Iraqi Journal of Science

Preparation and Characterization of New Metal Complexes of Schiff Bases Contaning a Thiazole Ring

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Received: 15/10/2003 Accepted: 21/1/2004

Abstract

New metal Complexes of two newly prepared Schiff bases (L_I and L_V) and three previously prepared Schiff bases HL_{II}, L_{III}, L_{IV} by reacting 2-amino benzothiazole(2-ABT) with 2,4-dimethoxybenzaldehyde, salicylaldehyde, 4-hydroxy benzaldehyde, N,N-dimethyl-4-aminobenzaldehyde and from reaction of 2-aminothiazole (2-AT) with 2,4-dimethoxy benzaldehyde respectively. Structures were proposed depending on elemental and thermal analyses (TG and DTG) and by i.r and u.v- visible spectra in addition to magnetic susceptibility and electrical conductivity measurements. Some of these compounds exhibited growth inhibition against two types of bacteria.

الخلاصة

حضرت معقدات فلزية جديدة لاثنين من قواعد شيف جديدة L_I وL_V وثلاثة من قواعد شيف محضرة سابقاً HL_{II} و L_{III} وL_{IV} من مفاعلة 2-امينوبنزوثارزول مع كل من 2 ,4 - ثنائي ميثوكسي بنزالديهايد وساليسيل الديهايد و4- هيدروكسي بنزالديها يد. و N, N - ثنائي مثيل بارا امينو بنزالديهايد ومن مفاعلة 2- امينو ثايازول مع 2 ,4 - ثنائي ميثوكسي بنزالديهيد على التوالي.

شخصت التراكيب الكيميائية بواسطة التحليل الدقيق للعناصر والتحاليل الحرارية TG ,DTG ونتائج اطياف الاشعة تحت الحمراء والاشعة فوق البنفسجية- المرئية فضلاً عن قياسات الحساسية المغناطيسية والتوصيلية الكهربائية للمعقدات الفلزية. اظهرت بعض المركبات المحضرة قابلية على تثبيط نمو نوعين من البكتريا المرضية

Introduction

Schiff bases derived from aromatic aldehydes containing- OCH_3, OH or halogen groups were reported to have higher antifungal activity than those of unsubstituted aromatic rings (1,2). In industry, these derivatives were used as anticorrosion agents and as fixing agents for fabric printing (3).

The importance of Schiff bases complexes were desecribed in the litrature (4,7). They were used as synthetic models for the explanation of biological reactions mediated by active metal centers such as oxygen carriers (hemocyanine, hemoglobin, myoglobin(6,7)) and in electron transfer reactions (4,5,7). Furthermore some complexes of Schiff bases were found more active than parent ligands against bacteria and fungi (8,9), herbicides, and anticancer agents(10). In this work a new series of transition metal complexes of two new Schiff bases was prepared and studied. New complexes of three previously prepared Schiff bases(11,13) , derived from condensation of 2- aminobenzothiazole (2-ABT) and 2- aminothiazole (2-AT) with different aromatic aldehydes were also prepared and studied. The structural formula of these compounds are illustrated in Scheme (1) and names are described in table (1).

Experimental

Apparatus:

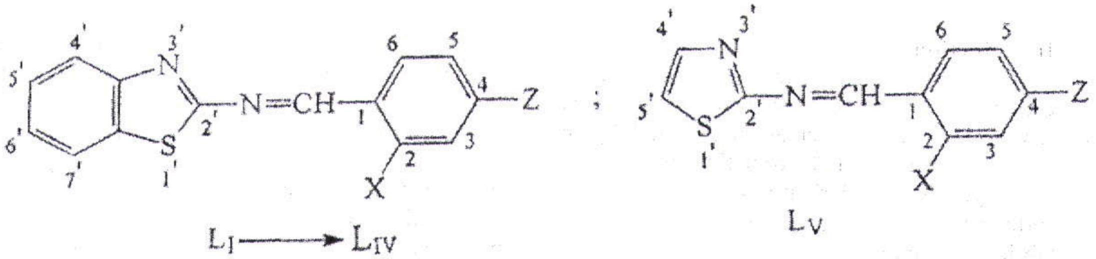
Melting points (uncorrected) were obtained using Gallenkamp MF 600-010F melting point apparatus. Elemental analyses were perfomed by using Elemental analysis – Perkin Elmer 240B and Elemental analysis model CHNSO-Carlo-Erba instruments. Infrared spectra of ligands and complexes were recorded as KBr and Csl discs respectively on Perkin- Elmer 983 GIP and Pyeunicam sp-300 i.r spectrophotometer. Electronic spectra of ligands in ethanol and complexes in DMF were recorded on u.v- visible spectrophotometer Shimadzu u.v- 160A. H.n.m.r Spectra of ligands in DMSO were recorded on Hitachi- Perkin- Elmer spectrophotometer at 60 MHz with TMS as a reference.. Thermal analyses by TG and DTG were obtained by using Stonton Redcorft TG 760 series and thermogravimetric Analyzer (TGA) A Du-pont Thermobablance Model 951. Electrical conductivity of metal complexes in DMF (10^{-3}M) were measured at room temperature by using Capacitor Analyzer and Resistance Bridge type CRB3. Magnetic susceptibilities (μ_{eff} B.M) of metal complexes in the solid states were measured at room temperature by Faraday method using Bruker Magnet B.M.6. Determination of metal content (%) of complexes were crried out by using Schimadzu-680G atomic absorption of flame emission spectrophotometer and Elemental analyser MOD 1106 Carlo-Erba.

