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Copper Sulfate-Induced Alterations In Growth Parameters And Tissue Copper Levels In Rohtee Ogilbii

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ABSTRACT

Ten Rohtee Ogilbii fish were placed in each of twelve glass aquariums and subjected to different amounts of copper sulfate (25 µg/L, 50 µg/L, and 75 µg/L), with control groups also being immersed in dechlorinated tap water. The fish started off with a body weight of 50 ± 2 g. Over the course of three sample days, the amounts of copper were recorded both before and after the water was renewed. Every day, the temperature, pH, conductivity, and unionized ammonia levels in the water were just right for the fish to thrive. Liver weights were assessed before freezing, and tissue samples (liver, gills, and muscle) were obtained and preserved for examination. The computed growth parameters demonstrated that the effects of copper sulfate on growth and tissue accumulation were significantly dose-dependent. There were significant differences ($p < 0.05$) across the treatment groups, as shown by statistical analysis using ANOVA and Duncan's multiple range tests. The results show that copper sulfate has physiological effects on Rohtee Ogilbii, which means that copper levels in water need to be carefully managed to prevent harmful effects on fish health and development.

Keywords: Growth, Tissue, Weight, Liver, Gill

I. INTRODUCTION

Rohtee ogilbii, or the Indian large carp, is an important fishery species and a measure of environmental health in South Asian freshwater environments. Copper sulfate is a chemical that is used extensively in agriculture and industry. It may get up in waterways via a number of different channels, including runoff from fields, industrial discharges, and incorrect trash disposal. Rohtee ogilbii and other aquatic creatures are affected in many ways by copper sulfate, which has both direct and indirect impacts on their ecology and physiology. In addition to being important for managing and preserving aquatic biodiversity, understanding these consequences is critical for addressing human health concerns about eating polluted fish.

Throughout South Asia, particularly the Indian subcontinent, you may find Rohtee ogilbii, a benthopelagic fish species belonging to the Cyprinidae family. As a key consumer of plankton, debris, and aquatic plants, as well as food for bigger predatory fish and birds, it plays an important ecological function. Rohtee ogilbii is economically and culturally significant in many areas because it helps sustain local fisheries and ensures food security, in addition to its ecological purpose. The chemical molecule known as copper sulfate ($CuSO_4$) has many agricultural applications, including as a pesticide, herbicide, and fungicide. Electroplating and metal surface treatment are only two of the many industrial uses for it. Agricultural runoff, industrial discharges, and accidental spills are the main ways that copper sulfate may end up in aquatic habitats. Rohtee ogilbii and other aquatic species may absorb copper ions directly via their skin and gills when they dissociate from copper sulfate in water. Rohtee ogilbii's growth characteristics and tissue health may be significantly impacted by copper sulfate exposure. The immunological system, cellular functions, and enzyme activity in fish are all negatively impacted by copper ions, which cause oxidative stress and poor ion control. Symptoms of these physiological disturbances include slowed development, changed reproductive outcomes, and an increased risk of illness. Additionally, Rohtee ogilbii's health and survival may be further jeopardized due to histological alterations in their liver, kidneys, and gills caused by prolonged exposure to sublethal amounts of copper sulfate.

Copper sulfate has both direct and indirect harmful effects on Rohtee ogilbii. The former happens when it changes the habitat and food supplies of the latter. Herbivorous fish like Rohtee ogilbii rely on macrophytes and algae for their nutrition, but excessive copper concentrations in water may harm these habitats. In addition, copper pollution may build up in the food chain, eventually reaching levels that might harm higher trophic levels, such as people who rely on fish for their protein needs. Exposure of Rohtee ogilbii to copper sulfate has ecological consequences that go beyond the health of individuals and affect the dynamics of populations and communities in freshwater environments. Alterations to Rohtee ogilbii's range and abundance have the power to change trophic relationships and ecological stability, which in turn may have a domino effect on other species in the food chain. In order to anticipate and lessen the wider ecological repercussions of copper sulfate, it is essential to comprehend how it affects Rohtee ogilbii. Regulatory actions, pollution control methods, and ecosystem-based management techniques must all be part of a comprehensive strategy to lessen the effects of copper sulfate pollution on Rohtee ogilbii and other aquatic species. Agricultural practices, chemical use, and industrial discharges should all be addressed via the implementation of wastewater treatment technology, the promotion of sustainable chemical use, and the improvement of agricultural practices overall in order to decrease copper inputs into aquatic habitats. Copper pollution may have devastating impacts on Rohtee ogilbii populations, although early warnings can be provided by monitoring systems and biomonitoring studies. This allows for prompt management actions.

