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The effect of the gradual salinity increase on some growing character of the common carp (*Cyprinus carpio*)

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Abstract
This study was conducted to demonstration the effect of high salinity gradually in the total daily and the relative and qualitative growth rate of fish common carp (*Cyprinus carpio*), as were exposed fish gradually to concentrations of salt 5, 10 and 15 g / liter as well as water liquefaction (treated 0.1 control g / liter) Like all independent concentration saline treatment included repeating. Distributed Fish experiment on 8 Aquarium glass at 10 fish / Aquarium at a rate of weight 15 ± 3 g to study the effect of salinity in the total growth and Daily growth rate, results reduced Total growth in high salinity reaching 32.6 and 14.8 and -12.3 g of concentrations Saline 5, 10 and 15 respectively as compared with the control treatment amounting to 45.5 g, and dropped the daily rate of growth to 0.36 and 0.16 and 0.13 - g / day increase concentrations of salt to 5, 10 and 15 respectively as compared with the control treatment, in which the daily growth reached 0.50 gm / day, and the relative growth rate of 24.21 and 11.12 and 9.38% - in concentrations of salt 5, 10 and 15, compared with treatment to control 34.46% and stood at 0.10 qualitative growth rate and 0.05 and 0.3% - g / day for concentrations of salt 5, 10 and 15, compared with the Treatment control 0.14% g / day. Fish fed during the experiment, which persist 90 days on a diet of 31% protein content.

Keywords: salinity, total growth, daily growth, relative growth, specific growth, common carp (*Cyprinus carpio*)

1. Introduction

The Iraqi inland waters are currently experiencing a continuous rise in salinity levels due to the scarcity of water discharges of the Tigris and Euphrates rivers, the impact of brackish water, the drying up of large areas of the marshes, the lack of rain and the decline of rivers. The salinity of the marshes in the southern region ranged from 2.20 to 3.82 g / l and is steadily increasing (Al-Najjar, 2009) [33]. As well as increased evaporation rates due to high temperatures and increased global warming rates.

Any environmental disturbance, such as changes in salinity concentrations, can be considered a major factor in changing the homeostasis of fish and thus requires many physiological responses in order to return to the state of stability that existed before exposure to the stressor (Enayati *et al*, 2013) [8]. The first effect of salinity is shown by the effect of osmotic regulation in fish, which affects the taking or loss of ions by increase or decrease in salinity, in order to maintain the ionic concentration and fluids within the body by working the organs responsible for the osmotic regulation of (gills, kidneys and intestines) together (McCormick, 2001). Freshwater fish regulate Osmosis through physiological responses that maintain Na^+ K and chlorine concentrations in the body at a higher than average rate in the external environment and compensate for lost ions due to pressure difference by the A active transport from the external environment (fresh water) to the plasma. This process occurs mainly through the gills and secondary through the kidneys and the digestive system (Smith *et al*., 1989) [39]. At the same time, these fish are putting large amounts of the kidneys in order to get rid of the large quantities of water entering permeable membranes through diffusion (Marshall and Grosell, 2005) [29]. The transfer of freshwater fish to salt water requires a change in many physiological characteristics at the level of the circulatory system, digestion, nervous system and hormones. This requires energy exchange and hormonal changes thus affecting fish growth and is the main objective of any fish breeding project (Whitfield, 2015) [43].

Since the need for water is becoming increasingly urgent in the salt concentration in fish farming due to the scarcity of freshwater sources and the availability of scarce brackish water resources, fish must be adapted to increase their salt tolerance in these waters. In fresh water, including common carp, salinity is not tolerated as a stenohaline fish and suffers loss when transported to salt water due to the occurrence of the so-called Osmotic shock (Jackson, 1981) [13]. The degree of tolerance the salt fish through the gradual transfer to water with degrees of salinity gradient (Bardach *et al*., 1972). Since the common carp is the first culture fish in Iraq, and because of the high rates of salinity in the southern parts and parts of the central regions of Iraq, which threatens the growth and production of these fish was conducted this study.

