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Research Article

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Synthesis spectral, thermal stability and antibacterial activity of schiff bases derived from alanine and threonine and their complexes.

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ABSTRACT

The metal complexes derived from Schiff base ligand resulted from condensation of some Amino Acid namely (DL – Alanine and DL – Threonine) and - 4- chloro benzadehyde by using microwave irradiation . The ligands characterized by FT-IR, HNMR, mass spectrometry and CHN elemental analysis . The Ligands acts as bidentate coordinating with Ni(II)in case of $[Ni(L^1)_2(H_2O)_2].H_2O$*and Cd (II) in case of* $[Cd(L^2)_2]. H_2O$ *type complexes using their carboxylate oxygens. The thermogravemetric (TG/DG) analysis confirm high stability for all complexes followed by thermal decomposition in different steps. Also the antibacterial activity of synthesized Schiff base and their complexes against two types of bacteria were tested.*

Key words: amino acid, Schiff base complexes

INTRODUCTION

The chemistry of the carbon-nitrogen double bond plays vital role in the progress of chemical science [1] Schiff base complexes have been extensively investigated for more than a century and employed in areas that include pharmaceutical , medicinal and coordination chemistry [2-6] Schiff bases have also been employed as ligands for complexation of metal ions [7] Amino acid Schiff bases are an important class of ligands because such ligands and their metal complexes have a variety of application including biological , clinical, analytical and industrial in addition to their important role in catalysis in organic synthesis [8,9].

Amino acids a significant class of organic-based compound, contain potential donor sites such as (COOH) and /or (NH_2) which have good ability to coordinate with the metal ions[10] . Microwave assisted synthesis of Schiff base is rapid and efficient with no use of solvent. The yield of products is also high and purification is done by simple recrystallization technique [11].

In the area of bioinorganic chemistry the interest in the Schiff base complexes Lies that they provide synthetic models for metal containing sites in metalloproteinase enzymes .And also contributed to the development of medical chemistry , cancer diagnosis and treatment of tumor [12-13] .The present study deals with the synthesis ,characterization and biological study of Schiff base derived from 4-chloro benzaldehyde and DL-alanine, DL-threonine and its Ni(II) and Cd (II) complexes .

EXPERIMENTAL SECTION

Martial : 4-chloro benzaldehyde and DL- Alanine, DL- threonine from Fluka. Metal chloride salts ,sodium hydroxid from fluka and Aldrich , all solvents used were of analytical grade and were used without further purification.

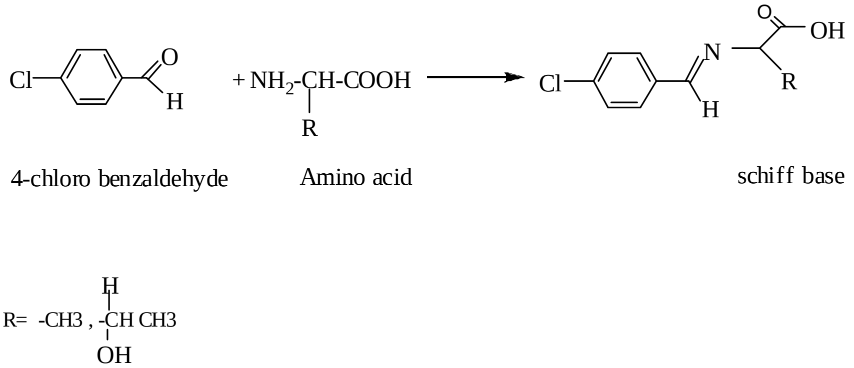
Instruments

IR spectra were recorded using shimadzu FT-IR as KBr pellet . The HNMR spectra were recorded on Bruker (400 MHz) . the spectra recorded in DMSO–d_6-. TMS as internal standard . EI- Mass was recorded on Agilent Molar conductance's were obtained using conduct meter- corning model 441 at room temperature . Elemental analysis (CHN) was performed using CHNS- 932 LECO Apparatus .

Synthesis of Schiff base ligands

The ligands were synthesized by the condensation of aldehyde and selected amino acid by using microwave irradiation without solvent (scheme1)

The microwave–assisted synthesis of Schiff bases from 4- chloro benzldehyde and different amino acids is performed efficiently and get high yield of products in short time [16] This is carried in an oven , Sanyo , EM-G8586V and is subjected to microwave for an optimized time (2-3 minute) on the (MW, Low 270w) setting .



Scheme(1)

The solvent free organic synthesis mediated by microwave irradiation performs several economies such as low risk of hazard and time economy. Purification by simple recrystallizatlon method by using CCl_4 .

Synthesis of metal complexes of Schiff bases

Synthesis of $[NiL^1_2(H_2O)_2]$-H_2O

An aqueous solution of sodium hydroxide (20mmol) was added to (10mmol) of methanolic solution of Schiff base ligand, methanolic solution (5mmol) of metal chloride ($NiCl_2.6H_2O$) was added drop wise . The above mixture was magnetically Stirred for 30 minute at room temperature .The metal complex obtained was filtered, wash with MeOH and dried in air .light green precipitate was obtained (yield 60%), m.p. (250 ^oC) dec.

Synthesis of $[CdL^2_2].H_2O$.

