



SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL SCREENING OF NICKEL (II) AND COPPER (II) COMPLEXES

Abdullahi Mustapha¹, Maryam Rabi'u Bakori, Sa'adatu M. Eri.¹ and Aminu Ahmed²

¹Department of Chemistry Federal University Dutse, PMB 7156, Jigawa State, Nigeria

²Department of Chemistry Kano University of Science and Technology, Wudil Kano State Nigeria

ARTICLE INFO

Keywords:
synthesis,
characterization,
complexes,
antimicrobial

Correspondence author:
e-mail:
abmustapha2004@yahoo.
com

ABSTRACT

In this study, metal complexes of Nickel and Copper were synthesized and characterized using IR and UV Visible spectroscopy. Their decomposition temperatures and solubility in different solvents were also investigated. Both complexes were found to be insoluble in ethanol, chloroform, ethylacetate, n-hexane and benzene but soluble in dimethyl sulfoxide (DMSO) and nitro benzene. The melting points of the synthesized Nickel and copper complexes were 100°C and 140° C respectively. The IR spectra bands observed in all complexes indicated $\nu(\text{C-O})$ band for the two complexes as; 1600.57 cm^{-1} and 1550.43 cm^{-1} and (C-O) bands at 1240.63 cm^{-1} and 1050 cm^{-1} ; (C-H) bands were observed at 1400 cm^{-1} and 1470 cm^{-1} ; (M-O) at 880 cm^{-1} and 950 cm^{-1} (N-M) bands at 780 cm^{-1} and 790 cm^{-1} respectively for the Nickel and Copper complexes. Both synthesized complexes showed the highest antimicrobial activity against E. Coli and Aspergillus at their highest concentrations. The synthesized copper complex however had the best anti-microbial potential than the synthesized nickel complex and synthetic penicillin put together due to lower microbial activity when used in the highest prepared concentration: 0.21cm for the copper complex, 0.44cm and 0.45cm for the nickel complex and penicillin respectively against E-coli and the same trend was maintained for aspergillus. The synthesized copper complex also had the highest anti fungal inhibitory potential than the synthesized nickel complex and synthetic penicillin.

Introduction

Schiff base metal complexes have been widely studied because they have industrial, antifungal, antibacterial, anticancer, anti viral and herbicidal application. They serve as models for biologically important species and find application on biometric catalytic reactions (Adeola, 2009). Global scientists and their limit of research are in search for these complexes that will be of biological importance. Emerging bacteria resistance to synthetic antibiotics has necessitated the search for new molecules which inhibit bacterial activity (Supran et al,

2001). Some metal complexes derivatives show significant biological activity and which may represent an interesting research approach for designing new anti bacterial and anti fungal drugs. This may be possible due to the joint interaction between the metal ions and ligands at different phases of the life cycles of the disease pathogens (Travis, and Potempa , 2000).They exhibit higher absorption peak and slightly smaller intensities. This research work is aimed at synthesizing transition metal (Ni and Cu^{2+}) complexes with 1-10 phenanthroline and

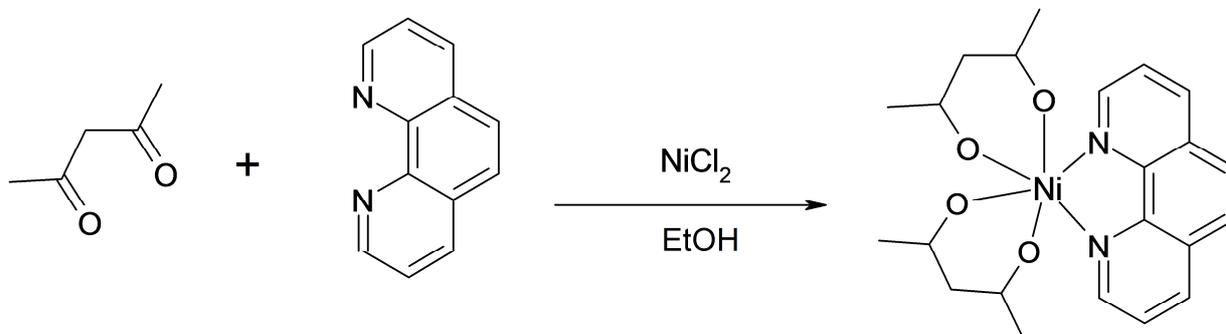
acetylacetonone and testing their anti
Techno Science Africa Journal Volume 10 Number 1

Although Industrial production and the use of Fe, Co, Cu, Ni, Zn, Cd, and Pb elements can cause environmental pollution, some of these metals are present in trace amounts as essential elements for biological systems and these metal ions also play an important role in bioinorganic chemistry. A recent study showed that Ni and Cu metal complexes have more anti fungal property than antibacterial property (Hakan et al., 2009). In order to understand the role of these metal ions in biological systems, structural studies of the biological compounds and their metal complexes are extremely important.

