



Preparation, Characterization and Antioxidant Activities for New Schiff Base (Z)-6-(4-hydroxyphenylimino)-1,3-dimethyl-6,7-dihydro-1H-purin-2(3H)-one and Some Metal Ion Complexes

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ABSTRACT

Background: Elemental analysis, metal content, chloride content, molar conductance, FT-IR spectra, ¹H-NMR, UV-Vis spectra, magnetic susceptibility, and mass spectra have all been used to analyze the ligand and its metal complexes, Mn(II), Ni(II), and Cu(II). Around the world, xanthine alkaloids are frequently used as pharmacological agents; they occur naturally in beans cacao and beverages popular such as coffee and tea.

Objective: to preparation of a new Schiff base ligand (HL1) from the condensation of 1,3-dimethyl-1H-purine (2,3-((3H,7H) dione and 4-aminophenol).

Materials and methods: Antioxidant efficiencies from compounds had been estimated versus 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical as well then they have been a subject of comparison with Gallic acid that employed as phenolic reference in order to make a study of the antioxidant activity.

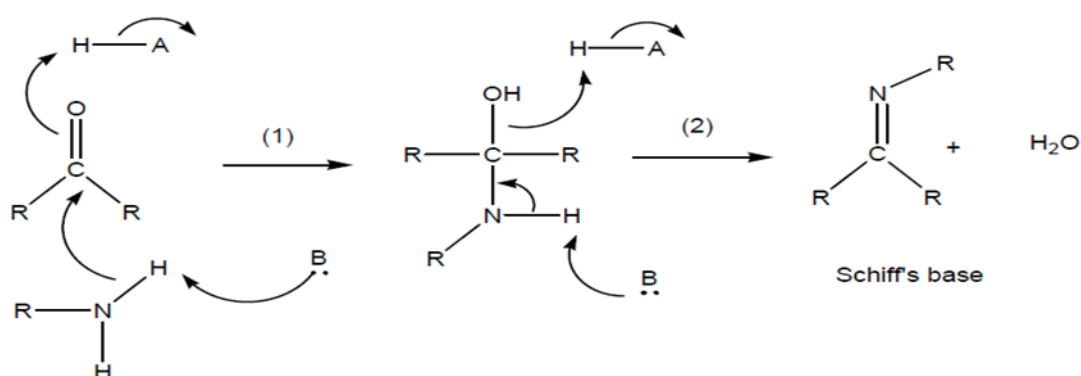
Results: The outcomes illustrate that the compounds display exceptional root scavenging efficacies.

Conclusion: Expression profile of miRNA-125b can be used as novel markers for AS.

Keywords: Schiff bases, Charge transfer (C.T), Gallic acid, Mass spectra.

INTRODUCTION

Theophylline, chemical formula (C₁₃H₁₃N₅O₂), is also known as (1,3-dimethylxanthine) or (1,3-dimethyl-3,7-dihydro-1H-purin-2,6-dione). As purines, it is composed of imidazole rings and fused pyrimidine, with the latter two endocyclic nitrogen atoms being either acidic or basic (N-9 and N-7, respectively) ^(1,2). Theophylline, a chemical with significant biological features, can be used to look into how metal ions and nucleic acid oxo purine bases interact. Theophylline is a monodentate ligand that coordinates with metal ions concurrently via N9 ⁽³⁾. Hugo Schiff, a German chemist and Nobel winner, Schiff bases discovered in 1864 ⁽⁴⁾. The Schiff base is produced via condensation of alkyl, aryl, cycloalkyl, or heterocyclic groups (RHC=N-R1), as demonstrated in (Scheme -1).



Scheme -1: Mechanism of Schiff base synthesis

Many ligands in chemical coordination because of their excellent donor abilities as chelating agent, including anticancer, antibacterial, antiviral, and antifungal medicines, have been Schiff bases ⁽¹¹⁻¹⁴⁾. Antioxidants play a critical role in anti-cancer and anti-inflammatory treatments by protecting cells from these medications' adverse effects and assisting in the prevention of heart disease, stroke, and other degenerative disorders ^(15,16). Endogenous and exogenous dietary antioxidants are critical for free radical neutralization ⁽¹⁷⁾. The different analytical methods for determining of the antioxidant capacity fall into four categories: (a) Spectrometry techniques. (b) Electrochemical techniques. (c) Chromatography techniques. (d) Fluorescence techniques.

Spectrometry techniques consist of: 1-The DPPH (2, 2-dipheyl-1- picrylhydrazyl) method, 2- The 2,2- azino-bis (3-ethylbenzthiazoline-6-sulphonic acid (ABTS) method, 3-The Ferric reducing antioxidant power (FRAP) method, 4-The Cupric reducing antioxidant power (CUPAC) assay, 5- The Potassium Ferricyanide Reducing (PFRAP) method. Blois has developed the DPPH (2, 2-diphenyl-1- picrylhydrazyl) method in 1958 from a stable free-radical α , α -diphenyl- β -picrylhydrazy ($M_{wt} = 394.3$ formula DPPH= $C_{18}H_{12}N_5O_6$) to evaluate the antioxidant activity⁽¹⁸⁾.

