



## Preparation, characterization and biological activity study of Co (II), Ni(II) and Cu(II) Complexes with 4-((Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene)amino)-3-methyl-8-oxo-5-thia-1-azabicyclo [4.2.0] oct-2-en-2-yl)-oxazol-5(4H)-one derivatives



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### Abstract

New succession related to the transition metal complexes Cu(II), Ni(II), and Co(II) with 4-((Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene)amino)-3-methyl-8-oxo-5-thia-1-azabicyclo[4.2.0]oct-2-en-2-yl)oxazol-5(4H)-one has been prepared and described. The structural descriptions have been reached from FT-IR, UV Vis-Spectrophotometer, molar conductance measurements, magnetic susceptibility, atomic absorption techniques as well as <sup>1</sup>HNMR. Based on these results, it is proposed that the coordinates of the ligand to metal ions from the nitrogen related to azomethine group as well as the oxygen of carbonyl group. In addition, the biological activity of the complexes and the ligand has been investigated opposite *Staphylococcus aureus*, *Aspergillus Niger*, *E.coli*, and *Candida albicans*. The products indicate that Co (II)-complex, Ni (II)-complex and Cu (II) –complex is the enhanced biological activity in comparison to the ligand.

**Keywords:** Transition metals, Complexes, Biological activity, spectral studies and Ligand

### Introduction

The coordination compounds appearance various properties on the basis of metal ion that they were bound to, the metal type, ligand's class, and so on, such as metal complexes are widely utilized in many fields. The Schiff bases are showing a significant impact on coordination chemistry since they simply process the stable complexes with majority of the transition metal ions. Also, they are utilized in various research areas because of the fact that they can be produced easily, also their wide range applications [1-7]. In addition, the Schiff bases were stemmed from the amino and carbonyl compounds significant ligand's class which coordinate to metal ions via azomethine nitrogen, oxygen or sulphur [8-13]. Schiff bases act as bi-, tri-, tetra- or multi-dentate ligands [14-15]. In this research, Co(II)-complex, Ni(II)-complex, and Cu(II)- complex with 4-((Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene)amino)-3-methyl-8-oxo-5-thia-1-azabicyclo[4.2.0]oct-2-en-2-yl)oxazol-5(4H)-one have been prepared. These compounds were characterization via, FTIR, UV-Vis and <sup>1</sup>HNMR.

Moreover, their antibacterial activity toward some bacteria was estimated.

### Experimental

#### Materials and Measures

All material and solvents utilized in the work of the two companies were produced BDH, Fuka and used without any modification. The measurements were done at Mustansiriyah University laboratories and Technology University laboratories. The (FT-IR) were registered using FT-IR 8300 Shimadzu spectrophotometer in frequency that is in range 400 cm<sup>-1</sup> – 4000 cm<sup>-1</sup>. In addition, the electronic spectra with a use of Varian UV-visible spectrophotometer and the molar conductivity measurement utilizing Philips conductivity meter, the melting points have been determined in the apparatus of Coslab melting point, while magnetic susceptibility which is related to solid complex types has been acquired at 25 Celsius with the use of Magnetic Susceptibility Balance Johnson Matthey. Elemental microanalysis is used to carry out the elemental analysis.

#### Synthetic Processes

Synthesis of compound 2:

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Mixture of aromatic aldehyde 0.012 mol with 0.012 mol of 7-[4-amino]-3-methyl-8-oxo-5-thia-1-azabicyclo [4.2.0] oct-2-ene-2-carboxylic acid [ was refluxed for 6 hours in absolute ethanol 25 ml, following cooling to the room temperature, the solid has been collected through washed and filtered with the cold ethanol [14]. Yield: 75%. M.p. 256 °C, FT-IR spectrum ( $\nu$ ,  $\text{cm}^{-1}$ ): (C = N) 1610 (C = O) lactam 1712 (C-H) ar 3028 (C-H)al 2950-2899.

#### Synthesis of compound 3:

Mixture of the phenyl acetic acid 0.012 mol with from the triethylamine 1.05 gm in chloroform 40 ml was added to the compound 2, such blend mixed in an Snow bath as well as involved a drop shrewd at a time blend from the thionyl chloride 5 ml, in chloroform 20 ml. After that, response is mixed for a period of 10 hours, left to dry in  $\text{Na}_2\text{SO}_4$  (5gm), re-crystallized from suitable solvent for managing the costs of coveted mixes [16]. Yield: 66%. Melting point 288 °C, FTIR spectrum ( $\nu$ ,  $\text{cm}^{-1}$ ): (C = O) lactam 1,722 (C = O) lactam 1637 (OH) 3422-3266 (C-H)ar 3047 (C-H)al 2933-2890.

