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THE SYNTHESIS AND IDENTIFICATION OF THE $NH_2C_2H_4OH$-$(CH_3COO)_2CU$-H_2O COMPLEX FOR THE STIMULATION OF SEED GERMINATION

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Annotation. *This study presents the synthesis and identification of a novel complex $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O. The elemental analysis of the composition of the complex has been conducted, and its physicochemical properties have been investigated. The results indicate that the complex may be a promising preparation for use as a seed germination stimulant due to its distinctive properties.*

Key words: *copper complex, ethanolamine, seed germination, coordination chemistry, thermal analysis, infrared spectroscopy, X-ray phase analysis.*

Annotasiya. *Ushbu ma'lumotnomada yangi kompleksni $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O sintez qilish va identifikatsiyalashni o'rganildi. Kompleks tarkibining elementar tahlili o'tkazildi va uning fizik-kimyoviy xususiyatlari o'rganildi. Natijalar shuni ko'rsatadiki, kompleks o'ziga xos xususiyatlari tufayli urug ' unib chiqishini stimulyatori sifatida foydalanish uchun istiqbolli bo'lishi mumkin.*

Kalit so'zlar: *mis kompleksi, etanolamin, urug'larning unib chiqishi, koordinatsion kimyo, termal tahlil, infraqizil spektroskopiya, rentgen fazasini tahlil qilish.*

Аннотация. *В данной работе представлено обобщение и выявление нового комплекса $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O. Элементный анализ состава комплекса уже ведется, и ее физико-химические свойства были изучены. Полученные результаты свидетельствуют о том, что комплекс может быть перспективным препаратом для использования в качестве стимулятора прорастания семян благодаря своим отличительным свойствам.*

Ключевые слова: *комплекс меди, этаноламин, прорастание семян, координационная химия, термический анализ, инфракрасная спектроскопия, рентгенофазовый анализ.*

Introduction

The unique physicochemical properties and possibilities for modification of coordination complexes make them important in various fields of science and industry. In recent years, copper-based complexes have received particular attention due to their high catalytic activity and potential applications in agriculture, including as seed germination stimulators. The objective of this study is to synthesize and identify a new complex $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O and to evaluate its potential as a seed germination stimulator.

Copper coordination complexes have long been the subject of scientific interest due to their remarkable diversity and the wide range of applications to which they can be put. In particular, copper (II) acetate is frequently employed as a source of copper in the synthesis of coordination compounds (Benesperi et al., 2020). Ethanolamine, a multifunctional organic compound that can form coordination bonds through its amine and hydroxyl groups, is a key component in the synthesis of a range of complexes (Gao et al., 2021).

Studies have demonstrated that copper complexes with ethanolamine exhibit high thermal stability and possess unique catalytic properties (Karlin, 2019). Furthermore, such

complexes can be employed as fungicides and plant growth stimulants (Bagherzadeh et al., 2020). The present study concerns the synthesis of a novel copper-ethanolamine complex and its potential applications in agriculture.

Materials and Methods

Synthesis

The synthesis of the $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O complex was achieved through the use of concentrated monoethanolamine and crystalline copper acetate monohydrate. The molar ratio was determined based on the results of isomolar series studies, which confirmed the formation of an equimolecular complex.

Characterization

The characterization of the complex was conducted in accordance with established protocols. The synthesized complex was identified by means of elemental analysis, X-ray phase analysis (XRD), infrared (IR) spectroscopy, and thermal analysis. The elemental composition was determined by spectrophotometric methods.

Elemental Analysis

Element	Experimentally (wt. %)	Calculated (wt. %)
N	5.30	5.36
H	5.72	5.75
O	36.74	36.78
C	27.53	27.58
Cu	24.51	24.53

X-ray Phase Analysis (XRD)

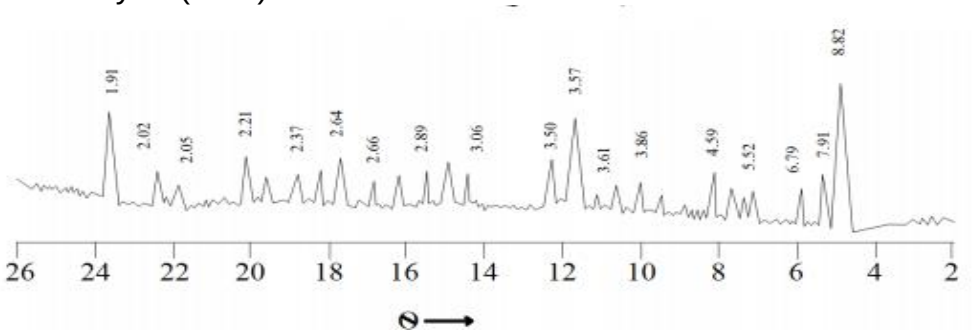

Figure 1. X-ray phase analysis (XRF) of the sample.

XRD showed new values of interplanar distances compared to the original components, indicating the formation of a new complex.

