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SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL STUDY OF NEW COMPLEXES SCHIFF BASE DERIVED FROM 4-BROMO-2-METHYLANINE

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ABSTRACT : The mixed ligand complexes of Schiff base ligand (Z)-2-(((4-bromo-2-methylphenyl) imino) methyl)-4-methylphenol (L) with some metals ion (II); Mn(1), Co(2), Ni(3), Cu(4), Zn(5) Cd(6) and Hg(7) and 1,10-Phenanthroline (phen) were Synthesis and characterized by the mass and ^{1}HNMR spectrometry (ligand Schiff base), the FTIR, UV-visible and the flame atomic absorption (A.A) spectrum, the C.H.N analysis and the chlorine content, in addition to measuring the magnetic sensitivity of the complexes. All the complexes had octahedral geometry. The bioactivity activity for compounds against; *Rhizopodium, Staphylococcus aureus* and *Escherichia coli*, the compounds showed different efficacy towards these microorganisms.

Key words : Ligand Schiff base, microorganisms, Schiff base, thermodynamic functions.

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INTRODUCTION

The ligand Schiff base (LSB) prepared from carboxylic compounds and primary amines was first reported by chemist Hugo Schiff (Nishad *et al*, 2007). Element ions have played an important role in the biological system (Sari *et al*, 2006; Campbell, 1975) for the past years. Metal ions can be introduced into a biological system (Campbell, 1975) for therapeutic or diagnostic purposes, although these purposes may overlap in many cases (Kuz'min *et al*, 2005; JAYASREE *et al*, 1993). Minerals not only provide a way to synthesize, but also introduce functions that enhance drug action (Yogeeswari *et al*, 2004). Synthesis of a series of ligand Schiff base (2-9), which one of these ligands was with the reaction of 4-bromo-2-methylanine with 3-acetylcoumarin. It was attracted great interest from organic chemists and medicine due to its photosynthetic and photochemical behavior (Olayinka *et al*, 2016). The structural and electronic properties of the metal–Schiff base complexes of NiL_2 2 (1), PdL1 2 (2), ZnL2 2 (3), and NiL1 2 (4), where L1 and L2 are Schiff bases synthesized from salicylaldehyde and 2-hydroxy-5-methylbenzaldehyde, respectively. Natural bond analysis showed that in complexes 1 and 2, the metal ion coordinates to the ligands through electron donation from lone pairs on ligand nitrogen and oxygen atoms to s and d orbitals on the metal ion. In complex 3, metal–N and metal–O bonds are formed through charge transfer from the lone pairs on nitrogen and oxygen atoms to an s orbital of Zn (Amina *et al*, 2018). In recent years the effect of alternate site on supramolecular topology formation, intramolecular geometry, tautomeric behavior, and elemental form dependence on solvent type were studied using XRD, UV-Vis, NMR, DFT, PES and HOMA methods on three novel methods from Schiff bases ligand from the reaction of 2-hydroxy-4-methoxybenzaldehyde with 4-bromo-2-methylaniline. XRD studies show that different alternative positions cause different types of interactions between non-covalent molecules in the crystalline enclosures of the compounds (Gokhan *et al*, 2020). The synthesized of three Schiff bases, by the condensation of 4-bromo-2-methylaniline, 4-bromo-3-methylaniline and 3-bromo-4-methylaniline with 2-hydroxy-4-methoxybenzaldehyde, the compounds have the substituents in different positions. The compounds have been investigated experimentally (XRD, UV-Vis, ^{1}H and ^{13}C NMR) and computationally (DFT and HOMA) by considering the relevant factors that affect the tautomeric behavior of an o-hydroxy Schiff basis in the solid-state and solvent media (Ka°ta° *et al*, 2020). In this study, mixed

ligand complexes derived from 4-bromo-2-methylanine with 1,10-Phenanthroline with M(II) were prepared and diagnosed by spectral methods, biological activity.

