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Synthesis and Characterization of Biologically Active Transition Metal Complexes containing Monobasic Tridentate Schiff Bases

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ABSTRACT

The complexes of V(III) and MoO(V) with the ligands like glycine 2,4-dihydroxybenzaldehyde(GDHB),L-alanine 2,4-dihydroxybenzaldehyde(ADHB) and valine 2,4-dihydroxybenzaldehyde (VAIA) have been synthesised and characterised by analytical data, conductivity, magnetic, infrared and electronic spectral data. The analytical data suggested 1:2(M:L) stoichiometry for all the synthesised complexes. Octahedral geometry has been proposed for all complexes. The ligands and their respective MoO(V) and V(III) complexes have been screened for their antimicrobial activities.

Key words: V(III), MoO(V), ligand, octahedral, antimicrobial activity.

INTRODUCTION

Vanadium and molybdenum are prominent among the transition metals which play important role in biochemical processes. There is heightened interest in the biological chemistry of vanadium due to the discovery of two types vanadium enzymes^{1,2}, Vanadium nitrogenase and vanadium bromoperoxidase. According to the available report³, V(III) is at the active site of vanadium nitrogenase. Vanadium is also known to be an essential nutrient in higher life forms⁴⁻⁷, where it is involved in phospholipid oxidation, sulphur metabolism and cholesterol biosynthesis⁹. Apart from this vanadium

has been a subject of investigation with regard to its association with insulin and its role in the body⁵. Vanadium salts also controls glucose level in plasma⁵. Vanadium is better absorbed in the form of an organic matrix⁶. In such a case Schiff base V(III) complexes seems to be important to synthesise. Similarly molybdenum(V) complexes have been found to act as simple models for biochemical redox⁶ and in nitrogenase enzymes⁷.

Keeping these facts in view, an attempt has been made to synthesise and characterize some of the biologically active Schiff base complexes of vanadium(III) and oxomolybdenum(v).

EXPERIMENTAL

All the chemicals used during this research work, various aldehydes and amino acids were of A.R grade or equivalent purity. The ligands as well as the metal complexes were analysed by standard methods. Conductivity measurements were carried out on Philips conductivity Bridge model PR 9500 using 10^{-3} M DMF and DMSO solution at 25°C. The I.R. spectra were recorded by Perkin Elmer FTIR spectrophotometer by using KBr pellets. Electronic spectra were recorded using Beckmann DU Spectrophotometer. The magnetic susceptibility was determined by Gouy's balance using $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ as calibrant.

Preparation of the ligands

The ligands were prepared by the reported standard method¹².

Preparation of metal complexes

The ethanolic solutions of the respective ligand and corresponding chlorides of V(III) and MoO(V) were refluxed for 4-5h. The precipitate so obtained was cooled, filtered, washed repeatedly with ethanol to remove any excess of metal chloride and /or ligand. Finally it was dried in vacuum.

RESULTS AND DISCUSSION

The analytical data of the metal complexes, along with melting points, magnetic moments and molar conductance is given in Table 1.

The IR spectra of the ligands were compared with those of the corresponding metal complexes to find out the possible coordination sites. The comparison revealed the monobasic tridentate nature of all the three ligands.

The IR spectra of the ligands exhibited a band in the range of 1640-1620 cm^{-1} assignable to $\nu(\text{C}=\text{N})$. These bands have shown a downward shift of 15-20 cm^{-1} in the IR spectra of the corresponding V(III) and MoO(V) complexes. These shifts suggested the involvement of azomethine nitrogen atom in coordination with the respective metal⁸. It is expected that coordination of nitrogen to the metal atom would reduce the electron density on the

azomethine link and thus lower the $\text{HC}=\text{N}$ absorption⁹. This assignment was further confirmed by the appearance of non-ligand band in the IR spectra of the corresponding metal complexes around 520-550 cm^{-1} , assignable to $\nu(\text{M}-\text{N})$ ¹⁰.

The asymmetric carboxyl stretching $\nu_{\text{asym}}(\text{COO}^-)$ has shifted to higher frequency while symmetric carboxyl stretching $\nu_{\text{sym}}(\text{COO}^-)$ has shifted to lower frequency in all the complexes indicating the linkage between metal ion and carboxylate oxygen atom¹³.

The bands appearing in the region of 1535-1515 cm^{-1} may be assigned to $\nu(\text{C}-\text{O})$ phenolic stretching¹⁴. These bands have shifted to higher frequency in the IR spectra of the complexes, suggesting coordination through phenolic oxygen with the metal ion. It was further supported by the appearance of non-ligand band in the far IR region of the spectra of the complexes at 440-400 cm^{-1} attributable to $\nu(\text{M}-\text{O})$ vibrations¹⁵.

In the IR spectra of oxomolybdenum (V) complexes, some new bands have appeared in the region of 3400-3250 cm^{-1} due to $\nu(\text{OH})$ vibrations of coordinated water molecules and 800-750 cm^{-1} , 720-700 cm^{-1} due to rocking and wagging modes of water molecules respectively¹⁶.

The IR spectra of the oxomolybdenum complexes also exhibited another new band in the 890-920 cm^{-1} due to the presence of $\text{Mo}=\text{O}$ moiety¹¹.

