ANTIFUNGAL ACTIVITY OF BIOGENIC METAL SALT COMPLEXES ($MnCL_2$, $ZnSO_4$) WITH AMINO ACIDS

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KEYWORDS

ABSTRACT:

The antifungal activity of complexes formed between biogenic metal salts ($MnCl_2$ and $ZnSO_4$) and amino acids (L-tryptophan) has garnered significant attention due to the combined effects of metal ions and amino acids on biological activity. The interaction between metal ions and amino acids can influence the stability and bioactivity of the resulting complexes, including their potential to inhibit fungal growth. Metal complexes may act synergistically with other antifungal agents, enhancing their efficacy. This synergy can arise from complementary mechanisms of action, such as disrupting fungal cell integrity while concurrently inhibiting key enzymatic functions.The findings show that the zinc and manganese complexes exhibited superior antibacterial activity compared to the tested standard, while the complex with tryptophan (Trp) exhibited satisfactory antifungal properties. This suggests that the complexes could potentially serve as novel active ingredients in dermatological products due to their promising antimicrobial effects. Further research and development could investigate their efficacy and safety in practical applications, particularly in the treatment of skin infections or as part of skin care formulations.

1.INTRODUCTION

The study of biogenic macro- and micronutrients has seen significant growth in recent decades, particularly regarding their roles in biochemical processes. One notable observation is that the effectiveness of these nutrients is often enhanced when they are used in combination with organic ligands, which can serve as metal-chelating agents[1-3]. These ligands bind to metal elements, facilitating their transport and enhancing their biological activity. This interaction is essential for creating drugs that effectively deliver these elements to their target sites within the body.In this context, organic ligands can play a pivotal role in connecting metal ions with specific elements, ensuring that they are in a bioavailable form that can be readily utilized by the organism. This has important implications for developing therapeutic agents that exploit these interactions. For example, many metal-amino acid complexes serve as models for understanding the biochemical processes that occur within living systems. Additionally, the therapeutic use of such complexes has been widely explored, as they can have a variety of beneficial effects when administered as medicines.Current scientific efforts are focused on further elucidating the composition and structure of these molecular and supramolecular complexes, aiming to better understand their mechanisms of action. Researchers are working to optimize the effectiveness of these compositions, ensuring that they are used in the most efficient way possible, whether for enhancing nutrient delivery, supporting metabolic processes, or developing new medicinal therapies. [4-22].

In this paper, we present methods of synthesis and study of the properties of $MnCL_2$, $ZnSO_4$complex with ligand (tryptophane) and their biological activity.

Physical measurements

The composition and chemical structure of the synthesis products obtained are studied by physical-chemical analysis methods: elemental analysis (İCP-MS); X-ray phase analysis (diffractometer (Germany) D-2 Phaser firm Bruker); IR spectroscopy ("Specord M-80" brand Carl Zeiss). The spectra of the reaction solutions in the IR and UV regions were recorded on the Nicolet IS10 spectrometer and the Evolution 60S spectrophotometer, manufactured by Thermo Scientific Spectronic (USA). Differential thermogravimetric analysis was performed on (NETZSCH STA 449F3 STA449FSA-0622-M)

Experimental part

Synthesis -[$ZnL_2(H_2O)_2$]

To a beige color solution obtained by dissolving 0.65 g (0.01 mole) – $ZnSO_4$in 20 ml of ethyl alcohol, 2.04 g (0.01 mole) of ligand L- tryptophan dissolved in 30 ml of ethyl alcohol (in a molar ratio 1: 1). The solution was heated for 2-2.5 hours at a temperature of 60 ° C. Further, the synthesis process was carried out according to the above described procedure. pH-7

Synthesis -[$MnL_2(H_2O)_2$]

The synthesis of a marqanes (II) complex with L- tryptophan was obtained by the method described above.

Results and conclusion

IR spectroscopy

To determine the coordination character of the synthesized complex compounds, IR (infrared) spectroscopic analysis is a useful technique. The infrared spectrum provides information about the vibrational modes of the molecules, which can be used to infer details about the bonding and structure of the complex.In the region of ν_{NH} = 3402.73 cm^{-1} of the tryptophan molecule, the absorption band of the valence vibration of the NH bond of the double amino group in the indole ring is observed. In the ν_{NH} = 3038 cm^{-1} region of the NH^{3+} band, the valence vibration of the NH bond and the valence vibration of the aromatic rings overlap. Vibrations the asymmetric valence of the C = O bond in the COO^- ion is observed at 1340,56 cm^{-1}(Fig 1).