EXPERIMENTAL

The materials and measurements

Unless otherwise specified, all reagents and chemicals used in this investigation were obtained from trustworthy commercial sources. The following tools were used to acquire the 1H -NMR spectra: Eurovector EA 3000A was used by al-Bayt University for NMR and C.H.N microanalysis (Ultra Sheild 300 MHz) (Jordan). Gravimetric analysis determined the number of metal ions in the form of metal oxides. The molar conductance of the complexes was determined using a Conduct meter WTW at a concentration of $1 \times 10^{-3} M$. The Johnson mattey catalytic system division conducted magnetic studies at a temperature of 25 degrees Celsius. The UV vis spectrum was determined using a quartz cell of wavelength and a Shimadzu UV-1800 spectrophotometer (200-1100 nm). The FT-IR spectra were collected using a SHIMADZU (FT-IR) 8400S. Department of chemistry, University of Baghdad, Fourier transforms in the range of wavenumbers 4000 to 200 cm^{-1} using KBr disc and CsI disc. At AL-Mustansiriyah University's College of Science, mass spectroscopy was performed using GC MS-QP 2010 VLTRA equipment.

Synthesis of ligand (HL₁): (Z)-6-(4-hydroxyphenylimino)-1,3-dimethyl-6,7-dihydro-1H-purin-2(3H)-one

The reaction between 1,3-dimethyl-1H-purine-2, 3(3H, 7H)-dione and 1,3-dimethyl-1H-purine-2, 3(3H, 7H)-dione produced this linker (3H, 7H) -dione (10 mmol, 1.8 g) (10 mmol, 1.8 g) (10 mmol, 1.2 g) A 20 mL ethanol medium and 5 drops of glacial acetic acid were added to the 4-aminophenol. The mixture was mixed for four hours to allow the product to condense, and then it was filtered and washed with ethanol and water. The product was recovered and dried over anhydrous CaCl₂ in vacuum after being recrystallized from ethanol-ether (1:1) under vacuum. The ligand was found to have a melting point of 253-255 °C and an overall yield of 80%, m.wt (271 g mol⁻¹). (Scheme-2.a) the process of synthesizing ligands. Figure 1 shows the HL₁ ligand's 1H NMR spectra in DMSO-d₆. The spectrum displayed a peaks observed at δ (2.508-2.743) ppm was assigned to solvent DMSO, peaks observed at δ δ (2.752-3.217) (6H) m, (N-CH₃), δ (7.360-7.797) (5H) m arom, δ (10.743) (1H) s, (NH), 12.556 (1H) s, ph(OH).

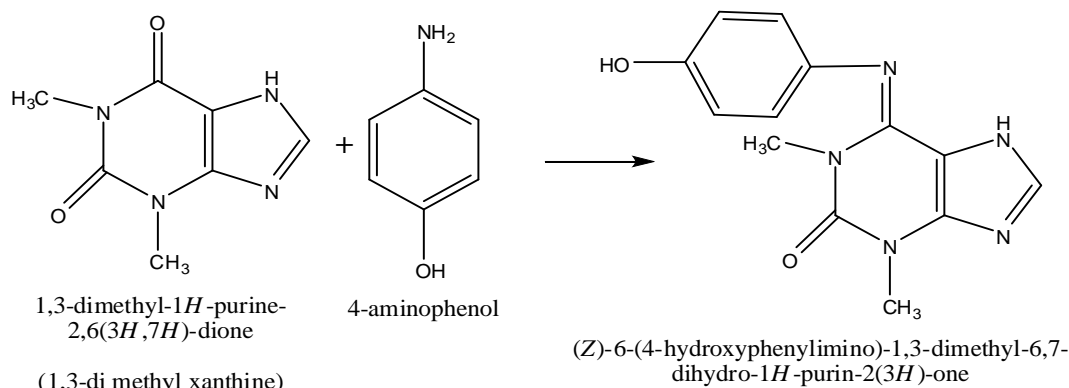
The procedures for metal complexes

The HL₁ ligand was first dissolved in 30 mL of Schiff's base, followed by the addition of (NaOH + water) while stirring, and finally the addition of a metal salt (1 mol) diluted in a 1: 1 ethanol - water solution (20 ml). Recrystallizing the crystals in diethyl ether and ethanol after filtering the precipitate and solution while they were still hot and heating the combination at reflux for two hours while stirring. The finished product was then collected and dried in a vacuum chamber over anhydrous calcium chloride. (Scheme-2b) mineral complexes having speculative structures.

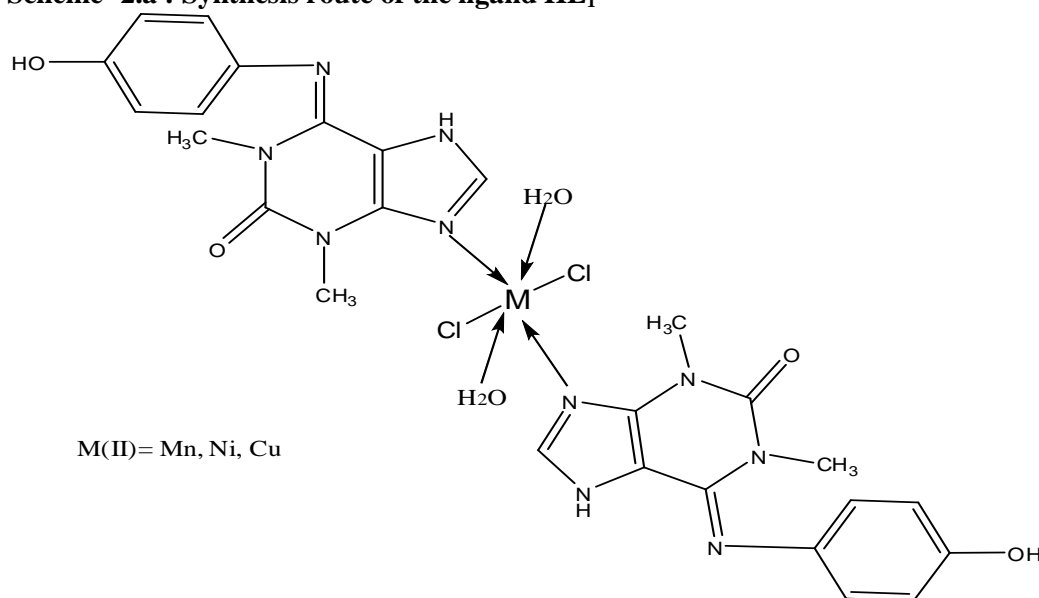
Study for antioxidant efficacy through means from DPPH manner

