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Study of the biological activity and total antioxidant content of complexes derived from sulfonic acid and 4-hydroxybenzaldehyde

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Abstract

The research includes the preparation of a new lipophilic base derived from the condensation of sulfonic acid with 4-hydroxybenzaldehyde and reacting the product with some binary metal salts (Mn, Co, Ni, Cu, Cd, Zn, Pt, Hg). The biological study was conducted against two types of Gram-positive and Gram-negative bacteria Staphylococcus aureus and Escherichia coli, as well as Condida albicans mushrooms were used, and all the prepared complexes showed higher activity against bacteria and fungus than in the ligand of the free lipid base, and the total antioxidant content of the ligand and the complexes was studied, and the results showed that they have activity as antioxidants compared to tannic acid and gallic acid.

Keywords: Sulfonic acid, 4-hydroxybenzaldehyde, biological activity, antioxidant content, Schiff bases

Introduction

The potential biological activity of Schiff base metal complexes has attracted the attention of researchers. The main focus of her studies is to identify direct treatment agents for a wide range of bacterial infections. Especially for basal-Schiff complexes. This is because many of these complexes can serve as templates of

practical biological importance [1-3].Although Schiff bases are useful antibacterial agents, their metal complexes have much higher antibacterial activity than free ligands [4].

1-amino-2-naphthol-4-sulfonic acid A needle-like crystalline solid of light pink color (pink color), poorly soluble in water and ether, soluble in chloroform and carbon tetrachloride and in many organic solvents. It contains three main functional groups (NH2, OH, SO3H), so it plays an important role in the manufacture of dyes. It is widely used as a dye in the synthesis of pungent acid dyes [5] and the biological activity derived from the sulfonic acid of the Schiff base was studied, which showed variation in its ability to inhibit selective bacteria [6].

p-hydroxybenzaldehyde (PHB) is a light brown or light yellow crystalline solid that has a nutty and vanilla odor, is slightly soluble in water and soluble in alcohol, ether and many organic solvents, and has various pharmacological effects such as antioxidant, anti-inflammatory and vasodilating effects [7] .

practical part

L-ligand preparation **[9,8]**

(E)-3-hydroxy-4-((4-hydroxybenzylidene)amino)naphthalene-1-sulfonic acid

The ligand was prepared by dissolving (0.610g, 5mmole) of (4-hydroxy benzaldehde) in (10ml) of absolute ethanol and adding (5 drops) of icy acetic acid (CH3COOH) in a round-bottomed flask with a capacity of (100 ml), and was added to it gradually With continuous stirring, (1.195g, 5mmole) of (1-amino-2naphthol-4-sulfonic acid) dissolved in ((30ml of absolute ethanol) and then left the mixture for the reflux process for (5hrs) and at a temperature of 80°C)) after that The reaction flask was placed in an ice bath for several minutes, then the precipitate was filtered and left to dry. It gave a dark violet precipitate with a weight of (1.4g) and a percentage of (81%) and its melting point (273-276°C) as shown in Scheme (1).