EXPERIMENTAL AND METHODS

Chemicals used in the laboratory, are the highest purity that does not need any further purity and they have been purchased from distinguished sources. The device used to measure the melting point is by Stuart Melting Point Kit; the CHN for all compounds is measured by Euro (EA 3000); the NMR and mass spectra were performed on by "Brucker DRX system 500 (500 MHz)" and Shimadzu, E170Ev.; ultra Violet-Visible spectra are performed on a Shimadzu UV-160A; in KBr discs the FTIR spectra are verified via FTIR - 8400S Spectrophotometer on 4000-200 cm^{-1}; atomic absorption method using AA 620G Shimadzu spectrophotometer; magnetic sensitivity was measured using a Faraday's method using Bruker BM6 instrument. The complexes and their metal substances have examined via Shimadzu AA (620G) atomic absorption spectrophotometer

Synthesis of ligand

A solution of 2-hydroxy-5-methylbenzaldehyde (0.136g, 1mol) in 10 ml ethanol has been inserted into a mixture solution of 4-bromo-2-methylaniline in 5ml ethanol and three drops of glacial acetic acid, the product combination has been refluxed for 4h. The resulted orange solid is composed of filtration, recrystallization from acetone absolute and dried (Fig. 1).

The product mixture is stirred for sixty minutes and, then, the result is filtered and dried through anhydrous $CaCl_2$.

Biological activity

The prepared compounds were tested against *Escharia coli* and *Staphylococcus aureus* and *Rhizopodium* by disc diffusion technique. The sample solution is prepared from the concentration of 0.001M in DMSO as a solvent. The dishes are incubated for 24 h at room temperature then the diameter of the inhibition is measured and this indicates the growth of bacteria.

RESULTS AND DISCUSSION

The results of the solubility test showed in DMF and DMSO and insoluble in H_2O, conductivity values of complexes (1-7) were 12–39 Ω^{-1} cm^2 mol^{-1}. The C.H. N analysis and the atomic absorption of the complexex (1-7) are listed in Table 1. The suggested formula for the complexes is [M(L)(phen) (Cl) (H_2O)] when M metal (II) ions are Co, Cd and Hg and [M(L)(phen) $(H_2O)_2$] Cl for Mn, Ni, Cu, Zn (Guelai *et al*, 2018; Gary *et al*, 1970).

Mass spectrum

Mass spectrum of the ligand L was recorded (Fig. 2). The spectrum showed a group of different fission peaks with M. wt with a difference in their multitude through the peak fractionation at $M^+ = 303$ (m/e) attributed to the partial ion of the ligand $C_{15}H_{14}BrNO$ (Mahdi *et al*, 2018; Mendham, 2006).

^{1}H-NMR spectrum

The ^{1}HNMR spectrum of the ligand (Fig. 3) was

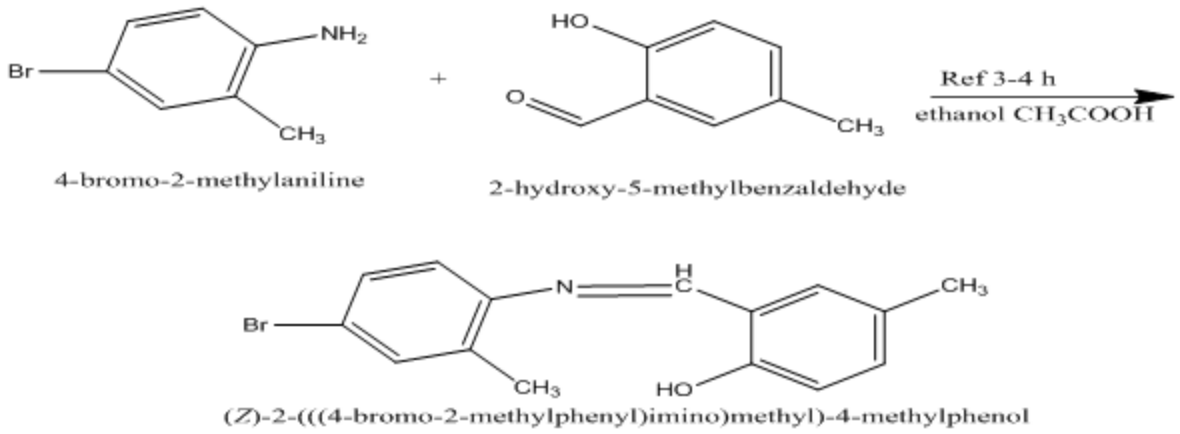

Fig. 1 : The preparation of ligand Schiff base.