To study antioxidant efficacy for ligand as well metal complexes, Gallic acid was employed as a phenolic reference. Gallic acid standards were prepared using five normal solutions of varied condensation (0.2, 0.4, 0.6, 0.8, and 1 mmol l⁻¹) that were prepared using ethanol as a diluent from (10 mmol L) of Gallic acidsolution. 6 mL of a 45 g/mL DPPH solution dissolved in 100 l of each of the standard gallic acid solutions. After 30 minutes of incubation at room temperature in dark, the reactant mixture was determined to be 517 nm. We dissolved the new Schiff base ligand (HL₁) in DMSO and ethanol, together with mineral substances, to obtain a condensation of (10 mmol l⁻¹). Stock solutions had been diluted after that into (0.2, 0.4, 0.6, 0.8 as well 1 mmol.l⁻¹). Whereas gallic acid like standard, the percentage from DPPH root scavenger has been calculated utilizing Equation ⁽¹⁹⁾.

$$\text{DPPH scavenging ability (\%)} = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \times 100$$



Scheme -2.a : Synthesis route of the ligand HL₁



Scheme.2.b: Metal complexes structures

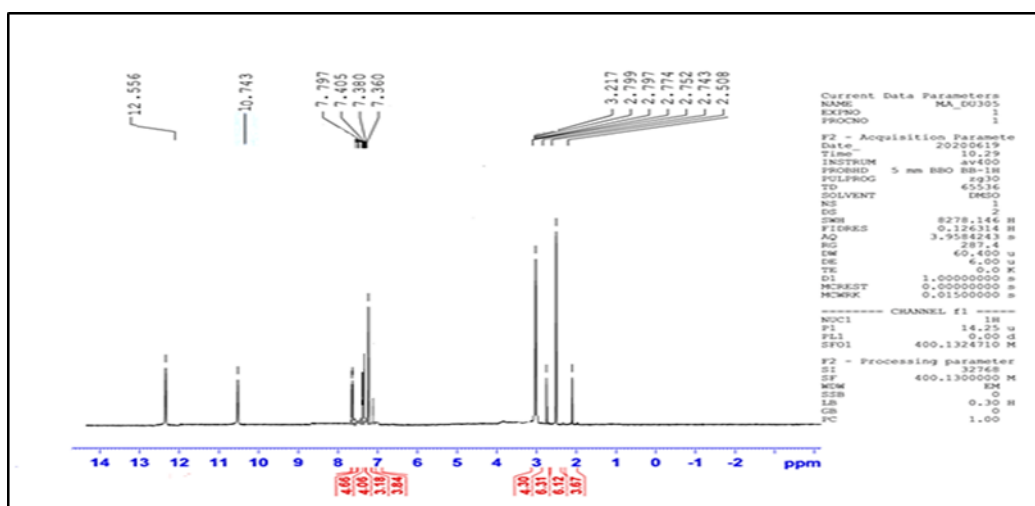


Figure -1. ¹H-NMR spectrum of ligand HL₁

RESULTS and DISCUSSIONS

Metal ions and Schiff bases were used in a 1:2 molar ratio process to form the complexes (metal:ligand). Data on physical and chemical properties are presented in the report by C.H.N microanalysis and all chemicals that are used in this work were of highest purity, available and supplied without further purification (Table-1).

Table 1: The elements that comprise the HL1 bond and its metal complexes were carefully determined, as were their compositions and different physical properties.

Amplify	Formula	M.wt	Cal (Found)% for Elemental Analysis				
			C	H	N	M	Cl
HL ₁	C ₁₃ H ₁₃ N ₅ O ₂	271	(56.30) 57.56	(4.24) 4.80	(24.50) 25.83	-	-
[Mn (HL ₁) ₂ (H ₂ O) ₂ Cl ₂]	C ₂₆ H ₃₀ N ₁₀ O ₄ MnCl ₂	703.83	(43.72) 44.32	(4.05) 4.26	(18.54) 19.89	(7.63) 7.80	(10.11) 10.07
[Ni (HL ₁) ₂ (H ₂ O) ₂ Cl ₂]	C ₂₆ H ₃₀ N ₁₀ O ₄ NiCl ₂	707.59	(43.86) 44.09	(4.10) 4.23	(18.94) 19.78	(8.13) 8.29	(9.93) 10.01
[Cu (HL ₁) ₂ (H ₂ O) ₂ Cl ₂]	C ₂₆ H ₃₀ N ₁₀ O ₄ CuCl ₂	712.44	(43.38) 43.79	(4.14) 4.21	(18.47) 19.65	(8.54) 8.91	(9.81) 9.95

Mass of the spectrum

The mass spectrum of the new linker was measured using the electron segmentation effect^(20, 21). The data from the mass spectrometry for the ligand HL₁ is examined using the electron effect (Fig. 2). This bond's expected molecular weight is (271.27) g/mol. The spectrum revealed a peak at (271) m/z that was assigned to the [C₁₃H₁₃N₅O₂] Base-Schiff moiety. Additional prominent peaks at (178, 148, 93, 80, and 70 m/z may correspond to different portions. Their abrasiveness reveals the fragments' stability. The book includes suggestions for fragmentation routes and the structural assignment of fragments (Scheme-3).

