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Synthesis, Characterization and Biological Evaluation Studies of 4-((3-Formyl-4-hydroxyphenyl) diazinyl) -N-(4-methyloxazol-2-yl) Benzene Sulfonamide With Cu(II), Ni (II), Zn(II) and Ag(I) Using a Microwave Irradiation.

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GREEN chemistry, a novel and simple method have been developed for the synthesis of some a new series of complexes of 4-((3-Formyl-4-hydroxyphenyl) diazenyl) -N-(4-methyloxazol-2-yl) benzenesulfonamide with the metal salts of Cu(II), Ni(II), Zn(II), and Ag(I)using a microwave irradiation. The structure of these sulfonamide compounds has been investigated by using elemental analysis, FT-IR, ^{1}H NMR, UV-Vis spectrometric methods, magnetic susceptibility, conductivity measurements and thermal studies. These compounds were screened for *in-vitro* antibacterial activity against staphylococcus aureus and Streptococcus mutans (Gram positive bacteria), Escherichia coli, Pseudomonas aeruginosa and klebsiella (Gram negative bacteria) and for *in-vitro* antifungal activity against Candida albicans. The results of the antimicrobial activity studies showed that metal complexes have higher activities than parent ligand. Also, ligand displayed potent antioxidant activity.

Keywords: Green chemistry, Sulfonamide derivatives, Complexes, Spectral studies, Antimicrobial activity, Antioxidant activity.

Introduction

It is widely acknowledged that there is a growing need for more environmentally acceptable processes in the chemical industry. This trend towards what has become known as 'Green Chemistry' [1-10]. 'Sustainable technology' necessitates a paradigm shift from traditional concepts of process efficiency, that focus largely on chemical yield, to one that assigns economic value to eliminating waste at source and avoiding the use of toxic and/or hazardous substances. The sulfonamides were the first effective chemotherapeutic agents to be employed systematically for the prevention and cure of bacterial infection in human beings [11]. Due to that the Sulfonamides inhibit the growth and multiplication of bacteria by their interfering with the synthesis of the folic acid [12], sulfonamides are the important class of drugs with several types of pharmacological activities such as antibacterial, anticancer, carbonic anhydrase inhibitory, antimalarial, antihypertensive and anti-inflammatory [13,14].

Also, chalcone derivatives contain α, β-unsaturated carbonyl moiety possesses a broad spectrum of biological activity in both medicinal and pharmaceutical, such as antimicrobial, anti-inflammatory, antitubercular, antioxidant and anticancer [14]. Besides some azo compounds have shown a good antibacterial activity. Furthermore, the existence of an azo moiety in different types of compounds has caused

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them to show inhibition of DNA, RNA, and protein synthesis [15]. Furthermore, some metal sulfonamides have been attracted much attention due to higher activities than free ligands and the corresponding metallic salts [16].

Based on the mentioned properties for sulfonamide and azo compound, it was reported here in the synthesis and characterization of a novel azo-dye derivative derived from sulfamethoxazole and its Cu(II), Ni(II), Zn(II), Ag(I), complexes. The antimicrobial activity of the new synthesized metal complexes also tested beside antioxidant activity of ligand was determined.

Material and Methods

Experimental

All chemicals used in the present study were of pure grade. The electronic absorption spectra (UV-Visible) of ligand and the metal complexes were obtained in DMF solvent from 900-200nm range using perkin-Elmer Lambda 35 UV/Vis Spectrophotometer fitted with a quartz cell of 1.0 cm path at Al-Azhar University. Thermal analysis measurements (TGA) were carried out on Shimadzu thermal analyzer model 50 at Cairo University, Egypt. The Fourier transform infrared spectra with the samples dissolved in K Br were recorded using a Vertex 70 Analyzer, Bruker, USA from 4000-200 cm^{-1} at Tanta University, Egypt. The C, H, N analyzer is carried out using a Flash 2000 organic Elemental Analyzer at Al-Azhar University. The 1H NMR spectra were recorded on an Agilent Technologies model spectrometer NMR400-mercury 400. 1H spectra were run at 400 MHz and 13C spectra were run at 75.46 MHz in (DMSO-d_6) at Cairo University. The conductivity of the solution was recorded using conductivity meter (JENWAY-3540, U.K) at Al-Azhar University. The magnetic Susceptibility were done by using Sherwood Scientific magnetic balance, Cambridge science. park, Cambridge, England Model no. MKI, Serial no. MSBI /230/95/680 at Cairo University. Metals were determined by complex metric titration [17]. Mass Spectra of the ligands performed by MS-QP1000 EX mass spectrometer at 70 e. v using the direct inlet system at Cairo University. The biological activity evaluation of compounds was determined at the Regional Center for Mycology and Biotechnology (RCMB) at Al-Azhar University.