#### Syntheses of compound 4:

Mixture of the compounds 2 and 3 (1:1) (0.012 mol) and thionyl chloride 15 ml was refluxed for a period of 7hours, then the overabundance related to thionyl chloride has been evacuated under decrease strain for the purpose of getting the acid chloride · Yield: 71%. M.p. 149 °C, FT-IR spectrum ( $\nu$ ,  $\text{cm}^{-1}$ ): C=O) acid 1761 (C = O) lactam 1712 (C=N) 1654 (C-H)ar 3037 (C-H) al 2962-2874.

#### Synthesis of compound 5:

Mixture of the compound 4 (0.012 mol ) with glycine (0.750 gm, 0.012 mol) and NaOH 10ml,10%, was refluxed for 2 hours in absolute ethanol 25 ml, couple of grams related to the crash ice was involved in the blending process. Then, the arrangement is fermented by conc. HCl acid, accelerate was assembled and re-crystallized from suitable solvent. Yield: 75%. M.p. 266 °C, FT-IR spectrum ( $\nu$ ,  $\text{cm}^{-1}$ ): (C= O) lactam 1720 (C=N) 1610.

#### Synthesis of ligand compound 6:

A combination of compound 5 (0.012 mol) with acetic acid (6 ml), acetic anhydride (25ml) and aromatic aldehyde (1mmol) was refluxed for 12 hours, After cooling to room temperature, a yellow precipitate created that has been washed and filtered with cold ethanol [14].  $^1\text{H}$ NMR (DMSO- $d_6$ ) ( $\delta$ ), 08.78-08.12ppm (m, ArH), 04.18 ppm (s, Ph-CH), 05.62ppm (s,s-CH- N), 06.72 ppm (s,Ph-CH=C), 07.11ppm (s,CH=N) Schiff base, 07.20 ppm (s,CH=N) second Schiff base, 01.40ppm (s,  $\text{CH}_3$ ) and 2.32 ppm (s,  $\text{CH}_2$ ). Yield: 76%. M.p. 232 °C.

Formation of Co(II), Ni(II) and Cu(II) compounds of 4-((Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene) amino)-3-methyl-8-oxo-5-thia-1-azabicyclo [4.2.0]oct-2en-2yl)oxazol-5(4H)-one

All metal –ligand complexes were created reaction of the hydrated metal salts and the ligand in mole ratio (1:1) under reflux for a period of 2 hours. In addition, the resulting solid was washed with hot ethanol and washed then with distilled water and left to dry. as shown in the Table1.



Scheme 1. Synthesis of 4-((Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene) amino)-3-methyl-8-oxo-5thia-1-azabicyclo[4.2.0]oct-2en-2yl)oxazol-5(4H)-one

**Table 1. Showed physical characteristics of metal complexes**

Compounds	Colour, Yield%	MP °C	M % Calc. (found)
CoLCl <sub>2</sub>	Deep green , 84	>332 dec	8.22 (8.32)
Ni LCl <sub>2</sub>	Deep brown 75	269 dec.	8.19 (8.44)
Cu LCl <sub>2</sub>	Green, 65	315 dec.	8.80 (8.74)

## Results and Discussion

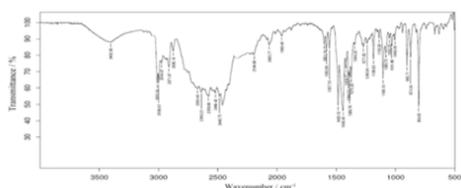
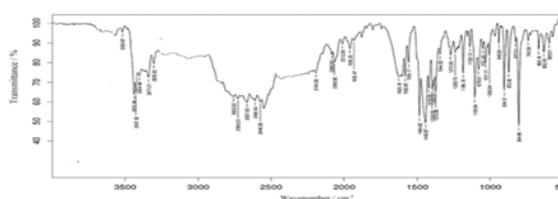
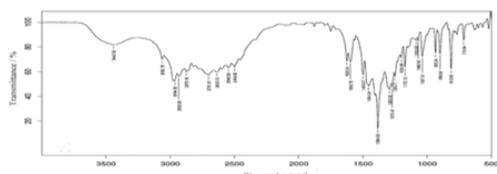
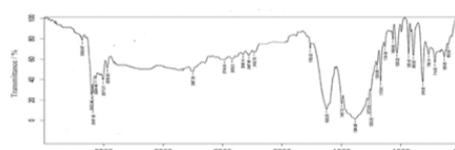
### FT-IR

