Journals Pub

International Journal of
Analytical and Applied Chemistry

ISSN: 2582-5933
Volume 12, Issue 1, 2026
January–June
DOI (Journal): 10.37628/IJAAC

https://journalspub.com/journal/IJAAC/

Research IJAAC

Synthesis, Characterization, Chromatographic, And Antifungal Evaluation of New Chalcone-Azo Ligand and Complexes

Safa Saleem Zayed[1,*], Fatima Fahim Abd[1]

Abstract

Ligand chemistry is fundamental to coordination chemistry, complex chemistry, analytical reagents, and the treatment of heavy ion pollutants. Recently, ligand complexes have been used in biological applications such as radiation and the treatment of certain types of tumors. Researchers have expanded their studies to include complexes such as nanomaterials and drug carriers, demonstrating their effectiveness through their nanoscale properties. It is worth noting that we chose indole and linked it to a chalcone group to enhance its activity and applications. The chalcone group contains a carbonyl group and an unsaturated alkene group with a sequential pattern, making it highly stable. It was also linked to a two-nitrogen azo bridge group, which includes electron pairs, further increasing its efficiency and applications. They are primarily synthesized via the Claisen-Schmidt condensation, a reaction between an aromatic aldehyde and an acetophenone in an alkaline or acidic medium; due to the restricted rotation around the double bond, chalcones predominantly exist in the thermodynamically stable E-configuration, which facilitates a planar structure optimal for electronic conjugation. Chromatographic separation is considered one of the best methods in analytical chemistry for achieving high purity in separation, as it relies on the molecular weight of the compound, the functional groups, interactions, and polarity of the functional groups within a single compound. This allowed us to prepare a new ligand, which was then synthesized with cadmium (Cd) and divalent zinc (Zn) ions. Its diagnostic spectra and antifungal activity against two types of fungi were studied, followed by an investigation of its chromatographic behavior.

Keywords: cadmium, chalcone, fungi, ligand, zinc

INTRODUCTION

Chalcones, or 1,3-diphenyl-2-propene-1-one, are prominent members of the flavonoid family, characterized by two aromatic rings joined by a three-carbon, beta-unsaturated carbonyl system [1–3]. This “enone” bridge is the source of their extensive chemical reactivity and biological potential [4, 5]. They are primarily synthesized via the Claisen-Schmidt condensation, a reaction between an aromatic aldehyde and an acetophenone in an alkaline or acidic medium [6, 7]. Due to the restricted rotation around the double bond, chalcones predominantly exist in the thermodynamically stable E-configuration, which facilitates a planar structure optimal for electronic conjugation [8–11].

***Author for Correspondence**
Safa Saleem Zayed
E-mail: rababmahdi49@gmail.com

[1]Lecturer, Department of Chemistry, College of Education for Girls, University of Kufa, Iraq

Received Date: January 15, 2026
Accepted Date: February 02, 2026
Published Date: February 03, 2026

Citation: Safa Saleem Zayed, Fatima Fahim Abd. Synthesis, Characterization, Chromatographic, And Antifungal Evaluation of New Chalcone-Azo Ligand and Complexes. International Journal of Analytical and Applied Chemistry. 2026;12(1): 10–19p.

Analytical and Preparative Chromatography

Chromatographic techniques are fundamental for the isolation and quality control of both natural and synthetic chalcones [12–14].

Thin-Layer Chromatography (TLC)

Serves as a primary tool for monitoring reaction progress and purity, where Rf values shift based on the electron-donating or withdrawing nature of substitutes on the aryl rings [15–18].

High-Performance Liquid Chromatography (HPLC)

This is the definitive method for quantifying chalcone derivatives. Using Reversed-Phase HPLC (C18 columns), researchers can resolve complex mixtures with high precision, utilizing the varying lipophilicity of the chalcone scaffold to achieve separation [19–22].

Complex Formation

Upon reacting with ions such as Cu2+, Ni2+, Co2+, Zn2+, and Fe, or any other ions, the chalcone undergoes deprotonation and coordinates through the carbonyl oxygen [23–25] and the phenolic oxygen. This results in the formation of a stable six-membered chelate ring [26–29].

Spectroscopic Characterization

The formation of these complexes is typically confirmed via FT-IR, which shows a distinct bathochromic shift in the carbonyl (C=O) stretching frequency, and UV-Vis spectroscopy, which reveals metal-to-ligand charge transfer (MLCT) bands.

EXPERIMENTAL SECTION

Formation of Chalcone-Azo Ligand

The methods for preparing chalcone and azo ligands are distinctive and do not consume expensive materials or many catalysts. Therefore, we used the best and simplest preparation methods, and the preparation of the primary azo compound was also done using the usual simplified coupling method. (0.04 mol) of 5-Bromo-2-aminoindole was occupied with (3 ml) concentrated hydrochloric acid and a cold sodium nitrite solution (0.003 mol), which was left to settle for 10 minutes. This was then mixed with a basic of 3,5-dimethyl benzaldehyde solution in the coupling reaction stage. The solvent was then detached by percolation, and the precipitate was bathed with distilled water, aeration, which (0.001 mol) rotated at room temperature for (6 h) with (0.001 mol) of (acetophenone) with 5% of basic solution to yield 72% orange precipitate of the ligand, following the routines explained in the studies [15, 18].

Formation of Complexes of (Cd, Zn)II

Complexes of two ions II (Zn, Cd) were formatted according to the ideal molar ratios and specifications for both complexes. The complexes were synthesized at molar ratios (1:2) (Ion:ligand) by dissolving the Chalcone-Azo ligand in ethyl alcohol, which was then diversified with both ions alone as the chloride ion after dissolving it in the ion solution [30–33] to form the complexes. Both complexes were then indicated by diagnostic spectroscopy to verify coordination, Figure (1).

