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Effect of Salinity on Feed Conversion Rate, Feed Conversion Efficiency, Protein Intake and Efficiency of Protein Utilization Ratio in Common Carp *Cyprinus Carpio*

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Abstract: This study was conducted to investigate the impact of increased salinity on some growth parameters of common carp (*Cyprinus carpio*). Fish, gradually have been exposed to the salt concentrations of 5, 10 and 15g/L, as well as tap water (control treatment of 0.1 g/L) for 84 days divided on 12 weeks, and each of salt concentration represented independent treatment with two replications. 80 fish at average weight of 15 ± 3 g were randomly distributed on 8 glass tanks at 10 fish / tank to study the effect of salinity on feed conversion rate, feed conversion efficiency, protein intake and efficiency of protein utilization ratio in common carp. Results showed a decrease in feed conversion rate to16.59, 24.49 and -20.11, when the salinity increased to 5, 10 and 15 g/L respectively, compared to the control treatment (13.32). This is reflected on feed conversion efficiency, which slump to 6.02, 4.08 and - 4.97% in the salt concentrations of 5, 10 and 15 g/L respectively, compared to the control treatment (7.50%). Protein intake, also decreased to 25.23, 24.07 and 21.37% with the increasing of salinity to 5, 10 and 15 g/L respectively, compared to the control treatment (25.67%), while the efficiency of protein utilization slump to 21.32, 10.94 and -10.07% in the salt concentrations of 5, 10 and 15 g/L, respectively while it was 29.16% in the control treatment. Fish were fed on a commercial diet with a protein content of 31% during the experiment.

Keywords: Salinity, Feed Conversion and Efficiency, Protein Intake, Protein Utilization, Common Carp

1. Introduction

Iraqi inland water is exposed to a continuous rise in salinity levels now due to several reasons, including the scarcity of water releases of Tigris and Euphrates rivers, impact of drainage salt water, drying of large areas of the marshes, lack of rain and receding of rivers [1]. Where, the salinity of the marshes in southern region of Iraq ranged from 2.20-3.82 g/L and is rising fast [2], as well as the increase of evaporation rates due to rising temperatures and increase of global warming rates. Salinity affecting on two physiological factors in fish, the first affects the osmoregulation process by increasing the amount of ions inside the body, and this leads to increase fish need for energy to get rid of the excess ions inside the body, this expend the energy which can be used in growth [3], where the optimum salinity of fish is varying according to the species, sex and water temperature [4]. The second factor is a direct effect of salinity on the digestion when the fish being in the higher salinities, that leads to a reduction in feed conversion rate, as well as the ability to digest the protein and carbohydrates in the intestine [5]. This is occurred during the osmoregulation process, where the freshwater fish trying to drink a lot of water in order to balance the external environment with the internal environment, and this leads to hasten the movement of interior articles in the intestine, hence that is affect the ability of digestion, lessening the time of exposure to the digestive enzymes, and affect the pH level of the gut [6]. Growth and the food consumption rate in fish are linked to the controlling internal factors include the central nervous system, endocrine system, neuroendocrine system, as well as environmental factors such as salinity. Many studies have shown that the salinity affecting the growth in fresh or saltwater, through the influence of four factors: the first is a change in the requirements of the standard metabolic rate [7], the second is the effect on fish appetite and feed intake [4], the third is the effect on the feed conversion efficiency [8], and finally to influence the balance of hormones that are involved in assimilation, besides the season and the duration of acclimation [9]. The present study aimed to investigate the effect of a gradual rise in the salt concentrations on some growth criteria include feed conversion rate, feed conversion efficiency, protein intake and efficiency of protein utilization ratio in common carp.

