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EFFECT OF COPPER ON FISH TESTIS

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Abstract

Copper is a vital trace element that plays an important role in many biological functions in both humans and fish, such as helping with enzymes activity. Oxygen transport, and energy production. However, when copper levels get too high, often due to pollution from industrial runoff, mining or agriculture, it can become toxic, especially to fish. The testisresponsible for sperm production and male fertility is highly sensitive to toxicants like copper. Research indicates that prolonged exposure to elevated copper levels can lead to oxidative stress, testicular histopathology, reduced sperm quality, and hormonal imbalances.Understanding these effects is crucial for sustainable aquaculture and environmental conservation.

Keywords: Copper toxicity, Testis damage, Oxidative stress, Environmental pollution, Fish health.

Introduction:

Copper is a naturally occurring trace element essentials for various biological functions in aquatic organisms, including enzyme activity, immune response and growth. Copper exposure adversely affected fish survival, growth and reproduction with maximum acceptable toxicant concentration (M A T C) for reproductive impairment identified (Horning *et al*., 1979). Since heavy metal pollution in rivers is continuously rising every year worldwide, it has been noted as a major problem. This results from the release of contaminants into the aquatic system either directly or indirectly from human-caused processes such as dissolving of minerals, soil erosion other sources of mining, agricultural, and industrial waste. The ecological balance of several systems has been

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upset as a result (Joshi, 2011). Copper's impact can be made worse by environmental factors like temperature, pH, and the presence of other pollutants like pesticides and heavy metals (Malhotra *et al*., 2020).

All living things are at risk from heavy metal contamination, including humans and marine life according to Ashraf *et al*., (2012), aquatic systems are particularly vulnerable to heavy metal pollution, and the concentration of these metals in aquatic ecosystems is increasing as a result of human activity. Fish are highly valuable aquatic organisms that react to changes in their environment. As a result, it is ideal for use as an indicator in pollution study. Additionally, fish is an excellent bioaccumulation since it is easy to get in large quantities for the purpose of sampling for deposited metals, has a long lifespan, and is the ideal size for analysis (Batvari*et al*., 2008; Ashraf *et al*., 2012). The process by which chemicals enter an organism by contact to a contaminated medium or ingestion of food containing the chemicals is known as bioaccumulation, according to Perera*et al*. (2015).

An important trace element required for the regular development and metabolism of living things is copper. If this element is utilized excessively, it can become extremely hazardous and transform into continuous metal compounds that can build up in water and upset the biological system.The rise in environmental contamination may potentially have an impact on aquaculture activities.Due to its toxicity, which can be examined at the organism's molecular and structural level, copper has been shown to have the potential to negatively impact fish. This is due to the fact that fish are among the aquatic species that have the capacity to store heavy metals within their tissues.In general, a number of parameters, including metal concentration, exposure methods for absorbing metals, external elements (pH, water temperature), and internal factors (fish size, age), duration, influence this accumulation (Padrilah*et al*., 2018).

Fish typically experience bioaccumulation when exposed to chemical contaminants, such as heavy metals, particularly copper. After the fishes body has been exposed to the chemical contaminants, they can impair and harm the relevant mechanism, resulting in changes to the fishes physiology, pathology, and biochemistry. Furthermore, toxic forms of copper may act as stressors for fish, causing several biological functions to be inhibited and histopathological changes to occur by Sabullah*et al*., (2014). The impact of copper on enzyme activities in fish sperm, revealing that copper notably inhibits acid phosphate, while copper having varying effects. The findings indicate significant disruption of sperm enzymatic functions due to heavy metals exposure highlighting potential reproductive risks (Farrag *et al*., 2004). Furthermore, emerging concerns around copper nanoparticles, which are increasingly found in aquatic environments, suggests that these may cause even more severe damage than traditional copper ions, adding complexity to the toxic effects (Alavi*et al*., 2008).

Review of literature:

Copper poisoning could affect cellular architecture and metabolic processes. "Fish Spermatology" is the first comprehensive volume dedicated to the germ cell of male fish, focusing on spermatogenesis and sperm biology in fish review by **Monteiro *et al*., (2012)**. The impact of anthropogenic pollutants on the reproductive health of fish, highlighting the detrimental effects of heavy metals and endocrine disruptors on reproduction, embryonic development, and larval survival. Findings suggest that these pollutants lead to germ cell degeneration and reproductive abnormalities, underscoring the urgent need for monitoring and conservation efforts to protect this species examined by **Sambroni*et al*., (2013)**.

