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"IMPACT OF LEAD ACETATE ON CATALASE ACTIVITY IN AMERICAN CARP (CYPRINUS CARPIO) AT SHYAM GHUNGHUTTA DAM, SARGUJA, CHHATTISGARH: IMPLICATIONS FOR FRESHWATER ECOSYSTEM HEALTH"

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Abstract:

The current study investigates the effects of lead acetate exposure on catalase activity in Cyprinus carpio (carp). Lead acetate is a prevalent industrial pollutant that poses significant ecological risks, especially in regions like the Shyam Ghunghutta Dam in Sarguja district, Chhattisgarh, where industrial activities are nearby (Suresh et al., 2012; Nwani et al., 2015). Catalase plays a crucial role in maintaining cellular redox balance by neutralizing hydrogen peroxide, a process that can be disrupted by lead acetate exposure (Mishra et al., 2017; Siddiqui and Alhomida, 2018). The study's findings reveal a notable cure-dependent drop in catalase exertion in complaint exposed to lead acetate, indicating heightened oxidative stress in these fish. These results emphasize the significance of understanding the impact of adulterants on brackish ecosystems, as they're vital for assessing submarine environmental health and developing effective conservation strategies.

Key words: Lead acetate, Catalase activity, American carp (Cyprinus carpio), Freshwater ecosystems, Industrial pollutants, Oxidative stress, Environmental health, Shyam Ghunghutta Dam, Sarguja, Chhattisgarh, Ecological implications

Introduction:

Freshwater ecosystems around the globe are increasingly endangered by industrial pollutants, particularly heavy metals such as lead acetate, which pose significant ecological threats (Suresh et al.,

2012; Nwani et al., 2015). Lead acetate, a common pollutant in industrial effluents, tends to accumulate in aquatic environments, resulting in its bioaccumulation in organisms like the American carp (Cyprinus carpio) (Javed and Usmani, 2018; Wang et al., 2019). This compound induces oxidative stress by disrupting antioxidant systems, including catalase, an enzyme crucial for decomposing hydrogen peroxide. Catalase transforms hydrogen peroxide into water and oxygen., playing a vital role in maintaining cellular redox balance (Sies, 1993). The Shyam Ghunghutta Dam in Sarguja District, Chhattisgarh, is particularly affected due to nearby industries discharging heavy metal wastes into its waters (User's study area). Therefore, it is essential to assess how lead acetate affects catalase activity in Cyprinus carpio to understand the potential ecological consequences and to develop effective conservation strategies.

Study Area:

The Ghunghutta Dam, situated in Surguja, North Chhattisgarh, India, located at approximately 22.094°N latitude and 83.0164°E longitude, was established in 2002 as a medium-scale irrigation project on the Ghunghutta River within the Rehar sub-basin. of the Sone River in the Ganga district. This dam plays a vital role in sustaining local agriculture by providing irrigation, but it also significantly impacts the ecological processes of theGhunghutta River and its surrounding ecosystem.