Materials and Methods

Metal salts Ru $Cl_3.3H_2O$, 98%, $H_2PtCl_6.6H_2O$ 38%, $Ni(CH_3COO)_2.4H_2O$ (Purum), $PdCl_2$, 60% (Fluka), $CuCl_2.2H_2O$. (extra pure) (Merck), were used as received from suppliers. N, N-Dimethyl – 4- amino benzaldehyde, 99% benzonitrile (puriss) (Fluka), and triethyl amine 99.5% (BDH) were used without further purification. Dimethy formamide and ethanol were dried before distillation (14,15). 2-Amino benzothiazole (2-ABT) was purified by crystallistion from boiling water (16) and 2-aminothiazole was purified by sublimation under reduced pressure. 4-Hydroxy benzaldehyde 99% was purified according to a method mentioned in the litrature (15). The preparation of 2- chlorobenzonitrile palladium (II) was carried out according to a reported method (17). The purity of all products were confirmed by T.L.C. using silica gel and different ratios of chloroform and acetone mixture as eluents.

Preparation of Schiff bases

The ligands L_I-Lv described in table (1) and illustrated by structures (a) and (b) in scheme –1- were prepared by adding ethanolic solutions (0.01 mole) of the amine to (0.01 mole) of aldehyde in dry ethanol. The amount of solvent should be as minimum as possible. 3-4 drops of piperidine were added and the solution was heated under reflux on a water bath for 30 min. with continuous stirring. A precipitate was formed after cooling the mixture to room temperature. The product was filtered off, washed with cold ethanol and ether and crystallized from ethanol then dried under vacuum.



Scheme (1):-Schiff bases derived from 2-amino thiazole and 2-amino benzothiazole

Table (1): Schiff bases derived from thiazoles and aromatic aldehydes

Symbol	Nomenclature	X	Z
L_I	N-(2,4- Dimethoxy benzylidene) benzothiazole	OCH_3	OCH_3
HL_{II}	N- (Salicylidene)- benzothiazole	OH	H
L_{III}	N- (4-Hydroxy benzylidene) benzothiazole	H	OH
L_{IV}	N-(4-N,N-Dimethylaminobenzylidene)- benzothiazole	H	$(CH_3)_2N$
Lv	N- (2,4- Dimethoxy benzylidene)- thiazole	OCH_3	OCH_3

Preparation of metal complexes

An ethanolic solution of metal salt (1 mmole) was added to an ethanolic solution of ligand (2 mmole) with continuous stirring. In case of C_4 and C_5 (2 mmole) of Et_3N were added. Precipitation took place immediately. Each mixture was then heated under reflux for 30 min to allow complete precipitation. The products were filtered off, washed with ethanol, followed by ether and dried under vacuum.

Results and Discussions

a) Physical data and elemental analyses:

Table (2) describes the physical properties of ligands and complexes together with CHN analyses and atomic absorption. The suggested molecular formulae were further supported by thermal analyses and spectral studies.Elemental analyses of some complexes recorded deviation in hydrogen content (especially C_7, C_8 and C_{11}) because of technical errors in the instrument.

b) H.M.R. Spectra:

The N.M.R. spectrum of L_I in DMSO gave the following chemical shifts δ(ppm): 2.85 (s, 3H, OCH_3), (18) 2.95 (s.3H, OCH_3) (18); 6.3-6.5 (m, $4H_A$, aromatic H_A) (18); 6.7-7.0 (m, $3H_B$ o,p-trisubsituted benzene) (18); 8.15-8.3 (s,1H, CH for schiff base) (19,20). Additional chemical shifts were observed and were assigned to lattice ethanol (18). 1.4-1.6 t (CH_3); 2.2 –2.5 g (CH_2); 5.6-2.75 (OH) and 3.2-3.4 for DMSO (21).