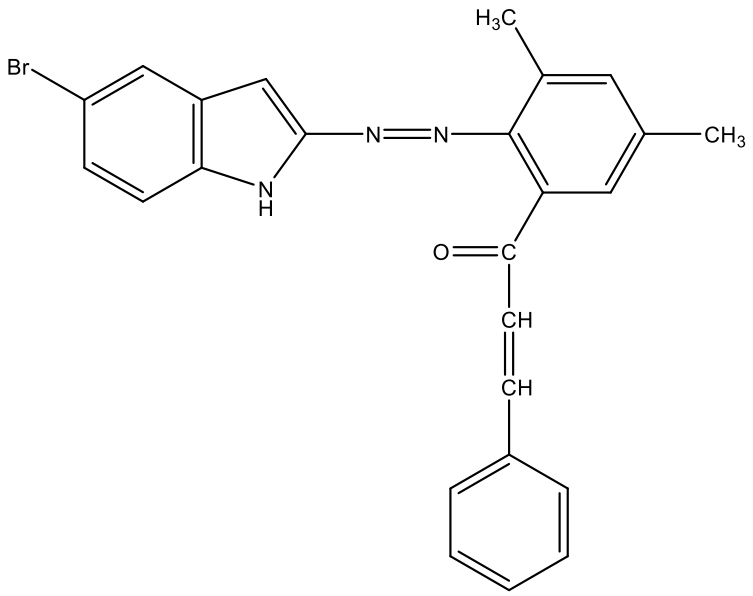

Figure 1. Preparation of chalcone-azo ligand.

RESULTS AND DISCUSSION

The (UV-Vis) Analysis

The determination wavelengths of Chalcone-Azo ligand, as well as the two ions cadmium and zinc complexes, were calculated via standard solution concentrations and challenging the ideal wavelength under best conditions, at test center temperature [34–36], and with the ligand soluble in ethanol. The wavelength curves were very clear and apparent for both complexes, as indicated in (Figures 2–4) and (Table 1) some properties for ligand and complexes.

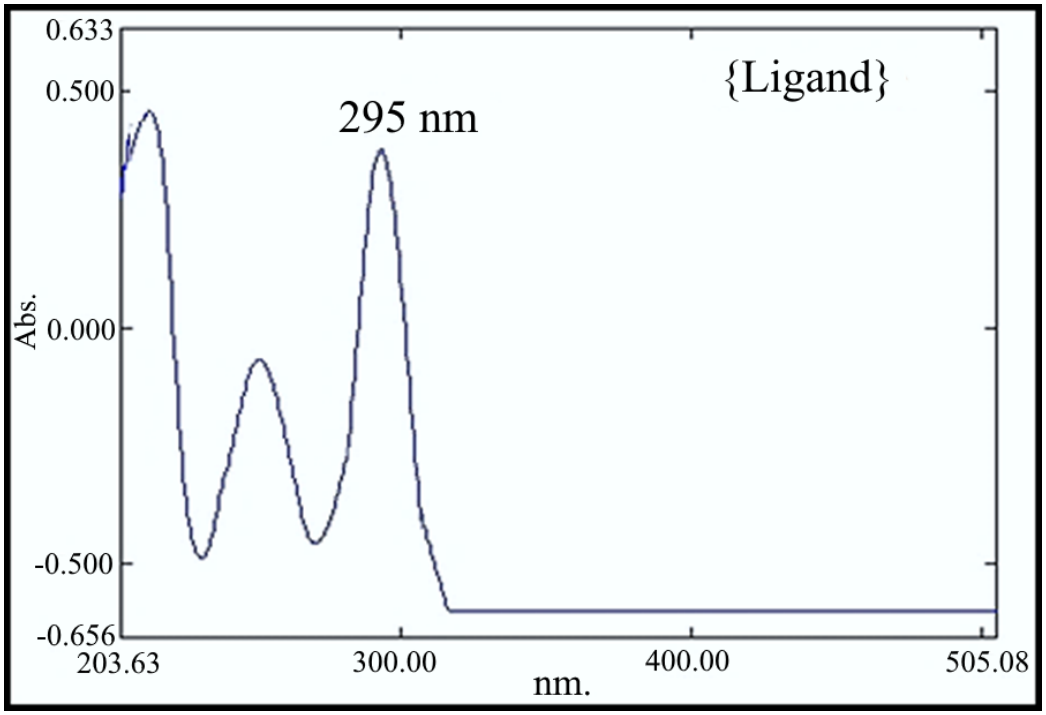

Figure 2. UV-Vis of {Ligand}.