An aqueous solution of sodium hydroxide (20mmol)was added to (10mmol) of methanolic solution of Schiff base ligand, methanolic solution (5mmol) of cadmium chloride ($CdCl_2$) was added drop wise . The above mixture was magnetically stirred for 30 minute at room temperature .The metal complex obtained was filtered, wash with methanol and dried in air ,light red precipitate was obtained (yield 64%) m.p. (220 ^oC)dec.

In vitro antimicrobial activity .

Antibacterial activities of the ligands and its complexes were tested in vitro against gram *(+ve)* staphylococcus Aurous (S.A) and Game *(-ve)* Aeromonas hydrophila (A. hydrophila) by diffusion method [14] the test organism were grown on nutrient agar medium in petri plates . The compounds were prepared in DMSO and soaked in filter paper disc of 5mm diameter and 1mm thickness. The discs were placed on the previously seeded plates and incubated at 37 ^{o}C and the diameter of inhibition zone around each disc was measured after 24 h for both kinds of these bacteria.

Table 1 . Analytical and physical data of ligands

Comp.	Formula	color	m.p. ^{oC}	Elemental analysis found (calc.)			Ω ohm^{1}.cm^{2}.mol^{-1}	Yield%
				C%	H%	N%		
L^1	$C_{10}H_{10}NCl$	Yellow	60-62	56.75(56.91)	4.76(4.36)	6.62(7.82)	-	54
L^2	$C_{11}H_{12}NCl$	Yellow	58-60	54.67(54.73)	5.00(5.42)	5.80(5.13)	-	70
Complex 1	$[Ni(L^1)_2)H_2O)_2].H_2O$	Light green	250 dec.	44.89(44.31)	4.55(4.92)	5.25(6.44)	1.25	60
Complex 2	$[Cd(L^2)_2)_2].H_2O$	Light red	220 dec.	45.58(45.92)	4.17(4.15)	4.83(4.93)	2.14	60

RESULTS AND DISCUSSION

Characterization of Schiff bases

Scheme1 show the step of synthesis of Schiff base

The Schiff base (HL) and metal complexes are subjected to elemental analysis . The results obtained are in good agreement with those calculated for suggested formula ,the Schiff base complexes are soluble in DMF , DMSO and insoluble in other common organic solvents the analytical data indicate that the metal to ligand ratio is (1:2)for the two complex $[NiL^1_2(H_2O)_2].H_2O$, and $[CdL^2_2].H_2O$ **.** The low conductivity values of the metal complexes (table 1)suggest their non – electrolytic nature. [15] . The values suggest that no anions are present outside the coordination spheres [16] .

IR SPECTRA

The IR spectra of the complexes were compared with these of the free ligands (Table2)in order to determine the coordination sites that may be involved in chelating .the position and intensities of these peaks are expected to be changed on chelating , the IR spectra of ligands[17,18]show the absence of bands at 3450 and 1693cm^{-1} due to νNH_2 group of amino acids and νC=O of aldehyde . Instead , a new prominent band at 1645,1639 cm^{-1} due to azomethine ν (C=N) linkage appeared in both ligands [19,20] indicaling that the condensation between aldehyde and amino acids has take place has take place resulting into the formation of the desired ligands L^1H , L^2H On complex action the band of azomethine group in the free ligand was shifted to lower frequency in the range ~ 1595 -1591 cm^{-1} indicating the coordination of the azomethine nitrogen atom to the metal ion [21.22]

The spectra of the complexes contain a broad absorption band appeared in the infrared spectra revealed that the asymetric and symetric sym) (coo^{-}) in the range of 1490 – 1492 cm^{-1}, and 1404 – 1406 cm^{-1} respectively [23,24].Further, the spectra of the metal complexes show new bands in the 521-510 cm^{-1} and 438-430 cm $^{-1}$region which may probably be due to the formation ay M-O and M-N bonds respectively [25] .

Table 2 .Important IR spectral Data (cm^{-1}) 0f Schiff base and their complexes

compound	$\upsilon_{(HC=N)}$	$\nu^{(C=O)}$	$\upsilon_{COO-(asy)}$	$\upsilon_{COO-(sy)}$	υ (C-H) aromatic	υ(C-H) aliphatic	υ_{OH} (COOH)
L^1	1645	1701	-	-	3066	2927	3373 br
L^2	1595	1647	-	-	3280	2980	
Complex 1	1639	1693	1490	1406	2976	2926	3412 br
Complex 2	-	1591	1492	1406	2976	2929	-