2. Materials and Methods

2.1. Acclimation of Trial Fish and Preparation of Salt Concentrations

300 fish of common carp at average weight ranged from 12-25 g were transferred to the laboratory. Glass tanks with dimensions of 60 × 40 × 30 cm were filled with about 40 liter of water and equipped with oxygen by air pump. Fish during the acclimation period, which lasted for two weeks were fed on a commercial diet with a protein content of 31.9% with two times a day, with a ratio of 3% of body weight to acclimate the fish to the feed.

Salt concentrations of 5,10 and 15 g/L were prepared by dissolving a known weight of salt (brought from local markets, Sharjah mark) in one liter of tap water, salt concentrations were quantified by salinometer. Fish which acclimated to the tap water (0.1 g/L) and on laboratory conditions, gradually exposed to the salt concentrations mentioned, and then to the higher salt concentration every four days to reach the next concentration. Each of salt concentration represented an independent treatment, and fish were exposed to the new concentration at the end of the fourth day of exposure to the lower concentration, fish at a concentration of 0.1 g/L are represented control treatment.

2.2. Effect of Salinity on Growth Rate

This experiment was designed to study the effect of a gradual increase of salinity on the rate and efficiency of feed conversion, protein intake and utilization efficiency of protein in common carp. Fish were distributed at average weight of 18.70 ± 1.50 g as 10 fish on each glass tank, treatments were tested with two replicates for each concentration, taking into account the convergence of the weights of the fish used in the experiment. Fish fed during the experiment, which lasted 84 days (divided to 12 weeks) on a diet with a protein content of 31.9% at a ratio of 4% of body weight with three times a day. Fish weighed every two weeks to check the growth and to modulate the amount of feed according to the body weight.

The following measurements were taken [10]

1 Feed conversion rate (F. C. R) = weight of feed given to fish (g) /moist weight gain of fish (g)

2 Feed conversion efficiency (F. C. E) = moist weight gain of fish (g) /weight of feed given to fish (g) × 100

3 Protein Intake (PI) = (feed intake × protein in the diet) / 100

4 Protein Efficiency Ratio (P. E. R) = (weight gain of fish / protein intake) × 100

3. Results and Discussion

Figure 1 shows the feed conversion rates of common carp during 12 weeks of the experiment in the control treatments (0.1 g/L) and another salt concentrations of 5, 10 and 15 g/L which is revealed an increase in feed conversion rate in the control treatment, while it is decreased in the other salt concentrations.

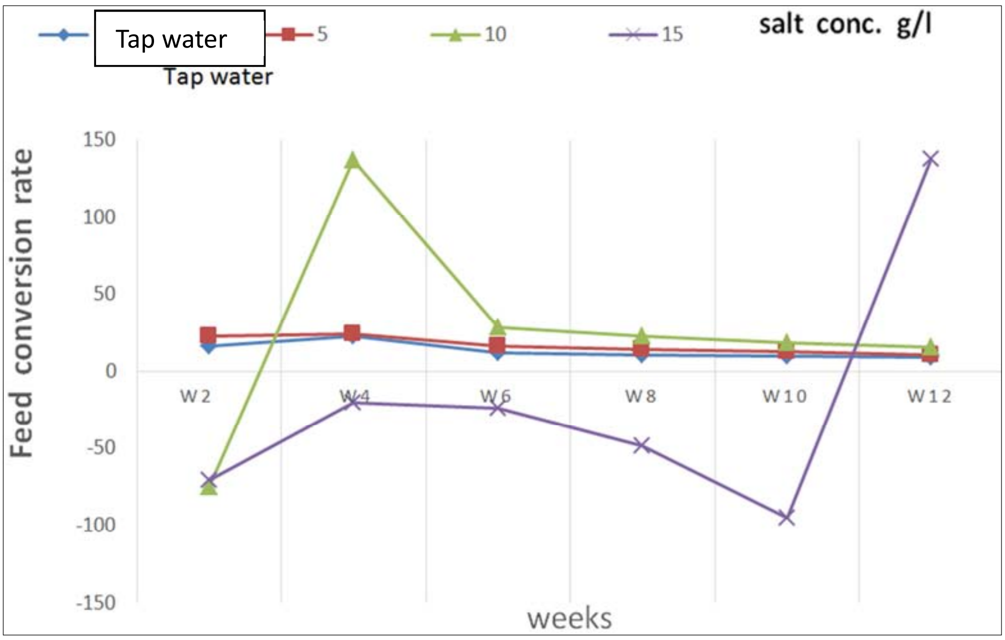

Figure 1. *Feed conversion rates in common carp during 12 weeks of the growing trial in different salt concentrations.*