2. Materials and Methodology

Experiment Fish

300 fish were obtained from common carp *Cyprinus carpio* on 20/12/2015, weighing between 12 - 25 g of a fish farm south of Baghdad. Glass basins with dimensions 60 x 40 x 30 cm were filled with about 40 liters of water and equipped with oxygen by an air pump. During the localization period, the fish were fed for two weeks on a commercial diet with protein content of 31.9% in a manner of two serves a day and in a percentage of 3% of the overall bodyweight in order to get the fish used to the diet. During the experiment which lasted for 90 days, the fish were fed on the same diet and in a manner of 3 serves a day and in a percentage of 4% of the overall bodyweight.

The needed salinity concentrations were prepared 5/10/15 g/l by solving a definite amount of coarse salt brought from the common market (Al-Sharqa) in one liter of pure liquefied water. The salinity of the pure water was taken into consideration and the salinity of the prepared saline concentrations has been made sure of by using the salinometer of the ExTech type (USA Made). After adapting the fish to the laboratory conditions and the saline concentration 0.1 g/L (liquefied water), they were gradually exposed to the above mentioned saline concentrations. The same fish were transferred to the top concentration every four days until the final concentration. Each saline concentration represented a particular treatment, and the fish were introduced to the new concentration at the end of the fourth day of exposure to the lower concentration. This period was not counted within the experimental period. The fish at 0.1 g/L were considered as control fish.

Composite of food diet

The food diet was commercially purchased from the local market (Baghdad) and analyzed in the Central Laboratory of the Faculty of Agriculture / University of Baghdad (Table 1). Because the commercial diet did not contain a protein ratio that covered the needs of common carp fingerlings (New, 1987) [34], it was necessary to increase the protein content in the basic diet by re-grinding it and adding fish powder to increase the protein content (Table 2).

The commercial diet was weighed at a weight of 7.5 kg after it was grinded and sifted with a 1 mm slotted sieve. Fish powder was added to the mixture and the vitamins were added 1% or 10 g / kg. The mixture was then mixed with a Japanese Sanyo meat grinder and left to dry. In order to be stored and stored in the refrigerator until use (Lovell, 1998).

The effect of salinity on the growth rate

The following measurements were taken (Jobling, 1993) [16]:

1. Weight gain

Weight gain (g) = Final weight (g) - Primary weight (g)

2. Daily growth rate represents the amount of daily increase during the duration of the experiment (g / day). Growth rate (g / day) = [Final weight (gm) - Primary weight (gm) / duration (day).

3. Relative growth rate (R.G.R)

The amount of the weight increase relative to the primary weight

Relative Growth Rate% = [Weight Increase (Gm) / Primary Weight (Gm)] X 100

4. Specific growth rate (S.G.R.)

The specific growth rate was calculated by taking the natural logarithm of the final and primary weight over a period of time

Experiment as in the following equation:

= (Natural logarithm of final weight - natural logarithm of primary weight) / duration of weight (day) × 100

Statistical analysis

Data were analyzed using a completely random design, and data shown represent means ± standard error. Significant differences between means were calculated using least significant differences (LSD). The data were analyzed by SPSS software Version 21.0 for Windows 7) SPSS Inc., Chicago, IL, USA) [40]. Results were analyzed using a *t*-test for comparison between treatments. Statistical significance was set at $p < 0.05$.

3. Results and discussion

Environmental factors of water in the growth experience:

Table 3 shows water temperature (ºC), dissolved oxygen (mg / L) and pH (pH) in different saline concentrations during the growth experiment

The impact of salinity on in the common carp fish growth rate

The figure 1,2,3,4 shows the primary and final biomass, the overall mean increase rate and the daily growth rate, as well as the normal and relative growth rate and Specific growth of common carp fish in the gradual transfer of brackish water to the saline concentrations, 5, 10 and 15 g / L during the 90 day growth experiment The results of the statistical analysis showed that there was significant difference (P <0.05) in the final biomass between all the coefficients, as well as for the total increase in weight. (P <0.05) in both the total weight and the growth rate between the control sample and all saline concentrations, while the differences were not significant (P> 0.05) between salt concentrations 5 and 10 g / L.