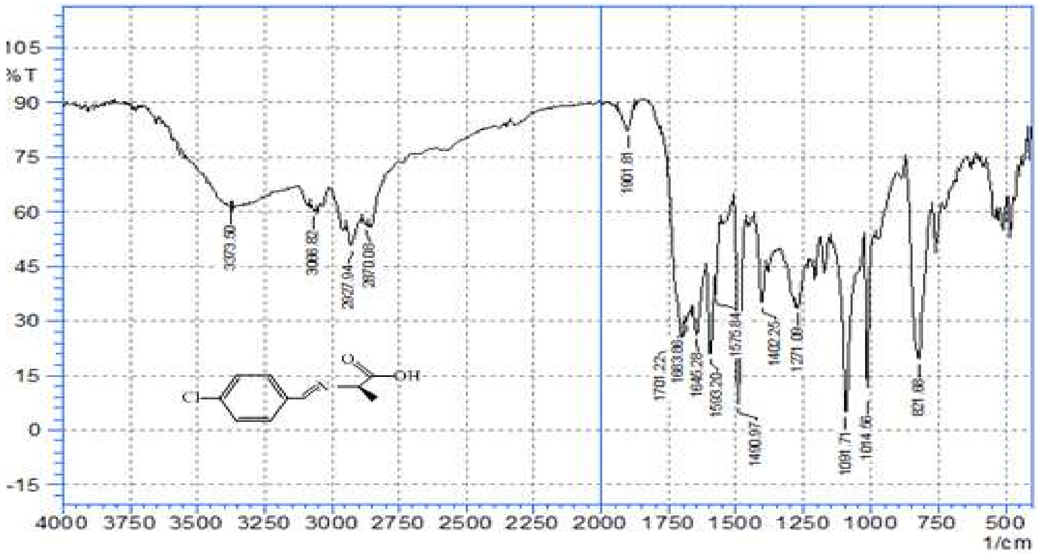


Figure 1 : IR spectrum of Schiff base L^1

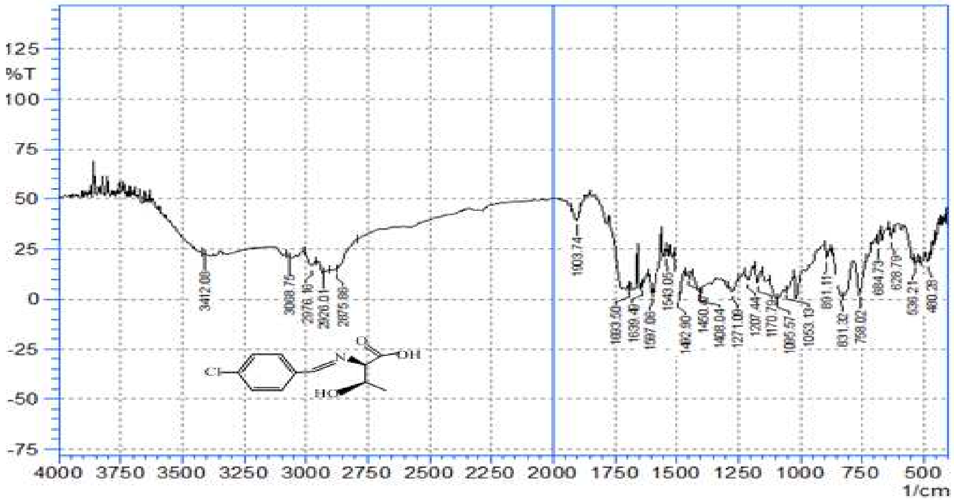


Figure 2 : IR spectrum of Schiff base L^2

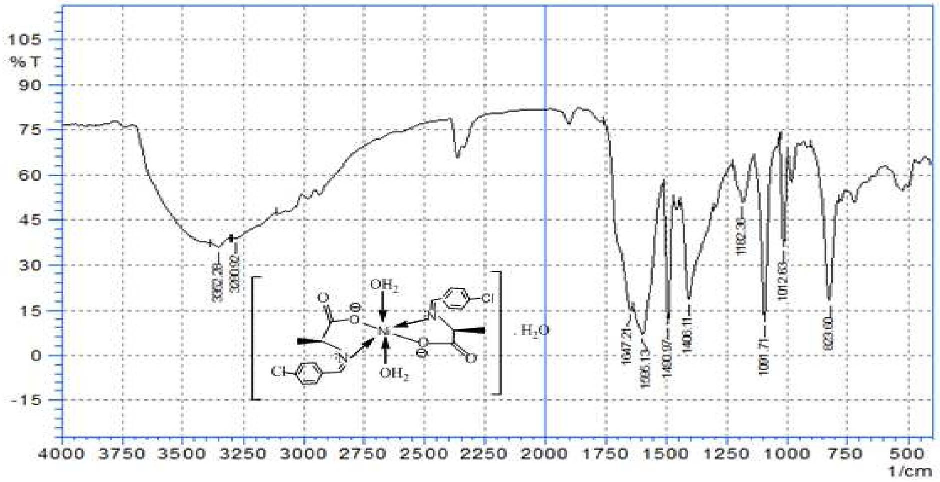


Figure 3 : the IR spectrum of complex [NiL$^1_2$(H$_2$O)$_2$]-H$_2$O

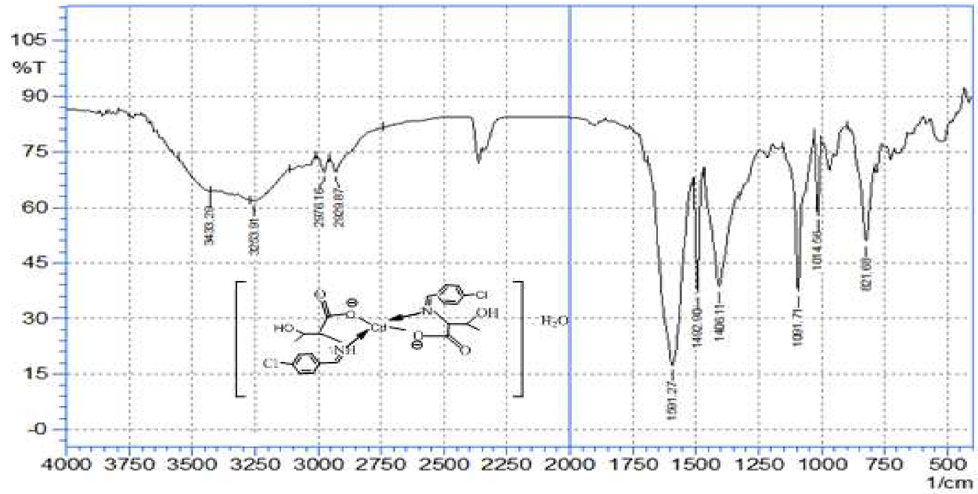


Figure 4 : the IR spectrum of complex [CdL^{2}2.H$_2$O].H$_2$O

H^{1}NMR spectra

All the protons were found as to be in their expected regions (Table 3) the conclusions drawn from these studies lend further support to the mode of bonding discussed in their IR spectrum Figs. (5,6) the H^{1}NMR spectrum of the schiff bases ligands show three singlet signal one of them at δ 8.3,8.5 ppm. attributed to azomethine (-CH=N-) proton [26,27] and the other signal at δ13.2,13.5 ppm (IH)) due to OH proton which is absent from the spectra of corresponding complexes, showing thereby chelating of the ligand moiety through the deprotonated carboxylate oxygen [18] , [Fig.7].

