BIOINORGANIC CHEMISTRY OF MOLYBDENUM: ENZYMES, COMPLEXES AND MEDICAL SIGNIFICANCE

Ibragimova Firuza Farxodovna
Lecturer, Department of General Medicine,
Faculty of Therapeutics, Angren University
firuzaibragimova96@gmail.com

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Relevance. Molybdenum is one of the most important transition metals in bioinorganic chemistry due to its essential role in enzymatic systems. It is present in the active centers of several enzymes such as xanthine oxidase, aldehyde oxidase, and sulfite oxidase, which are involved in critical metabolic pathways including purine degradation, detoxification processes, and sulfur metabolism. The biological activity of these enzymes is directly dependent on the unique coordination environment of molybdenum.

Despite its low concentration in biological systems, molybdenum deficiency or dysfunction in molybdenum-dependent enzymes can lead to severe metabolic disorders. This highlights the medical significance of understanding its biochemical behavior. In addition, synthetic molybdenum complexes have gained increasing attention due to their structural similarity to natural enzyme centers and their potential pharmacological properties.

Recent studies in bioinorganic chemistry have shown that molybdenum complexes exhibit promising catalytic, redox, and biological activities. However, the relationship between structure, coordination environment, and biological function is still not fully understood. Therefore, further investigation is required to clarify the role of molybdenum in both natural enzymatic systems and synthetic coordination compounds.

The Purpose of the Study. The purpose of this study is to investigate the biological role of molybdenum in enzymatic systems and to analyze the structural and functional properties of molybdenum coordination complexes. The study also aims to evaluate the relationship between natural molybdenum-containing enzymes and synthetic complexes, with special attention to their potential medical applications.

Research Materials and Methods. The study is based on a comprehensive literature review of bioinorganic chemistry, enzymology, and coordination chemistry of molybdenum. Structural data of molybdenum-containing enzymes were analyzed using published crystallographic and spectroscopic studies. Comparative analysis was carried out between natural enzymatic systems and synthetic molybdenum complexes.

Spectroscopic methods such as UV-Vis, IR, and X-ray crystallography data from previous studies were used to examine coordination geometry and oxidation states of molybdenum. In addition, biochemical and pharmacological reports were reviewed to evaluate the medical relevance of molybdenum compounds.

Results and Discussion. The analysis shows that molybdenum exists in various oxidation states, most commonly Mo(VI) and Mo(IV), which are essential for its biological activity. In enzymes, molybdenum is coordinated with sulfur and oxygen donor atoms, forming complex active centers responsible for electron transfer reactions.

It was found that molybdenum enzymes play a key role in oxidative metabolism, particularly in detoxification of sulfites and metabolism of purines. Structural similarity between natural enzyme centers and synthetic molybdenum complexes suggests that coordination chemistry can be used to model biological systems effectively.

Furthermore, synthetic molybdenum complexes exhibit catalytic and redox properties that may be useful in medicinal chemistry. Some complexes

show potential antioxidant and enzyme-like activity, indicating possible applications in drug design and therapy.

However, the biological behavior of molybdenum complexes strongly depends on ligand type, coordination geometry, and oxidation state. This makes rational design of such compounds crucial for biomedical applications.

Conclusion. Molybdenum is a biologically essential element with a significant role in enzymatic reactions and metabolic processes. Its coordination chemistry provides a foundation for understanding both natural enzymatic systems and synthetic bioinorganic compounds.

The study confirms that molybdenum-containing enzymes are vital for maintaining metabolic balance, while synthetic molybdenum complexes demonstrate promising potential in biomedical applications. Further research is required to fully explore their pharmacological properties and therapeutic applications in medicine.

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