Figure (1) shows the increase in weight during the experimental weeks in common carp in the control sample and each of the saline concentrations 5, 10 and 15 g / L,

Figure (2) shows the daily growth rate (g / day) in common carp fish during the growth experiment in both the control sample and the saline concentrations 5, 10 and 15 g / L.

Relative growth rate

Figure (3) shows the relative growth rate of common carp fish during the trial weeks in both control sample and saline concentrations 5, 10 and 15 g / L

Figure 4 shows the specific growth rate of common carp fish during the trial weeks in both the control sample and the saline concentrations 5, 10 and 15 g / L.

The rate of growth represents each increase in the living mass of the organism and decreases with the increase of the mass of the animal in size and age. Growth can be defined as the natural increase in the size and number of cells of the body, a process by which the body seeks energy and represents a large proportion of the total amount of energy spent (Conceic¸a *et al*., 1998) [6]. When a change in environmental salinity occurs, fish enter the stage of morphological changes, biological reactions and the endocrine system during the period of adaptation to new saline concentrations. These changes require greater energy consumption and oxygen (Morgan and Iwama, 1991) [31]. For example, grass carp can grow up to 9 g / l (Maceina and Shireman, 1980) [28], while tilapia can live up to 10-20 g / L. Fish growth is a saline-induced physiological function (Boeuf and Payan, 2001)[5]; (Engström- Öst *et al.*, 2005) [9]. Therefore, low salinity in larval farms is better to ensure high survival and growth rates for water fish Fresh narrow tolerant saline (Luz and Portella, 2002) [26]. Both the metabolic rate and the energy of osmotic regulation reflect the salinity effect on growth (Mylonas *et al.*, 2009) [32]. The exposure of fish to higher salinity levels leads to an increase in metabolic rate due to the increased energy requirement for ionic and ammonia regulation to maintain internal stability under (Sangiao-Alvarellos *et al.*, 2003) [37], and that the increasing cost of energy required for osmotic and ionic regulation reduces the rate of growth (Boeuf and Payan, 2001) [5]. It is noted that the high salinity effect of the growth rate is indirectly due to the "increased energy cost of the osmotic and ionic regulation so little" of energy is available for growth (Laiz-Carrion *et al*., 2005) [21]