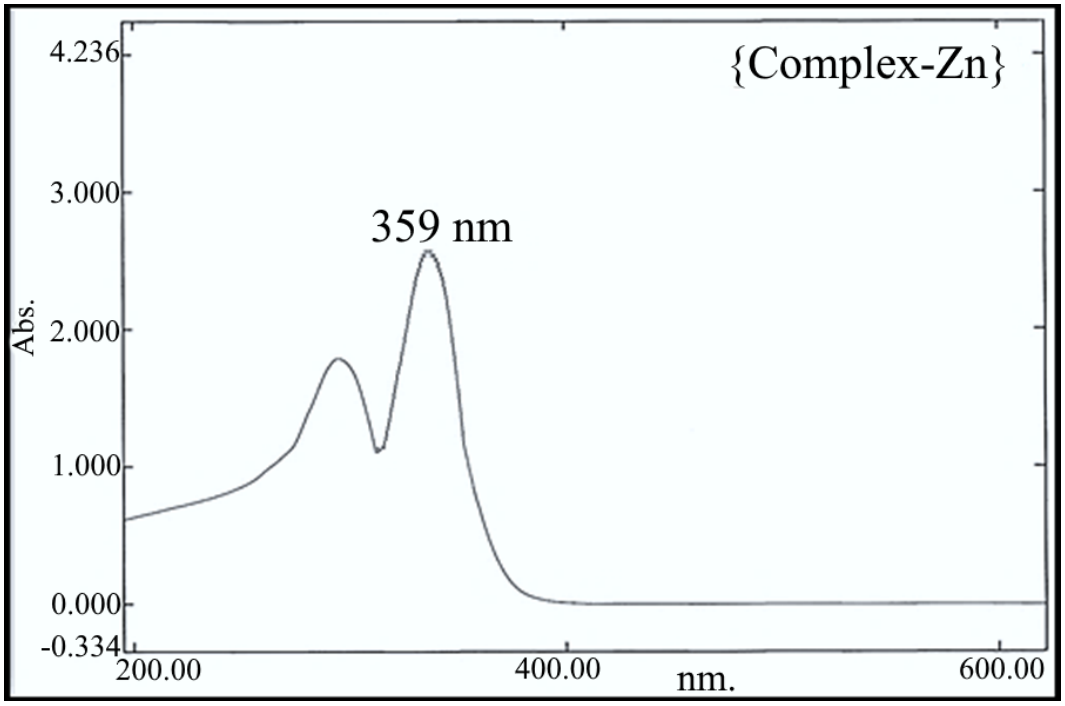

Figure 3. UV-Vis of {Complex-Zn}.

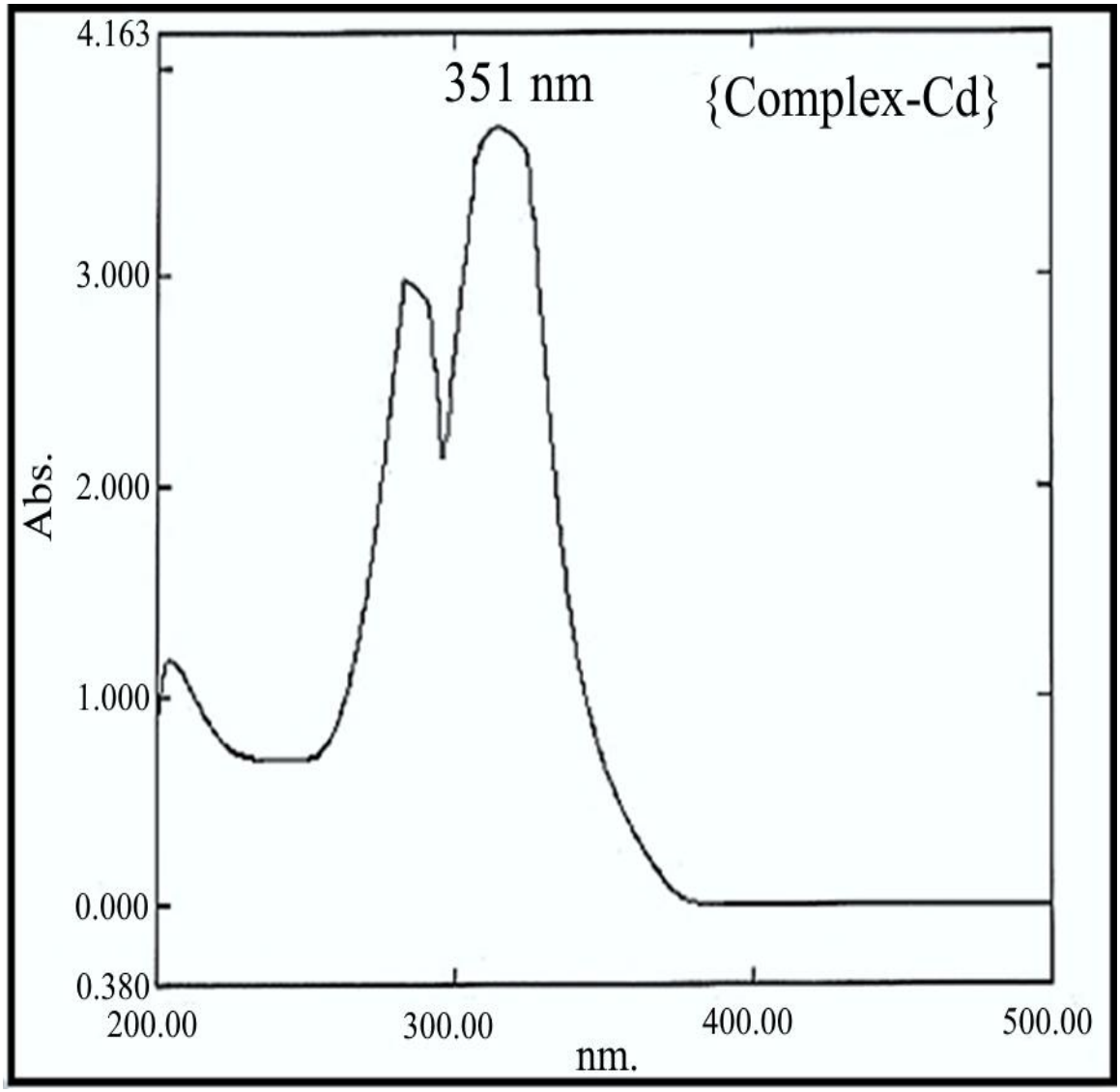

Figure 4. UV-Vis of {Complex-Cd}.

Table 1. Some properties of ligand and complexes.

Ligand and Complexes	Color	Melting Points	Percentage %
Chalcone Azo Ligand	Orange	168	72 %
Complex- Cd	Pill Green	212	86 %
Complex- Zn	Yellowish Green	204	82 %

The (IR) Analysis

To confirm the identity of any chemical compound or to establish the chemical structure of a ligand and its complexes, researchers resort to structural analysis to determine the composition of the ligand and the functional groups it contains, such as the azo bridge group, and how the ion binds to the ligand to form the complex by detecting the spectral statistics of the arranged ligands and complexes, a band appeared at {3448, 3281, 3120} cm-1 indicating the amine group of Indole cycle in the ligand [38–40] and three complexes {ligand, Complex-Cd, Complex-Zn} respectively; also azo group appeared at {(1442, 1500), (1406, 1490), (1433, 1503)} cm-1 indicating the (-N=N-) group in the ligand and three complexes {ligand, Complex-Cd, Complex-Zn} respectively; also bands for carbonyl of chalcone {1690, 1710, 1720} respectively. Thus, the further quintets and occurrences are revealed in the spectral (Figures 5–7).

