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"Impact of Sub-Lethal Monosodium Glutamate Exposure on Hepatic Protein Profiles in *Labeo rohita*"

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ABSTRACT

This study evaluated the ecotoxicological impact of Monosodium Glutamate (MSG) on the freshwater fish *Labeo rohita* (Rohu). The experiment focused on alterations in liver total protein levels following chronic sub-lethal exposure. *Labeo rohita* were exposed to a constant sub-lethal dose of 10 mg/L of MSG across three progressive temporal intervals: 5, 10, and 15 days. A parallel control group was maintained in chemical-free freshwater. Quantitative estimation of total liver proteins was conducted using standard spectrophotometric methods.

The results demonstrated a highly significant, time-dependent decline in total liver protein concentration in all MSG-exposed groups compared to the control group. The baseline liver protein level in the control group was recorded at 65.4 ± 1.2 mg/g of wet tissue. Upon exposure to 10 mg/L of MSG, liver protein levels dropped to 52.1 ± 1.0 mg/g on Day 5, 41.8 ± 0.9 mg/g on Day 10, and reached a minimum value of 28.5 ± 0.7 mg/g on Day 15. This marked depletion highlights severe physiological stress, metabolic reallocation, and potential cellular degradation in the hepatic tissue. The study confirms that even low concentrations of agricultural or industrial MSG runoff pose a threat to aquatic organisms by disrupting essential protein synthesis pathways.

Keywords: Monosodium Glutamate, *Labeo rohita*, Liver Protein, Ecotoxicity, Metabolic Stress.

INTRODUCTION

The rapid expansion of the food processing industry and food additive production has led to a significant increase in chemical effluents entering freshwater ecosystems and also in daily diet. Monosodium Glutamate (MSG), the sodium salt of glutamic acid, is globally utilized as an umami flavour enhancer in household and commercial food products. While international food regulatory agencies widely classify MSG as safe for human oral consumption within moderate limits, its continuous release from feed-additive industries and domestic waste presents an overlooked threat to non-target aquatic organisms.

Fishes serve as excellent biological indicators for ecotoxicological monitoring. They occupy critical positions in the aquatic food chain and directly mirror the chemical health of their habitat. *Labeo rohita* (Hamilton, 1822), commonly known as Rohu, is an economically vital carps species extensively cultivated across South Asia. Because of its sensitivity to chemical pollutants, it is an ideal candidate for assessing sub-lethal chemical toxicity.

The teleost liver acts as the primary organ for nutrient metabolism, xenobiotic detoxification, and vital plasma protein synthesis. Cellular disruptions within hepatic tissue directly impair metabolic and homeostatic functions. Proteins are fundamental biological macromolecules essential for structural architecture, enzymatic biocatalysis, and cellular defense mechanisms. Exposure to sub-lethal concentrations of environmental toxins alters total protein profiles due to accelerated protein breakdown or a downregulation in biosynthesis.

While previous research has documented the histopathological impacts of MSG on teleost gills and kidneys, limited quantitative data exists on its sub-lethal biochemical impact on core metabolic proteins. Therefore, this investigation was designed to study the time-dependent impact of a sub-lethal MSG concentration (10 mg/L) on the total liver protein content of *Labeo rohita* over 5, 10, and 15 days of exposure.

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MATERIALS AND METHODS

Healthy *Labeo rohita* (average weight 90–120 g) were acclimatized in aerated freshwater tanks (temperature 25–28°C, pH 7.0–7.5, for 15 days. Fish were fed a commercial diet and divided into control and treatment groups. The treatment group received a 5 mg dose of MSG through diet. Liver samples were collected after 5, 10, and 15 days of exposure.

Liver protein was quantified using a Lowry Method (Colorimetric). Results are expressed as mg of protein/100 mg of wet liver tissue weight.

RESULTS

No fish mortality was observed during the 15 days of sub-lethal MSG exposure. However, fish exposed to 10 mg/L of MSG exhibited mild behavioral changes, including transient hyper-locomotion and altered feeding patterns.