The multiplet signal in the region δ 6.4-7.9 ppm for the aromatic protons and these remain almost at the same position in the spectra of the metal complexes , the HNMR spectrum in DMSO-d$_6$ of diamagnetic complex (Cd complex) spectrum shows a single signal at δ 8.4 ppm assigned to the proton of the (-HC=N-) which shift to higher field , this is probably due to the involvement of C=N to from M← N Linkage[28] according to the empirical formula of these complexes.

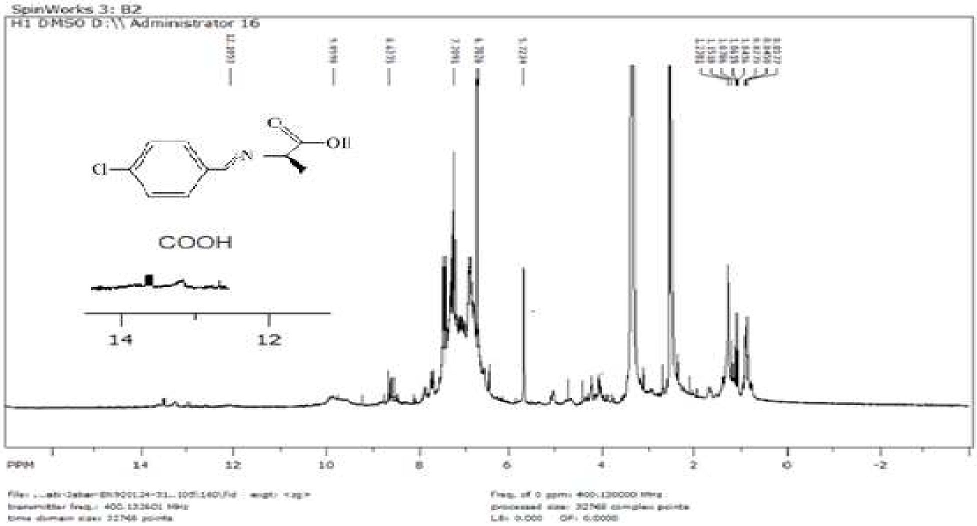


Figure 5 : H^1NMR spectrum of Schiff base L^1

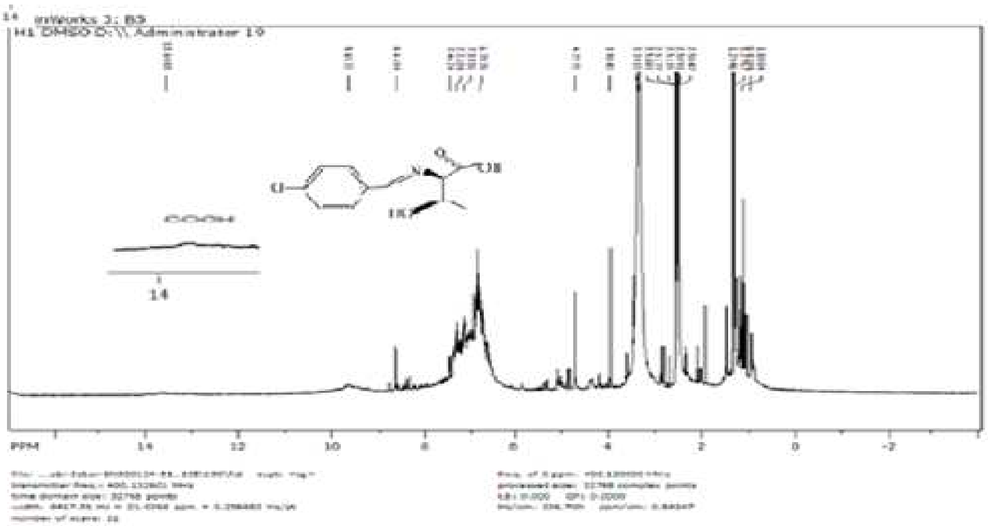


Figure 6 H^1NMR spectrum of Schiff base L^2

Table 3: The ^1HNMR spectral data for Schiff bases and their complexes

Compound	Chemical shift (ppm)				
	COOH	CH=N	CH=N-CH	Aromatic	Me
L^1	13.2	8.3	4.7	6.8-7.7	1.3
L^2	13.5 (s)	8.5	3.9	6.4-7.9 (m)	1.5
$[CdL^2_2].H_2O$	-	8.37	3.9	7.1- 7.8	1,5