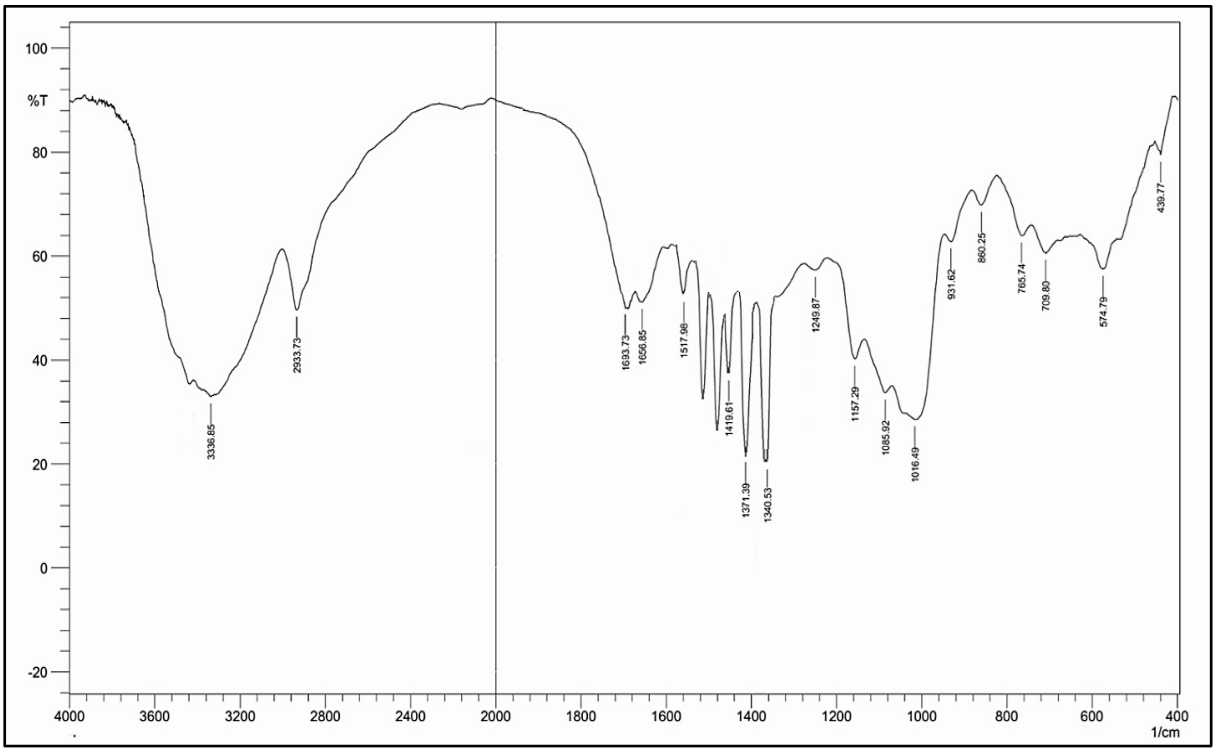

Figure 5. IR for chalcone-azo ligand.

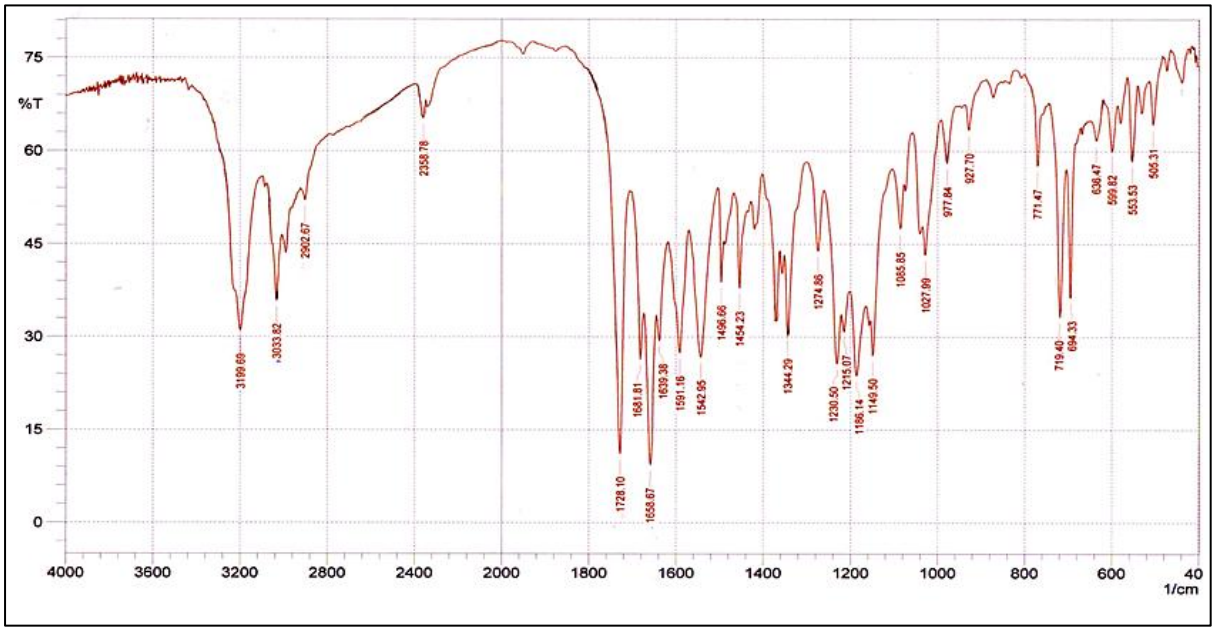

Figure 6. IR for Complex-Zn.