For the purpose of determining the binding kind related to ligand to metal in the complexes. In addition, the diagnostic FT-IR spectra bands regarding the ligand in addition to their metal complexes have been provided in table 2. Also, the characteristic absorption bands related to ligand occur at 1645 cm<sup>-1</sup> due to (C=N) stretching vibration[17] and at 1764cm<sup>-1</sup> due to (C=O) stretching

vibration[18] The band of carbonyl group shift to lower frequency up on complexation, indicating the involvement oxygen of carbonyl group in coordination, the band of azomethine nitrogen atom was shift to the lower frequency up on complexation, indicating the involvement nitrogen of azomethine group in coordination and thus can be concluded the ligand is bidentate ligand. The bands at 320–360 cm<sup>-1</sup> were assigned to  $\nu$  (M–Cl) [19].

**Table 2. FTIR ( $\nu$  cm<sup>-1</sup>) spectral data of ligand and its complexes.**

Compounds	$\nu$ (C=O)	$\nu$ (C=N)	$\nu$ (M-O)	$\nu$ (M-N)	$\nu$ (M-Cl)
L	1764	1645	-	-	-
CoLCl <sub>2</sub>	1755	1594	540	495	360
NiLCl <sub>2</sub>	1722	1620	503	487	345
CuLCl <sub>2</sub>	1750	1633	525	464	325


**Fig. 1. FT-IR - of ligand**

**Fig. 2. FT-IR -of [CoLCl<sub>2</sub>] complex**

**Fig. 3. FT-IR -of [NiLCl<sub>2</sub>] complex**

**Fig. 4. FT-IR - of [CuLCl<sub>2</sub>] complex.**

### Molar conductivity measurement of ligand metal complexes:

Molar conductivity measurement for cobalt (II), nickel (II) and copper (II) complexes were taken in 10<sup>-3</sup> solution in DMF; the Molar conductivity values are (8.3, 27.8 and 15.2)  $\Omega^{-1}$  cm<sup>2</sup> mol<sup>-1</sup>. for Ni(II), Co(II) and Cu(II) metal complexes. These values were predictable non-electrolytic nature for these complexes [20-21].

### U.V & Magnetic measurements studies

The electronic spectrum shows electronic transition for the free ligand displays 2 bands at 35714 cm<sup>-1</sup> and 31250 cm<sup>-1</sup> that are as a result of  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$  transitions. The electronic spectrum of Co(II) complex exhibits a band at 16728cm<sup>-1</sup> which

results from  ${}^2A_{1g} \rightarrow {}^2E_g$ . In addition, this complex's magnetic moment is considered to be common for the square planar geometry [22]. The Ni-complex is showing absorption bands at (26025 cm<sup>-1</sup>) as well as (22846cm<sup>-1</sup>), such bands might be allocated to  ${}^1A_{1g} \rightarrow {}^1E_g$  &  ${}^1A_{1g} \rightarrow {}^1B_{2g}$  transition specifying a square planar geometry around the Ni(II). Furthermore, the diamagnetic behavior was consistent that geometry [23]. The Cu(II)-complex spectrum shows two bands at (25325 cm<sup>-1</sup>) & (16656cm<sup>-1</sup>) assigned to the transition CT and to  $T_{2g} \rightarrow 2E_g$  & Cu(II)-complex magnetic moment has been 1.83 BM Both electronic absorption spectrum of paramagnetic Cu(II)-complex and magnetic values are suggestive of tetrahedral geometry [24].