Figure 2 shows the feed conversion efficiency of common carp during 12 weeks of the experiment in the control treatments (0.1 g/L) and another salt concentrations of 5, 10 and 15 g/L which is showed an increase in feed conversion efficiency in the control treatment, while it is decreased in the other salt concentrations.

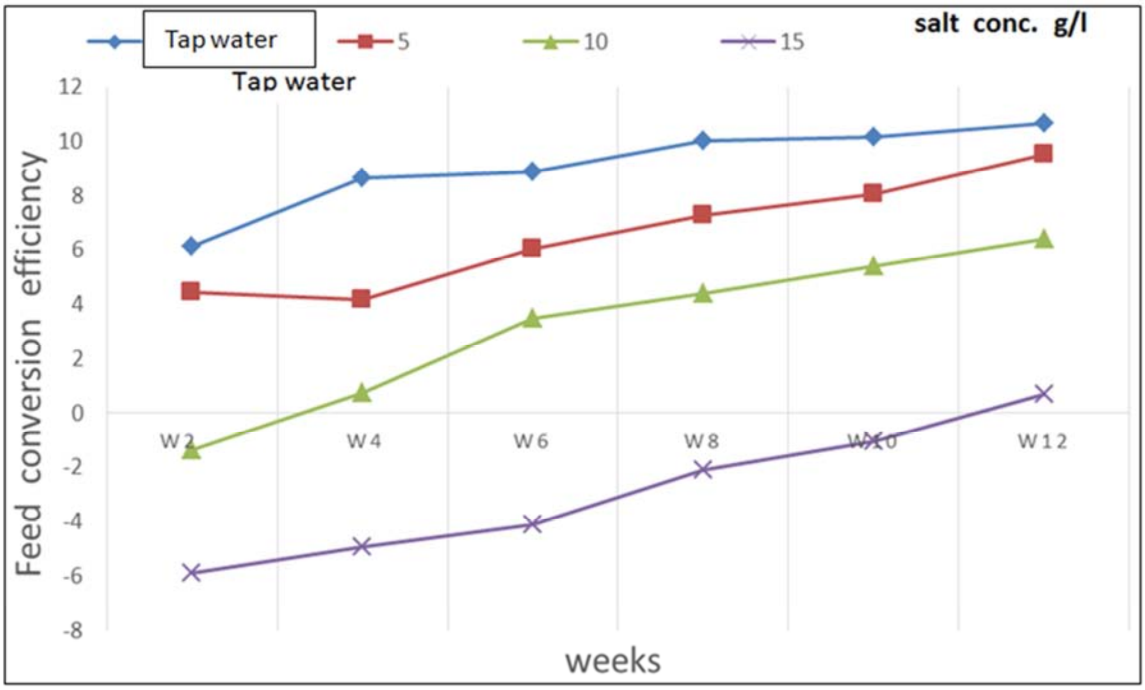

Figure 2. *Feed conversion efficiency in common carp during12 weeks of the growing trial in different salt concentrations.*

Figure 3 includes the ratios of protein intake in common carp at a gradual exposure to the salt concentrations of 5, 10 and 15 g/L as the results showed an increase in protein intake in the control treatment during all the weeks of experiment, while it was fluctuating in the rest of the mentioned salt concentrations.

