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Gender Disparities in Hepatic Glycogen Depletion During Prolonged Starvation in *Clarias batrachus*

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Abstract:

This study investigates the impact of prolonged starvation on hepatic glycogen levels in *Clarias batrachus*, a commonly found air-breathing catfish. Both male and female specimens were utilized due to their widespread availability in local ponds and their ability to endure extended periods of starvation. The glycogen content in the liver was assessed after 0, 10, 20, 30, and 40 days of starvation to evaluate the effects of fasting on hepatic tissues. Glycogen levels were determined using a modified version of the calorimetric method developed by Kemp et al. (1954) and Krishnaswamy & Srinivasan (1961). Our results indicate a gradual depletion of glycogen in the liver over the course of starvation. Interestingly, females exhibited higher levels of glycogen compared to males under both normal feeding and starved conditions. However, after 40 days of starvation, males demonstrated a more pronounced depletion of liver glycogen compared to females. These findings shed light on gender disparities in energy metabolism during prolonged periods of fasting in *Clarias batrachus*.

Keywords: *Clarias batrachus*, glycogen, liver, starvation.

Introduction:

Starvation poses a significant threat to normal body metabolism, with prolonged deprivation often leading to the demise of the affected organism. This dire situation is particularly pronounced in underdeveloped and developing nations. Organisms facing starvation often engage in a desperate struggle, depleting their body reserves until succumbing to death. Numerous studies have documented the decline in various body constituents of fish following experimental starvation. However, much of the research in this area has been focused on

mammalian species, leaving a gap in our understanding of the effects of starvation on fish physiology. Fish, including the freshwater catfish *Clarias batrachus*, possess unique adaptations that enable them to endure prolonged periods of starvation through physiological and biochemical changes (Mustafa Salim, 1983). Moreover, environmental conditions often subject fish to seasonal periods of starvation. Consequently, starvation can profoundly impact the physiological and biochemical status of fish (Rajyasree and Naidu, 1989; Tripathi G & Verma R, 2003).

In light of the above considerations, this study aims to investigate the glycogen content of hepatic tissue in both male and female *Clarias batrachus* during a 40-day period of starvation. Glycogen levels were assessed at 10-day intervals, providing insights into the physiological responses to prolonged fasting.

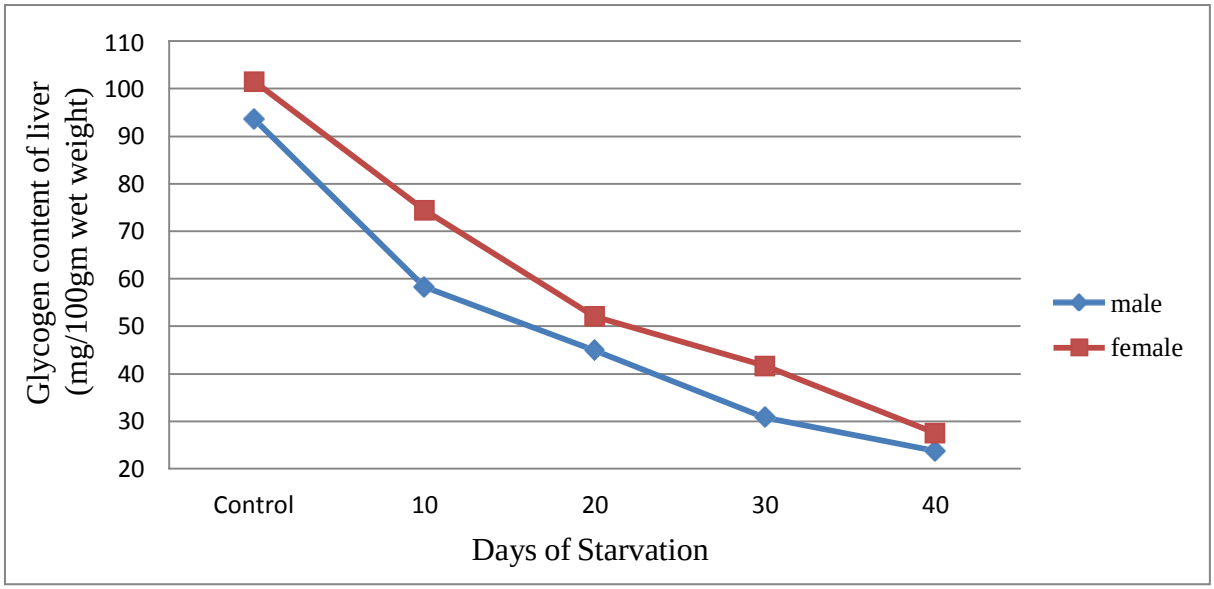
Material and Methods:

For this investigation, healthy *Clarias batrachus* specimens measuring approximately 18.8 cm in length and weighing about 30.4 g were collected. Following collection, the fish were acclimatized to laboratory conditions and provided with daily feedings. After a thorough acclimation period of 20 days, the experiment commenced, with 10 fish allocated to each of four aquaria. Over the subsequent 40-day period, fish were dissected at 10-day intervals, and their liver tissues were promptly removed for analysis. Total glycogen content in the liver was estimated using the calorimetric method developed by Kemp et al. (1954), as modified by Krishnaswami et al. (1961).