Synthesis of Azo-dye sulfonamide.

Diazotization and coupling.

Sulfamethoxazole (0.01mol) mixed with a mixture of Conc. H Cl and water and then digested on a water bath for 30 min. The sulfamethoxazole hydrochloride was cooled to 0°C and diazotized with ice-cold aqueous $NaNO_2$ solution (2 g, 50 mL) water, stir the solution well during the diazotization, and keep the mixture at a temperature of 0–5 °C by the addition of a little crushed an ice-cold from time to time. The very soluble diazonium salt is formed. We dissolved salicylaldehyde (0.01mol) in 10% KOH solution (100 ml) water, cooled in ice and add the diazotized solution slowly and with stirring, then add concentrated hydrochloric acid slowly and with constant stirring to the cold mixture. The yellow orange precipitate separated out. The precipitate was filtered, washed several times with water to remove excess hydrochloric acid and water-soluble materials, and finally dried in air. The crude product was washed with hexane to remove any tarry materials, dried in a vacuum and recrystallized with ethanol to yield yellow powder of 4-((3-Formyl-4-hydroxyphenyl) diazenyl) -N-(4-methyloxazol-2-yl) benzene sulfonamide [18].

Preparation of metal complexes by reflux.

4 - ((3 - Formyl - 4 - hydroxyphenyl) diazinyl) - N - (4 - methyloxazol - 2 - yl) Benzene Sulfonamide and the metal salts $Cu(CH_3COOH)_2H_2O$, $Ni(CH_3COOH)_2.4H_2O$, $Zn(CH_3COOH)_2.4H_2O$, and $AgNO_3$ in (2M:1M) mixed together. The metal salts were dissolved in ~50 mL methanol. This solution was added dropwise to the ligand dissolved in ~50 mL methanol with continues stirring. The mixture was heated under reflux for 2.0 hrs. The precipitate was formed and filtered off, washed with diethyl ether and finally dried in an open air. The physical properties of the metal complexes are listed in Table 1.

Preparation of metal complexes by microwave irradiation method.

4- ((3 - Formyl - 4 - hydroxyphenyl) diazinyl) - N - (4 - methyloxazol - 2 - yl) Benzene Sulfonamide and the metal salts $Cu(CH_3COOH)_2H_2O$, $Ni(CH_3COOH)_2.4H_2O$, $Zn(CH_3COOH)_2.4H_2O$, and $AgNO_3$ in (2M:1M) mixed together. The reaction mixture irradiated in 1-3 ml of methanol. The reaction completed in a short time (3-10 min) with higher yield [6-10]. The resulting product was washed with ethanol and ether and finally dried under reduced pressure

over anhydrous $CaCl_2$ in a desiccator. The progress of the reaction and purity of the product was monitored by TLC using silica gel G (yield: 89 - 93 %). Physical, analytical and spectral data is given in Tables 1 and 2.

Procedure for antibacterial activity

The synthesized compounds, 1-5 were studied against Gram-negative, Gram-positive bacteria and fungi. Bacterial strains according to the literature protocol and their results were screened for their antimicrobial activity against six different test organisms having environmental and clinically importance the antimicrobial activity of synthesized compounds using agar well diffusion method. All the compounds were tested in vitro for their antibacterial activity against staphylococcus aureus and Streptococcus mutans (Gram positive bacteria), Escherichia coli, Pseudomonas aeruginosa and klebsiella (Gram negative bacteria) using nutrient agar medium. Ampicillin and Gentamicin were used as standard drugs for Gram positive and Gram negative respectively. DMSO was used a solvent control. The compounds were tested at a concentration of 15 mg/ml against both bacterial and fungal strains.

TABLE 1.Physical and analytical data for ligand and its metal complexes.

Symbol Molecular formula	Yield% Microwave	Time (min)	M.P ^{0}C.	Color	Yield% Reflux	Elemental analysis found (Calc /found) % C	H	N	M
Ligand (HL)						52.85	306	14.13	
$C_{17}H_{14}N_4O_5S$ (386)			220	Orange		(52.84)	3.65	(14.50)	
$[Cu(L)_2]H_2O$ (LC)				Dark		48.91	3.31	13.15	7 .46
					74				
$C_{34}H_{28}N_8O_{11}S_2Cu$ (852)	93	10	>300	Green		(49.13)	(3.76)	(13.69)	(7.98)
$[Ni(L)_2(H2O)_2]$ $(H_2O)_4$ (LN)						43.56	4.09	9.95	6.26
	92	8	<300	Brown	75				
$C_{34}H_{38}N_8O_{16}S_2Ni$ (937)						43.41	4.01	9.65	7.24
$[Zn(L)_2(H2O)_2]$ $(H_2O)_5$ (LZ)					73	42.44	4.19	11.65	6.8
	89	9	>300	Brown					
$C34H40N8O17S_2Zn$ (962)						(42.08)	3.50)	(11.74)	(5.2)
$[Ag(L)_2]$ $(H2O)_2$ (LA)				Brown		44.85	3.31	12.25	11.79
					77				
$C_{34}H_{30}N_8O_{12}S_2Ag$ (914)	90	8	>300			(44.77)	(3.06)	(11.79)	(12.04)