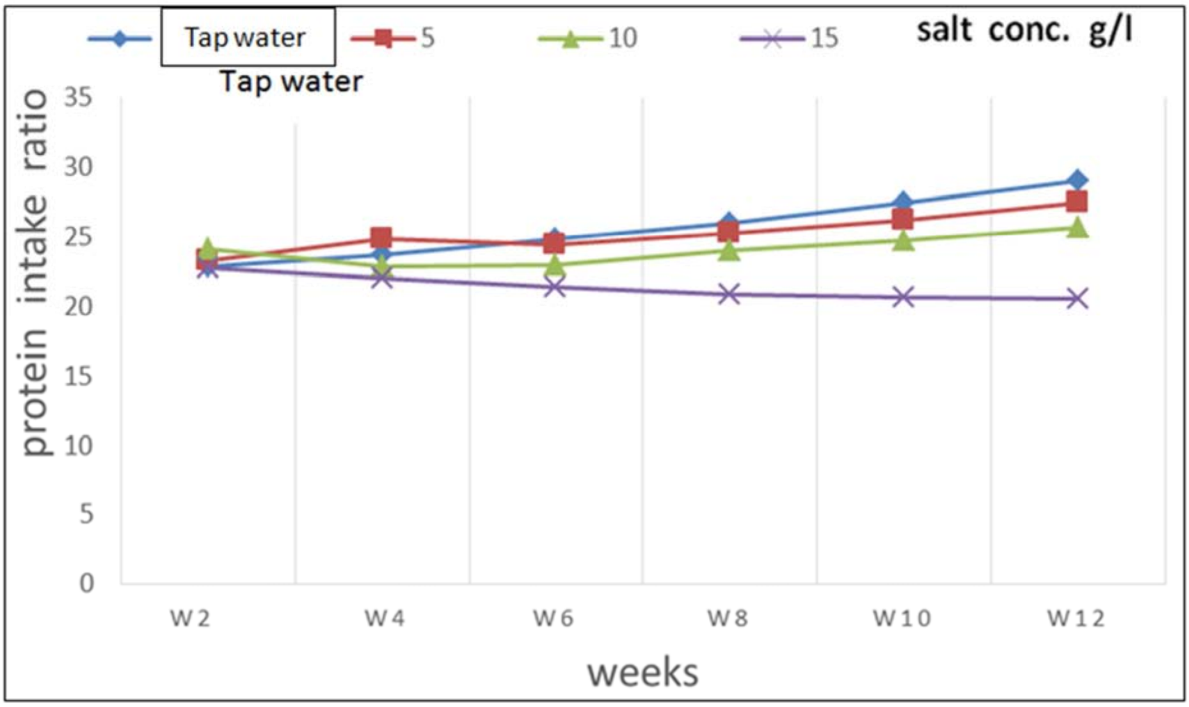

Figure 3. *Protein intake ratio in common carp during12 weeks of the growing trial in different salt concentrations.*

Figure 4 shows the efficiency of protein utilization ratio in common carp which gradually exposed to the salt concentrations of 5, 10 and 15 g/L, as we note there is an increase in the efficiency of protein utilization ratio in the control treatment, while it was significantly decreased within weeks in the salt concentrations above.

