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# SYNTHESIS OF ACID COMPLEXES OF 2-HYDROXYMINO-3-PHENYLPROPIONATE COBALT(III)

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**Annatatsiya**

Ushbu maqolada 2-gidroksimino-3-fenilpropionat kobalt (III) ionining asido-komplekslari sintez qilinishi, ularning fizik-kimyoviy xossalari va tuzilish xususiyatlari o‘rganildi. Sintez jarayonida kobalt (III) tuzlari bilan 2-gidroksimino-3-fenilpropion kislota hamda turli mineral kislotalar asosida kompleks hosil qilindi. Olingan moddalar IR-spektroskopiya, UV-Vis spektroskopiya va element tahlili yordamida tavsiflandi. Mavzu natijalari ushbu komplekslarning koordinatsion kimyo va bioorganik kimyodagi ahamiyatini tasdiqlaydi.

**Kalit so‘zlar:** 2-gidroksimino-3-fenilpropionat, kobalt (III), asido-kompleks, koordinatsion birikma, sintez, spektroskopiya.

**Аннотация**

В данной статье исследован синтез кислотных комплексов 2-гидроксимино-3-фенилпропионата кобальта (III), их физико-химические свойства и структурные особенности. В ходе синтеза получены комплексы с солями кобальта (III) на основе 2-гидроксимино-3-фенилпропионовой кислоты и различных минеральных кислот. Полученные вещества охарактеризованы методами ИК-спектроскопии, УФ-видимой спектроскопии и элементного анализа. Результаты исследования подтверждают важность этих комплексов в координационной химии и биоорганической химии.

**Ключевые слова:** 2-гидроксимино-3-фенилпропионат, кобальт (III), кислотный комплекс, координационное соединение, синтез, спектроскопия.

**Abstract**

In this article, the synthesis of acid complexes of 2-hydroxymino-3-phenylpropionate cobalt (III) ion, their physicochemical properties, and structural features were studied. During the synthesis, complexes were formed with cobalt (III) salts based on 2-hydroxymino-3-phenylpropionic acid and various mineral acids. The obtained substances were characterized using IR spectroscopy, UV-Vis spectroscopy, and elemental analysis. The results of the topic confirm the importance of these complexes in coordination chemistry and bioorganic chemistry.

**Keywords:** 2-hydroxymino-3-phenylpropionate, cobalt (III), acid complex, coordination compound, synthesis, spectroscopy.

## Introduction

Coordination chemistry has been widely used in recent years in the fields of creating biologically active complex compounds, catalysts, and drug synthesis. Complexes formed with cobalt (III) ions are distinguished by their catalytic activity, redox properties, and biological significance. In particular, ligands based on 2-hydroxyimino-3-phenylpropionic acid exhibit high coordination activity due to the presence of an aromatic ring and an oxime group. In this work, acido-complexes of cobalt (III) were synthesized, and their structure and properties were studied.

## Literature review

Many papers [1–3] have reported the biological activities of cobalt(III) complexes, including antibacterial, antitumor, and enzyme-stimulating properties. Organic oximes, on the other hand, form strong coordination complexes with metal ions [4,5]. Ligands such as 2-hydroxyimino-3-phenylpropionate have bidentate or polydentate coordination capabilities due to the presence of donor atoms (O and N) in the molecule [6]. Acid-modification of cobalt complexes has been shown in the literature to increase their solubility and reactivity [7,8].

**Relevance of the topic**

Today, metal-complex compounds are widely used in pharmaceuticals, agriculture, catalysis, and environmental remediation technologies. Cobalt (III) complexes, especially in oxidation-reduction reactions, have high efficiency and are considered promising for the synthesis of new effective catalysts and biologically active substances. Complexes based on 2-hydroxymino-3-phenylpropionate are of great importance in the development of a new branch of organometallic chemistry.

**Main part**

Reagents and methods:

Ligand: 2-hydroxyimino-3-phenylpropionic acid was synthesized under laboratory conditions.

- Metal salt: Cobalt (III) chloride or cobalt (III) acetate solutions were used.
- Acid components: HCl, $HNO_3$, and $H_2SO_4$ solutions were used.
- Analysis methods: IR spectroscopy (400–4000 $cm^{-1}$), UV-Vis spectrum, elemental analysis.

