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Metabolic and cellular stress responses of catfish, *Horabagrus brachysoma* (Günther) acclimated to increasing temperatures

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ABSTRACT

We investigated the metabolic and cellular stress responses in an endemic catfish *Horabagrus brachysoma* acclimated to ambient (26 °C), 31, 33 and 36 °C for 30 days. After acclimation, fish were sampled to investigate changes in the levels of blood glucose, tissue glycogen and ascorbic acid, activities of enzymes involved in glycolysis (LDH), citric acid cycle (MDH), gluconeogenesis (FBPase and G6Pase), pentose phosphate pathway (G6PDH), protein metabolism (AST and ALT), phosphate metabolism (ACP and ALP) and energy metabolism (ATPase), and HSP70 levels in various tissues. Acclimation to higher temperatures (33 and 36 °C) significantly increased activities of LDH, MDH, ALP, ACP, AST, ALT and ATPase and blood glucose levels, whereas decreased the G6PDH enzyme activity and, tissue glycogen and ascorbic acid. Results indicated an overall increase in the carbohydrate, protein and lipid metabolism implying increased metabolic demands for maintaining homeostasis in fish acclimated to higher temperatures (33 and 36 °C). We observed tissue specific response of HSP70 in *H. brachysoma*, with significant increase in gill and liver at 33 and 36 °C, and in brain and muscle at 36 °C, enabling cellular protection at higher acclimation temperatures. In conclusion, *H. brachysoma* adjusted metabolic and cellular responses to withstand increased temperatures, however, these responses suggest that the fish was under stress at 33 °C or higher temperature.

1. Introduction

Temperature is one of the most important abiotic factors which influences all biochemical reactions and therefore has great impact on the physiology of fish. Vast literature documents various aspects of thermal consequences in fishes inhabiting different climatic regions of the world (Fry, 1971; Hazel and Prosser, 1974; Somero, 2004; Schulte, 2004; Pörtner and Knust, 2007). Generally, fish gets acclimated when kept at an altered temperature regime for a sufficiently long duration. Most enzymes that are responsible for acclimatory responses in fish are primarily associated with pathways of energy production including glycolysis, gluconeogenesis, hexose monophosphate shunt, citric acid cycle, electron transport system, digestion and protein synthesis (Hazel and Prosser, 1974; Schreck, 2000). A profound effect of thermal acclimation observed in fish is the shift in the carbohydrate (Woo, 1990; Das, 2006), protein (Mayerle and Butler, 1971; Bennemann, 1977) and lipid (Hwang and Lin, 2002; Parihar and Dubey, 1995) metabolism. However, it is difficult to delineate a generalized pattern of shifts in metabolic patterns in response to thermal acclimation because the metabolic responses vary according to the fish species under investigation. For example, the enzyme aspartate transaminase in white muscle of rainbow trout (*Salmo gairdneri*) did not increase at low temperature (Jurss, 1981), but was elevated in muscle of pond loach, *Misgurnus fossilis* acclimated to cold (Mester et al., 1973). Similarly, the liver glycogen in red sea bream (*Chrysophrys major*) increased with increasing acclimation temperatures (Woo, 1990) but

Abbreviations used: ACP, Acid Phosphatase; ALP, Alkaline Phosphatase; ALT, Alanine Aminotransferase; AST, Aspartate Aminotransferase; ATPase, Adenosine Triphosphatase; FBPase, Fructose-1, 6-Bisphosphatase; G6Pase, Glucose-6-Phosphatase; G6PDH, Glucose-6-Phosphate Dehydrogenase; HSP70, Heat Shock Protein 70; LDH, Lactate Dehydrogenase; MDH, Malate Dehydrogenase; NADPH, Nicotinamide Adenine Dinucleotide Phosphate; ROS, Reactive Oxygen Species; RT, Room Temperature; SDS-PAGE, Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis

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