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Research Article
Effect of Gradual Different Salinity Concentrations on the Water Content of Common Carp Muscles

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Abstract

Background and Objective: Salinity is one of the important factors beside the oxygen and the temperature effecting on the fish, it had a direct effect on fish. **Materials and Methods:** About 300 fish were obtained from common carp (*Cyprinus carpio)*, the fish were fed for 2 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 body weight, the treatments divided in 4 group 5, 10,15 g L^{-1} with the control treatment 0.1 g L^{-1}. After adapting the fish to the laboratory conditions and the saline concentration 0.1 g L^{-1} (liquefied water), they were gradually exposed to the above mentioned saline concentrations. **Results:** The percentage of water content in the muscles decreased to 77.34, 63.20 and 62.12% when salinity increased to 5, 10 and 15 g L^{-1} compared to control sample (78.18%). **Conclusion:** From the obtained results, it is concluded the salinity effect on the water content of the muscles and that as important for the osmoregulation indictor in fresh water fish.

Key words: *Cyprinus carpio*, water content in muscle, salinity, osmoregulation, fish farm, fresh water

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fish farming is considered as one of the fastest growing sectors in the world and occupies what may reach to 50% of the total production of fish[1]. The problems of water salinity and scarcity were considered the two biggest problems facing the agricultural sector in general and fish farming in particular[2]. This can be traced back to the fact that water shortage and the rising temperature had led to greater evaporation rates and hence to a greater salinity concentration in water, a thing which is considered another source of danger that threatens the life of living things[3]. Salinity had a direct impact on the physiology of fish and this is why it is considered as an important ecological factor. Salinity in water varies from 0.7 in fresh water to 33 in saline water and it may sometimes be higher than that in the highly saline lakes, tide water and saline ponds as it could reach[4] more than 50. Fish generally use three basic strategies to deal with the varying osmotic pressure inside and outside the cells in the less or more salinity water. These strategies include: the plasma, the lymphocytes and the liquid existing between the cells. Fresh water fish differ from saline water fish because of the difference in the ions concentrations inside and outside their bodies[5]. Most inhabitant freshwater fish come under the category of low-endurance to saline fish because they cannot endure high saline concentrations and suffers from a high percentage of mortality when transferred to saline water because of the occurrence of what is generally called as the osmotic shock[6]. Many studies, however, proved that this is a solvable issue and that the saline endurance power can be increased by using the gradient transfer technique which involves transferring the fish into solutions whose salinity increases gradually[7]. Common carp belong to the Carpathian family and usually live in freshwater, particularly lakes and rivers and also live in low saline ecosystems[8]. Common carp are widely distributed throughout the world, especially in Asian and European countries[9]. Common carp are the 3rd most species in terms of fish farming worldwide and can be ranked first because of their high adaptability in the water and nutrition environment[10]. Freshwater fish need to regulate osmosis in saline environments and in this way, they face loss of water because of the osmotic feature and the entering of the ions in what is called as the negative gaining of ions[11]. Muscle is the primary source of any water transferred to the blood, providing protection for vital organs (brain, liver and kidney) from osmotic stress during exposure to high salinity[12], this study aims to investigate the effect of the increase in the salinity water of the *Cyprinus carpio* and study of physiological indicators like water content in the muscle is considered an indication of the negative effects of salinity increase and effect on the fish meat. This study also different from other studies because it is concerned the effect salinity on the quality of fish meat and the water content of muscles could be used as an indicator of the fish ability to regulate osmosis. This is a particularly important feature in small fish due to the difficulty of obtaining a large amount of plasma to study effect salinity on the *cyprinus carpio*.

MATERIALS AND METHODS

About 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 60×40×30 cm were filled with about 40 L of water and equipped with oxygen by an air pump. During the localization period, the fish were fed for 2 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 body weight 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 body weight.

The needed salinity concentrations were prepared 5/10/15 g L^{-1} by solving a definite amount of coarse salt brought from the common market (Al-Sharqa) in 1 L of pure liquefied water. The salinity of the pure water was taken into consideration and the salinity of the prepared saline concentrations had 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^{-1} (liquefied water), they were gradually exposed to the above mentioned saline concentrations. The same fish were transferred to the top concentration every 4 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 4th day of exposure to the lower concentration. This period was not counted within the experimental period. The fish at 0.1 g L^{-1} were considered as control fish.

Water content of muscles: After removing of the scales and skin from the area under the dorsal fin, a piece of muscle tissue is taken and washed with distilled water to get rid of the external salts. The muscle tissue is then dried by a filter paper and the wet weight is then taken using a sensitive balance. The meat is then dried in the oven at 105°C 24 h until the dry weight is stable. The percentage of water in the muscle is calculated according to the following Equation:

$$\text{Water content in muscle (\%)} = \frac{\text{Wet weight of meat (g)-Dry weight of meat (g)}}{\text{Wet weight of meat (g)}} \times 100$$

Statistical analysis: Data were analyzed using a completely random design and data shown represent Mean±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)[13]. Results were analyzed using a t-test for comparison between treatments. Statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSION

Water content in muscles: Figure 1 showed the effect of the gradual increase in salinity to 5, 10 and 15 g L^{-1} on the water content of common carp fish. The percentage of water content of the muscles decreased to 77.34, 63.20 and 62.12% when salinity increased to 5, 10 and 15 g L^{-1} compared to control sample (78.18%). The statistical analysis showed significant differences ($p>0.05$) in the water content ($p<0.05$) between the control sample and saline concentrations 10 and 15 g L^{-1} and the differences were significant ($p<0.05$) between the saline concentrations 5 and 15 g L^{-1}, while there were no significant differences ($p>0.05$) between saline concentrations 10 and 15 g L^{-1}.