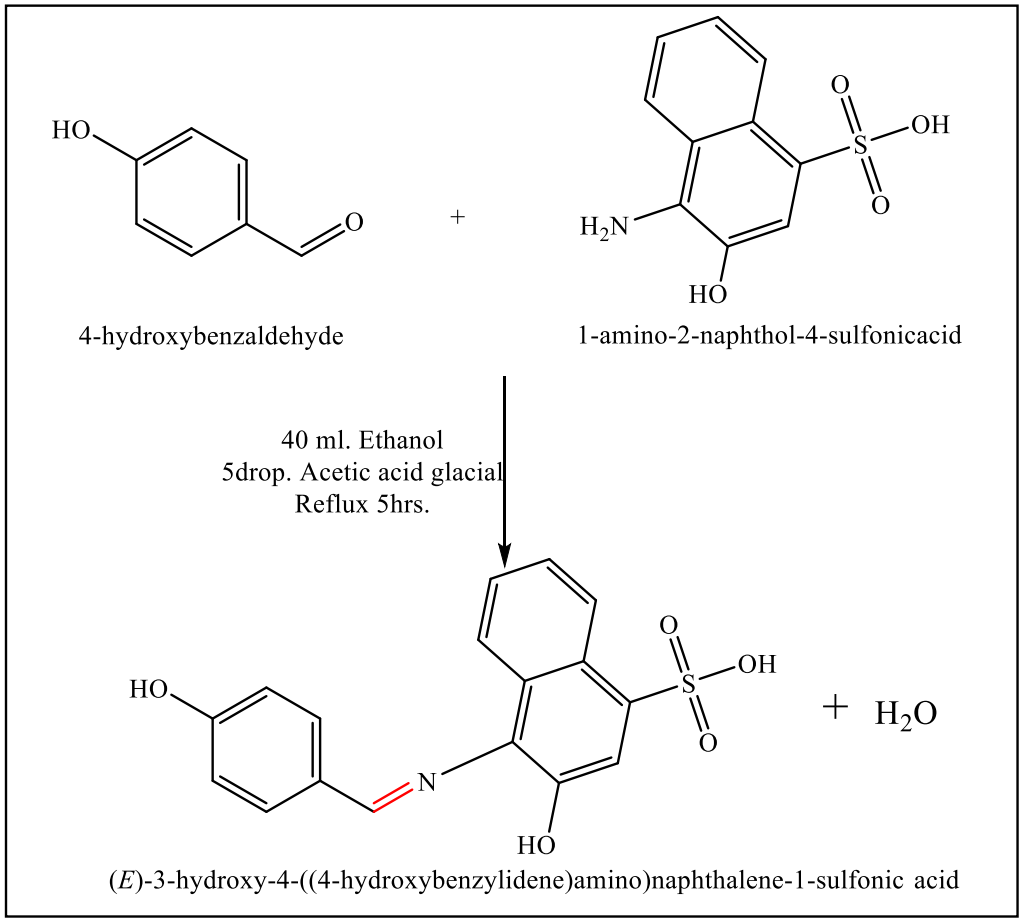


Figure (1) Preparation of Schiff base (L) ligand

Preparation of ligand complexes (L) with metal ions [(10)].

All slices of the Lycand (L) attended the LECED reactor with dual metal ions ions nicl2.6h2o cocl2.6h2o, K2ptCl4, Zncl2, HGCL2, MNCL2.4H2O, CUCL2.2H2O, CDCL2.H2O, and by (2: 1) (L) : M) Using ethanol as a solvent, as follows:

Preparation of cobalt ligand complex [Co(L)2(H2O)2]

The complex was prepared by dissolving (0.2g, 0.583mmole) of the ligand (L2) in (10ml) of absolute ethanol, then 0.06g of potassium hydroxide (KOH) dissolved in 10ml of distilled water was added to it, then 0.0693g, 0.291mmole was added.) of CoCl2.6H2O dissolved in (10ml) ethanol gradually with continuous stirring in a round-bottomed flask with a capacity of (100ml), and the mixture was left for the reflux process for a period of (4 hrs) at (80oC), then the solution was filtered after being cooled by placing it in An ice bath, then dried and weighed the precipitate (2g). The quantity of metals used in the preparation of the complexes, the molecular formulas of the prepared complexes, their weights, the percentage of the resulting complex, their colors, and some of their physical properties.

Table (1) some physical properties, weight of raw materials and the percentage of the prepared complexes

No.	Compound	Weight (g)	Empirical formula	Color	M.PC°	Yield %
1	L	0.2	$C_{17}H_{13}NO_5S$	Dark purple	273-276	81
2	$CoCl_2.6H_2O$	0.0642	$[Co\ (L)_2(H_2O)_2]$	green	259-262	88
3	$Ni\ Cl_2.6H_2O$	0.0640	$[Ni(L)_2(H_2O)_2]$	light green	390<	79
4	$CuCl_2.2H_2O$	0.0460	$[Cu(L)_2(H_2O)_2]$	light green	362-365	85
5	$HgCl_2$	0.0728	$[Hg(L)_2(H_2O)_2]$	yellow	197-200	55
6	$CdCl_2.\ H_2O$	0.0542	$[Cd(L)_2(H_2O)_2]$	Light yellow	337-340	65
7	$ZnCl_2$	0.0368	$[Zn(L)_2(H_2O)_2]$	violate	284-288	69
8	$MnCl_2.\ 4H_2O$	0.0534	$[Mn(L)_2(H_2O)_2]$	orange	390<	70
9	K_2PtCl_4	0.1120	$[Pt(L)_2]$	Maronite	172-175	89