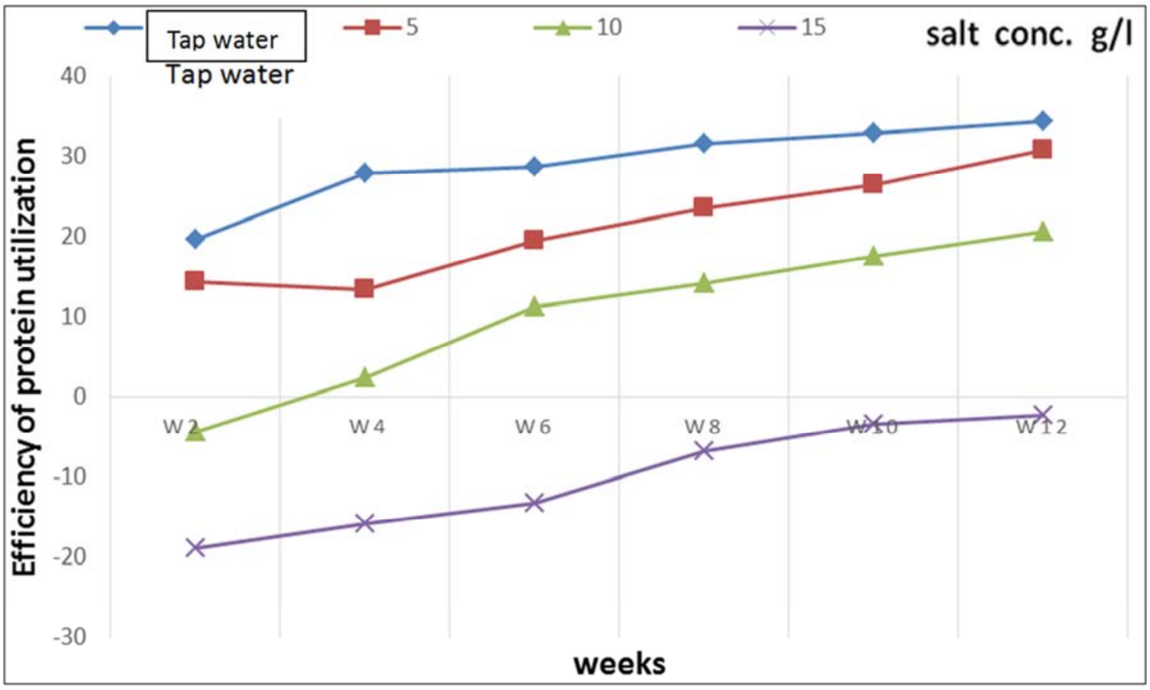

Figure 4. *Efficiency of protein utilization ratio in common carp during the growing trial in different salt concentrations.*

Growth in fish is one of the physiological functions that affected by the water salinity, where the metabolic rate and the energy of osmoregulation process were reflect the effect of salinity on growth [11]. The exposure of fish to high levels of salinity leads to an increase in metabolic rate as a result of the increasing need to the necessary energy for iono-osmoregulation to maintain the internal stability (homeostasis) under the new osmotic conditions. The increasing cost of energy needed leads to a reduction in growth rate, which negatively affects the rate and efficiency of feed conversion, protein intake and efficiency of protein utilization in fish, so a little of the energy will be available for growth [12]. The effect of salinity on fish growth is similar to the effect of temperature, this effect mainly depends on fish species and duration of exposure to the salinity [3]. De Silva and Perera [6] noted a decline in the rate and efficiency of feed conversion and efficiency of protein utilization in grey mullet *Mugil cephalus* with high salinity, Barman *et al*. [13] revealed that the best feed conversion rate and protein utilization of grey mullet were obtained in the salt concentration of 10 g/L, compared with other salt concentrations (0, 15, 25 and 30 g/L).

McCormick *et al.* [14] explained there is no effect of salinity on feed conversion rate in *Salmo salar* when exposed to salt concentrations of 0, 10, 20 and 30 g/L, while Partridge and Jenkins [15] recorded there were no significant differences in feed conversion rate in black bream *Acanthopagrus butcheri* when transferred to salt concentrations of 12, 24, 36 and 48 g/L, although the growth was high in salt concentration of 24 g/L, Likongwe *et al.* [16] revealed that the cost of devoted energy to the ionic and osmoregulation be low in iso-osmotic environment, and the stored energy is sufficient to increase the feed conversion rate.