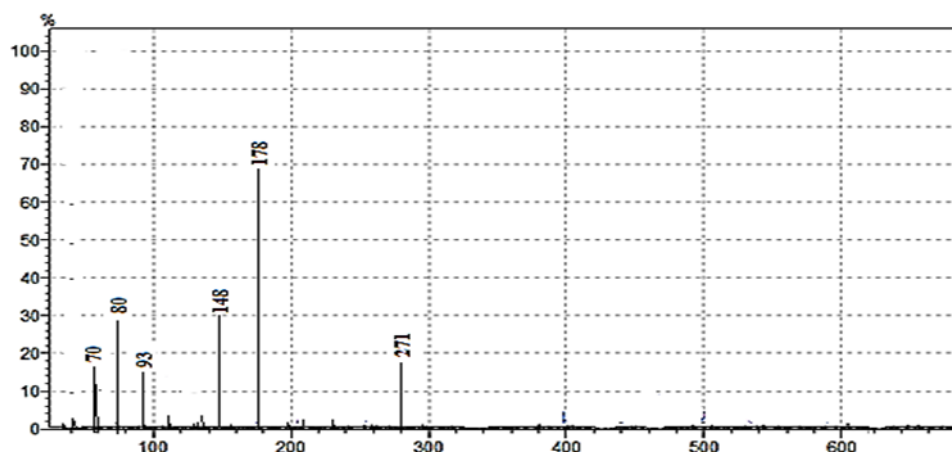
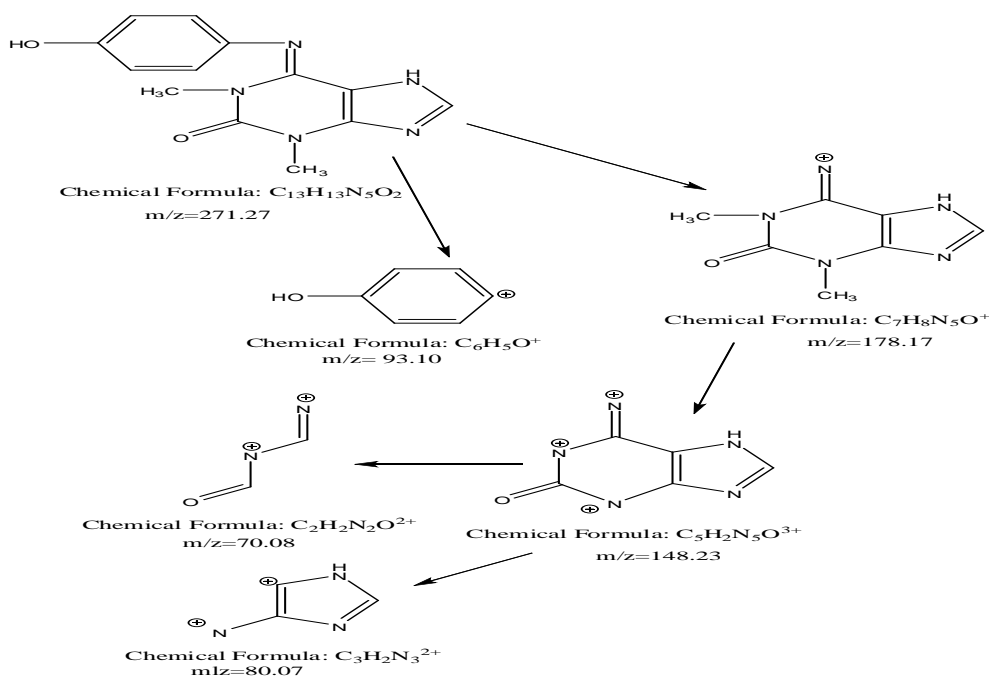


Figure 2: LC-Mass spectrum of ligand HL₁



Scheme 3. Fragmentation pattern of ligand HL₁

Infrared analysis

It is revealed in Figure 3 and Table 2 that There are presented the ligand HL₁'s significant absorption bands and those of its metal complexes. An extra band at (760,754, 768) cm⁻¹ was attributed to the (H₂O), showing that ligand coordination with the metal ion was accomplished via the H₂O atom in the IR spectrum of all complexes. Aside from that, there were new high-intensity bands (551, 535, 567) cm⁻¹ and medium-intensity bands (463,450, 474) cm⁻¹ assigned to the (M-N) region (M-Cl) (20, 22-26).

Table 2. The ligand of Infrared spectral data (HL1) and complexes metal

Sym.	$\nu(OH)$ Ph.	$\nu(CH)$ Arom	$\nu(C=O)$	$\nu(C-N)$ azomethine	$\nu(C-C)$ Arom.	δ (M- OH ₂)	ν (M- N)	ν (M- Cl)
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HL ₁	3425	3238	1737	1631	1448	-	-	-
Mn HL ₁	3402	3128	1712	1657	1485	760	551	463
Ni HL ₁	3357	3199	1724	1641	1458	754	535	450
Cu HL ₁	3362	3157	1707	1646	1463	768	567	474