Synthesis of complexes

A solution of 1 mmol of ligand Schiff base and 1,10-Phenanthroline in 10ml absolute ethanol for both of them, were added with stirring to a solution consisting of 1 mmol and 10 ml ethanol and Mn(II) chloride, Co(II) chlorid.$6H_2O$, Ni(II) chloride.$6H_2O$, Cu(II) chlorid.$2H_2O$, Zn(II) chlorid, Cd(II) chlorid.H_2O, and Hg(II) chloride).

prepared by using the solvent DMSO and (TMS) as a basic reference, as shown in Table 2 and Fig. 3. Where the spectrum showed the signal appeared at (1.12, 1.10) ppm which refers to the protons of the -CH_3 group associated with the two benzene rings, while the signal in (2.51-2.49) ppm) refers to DMSO solvent, a signal at (3.4, 3.77) ppm where it indicates the presence of H_2O

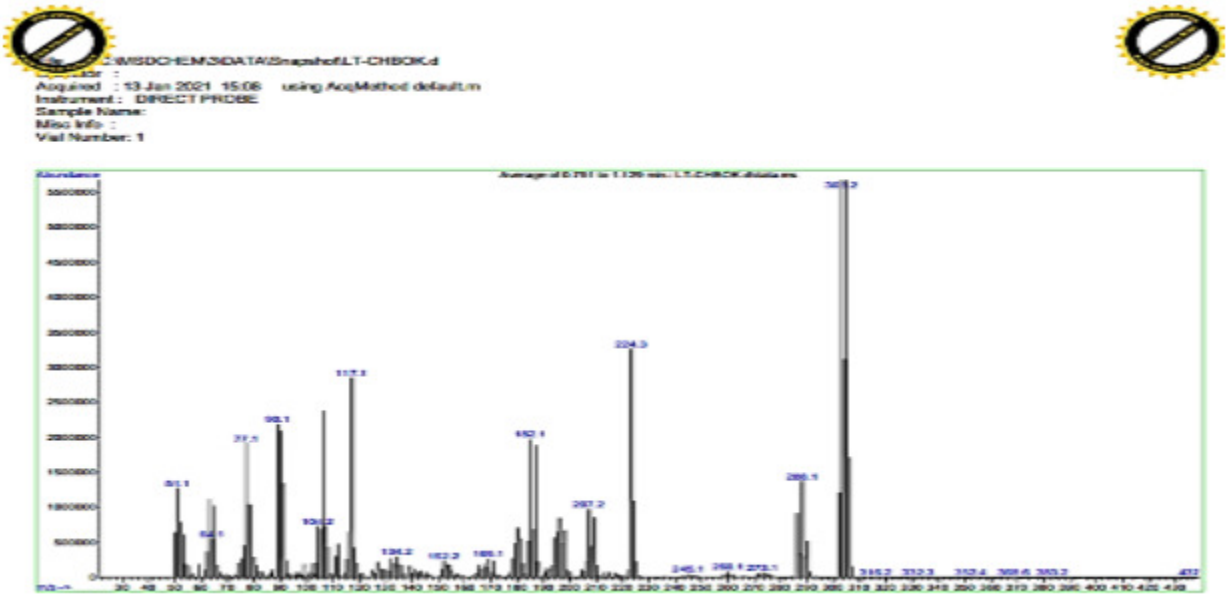

Fig. 2 : Mass spectrum of L.