**Table 3. Electronic spectrums and Magnetic measurements of ligand and their metal complexes**

Compound	Absorption $\lambda_{max}$ ( $cm^{-1}$ )	Transition	$\mu(B.M)$	Proposed geometry
L	35714 31250	$\pi \rightarrow \pi^*$ $n \rightarrow \pi^*$	-	-
CoLCl <sub>2</sub>	16728	$^2A_{1g} \rightarrow ^2E_g$	2.32	Square planar
NiLCl <sub>2</sub>	26025 22846	$^1A_{1g} \rightarrow ^1E_g$ $^1A_{1g} \rightarrow ^1B_{2g}$	0.0	Square planar
CuLCl <sub>2</sub>	25325 16656	CT $T_{2g} \rightarrow 2E_g$	1.83	Tetrahedral

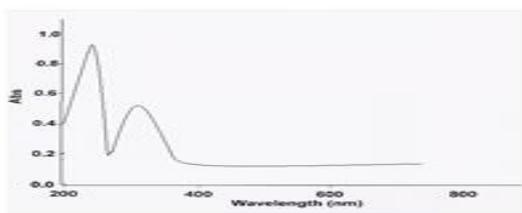


Fig 5: Electronic Spectral of Ligand

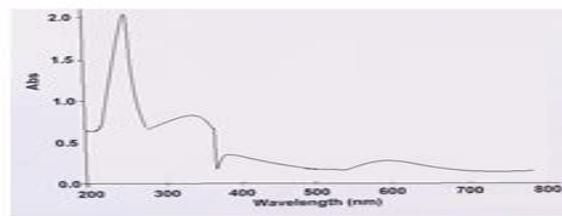


Fig 6: Electronic Spectral of Co-complex

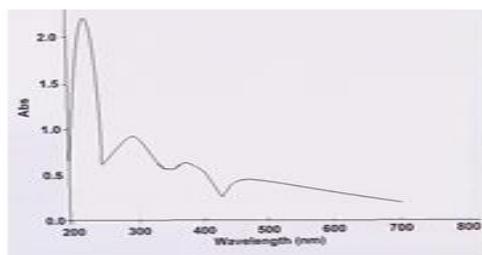


Fig 7: Electronic Spectral of Ni-complex

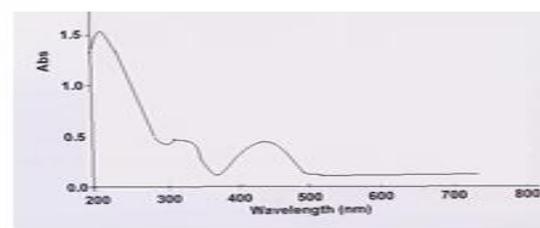


Fig 8: Electronic Spectral of Cu-complex

### Biological Activity

The ligand and the corresponding metal compounds under study were tested against five antimicrobial activity *Staphylococcus aureus*, *S. epidermidis*, *E.coli*, *Klebeilla* spp and *candidx* by plate well into agar nutrient method. Antimicrobial activity was expressed in millimeters (mm) by measuring the diameters of the inhibitory region and contrasting with the DMSO control and the values were explained in Table-4. The well diffusion technique has been utilized for screening the anti-microbial activity in- vitro with the use of Muller-Hinton Agar. Also, the plates have been prepared after pouring molten media of 15 ml in sterile Petri dishes. Bacterial suspension with  $1.5 \times 10^6$  has been inoculated for each one of the plates. Sterile cork borer with diameter of 5 mm has been utilized for boring 7 wells in all the agar plates. Volume of 1ml related to each of the compounds has been utilized via micropipette for each one of the wells. Also, one well has been filled with the solution of DMSO, as control. All the plates have been set in the refrigerator for a period of 30 mins and temperature of  $4^\circ C$  for

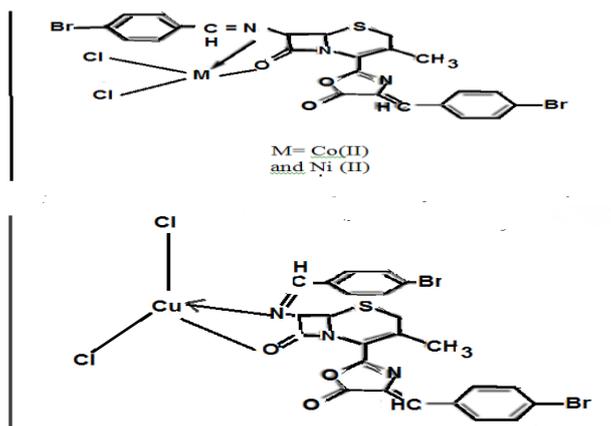
allowing the occurrence of simple compound's diffusion, after that subjected to incubation for 24 hours and a temperature of  $37^\circ C$ . The results related to all compounds have been indicated via evaluating the inhibition zone which is around wells. Abusive and inadequate use regarding the anti-microbial agents led to various microbial infections which fails in responding to anti-microbial treatments as well as consequent resistance to such drugs. A lot of studies indicated that the coordination related to organic compounds to metallic elements causing considerable modifications in biological activity of metal and organic ligand.