The results of some studies support the idea of increased growth in low metabolic costs for osmotic regulation (Woo and Kelly, 1995) [44]. abo Hegab and Hanke (1982) [1] The exposure of common carp to diluted seawater (10 and 15 g / L) resulted in A decrease in the growth rate between DeBoeck *et al.* (2000) [7] and the transfer of common carp to salinity of 10 g / L had a negative impact on growth rates. The reason was to convert the energy allocated to growth towards internal balancing processes. The stress caused the use of low levels of protein and high levels of carbohydrates as a fuel, causing depletion of liver and muscle corticosteroids. Al-khshali (2012) [2] showed that the gradual increase in salinity to 4, 8 and 12 g / L of grass carp resulted in a decrease in growth compared with the control sample. This was attributed to increased demand for energy and Maceina and Shireman (1980) [28] indicated a decrease in weight Fish carp was 8.5% at salinity of 12 g / L and 11.3% at 14 g / L while the decrease in weight was 0.8% And 1.7% in low saline concentrations (3 and 6 g / L). The same researchers (1980) confirmed a decrease in the growth rates of carp fish exposed to salinity 3, 6 and 9 g / L. Kilambi and Zadinak (1980) [17] observed a decline in the growth rate of grass carp at salinity to 12 g / l. Iqbal *et al.* (2012) [12] reported that the exposure of Nile tilapia to 4 saline treatments was 2400 ppm / And the third was 4000 ppm compared to the control treatment of 800 ppm, where he observed that the best growth was in the second treatment and that the growth rate of food intake and food conversion was significantly decreased in the third treatment, where the experiment lasted 3 months and Lawson and Alake (2011) [22] Body weight with increased salinity in the goldfish *Carassius auratus* has lost The percentage increase of 48.75, 42.1, 41.8, 39.4, 38.05 and 36.2% at salinity 0, 1, 2, 3, 4 and 5 g / L respectively . Küçük (a2013) [20] showed that *oleochromis aureus* were exposed to 5 saline concentrations And 12, 16, 20 and 24 g / l after absorption on saline water at a concentration of 8 g / L resulted in an increase in growth rate, growth rate, and dietary conversion efficiency of the first three treatments. The best growth obtained in the second treatment was 12 g / The growth rate, the rate of qualitative growth and the efficiency of food conversion in the last two treatments where the growth was reduced by high salinity Salt concentration of 12 g / L resulted in fish living in a balanced Ionic center and also The shift away from this focus in Concentration 20 and 24 led to an increase in energy demand for azimuth regulation, which reduced the energy spent on growth. Schofield *et al*. (2011) [38] suggested that *oleochromis niloticus* was exposed to high salt concentrations and transferred from fresh water to saline concentrations of 0, 5 and 10 15, 20, 25, 30 and 35, where the fish remain in the salt concentration for a week and then transferred to the higher salt concentration. The growth rate was observed with salinity increasing to a minimum of 35 g / L and a decrease in weight. According to Küçük *et al.,* (2013) [19], the exposure of the golden fish *Carassius carassius* to saline concentrations 8, 12, 16 and 20 g / L after its absorption at 8 g / L resulted in a decrease in growth with a final increase of 938, 723, 475 and 106 mg respectively, The growth rate of Tilapia *rendalli* was better at 10% salinity compared to concentrations 5 and 15 in addition to the water of the salinity. Conversion The efficiency of food conversion at salinity 5 and 15 decreased and growth rate decreased with a salinity increase of 15 g / L in a 70-day experiment. The researcher attributed this to the absence of fish in concentrations 5 and 10, in addition to the saline water from the optimal salt concentration of the fish species, which led to an increase in the energy exchange for regulating the osmotic and thus a decrease in growth. Imsland *et al.* (2008) [11] found that the presence of fish in an equal osmotic environment reduces the amount of energy needed for osmotic regulation and therefore has greater energy used for growth. There are also some factors that influence growth rate, such as eating habits and appetite, and these factors are also affected by salinity (McCormick, 2001) [30]. Studies indicate that fish yields are low in salinity levels leading to reduced food consumption in fish and thus affect the growth rate (Usher *et al*., 1991) [42]; (Plaut, 1998) [36]. Imsland *et al.* (2003) [10] The increase in the rate of food consumption and the improvement of the efficiency of food conversion compared with the education in different osmotic environments and in the study of growth of the golden Mugil cephalus exposed to four saline concentrations (1.5, 7.5, 15 and 30 g / L) showed the highest increase in weight and the highest growth rate and qualitative conversion efficiency Food recorded at salt concentration 15 g / L (Yasser *et al*, 1999) [46] as a result of reduced energy consumption in the azimuth process at this concentration. Sultan (2007) [41] reported that silver shoots gave the best rate of growth at salinity of 7 and 15 g / l compared with saline concentrations of 23 and 30 g / l as there was weight loss in the early stages of transport to these level of salinity.