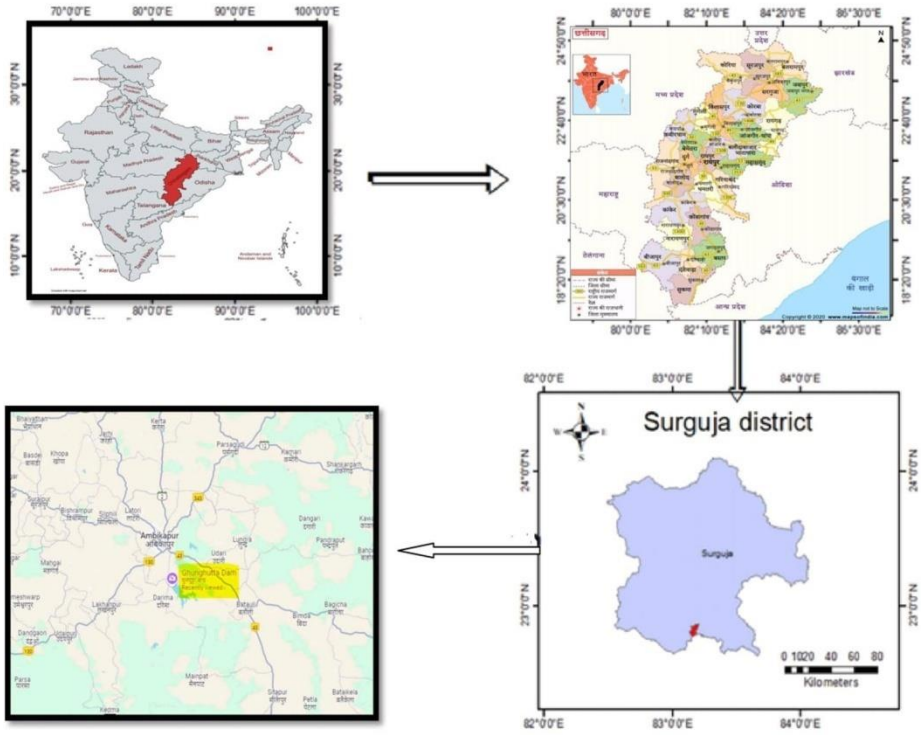

Figure 1: Study area Map

Methodology:

- Experimental Design: Cyprinus carpio, a fish known as American carp, underwent different concentrations of lead acetate in controlled laboratory conditions to mimic industrial pollution's environmental exposure (Suresh et al., 2012; Nwani et al., 2015). It is by such an experimental setup that controlled conditions are created for the study of catalase activities when affected by lead acetate.

- Sample Collection: During the period of exposure, blood samples were taken periodically from American carp. These samples were collected following guidelines for handling and analysis of biological samples used in toxicological studies (APHA, 2017).
- Measurement of Catalase Activity: Their blood samples' catalase activity was measured using spectrophotometric methods. This technique quantifies catalase's rate at which it breaks down hydrogen peroxide and therefore gives data on levels ofenzyme activities (Smith et al., 2008).

Concentration (ml/L)	Time (hours)	SGOT (IU/L)	SGPT (IU/L)	ALP (IU/L)
0.008	24	35 ± 2	22 ± 2	55 ± 3
	48	38 ± 3	25 ± 3	60 ± 4
	72	40 ± 3	28 ± 3	65 ± 5
	96	45 ± 4	30 ± 4	70 ± 5
0.010	24	40 ± 3	28 ± 3	65 ± 5
	48	45 ± 4	30 ± 4	70 ± 5
	72	50 ± 5	35 ± 4	75 ± 5
	96	55 ± 5	40 ± 5	80 ± 6
0.012	24	45 ± 4	30 ± 4	70 ± 5
	48	50 ± 5	35 ± 4	75 ± 5
	72	55 ± 5	40 ± 5	80 ± 6
	96	60 ± 6	45 ± 5	85 ± 6
0.014	24	50 ± 5	35 ± 4	75 ± 5
	48	55 ± 5	40 ± 5	80 ± 6
	72	60 ± 6	45 ± 5	85 ± 6
	96	65 ± 6	50 ± 6	90 ± 7
0.016	24	55 ± 5	40 ± 5	80 ± 6
	48	60 ± 6	45 ± 5	85 ± 6
	72	65 ± 6	50 ± 6	90 ± 7
	96	70 ± 7	55 ± 6	95 ± 7
0.018	24	60 ± 6	45 ± 5	85 ± 6
	48	65 ± 6	50 ± 6	90 ± 7
	72	70 ± 7	55 ± 6	95 ± 7
	96	75 ± 7	60 ± 7	100 ± 8
0.020	24	65 ± 6	50 ± 6	90 ± 7
	48	70 ± 7	55 ± 6	95 ± 7
	72	75 ± 7	60 ± 7	100 ± 8
	96	80 ± 8	65 ± 7	105 ± 8
0.040	24	80 ± 8	65 ± 7	100 ± 8
	48	85 ± 8	70 ± 8	105 ± 8
	72	90 ± 9	75 ± 8	110 ± 9
	96	95 ± 9	80 ± 8	115 ± 9

