THE EFFECT OF METAL IONS ON CATALASE ENZYME REACTIONS

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BACKGROUND

Catalase is an enzyme present in liver tissue. It breaks down Hydrogen peroxide into H2O and Oxygen gas.

This gas production, measured as foam height, is used as a measure of catalase activity in this experiment.This investigation looks at how different metal ions can affect catalase activity.

THE QUESTION

How do different metal ions affect Catalase activity in the breakdown of Hydrogen Peroxide?

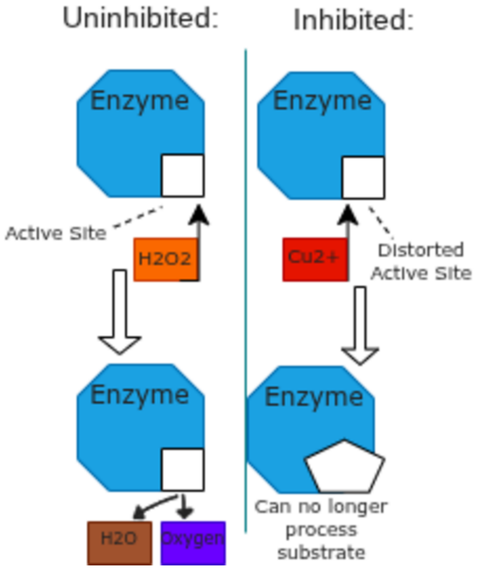
THE AIM

To investigate how different metal ions influence catalase activity by measuring resultant foam height.

HYPOTHESIS

If different metal ions are added to catalase then catalase activity will fluctuate because some ions may inhibit or others stabilise the enzyme's active site and structure.

FIGURE 1. SIMPLIFIED REPRESENTATION OF ENZYME INHIBITION



DISCUSSION

Copper sulfate strongly inhibited catalase, resulting in the lowest foam height, which served as an indirect measure of oxygen production and enzyme activity rates. Other metals also had varying effects, with **Sodium Chloride** increasing the reaction compared to the control. These results support the hypothesis that different metal ions alter enzyme structure and substrate interactions. While multiple trials ensured data reliability, future investigations should utilize an oxygen sensor for more precise measurements.

THE BIG PICTURE

While this investigation was carried out in a school lab, the principles behind it are vital to modern biotechnology. Concepts like inhibition are essential for developing medicines, improving industrial processes, monitoring the environment and creating more efficient catalysts for future generations.

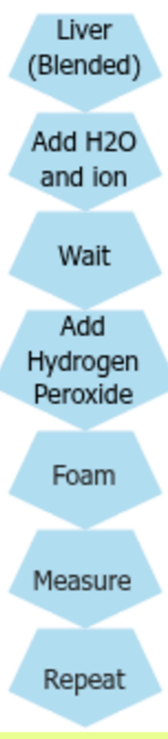
KEY FINDING:

Different metal ions affected catalase activity to varying degrees, with CuSO4 displaying the strongest inhibitory effect on the enzyme, and NaCl producing the highest enzyme activity.

CONCLUSION

This investigation demonstrated that various metal ions affect Catalase activity by altering conformation, enzyme structure and binding. **Copper Sulfate** exhibited the strongest observed inhibitory effect, possibly disrupting the active site, while **Sodium Chloride** appeared to optimise enzymatic activity. Principally the data can substantiate the hypothesis that different metal ions may inhibit or stabilise enzyme structure. Future iterations, however, may be improved by standardisation of ion concentrations along with the deployment of Oxygen sensors

METHODOLOGY



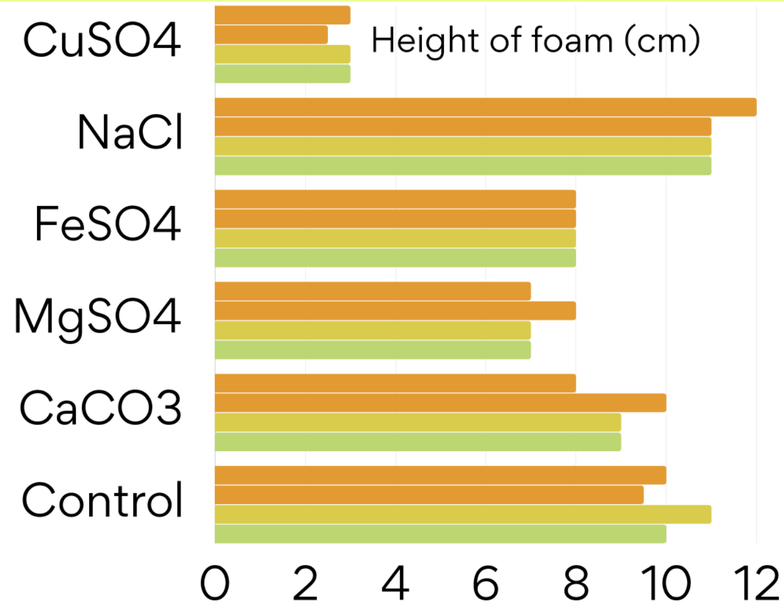


TABLE OF RESULTS

Ion / Trial no.	Control	CaCO3	MgSO4	FeSO4	NaCl	CuSO4
1	10	10	7	8	11.5	3
2	9.5	7.5	7.5	8	10.7	2.5
3	11	9	7.5	8	11	2.5
Avg.	10	9	7.5	8	11	2.7

REFERENCES & ACKNOWLEDGEMENTS

GÜLÜZAR ATLI, & MUSTAFA CANLI. (2007). ENZYMATIC RESPONSES TO METAL EXPOSURES IN A FRESHWATER FISH OREOCHROMIS NILOTICUS. COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY PART C TOXICOLOGY & PHARMACOLOGY, 145(2), 282–287. HTTPS://DOI.ORG/10.1016/J.CBPC.2006.12.012
HAO, F., JING, M., ZHAO, X., & LIU, R. (2015). SPECTROSCOPY, CALORIMETRY AND MOLECULAR SIMULATION STUDIES ON THE INTERACTION OF CATALASE WITH COPPER ION. JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY B: BIOLOGY, 143, 100–106. HTTPS://DOI.ORG/10.1016/J.JPHOTOBIOL.2015.01.003
HUSSEIN HADWAN, M., HASSAN ALTA'EE, A., MOHAMMED, R. M., HADWAN, A. M., SAAD AL-KAWAZ, H., & TALEBI, A. (2024). AN EFFICIENT PROTOCOL FOR QUANTIFYING CATALASE ACTIVITY IN BIOLOGICAL SAMPLES. BULLETIN OF THE NATIONAL RESEARCH CENTRE/BULLETIN OF THE NATIONAL RESEARCH CENTER, 48(1). HTTPS://DOI.ORG/10.1186/S42269-024-01189-Z
SHARMA, S., SAMAL, R. R., UMAKANTA SUBUDHI, & GAGAN B.N. CHAINY. (2018). LANTHANUM CHLORIDE-INDUCED CONFORMATIONAL CHANGES OF BOVINE LIVER CATALASE: A COMPUTATIONAL AND BIOPHYSICAL STUDY. INTERNATIONAL JOURNAL OF BIOLOGICAL MACROMOLECULES, 115, 853–860. HTTPS://DOI.ORG/10.1016/J.IJBIOMAC.2018.04.116

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