The results of the present study are consistent with many of the results of the previous studies, with regard to the reduction of each growth rate with higher levels of salinity than normal levels in the fish environment or as a result of the transfer of fish to a different environment. Likongwe *et al*. (1996) [23] reported that growth in Nile tilapia (*Oreochromis niloticus*) decreased when salinity increased to 8, 12 and 16. This decline was associated with temperature and in another study conducted by Kocabas *et al*. (2011) [18] on trout *abanticus Salmo trutta* presented to saline concentrations. And 9 and 18 g / l for 154 days to determine the effect of salinity on growth rate, food conversion coefficient and food consumption. It was found that the best growth, conversion rate and food consumption occurred at salinity 0 where the salinity coefficient decreased by 1.29 at 0 g / L and 1.22 At 9 g / l and 1.10 at 18 g / l. The ratio of food intake in the two concentrations above was 3.01 and 2.39 g respectively, The control treatment (3.59%), Arjona *et al*., (2009) [3] showed that the best growth rate for *Solea senegalensis* was salinity 39 g / L and that the growth rate was reduced in salt-fed fish 15 and 25 g / L so that the best growth obtained was in equal salinity concentrations. Norris *et al.* (2010) [35] noted that the best growth of Largmouth bass (*Micropterus salmoides*) was in fresh water while growth in the downstream environment declined. Luz *et al*. (2008) [27] noted a decrease in food intake and dietary conversion rate and in the growth of *Carassius auratus* exposed to salinity 8 and 10 g / L, compared to fresh water and salinity of 2 g / L and between Jia *et al.* (2009) [15] It is possible to salinity at 10 g / L but its best growth is achieved at salinity of 0 and 5 g / l, and Xin-Hail *et al.* (2007) [45] observed that *Chalcalburnus chalcoidesarelensis*, exposed to different concentrations of NaCl, had good growth rates of 2 and 4 g / While a decrease in growth rates was observed in saline-exposed individuals (6 and 8 g / L). Liu *et al* (2017) [24] noted that evaluated in the American shad (*Alosa sapidissima*). Juveniles of 35 days after hatching were reared at 0 (control), 7, 14, 21, and 28 ppt for 60 days. At the end of the experiment, juvenile American shad presented higher survival and specific growth rate (SGR) in salinity group (7, 14, and 21 ppt) than control group ($P < 0.05$). Jarabo, *et al* (2019) [14] revealed that the best specific growth rate for that fingerlings *Argyrosomus regius* in brackish waters (12 ppt) compared to 39 ppt.

4. Table and figure

Table 1: Explains the chemical analysis of the market diet

Moisture	**5.65%**
Protein	23.14%
Fat	5.24%
Ash	9.13%
Carbohydrate	48.65%
Fiber	8.06%

Table 2: Chemical analysis of the mixture after adding fish powder

Protein	**31.+-0.09%**
fat	9.00+-0.02%
Ash	8.66+-0.21%
Moisture	11.47+-1.2%
Carbohydrate	40.88+-0.12%

Table 3: Shows water temperature (ºC), dissolved oxygen (mg / L) and pH (pH) in different saline concentrations during the growth experiment

Saline water	**Water teampature ºC**	**Oxygen mg/l**	**pH**
0.1	22-24	7.4-8.1	6.7-7.1
5	22-24	7.3-7.6	6.8-7.3
10	22-24	6.8-7.1	7.0-7.5
15	22-24	6.2-6.5	7.2-7.9

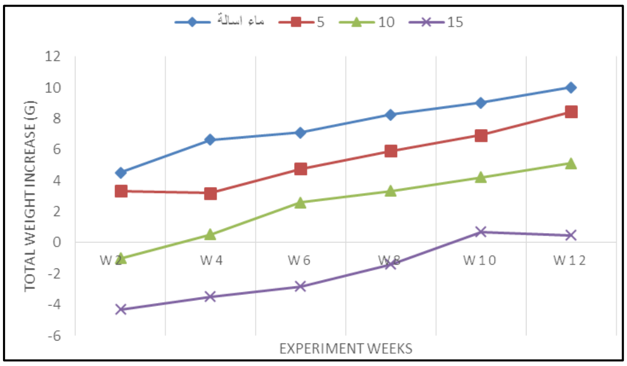

Fig 1: Total weight increase (g) in common carp fish during the growth experiment in different saline concentrations by experiment weeks