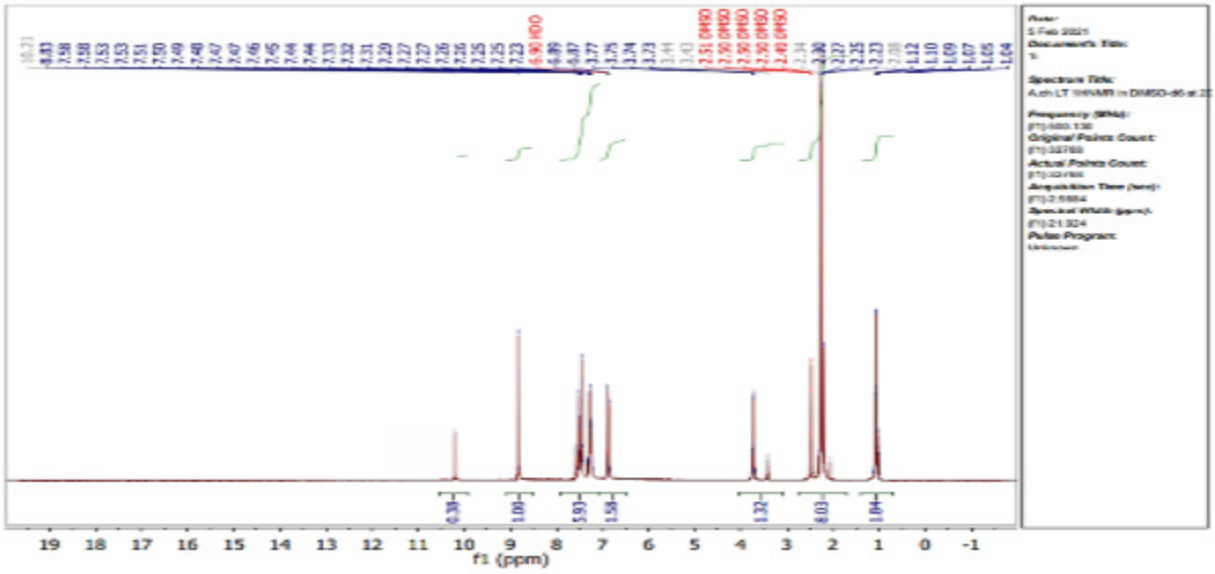

Fig. 3 : The NMR for ligand L.

in the ligand, while the single signal at the site (10.21 ppm) it refers to the proton of the phenolic (OH) group. Also, multiple signals that appeared in the region (7.58-6.89) ppm were attributed to the protons of the aromatic ring, while the single signal in the 8.83 ppm is attributed to the proton of the -CH=N group (Silverstein *et al*, 1962; Ovas *et al*, 2019).

FTIR spectral

The infrared spectra of 1, 2, 3, 4, 5, 6 and 7 complexes, Table 2 showed absorption bands within the range (1650-1620) cm^{-1}, which is due to the stretching frequency of the (HC = N) of the L, which shifted significantly in the complexes compared to their frequency in the L at the site. 1643cm^{-1}, which results in the symmetry between the metal and the nitrogen atom as a donor atom (Silverstein *et al*, 1962). The complex spectrum also showed a shift in position (1624-1585) for the group (C = N) ring, which indicates the consistency of the two nitrogen atoms in the 1,10-Phenanthroline ring with the atoms of the central ion (Nakamoto, 1970). The emergence of absorption bands at the site cm^{-1} (3417, 3452, 3417, 3425, 3414, 3425, 3400) for the 1, 2, 3, 4, 5, 6 and 7 complexes respectively, which indicate the presence of coordinated water, in addition to that the appearance of new weak to medium intensity bands within the range (860–844 cm^{-1}) refers to the presence of coordinated water from the oxygen atom as a donor atom of the electron duplex to the metal atom (Sahib *et al*, 2020). In addition to the appearance of new absorption bands in the complexes spectra in the range between (594-567