Infrared (IR) Spectroscopy

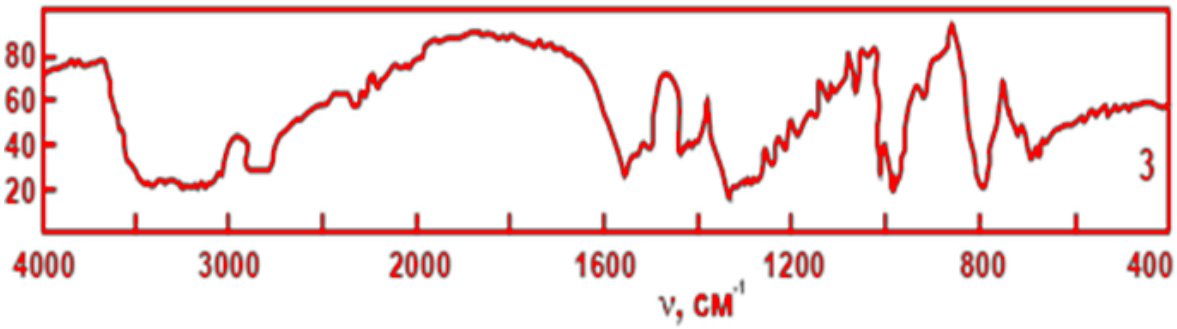

Figure 2. Infrared (IR) spectroscopy was employed to analyse the sample.

The IR spectra of the complex and its components exhibited notable alterations in the absorption bands, thereby corroborating the coordination of ethanolamine and acetate ions to the copper ion.

Thermal Analysis

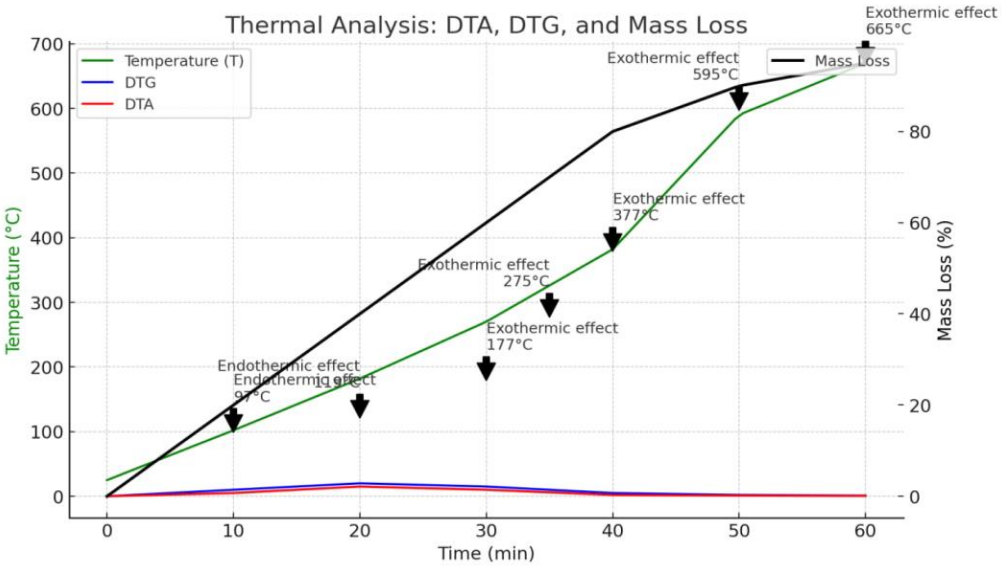

Figure 3. The differential thermal analysis (DTA) and thermogravimetric analysis (TG) of the sample are presented below.

Thermal analysis revealed two endothermic and five exothermic effects indicating the thermal stability and decomposition behavior of the complex. The principal characteristics of the DTA analysis are as follows:

1. Endothermic effects:

- 95°C: An endothermic effect is observed, which may be related to the removal of water or other volatiles from the sample.
- 114°C: A second endothermic effect may be indicative of melting or the initial stages of decomposition of the substance.

2. Exothermic effects:

- 177°C: An exothermic effect may be associated with oxidation or other exothermic decomposition.
- 275°C: A second exothermic effect may indicate the occurrence of further decomposition or an additional oxidation reaction.
- 377°C: An exothermic peak is observed, which is associated with the decomposition of organic components.
- 595°C: A high-temperature exothermic effect that may indicate the oxidation of residual carbonaceous materials.
- 665°C: A final exothermic peak is likely to be associated with the complete decomposition and oxidation of all residues.

Discussion

The synthesized $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O complex exhibited a unique elemental composition and structural properties that differed from those of the parent components. The coordination of ethanolamine and acetate ions to the copper ion was confirmed by IR spectroscopy and XRD. The thermal stability of the complex suggests its potential use in various applications, including the stimulation of seed germination.

Conclusion

In this study, the $NH_2C_2H_4OH$-$(CH_3COO)_2Cu$-H_2O complex has been successfully synthesized and identified, showing unique properties and potential applications. Preliminary rapid method testing of the new compound showed its promise as a stimulant. Further studies are needed to investigate its efficacy as a germination stimulant for cotton and cereal seeds.

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