TABLE 2: Major IR absorption bands (cm^{-1}) of sulfonamide derivatives and its complexes.

Compound	Assignment					
	ν (C=O)	ν (C=N)	ν C-O	ν (N=N)	νas(S=O)	νs(S=O)
HL	1660	1620	1279	1471	1342	1170
LC	1706	1618	1269	1472	1342	1170
LN	1720	1617	1266	1473	1342	1169
LZ	1756	1618	1265	1471	1344	1168
LA	1730	1616	1268	1468	1345	1167

Disc diffusion method.

The sterilized media was poured onto the sterilized Petri dishes (20-25 ml, each petri dish) and allowed to solidify at room temperature. Microbial suspension was prepared in sterilized saline equivalent to McFarland 0.5 standard solution (1.5x 105 CFU mL-1) and its turbidity was adjusted to OD= 0.13 using spectrophotometer at 625 nm. Optimally, within 15 minutes after adjusting the turbidity of the inoculum suspension, a sterile cotton swab was dipped into the adjusted suspension and was flooded on the dried agar surface then allowed to dry for 15 minutes with lid in place. Wells of 6 mm diameter were made in the solidified media with the help of sterile borer. 100 µ L of the solution of the tested compound was added to each well with the help of micropipette. The plates were incubated at 37°C for 24h in case of antibacterial activity. This experiment was carried out in triplicate and zones of inhibition were measured in mm. scale. [19].

Microdilution method

The minimal inhibition concentration (MIC) is defined as the lowest concentration of the compounds to inhibit the growth of the microorganisms. For each strain, three to five isolated colonies were selected from the fresh agar plate and were transferred into a tube containing 3-4 ml of sterile broth medium. The bacterial suspension was mixed well and incubated at 35-37°C for 2-6 h. The turbidity of the bacterial suspension should be equal to or greater than the turbidity of a McFarland Standard 0.5. After that, 1 mg of the tested compound (antimicrobial agent) was dissolved in 1 ml DMSO and two-fold serial dilution was done using broth medium. A fixed volume of the prepared bacterial inoculum was added to each tube and incubated for at 37°C 16-20 h. The MIC is defined as the lowest concentration of the antimicrobial agent that inhibits visible growth of the tested isolate as observed with the unaided eye [20].

Antioxidant assay

The antioxidant activity of extract was determined *by* the DPPH free radical scavenging assay in triplicate and average values were considered. Freshly prepared (0.004%w/v) methanol solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical was prepared and stored at 10 ^{0}C in the dark. A methanol solution of the test compound was prepared. A 40 µL aliquot of the methanol solution was added to 3ml of DPPH solution. Absorbance measurements were recorded immediately with a UV-visible spectrophotometer (Milton Roy, Spintronic 1201). The decrease in absorbance at 515 nm was determined continuously, with data being recorded at 1 min intervals until the absorbance stabilized (16 min). The absorbance of the DPPH radical without antioxidant (control) and the reference compound ascorbic acid were also measured. All the determinations were performed in three replicates and averaged. The percentage inhibition (PI) of the DPPH radical was calculated according to the formula [21].

PI = [{(*A*C- *A*T)/ *A*C} x 100] (1) Where *A*C = Absorbance of the control at t = 0 min and *A*T = absorbance of the sample +DPPH at t = 16 min

Results and Discussion

Characterization of compounds

Microwave results observed that the reaction completed in a short time with higher yield compared to the conventional method and homogeneity of the reaction mixture increase [18]. The results have been confirmed by repeating the synthesis process many times. The obtained ligand and metal complexes are colored, solid, stable towards air at room temperature, insoluble in ethanol, methanol while soluble in DMF and DMSO. The analytical data of the obtained complexes tabled in Table 1. The conductivity in none aqueous solutions like (DMF) had frequently been used in the structure study of metal complexes within the limits of their solubility. It is clear from the conductivity data, shown in Table 4, that all the complexes (1:2) (M: L) have lower values of conductivity with non-electrolytic nature of conductivity [15,22] Physical measurements and analytical data of the complexes are given in Table 1.