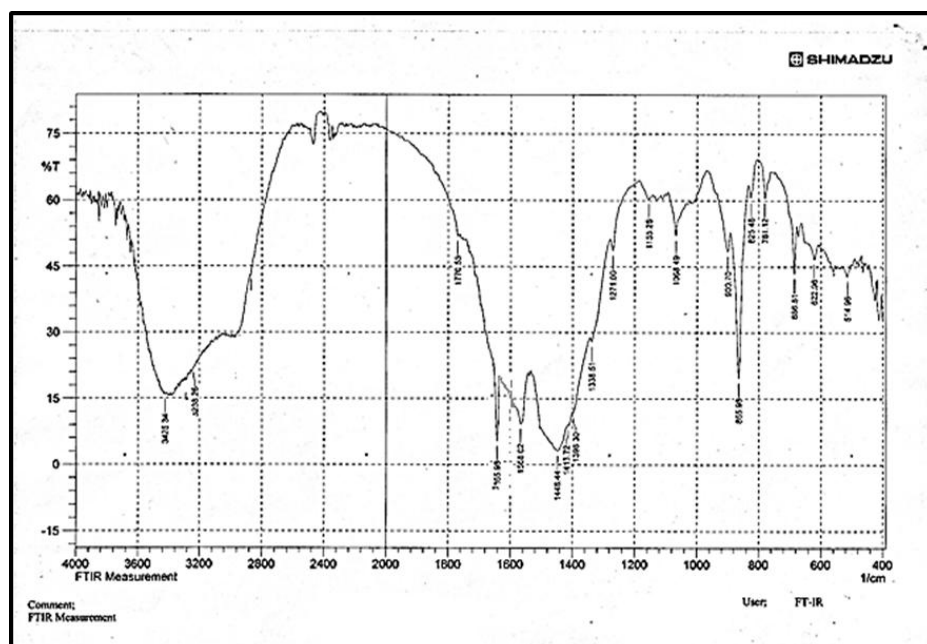


Figure 3. FT.IR Spectrum of ligand HL₁

The UV-Vis. spectra of ligand HL₁ Magnetic moments and complexes and magnetic moments explain in the (Table-3) ⁽²⁷⁻³¹⁾.

Table 3. Molar Conductivity in (DMSO 1103M) and Magnetic Moments of Metal Complexes with (HL₁) Ligand

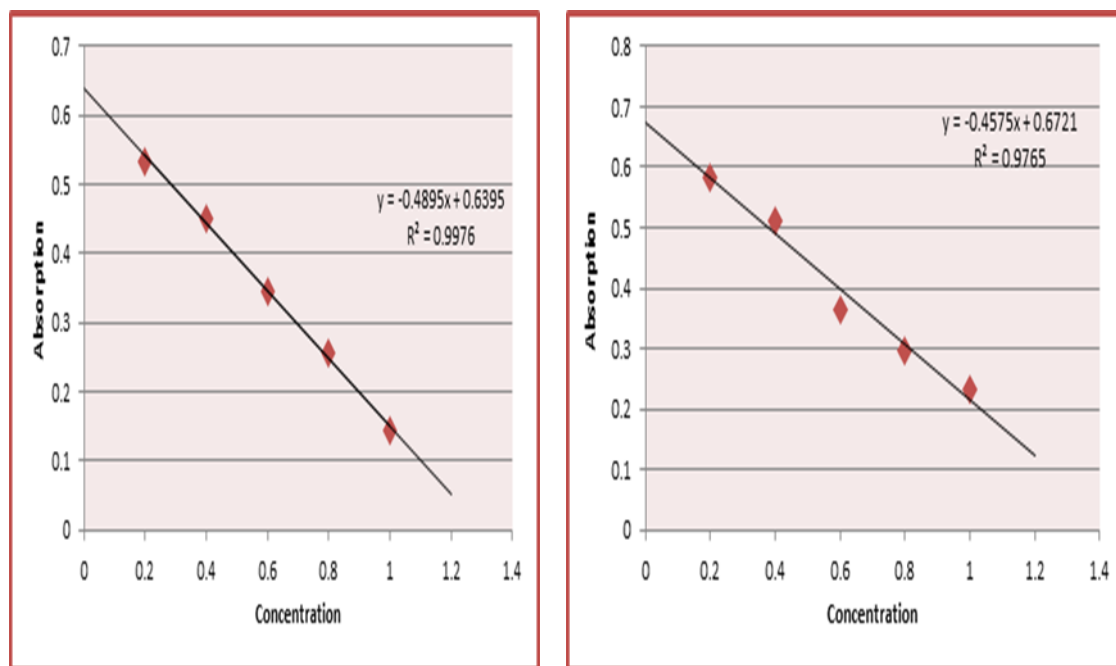
Complex \sGeometry	λ_{\max} (nm)	ν cm ⁻¹	ABS	ϵ_{\max} L mol ⁻¹ cm ⁻¹	Assignment	Λ_m cm ² Ω ⁻¹ mol ⁻¹	μ_{eff} B.M

HL₁	264	37878.7	2.124	2124	$\pi \rightarrow \pi^*$	-	-
	322	31055.9	1.450	1450	$n \rightarrow \pi^*$		
	346	28901.7	1.225	1225	$n \rightarrow \pi^*$		
[Mn (HL₁)₂ (H₂O)₂Cl₂] Oh	289	34602.0	1.825	1825	L.F		
	318	31446.5	1.510	1510	C.T	13.18	5.03
	475	21052.6	1.224	1224	${}^6A_{1g} \rightarrow {}^4T_{2g}(G)$		
	530	18867.9	0.782	782	${}^6A_{1g} \rightarrow {}^4T_{2g}(F)$		
	718	13927.5	0.524	524	${}^6A_{1g} \rightarrow {}^4E_g(D)$		
[Ni (HL₁)₂ (H₂O)₂Cl₂] Oh	275	36383.6	2.237	2237	L.F		
	332	30120.4	1.645	1645	C.T	12.57	2.21
	470	21276.5	1.244	1244	${}^3A_{2g}(F) \rightarrow {}^3T_{1g}(P)$		
	590	16949.1	0.627	627	${}^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$		
	665	15037.5	0.426	426	${}^3A_{2g}(F) \rightarrow {}^3T_{2g}(F)$		
[Cu (HL₁)₂ (H₂O)₂Cl₂] Oh	279	35842.2	2.053	2053	L.F		
	312	32051.2	1.613	1613	C.T	17.15	1.85
	535	18615.8	0.559	559	${}^2E_g \rightarrow {}^2T_{2g}$		