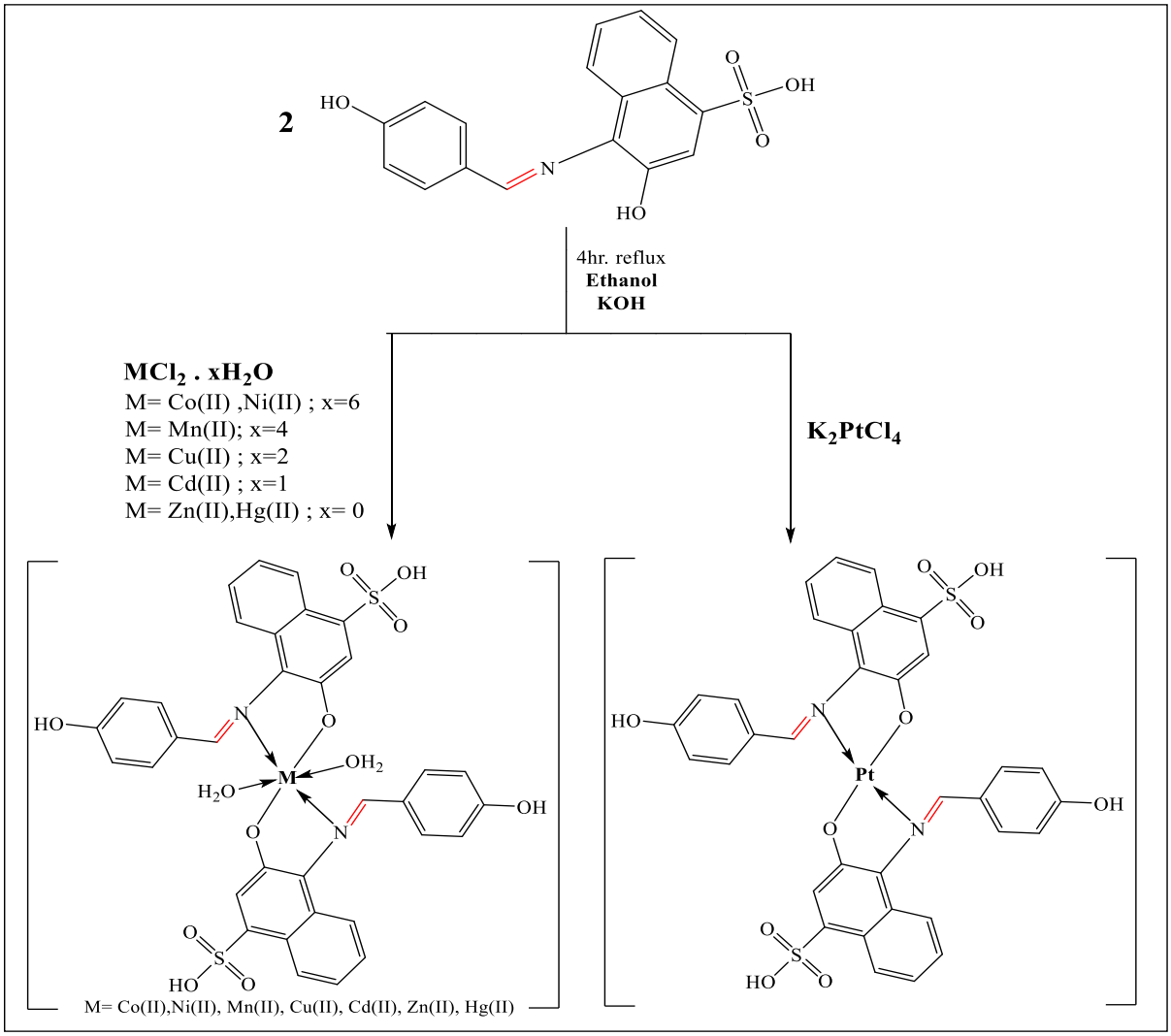


Figure (2) Preparation of complexes of the Schaff base ligand (L) with binary metal salts.