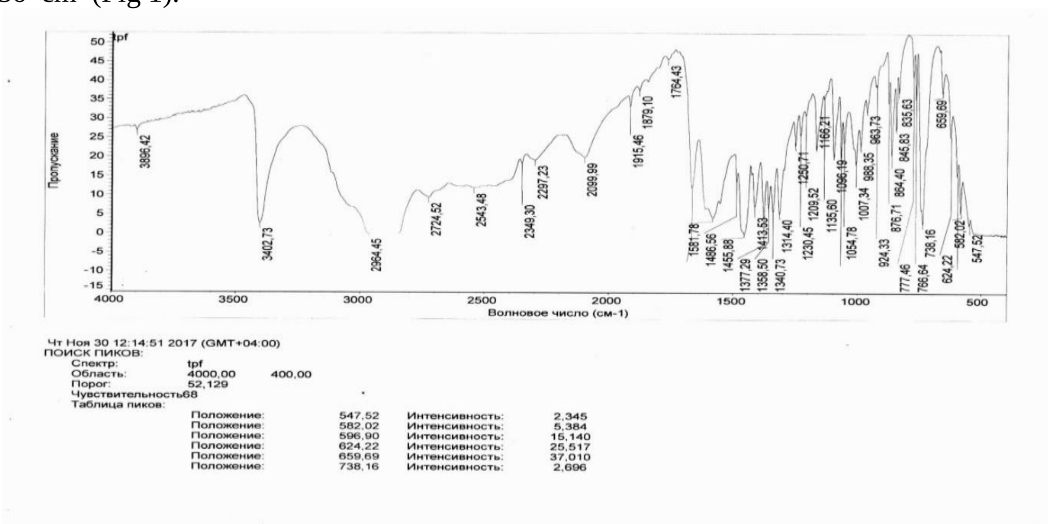

Figure1. IR spectra of tryptophan

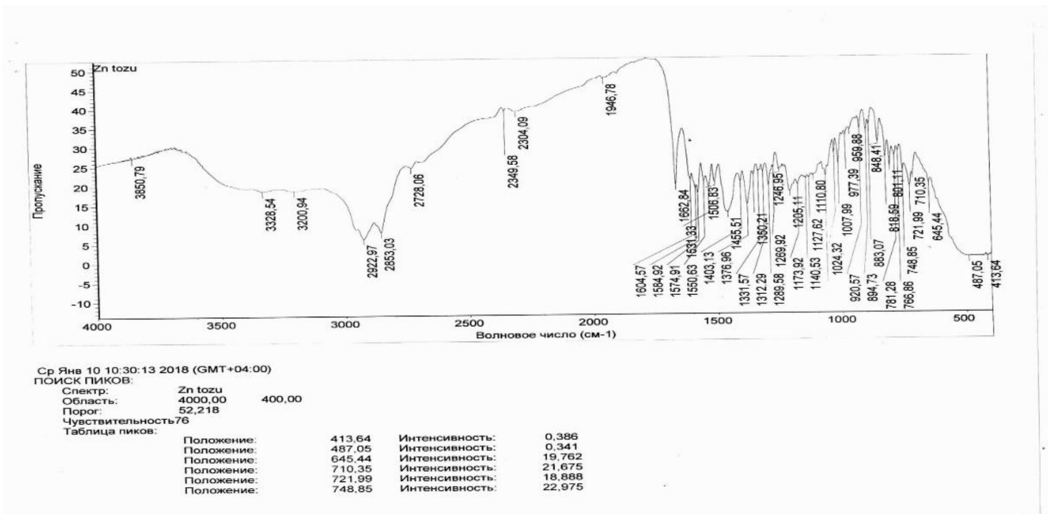

Figure2. IR spectra of complex [$ZnL_2(H_2O)_2$]

When the IR spectra of the free ligand are aligned with the spectra of the complexes obtained, an obvious change is observed. In the reaction of zinc with a tryptophan molecule, the double absorption bands of amine NH tryptophanν_{NH} = 3402, 73 cm-1 and δ_{NH} = 738.16 cm^{-1} disappear. A comparative analysis of the results of IR spectral analysis shows that a crystalline complex of the ionic type of tryptophan and Zn is synthesized(Fig2).

Figure 3. shows the result of X-ray phase analysis of the synthesis product. The interpretation of the obtained data also confirms the formation of the $[ZnL_2(H_2O)_2]$ complex (Fig3)**.**