Many of studies supported the idea of increasing feed conversion rate with the decreasing of metabolic cost for osmoregulation, where Abo- Hegab and Hanke [17] stated that the exposure of common carp to diluted seawater (10 and 15 g/L) led to a decline in feed conversion rate with the increase of salt concentrations. Luz *et al*. [18] noted a reduction in feed conversion rate and efficiency in goldfish *Carassius auratus* exposed to the salt concentrations of 8 and 10 g/L, compared to fish in freshwater and salinity of 2 g/L, Xia *et al*. [19] recorded that the grass carp *Ctenopharyngodon idella* exposed to various concentrations of sodium chloride NaCl showed a good growth rates at thesalt concentrations of 2 and 4 g/L, while there was a decrease in feed conversion rate in fish exposed to the salinity of 6 and 8 g/L, Yesser *et al.* [20] studied the growth and feed conversion of golden mullet *Liza carinata* when exposed to four salt concentrations ranged from 1.5 to 30 g/L, the highest growth rate and better feed conversion rate was in the salinity of 15 g/L as a result of reduction of spent energy in the osmoregulation process. DeBoeck *et al*. [21] stated that the transfer of common carp to the salinity of 10 g/L, has negatively impact on feed conversion rate and utilization ratio of protein, the researchers connected the reason of low growth with transfer of energy devoted to the growth towards the internal equilibrium processes. Wang *et al.* [22] explained that the best growth of common carp fingerlings was recorded at a salt concentration of 0.1 g/L, and the feed conversion rate decreased with the increase of salinity to 10.5 g/L, pointing out that the best feed conversion rate, protein utilization ratio and protein intake in common carp was in salinity of 0.5 - 2.5 g/L, Maceina and Shireman [23] pointed to a decline in feed conversion rate and utilization ratio of protein in grass carp at the salinity of 12 g/L, and decreased more when the salinity reached 14 g/L, while the decline was less in low salinity (3 and 6 g/L).

Lawson and Alake [24] revealed a significant decrease in feed conversion rate and utilization ratio of protein with increase of salinity in juvenile goldfish *Carassius auratus*. Schofield *et al*. [25] stated that the transfer of Nile tilapia *Oreochromis niloticus* from the freshwater to the gradual salt concentrations of 0, 5, 10, 15, 20, 25, 30 and 35 g/L, where the fish remained in each salt concentration for a week and then transported to the higher salt concentration, the researchers observed a decline infeed conversion rates and utilization ratio of protein, with increasing of salinity, until they reached the lowest levels at a concentration of 35 g/L, Küçük [26] noted that the exposure of goldfish *Carassius auratus* and Crucian carp *Carassius carassius* to the salt concentrations of 8, 12, 16 and 20 g/L after acclimated to the concentration of 8 g/L has led to a decline in feed conversion rate and protein intake, this was attributed to the move away of fish from the osmotic balance point. Imsland [27] recorded that the presence of fish in iso-osmotic environment reduces the amount of energy needed to osmoregulation, thus there will be more energy is devoted for growth, and then raising the feed conversion rate and ratio of protein intake and efficiently. There are also some factors that will influence the growth rate like nutrition and appetite, and these same factors are affected by salinity which affect on feed conversion rate [28].

AlFaez *et al*. [1] reported a decrease in feed conversion rate and protein intake of common carp in both concentrations of4 and 6 g/L respectively, compared to control treatment (2.2 g/L), the researchers attributed the cause of low growth to the osmotic shock which occurred when the fish exposed to high levels of salinity, this increased the osmotic pressure of blood plasma, and leads to a loss of fish appetite, and thus lower the feed conversion rate. Daham and Sayyab [29] noted a decrease in feed conversion rate with a ratio of 10% in the grass carp, when the salinity raised to 15 g/L, this also caused a decrease in feed conversion efficiency and protein utilization with high salinity, compared to them in salinity of 6 g/L.

4. Conclusion

The study summarized that the increased salinity, negatively influenced in feed conversion rate, feed conversion efficiency, protein intake and efficiency of protein utilization in common carp.

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