Experimental

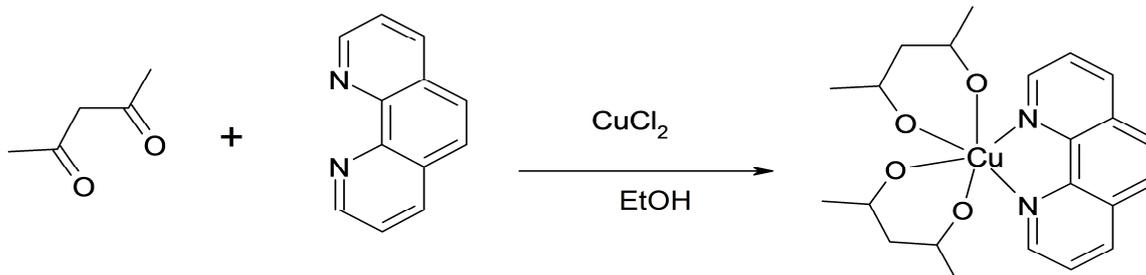
Synthesis of Nickel II Complex

Absolute ethanol (50cm³) was added to acetyl acetone (1g) in a 250cm³ round bottom flask and stirred, followed by the addition of 1-10 phenanthroline (1.97g) in the ratio of 2:1. The solution was kept at room temperature. Nickel (II) salt (2.3g) was dissolved in the mixture, and the mixture immediately turned to a pale green color. The coloured mixture was refluxed for 2 hours, allowed to cool and then the pale green coloured powder was collected by gravity.



Synthesis of Copper (II) Complex

The same procedure as above was followed in the preparation of the Cu(acac)₂ phen complex. The weight of the copper salt used for this preparation was 1.7g.



In vitro Antimicrobial Activity

Source of Microorganisms

The micro organisms used for this study (*E-coli* and *Aspergillus*) were obtained from the Biology Laboratory of Umaru Musa Yar'adua University (UMYU) Katsina.

Preparation of The Culture Medium

Nutrient Agar (N. A) and Potato Dextrose Agar (P. D. A) were prepared according to the method of Anacona and Gladdys., 2005.

Serial Dilution

Various concentrations of the synthesized complexes (1000µg/cm³, 100µg/cm³, 10µg/cm³ and 1 µg/cm³), using DMSO as a solvent were prepared by serial dilution.

Antimicrobial Activity Testing

Disk method and pouring method were adopted according to the procedure prescribed by Banso, et. al., 1999 and Anacona and Gladdys, 2005.

Characterization of the Complexes

The synthesized metal complexes were analysed using the melting point apparatus to determine their melting points, IR and UV visible spectroscopic techniques were also employed.

RESULTS

TABLE 1: IR spectra of the synthesized complexes showing absorption of different functional groups.

Complexes	V(C-O)	(M-O)	(C-O)	(C-H)	(N-M)
[Ni(acac) ₂ (phen)]	1600 cm ⁻¹	880 cm ⁻¹	1240 cm ⁻¹	1400 cm ⁻¹	780 cm ⁻¹
[Cu(acac) ₂ (phen)]	1550cm ⁻¹	950 cm ⁻¹	1050 cm ⁻¹	1470 cm ⁻¹	790 cm ⁻¹

TABLE 2: Results of fungal growth recorded in three (3) days for the synthesized complexes and penicilline

Concentration of the complexes (µg/cm ³)	[Ni (acac) ₂ (phen)] growth/day (cm)			[Cu(acac) ₂ phen] growth/day (cm)			Penicilline growth/day (cm)		
	1	2	3	1	2	3	1	2	3
10 ⁰	0.893	0.96	1.02	0.952	1.01	2.05	0.234	1.00	2.00
10 ¹	0.852	0.90	1.00	0.851	0.889	1.765	0.451	0.884	1.980
10 ²	0.755	0.84	0.981	0.793	0.832	1.230	0.678	0.835	1.765
10 ³	0.553	0.65	0.932	0.451	0.553	1.00	0.861	0.777	1.654

TABLE 3: Size of inhibition(cm) for the synthesized complexes against E. Coli and Aspergillus recorded on Day 4