Table (2): Molecular formula, Physical properties, and elemental analyses (%) of Schiff bases and their metal complexes.

Symble Molecular formula (Colour)	(m.p)°C Yield %	Elemental analysis % found (calculated			M% Found (Calculated
		C%	H%	N%	
L_I $[C_{16}H_{14}N_2SO_2]$.0.5 EtOH(yellow)	(135-137) 70%	61.7 (61.62)	4.45 (5.29)	8.24 (8.71)	-
C_I $[PdL_ICl_2]$.05 H_2O. 0.5 EtOH (yellow)	(287) decomp. 38%	-	-	-	20.75 (20.73)
C_2 $[PtL_ICl_2(H_2O)_2].Cl_2.2H_2O$.EtOH (yellow)	(259-261) sub. 43.8%	28.54 (28.67)	2.55 (2.52)	4.75 (3.72)	-
C_3 $[RuL_ICl_3H_2O].2H_2O$ (greenish black)	>(300) 25.4%	33.48 (34.29)	2.98 (3.57)	5.8 (5.0)	17.81 (18.05)
HL_{II} $C_{14}H_{10}N_2SO$ (yellow)	(145-147) 54%	65.5 (66.06)	4.20 (3.93)	10.43 (11.01)	-
C_4 $Co(L_{II})_2(H_2O)_2$ (reddish brown)	(282) decomp. 33%	55.85 (55.85)	3.40 (3.66)	8.39 (9.31)	-
C_5 $[Ni(L_{II})_2(H_2O)_2$ 2EtOH (orange)	>(305) 30.8%	-	-	-	8.43 (8.47)
L_{III}	(189-190)	65.73	4.20	10.62	

$C_{14}H_{10}N_2SO$ (yellow)	lit.185[(12)] 33%	(66.06)	(3.93)	(11.01)	-
C_6 $[PdL_{III}Cl_2).2H_2O$ (Olive green)	>(305) decomp. 44.5%	-	-	-	19.33 (20.71)
C_7 $[Pt(L_{III})_2Cl_2(H_2O)_2].Cl_2.1.5H_2O.$ EtOH(1) (pale yellow)	(259-260) decomp. 37.3%	37.45 (38.41)	2.58 (3.31)	5.82 (5.98)	19.76 (20.40)
L_{IV} $C_{16}H_{15}N_3N_3S$ (orange)	(187-189) lit:(186-187)[(13)] 67.0%	59.34 (59.74)	4.92 (5.33)	14.50 (14.94)	
C_8 $[Co(L_{IV})_2Cl_2(H_2O)_2].1.5H_2O.EtOH$ (Grey violet)	(289-290) decomp. 20.9%	50.02 (50.92)	4.38 (5.36)	9.29 (10.48)	7.01 7.48
C_9 $[Ni(L_{IV})_2\ (H_2O)_4].(NO_3)_2$ (orange yellow)	>(305) 29.3%	-	-	-	6.96 (7.46)
C_{10} $[Pd(L_{IV})_2Cl_2].3H_2O.0.5EtOH$ (bright orange)	(259) decomp. (264-266) sub. 30.0%	-	-	-	13.31 (13.03
L_V $C_{12}H_{12}N_2SO_2$ (yellow)	(87-90) 20%	57.40 (57.99)	5.22 (4.83)	5.50 (5.64)	-
C_{11} $[Cu(L_V)Cl_2(H_2O)_3].0.2H_2O$ (yellow)	(102-105) decomp. 15.8%	33.28 (32.69)	3.58 (4.17)	7.20 (6.36)	14.92 (14.43)

c) Infrared spectra:

Important characterstic stretching frequencies of the ligands and their metal complexes are described in Table (3).

i) Complexes of $L_I(C_1$- $C_3)$ and $L_V(C_{11})$:

Bands related to methyl C-H, C-O, stretching and CH_3 bending vibrations of the ligand appeared at 2920, 1020 and 1355 cm^{-1} respectively (17). All complexes C_1-C_3 showed shifts in positions of azomethine group stretching vibrations, as a result of coordination with metal ions (9,22). The thiazole ring exhibited shifts of C=N, C-N and C-S stretching vibrations to higher frequencies in C_1 and C_2 and of C=N to lower frequencies in C_3. This refers to the coordination of metal ion to sulfur atom (23) in C1 and C_2 and to nitrogen atom (24) in C_3. New low intensity bands were observed at lower frequencies were assigned to υM-S and υM-N vibrations respectively (25,26).