EI-mass

The mass spectrum of ligands (Fig 8) shows the exact molecular ion at m/z =211 . The peak undergoes fragmentation to produce stable peak by losing (-COOH) species and produced the ion $C_9H_9NCl^+$ in the case of HL^1 Schiff base ligand) [17] while the mass spectrum of the Schiff base ligand L^2 (Fig 9) shows the exact molecular ion at m/z= 241 which undergoes fragmentation by cleavage of single C-N to produce base peak at m/z=139 the proposed fragmentation keys pathways for L^1 , L^2 are shown in schemes (2,3) .

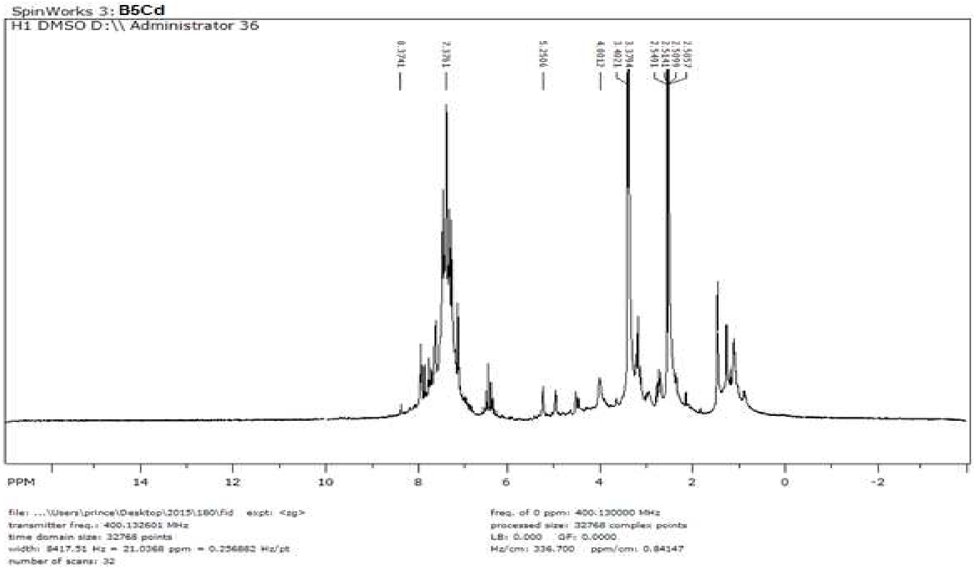
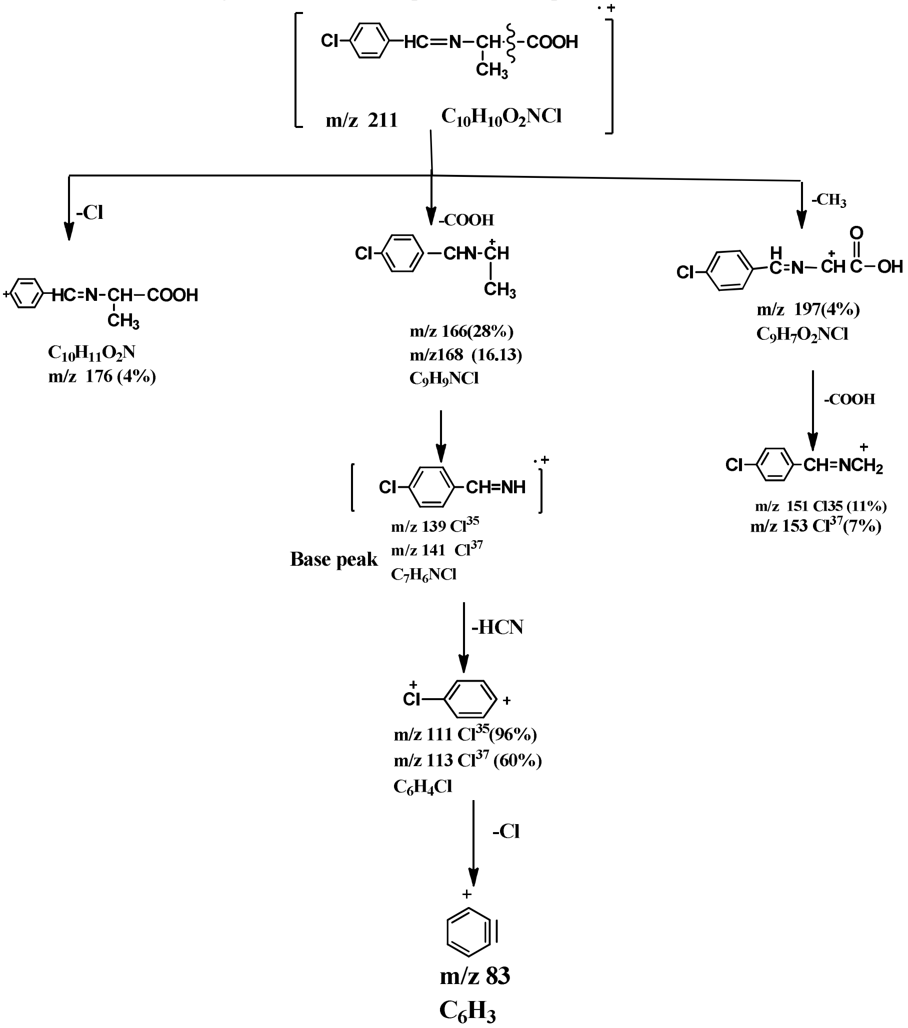
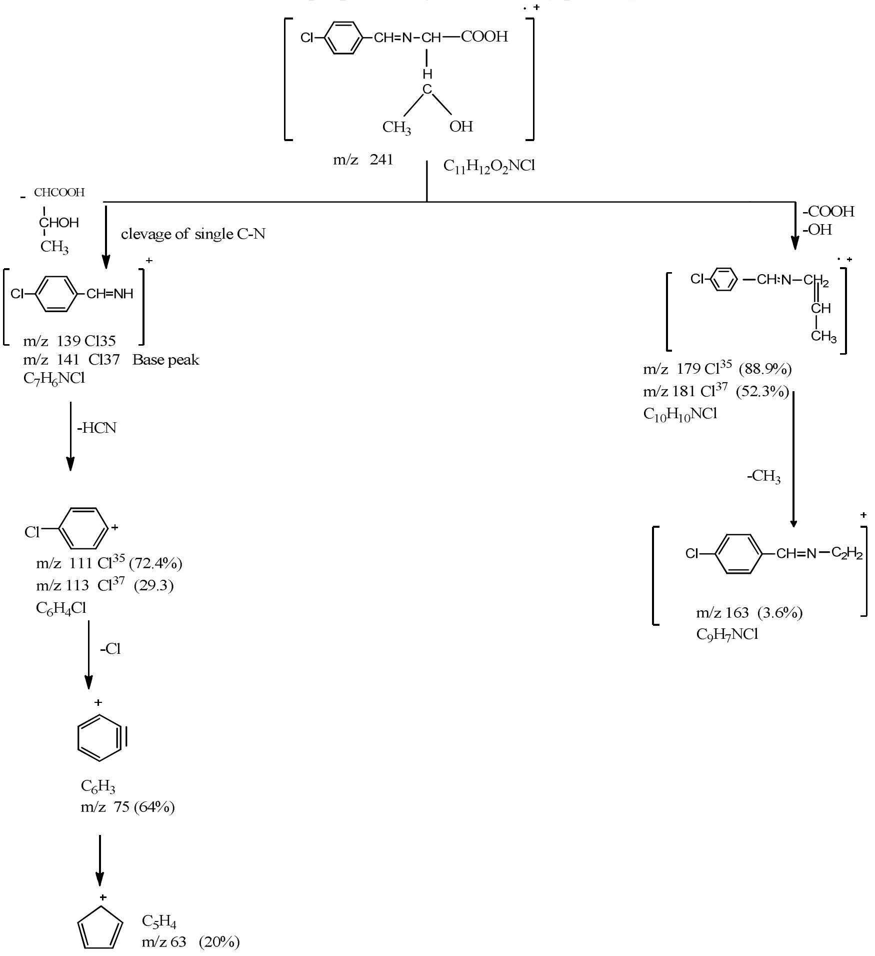