Table-1

Glycogen Content of Liver (mg/gm wet weight) in *Clarias batrachus*

Sex	**Days of Starvation**				
	0	10	20	30	40
Male	93.60 ± 1.09	58.30** ±1.10	44.99 ± 1.71	30.85** ±0.77	23.76** ±0.65
Female	101.5 ± 0.81	74.44 ±1.61	52.11 ±0.30	41.66** ±0.44	27.53** ±0.69



Results:

At the onset of our study, we observed a higher glycogen content in the liver of female *Clarias batrachus* (approximately 101.5 mg/g) compared to male specimens (approximately 93.60 mg/g). Throughout the experimental period of starvation, both male and female *Clarias* exhibited gradual depletion of liver glycogen. Notably, differential decreases were noted in the glycogen content between male and female fish, with males showing a more pronounced depletion compared to females. After 40 days of starvation, liver glycogen depletion reached approximately 75% in males and approximately 73% in females relative to their initial values.

Discussion:

An energy source must be available continuously for biological processes to continue. Since the energy within the cell keeps it alive, it needs systems to take in energy and numerous energy transducers to convert that energy into work. Every organism has these systems in place all the time, but in response to stressors including toxicity, temperature swings, fear, and starvation, a number of extra adjustments are anticipated to take place (Davison et al., 1961).

The body uses its own tissue to survive famine in order to produce energy (Wright, 1976). Various components of the cell break down and become mobilized as a result. Consumption of the carbs occurs first, followed by the mobilization of lipid stores. Though sporadically, protein catabolism occurs at the last stages of hunger (Reichsman, 1972).

Fish have exceptionally low basal energy consumption because they receive the most support from their surroundings, which allows them to carry out their tasks without using any of their

body's components. Because of this, fish may endure remarkably extended periods of famine. For example, an *Amia calve* lived for 20 months without food (Smallwood, 1916), and more remarkably, an *Anguilla anguilla* survived for 15 days without food, whereas *Clunes harengus* lived for 129 days (Boetius, 1967).

Many studies have been conducted on the effects of both short-term and long-term hunger, primarily on temperate fish. Salmo salar's liver glycogen concentration dropped by 54% during spawning migratory famine, according to Fontaine and Hatey's (1953) observations. In starved *Anguilla japonica*, Inui and Dshima (1966) found a slower rate of glycogen depletion in the muscle compared to the liver. Prasad (2014) reported that the glycogen depletion in the muscles of *Clarius batrachus* was about 81% after 40 days of starvation.

Since carbohydrates are the main fuel used to produce energy, the metabolism of carbohydrates is crucial during periods of food shortage. To release energy, glucose molecules undergo continual oxidation. During famine, glucose is created when glycogen is broken down and sent to the starving organs via blood. The synthesis of glucose from glycogen is stimulated by the elevated level of glucagon that occurs during fasting (Cahill, 1970; and Bell, 1976). Direct glucose synthesis arises from the liver's glycogen stores, and indirect glucose generation happens via the alanine glucose cycle and Coricycle in other tissues such as the brain, gonad, and muscle (Cori, 1931).

Numerous researchers have noted a decrease in the amount of carbohydrates in the starving organism in various animal tissues. These include the liver of Salmo salar by Fontain & Hatey (1953), the liver of *Rooseveltielia nattereri* by Bellamy (1968), and the liver of mammals by Matsumoto et al (1980) and some teleosts by Prasad (1980).

The current study found that the liver's glycogen content was gradually and significantly reduced. Both male and female *Clarias* lost more than 70% of their liver glycogen after 40 days of fasting. Glycogen content depletion was greater in males (about 75%) than in females (73%).

The current results are consistent with those of Freedland (1967), Ottolenghi et al. (1981), Fontain and Hatey (1953), Freminet et al. (1981), and Prasad (2015a).

Under both normal and deprived conditions, it was discovered that females had higher glycogen values than males. These findings of sex difference seen here are consistent with Singh (1981), Singhal et al. (1981), and Prasad (2015b).

Conclusion:

Our study highlights the resilience of freshwater catfish, *Clarias batrachus*, to prolonged starvation and its profound influence on the biochemical composition of various organs. We

found that glycogen levels in the liver remain higher in females than males under both during normal and starved conditions, gradually decreasing with prolonged starvation. Starvation emerges as the primary factor contributing to liver glycogen depletion in both sexes of *Clarias batrachus*. Further investigations are warranted to elucidate the potential implications of glycogen depletion on overall organismal biology.

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