II. REVIEW OF LITERATURE

Kim, Byeonghyeon et al., (2022) Growing pigs were subjected to three levels of copper (Cu)—one inorganic and two organic—and three different sources (0, 50, and 100 mg/kg) to examine its effects on growth performance, Cu digestibility, fecal mineral excretion, serum mineral concentration, jejunal morphology, and serum biochemical profile. For a period of 28 days, 42 male pigs that were roughly 31.08 ± 1.82 kg were divided into seven groups and given different treatments. One group served as a control, while the other groups received copper sulfate ($CuSO_4$), copper amino acid complex (CuAA), or copper hydroxy-4-methylthio butanoate chelate complex (CuHMB) at doses of 50 and 100 mg/kg, respectively. The average daily growth and feed intake of pigs given 50 or 100 mg/kg of Cu were significantly enhanced ($p < 0.05$). There was no difference in Cu excretion between the sources in pigs given 50 mg/kg of organic Cu sources and those fed 100 mg/kg of $CuSO_4$, even though there was a reduction ($p < 0.01$) in the former group. Nevertheless, when comparing pigs given organic Cu sources to those given $CuSO_4$, the apparent total tract digestibility of Cu was higher in the former group ($p < 0.01$). Jejunal morphology and serum biochemical profile were unaffected by source and amount, although serum phosphorus and sulfur concentrations were raised ($p < 0.01$) by the addition of CuHMB. Incorporating organic Cu sources (CuAA and CuHMB) into the diet of developing pigs at a rate of 50 mg/kg may have positive effects on growth performance and Cu availability while simultaneously reducing environmental pollution, according to these studies.

Wilk, Martyna et al., (2022) the metabolic activities of mammals rely on the microelement copper. Lack of thorough analysis surrounds copper's role in methanogenesis and rumen fermentation. The research set out to compare several copper supplement kinds, how they broke down in the rumen, and how they affected methanogenesis and in vitro ruminal fermentation. Within the experiment, two distinct copper additives were utilized: CS, which stands for copper sulfate, and EC, which stands for encapsulated copper. CS is composed of tribasic copper chloride and copper sulfate, while EC is a polysaccharide polymer covering. A control (C) was used, which was a whole mixed ration devoid of copper addition. The fermentation profile, gas generation, and methanogenesis were assessed using in vitro rumen fermentation. The copper concentration in the rumen fluid was much greater in the CS group after 24 hours of fermentation. There was a higher level of protection for EC against rumen degradation. Fermentation in the rumen is affected by the kind of copper supplement utilized. Nevertheless, the impact on methanogenesis remains unclear. Although it has no effect on methanogenesis, CS supplementation increases rumen gas output. The findings show that the EC supplement has the potential to increase economic indicators of milk production and decrease the danger of low-fat milk. To correlate the findings achieved in vitro with animal production, an in vivo investigation is required.

Hernandez, David et al., (2018) there has been a lack of thorough analysis into the role of copper (Cu), a microelement crucial to animal metabolism, in fermentation and the production of methane (CH4) in the rumen. What made this research unique was that it used copper sulfate to examine how high dosages of Cu affected fermentation patterns, CH4 generation, and in vitro ruminal breakdown. The in vitro dry matter (DM) and organic matter degradability decreased from 60 to 100 µg Cu/g DM ($P < 0.04$), according to the results. The concentration of ammonia dropped significantly as the amounts of Cu increased (linear impact, $P < 0.01$). Eighty and one hundred micrograms of Cu/gram of dry matter decreased the amount of total bacteria and volatile fatty acids (quadratic impact, $P < 0.02$). As the doses of Cu were raised, the generation of methane (milliliters per gram digestible organic matter) reduced (linear impact, $P < 0.003$). Conclusion: Adding increasing amounts of Cu up to 40 µg Cu/g DM had no negative effect on the development of ruminal bacteria, and it reduced CH4 generation without influencing the ruminal kinetics. The sentence is copyrighted by the SOCI in 2018.

Padrilah, Siti et al., (2018) all living things need copper, a major trace metal, for proper development and metabolism. A harmful accumulation of continuous metal compounds that may enter water and disrupt biological systems is a possible consequence of using this element beyond its safe limits. Rising levels of pollution in the environment might have an impact on aquaculture as well. When examined at the molecular and structural levels of an organism, copper is shown to have a poisonous impact that may harm fish. This is due to the fact that fish are capable of accumulating heavy metals in their tissues, like other aquatic creatures. Metal concentration, exposure duration, metal absorption mechanisms, environmental conditions (pH, water temperature), and inherent characteristics (fish size, age) are the main determinants of this accumulation. Copper accumulates differently in various fish organs. Because of the histopathological changes seen in fish and the buildup of copper in their organs, this review set out to investigate the negative impacts of copper on fish.