Figure 7: the H^1NMR spectrum of complex $[CdL^2_2].H_2O$



Scheme 2: The proposed fragmentation key pathway for L^1



Scheme 3: The proposed fragmentation key pathway for L^2

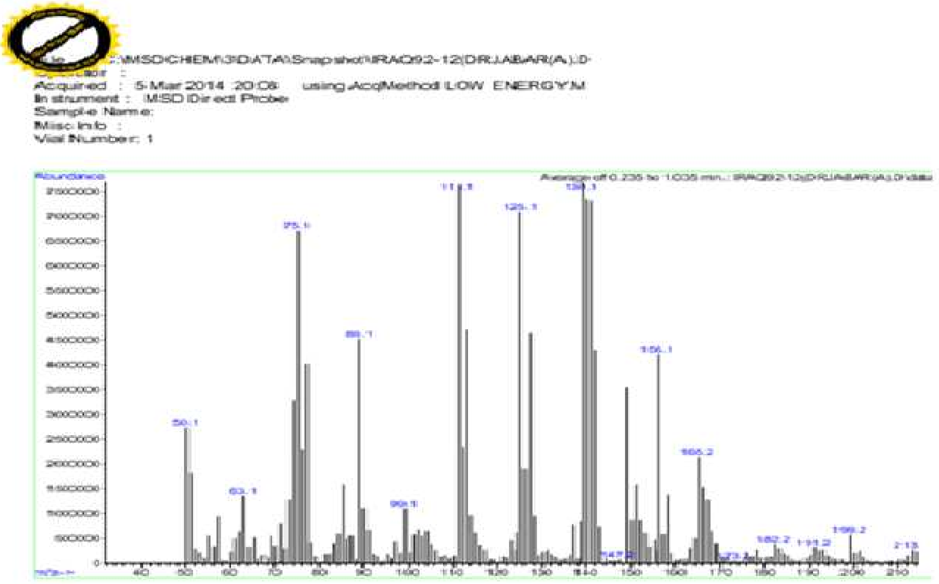


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Figure 8 : mass spectrum of Schiff base L^1