3.2. IR spectra

FT-IR spectra of the produced complexes and ligand carried out and It was found that, the presence of variable bonding modes due to numerous coordination sites in the ligand, IR spectra of the free ligand and those of its ion complexes are given in Table 2. We found that;

1. The spectra of the ligand showed a broad absorbing band at 3432 cm^{-1} attributed to the OH stretching vibration of the phenolic OH group. The broadening of this band indicates that the OH group is involved in hydrogen bonding [23].
2. Ligand spectrum showed that, band at 1279 cm^{-1} assigned to (CO) stretching vibration.

This band is affected by chelation through the phenolic -C-O group and is shifted to lower wavenumber (10-13 cm^{1-}) indicating that the metal ions were coordinated through the oxygen atom of the phenolic group deprotonation, strong the band at 1660 cm^{1-} is assigned to the ν(C=O) and shifted to higher wavenumber by (46-70 cm^{1-}) with reference to spectra of metal complexes which indicates participation of the carbonyl oxygen in coordination [24].

3. ligand assigned stretching frequencies at 1471, 1342 and 1172 cm^{-1} due to ν(N=N), νSO_2 asy, νSO_2 sym and NH respectively which unchanged according to spectra of complexes, indicating that sulfonamide oxygens and the azo-dye nitrogen are not participating in coordination [11,12,25].

4. The coordination number six is favored with Zn (II) metal ion when oxygen donors are present in the complex, there are two water molecules which occupy the fifth and sixth positions in the octahedron [22,26].

5. By comparing the IR spectral data of the ligand and its metal ion complexes. we find that all metal ions bind to ligand through the phenolic OH group with the liberation of its hydrogen atom and oxygen atom of the aldehydic group.

3.3. Mass Spectra of the ligand

Mass spectrum of ligand ($C_{17}H_{14}N_4O_5S$; 386 g / mol) showed parent peak at m/z = 386 [27] and a base peak at m/z = 121.

3.4. ^{1}H NMR spectra of the ligand and LZ complex.

The ^{1}H NMR spectrum (*DMSO-d6)* of ligand showed a singlet signal at 11.62 ppm, attributed to phenolic -OH proton disappeared with D_2O, multiplet aromatic protons at (7.10–8.6 ppm). A comparison of ^{1}H NMR spectrum of diamagnetic LZ complex with the spectrum of the corresponding ligand noticed that absence of -OH signals and this indicates deprotonation of the hydroxyl group of the ligand referred to the bonding of oxygen to the metal ion(C-O-M) [28-29] Fig.1.

3.5. Electronic spectra and magnetic moment measurements.

The electronic absorption spectra of the produced solid complexes measured in DMF solution within a range between 200 and 800 nm. The position of the band maxima, the molar conductivities and the magnetic moment values of the complexes are mentioned in Table 3. The most important bands for ligand observed in the region of 272 nm and 325 nm. Which referred to (π-π*, aromatic ring) while the third band at 370 nm for (n-π*, C=O). The magnetic moment of the Cu (II) complex was found to be 1.88 (B.M). The electronic spectrum of the LC complex recorded in DMF revealed an absorption band at 505 nm which referred to d-d transition ($2B_1g \rightarrow 2A_1g$), and this support square-planar geometry around orbitals Cu (II) to the anti-bonding π*orbitals of the ligand [18]. The electronic spectra of Ni(II) complexes displayed three bands 760nm ,450nm and 390nm assigned for electronic transition $3A_2g(F) \rightarrow 3T_2g(F)$ (ν_1), $3A_2g \rightarrow 3T_1g(F)$ (ν_2) and $3A_2g(F) \rightarrow 3T_1g(p)$ (ν_3), respectively. These electronic transitions of complex referred to

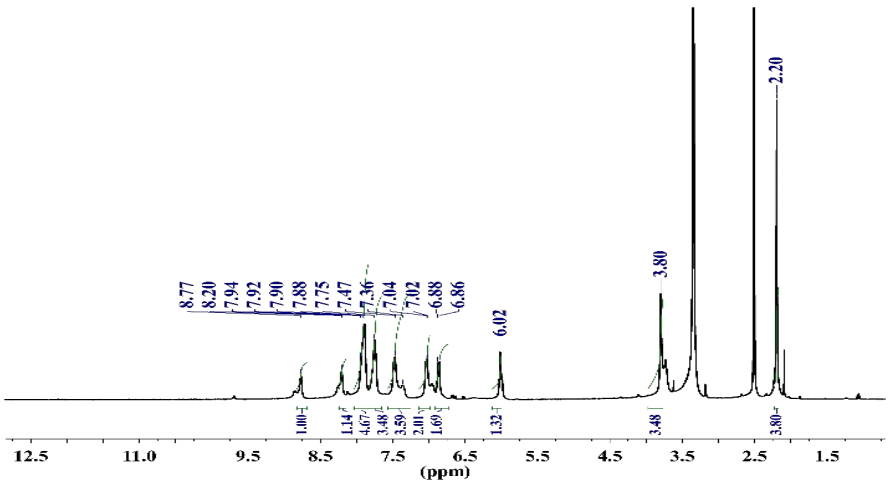


Fig.1.1H NMR spectrum of the LZ complex.