Complexation of L_{IV} with Cu(II) ion caused a shift of υ_C=N of azomethine group only to higher frequencies which refers to the coordination of metal ion to imino nitrogen (9,22). A new low intensity band appeared at lower frequencies and was assigned to Cu-C_l stretching modes of cis form (25).

ii) Complexes of HL_{II} (C_4, C_5):

The spectra of C_4 and C_5 exhibited shifts in position of υ_C=N vibrations and the disappearance of phenolic OH stretching modes together with the appearance of bands related to M-O and M-N=C stretching vibrations. This refers to the coordination of metal ions with imino nitrogen (9,22) and phenoxy group of the ligand (27, 28) .Vibrations related to lattice water (25,26) were also observed.

iii) Complexes of L_{III} (C_6, C_7):

The spectra of C_6 and C_7 showed shifts in streching vibrations of azomethine group which refers to the coordination of azomethine group to metal ions (9,22). The spectrum of C_6 exhibited shifts of thiazole ring vibrations to higher frequencies which refers to further coordination of metal ion to sulfur atom (23).

Table (3): Characterterstic stretching vibrations υ(cm-1) of i.r spectra for Schiff bases and their metal complexes

Symbol	**Azome thine**	*Thiazole vibrations*			υ_{OH}	υ_{H2O}				υ_{MS}
	$\upsilon_{C=N}$	$\upsilon_{C=N}$	υ_{C-N}	$\upsilon_{C=S}$	**Phenolic** (EtOH)	**Lattice** (coordinate)	υ_{M-N}	υ_{M-O}	υ_{M-Cl}	(υ_{NO3})
L_I	1610	1500	1105	730	(3500-3100)	-	-	-	-	-
C_1	1595	1520	1120	750	(3600-3420)	3380-3270	420^a	-	335	375
C_2	1630	1520	1130	750	(3320)	3260-3200 (695pr), (645pw)	480^a	$(390)^g$	335	420
C_3	1585	1449	1120	745	-	3500-3200 (600)	420^a 260^b	$(490)^g$	370 355 310	-
HL_{II}	1595	1500	1110	745	3580-3180	-	-	-	-	-
C_4	1630-1595	1510	1110	745	-	(840 pr) (575 pw)	495^a	$(460)^d$ $(405)^g$	-	-
C_5	1630-1600	1513	1115	745	(3600-3380)	(700 pr) (690 pw)	500^a	$(410)^d$ $(400)^g$		-
L_{III}	1621	1525	1105	745	-	-	-	-	-	-

Table (3): (continued)

	Azome thine	***Thiazole vibrations***			υ_{OH} **Phenolic** **(EtOH)**	υ_{H2O} **Lattice** **(coordinate)**				υ_{M-S}
Symbol	$\upsilon_{C=N}$	$\upsilon_{C=N}$	υ_{C-N}	$\upsilon_{C=S}$			υ_{M-N}	υ_{M-O}	υ_{M-Cl}	(υ_{NO3})
C_6	1610	1540	1130	754	(3600-3440)	3400-3290	440^a	-	350,320	410
C_7	1630	1515	1110	745	(3700-3400) 3340	3206-3210 770pr 660pw	490^a	$(415)^g$	320	-
L_{IV}	1621	1525	1118	740	-	-	-	-	-	-
C_8	1600	1520	1118	740	(3700-3500)	3480-3160 (660)	505^a	$(435)^g$	300 295	-
C_9	1600	1520	1118	740	-	(710) (660)	570^a	$(490)^g$	-	(1400) (1280) (1018)
C_{10}	1595	1520	1118	740	3600-3500	3380-3270	550^a	-	410,360	-
L_v	1583	1500	1100	740	-	-	-	-	-	-
C_{11}	1610	1510	1110	740	-	3630-3230 830pr,640pw	560^a	$(470)^g$	380 330	-

(a) υ_{M-N} of Schiff base, (b) υ_{M-N} of thiazole ring; (c) υ_{M-N} of Et_3N (d) υ_{M-N} of ligand; (e) υ_{M-O} of M-OH; (f) $\delta_{M-O;}$ (g) υ_{M-O} of H_2O Hb= hydrogen bonded; sh= shoulder; pr= rocking; pw= wagging

iv) Complexes of L_{IV} (C_8 - C_{10}):

All complexes exhibited shifts in postions of azomethine group stretching vibrations only which indicates the coordination of nitrogen of this group to metal ions (9,22).

d) Electronic spectra, magnetic susceptibility and conductivity measurements:

i) Electronic spectra of ligands:

Table (4) describes the electronic spectra of the prepared Schiff bases in both DMF and ethanol. Two main bands were observed in the u.v region. The first band was assigned to $\pi \rightarrow \pi^*$ transition of the aromatic rings. The second band appeared at lower wavenumber was assigned to extended $\pi \rightarrow \pi^*$ of the conjugated Schiff bases (17,19). It was difficult to locate bands assigned to $n \rightarrow \pi^*$ transitions as they might be masked by $\pi \rightarrow \pi^*$ bands. Complexation with metal ion caused shifts of ligand bands to lower wavenumbers and the appearance of new bands in the visible, and near i.r region. These additional bands may be related to M-L charge transfer bands and ligand field transitions.

Table (4): bands of maximum absorptions (cm^{-1}) in electronic spectra of Sciff bases (L_I-L_V) with molar extinction coefficients E_{max} (1.mol.$^{-1}$ cm^{-1}).

Symbol	DMF		Ethanol	
	ν_{max} (cm^{-1})	ε_{max} (1.mol.$^{-1}$.cm^{-1})	ν_{max} (cm^{-1})	ε_{max} (1.mol.$^{-1}$.cm^{-1})
L_I	31628	12341.00	25510	18555.50
	33278	13523.70	29046	19113.15
	36269	12212.50	33816	9183.31
			43860	11629.79
HL_{II}	31546	17326.80	26022	6515.70
	33333	16884.30	31546	16746.90
	36269	15389.10	39526	18303.00
L_{III}	33333	14831.90	21053	3303.60
	36101	15648.30	29851	8446.00
			39063	18196.60
L_{IV}	30395	34451.00	23474	32778.34
	36630	14400.00	31348	4671.15
			36364	4765.60
L_V	26810	26754.90	26525	27864.20
	28571	32036.40	28571	38741.70
	34130	15215.20	33010	12251.70
	36969	12019.90	41152	25745.00
			45638	11589.00

Table (5): describes bands of maximum absorption of complexes in DMF with their assignments together with crystal field parameters (10Dq, B′, 10Dq/B′ and β). The latters were determined by applying band ratios on Tanaba Sangano diagrams of the specified metal ion (30-33). All Complexes showed spectral behaviours related to octahedral geometries except Pd (II) complex

Table (5): Electronic Spectral data electrical conductivities (DMF 10^{-3}) Magnetic susceptibilities (μeff, B.M) and suggested geometries for metal complexes of H_2L_1 and Mixed ligands complexes.

A	Max. absorption $\acute{\upsilon}_{max}(cm^{-1})$	Band assignment	Dq/B′	B′ (cm^{-1})	β	10Dq (cm^{-1})	Conductivity Scm^2mol^{-1}	μ_{eff} BM	Suggested geometry
C1 Pd(II)	υ1 16393 υ2 20833 υ3 25906	$^1A_1g\rightarrow{}^1A_2g$ $^1A_1g\rightarrow{}^1B_1g$ $^1A_1g\rightarrow{}^1Eg$	-	-	-	20833	18.5	Diamag.	Square Planar
C_2 $Pt_{(III)}$	υ_1 21413 υ_2 26881	$^1A_1g\rightarrow{}^3T_1g$ ^1A_1g $\rightarrow{}^1T_{1g}$	-	-	-	-	168.9	Diamag.	Square Planar
C_3 $Ru_{(II)}$	υ_1 10537 υ_2 11628 υ_3 21905 υ_4 27778	$^2T_2g\rightarrow{}^4T_1g(G)$ $^2T_2g\rightarrow{}^4T_1g(G)$ $^2T_2g\rightarrow{}^2A_2g,{}^2Eg$ CT(M→L)	-	-	-	-	12.2	1.36	Octahedral
C_4 $Co_{(II)}$	υ_1 5974(calc-) υ_2 12392 υ_3 15385 υ_4 25641	$^4T_1g\rightarrow{}^4T_{2g}$ $^4T_1g\rightarrow{}^4A_2g$ $^4T_1g_{(F)}\rightarrow{}^4T_1g(p)$ CT(M→L)	0.88	693	0.71	6099	9.8	5.7	Octahedral
C_5 $Ni_{(II)}$	υ_1 10537 υ_2 15700 υ_3 23816(calc-) υ_4 21505 υ_5 2641	$^3A_1g\rightarrow{}^3T_2g$ $^3A_2g\rightarrow{}^3T_1g(f)$ $^3A_2g\rightarrow{}^3T_1g(p)$ CT $\pi\rightarrow\pi^*$	1.9	527	0.51	10010	3.1	4.02	Octahedral

