every 48 hours.



**Fig.4.Carp in a glass container.**

## **3- Preparing brine solution**

Firstly, brine solution was prepared by adding the commercial-grade sodium chloride (NaCl) to freshwater until reaching the desired levels of salinity. Sodium chloride was used in this study instead of seawater as this method is most commonly employed to raise

salinity under laboratory practices of this species [17],. Salinity level was measured by Refractometer (REF 211).

#### 4- Recorded data

Fish survival was recorded every 12 hours during the tolerance test. Swimming activity and appetite (feed intake) of fish was observed to record any behavioural abnormalities under salinity stress.

Fish weight was measured for each individual. The growth performance indicators were calculated [18], they included culture duration (days); average initial total weight ( $W_i$ , g); average final total weight ( $W_f$ , g); Daily Growth Rate ( $\% \text{ day}^{-1}$ ), specific growth rate (SGR,  $\% \text{ day}^{-1}$ ); feed conversion ratio (FCR) and survival rate (%). Growth and survival were compared at the beginning and at the end of the trial. The specific growth rate (SGR) was calculated at the end of the experimental period using this formula [19]  $SGR = [(\ln(\text{final wet body weight}) - \ln(\text{initial wet body weight})) / \text{time (days)}] * 100$ .

#### 5- Data analysis:

Data were analyzed by ANOVA test [20] and the results were expressed as Mean  $\pm$  Standard Deviation. Statistical software SPSS (version 16.0) was used for data analyzes. with the levels of significance set at 0.05 level.

## Results and Disussion

### 1.Ecological Factors:

Table (1) shows the environmental factors that have been conducted throughout the duration of the experiment. Water temperature was  $23.75^\circ\text{C} \pm 0.93$  in Feberury and  $24.81^\circ\text{C} \pm 0.9$  in March and the rate of dissolved oxygen was  $5.24 \pm 0.37 \text{ mg/l}$  in Feberury and  $4.26 \pm 0.98 \text{ mg/l}$  in March, while the pH value was  $7.06 \pm 0.5$  in Feberury and  $8.16 \pm 0.33$  in March.

**Table 1: Environmental factors (average  $\pm$  standard deviation).**

	Temperature $^\circ\text{C}$	pH	O2(mg/l)
Ferberury	$23.75 \pm 0.93$	$7.06 \pm 0.5$	$5.24 \pm 0.37$
March	$24.81 \pm 0.9$	$8.16 \pm 0.33$	$4.26 \pm 0.98$

### 2.Survival Rate:

Swimming movement of fish remained unaffected during the first two weeks of tolerance test in salinity levels less than 12ppt, while the fish became comparatively less active in 15 to 21 ppt treatments.

Survival rate data is listed in Table 2. The fingerlings remained apparently calm with no mortality even at 12 ppt. At 15ppt, the fingerlings remained alive for 17 hours, for 9 hours at 18ppt and for about an hour at 21ppt. These results were similar to those obtained by [21] on the acclimatized carp, which showed no fish mortality during the tolerance test up to 10 ppt salinity level.

**Table 2: Survival Rate of Carp fingerlings exposed to different salinity levels.**

Salinity (ppt)	Survival %
$\leq 0.5$ (Control)	100
3	100
6	100
9	100
12	100
15	Remaing alive for 17 hours
18	Remaing alive for 9 hours
21	Remaing alive for less than an hour
24	Remaing alive for just five minutes

### 3. Daily Growth Rate at different salinity concentrations:

Acclimating fishes to different salinities exposes them to morphological, biochemical and endocrinological alterations, and will inevitably affect growth and survival rates. The ability of fish to grow at different salinity levels, under different culture conditions, provides a bio-energetic basis for evaluating the performance of carp. Results of a study in 2023 [22] showed that fish growth declined significantly at all salinity levels when acclimatizing the Carp to 15 ppt.

Table (3) presents the Daily Growth Rate of carp fingerlings after being exposed to different salinity levels for 45 days. The highest percentage of DGR (0.67g) was obtained in the treatment exposed to salinity of 12ppt.

Regarding DGR, the results showed that there are no significant differences ( $P>0.05$ ) among the treatments exposed to water salinities of  $\leq 0.5$ , 3, 6, 9 and 12ppt.

Table 3: Some growth parameters of different water salinities during the period 2February-21March 2022.

Parameters/ salinity levels	$\leq 0.5\text{‰}$	3‰	6‰	9‰	12‰
Wi (g)	15.79	16.3	14.12	17.69	15.72
Wf (g)	22.61	22.67	20.3	23.75	32.09
weight Gain (g)	6.82	6.37	6.18	6.06	16.37
Daily Growth Rate %	0.23	0.32	0.33	0.3	0.67

### 4. Feed Conversion Rate:

FCR in culture systems depended on the species, fish size, feeding practices and water quality conditions [23]. The best percentage of FCR (1.65) was reached in the treatment exposed to salinity level of 12ppt. Statical analysis revealed significant differences ( $P\leq 0.05$ ) in FCR between various salinity levels.

Table 4: Feed Conversion Rate in different salinity levels during the period 2February-21March 2022.

Salinity	$\leq 0.5\text{ppt}$	3ppt	6ppt	9ppt	12ppt
FCR-February	2.88	3.06	3.56	3.12	1.34
FCR-March	3.66	3.96	3.53	4.34	1.96
Average	3.27	3.50	3.54	3.72	1.65

### 5. Specific growth rate:

Figure3 reveals the specific growth rate in various salinity levels. The SGR reached the highest value (0.82) in treatment exposed to 12ppt of salinity: the lowest value (0.38) was in the control teartment. Statical analysis showed no significant differences ( $P>0.05$ ) in SGR between various concentrations of salinity. These results agree with [24] study on acclimatized common carp as there were significant differences in the relative growth rate between the treatment of 12 ppt and other treatments.

**Table 5: Specific growth rate (SGR) in various salinity levels during 2February-21March 2022.**

Salinity	≤0.5ppt	3ppt	6ppt	9ppt	12ppt
SGR- February	0.47	0.48	0.5	0.49	0.83
SGR- March	0.3	0.85	0.86	0.61	0.8
Average	0.38	0.67	0.68	0.55	0.82

## Conclusion and Recommendations

Common carp *C. carpio* (L. 1758) fingerlings can adapt to gradual increase of salinity. The baseline data from this study indicates that fingerlings of this species will easily adapt and succeed in culture systems of fresh and brackish waters with salinity levels of 0-12 ppt.

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