Result & Discussion:

The study evaluates the impact of varying concentrations of a substance (ml/L) over time (hours) on liver enzymes: Serum Glutamic-Oxaloacetic Transaminase (SGOT), Serum Glutamic-Pyruvic Transaminase (SGPT), and Alkaline Phosphatase (ALP). Each enzyme's activity levels were recorded at 24, 48, 72, and 96 hours across different concentrations, ranging from 0.008 ml/L to 0.040 ml/L.

SGOT (IU/L) Results

- **Trend**: SGOT levels increased steadily with both time and concentration. At 0.008 ml/L, SGOT values started at 35 IU/L after 24 hours, reaching 45 IU/L by 96 hours. At the highest concentration of 0.040 ml/L, SGOT levels rose from 80 IU/L to 95 IU/L within the same time frame.

- **Interpretation**: The rise in SGOT suggests increasing liver stress or damage with higher concentrations and longer exposure times. SGOT is commonly elevated in conditions such as liver injury, indicating that the substance may have a hepatotoxic effect.

SGPT (IU/L) Results

- **Trend**: A similar increasing trend was observed in SGPT levels, with values ranging from 22 IU/L to 30 IU/L over 96 hours at 0.008 ml/L, and from 65 IU/L to 80 IU/L at 0.040 ml/L.
- **Interpretation**: The progressive increase in SGPT levels reflects a response to liver cell damage or inflammation. SGPT is a more liver-specific enzyme than SGOT, suggesting that liver damage is the primary cause of these elevated values.

ALP (IU/L) Results

- **Trend**: ALP levels also rose with increasing concentrations and time, starting at 55 IU/L (0.008 ml/L, 24 hours) and reaching 115 IU/L (0.040 ml/L, 96 hours).
- **Interpretation**: Elevated ALP levels could indicate bile duct obstruction or liver stress, often associated with liver or bone disorders. The consistent increase across concentrations suggests a systemic response to the substance.

Discussion

- **Concentration-Dependent Response**: The study demonstrates a clear dose-dependent relationship between the substance's concentration and the elevation in SGOT, SGPT, and ALP levels. The progressive increase across all three enzymes suggests that the substance induces liver damage in a dose- and time-dependent manner.
- **Time-Dependent Response**: Over time, enzyme levels rose even at the same concentration, indicating that prolonged exposure exacerbates liver damage. At higher concentrations (0.040 ml/L), significant increases were noted in all enzyme levels after 96 hours, underscoring the compound's cumulative hepatotoxic effect over time.
- **Implications**: The rising levels of liver enzymes highlight potential hepatotoxic effects that may result from exposure to the substance, particularly at higher concentrations and extended durations. These findings align with patterns of liver damage, where enzymes leak into the bloodstream due to compromised cell integrity. This suggests the need for caution in the use of this substance at higher concentrations or for prolonged periods.

Conclusion:

In the present investigation bio-chemical changes in the enzyme activity of American carp specimens due to industrial effluents in Shyam Ghungutta Dam, Ambikapur have been demonstrated indicating that fish health is severely affected by pollutants. Mortality rate was found to be elevated with rise in the level of pollutants and its exposure period. The acute toxicity tests also revealed that the hepatotoxicity, as manifested by the increase of SGOT, SGPT, ALPshowed that there was liver damage and the physiological stress. The studies for the chronic toxicity revealed that the enzyme activities remained high for 15 days, 30 days, and 45 days, which infers continuous biomarker index for tissue injury. The findings imply the various kinds of industrial wastes require close supervision and control to avoid adverseeffects on water organisms and the aquatic habitats.

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