Table (5): (continued)

Symbol	**Max. absorption** $\acute{\upsilon}_{max}$**(cm^{-1})**	**Band assignment**	**Dq/B′**	**B′ (cm^{-1})**	**β**	**10Dq (cm^{-1})**	**Conductivity Scm^{2}mol^{-1}**	**μ_{eff} BM**	**Suggested geometry**
C_6 $Pd_{(II)}$	υ_1 20202 υ_2 25906	$^1A_1g\rightarrow{}^1A_2g$ $^1A_1g\rightarrow{}^1B_1g$	-	-	-	25906	4.7	Diamag.	Square planar
C_7 $Pt_{(IV)}$	υ_1 22222 υ_2 27397	$^1A_1g\rightarrow{}^3T_1g$ $^1A_1g\rightarrow{}^1T_1g$	-	-	-	-	116	Diamag.	Octahedral
C_8 $Co_{(II)}$	$\upsilon_1$6073(cal.) υ_2 129532 υ_3 16547 υ_4 23810	$^4T_1g\rightarrow{}^4T_2g$ $^4T_1g\rightarrow{}^4A_2g$ $^4T_1g_{(F)}\rightarrow{}^4T_1g(p)$ CT(M→L)	0.88 -	752	0.77	6619	34.4	4.79	Octahedral
C_9 $Ni_{(II)}$	υ_1 9320 υ_2 14661 $\upsilon_3$23319 (calc.) υ_4 23981	$^3A_2g\rightarrow{}^3T_2g$ $^3A_2g\rightarrow{}^3T_1g(f)$ $^3A_2g\rightarrow{}^3T_1g(p)$ CT	1.37	669	0.65	9172	156.6	3.7	Octahedral
C_{10} $Pd_{(II)}$	υ_1 16666 υ_2 20721 υ_3 23981	$^1A_1g\rightarrow{}^1A_2g$ $^1A_1g\rightarrow{}^1B_1g$ $^1A_1g\rightarrow{}^1Eg$	-	-	-	24468	20	Diamag.	Square planer
C_{11} $Cu_{(II)}$	υ_1 12360 υ_2 16393	$^2B_1g\rightarrow{}^2A_1g$ $^2B_1g\rightarrow{}^2B_2g$	-	-	-	-	10.5	2.03	Octahedral

which showed square planer behaviours (30,31). The Cu(II) complex exhibited behaviours related to Jahn-Teller distortion of ^2D term of octahedral complexes (31,34). The bands observed in Ru(III) complex are referred mainly to L→ M charge transfer and lie mainly near intraligand $\pi \rightarrow \pi^*$ transition bands (30). Conductivity measurements of C_1, C_3, C_6, C_8, C_{10} and C_{11} in DMF (10^{-3}M) showed that they were non electrolytes while C_2, C_7 and C_9 were found to be elctrolytic with ionic ratio of 1:2.

According to these observations and those obtained from CHN, A. A and thermal analyses and i.r spectra the structures of complexes were suggested as illustrated in Scheme –2.

e) Thermal analyses:

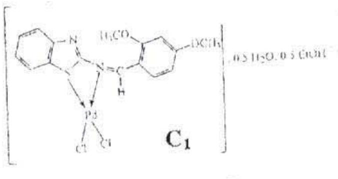
Thermal decomposition of some complexes by TG and DTG techniques are described in table (6) and thermographs for other complexes are shown in Figure (1). Results were in agreement with those obtained from CHN analysis and atomic absorption. Fragments which are not directly bonded to metal ion were found to leave at lower temperature than those directly bonded. C_1 and C_6 gave PdS as final product. This reflects the high affinity of Pd (II), ion to sulphide as both ions are soft acid and base respectively (35, 36). Different behavior was shown by C_9 and C_{10} within the same temperature range of decomposition which reflects the higher affinity of Ni (II) ions towards nitrogen compared with Pd (II) ions (37).

f) Biological activity:

A preliminary study of biological activity of the prepared complexes was carried out in DMF (1 mg/ml) on two types of bacteria namely gram (-) E. Coli and grm (+) B. Subtuluse. The following results were observed.

No antibacterial actions were exhibited by the ligands except HL_{II} which showed growth inhibition diameter of 8-10 mm against E. Coli.

In contrast to their ligands complexes of Cu(II), Pd(II), Pt(IV) and Ru(III) showed successful variable antibacterial activity against both types. C_6 and C_2 showed growth inhibition of 10 and 8-10 mm diameter respectively against B. Subtluse.



