Abstract

Lake Magadi, Kenya, is one of the most extreme aquatic environments on Earth (pH~10, anoxic to hyperoxic, high temperatures). Recently, increased water demand and siltation have threatened the viable hot springs near the margins of the lake where Alcolapia grahami, the only fish surviving in the lake, live. These Lake Magadi tilapia largely depend on nitrogen-rich cyanobacteria for food and are 100% ureotelic. Their exceptionally high aerobic metabolic rate, together with their emaciated appearance, suggests that they are energy-limited. Therefore, we hypothesized that during food deprivation, Magadi tilapia would economize their energy expenditure and reduce metabolic rate, aerobic performance and urea-N excretion. Surprisingly, during a 5-day fasting period, routine metabolic rates increased and swimming performance (critical swimming speed) was not affected. Urea-N excretion remained stable despite the lack of their N-rich food source. Their nitrogen use switched to endogenous sources as liver and muscle protein levels decreased after a 5-day fast, indicating proteolysis. Additionally, fish relied on carbohydrates with lowered muscle glycogen levels, but there were no signs indicating use of lipid stores. Gene expression of gill and gut urea transporters were transiently reduced as were gill rhesus glycoprotein Rhbg and Rhcg-2. The reduction in gill glutamine synthetase expression concomitant with the reduction in Rh glycoprotein gene expression indicates reduced nitrogen/ammonia metabolism, most likely decreased protein synthesis. Additionally, fish showed reduced plasma total CO2, osmolality and Na+ (but not Cl−) levels, possibly related to reduced drinking rates and metabolic acidosis. Our work shows that Lake Magadi tilapia have the capacity to survive short periods of starvation which could occur when siltation linked to flash floods covers their main food source, but their seemingly hardwired high metabolic rates would compromise long-term survival.