TABLE 3. Physical and spectroscopic data of the ligand and its metal Complexes Conductivity, magnetic and spectral data of the ligand and its metal complexes.

Compound	Conductance (μS cm^{-1})	*μeff BM*	Absorption λ max (nm)	*Assignment*	Suggested Structure
Ligand			273,325,	π →π*	
HL			372	n →π	
LC	12.1	1.92	505	$2B_1g \rightarrow 2A_1g$	Square planar
			760	$3A_2g(F) \rightarrow 3T_2g(F)$	
LN	11.4	3.1	450	$3A_2g(F) \rightarrow 3T_1g(F)$	Octahedral
			390	$3A_2g(F) \rightarrow 3T_1g(P)$	
LZ	9.5	D	315,380	M ⟶ LCT	Octahedral
LA	14.3	D	3 55,475	M ⟶ LCT $2B_1g \longrightarrow 2A_1g$	Tetrahedral

octahedral geometry [30]. The magnetic moment of the complex was found to be 3.1 B.M. which lies in the range of the LN octahedral complex. The LZ complex was expectedly diamagnetic. LZ complex displayed only charge transfer transitions while no d-d transition expected. In the electronic spectra of LZ complex, absorption bands found at 315 nm and 380 nm, respectively and assigned to M →LCT which is compatible with octahedral structure [22]. The diamagnetic LA complex possesses a tetrahedral structure. For LA, the two absorption bands at 475 nm and 355 nm assigned to $2B_1g \rightarrow 2A_1g$ and M →LCT, respectively in a tetrahedral geometry confirmed by the diamagnetic properties [31].

3.6. ESR spectra.

The ESR spectral studies of LC complexes, (Fig. 3) displayed that the magnetic parameters measured in this study are related to the structure of the paramagnetic species, the number of ligands and the bonding parameters and spatial arrangements of the ligands around the central metal ion. The room temperature X-band ESR spectra of polycrystalline LC complex recorded. The ESR spectrum of this complex is quite similar and exhibited an axially symmetric with g//=2.01919 and g -2.03074 indicating that the unpaired electron most likely residue in dx2-y2 ground state and characteristic for square planar [32,33,18]. G value has been calculated by Kivelson's method. [34]. The calculated g// for the complex is less than 2.3 indicating presence of considerable covalence. The evaluation of ESR covalence parameters also supports that the g values are related by the expression G = (g//-2) / (g--2) = 0.6242, If the value of G > 4, the exchange interaction is negligible where as if G < 4, a considerable exchange interaction is indicated in the solid complexes since G values are lower than 4 for the studied azo-dye complexes [35] Fig.2.

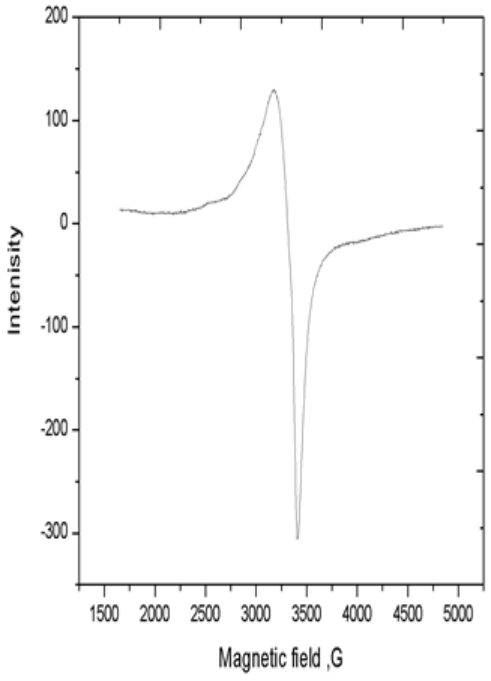


Fig. 2. ESR for [Cu (L)2] H2O complex.