Bio study

Bacterial and fungal isolates

Two types of bacterial isolates were tested, which were obtained from the Microbiology Division/Central Laboratory Department - Quality Control Department/General Company for Pharmaceuticals and Medical Supplies Manufacturing - Samarra, one of which was Gr-ve negative (Escherichia coli) and the other was Gr-ve positive (Escherichia coli). Gr+ve) which is Staphylococcus aureus. And a type of fungus: Candida albicans.

Testing the sensitivity of bacteria and fungi to the prepared ligands and complexes [(11)].

Petri dishes with a diameter of (6.0 mm) were prepared containing Mueller Hinton agar (for fungi) and (100 µL) of microorganisms suspended with half McFarland turbidity equivalent to that of the culture medium after solidification. American Medicines USP 35) by cork borer, and certain weights of the samples were dissolved in the solvent ((DMSO) to make three different concentrations for each: (40 mg, 20 mg, 10mg). In addition to the solvent (Control: DMSO), they were incubated petri dishes at (37°C) for (24 hr) for bacterial strains and (31-32°C) for (48 hr) for fungal strain, the antimicrobial activity of each microorganism was evaluated by measuring the diameter of microbial growth inhibition (in mm) .

Total antioxidant content [(12)]

Preparing the standard solution and sample:

Different concentrations of tannic acid, standard gallic acid, and samples were prepared at concentrations from 25 to 200 micrograms per ml.

- **Solutions used : -**

The working solution consists of :

1) Solution (4 mmol ammonium molybdate).

2) Solution (28 mmol sodium phosphate).

3) Solution (600 mmol sulfuric acid).

- **Working solution:** Mix the above solutions in a 100cm3 volumetric bottle and bring the volume to the mark.

- How to work:-

1) 3 cm3 of the working solution was taken and mixed with 1 cm3 of the sample or standard.

2) The tubes were covered with aluminum foil and incubated in a water bath at (95°C) for 90 minutes.

3) The tubes were cooled to laboratory temperature and the absorbance was measured at (695nm) after zeroing out the equivalent that represents the solvent used.

Results and discussion

Biological study of prepared ligands and complexes:

Schiff base ligands and their complexes have distinct and important biological effects, as these ligands and their complexes have been used in many medical researches [13-15].

The antibacterial and antifungal biological study of ligands and complexes prepared using the inhibition method (diffusion in pits method) was conducted on two bacterial species, one of which is Gram-positive and the other Gram-negative, and one type of mushroom:

- Gram-positive Staphylococcus aureus.
- Gram-negative Escherichia coli.
- Candida albicans or vaginal fungi Candida albicans.

The effect of the prepared ligands and complexes on the above two types of bacteria and fungi was studied, using dimethyl sulfoxide ((DMSO) as a solvent and a control model (Control), which gave an effectiveness of zero, and the study was done under the same conditions to avoid solvent interference, Tables (2) and (3) show And (4) the results obtained for the ability of the prepared ligands and complexes to inhibit the growth of bacteria and fungi. Figures (1) to (9) show the bacterial and fungal activity of the prepared ligands and complexes.

Table (2) shows the significant difference between the different concentrations of lycans and the prepared complexes

Mean	Escherichia coli			Parameter
	3	2	1	
22.67a	19	23	26	L
13.33d	11	13	16	NiL
15.67b	13	15	19	CuL
13.00d	11	13	15	CoL
22.00a	18	22	26	HgL
14.33bcd	11	14	18	CdL
11.33e	9	11	14	ZnL
15.00bc	13	15	17	MnL
13.67cd	11	13	17	PtL
	12.89c	15.44b	18.67a	Mean

The results of the above table indicate significant differences between the concentrations and variables of the species (Escherichia coli) of ligands and the prepared complexes, where similar letters indicate that there are no significant differences, while different letters indicate that there are significant differences at the level of significance (0.05).