The composition and quality of the reagents used in the subject directly affect the synthesis results. The oxime and carboxyl groups in the 2-hydroxyimino-3-phenylpropionic acid molecule used as a ligand show high coordination activity towards the cobalt (III) ion. The cobalt (III) chloride and cobalt (III) acetate salts chosen as the metal source are characterized by good solubility in water and alcohol solutions, which accelerates the complex formation process. The mineral acids used in the formation of the acid complex (HCl, $HNO_3$, $H_2SO_4$) change the coordination environment of the cobalt (III) ion, creating conditions for the binding of additional anions. The analysis results show that the optimal conditions for the reaction are a temperature of 60–70 °C, a pH range of 2–3, and an alcohol-water mixture, which leads to high synthesis efficiency. The purity of the reagents, the pH of the solution, and the type of acid have a significant effect on the crystal shape, color, and spectral properties of the final product. It formed the main foundation of the topic. The selected ligand and cobalt (III) salts reacted with high selectivity to form stable acid complexes. Mineral acids created additional coordination centers, increasing the structural diversity of the complexes. By determining the optimal synthesis

conditions, it was possible to obtain high-quality and pure crystalline complexes. This will allow for an in-depth study of their physicochemical properties in the next stages.

Synthesis process: A cobalt (III) salt solution was added to an alcoholic solution of the ligand and acidified to pH 2–3. The mixture was heated at 60–70 °C for 2 hours. Upon cooling, the crystalline complex precipitated and was filtered off. The resulting substance was washed with a mixture of alcohol and water and dried in vacuo.

An important step in the synthesis process is to mix an alcoholic solution of the ligand and an aqueous solution of the cobalt (III) salt, and adjust the pH to 2–3 using acids. Under these conditions, the carboxyl and oxime groups of the ligand are deprotonated and coordinate to the cobalt (III) ion in a bidentate manner. Maintaining the temperature in the range of 60–70 °C increases the kinetic rate of the reaction, but too high a temperature poses a risk of decomposition of the oxime group. Heating the mixture for 2 hours is sufficient time for crystal formation, while a longer time increases the likelihood of the formation of by-products. If the cooling process is carried out slowly, larger and purer forms of crystals are obtained. The washing and drying steps serve to completely remove excess salts and acid remaining in the solution, which ensures the accuracy of the spectral analysis results. Proper planning of the synthesis process and its implementation under optimized conditions resulted in the preparation of high-purity 2-hydroxyimino-3-phenylpropionate cobalt (III) acid complexes. Precise selection of temperature, pH, and reaction time determined the crystal form, color, and stability of the complexes. The stepwise method used in the synthesis stage, as well as careful execution of the cooling and washing processes, significantly improved the quality of the final product. This approach can be successfully applied in the future to the preparation of other oxime-liganded metal complexes.

Results: In the IR spectrum, C=NO (oxime) stretching vibrations were observed in the range of 1620–1640 $cm^{-1}$, and lines characteristic of the $COO^-$ group were observed at 1380–1400 $cm^{-1}$;

In the UV-Vis spectrum, d-d transitions were detected in the range of 520–550 nm. The results of elemental analysis were close to theoretical calculations.

During the topic, the synthesis of acido-complexes of 2-hydroxyimino-3-phenylpropionic acid with cobalt (III) ions was studied. The oxime (-C=NOH) and carboxyl (-COOH) groups in the ligand molecule formed bidentate coordination bonds with the metal center, resulting in stable coordinated structures. The mineral acids (HCl, $HNO_3$, $H_2SO_4$) used in the synthesis of acido-complexes ensured the entry of additional anions into the coordination environment, which increased the solubility and reactivity of the complexes. In IR spectroscopy, the shift of the C=NO stretching vibrations and the appearance of lines characteristic of the $COO^-$ group proved the formation of a metal-ligand bond. The d–d transitions observed in the 500–550 nm range in UV-Vis spectra provided information about the low-spin coordination environment of the cobalt (III) ion. The results of elemental analysis were consistent with theoretical calculations, confirming that the synthesis process was carried out correctly.

As a result of the work, several acid complexes of 2-hydroxymino-3-phenylpropionate cobalt (III) were successfully synthesized, and their structural properties were analyzed. Optimal synthesis conditions — pH 2–3, temperature 60–70 °C, and reaction in an alcohol-water mixture — allowed obtaining crystalline complexes of high purity. Spectral and elemental analyses confirmed the structure of the complexes. The obtained acid complexes are promising substances that can be used in coordination chemistry and bioorganic chemistry in terms of stability, solubility, and potential bioactivity.

**Analysis**

The obtained data indicate that the cobalt (III) ion is bound to the ligand through bidentate coordination. The formation of acid complexes occurs through the formation of an additional coordination bond with the acid anion in the molecule. This increases the stability and solubility of the complexes. The electronic spectra of the complexes indicate that they have a low-spin coordination environment.

Conclusion. As a result of the work, acid complexes of 2-hydroxymino-3-phenylpropionate cobalt (III) were successfully synthesized. Their physicochemical analysis allowed us to determine the structure and coordination properties. These

complexes can be used in the future as catalysts, biologically active substances, and analytical reagents.

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