Concentration of complexes (µg/cm ³)		10 ⁰	10 ¹	10 ²	10 ³
Cu(acac) ₂ phen (cm)	<i>E-coli</i>	0.44	0.35	0.25	0.21
	<i>Aspergillus</i>	0.66	0.52	0.48	0.35
Ni(acac) ₂ phen (cm)	<i>E-coli</i>	0.60	0.56	0.51	0.44
	<i>Aspergillus</i>	0.96	0.78	0.70	0.60
Penicilline (cm)	<i>E-coli</i>	0.34	0.38	0.40	0.45
	<i>Aspergillus</i>	0.60	0.67	0.76	0.84

Discussion

The IR spectra observed bands observed in all complexes indicated v(C-O) band for all the complexes as; 1550cm⁻¹- 1600cm⁻¹ and (C-O) bands around 1240cm⁻¹ - 1400cm⁻¹ which conformed with the findings of Brian, 1999. This applied to the C-H, M-O and N-M bands (table 1).

The Uv-Vis result for the complexes showed copper complex to have absorption around 350nm and a shoulder around 400nm; Nickel (II) complex showed absorption peak around 450nm and a shoulder around 400nm. These results showed conformity with the literature of Bell et al 2002.

Results of the anti microbial potential of the synthesized complexes revealed a more significant pattern for the disc method than the pouring method. No wonder the pouring method was only scarcely documented in literature. Growth pattern using the pouring method was dispersed and random and as such measurement of the result was difficult and un precise. The size of the bacterial growth was not easy to measure, due to its very light nature and poor appearance . For this reason, only the size of the inhibition was measured, as outlined in Table 3.

It was generally observed during the three-day study period that microbial activity decreased as the concentration of the complexes was increased (table 3). Comparing the complex of copper with that of nickel and the penicillin it was observed that Copper was more active than the penicillin and the complex of nickel considering *E. Coli* growth: 0.21cm for Cu, 0.6cm for Nickel and 0.45cm for penicillin at the highest concentration of the complexes (table 3). The control complex (penicillin) however showed a different trend on the first day with a direct relationship as the concentration of the complex was increased in the samples i.e the lower the concentration the lower the colony growth. This trend however changed as the days progressed and a similar pattern was also observed for the penicillin as the other synthesized complexes (table 3). It may therefore be hypothetically mentioned that penicillin is a slow antimicrobial agent against bacterial growth. This difference in antimicrobial activity may be attributed to the nature of the cells of the micro

organisms used in the study. It could also be due to the difference in absorption of the synthesized complexes by the micro organisms as the cell walls of fungi are made of chitin while those of bacteria are made of murein (Eweis *et al.*, 2006).

Considering the activity of the fungi (*aspergillus*) used in the study against the synthesized and control antimicrobial agents, fungal growth generally decreased as the concentration of the complexes was increased in the media (table 2).

The higher activity of copper complex against the micro organisms than nickel may be attributed to the effect of copper ion on normal cell processes. The positive charge of the metal ion is shared with the donor groups of the chelating complex. This leads to an increase in lipophilic character of the central metal atom which results in higher penetration of the microorganisms (Hakan *et al.*, 2009). More complex methods of analysis should be explored in this area to compare the results so that a decision can be reached on the use of these synthesized complexes for clinical applications.

References

- Adeola A. N. (2009). Metal (ii) Schiff Base Complexes and the Insulin Mimetic Studies on the Oxovanadium (iv) Complexes. Phd Thesis, University of Zululand.
- Anacona, J. R. and Gladdys, D. (2005). Synthesis and Antibacterial Activity of Cefotaxim MetalComplex. *Journal of Chilean Chemical Society*. <http://www.msn/science direct.com>.
- Banso, A., Adeyemo S. O. And Jeremiah, P. (1999). Antimicrobial properties of *Vernonia amygdalina* extract, *J. Appl. Sci.* 3: 9-11.
- Bell, Z. R., Laye, R. H., and Ward, M. D. (2002). Tris(tricarbonylphosphine) ruthenium in Metal- organic compounds. 58: 165-166.
- Brian S., (1999). Infrared Spectral Interpretation- a systematic approach, CRC press.
- Eweis, M., Elkholy, S.S., and Elsabee, M. Z. (2006). Antifungal efficacy of chitosan and its thiourea derivatives upon the growth of some sugar-beet pathogens. *Int. J. Biol. Macromol.*, 38, 1-8.
- Hakan, A., Nizami D., Gulay B., Cemal K. O. and Cevdet A. (2009). Antimicrobial Activity of some Thiourea derivatives and their Nickel and Copper Complexes *Molecules*. 14, 519-527.
- Supran, C.T., Scozzafava, A. and Mastrolor, A. (2001). *Enzo. Exp. Opin. Ther. Patents* 11, 221.
- Travis, J. and Potempa (2000). *J. Biochem. Biophys. Acta*, 14, 35.