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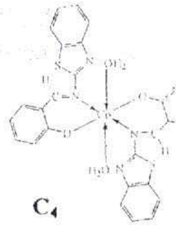

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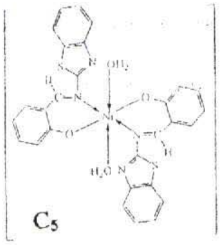

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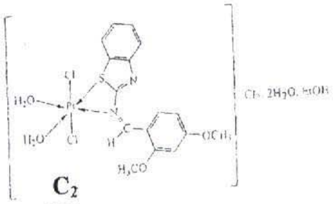

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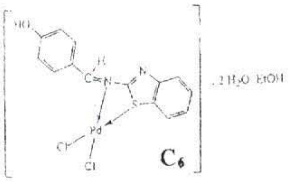

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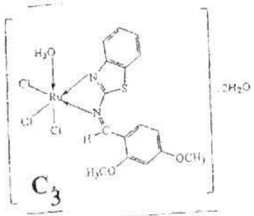

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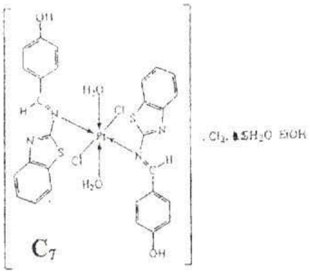

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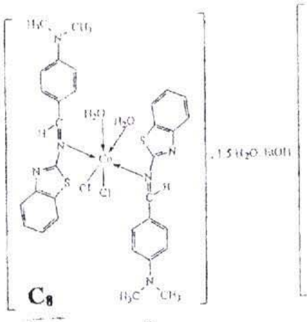

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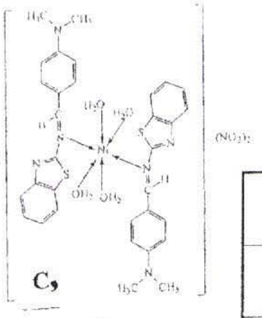
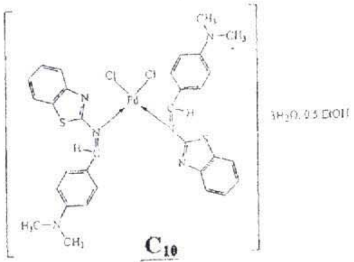
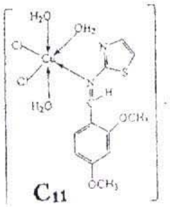


C₉



C₁₀



C₁₁

C₁	[Dichloro{N-2-(benzothiazolo-S)-2,4-dimethoxybenzylidene-iminato}palladium(II)]Water (0.5) Ethanol(0.5)
C₂	[Dichlorodiaqua{N-2-thiazolo-S)2,4-dimethoxybenzylidene-iminato} platinum (IV)dichloride]Water(2)Ethanol(1)
C₃	[Trichloroaqua{N-2-(benzothia- zolo-N`)-2,4-dimethoxy-benzylideneiminato} ruthenium (III)]Water(2)
C₄	Diaquabis{N-2-(benzothiazolyl) salicylidene iminato}cobalt(II).
C₅	[Diaquabis{N-2-(benzothiazolyl) salicylideneiminato}nickel(II)] Ethanol(2).
C6	[Dichloro{N-2-benzothiazolo-S)-4-hydroxybenzylideneiminato}palladium (II)] Water(2). Ethanol (1).
C7	Dichlorodiaquabis{N-2-(benzo thiazolyl)-4-hydroxybenzylidene- iminato}platinum (IV)]dichloride Water(0.5) Ethanol(1).
C8	[Dichlorodiaquabis(4-(N,N-dimethylamino)benzylidene-2`-imino benzothiazole)cobalt(II)]Water(1.5) Ethanol(1).
C9	[Tetraaquabis(4-(N,N-dimethyl-amino) benzylidene-2`-imino-benzothiazole) nickel(II)] nitrate.
C10	[Dichlorobis(4-(N,N-dimethyl-amino) benzylidene-2`-imino-benzothiazole) palladium(II)]Water(3) Ethanol(0.5).
C11	[Dichlorotetraaqua(2,4-dimethoxy-benzylidene-2`-iminobenzothiazole)

Acheme (2): Suggested stereochemical structures and names of schiff base complexes

Table (6): Stages of thermal decomposition of Schiff base complexes C_1, C_2, C_6, C_9 and C_{10}.