Khalek *et al*., (2012), observed the impact of hazardous waste discharge into river on the health of fish revealing significant oxidative damage and testicular dysfunction linked to metal bioaccumulation. Increased histological alterations and disrupted antioxidant activity in fish exposed to contaminated water highlight the severe consequences of anthropogenic pollution on aquatic ecosystems. Polluted water affecting the reproductive health of fish with significant histological damage observed in both testes and ovaries.

Oda*et al*., (2022), reviewed that the synergistic effects of carbofuran and copper sulphate on male fertility, revealing significant reproductive impairment and testicular damage from both individual and combined exposure. Findings indicate increased oxidative stress and reduced sperm quality, particularly in the group exposed to both chemicals.

The impact of heavy metals on the reproductive health of fish revealing significant tissue damage and hormonal alterations in fish from the more polluted sites.Findings indicate increased oxidative stress and reproductive abnormalities particularly in testicular tissues linked to higher concentration**(Bhat*et al*., 2023)** The effects of copper on sperm steroidogenesis in fish indicating that low level pollutant can impair fish fecundity by accumulating in reproductive organs. The activity of the hydroxy steroids dehydrogenase enzyme in sperm serves as a reliable indicator of water contamination, revealing significant differences in enzymes activity based on metal exposurereviewed by **Prayogo*et al*., (2024).**

Marquez *et al*., (2019); Hayati *et al*., (2019);Zebral*et al*., (2019), examined that spermatogenesis is the process through which a small number of diploid stem cells (spermatogonia) produce a large number of highly differentiated spermatozoa with a haploid, recombined genome and a structurally complete flagellum,heavy metals have an impact on the generation of sperm. Numerous fish species gonads have been discovered to be histologically damaged by heavy metals **(Zulfahmi*et al*., 2018; Garriz*et al*., 2019).**

Pyknotic cells in the *Channa punctatus* testis in all heavy metal treatments investigated, pyknotic cells among spermatogonia have been shown to be a sign of sterility-causing germinal cell degeneration observed by researcher **Gárriz*et al*., (2017).**In *Channa punctatus* testis histological studies showed cell pyknosis, stromal hemorrhage, bursting, vacuolization, inflammation and

necrosis after treatment of copper sulphate as comparison to control in which spermatozoa and testicular lobules are proper **(Ratn et al., 2023).**

Shrivastav *et al*., (2023), observed that the effects of copper sulfate after exposure on the gonads, muscle, and heart of fish. Fish were exposed to 0.40 mg/L copper sulfate, and significant organ-specific damage was observed after 7, 14, and 21 days. These alterations serve as structural indicators for assessing copper contamination in aquatic environments. The results mentioned the need forbetter management of aquatic ecosystems impacted by copper pollution.

Copper on reproductive toxicity of fish *channas punctata* reviewed oxide nanoparticles (CuO NPs) in fish at low concentrations. Exposure led to gonadal damage, hormonal imbalances with increased 17β-estradiol (E2) and decreased testosterone (T), and altered gene expression along the hypothalamic-pituitary-gonadal (HPG) axis. These findings highlight CuO NPs' potential to disrupt endocrine function and gonad development in fish. The study provides valuable data for evaluating the environmental safety of nanoparticles.**(Guizhu*et al*., 2023).**

Prayogo*et al*., (2024),examined on the effects of copper on sperm steroidogenesis in fish indicating that low level pollutant can impair fish fecundity by accumulating in reproductive organs. The activity of the hydroxy steroids dehydrogenase enzyme in sperm serves as a reliable indicator of water contamination, revealing significant differences in enzymes activity based on metal exposure.

Conclusion:

While copper is an essentialmicronutrients, excessive exposure has detrimental effects on the testis of fish impairing spermatogenesis, causing oxidative stress, and altering hormone levels. These reproductive impairments threaten both aquaculture productivity and the ecological balance of freshwater ecosystems. Other environmental factors, like water pH and pollution from different sources can make copper copper's harmful effects worse, threating the health of fish population.

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