The saline stress faced by freshwater fish due to higher levels of salinity than normal levels in the environment causes it to react. The first response to this reaction is to increase drinking water[14] a thing which is considered as a regulation process to compensate the existing loss in the tissue water and then minimizing the exhaustion resulting from high blood pressure[15]. The water content of muscles could be used as an indicator of the fish ability to regulate osmosis. This is a particularly important feature in small fish due to the difficulty of obtaining a large amount of plasma together with an increase in potassium and sodium ions in the muscles during the first phase of exposure to high salinity concentrations in many freshwater fish when they are transferred to higher saline concentrations and can be explained by the difference in the osmotic concentration between the internal environment (fish body) and the external environment (aquatic environment)[16]. In the present study, it had been made clear that the gradual increase in salinity had led to a decrease in the water content of common carp. In general, the disruption of osmotic regulation function is a natural

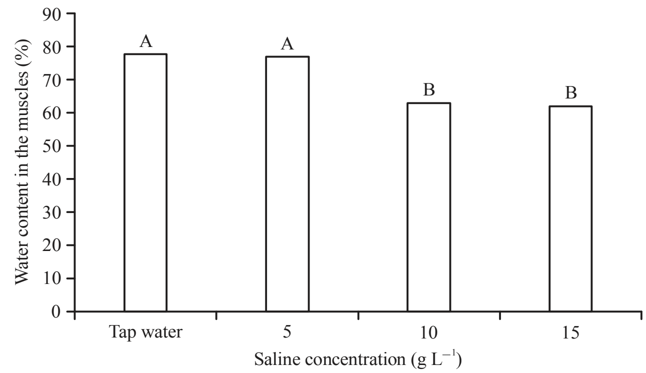

Fig. 1: Water content (%) in common carp fish in different saline concentrations

result of salt stress[17]. If extracellular fluids (ECF) are highly concentrated, the tissues are located under an osmotic challenge and the water is expected to come out of them, causing a state of dehydration[18]. Muscles are considered as the main source of any water that is transferred to the blood providing as such a protection of the vital organs (brain, liver and kidneys) from the osmotic stress caused by the projection to high salinity[12]. The decrease in the percentage of water content in the common carp muscle could be due to the external loss of water propagated through the gills and the transfer of water from the cellular components to the extracellular components[15].

This drop in water content in muscle tissue had been confirmed in many species of fish, as Parry[19] found a 78-68% decrease in water content in the muscle tissues in Atlantic salmon migrating from freshwater to saline water, Schmidt-Nielsen[20] reported that Killifish (*heteroclitus*) contained larger amounts of water within its freshwater muscles compared to what they were in sea water. In general, freshwater fish should maintain the amount of water in their muscles. Although there is a continuous flow of water when the concentration of external ions is higher than the concentration of internal ions at the point where natural physiological processes that control water volume are not useful to fish and that the drop in fish weight when exposed to high saline concentrations was directly associated with the loss of water from the muscle tissue[21] when the external environment is hypo osmotic in the stenohaline fish. Salman[22] explained that the cause of reduced water content of the muscles is based on the large gradient of the osmotic pressure between the blood and the external environment, which stimulates the loss of water from the body of the fish to the external medium of high salinity. Al-Khshali[23] indicated that the percentage of water content in the muscle in the grass carp and DiMaggio *et al*.[24] reported a decrease in the water content of *Seminol killifish* exposed to a gradual increase in salinity to 32 g L^{-1} compared to the water content of their muscles in fresh water. Martinez-Alvarez *et al*.[25] signified that the water content in the *Acipenser naccarii* decreased to 75.9 and 75.0 when salinity increased to 15 and 25 g (76.5%) and Luz *et al*.[7] showed a significant decrease in the moisture of the goldfish muscle *Carassius auratus* due to salinity elevation to 8 and 10 g L^{-1} and Sultan[26] reported a decrease in the water content of the *Acanthopagrus latus*, which is exposed to salinity increase to 7, 15, 23 and 30 g L^{-1}. Salman *et al*.[27] noted a decrease in the water content of 72.12% for *Barbus harpeyi*, known as the brown in our societies, when salinity was gradually increased to 10.9 g L^{-1} while the value in fresh water was (76.06%). Sangaio-Alvarellos *et al*.[28] showed that Gillthead seabream *Sparus aurata* which suffered from salinity increase to 12, 38 and 55 g L^{-1} decreased water content of its muscles after 14 days. Kelly *et al*.[29] observed an increase in the water content of *Mylio macrocephalus* which were transferred from salinity 55, 33, 12 and 6 g L^{-1} to fresh water. MacEina and Shireman[30] showed that the water content of the grass carp dropped from 80% in fresh water to 74.4% in salinity of 14 g L^{-1}. Lotan[31] reported that the transfer of *Aphanius disparriipell* from seawater to fresh water was accompanied by a decrease in the water content of the plasma with increased water content of the muscles with rapid loss of electrolytes from the plasma and the muscles after the first hour of moving, while the water content of the muscles decreased after 48 h with an increase in plasma and muscles electrolytes.

CONCLUSION

The gradual increase in salinity to 5, 10 and 15 g L^{-1} on the water content of common carp fish effect onthe percentage of water content of the muscles. The increase in the concentration of ions in the external environment, water in the body, including the water in the muscles leaves from the internal environment to the outer environment in a way that it affects the amount of water in the muscles, that indicate effect salinity on the fish meat and weight. So this present study can use successfully for small fish to study effect salinity on the osmo regulation.

SIGNIFICANCE STATEMENT

This study discover the relationship between the increase of salinity and the Water Contentin the Tissue Muscle of common carp. This is important for use as an indicator of the salinity effect on fish. This study will help the researchers to uncover the critical area about the effect salinity on the fish, especially the salinityhad become a global problem in all the world.

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