Gharedaashi, Esmail et al., (2013) The current research set out to find out how well Caspian Sea kutum (Rutilus frisii kutum) fingerlings fared after a 60-day sub-lethal copper (Cu) exposure period, as well as the LC50/96 h value of copper sulfate. After two weeks of acclimatization, a total of twenty-seven 60-liter aquariums containing ten fish each were used to calculate the LC50/96-hour value. The 24 treatments consisted of four aquariums maintained by Tunney and eight different concentrations of Cu; three additional aquariums served as controls. Three independent trials were carried out for every therapy. As part of the experiment to find out how well the fish grew, they were put inside 200-liter fiberglass aquariums. While the control group grew in an aquarium devoid of metals, the treated fish were allowed to thrive in an environment with sub-lethal amounts of Cu (0.11 and 0.23 mg L(-1)). According to the findings, the median lethal concentration (LC50) of copper after 96 hours of exposure to kutum in the Caspian Sea was 2.310 ppm. Final body weight was considerably lower in the fish treated with chronic sub-lethal water-borne Cu compared to the control group. Copper sulfate significantly reduced feed conversion efficiency (FCE) and specific growth rate (SGR) compared to the control group. When compared to the control group, there was a substantial increase in the feed conversion ratio (FCR) and condition factor (CF) ($P < 0.05$). Additionally, there was a substantial drop ($P < 0.05$) in the survival rate of the experimental treatments compared to the control group. Both the weight and length increases of the treated fish were much lower than those of the control group. Throughout the course of the research, there was a marked difference between the treated and control groups with respect to the growth rates of the fish's weight, fork and total lengths, condition factor, feed consumption, and condition factor. The results show that the Caspian sea kutum (Rutilus frisii kutum) is poisonous to copper sulfate.

Ordax, M.et al., (2009) at relatively high concentrations, copper, an important element, may enhance bacterial growth on medium rich in nutrients. Erwinia amylovora, the causative agent of fire blight, a devastating and extensively distributed disease of pome fruits and ornamental plants, is one example of a bacterium whose exopolysaccharide synthesis is enhanced by copper. The only way to know for sure whether E. amylovora is in a plant sample is to isolate it and identify it further. But there are a number of things that might make it harder for germs to thrive on solid medium. We have added copper to a popular nonselective medium, King's B (KB), in order to improve the recovery process. Colonies of E. amylovora emerged rapidly in the copper-modified KB medium, and their distinctive yellow color and high mucoid were easy to spot. Both in vitro and in vivo tests demonstrated that the novel medium recovered E. amylovora more effectively than the previously used oil-based media. , leading to a practical instrument for removing the disease-causing microbe from the plant.

III. MATERIALS AND METHODS

Rohtee Ogilbii were collected from Kolleru Lake in Andhra Pradesh and their body weight was 50 ± 2 g. Twelve glass aquaria with ten fish each were randomly assigned to them. We performed three sets of tests on each treatment group and control. Tap water that had been dechlorinated was given to the control groups. Over the course of the experiment, three separate sample days were used to measure the real copper concentrations. Each sampling day was conducted before and after the bath renewal. Every day, the experiment was carried out and data was collected. Tap water that had been dechlorinated was given to the control groups. For every category.

Each aquarium's water was sampled at a depth of 20 cm. Every day at the location, a portable DO meter was used to test the temperature and dissolved oxygen. A Digital Mini-pH Meter was used to measure the pH readings. A Portable Conductivity Meter was used to test the electric conductivity of the water. Using a Multiparameter Ion Analyzer, the concentration of unionized ammonia (NH3) was measured. The titration technique was used to measure the total alkalinity and total hardness. The temperature of the water varied between 28 and 30 °C, the pH between 7.5 and 7.6, the conductivity between 51 and 52 uS/cm, and the amounts of unionized ammonia between 0.10 and 0.12 mg/L throughout all treatments. As CaCO3, the total hardness ranged from 240 to 241 mg/L and the total alkalinity from 115 to 116 mg/L. For fish to flourish, each of the aforementioned water quality indicators must be within a certain range. Before further analysis, the liver and gills were taken and preserved at -85°C. Liver samples were weighed before being frozen. Here are the calculations for fish growth: The equation for weight increase (g) is the difference between the starting weight (g) and the end weight (g), The percentage of weight increase is one hundred. The condition factor, which is equal to (weight × 100)/length3/, is equal to [final weight (g) - initial weight (g)]/initial weight (g). HSI, which stands for Hepatosomatic Index, is calculated as the ratio of liver weight to body weight, multiplied by 100. Homogenization of the liver, gills, and muscle samples was performed in a pH 7.4 solution containing 50mM potassium phosphate buffer and 1mM EDTA.

This study's data was subjected to statistical analyses using LSD (Least Significant Difference) and variance ANOVA. To compare the means of the treatments, Duncan's multiple range tests were used. Mean ± SE was used to show the data, and significance was indicated when the p-value was less than 0.05.