Stable phase C_1	Temp. range of decomposition at TG (°C)	Peak Temp. at DTG (°C)	Weight loss% found (Calc.)
$[PdL_1Cl_2]$ .0.5 H_2O.0.5 EtOH			
↓-0.5 H_2O	(65-95)	65	3.31 (4.15)
↓-2(OCH_3) ↓- Cl	(95-260)	*	1.969 (1.76)
↓-Ph ↓- PhCHN	(335-420)	410	35.43 (34.71)
↓-CN	(420-480)	445	5.51 (5.07)
PdS			27.95 (27.01)
C_2			
$[PtL_1Cl_2H_2O)_2]$ .Cl_2.2H_2O EtOH			
↓-EtOH	(65-150)	*	5.81 (6.11)
↓-2H_2O ↓- 2Cl	(150-230)	225	14.12 (14.20)
↓-2H_2O ↓- Ph	(230-300)	270	14.93 (14.86)
↓-$(OCH_3)_2$PhCHN	(300-410)	*	21.16 (21.77)
$Cl_2Pt \leftarrow SCN$	(410-500)	445	17.01 (17.31)
C_6			
$[PdL_{III}Cl_2]$ .2H_2O. EtOH			
↓-2H_2O ↓- EtOH ↓- Cl	(101-375)	349	22.59 (22.87)
↓-Ph ↓- CHN	(387-428)	393	20.03 20-05)
↓-PhOH	(428-590)	489	19.39 (18.10)

Table (2): Continued

Stable phase C_6	Temp. range of decomposition at TG (°C)	Peak Temp. at DTG (°C)	Weight loss% found (Calc.)
↓-CN ↓-Cl	(796-825)	812	11.38 (11.97)
↓PdS	(825-1000)	*	25.16 (26.96)
C_9			
$[Ni\ L_{IV}(H_2O)_4].(NO_3)_2$			
↓- $2NO_3$	(25-220)	205	15.32 (15.75)
↓-$4H_2O$	(220-300)	275	9.27 (9.15)
↓-$N(CH_3)_2$ Ph CHN ↓- 2Ph	(300-405)	370	37.09 (37.98)
↓-2NCS	(405-438)	410	14.11 (14-76)
$N(CH_3)_2PhCHN \rightarrow Ni$			25.0 (26.13)
C_{10}			
$[PdL_{(IV)}Cl_2].3H_2O.0.5\ EtOH$			
↓-0.5 EtOH	(35-125)	65	2.40 (2.82)
↓-H_2O	(125-165)	150	2.05 (2.20)
↓-H_2O	(125-165)	150	2.05 (2.20)
↓-$2H_2O$	(165-205)	*	4.50 (4.41)
↓-2Ph	(205-300)	*	19.66 (18.61)
↓-$2N(CH_3)_2$ Ph CHN	(300-405)	325	34.81 (35.99)
$PdCl_2$+ 2NCS			34.81 35.99

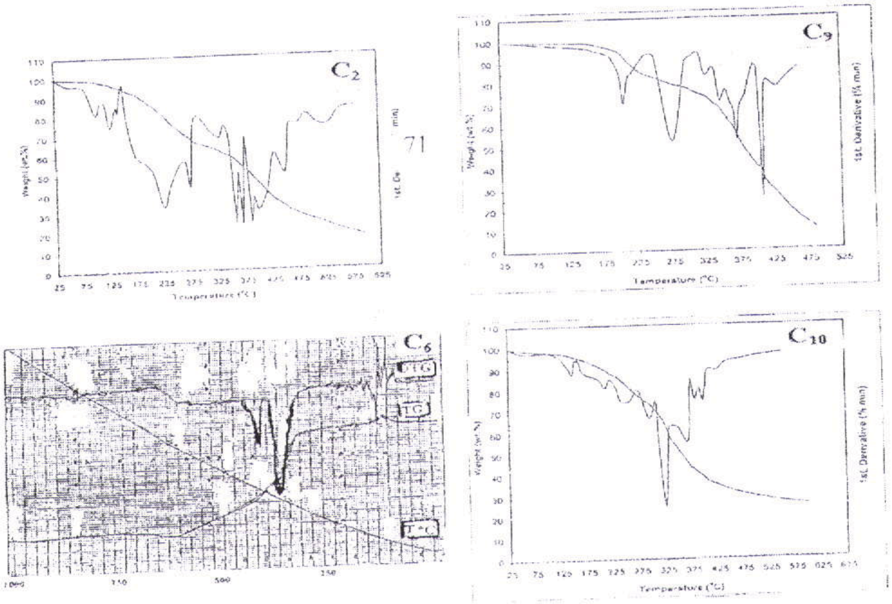


Figure (1): Thermograms of TG and DTG showing thermal behaviours of C_2, C_6, C_9 and C_{10}

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