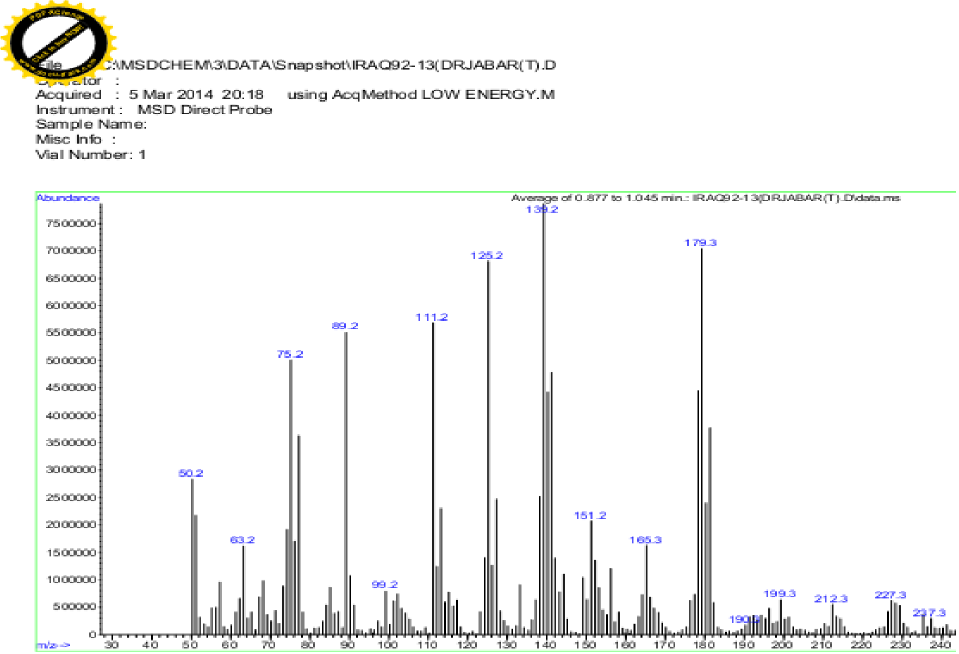


Figure 9: mass spectrum of Schiff base L^2

Thermal analysis

The thermal investigations were carried out from room temperature to 800 C with heating rate of 10 ℃/min in nitrogen atmosphere .

The thermal degradation of $[NiL^1_2(H_2O)_2]$ H_2O proceeds in three different stage (Fig. 10) the first decomposition process take between 30 and 140 ℃ with 3.7% weight loss (theoretical 3.6%) (DTG max 41 ℃) which assigned to the loss of one lattice water molecule [29] , the second step lies in the temperature rang 150-500℃ (DTG max 342℃) with loss 40.5% (theoretical 43%) with assigned to the loss one of the ligands. The third step lies in the temperature rang 700-800℃ corresponded to the loss of another ligand in fast rate to give the final residue 17% (theoretical 14.8%) which may be attributed to NiO.