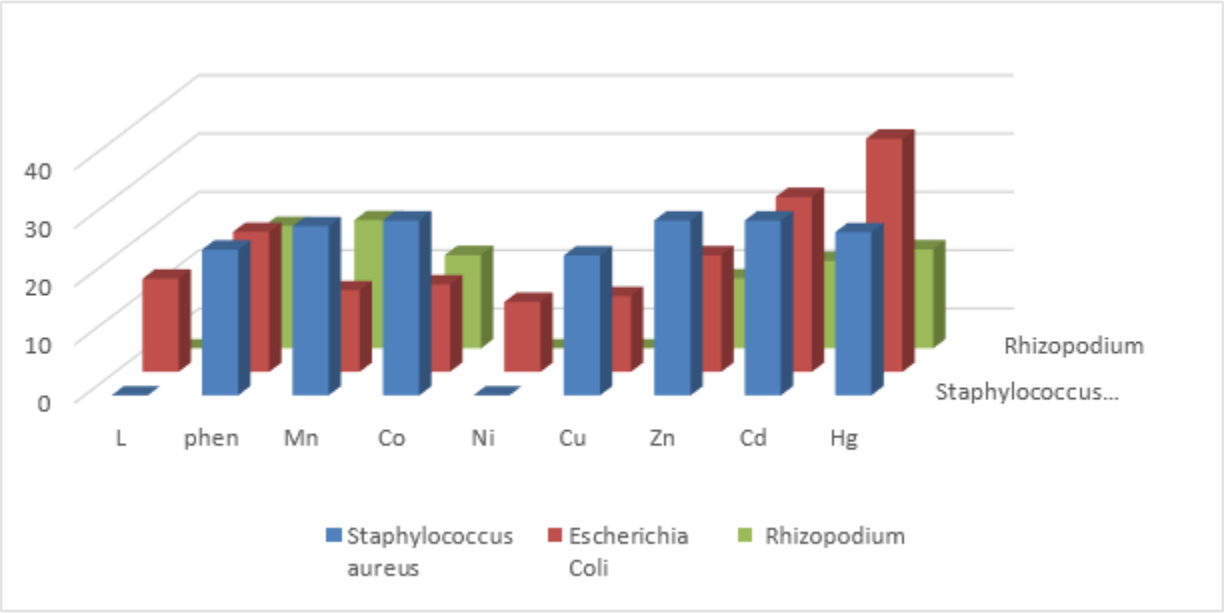

Fig. 4 : The inhibitions zone of the compounds.

Table 1 : Physical properties and conductivity of prepared compounds.

Compounds	M. wt (g/mole)	M.P°C	Color	Elemental analysis				Cond.Ω⁻¹
				C	H	N	M	
$C_{15}H_{14}BrNO$	304	170	Yellow	59.19 59.00	4.50 4.55	4.59 4.58	—	—
$C_{27}H_{25}BrClMnN_3O_3$	610	260	Orange	53.18	4.13	6.89	9.01	34
$C_{27}H_{25}BrClCoN_3O_2$	596	189	Pail- brown	54.43	3.89	7.05	9.89	17
$C_{27}H_{25}BrClN_3NiO_3$	614	183	Brown	52.85	4.11	6.85	9.57	36
$C_{27}H_{25}BrClCuN_3O_3$	618	250	Pail-brown	52.44	4.07	6.79	10.28	39
$C_{27}H_{25}BrClN_3O_2Zn$	620	260	Orange	52.28	4.06	6.77	10.48	36
$C_{27}H_{25}BrClCdN_2O_3$	649	255	Pail-brown	54.43	3.89	7.05	9.89	14
$C_{27}H_{25}BrClHgN_2O_3$	737	245	Dark brown	43.98	3.14	5.70	27.2 059.19	12

Table 2 : The FTIR spectra bands of compounds.

Complexes	õ (O-H_2)	õ(C-H)arom õ(C-H)alph.	C=N) $_{Schiff}$) õ C=N)phen) õ	õ(M-O)aq õ(M-O)	õ(M-N) õ(M-N)	õ(M-Cl)
1	3400	3047 2912	1635 1616	844 586	482 459	—
2	3425	3046 2912	1624 Broad	848 570	462 432	350
3	3414	2989 2904	1639 1620	848 567	493 459	—
4	3425	3043 2965	1620 1589	852 594	489 428	—
5	3417	3055 2985	1620 1585	848 574	466 433	—
6	3452	3047 2989	1620 1585	860 578	482 436	320
7	3417	3055 2985	1635 1616	844 586	466 443	320

Table 3 : The UV- visible transition of complexes.

Comp.	nmλ	ε_{max}	$cm^{-1}\nu$	Transition type	Assignment
1	278	2248	35971	Intra-ligand	Octahedral
	326	1619	30674	Intra-ligand	
	345	2126	28985	Intra-ligand	
	359	1143	27855	C.T.	
	549	3	18215	$^6A_{1g} \rightarrow {}^4T_{1g}(G)$	
2	270	1620	37037	Intra-ligand	Octahedral
	348	521	28735	Intra-ligand	
	350	29	19493	C.T	
	513	5	19493	$^4T_1g(F) \rightarrow {}^2A_2g(F)$	
	819	3	12210	$^4T_1g(F) \rightarrow {}^2T_2g(F)$	
3	279	2275	35842	Intra-ligand	Octahedral
	359	915	27855	C.T	
	409	47	24449	$^3A_2g(F) \rightarrow {}^3T_1g(F)$	
	829	3	12062	$^3A_2g(F) \rightarrow {}^3T_1g(F)$	
4	280	2379	35714	Intra-ligand	Octahedra
	346	1655	28917	Intra-ligand	
	360	984	27777	C.T.	
	637	3	15698	$^2Eg \rightarrow {}^2T_{2g}$	
5	273	2007	36630	Intra-ligand	Octahedra
	359	25	27855	C.T	
6	276	2200	35971	Intra-ligand	Octahedra
	345	2347	30674	Intra-ligand	
	359	1203	27855	C.T.	
7	271	1871	36900	Intra-ligand	Octahedra
	348	901	28735	C.T.	