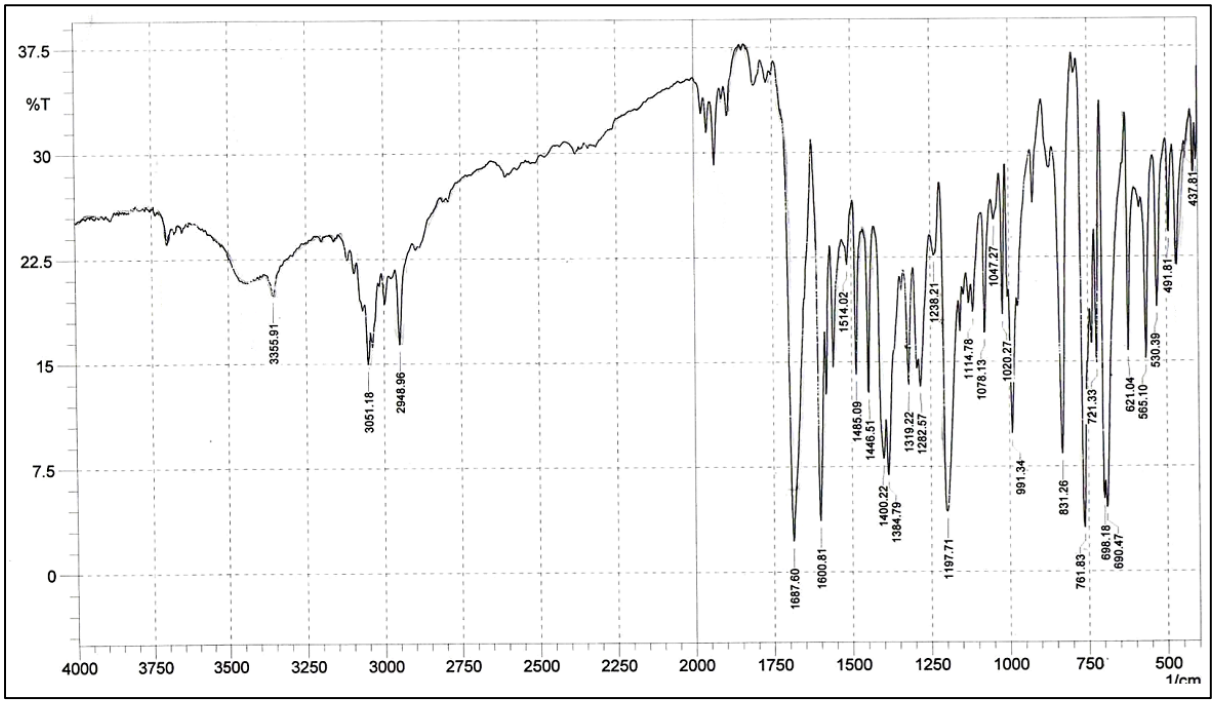

Figure 7. IR for complex-Cd.

Evaluation of Chromatographic Behavior of Complexes

This technique provides essential data regarding molecular fragmentation, allowing for the definitive structural elucidation of volatile chalcone derivatives. Chromatographic separation is considered one of the best methods [41, 42] in analytical chemistry for achieving high purity in separation, as it relies on the molecular weight of the compound, the functional groups, interactions, and polarity of the functional groups within a single compound. Solutions of 10 ml of ligands and complexes were prepared and injected onto the column [42], and the results were clearly visible in Figures (8–10).

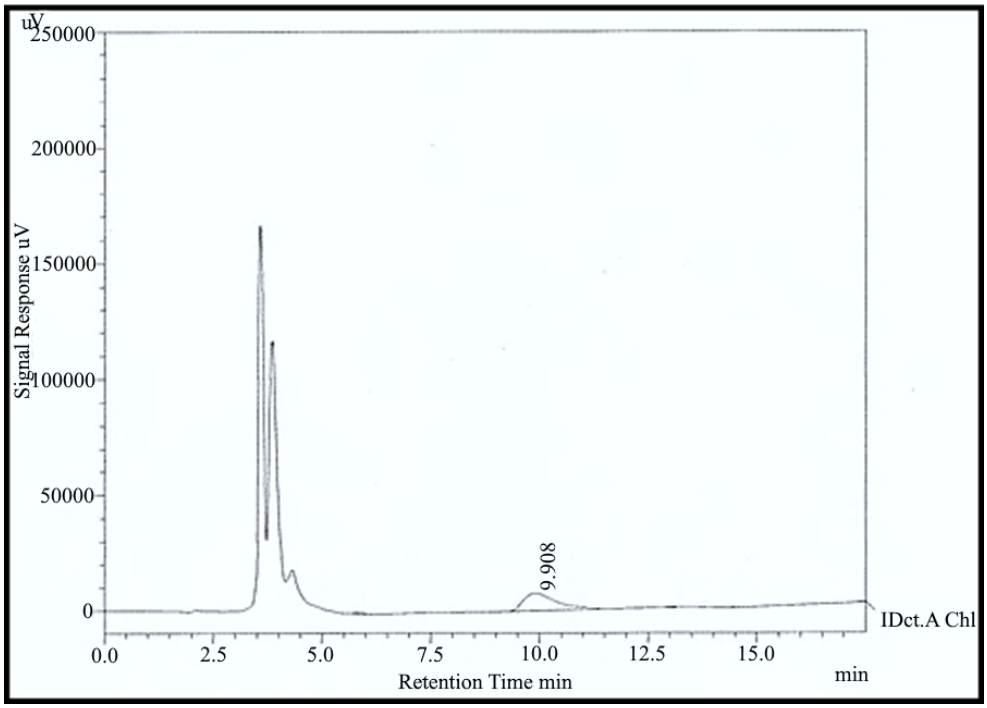

Figure 8. Chromatogram of ligand.