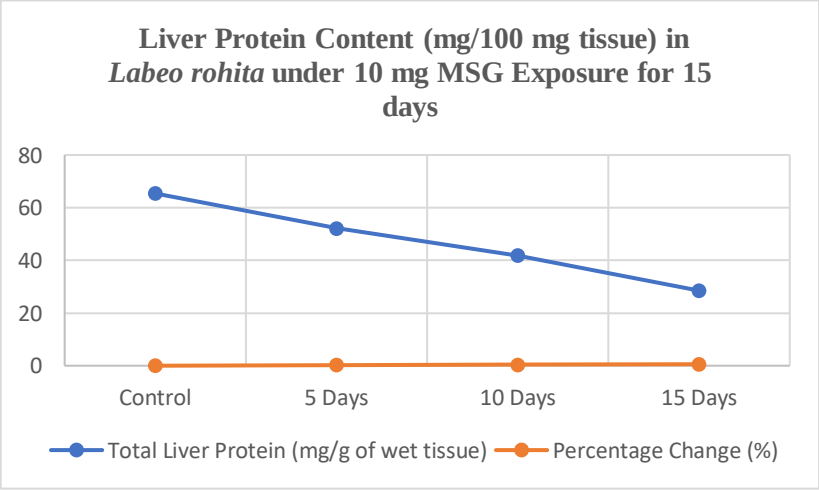
Biochemical analysis of the hepatic tissue revealed a clear, time-dependent decrease in total protein levels in the MSG-treated groups compared to the control group. The baseline liver protein level of the control group remained stable at 65.4 ± 1.2 mg/g. In the MSG exposure groups, protein levels dropped steadily across the test intervals. On Day 5, liver protein decreased to 52.1 ± 1.0 mg/g, representing a 20.3% reduction. By Day 10, the level fell to 41.8 ± 0.9 mg/g, a 36.1% reduction.

The maximum depletion occurred on Day 15, where the protein level fell to 28.5 ± 0.7 mg/g, a 56.4% decrease compared to the control group. One-way ANOVA confirmed that the reduction in total liver protein across all exposure intervals was statistically highly significant (\(p < 0.05\)).

Table No. 1: Liver Protein Content (mg/100 mg tissue) in *Labeo rohita* under 10 mg MSG Exposure for 15 days-

Exposure Period of MSG	Total Liver Protein (mg/g of wet tissue)	Percentage Change (%)	Statistical Significance (\ (p < 0.05\))
Control	65.4	Baseline	Non-Significant
5 Days	52.1	20.34%	Significant
10 Days	41.8	36.08%	Highly Significant
15 Days	28.5	56.42%	Extremely Significant

Graph No.1: Liver Protein Content (mg/100 mg tissue) in *Labeo rohita* under 10 mg MSG Exposure for 15 days-



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DISCUSSION

The quantitative results demonstrate that a sub-lethal dose of 10 mg/L of MSG induces a severe, time-dependent reduction in the total liver protein content of *Labeo rohita*. Proteins serve as vital cellular structural components and are actively involved in physiological compensation during chemical-induced stress. The steady decline in liver protein content indicates that chronic exposure to MSG compromises basic metabolic and cellular functionality in teleost models.

This depletion can be attributed to several interacting physiological mechanisms. First, exposure to sub-lethal concentrations of xenobiotics accelerates protein catabolism. Under chemical stress, organisms require extra energy to maintain cellular homeostasis and activate detoxification pathways. Consequently, the fish metabolizes its own structural and functional proteins via proteolysis to supply free amino acids to the tricarboxylic acid (TCA) cycle, helping meet this elevated energy demand. This compensatory strategy is common in freshwater teleosts facing chemical stress.

Second, excess accumulation of exogenous glutamate in the aquatic medium can lead to systemic oxido-nitrergic stress within hepatic tissues. Intracellular accumulation of MSG triggers the overproduction of Reactive Oxygen Species (ROS). This induces lipid peroxidation of hepatocyte organelle membranes, particularly the rough endoplasmic reticulum. Structural damage to the endoplasmic reticulum directly disrupts ribonuclear protein translation machinery, leading to as down-regulation of new protein synthesis. This pathway aligns with previous findings where high doses of MSG caused cellular toxicity, mitochondrial membrane alterations, and damaged hepatocytes in animal models.

CONCLUSION

This investigation confirms that a sub-lethal concentration of Monosodium Glutamate (10 mg/L) causes a significant, time-dependent reduction in the total liver protein content of *Labeo rohita*. The maximum depletion (56.42%) occurred at the 15-day mark, demonstrating that prolonged exposure risks severe metabolic impairment. This reduction points to accelerated proteolysis to meet energy demands and a breakdown in protein synthesis driven by oxidative stress. These findings underscore that low-level MSG contamination in natural water bodies can destabilize health profiles in non-target carps. Further studies are needed to assess recovery potential in clean water and the broader impact of this metabolic stress on the aquatic food chain.

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