### Conclusion

The ligand was produced effectively; the ligand is treated to various ions salts to produce the complexes. It ligand coordinated through O- of carbonyl group and the N - of the of azomethine group. The complexes were proposed to be square planar.

**Table 4. Antimicrobial properties of ligand and its complexes**

Bacterial	DMSO	Ligand/ DMSO	Ni-complex/ DMSO	Co- complex / DMSO	Cu- complex / DMSO
<i>Staphylococcus aureus</i>	-	-	33	25	11
S.epidermidis	-	15	18	21	14
<i>E. coli</i>	-	-	16	-	18
Klebeilla spp	-	16	-	22	27
candidx	-	10	18	-	-

**Fig. 9. Suggested chemical structure of metal complexes****References**

- [1] Ahmed G. H., Fatma M. A., Eman F. M. Spectrophotometric Study on Determination of Aripiprazole in Tablets by Charge-Transfer and Ion-Pair Complexation Reactions with Some Acceptors. *Asian J. Pharm. Ana.*, 21: 12-19 (2012).
- [2] Vinita G., Sanchita S. Y., Gupta, K. Synthesis, Characterization and antimicrobial activity of Co(II), Ni(II), Cu(II) and Zn(II) complexes N- O- S donor ligands. *Asian J. Pharm.*, 44: 174-177 (2014).
- [3] Otuokere I. E., Ndukwe M. C., Akachukwu D. Synthesis, Characterization and Antimalarial Studies of Cd(II), Cu(I) and Ni(II) Complexes of 5-(4-chlorophenyl)-6-ethyl-2,4-Pyrimidinediamine and 4-Amino-N-(5,6-dimethoxy-4-pyrimidinyl) benzenesulfonamide Mixed Ligand. *Asian J. Pharm. Tech.*, 4(4): 211-217 (2014).
- [4] Otuokere I. E., Ndukwe M. C., Akachukwu D. Synthesis, Characterization and Antimalarial Studies of Cd(II), Cu(I) and Ni(II) Complexes of 5-(4-chlorophenyl)-6-ethyl-2,4-Pyrimidinediamine and 4-Amino-N-(5,6-dimethoxy-4-pyrimidinyl) benzenesulfonamide Mixed Ligand. *Asian J. Pharm. Tech.*, 4(4): 211-217 (2014).
- [5] A. S. H. R. NAIR Synthesis and antibacterial activity of some Schiff base complexes. *J. Serb. Chem Soc.*, 71 (7): 733-744 (2006).
- [6] Abel E. W., Parth J. M., Whelam R. *J. Inorg. Nuclear Chem.*, 7: 184-190 (1971).
- [7] Thomas R., J. Malik M. A., Dar O. A., Gull P., Wani M. Y. and Ashmi A. A. H., Heterocyclic Schiff base transition metal complexes in antimicrobial and anticancer chemotherapy. *Med. Chem. Commun.* 9 (3), 409-436 (2018)
- [8] Divya K., Pinto G. M. and Pinto A. F., Application of metal complexes of Schiff bases as an antimicrobial drug: a review of recent works. *Int. J. Curr. Pharm. Res.*, 9 (3), 27-30 (2017).
- [9] Shehata I., Kenaway I., Askalany A. H., Hassan A. A. *Can. J. Chem.*, 79: 42 (2001).
- [10] Khalil M. M., Attia A. E. Potentiometric Studies on the Binary and Ternary Complexes of Copper(II). *J. of Chem. Eng. Data*, 44: 180 (1999).
- [11] Ghosh S., Lippert B., Müller J., Smith J. M., Swart M., *Inorganica Chimica Acta, J. The International Inorganic Chemistry. Acta*, 257: 1077 (2004).
- [12] Abba H. S., Salam J. J., Prasad T. R. S., 2 (5): 225 (2005).
- [13] Malik M. A., Dar O. A., Gull P., Wani M. Y. and Ashmi A. A. H., Heterocyclic Schiff base transition metal complexes in antimicrobial and