Table (3) shows the significant differences between the different concentrations of ligands and the prepared complexes

Mean	Staphylococcus aureus			Parameter
	3	2	1	
19.33b	15	19	24	L
11.33d	10	11	13	NiL
15.00c	13	15	17	CuL
13.67c	11	13	17	CoL
25.33a	21	25	30	HgL
15.00c	11	15	19	CdL
11.33d	9	11	14	ZnL
10.67d	8	10	14	MnL
13.67c	11	14	16	PtL
	12.11c	14.78b	18.22a	Mean

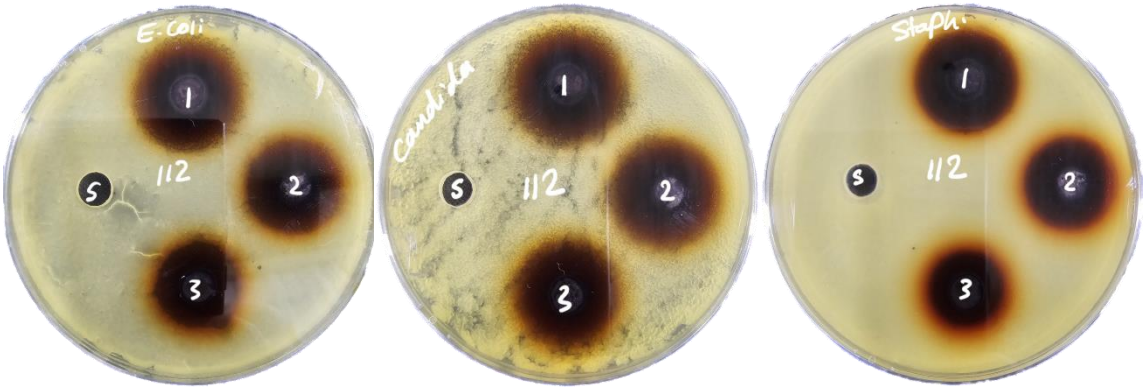
The results of the above table indicate significant differences between the concentrations and variables of the species (Staphylococcus aureus) of the ligand and the prepared complexes, where similar letters indicate that there are no significant differences, while different letters indicate that there are significant differences at the level of significance (0.05).

Table No. (4) shows the significant differences between the different concentrations of ligands and the prepared complexes

Mean	Candida albicans			Parameter
	3	2	1	

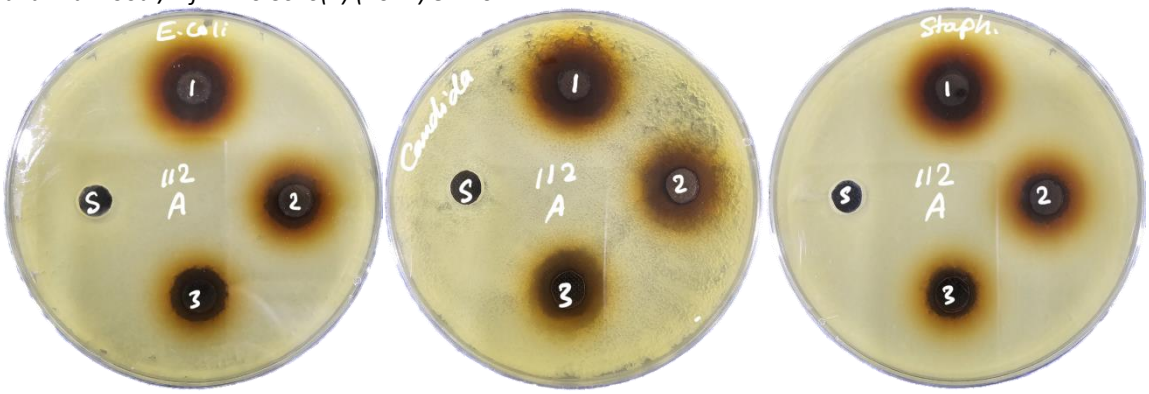
23.00b	**19**	**23**	**27**	**L**
14.23e	**12.7**	**14**	**16**	**NiL**
17.33d	**15**	**17**	**20**	**CuL**
14.33e	**12**	**14**	**17**	**CoL**
27.00a	**23**	**26**	**32**	**HgL**
20.33c	**17**	**20**	**24**	**CdL**
16.00de	**13**	**15**	**20**	**ZnL**
14.50e	**13**	**14.5**	**16**	**MnL**
15.00e	**13**	**15**	**17**	**PtL**
	15.30c	**17.61b**	**21.00a**	**Mean**

