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CHANGES IN THE PLASMA ELECTROLYTES OF FRESH WATER TELEOST FISH *LABEO ROHITA* EXPOSED TO SUBLETHAL CONCENTRATION OF MONOSODIUM GLUTAMATE (MSG)

Environmental Science

N. Geetha Department of Zoology, PSG College of Arts & Science, Civil Aerodrome Post, Coimbatore – 641014.

ABSTRACT

Background: Extensive usage of MSG in numerous food products as taste enhancer, and continuous release of effluents from Feed additive industries pose a threat to aquatic organisms.MSG induced cellular damages were reported in laboratory animals but there were no reports of MSG induced stress to fishes.
Methods: Fish Labeo rohita exposed to sublethal concentration of MSG (150mg/L) for 15 days and plasma electrolytes level were estimated.
Results: MSG is toxic to fish even in sub lethal concentration. Decrease in plasma electrolytes during initial exposure to MSG may be due to disturbances in the membrane permeability of gills or inhibition of Na^+ K^+ATP-ase activity in the gills. Elevated plasma electrolytes in MSG exposed fish may be due to efflux of ions from their tissues there by indicating severe imbalance in the osmoregulation phenomena.
Conclusion: MSG is toxic to fish and caused severe osmotic imbalance. Prolonged consumption of MSG through food as well as MSG intoxicated fish may affect human health via ecological cycling and biological magnification and cause serious health hazards like susceptibility to infectious diseases and even cancer.

KEYWORDS

Monosodium glutamate, sublethal toxicity, plasma electrolytes, Labeo rohita.

INTRODUCTION:

Recent revolution in food industry imposed tremendous changes in human diets. Now a day's food industry is extensively using feed additives as flavour enhancers, antioxidants, colourings, emulsifiers, preservatives, and stabilizers (1). Monosodium Glutamate (MSG) is widely used as a flavour enhancer all around the world. MSG is present in various concentrations in numerous food products and consumed by people of almost all age groups (2). Though, MSG has been regarded as safe for human consumption, it causes biological effects and deformities in many animal models and may pose threat to human through food chain(3).

Release of industrial effluents in the water causes disastrous effect on aquatic organisms. Fishes are one of the most important groups of aquatic organisms, which are vulnerable to such conditions and can be considered as an important indicator of environmental stressors (4). For Biological monitoring, aquatic organisms are exposed to environmental pollutants and markers in these organisms are used to assess the toxic effects of the water pollutants. These biomarkers include serum enzymes, plasma electrolytes and biochemical constituents (5). Since, *Labeo rohita* is economically important fish and readily available in local markets throughout the year in India for human consumption, the present study was designed to assess the toxic level of Monosodium glutamate to *Labeo rohita* using plasma electrolytes as biomarker.

MATERIAL AND METHODS:

Fish fingerlings of *Labeo rohita* procured from TamilNadu Fisheries Development Farm, Aliyar, Tamil Nadu and acclimatised under laboratory condition (Dissolved oxygen 5.5 ± 0.1 mg/L; p^H 7.34 ± 0.55; Salinity 0.5 ± 0.35 ppt; Total hardness 20.23 ± 0.35 mg/L). Fish were fed *ad libitum* with rice bran and groundnut oil cake 2:1 ratio in the form of dough twice a day and leftover feed and faecal matter were removed to ensure proper dissolved oxygen supply. Fish were withheld from feed for 24h prior to the experiments in order to keep them in same metabolic rate. Stock solution of MSG (10g/L) was prepared and utilized for toxicity analysis. Median lethal concentration (LC_{50}) of MSG for 96h was determined by following Static Renewal Bioassay Test (6) which was1.5g/L.

For sub-lethal toxicity study, two glass aquaria of 100 L capacity filled with chlorine free water were taken and designated as Control (Aquaria I) and Experiment (Aquaria II). Sublethal concentration of MSG ($1/10^{th}$ 96h acute LC_{50} value; 150mg/L) was added to the Aquarium II by removing the equal volume of water. At the end of every 24hrs, water was renewed and corresponding to the number of fish, freshly prepared MSG solution was dispensed to maintain the same MSG concentration throughout the study period. After stipulated time (5^{th}, 10th & 15^{th} days), blood was drawn from both experimental and control groups by cardiac puncture using syringe pre-rinsed with an anticoagulant Beparine (10,000 IU/mL,). Blood samples were centrifuged at 10,000rpm for 15min at 4.0°C. Plasma was withdrawn and transferred into the respective clean vials already moisture with beparin for further analysis. Plasma sodium (7) potassium (8) and chloride (9) were estimated from both experiment and control groups.