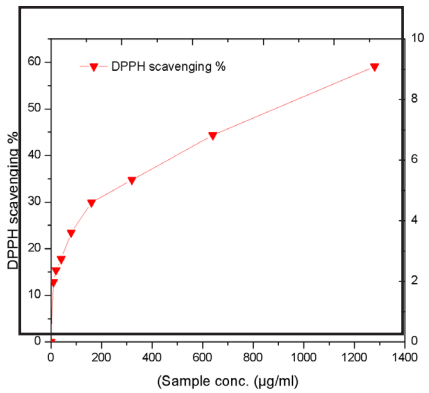


Fig. 3: The in vitro antioxidant activity of ligand in DPPH method.

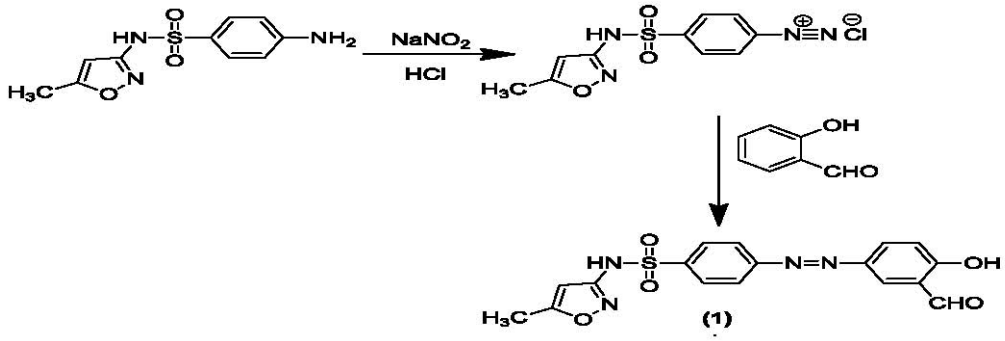
3.7. Thermal gravimetric analysis (TGA)

The thermal analysis for 4- ((3 - Formyl - 4 - hydroxyphenyl) diazinyl) - N - (4 - methyloxazol - 2 - yl)Benzene Sulfonamide derivative with Cu(II), Ni(II), Zn (II) and Ag(I) metal ions carried out in nitrogen gas atmosphere with heating rate 10 $^{o}C.min^{-1}$ and the weight loss was measured up to 1000 ^{o}C. In the thermogram of **[Cu(L)$_2$]** H_2O, the first decomposition step one crystal water molecule was lost, it is observed within a mass loss of 1.96% (calcd 2.1%) in the temperature range of 90–110^{0}C while the thermogram of **[Ag(L)$_2$]** $(H_2O)_2$, in the first decomposition step two crystal water molecules were lost, it is observed with in a mass loss of 3.37% (calcd 3.93 %) in the temperature range of 100–120^{0}C. The thermogram of $[Ni((L)_2(H_2O)_2]$ $(H_2O)_4$ showed decomposition at first step with a mass loss of 4.19% (calcd. 3.84%) in the temperature 110-115^{0}C and second step with a mass loss of 8.44% (calcd.7 68%) at 220 ^{0}C, which corresponds to the loss of two crystal water and four coordinated water molecules. while the thermogram of $[Zn((L)_2(H_2O)_2]$ $(H_2O)_5$ showed decomposition at first step with a mass loss of 4.49% (calcd. 3.74%) in the temperature 110-115^{0}C and second step with a mass loss of 8.84% (calcd9. 35%) at 220 ^{0}C, which corresponds to the loss of two crystal water and four coordinated water molecules [36]. According to these results the structure of these complexes may be as in Scheme 2.