The results of the table above indicate the differences in significance between the concentrations and variables of the species (Candida albicans) of the ligand and the prepared complexes, where similar letters indicate the absence of significant differences, while different letters indicate the presence of significant differences at the significance level (0.05).



C B A

Figure (1) Bioactivity of the prepared ligand (L)

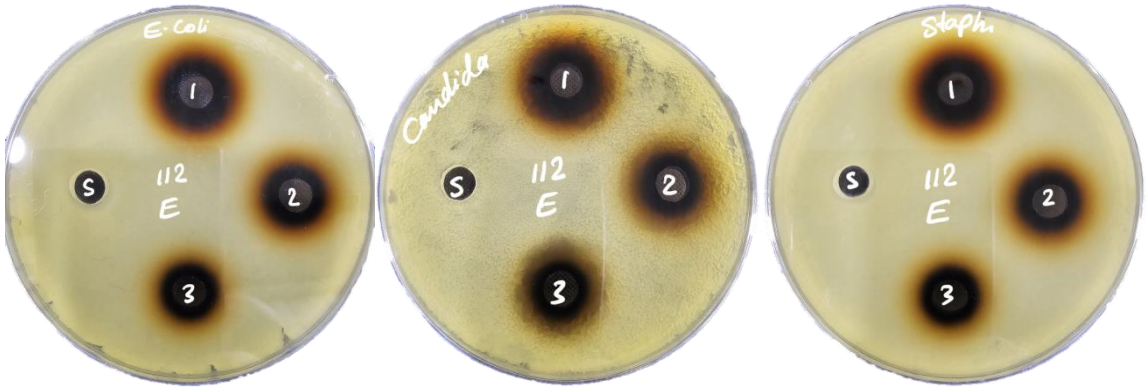


C B A

Figure (2) Bioactivity of the complex [Ni(L)2(H2O)2]

C B A

Figure 3 Biological activity of [Cu(L)2(H2O)2]

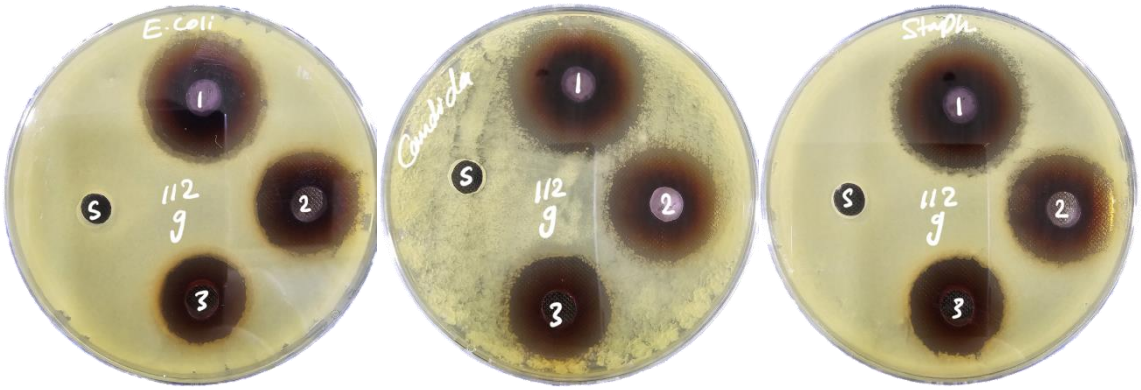


C B A

Figure 4. Bioactivity of [Co(L)2(H2O)2]