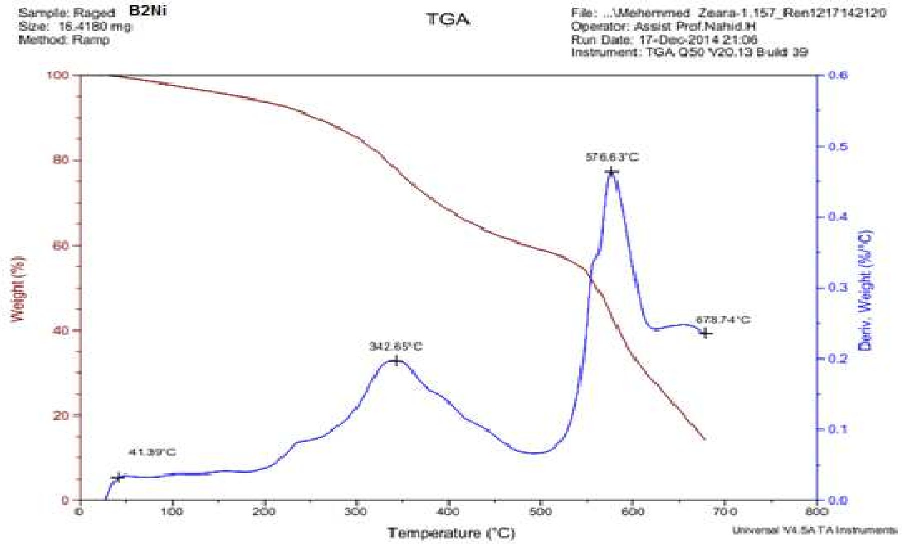


Figure 10 : TG/DTG curves of $[NiL^1_2(H_2O)_2]$-H_2O

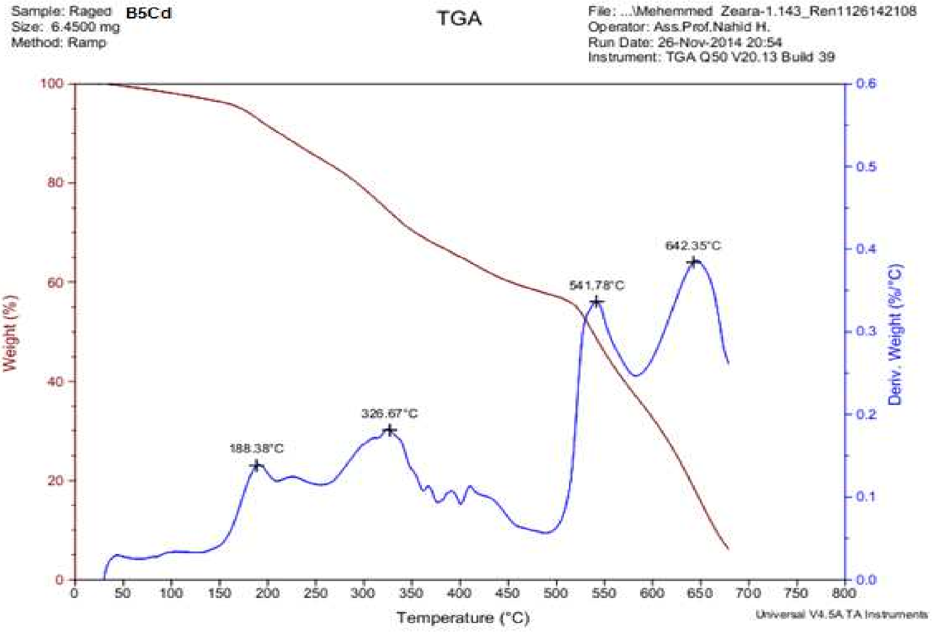
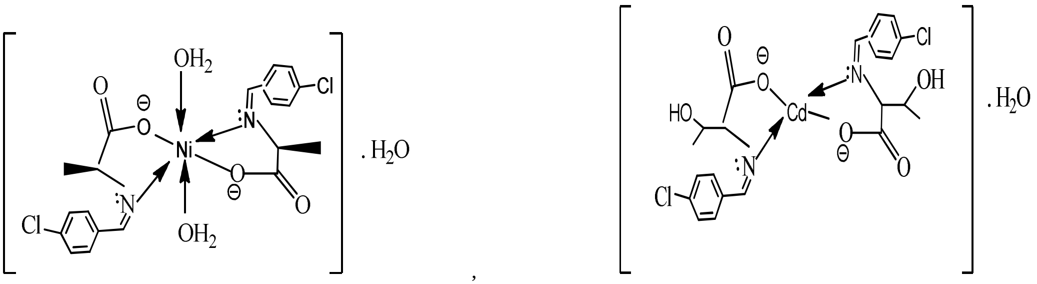


Figure 11 : TG/DTG curves of [CdL^2_2].H_2O

For [Cd L^2_3] H_2O complex the first mass loss in the range 40-140 C° found 2.75 % (theoretical 2.9 %) which prove the presence of one lattice water molecules [fig 11]. The second of decomposition in the rang 160-500 ℃ found 40.1% (theoretical 41%) (DTG 188,3℃) which assigned to the Loss of one ligand followed by thired mass loss which occur very fast and indicate to decompose of the residue complex .

Based on the thermal and spectral data (IR, HNMR), the following structure are proposed for complexes as shows in Fig (12) .



Structure of complex [$NiL^1_2(H_2O)_2$]-H_2O , **Structure of complex[CdL^2_2].H_2O**

Figure : 12

Biological activity Studies .

In vitro biological activity of Schiff bases and the complexes, DMSO is used as negative control , and the inhibition zone perform with concentration (100mg/ml) , and from the result , it has been observed that the metal complexes and the ligands gave negative test against gram positive bacteria and gram negative bacteria , This can be explained in terms of the greatest lipid solubility[30] .

According to concept of cell permeability the liquid membrane that . Surrounds the cell favors the passage of only the Lipid soluble materials makes wish Lipid solubility is an important factor which controls the antimicrobial activity , thus the Schiff base ligands and their complexes can't have lipid solubility and then reduced the antibacterial activity.

CONCLUSION

Octahedral geometries have been proposed for the Ni(II) complex and tetrahedral geometers for the Cd(II) complex , with the help of different spectral like IR , HNMR , CHN elemental analysis and thermal analysis. The free Schiff bases and their metal complexes exhibit negative anti bacterial activity against all the species that we use fig (14) species that .

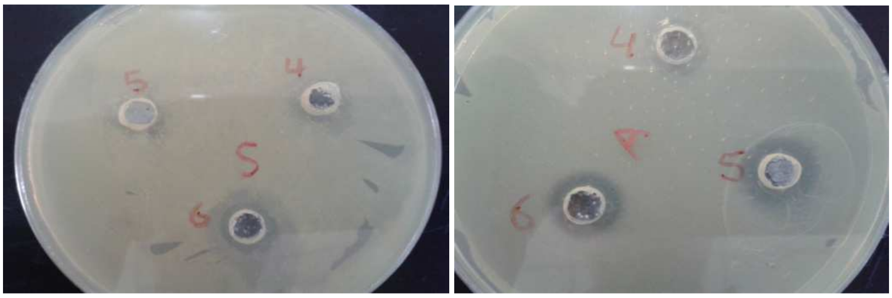


fig (14): Antibacterial activity of Schiff bases and their complexes

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