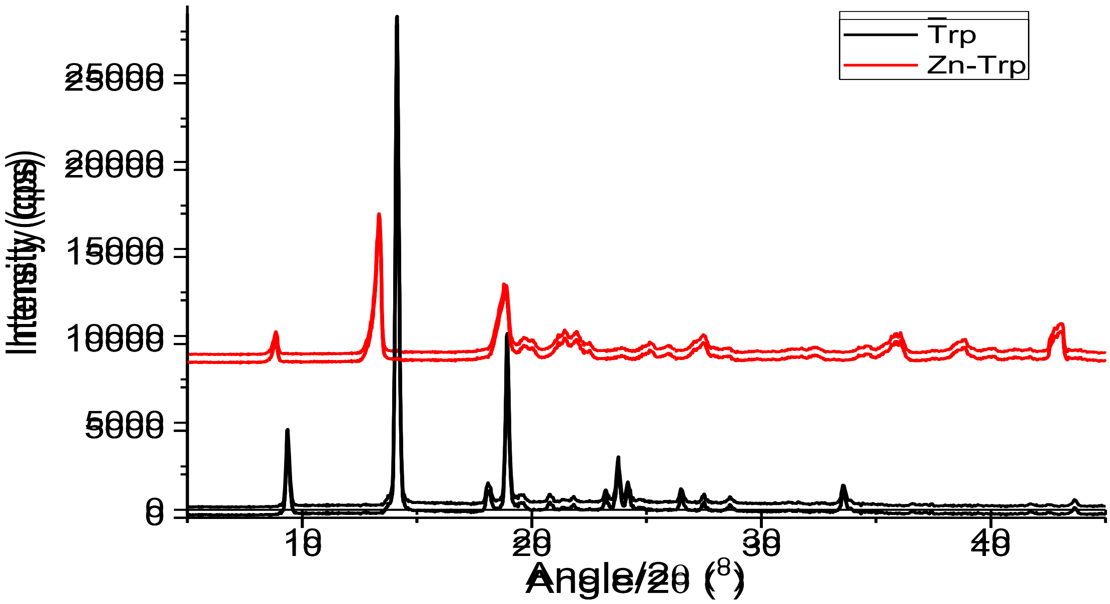

Figure3. Diffractogram of the complex $[ZnL_2(H_2O)_2]$

Since the parameters of the crystalline cell differ from each other, a coordination complex Zn-tryptophan was created. Tryptophan peaks did not appear in Zn- tryptophan, but almost all complexes were created.

Differential Scanning Calorimetry

With the definition of the thermic stability and the composition of synthesized complexes $[ZnL_2(H_2O)_2]$. the thermographic analysis was made (Fig4).

Thermocouples were used to determine the composition and durability of the synthesized complex compound and it was established that the complex is resistant to a temperature 298° C. At higher temperatures, the complex gradually breaks down, and this process ends in several stages, and in all cases the final product of the thermolysis process consists of metal oxides.

The statement you've provided suggests that the composition and structure of the complexes synthesized in the study are influenced by the proportion of the initial reactants. In other words, the results of the physico-chemical analyses indicate that varying the ratio of the starting materials leads to different outcomes in terms of the chemical composition and structural characteristics of the resulting complexes.

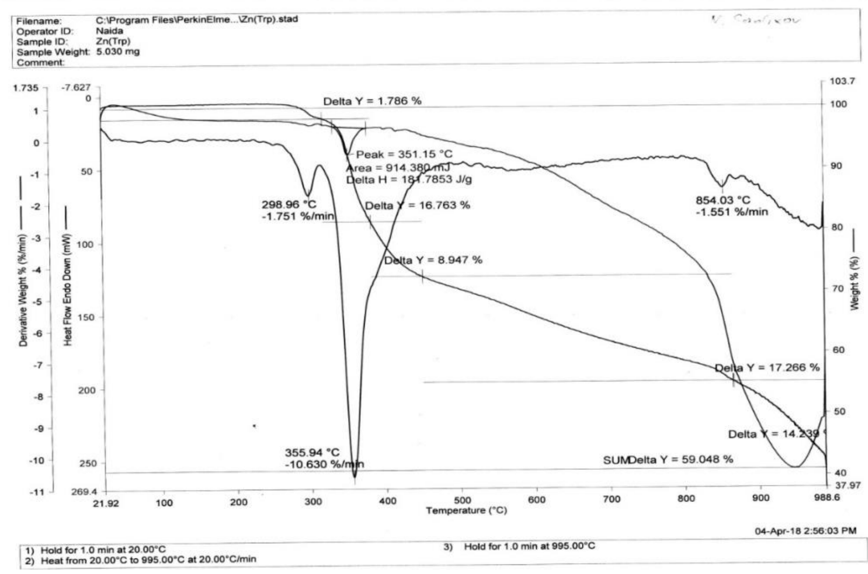

Figure4.Thermogravigram complex [$MnL_2(H_2O)_2$]

To determine the composition and thermal stability of the complexes under study, we performed elemental analysis, IR and UV-VIS spectral and thermogravimetric analysis. The results of the investigations showed that in all cases the final product of the thermal decomposition of the complexes is metal oxide. Thus, according to the results of the physico-chemical methods used in the work, it is established that the composition and structure of the obtained complexes directly depends on the ratio of the initial products.