IV. RESULTS AND DISCUSSION

Table 1. Effect of different copper concentrations on growth parameters of Rohtee Ogilbii

Parameters		**Doses of copper sulfate**		
	Control (Mean ± SD)	**25 µg/L (Mean ± SD)**	**50 µg/L (Mean ± SD)**	**75 µg/L (Mean ± SD)**
Initial weight (g)	50.02 ± 3.3	50.02 ± 3.5	50.02 ± 2.2	50.02 ± 1.2
Final weight (g)	74.03 ± 2.4	73.01 ± 4.3	68.5 ± 2.6	64.02 ± 3.1
Weight gain (g)	24.05 ± 2.7	23 ± 2.4	18.02 ± 1.7	14.05 ± 6.3
Weight gain %	48.02 ± 2.21	46.08 ± 3.21	35.97 ± 1.18	28.12 ± 1.14
Hepatosomatic index	3.79 ± 0.11	3.39 ± 0.13	2.90 ± 0.10	2.39 ± 0.16
Condition factor	2.35 ± 0.07	2.28 ± 0.05	2.23 ± 0.06	2.23 ± 0.01

Several growth characteristics of Rohtee Ogilbii fish were examined in relation to various amounts of copper sulfate, as shown in the table. In the experiment, four groups were used: one that served as a control and was given dechlorinated tap water, and three that were treated with copper sulfate at doses of 25, 50, and 75 µg/L, respectively. All groups started off with similar beginning weights, which were approximately 50.02 g, with just little differences. Study participants' ultimate weights dropped from 74.03 g in the control group to 64.02 g in the group that received the greatest concentration of copper, with the drop being dose-dependent. Thus, both the absolute and relative rates of weight growth decreased dramatically when copper levels rose. Additionally, measures of liver size relative to body weight and general fish health, the hepatosomatic index (HSI) and condition factor (CF), showed a decrease with increasing copper exposure, indicating physiological stress. The negative effects of high copper levels on Rohtee Ogilbii's development and health parameters were shown by statistical analysis, which included ANOVA and Duncan's multiple range tests, which verified statistically significant differences among treatment groups ($p < 0.05$).

Table 2: Effect of different Copper sulfate on accumulation of copper in tissues of Rohtee Ogilbii

Parameters		Doses of copper sulfate		
	Control (Mean ± SD)	25 µg/L (Mean ± SD)	50 µg/L (Mean ± SD)	75 µg/L (Mean ± SD)
Liver	144.3 ± 4.5	166.3 ± 3.4	182.2 ± 2.5	221.4 ± 11.9
Gills	44.02 ± 3.3	67.05 ± 1.0	73.5 ± 2.3	75.9 ± 3.1
Kidney	27.14 ± 2.2	44.3 ± 4.3	55.4 ± 1.7	53.7 ± 3.2
Muscle	14.79 ± 0.4	31.2 ± 1.7	37.2 ± 1.7	36.03 ± 3.4

Rohtee Ogilbii fish treated to varying amounts of copper sulfate accumulated copper in various tissues, as seen in the table. A control group was given dechlorinated tap water, while three groups were exposed to copper sulfate doses of 25 µg/L, 50 µg/L, and 75 µg/L. The four experimental groups were evaluated by analyzing tissue samples from the liver, gills, kidney, and muscle. As the exposure concentration increases, the data reveal that copper accumulation across all organs increases in a dose-dependent manner. Copper levels in the liver varied from 144.3 µg/g in the control group to 221.4 µg/g in the highest treatment group, suggesting a considerable buildup in this crucial organ that is in charge of detoxification and metabolism. Similarly, copper levels in the gills, kidneys, and muscle tissues increased as the exposure concentrations did, but to different degrees. The significance of these differences ($p < 0.05$) across treatment groups would be confirmed by statistical analysis, which would probably include ANOVA and Duncan's multiple range tests.

V. CONCLUSION

The research highlights the serious ecological consequences of copper pollution in freshwater ecosystems by studying the impact of copper sulfate exposure on growth metrics and tissue health in Rohtee Ogilbii. Results show that Rohtee Ogilbii's growth performance is negatively affected by copper sulfate exposure, as seen by lower weight gain and changes in condition factor (CF) and hepatosomatic index (HSI) at increasing concentrations of exposure. Potential long-term effects on fish populations and ecological dynamics may be suggested by these physiological alterations, which emphasize the susceptibility of Rohtee Ogilbii to copper poisoning. The research also shows that copper accumulates in Rohtee Ogilbii organs, namely in the kidney, liver, gills, and muscles after exposure to high amounts of copper sulfate. There is a threat to the health and survival of fish in polluted environments due to the fact that elevated copper levels in these tissues may cause cellular damage, oxidative stress, and decreased organ function.

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