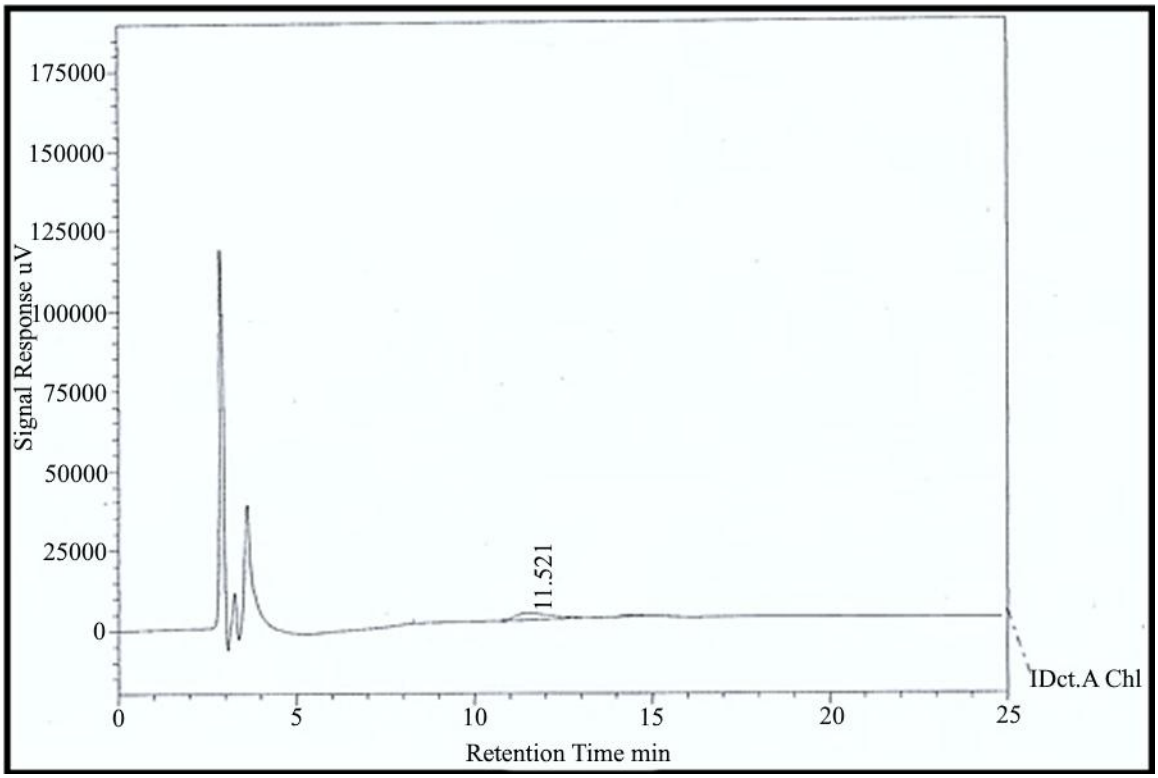

Figure 9. Chromatogram of complex-Zn.

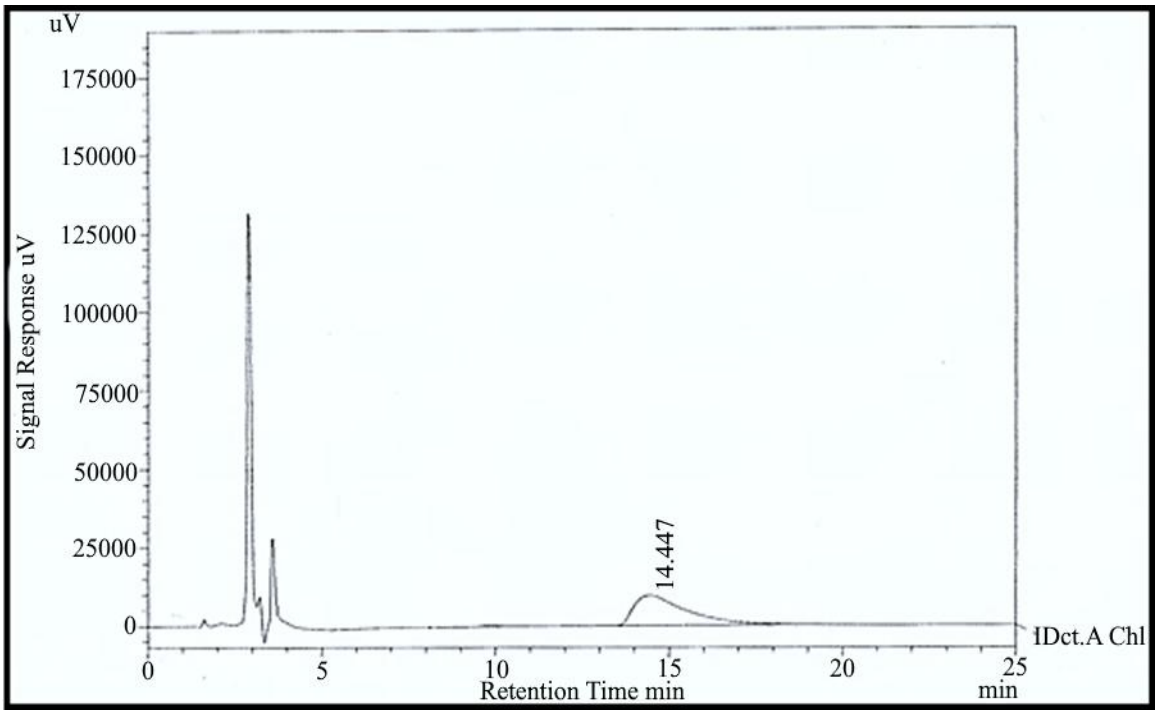

Figure 10. Chromatogram of complex-Cd.