STATISTICAL ANALYSIS:

Data are mean ± SE properly mentioned in bar diagrams. Student't' test was performed for each parameter to find the statistical significance at $p < 0.05$ using SPSS software version 25.

RESULTS:

During acute toxicity analysis, fish showed drastic behavioural changes such as rapid movement around the trough and gradual retardation in the movement with extend of time, spreading excess of mucous all over the surface of body, as well as the thick coat of mucous over the gills. After 96 h, 50% mortality was recorded at 1.5g/L MSG concentration. Towards the end of the experiment fish showed gulping of air, erratic movement, lost its equilibrium turning upside down before they died. Chi- square test for the toxicity (data not shown) proved that fish population used in the present study was homogenous.

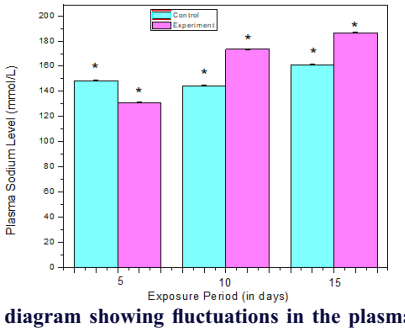

Fig 1: Bar diagram showing fluctuations in the plasma sodium level (mmol/L) of *Labeo rohita* exposed to varying periods of sub lethal concentration of Monosodium glutamate.

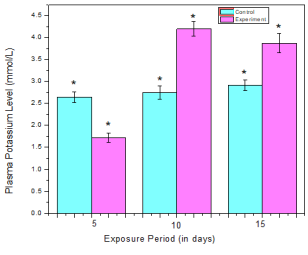

Fig 2: Bar diagram showing alterations in the plasma potassium level (mmol/L) of *Labeo rohita* exposed to varying periods of sub lethal concentration of Monosodium glutamate.

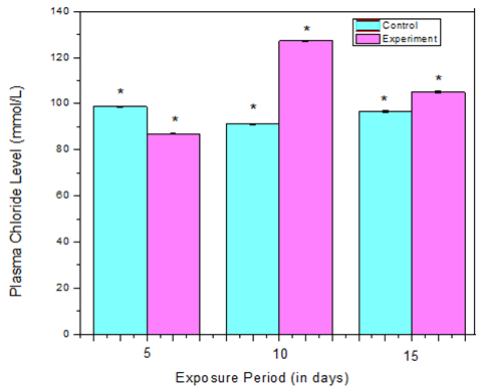

Fig 3: Bar diagram showing changes in the plasma chloride level (mmol/L) of *Labeo rohita* exposed to varying periods of sub lethal concentration of Monosodium glutamate.

Student t test revealed that all values are highly significant at $p < 0.005$.

DISCUSSION:

MSG exposed fish displayed thick coating of mucus over the gill membrane and gulping of air from the water surface and this may be an attempt by the fish to avoid the direct exposure to the MSG poisoned water. Erratic swimming and backward movement in sub lethal treatment may be due to the toxic effect of MSG on the central nervous system of fish.The fluctuations and stabilization of values of electrolytes is a clear indication of distortion of metabolic functions of the vital organs (10). Plasma sodium level was slightly decreased at the end of 5th day treatment. This might be due to increased urinary excretion of sodium due to renal tubular dysfunction or reduced intestinal absorption. However, elevated sodium level from 10th day onwards might be due to gradual repair of injured tissues and sites where entry and exit of these ions take place and also elevation of cortisol level in the blood may rise the plasma sodium level in the fish(11). Similar trend was noticed in the plasma potassium level. The disturbed potassium regulation might be due to an impaired active reabsorption of potassium in renal tubules. The increased potassium level from 10th day, might be due to inhibition of Na^+/K^+ ATPaseand /or the continuous efflux of potassium ion from intracellular fluid into the extracellular fluid(12).

plasma chloride level was initially decreased and at the end of 10th day the highest elevated level was recorded. The alteration in the blood chloride level could be mediated by the release of stored pre-existing cortisol in the fish due to Sub lethal MSG exposure. Alternatively, carbonic anhydrase also plays an important role in electrolyte regulation in fish(13). The decrease in chloride uptake might be due to the inhibition of carbonic anhydrase.

CONCLUSION:

Fish has undergone severe stress due to the exposure to MSG. Daily consumption of MSG intoxicated fish may cause several health hazards to human, as fish tend to accumulate toxicant in vital organs and can be biomagnified through food chain. Hence, it is necessary to create awareness among the people and help them to realize its health hazards.

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