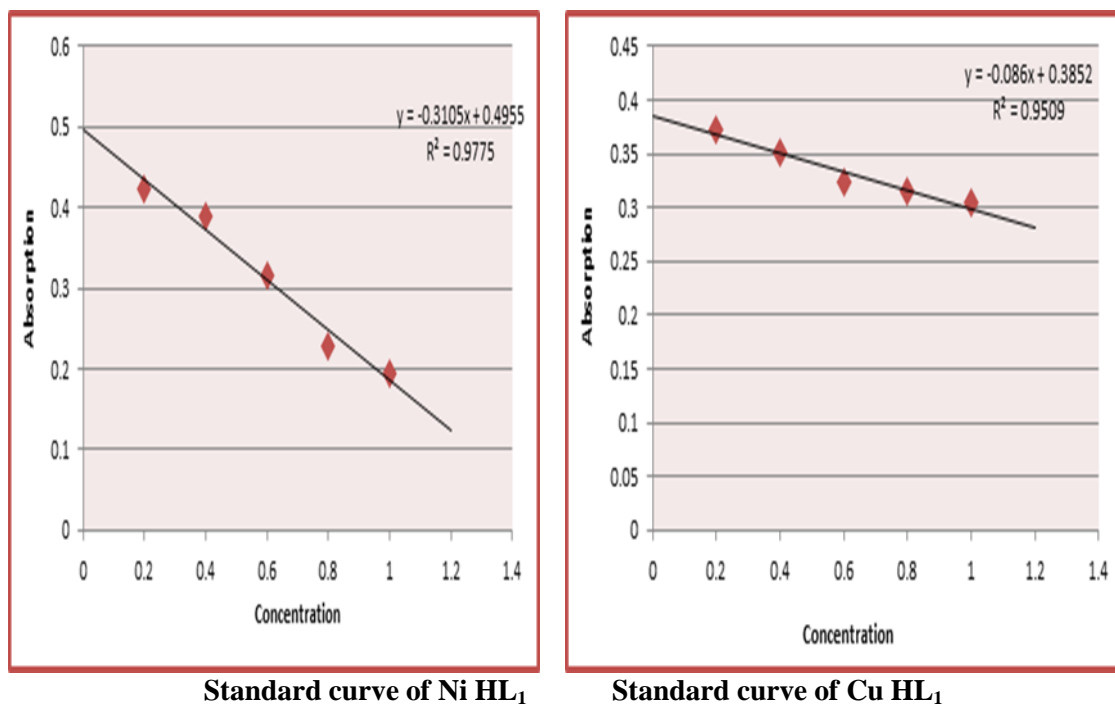
Oh= Octahedral

Antioxidant efficacy for ligand HL₁ as well metal complexes by DPPH manner

DPPH reacts with ligand and their metal complexes purple to yellow color change, this is shown in (Scheme - 4), after the reduction which can be measurement by their absorbance at 517 nm UV-Vis spectrophotometer⁽³²⁻³⁶⁾, which shown in (Figure-7). The following order of antioxidant activity: (Cu HL₁ > Ni HL₁ > HL₁ > Mn HL₁) at 30 minute, the metal complex Cu HL₁ show more antioxidant activity at 30 minute, which shown in (Figures- 8,9).



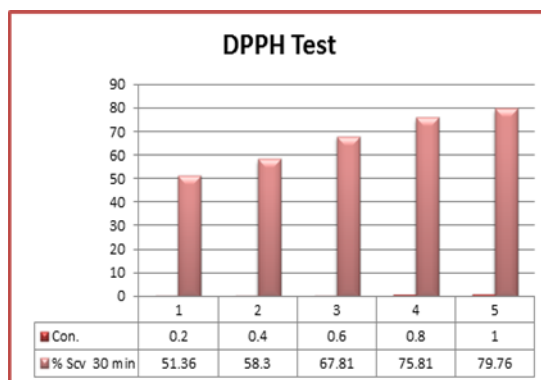
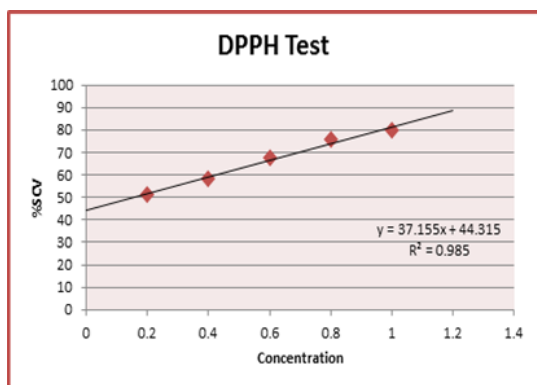
Standard curve of HL₁ Standard curve of Mn HL₁