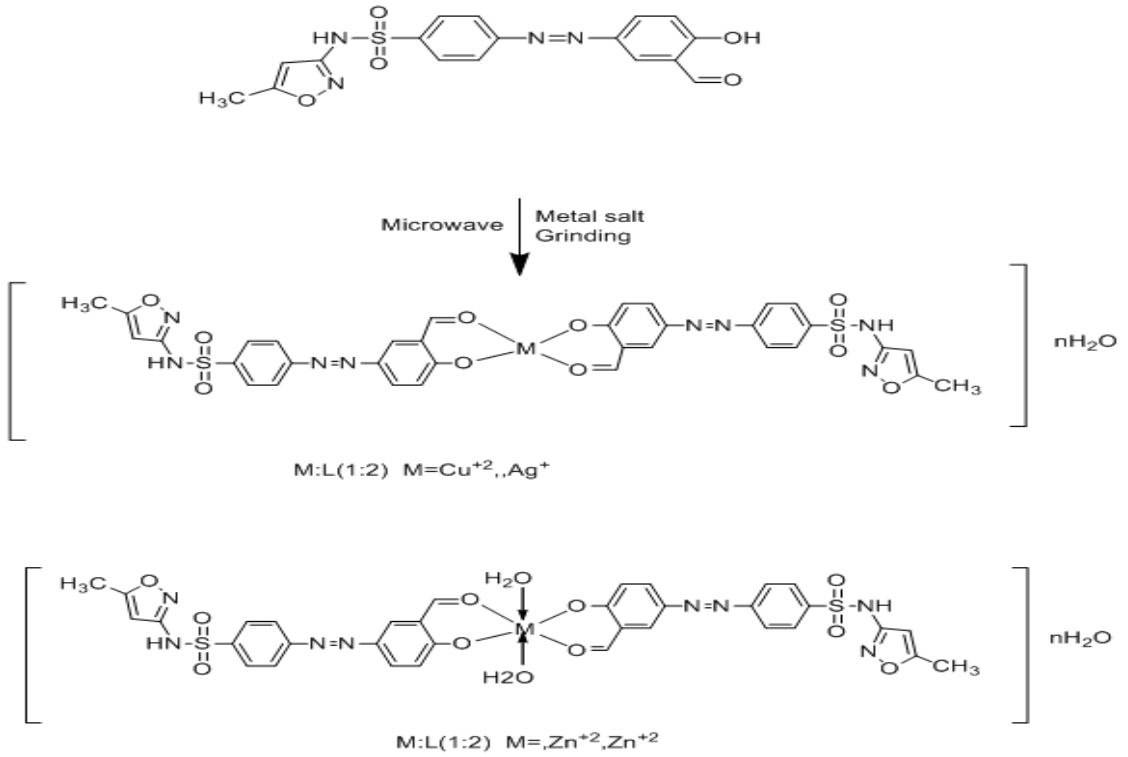
3.8. Biological activity.

3.8.1 Antimicrobial activity of ligand and metal complexes.

The synthesized ligand and its metal complexes tested against bacterial and fungal strains by disc diffusion method. The microorganisms used in the present investigations included bacterial and fungal strains. Bacterial strains; Gram-positive bacteria (Staphylococcus aureus (ATCC:6538) and Streptococcus mutants (ATCC:25175)), Gram-negative bacteria (Klebsiella pneumonia (ATCC:4415), Pseudomonas aeruginosa (ATCC:27853) and Escherichia coli (ATCC:3008)) and fungal strains; Candida albicans (ATCC:10231). The results were compared with those of the standard drugs (Gentamicin for Gram positive bacteria, Ampicillin for gram negative bacteria and Nystatin for fungal strains) and calculated the diameter of inhibition zone for each by mm. The antimicrobial results are shown in Tables 5 and 6. This showed that the sulfamethoxazole derivatives and their metal complexes possess a broad spectrum of activity against the tested organisms. Also showed that metal complexes exhibited a broad spectrum



Scheme 1. 4 - ((3 - Formyl - 4 - hydroxyphenyl) diazinyl) - N - (4 - methyloxazol - 2 - yl) Benzene Sulfonamide.



Scheme 2. Preparation of the ligand and its metal complexes 1-4.
M= Cu(II), Ni(II), Zn (II) and Ag(I) metal ions; n= number of crystalline water molecules.

of activity more than parent ligand. Also, The LA and LZ complexes exhibited good antimicrobial activity against most bacteria while the LC and LN complexes exhibited good antifungal activity against Candida albicans.

According to data represented in Table 6. The increased activity of the metal chelates can be explained on basis of chelation theory. It is known that Metal complexes show significant activity against the microorganisms. It is supposed that the increased lipophilic character of bulky complexes may be responsible for their potent antimicrobial activity than ligand. The permeation of complexes through the lipid layer of the cell membranes deactivates diverse cellular enzymes which play a vital role in various metabolic systems of these microorganisms [11,37].

On chelation, the polarity of the metal ion will be reduced significantly due to the overlap with the ligand orbital. Furthermore, it increases the delocalization of π-electrons over the whole chelate tends to make the metal complexes act more powerful and potent bactericidal agents, thus, killing more of the tested bacterial strains than the free ligand. It is observed that, in a complex, the positive charge of the metal is partially shared with the donor atoms present in the ligand and there may be p-electron delocalization over the whole chelating site. This increases the lipophilic character of the metal chelation and favors its permeation through the lipid layer of the bacterial membranes. [16,38]

The results of fungicidal screening (Table 5) show that metal chelates were highly active than the free ligand against phytopathogenic fungi. The variation in the effectiveness of different compounds against different organisms depends either on the impermeability of the cells of the microbes or the difference in ribosomes of microbial cells [39].