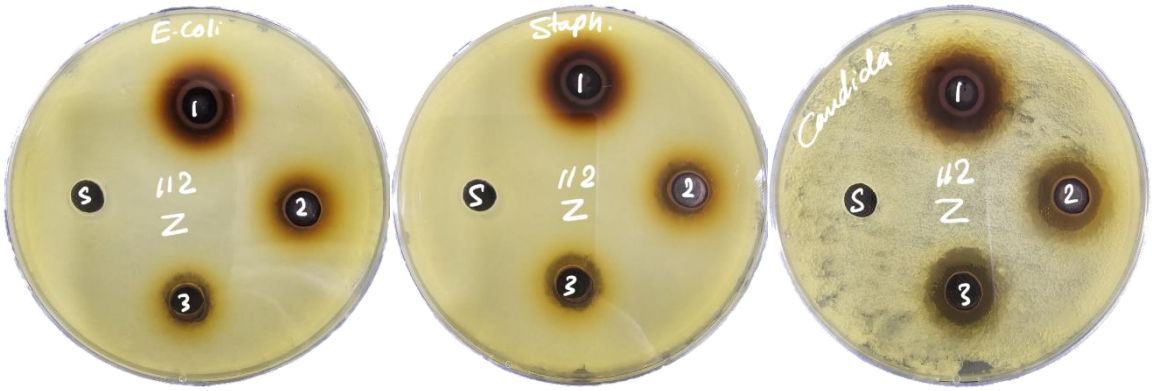
C B A

Figure 5. Bioactivity of [Cd(L)2(H2O)2]



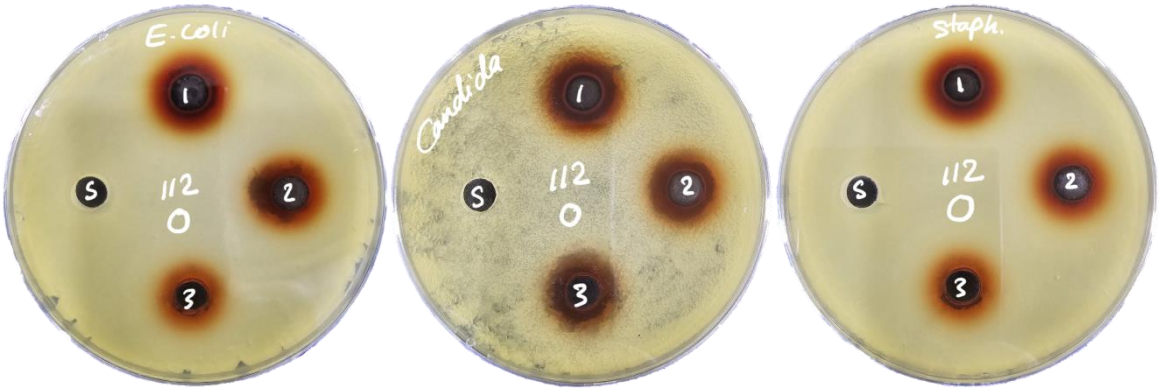
C B A

Figure (6) Bioactivity of the complex [Hg(L)2(H2O)2]



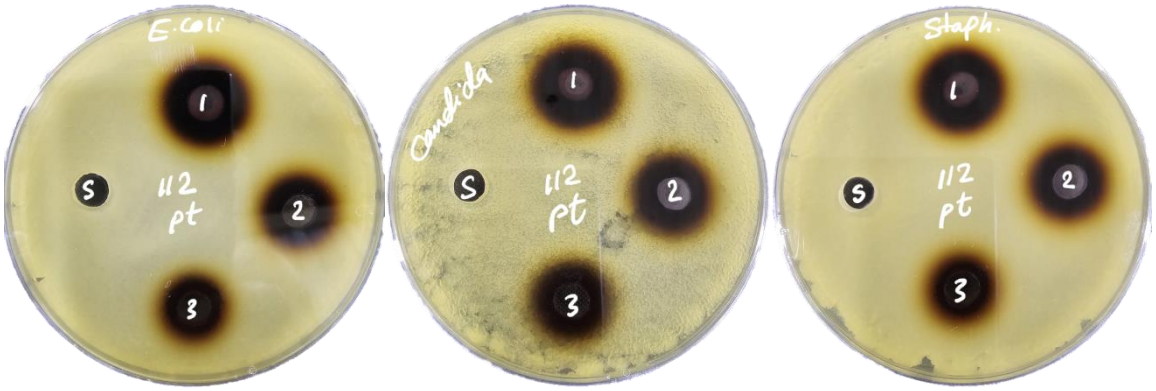
C B A

Figure (7) Bioactivity of the complex [Zn(L)2(H2O)2]