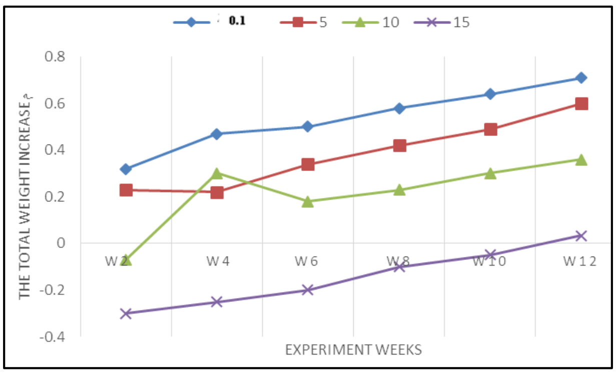

Fig 2: Daily growth rate (g / day) in common carp fish during growth experiment in different saline concentrations, by weeks of experiment

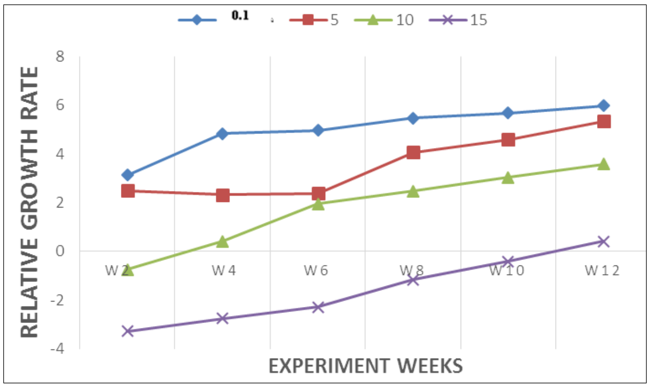

Fig 3: Relative growth rate (%) in common carp fish during growth experiment in different saline concentrations by trial weeks

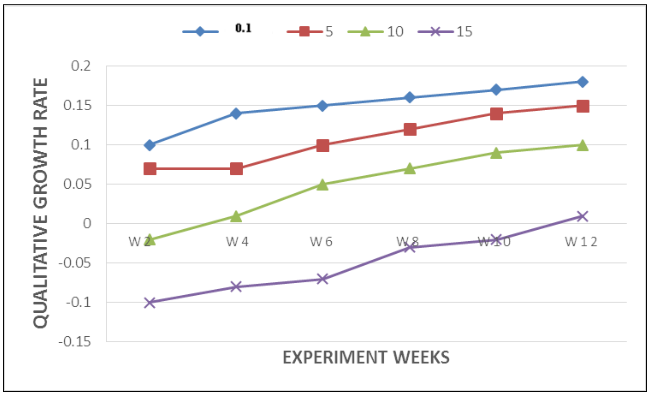

Fig 4: Specific growth rate in common carp fish during the growth experiment in different saline concentrations, by trial weeks.

5. Conclusions

The gradual increase in salinity to 5, 10 and 15 g / l on the water content of common carp fish. results reduced Total growth in high salinity reaching 32.6 and 14.8 and - 12.3 g of concentrations Saline 5, 10 and 15 respectively as compared with the control treatment amounting to 45.5 g, and dropped the daily rate of growth to 0.36 and 0.16 and 0.13 - g / day increase concentrations of salt to 5, 10 and 15 respectively as compared with the control treatment, in which the daily growth reached 0.50 gm / day, and the relative growth rate of 24.21 and 11.12 and 9.38% - in concentrations of salt 5, 10 and 15, compared with treatment to control 34.46% and stood at 0.10 qualitative growth rate and 0.05 and 0.3% - g / day for concentrations of salt 5, 10 and 15, compared with the Treatment control 0.14% g / day. Fish can be adapted to high salinity through gradual exposure**,** Growth is decreasing as salinity increases, which is a troubling cause for aquaculture and that lead to reduced profits.

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