- anticancer chemotherapy. *Med. Chem. Commun.* 9 (3), 409-436 (2018).
- [14] Manju, Joshi P. and Kumar D., Metal complexes of biological active 2-aminothiazole derived ligands. *Rus. J. Coord. Chem.*, 40 (7), 445-459(2014)
- [15] Kumara R. and Ravikant, Review on synthesis and application of Schiff base and its transition metal complexes. *Res. J. Chem. Environ. Sci.*, 2(2), 01-04 (2014).
- [16] Nagham M. et al. Synthesis of some new heterocyclic compounds derived from  $\beta$ -Lactam derivatives and Their Biological Activity Study. *J. Pharm. Sci. Res.*, 111: 2964-2968 (2018).
- [17] Dean A. J. Lange's Hand Book of Chemistry. 12<sup>th</sup> ed., Mc Graw- Hill Book Co. Inc., New York, 134: 264-275 (1978).
- [18] Spooner D. F., Sykes G. Methods in Microbiology, Academic Press, London, Vol. 51: 11- 24 (1972).
- [19] Sirajuddin M., Ali S., Haider A., Shah N. A., Shah A., Khan M. R. Synthesis, characterization, biological screenings and interaction with calf thymus DNA as well as electrochemical studies of adducts formed by azomethine [2-((3,5-dimethylphenylimino)methyl)phenol] and organotin (IV) chlorides. *Polyhedron*, 40: 122-134 (2012).
- [20] Maslem H. S., Waters T. N. The conformation of Schiff-base complexes of copper(II): a stereoelectronic view. *Coord Chem. Rev.*, 17: 137 (1975).
- [21] Boraey H. A. Structural and thermal studies of some aroylhydrazone Schiff's bases transition metal complexes. *J. Therm. Anal. Calorim.*, 81: 339 (2005).
- [22] Nishida Y., Kida S. Preparation and spectroscopic characterization of some heterobimetallic complexes of 1,1-dicarboethoxy-2,2-ethylene dithiolate involving divalent and monovalent metal ions. *Chem., lett.*, 9: 1441-1445 (1990).
- [23] Parikh V. M. Absorption Spectroscopy of Organic Molecules. (1985).
- [24] S. Jana, P. Bhowmik, M. Das, P. P. Jana, K. Harms, and S. Chattopadhyay, "Synthesis and characterisation of two double EE azido and thiocyanato bridged dimeric Cu(II) complexes with tridentate Schiff bases as blocking ligands," *Polyhedron*, vol. 37, no. 1, pp. 21-26, 2012

## تحضير وتشخيص ودراسة الفعالية البيولوجية لمعقدات Cu (II) و Ni(II), Co (II) مع مشتقات 4-(( Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene)amino)-3-methyl-8-oxo-5-thia-1azabicyclo[4.2.0]oct-2-en-2yl)oxazol-5(4H)-one)

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### الخلاصة:

تم تحضير وتشخيص معقدات العناصر الانتقالية ل Cu (II) و Ni (II) و Co (II) مع 4-(( Z)-4-bromobenzylidene)-2-(7-((4-bromobenzylidene)amino)-3-methyl-8-oxo-5-thia-1azabicyclo[4.2.0]oct-2-en-2yl)oxazol-5(4H)-one). تم الوصول إلى الأشكال الهندسية باستخدام FT-IR وقياسات التوصيلية الكهربائية والحساسية المغناطيسية , وأطياف الأشعة فوق البنفسجية والامتصاص الذري اللهيبي وكذلك <sup>1</sup>HNMR بناءً على هذه النتائج، يُقترح أن الليكاند يتناسق مع الأيونات الفلزية من النيتروجين التابعة لمجموعة الأزوميثين بالإضافة إلى أوكسجين مجموعة الكاربونيل. بالإضافة إلى ذلك، تم فحص النشاط البيولوجي للمعقدات الفلزية مع *Candida albicans* و *Aspergillus Niger* و *Staphylococcus aureus* و *E. coli* و *Candida albicans*. تشير النتائج إلى أن معقد Co (II) ومعقد Ni (II) وكذلك معقد Cu (II) يمتلك النشاط البيولوجي مقارنةً بالليكاند.