EFFECTS OF TEMPERATURE SHOCK

ON THE ENERGY DISTRIBUTION IN GRASS CARP

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Grass carp, or *Ctenopharyngodon idella*, are euryothermal teleosts capable of tolerating large temperature fluctuations by maintaining physiological homeostasis utilizing inherited regulatory capabilities. Since temperature is one of the primary environmental factors influencing the behavioral and physiological responses of poikilothermal teleosts, we have investigated the physiological response of grass carp subjected to temperature shock, in order to understand the temperature adaptation mechanism in euryothermal teleosts.

Changes in blood glucose and cortisol content have been suggested as sensitive and reliable stress indicators. Hyperglycemia is also known as a typical sub-lethal response of aquatic animals to environmental stress, such as hypoxia and heavy metals. Lactate is the major anaerobic end product in fish under hypoxic and anoxic conditions. As a physiological energy indicator, adenylate energy charge (AEC) can also be used to quantify the level of high-energy phosphate in the adenosine storage system of organisms. The presented study focused on the metabolism of adenylate phosphate compounds and the energy distribution in grass carp under acute temperature shock, with respect to glycemia, lactacemia, and adenylate energy charge.

Before undergoing temperature shock, the grass carp were acclimated in fresh water at 25 °C and a 12L/12D photoperiod regime for 1 month. Next, they were directly transferred to the following temperatures: 5 °C, 10 °C, 12.5 °C, 15 °C and 35 °C. Six fish in each group were sampled at 0, 0.25, 0.5, 1, 3, 6 and 12 hours. Plasma glucose, plasma lactate and hepatic phosphate levels were quantified.

Grass carp exposed to extreme temperatures, 5 °C, 10 °C and 35 °C, showed symptoms of coma, and mortalities at 0.05, 0.25 and 7 h, respectively. The plasma glucose content of fish at 5 °C decreased from 41.80 ± 1.61 mg/dl to 32.21 ± 3.95 mg/dl after 3 min, while those at 10 °C increased from 46.15 ± 4.01mg/dl to 59.26 ± 8.70 mg/dl in 15 min. The trend in plasma lactate at these two temperatures was similar to that of the plasma glucose content. In addition, the plasma glucose content of fish exposed to temperatures varying from 12.5 to 35 °C increased continuously, however, plasma lactate content increased rapidly initially, and then gradually declined. Moreover, AMP, ADP, ATP and TA contents in fish at 5 °C and 10 °C showed similar trends of decreasing, but almost no changes in the AEC index were detected. All of the AMP, ADP, ATP, TA and AEC contents showed similar trends of increasing and decreasing for the fish at 12.5°C and 15 °C, however, they all decreased more significantly for the fish at 35 °C.

These observations suggested the urgent need for supplementary energy in order to maintain physiological homeostasis under thermal stress. Because the energy supply is prominently compensated by anaerobic metabolism, these changes suggest that the shift in the energy metabolic pathway occurred while in the stressed temperatures. Furthermore, the values of AEC, ATP/AMP and ATP/ADP of the fish all decreased throughout the experimental period at temperatures of 5 °C, 10 °C and 35 °C. This indicated that the fish were under the retarded states of energy metabolism. In summary, the plasma glucose content can be used as a stress indicator for grass carp, but the AEC value can only be used in imminent temperatures.

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