UV-VIS spectroscopy

UV spectral analysis of the 0.01 M [$MnL_2(H_2O)_2$] complex was performed, which retained a water molecule. The pattern shows that the d-d transition has a wavelength of 480-560 nm (Fig 5).

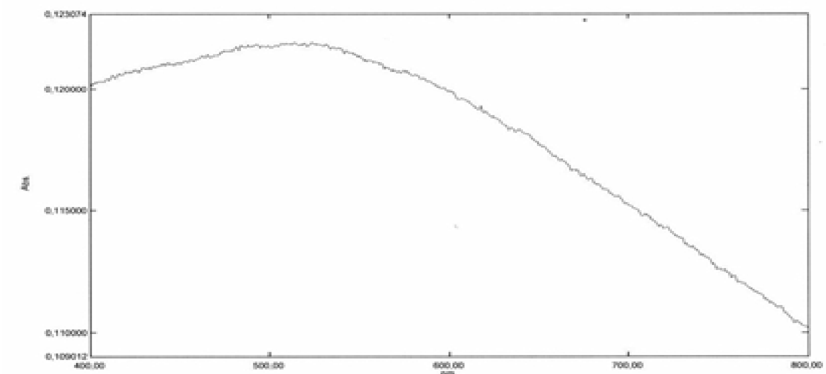

Figure5. Ultraviolet absorption spectrum of a 0.01 M solution of the [$MnL_2(H_2O)_2$] complex. (L-tryptophan)

Biological activity of complexes

Saburo agar was used as a nutrient medium when determining the antifungal activity of the complexes. At this time, a suspension prepared from the spores of fungi (E-soli) selected as a test culture was taken in a volume of 10.0 ml and placed in test tubes, a specific concentration (0.1%) solution of the corresponding complexes was added and kept for 30 minutes. After the end of the period, 1.0 ml of the solution in the test tube was separated and added to the nutrient medium and placed in a thermostat for cultivation. During the study, the presence or absence of growth was monitored for 5 days and the antifungal activity was visually assessed. When finding the optimal concentration of complexes of biologically active ligands of transition metal elements that cause antifungal activity, the studies were also conducted under the same conditions, but the concentration of the substance added to the spore

suspension was used in the interval of 0.01-1.0%. All experiments were carried out in at least 4 repetitions and the results obtained were studied from a statistical aspect based on scientific methods.
The antifungal activity of the [$MnL_2(H_2O)_2$] and [$ZnL_2(H_2O)_2$] complexes is given in the table below. (L-tryptophan) (M-Mn,Zn)(Table 1).

(Table 1).

№	*Testculture*	*L-tryptophan*	*of the lysis zonediametermm*
1	*E-soli*	(Zn)	**9**
2	*E-soli*	(Mn)	**12**
3	*E-soli*	kontrol (DMSO)	**6.4**

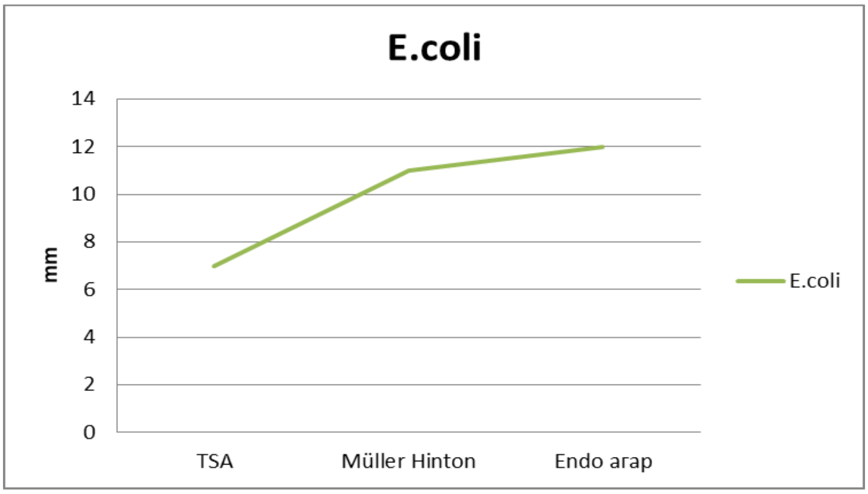

Figure 6. Graphical interpretation of the antifungal activity of the complexes

A graphical interpretation of the antifungal activity of the complexes is given in Figure 6. The results showed that the antifungal activity of the complex compounds [$MnL_2(H_2O)_2$] and [$ZnL_2(H_2O)_2$], under the influence of which the growth of fungi (E-soli) was tested, was either weakened or significantly inhibited, depending on the fungi used as the test culture. More precisely, depending on the chemical composition of the tested complexes and the biological properties of the test cultures, either a fungistatic or fungicidal effect on the growth of fungi was observed. The antifungal activity of the obtained complexes is given in (Table 1).

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