Table 4 : The inhibiting zone effect on bacteria.

Comp.	*Staphylococcus aureus*	*Escherichia coli*	*Rhizopodium*
L	—	16	—
phen	25	24	21
1	29	14	22
2	30	15	16
3	—	12	—
4	24	13	—
5	30	20	12
6	30	30	15
7	28	40	15

cm^{-1}), (493-462 cm^{-1}) and (428-459 cm^{-1}) due to the stretching vibration of the (M-O) and (M-N) of the N-Schiff base group and (M-N) N- ring, respectively and at the rang (350-320 cm^{-1}), due to the (M-Cl) for Co, Cd and Hg complexes (Donatus *et al*, 2020).

The magnetic sensitivity

The Magnetic sensitivity of the Mn, Co, Ni and Cu complexes were 3.48, 3.88, 2.75 and 1.75 respectively showed that they have paramagnetic properties (Mumtaz *et al*, 2020).

UV-visible spectral

The UV-vis spectrum of the L appeared peaks at (217-341 nm), which due to ð →ð* and n→ ð* transition (Lever, 1984; Mahdi *et al*, 2019). Spectrum have 1,10-Phenanthroline peaks at (265-325) nm due to ð →ð* and n→ ð* (Hanan *et al*, 2017). Electronic spectra of complexes in Table 3 reveal peaks at (270-280 nm) due to ligand field. The wavelength d-d in complexes appeared as follows: (1) complex display one peaks for $^6A_1g \rightarrow {}^4T_2g(G)$ at 549 nm (Naji *et al*, 2017). (2) complex displays peaks in (513 and 819 nm), which have been due to $^4T_1g \rightarrow {}^4A_2g$ (F) and $^4T_1g \rightarrow {}^4T_2g$ (F), respectively. (3) complex shows peaks at (409 and 829) nm attributed to

the $^3A_2g \rightarrow {}^3T_1g$ and $^3A_2g(F) \rightarrow {}^3T_1g$ (Karem *et al*, 2017). (4) complex displays bands in the position 637nm attributed to $^2Eg \rightarrow {}^2T_2g$. the spectra of (5, 6 and 7) complexes show peaks at (359, 359) nm and 348 nm due to charge transfer (Karem *et al*, 2017).

Antibacterial activities

In this study, all prepared compounds have been evaluated *in vitro* as microorganisms of one type of Gram-positive (*Staphylococcus aureus*), Gram-negative bacteria (*Echerchia coli*) and *Rhizopodium* as fungus However, the compounds have a good inhibiting effect on microorganisms, except L and (3) complex against Gram-negative and fungus, which show a good effect of inhibition on the Gram-negative, the reason is due to "Tweedy's" chelation theory in the complexes, the polarity of the metal ion will be reduced to a greater extent leads to the overlap of the ligand orbital and partial sharing of the M^{+2} with donor groups, the delocalization of (ð electrons) over the whole chelate ring and the large ring size of ligands moiety makes the complexes more lipophilic (Tweedy, 1964; Karem, 2017; Ashraf *et al*, 2020; Neelkantan *et al*, 2010).

CONCLUSION

The new Schiff base derived from 4-bromo-2-methylanine with 2-hydroxy-5-methylbenzaldehyde was preparation and diagnosed. The results indicated that the ligand Schiff base was coordinated with the metal ions via nitrogen (imine group) and oxygen (phenolic group), the co-ligand 1,10-Phenanthroline was coordinated with the metal ions via nitrogen ring. The proposed form of complexes is octahedral geometry.

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