Antifungal Guesstimate

These supplies reveal potent antifungal and antitumor activities via assisting the intracellular creation of bioactivity and improving DNA-compulsory attraction. Systematically, they attend as greatly sensitive colorimetric and electrochemical devices for identifying waste product [43, 44]. Environmentally, they are developed as competent photo mechanisms for the degradation of natural

colorants and as high-capacity adsorbents for the exclusion of elements from engineering sewer water, adopting detailed argues in ecological remedy. For this the genetic value of Ligand and (Cd, Zn) complexes were established as antifungal agents via advanced concentrations (3 recordings) as ($4x10^{-}1$, $4x10^{-}3$, $4x10^{-}5$ molar) decisive to references [15, 18], all data logged in (Table 2) with (Figure 11).

Table 2. Antifungal Inhibition of Ligands and Complexes.

Ligands & Complexes	Aspergillus	Candida albicans
Chalcone Azo Ligand	6	8
Complex- Cd	10	12
Complex- Zn	10	14

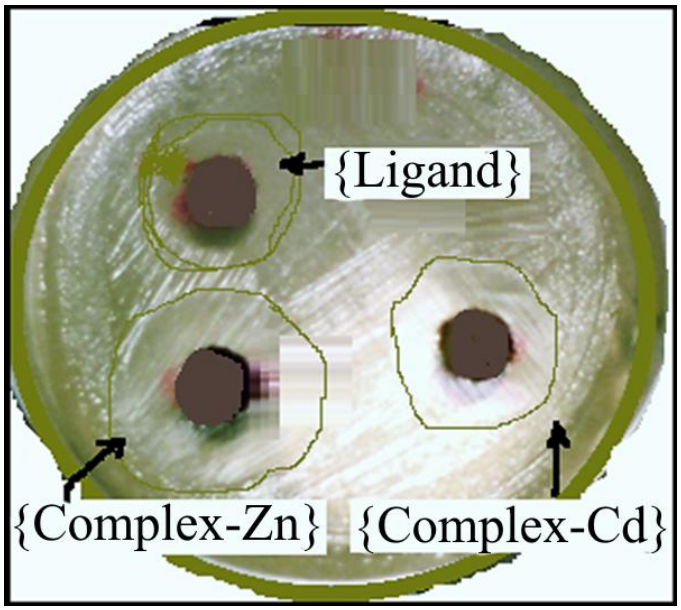

Figure 11. Reticence distance of candida albicans.

CONCLUSIONS

The results obtained from the chromatogram curves in the separation proved that they depend on the molecular weight of the compound, the functional groups, the interactions, and the polarity of the functional groups within a single compound. The ligand was the first compound to separate because its molecular weight is lower than that of the complexes. As for fungicidal activity, the zinc complex was the most effective against fungi compared to the other compounds. Azo derivatives are antifungal agents that have been used in several studies on burns, directly in the form of ointments or creams, and have been shown to eliminate fungal infections caused by the spread of dermatitis, as well as fungi prevalent in hospitals, health centers, and operating rooms.

REFERENCES

1. Silva M. Recent advances in the synthesis and biological applications of prenylated chalcones. Int J Mol Sci. 2025;26(20):23–34.
2. Karimi H. Synthesis and pharmacological activities of chalcone derivatives bearing N-heterocyclic scaffolds: a comprehensive review. ACS Omega. 2023;8(11):45–57.
3. Alam M. Synthesis, biological evaluation, quantitative-SAR and docking studies of novel chalcone derivatives as antibacterial and antioxidant agents. Chem Pap. 2015;69(8):24–36.
4. Gade R. Advances in chromatographic analysis of phenolic phytochemicals. Foods. 2024;14(13):66–79.
5. Karaman I. A comprehensive evaluation of a chalcone derivative: structural, spectroscopic, and pharmacological perspectives. Molecules. 2024;11(12):37–45.