C B A

Figure (8) Bioactivity of the complex [Mn(L)2(H2O)2]



C B A

Figure (9) Bioactivity of the complex [Pt(L) 2]

Total antioxidant capacity

Free radicals play an important role in the process of treating pathological infections, as many complexes have been used as free radical inhibitors or radical scavengers, and the ligands and their metal complexes show activity as antioxidants, through the use of the prepared compounds in the treatment of diseases resulting from oxidative stress [16, 17].

The antioxidant activity of the prepared ligands and complexes was evaluated through a radical scavenging study compared to tannic acid and gallic acid. The results obtained in Tables (5) and Figure (10) show the behavior of the prepared complexes as antioxidants.

Table (5): Behavior values of the prepared complexes as antioxidants

PtL	ZnL	MnL	CdL	HgL	CoL	CuL	NiL	L	Tannic acid	Gallic acid
0.046	0.108	0.113	0.089	0.041	0.066	0.094	0.076	0.054	**0.024**	**0.02**

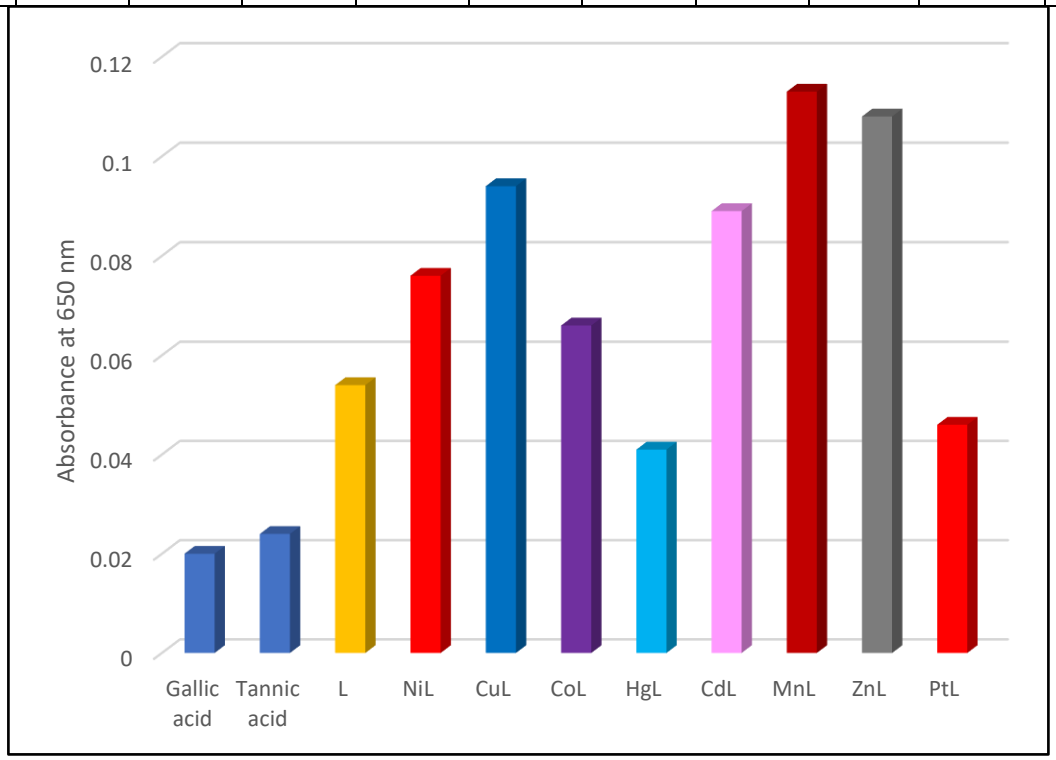


Figure (10) Behavior of (L) ligand and its complexes prepared as antioxidants

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