3.8.2. Evaluation of antioxidant activity of ligand using DPPH scavenging.

The ligand showed an antioxidant activity under these experimental conditions. It was observed that the ligand exhibited antioxidant activity lower than the standard Ascorbic acid. Besides, the perusal of Tables 6 and Fig. 3, indicated that radical scavenging activity increases with increase in concentration

[14]. The ligand showed an antioxidant activity under these experimental conditions with IC_{50} = 885.8 µg/ml (Fig. 3.

Conclusion

In this study we have reported that synthesis of azo-dye sulfonamide complexes of Cu(II), Ni(II) Zn(II) and Ag(I) derived from L. The structural characterizations of the synthesized compounds were made by using the elemental analysis, spectroscopic methods, magnetic and conductance studies, and thermal analysis. From the spectroscopic characterization, it is concluded that azo-dye sulfonamide act as bidentate ligand, coordinating through >C= O and phenolic –

TABLE 4: The antimicrobial activity of ligand and their metal complexes.

Bacteria strains.	**Diameter inhibition zone (mm,100µg/dis)**					**antibiotic Standard**
Gram negative bacteria	**L1**	**L1C**	**L1N**	**L1Z**	**L1A**	**Gentamicin**
Escherichia coli (ATCC:3008)	10.3 ±0.5	15.0±1.0	15.3±0.6	NA	10.3±0.6	35±0.5
Klebsiella pneumonia (ATCC:4415)	16.7± 0.5	15.3±0.5	16.3±0.6	26.0±1.0	31.0±1.0	35±0.5
Pseudomonas aeruginosa (ATCC:27853	12.3 ±0.5	13.6±0.6	13.3±0.5	13.3±0.5	12.3±0.6	30±0.5
Gram positive bacteria						**Ampicilin**
Staphylococcus aureus (ATCC:6538)	NA	14.3±0.5	NA	17.0±1.0	19.7±0.6	30±0.1
Streptococcus mutans (ATCC:25175)	29.3±0.6	28.3±	30.3±0.6	30.0±1.0	26.7±0.6	35±0.5
Fungi						**Nystatin**
Candida albicans. (ATCC:10231)	NA	18.3±0.6	19.3±0.6	10.3±0.5	10.3±0.5	20±0.5

Zone of inhibition is expressed in the form of mean± standard deviation (mm).
NA: No activity
Well diameter (6mm). 100µl was tested

TABLE 5: The MICs of antibacterial activity of the compounds.

Bacteria strains	LC	L N	L Z	L A
Escherichia coli(ATCC:3008)	500	500		
Klebsiella pneumonia(ATCC:4415)	125	125	62.5	15.6
Pseudomonas aeruginosa(ATCC:27853)				
Gram positive bacteria				
Staphylococcus aureus(ATCC:6538)			125	125
Streptococcus mutans(ATCC:25175)	125	125	250	31`.25

TABLE 6 : The in vitro antioxidant activity of ligand in DPPH method.

Sample conc. (µg/ml)	DPPH scavenging%
1280	59.08
640	44.34
320	34.74
160	29.87
80	23.42
40	17.76
20	15.39
10	12.76
0	0

OH via deprotonation. The biological activity screening showed that complexes have more activity than ligand against the tested bacteria. Furthermore, the ligand exhibited antioxidant activity. The importance of our present work is the possibility of metal complexes that is more efficacious as antibacterial and antifungal activity. However, a thorough investigation relating the structure and the activity of the complexes as well as their stability under biological conditions is required. These detailed investigations could be helpful in designing more potent antibacterial and antifungal agents for the therapeutic use. However, further in vitro and in vivo studies need to be performed to verify their antimicrobial drug potential.

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استخدام الكيمياء الخضراء في تحضير بعض المتراكبات الأيونيه لعناصرالنحاس والنيكل والزنك والفضة لمشتقات السلفا ودراسة خصائصها والنشاط البيولوجي لها

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استخدام الكيمياء الخضراء كطريقه جديده وبسيطه في تحضير بعض المتراكبات الأيونيه لعناصر النحاس والنيكل والزنك والفضة مع المترابط(مشتق السلفا) وذلك باستعمال الميكرويف تم وصف المتراكبات الأيونيه واثباتها باستخدام التحاليل العنصريه والقياسات الطيفيه الخاصه بالأشعه فوق البنفسجيه والأشعه تحت الحمراء والرنين النووي المغناطيسي ومطياف الكتله والعزم المغناطيسي والتوصيل الكهربي والتحليل الحراري كذلك تمت دراسة النشاط البيولوجي لهم واظهرت ان المتراكبات لها تأثير قوي كمضادات للبكتريا والفطريات مقارنة مع المرتبط كما اظهر المرتبط تأثير قوي كمضاد للاكسده وخاصة ان هذه المركبات يمكن تحضيرها بسهوله .وقليلة التكلفه