6. Anwer S. Synthesis, characterization and antioxidant studies of some transition metal complexes with chalcone derivative (2-chloroacetophenone) and 2-hydroxybenzaldehyde. Res Sci J. 2024;34(11):39–48.
7. Hussein A, Abbas R. Synthesis, characterization, industrial and biological studies of azo dye ligand and their some metallic ions. Baghdad Sci J. 2024;21(10):42–55.
8. Mamataj S, Roy S, Ravindiran G, Datta D, Das B. Contemporary research on synthesis of silver nanoparticles and its applications. Indian Chem Eng. 2024;7(11):1–30.
9. Pan H, Yao C, Yao S, Yang W, Wu W, Guo D. Metabolomics strategy for authentication of plant medicines with multiple botanical origins, a case study of Uncariae Rammulus Cum Uncis. J Sep Sci. 2020;43(5):1043–1050.
10. Mahmood N. Effect of conditions and catalysis on products. 1st ed. Eliva Press SRL; 2021. ISBN: 9781636482286.
11. Gaul D, Mezencev R, Long T, Jones, Benigno B, Gray A, et al. Highly-accurate metabolomic detection of early-stage ovarian cancer. Sci Rep. 2015;5:16351.
12. Mahmood N. Alternative methods in organic synthesis. 1st ed. Eliva Press SRL; 2020. ISBN: 9798680201176.
13. Nagham M. The various preparation methods in synthetic chemistry. 1st ed. Evincepub Publishing House; 2019. ISBN: 978-93-88277-82-2.
14. Alsbr I, Abdullabass H, Mahmood N. Invention of (Gluta.Sulfazane-Cefixime) compounds as inhibitors of cancerous tumors. J Cardiovasc Dis Res. 2020;11(2):44–55.
15. Nagham MA. Synthesis of antifungal chemical compounds from fluconazole with (pharma-chemical) studying. Res J Pharm Biol Chem Sci. 2017;8(3):564–573.
16. Hall L, Hill D, Bugden K, Cawley S, Hall L, Chen M, et al. Development of a reverse phase HPLC retention index model for nontargeted metabolomics using synthetic compounds. J Chem Inf Model. 2018;58(5):591–604.
17. Tada R, Chavda N, Shah MK. Synthesis and characterization of some new thiosemicarbazide derivatives and their transition metal complexes. J Chem Pharm Res. 2011;3:290–297.
18. Mahmood N. Synthesis and biological study of hetero (atoms and cycles) compounds. Der Pharma Chem. 2016;8(6):40–48.
19. Hasaneen K, Aseel M, Mahmood N. Synthesis of drugs derivatives as inhibitors of cancerous cells. Biochem Cell Arch. 2020;20(2):82–96.
20. Afaq J. Synthesis, spectral investigation and study of nano-applications of new anil-azo ligands. Al-Harf J. 2025;24(4):28–39.
21. Atheraa A. Studying of thermal, spectral and liquid crystal properties of new monomers for Schiff base reaction. Al-Harf J. 2024;20(1):45–55.
22. Rajaa A. Preparation and characterization, and study of nano-behaviour of new benzothiazole and triazole derivatives. Al-Harf J. 2025;24(3):73–87.
23. Alfatlawi I, Mahmood N, Nuha S, Zainab M. Synthesis of new organic compounds via three components reaction with studying of (identification, thermal behavior, bioactivity on bacteria of teeth). J Glob Pharma Technol. 2017;11(9):157–164.
24. Mahmood N, Saher M, Zainab M, Intisar O. Inhibition activity of (azo–acetyl acetone) on bacteria of mouth. Res J Pharm Technol. 2017;10(6):1683–1686.
25. Jawad A, Mahmood N, Saher M. Development and preparation of ciprofloxacin drug derivatives for treatment of microbial contamination in hospitals and environment. Indian J Forensic Med Toxicol. 2020;14(2):1115–1122.
26. Kalapala V, Banothu V, Chandra S. Synthesis and characterization of some new thiosemicarbazide derivatives and their transition metal complexes. J Chem Pharm Res. 2015;7(9):437–445.
27. Nagham M. Synthesis and chemical identification of macro compounds of (thiazol and imidazol). Res J Pharm Technol. 2015;8(1):78–84.
28. Dakshayani K, Lingappa Y, Sayaji Rao M. Synthesis, characterization and biological activity of 5-methyl, thiophene-2-carboxaldehyde derivatives of copper (II), cobalt (II) and nickel (II) complexes. Res Pap Int J Chem Pharm Sci. 2012;3(6):50–55.

29. Faria J, Ruiz M, Resasco D. Phase-selective catalysis in emulsions stabilized by Janus silica-nanoparticles. Adv Synth Catal. 2010;352(15):2359–2364.
30. Naumann D, Raoul C, Lénárd H, Michael G. The reaction network in propane oxidation over phase-pure MoVTeNb M1 oxide catalysts. J Catal. 2014;311:369–385.
31. Mahmood N. Review in azo compounds and its biological activity. Biochem Anal Biochem. 2015;5(3):169–176.
32. Nagham M. Creation of originated macrocyclic sulfazan-formazan compounds and linear sulfazan-formazan for the first time globally with their assay as antifungal. Biomed J Sci Tech Res. 2021;40(3):32266–32272.
33. Mokrani T, Van R, Albert A, Ismael. Molecular weight and tacticity effect on morphological and mechanical properties of Ziegler–Natta catalyzed isotactic polypropylenes. Polímeros. 2024;25(6):556–563.
34. Shireen R, Mahmood N, Ali J. Guanine substituted heterocyclic derivatives as bioactive compounds. Biochem Cell Arch. 2020;20(2):3651–3655.
35. Mahmood N, Nemah S. Chemo-spectral and biological studying of new ligands. Res J Pharm Biol Chem Sci. 2017;8(3):674–689.
36. Mahmood N. Designation of macrocyclic sulfazan and triazan as originated compounds with their estimation in nano-activities by the scanning microscope. Int J Converg Healthc. 2022;2(1):25–34.
37. Li Z, Zhuang T, Dong J, Wang L, Xia J, Wang H, et al. Sonochemical fabrication of inorganic nanoparticles for applications in catalysis. Ultrason Sonochem. 2021;71:105–114.
38. Naik R, David M. Green synthesis of silver nanoparticles using Caesalpinia bonducella leaf extract: characterization and evaluation of in vitro anti-inflammatory and anti-cancer activities. Inorg Nano-Met Chem. 2024;54(4):376–386.
39. Mahmood NA. Origination of macrocyclic formazan with macrocyclic sulfazan and triazan as originated compounds and compared their efficiency against breast cancer. Open Access J Biomed Sci. 2022;4(1):52–67.
40. Mahmood N. Synthesis innovative cyclic formazan compounds for the first time and evaluation of their biological activity. Int J Polym Sci Eng. 2021;7(2):5–14.
41. Brédas JL, Persson K, Seshadri R. Computational design of functional materials. Chem Mater. 2017;29(6):2399–2401.
42. Mahmood N. Inventing of macrocyclic formazan compounds with their evaluation in nano-behavior in the scanning microscope and chromatography. Biomed J Sci Tech Res. 2022;41(3):32783–32792.
43. Olivares R, Amador C, Hachmann J, Atahan S, Sanchez S, Vogt L. Accelerated computational discovery of high-performance materials for organic photovoltaics by means of cheminformatics. Energy Environ Sci. 2011;4(12):4849–4861.
44. Abdellah I, Koraiem A, El-Shafei A. Structure-property relationship of novel monosubstituted Ru(II) complexes for high photocurrent and high efficiency DSSCs: influence of donor versus acceptor ancillary ligand on DSSCs performance. Sol Energy. 2019;177:642–651.

