Synthesis and X-ray Study the Complexes of ATP with Sb(III) and Bi(III)

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Abstract: Interaction of antimony and bismuth ions with Adenosine 5'-triphosphate obtained complexes and X-ray method to explore these complexes.

Key words: Synthesis, X-ray, adenosine, antimony and bismuth complexes.

1. Introduction

Metal complex formation of nucleotides is well documented, as well as its biological importance. Metal-nucleotide complex may act as cofactor, substrate or modifier in promoting enzymatic catalysis of displacement reactions of phosphorus and maintaining structural integrity and specificity of nucleic acids. Nucleotides bind metal through three potential binding sites: phosphate groups, sugar hydroxyl groups and ring nitrogen of base [1-6].

Organic arsenicals were the first antimicrobial agents specifically synthesized for the treatment of infectious diseases such as syphilis and sleeping sickness.

The interaction of proteins with low molecular weight ligands—their natural substrates, inhibitors, signaling substances, cofactors underlies biochemical processes that support cellular activity. To understand the functioning of the mechanisms at the molecular level of proteins, as well as for rational design of new drugs process requires knowledge of their spatial structure in complexes with ligands.

The purpose of our work to obtain a complex of adenosine-5'-triphosphate with antimony and bismuth ions and X-ray method to explore these complexes.

2. Experimental

Antimony and bismuth ions were used as nitrate salts. 5'-ATP (adenosine 5'-triphosphate), was used as disodium salt. Interaction of antimony and bismuth salts with ATP was performed at room temperature.

3. Results and Discussion

The universal energy source for all biochemical processes in living systems is the ATP—adenosine triphosphate, in the molecule which contains three residues of phosphoric acid.

Hydrolysis of energy-rich ATP molecules linkages accompanied by cleavage of one or two residues of phosphoric acid leads to the release of energy, according to various sources, from 40 to 60 kJ/mol.

Arsenic, antimony and bismuth are constantly in living organisms, but their physiological role is practically not clear. Ions of As3+ and Sb3+ and less Bi3+ are synergistic. Arsenic and antimony are accumulated in the thyroid gland, inhibit its function, causing endemic goiter.

Arsenite [As(III)] is well known to exert mutagenic or carcinogenic effects. Arsenic (III) binds proteins...
with its cystine–SH group to DNA. Overall binding constant $K = 1.12 \times 10^4 \text{ M}^{-1}$ and exponential decay constant $T_1 = 271 \text{ s}$ for DNA-As(III) interaction were measured spectrophotometrically at $\lambda_{\text{max}} = 260 \text{ nm}$. FTIR (Fourier transform infrared) spectrometric method was used to characterize and determine the arsenite binding site in DNA-As(III) interaction. FTIR spectroscopic results showed that As(III) indirectly binds to the nitrogen bases of DNA and predominantly affected the H-bonded OH and NH bands, whereas no interaction was found with phosphate groups. No transitions from B to A or B to Z was observed in B-DNA structure [4].

The interaction of adenosine with uranyl ions is described by the Eqs. (1 and 2):

$$p\text{Sb}^{3+} + q(\text{ATP}^{4-}) + r\text{H}^+ \rightarrow (\text{Sb})_p(\text{ATP})_q\text{H}_r^{(2p - 4q + r)}$$  \hspace{1cm} (1)

$$p\text{Bi}^{3+} + q(\text{ATP}^{4-}) + r\text{H}^+ \rightarrow (\text{Bi})_p(\text{ATP})_q\text{H}_r^{(2p - 4q + r)}$$  \hspace{1cm} (2)

Analysis of the complex of adenosine with antimony and bismuth ions was performed by X-ray microanalysis. Instrument: electron probe microanalyzer. Brand: Superprobe 733, Japan Electron Optics Laboratories, Japan.

Fig. 1 shows the X-ray spectrum of antimony complex with adenosine 5′-triphosphate.

Fig. 2 shows the X-ray spectrum of bismuth complex with adenosine 5′-triphosphate.
Thus, we obtained a complex of adenosine with antimony and bismuth ions and X-ray method to explore these complexes.

4. Conclusion

Interaction of antimony and bismuth ions with ATP, was obtained a complex of adenosine-5'-triphosphate with antimony and bismuth and X-ray method to explore these complexes.

For the first time obtained X-ray diffraction characteristics of antimony and bismuth complexes with ATP. Demonstrated that ATP is able to complexes of bismuth and antimony in the oxidation of complex is +3.

New knowledge about the mechanism of action of the enzyme through the development and study of new types of non-protein systems modeling various aspects of the action of the enzyme.

References