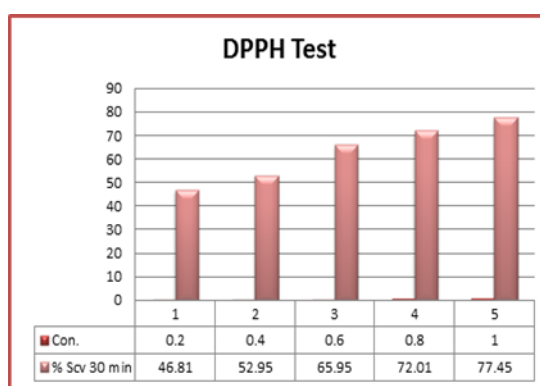
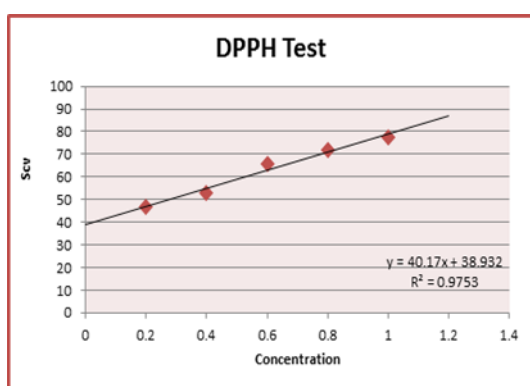
Standard curve of Ni HL₁

Standard curve of Cu HL₁

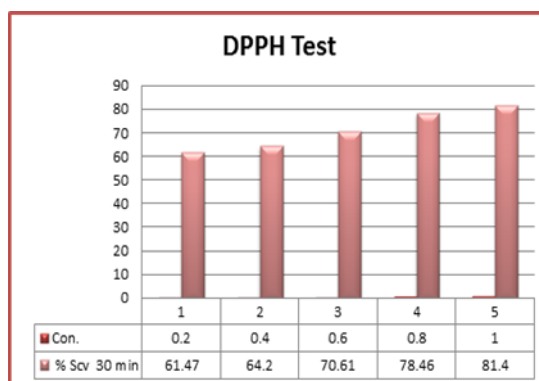
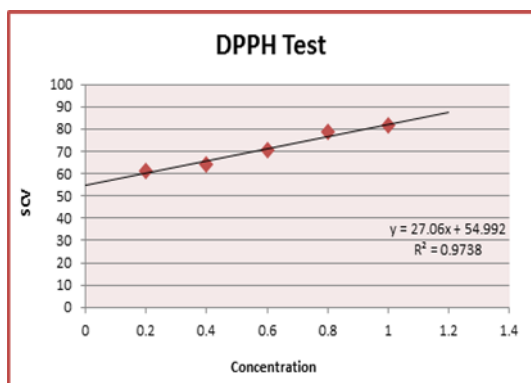
Figure 7 . Standard curve of HL₁ , Mn HL₁, Ni HL₁ and Cu HL₁ complexes .



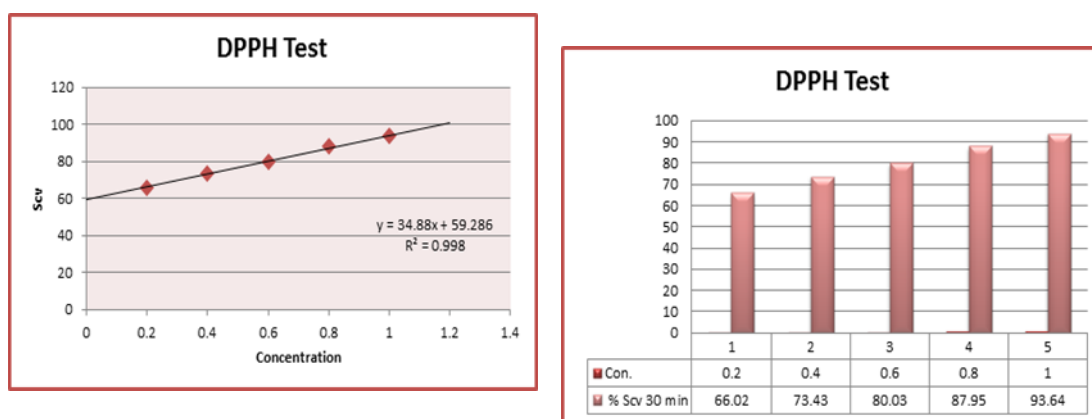
DPPH scavenging activity of HL₁ at 30 minute



