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PHYSICOCHEMICAL CHARACTERIZATION OF CHITOSAN-BASED COORDINATION COMPOUNDS

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Abstract

In this work, the synthesis of coordination compounds based on chitosan, which is a natural biopolymer, and their physicochemical properties were studied. Chitosan is understood as the property of a substance to work together with a living organism without causing harm, and simply put, if a substance does not harm the body, does not cause allergies, and is compatible with tissues, it is considered biocompatible, and due to its biodegradability and complex-forming properties, it is widely used in pharmaceuticals, medicine, and ecology. During the study, we studied the mechanism of complex formation of chitosan with metal ions, as well as the analysis of the solubility, thermal stability, and adsorption properties of the resulting compounds. The results obtained show that chitosan-based complexes are promising functional materials, as shown below.

Keywords: Chitosan, coordination compound, complex compounds, adsorption, metal ions, physicochemical properties.

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Introduction

Currently, in chemistry and various related fields of biotechnology, the creation of new materials based on natural polymers is considered one of the important scientific directions. In particular, biodegradable and non-toxic polymers are of great importance. One of such substances is chitosan, and chitosan is a natural polysaccharide obtained as a result of partial deacetylation of chitin. Chitin is found in large quantities in the shells of crustaceans, insect skeletons, and fungi.

The main properties of chitosan:

• Biological compatibility
• Biodegradability
• Non-toxicity
• Antibacterial properties
• Ability to bind metal ions

Due to the amine ($-NH_2$) and hydroxyl (-OH) groups present in the chitosan molecule, it forms coordination complexes with metal ions, and it is this property that makes chitosan an important material in the following fields:

- Medicine
- Pharmacy
- Ecology
- Biotechnology
- Analytical chemistry

The aim of the research is to synthesize coordination complex compounds based on chitosan and study their physicochemical properties.

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Research objectives

The following tasks were performed during the research:

- Obtaining complex compounds based on chitosan, studying the mechanism of binding with metal ions
- Determining the solubility of complexes
- Studying thermal stability
- Determining adsorption properties
- Evaluating physicochemical parameters

Chemical structure of chitosan

Chitosan is composed of D-glucosamine and N-acetyl-D-glucosamine residues linked by β-(1→4) bonds.

The general formula of the chitosan molecule is:

$(C_6H_{11}NO_4)n$

The important functional groups of chitosan are:

- Amine group ($-NH_2$)
- Hydroxyl group (-OH)

These groups form coordination bonds with metal ions via a donor-acceptor mechanism.

Synthesis of coordination compounds

Chitosan has the ability to form complexes with metal ions. Complexes are often obtained with the following metal ions:

- Cu^{2+}
- Zn^{2+}
- Fe^{3+}
- Co^{2+}

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• Ni^{2+}

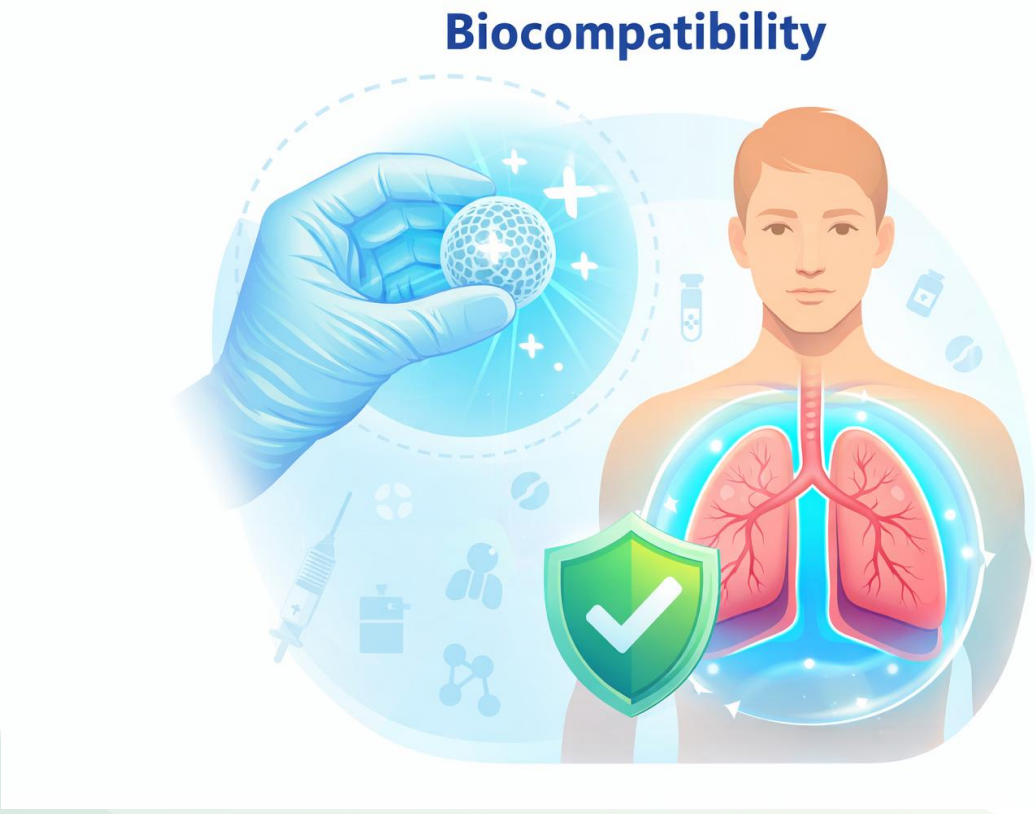
The general reaction of complex formation is:

Chitosan + Me^{2+} → Chitosan–Me complex

Where:

Me – metal ion

The amine groups of chitosan play a key role in complex formation.



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Physicochemical properties

Solubility

Chitosan is usually:

• Poorly soluble in water

• Well soluble in acidic media

After complexation:

• Solubility changes

• Chemical stability increases

Thermal properties of this process

Thermal analysis results show that:

Complex formation:

• Increases the decomposition temperature of the polymer

• Increases the structural strength

Adsorption properties

Chitosan complexes adsorb the following substances well:

• Heavy metal ions

• Organic dyes

• Toxic substances

This property is very important in ecology.

Spectral analysis

IR spectroscopy results:

When the complex is formed:

• The vibrational frequency of the NH group changes

• Metal bonding is observed

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This confirms the formation of a coordination bond.

Arias applications

Chitosan-based complexes are used in the following areas:

In medicine:

• Wound healing materials
• Antibacterial coatings
• Drug delivery systems

In ecology:

• Water purification
• Heavy metal ion absorption
• Filter materials

In pharmacy:

• Drug capsules
• Biopolymer membranes

In biotechnology:

• Enzyme immobilization
• Creation of biosensors

Research results

The conducted studies have shown that:

• Chitosan forms stable complexes with metal ions
• Complexes have high adsorption properties
• Thermal stability increases

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• Chemical activity increases

This allows them to be used as modern materials.

Conclusion

Coordination complexes based on chitosan have been found to have high biological and physicochemical properties. Complexing with metal ions significantly improves the functional properties of chitosan.

Chitosan complexes:

• Environmentally safe
• Biologically compatible
• Non-toxic
• Practically promising

In the future, these materials can be widely used in nanomaterials, biomedicine and environmental technologies, and many chitosan functions have been identified and are being used in many areas.

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