DPPH scavenging activity of Mn HL₁ at 30 minute



DPPH scavenging activity of Ni HL₁ at 30 minute



Cu HL₁'s DPPH scavenging activity at 30 minute

Figure 8. DPPH scavenging activity of HL₁, Mn HL₁, Ni HL₁ and Cu HL₁

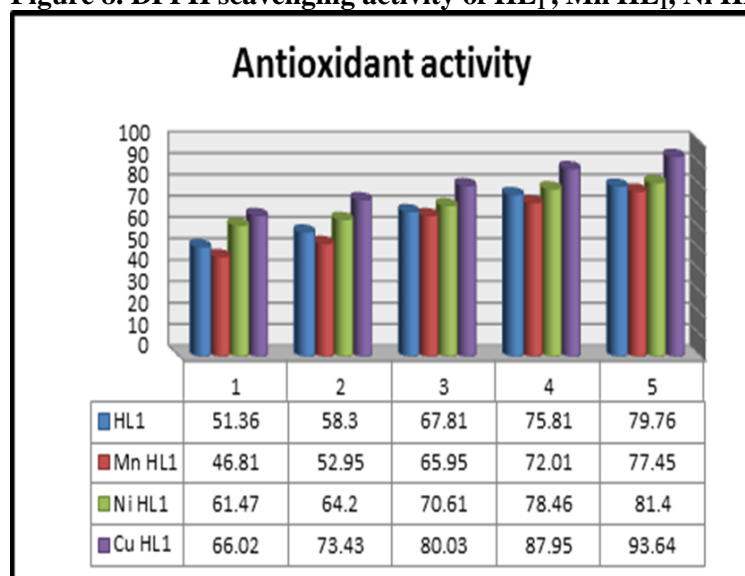


Figure 9. Antioxidant activity of HL₁, Mn HL₁, Ni HL₁ and Cu HL₁ complexes

STATISTICAL ANALYSIS

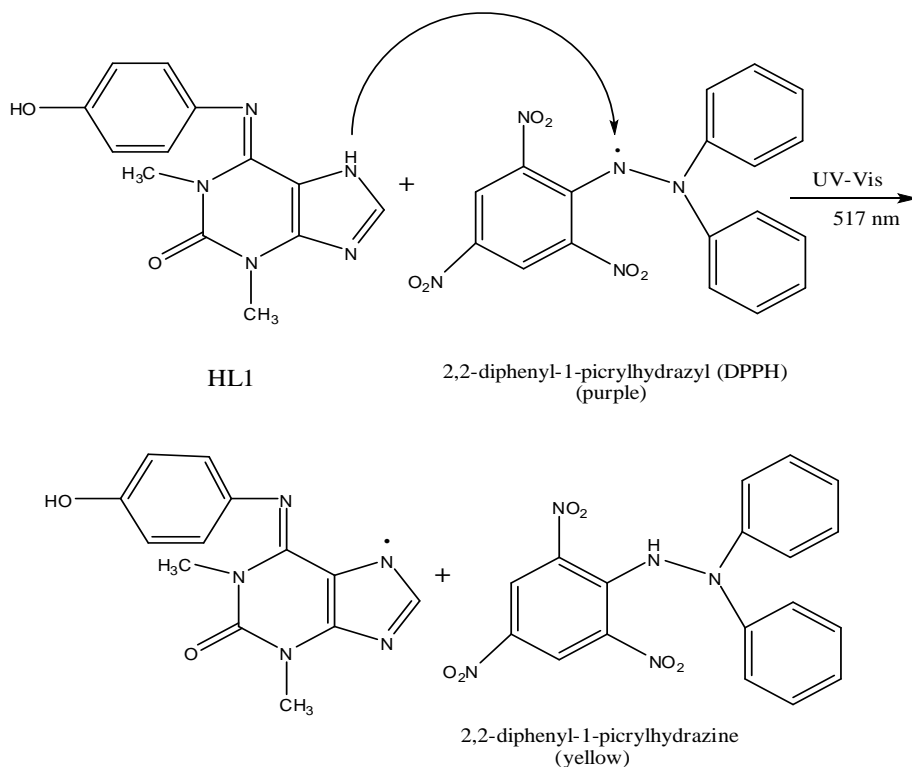
All analyses have been performed at Excel as well stated like mean, standard deviation, and the like are all terms for The standard deviation, expressed as a percentage, the correlation coefficient as well IC₅₀ are shown at (Table .4).

Table 4. IC₅₀ values, means, standard deviations, coefficients of variation, and correlation coefficient for antioxidant efficacy reported as percentages (aa percent) from 30.

Examined Samples	Mean	Standard deviation	Coefficient variation %	Correlation coefficient	IC ₅₀
HL ₁	66.608	11.838732	17.773738	0.992458943	0.1530
Mn HL ₁	63.034	12.862716	20.405996	0.987572819	0.2755
Ni HL ₁	71.228	8.6712840	12.173982	0.986834606	-1.8447
Cu HL ₁	80.214	11.041165	13.764635	0.992635017	-2.6627

GA	93.560	2.0846822	2.2281768	0.996610607	- 6.0301
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Where IC₅₀: Half maximal inhibitory condensation



Scheme 4. Proton transfer transforms DPPH (purple) to hydrazine (yellow) by adding (Ligand HL₁) molecules.

CONCLUSION

A new Schiff base ligand (HL₁) (Z)-6-(4-hydroxyphenylimino)-1,3-dimethyl-6,7-dihydro-1H-purin-2(3H)-one was used to synthesize novel Mn(II), Ni(II), and Cu(II) metal complexes. Physico-chemical and spectroscopic methods were used to find the bonding mechanisms complexes and overall structure. According to the structure of the complexes based on Uv-vis and FT-IR spectra, all complex metals have octahedral geometry, and the metal complex Cu HL₁ is one such example. show more antioxidant activity at 30 minute (Figure -10).

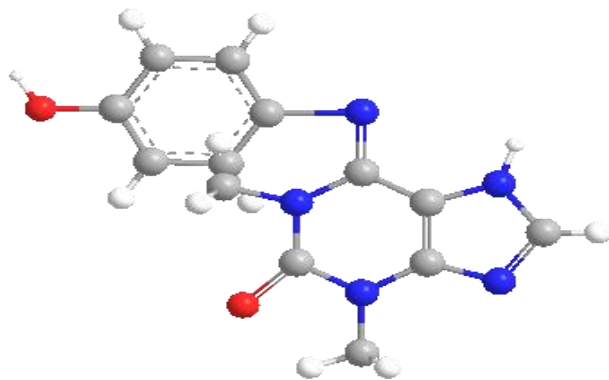


Figure 10. The chemical structures 3D of the ligand HL₁

Consent:I attest that everyone signed off on the manuscript submission.

Data and material accessibility: available.

No competing interests.

Financing: None.

Potential Conflicts of Interest: The authors affirm that they have none regarding the publishing of this research.

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