As expected, all the vanadium (III) and oxomolybdenum (V) complexes are paramagnetic in nature (values in table-1) with two unpaired electrons in V(III) and one unpaired electron in the case of MoO(V). Conductivity for the complexes measured at 25°C and 10^{-3} M dilution suggested 1:1 and 1:2 electrolytic nature for V(III) and MoO(V) complexes respectively.

The electronic spectra of oxomolybdenum (V) complexes are similar to each other, thereby suggesting a uniform structure for all of them. The complexes may be considered as octahedral with strong distortion resulting from molybdenum - oxygen bond ($\text{Mo}=\text{O}$). The complexes exhibit three distinct absorption bands in the ligand field region.

Table 1: Characterisation of complexes prepared

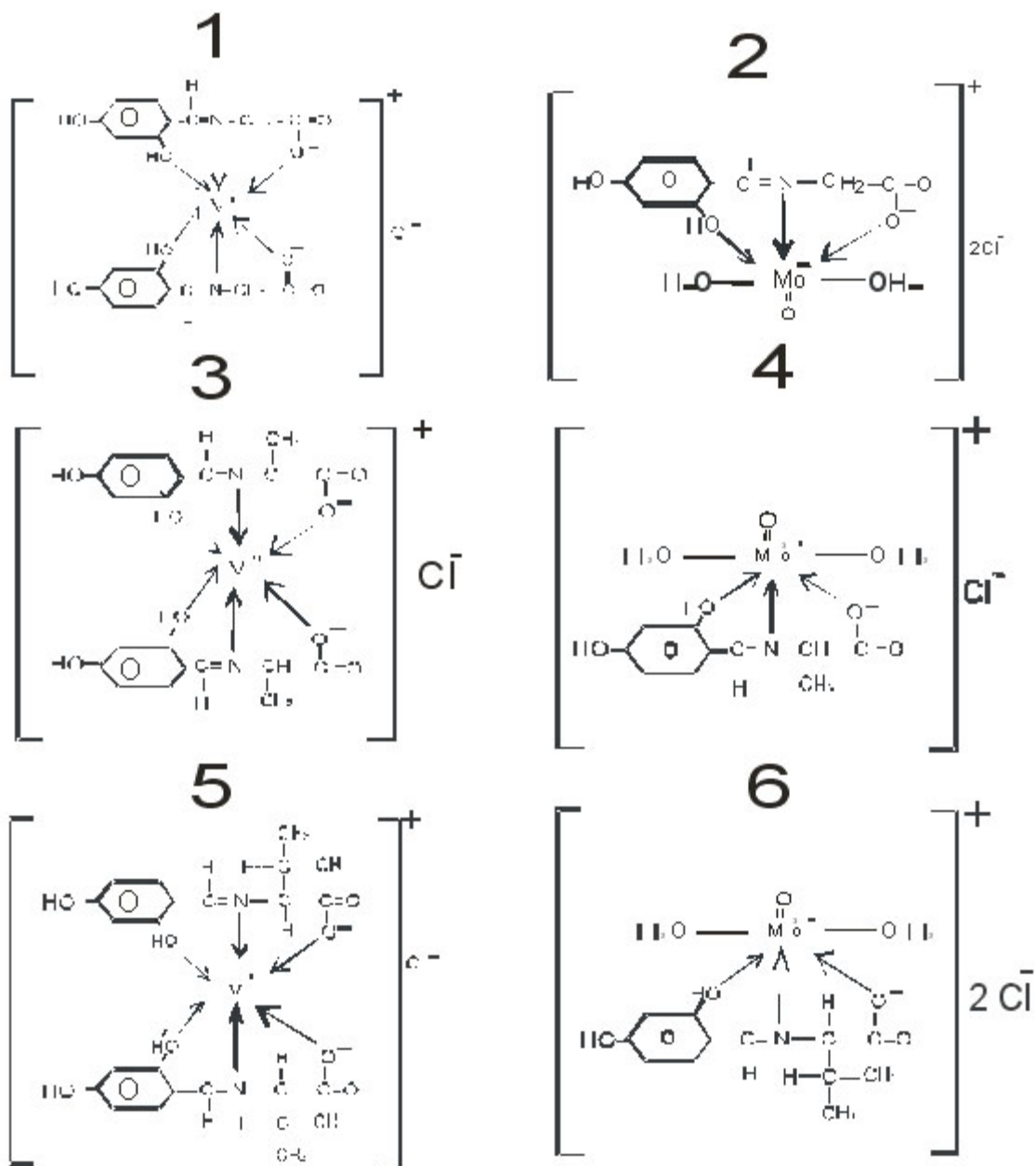
S. NO.	Complex	Molecular Formula	M.Pt. (In °C)	Elemental analyses					Magnetic Moment (B.M.)	MOLAR Conductance Values (ohm ⁻¹ cm ⁻² mol ⁻¹)	
				%Metal	% C	% H	% N	%Cl		DMSO	DMF
1	bis(Glycine 2,4 di hydroxy benzaldehyde) vanadium(III) chloride	[V(C ₉ H ₈ NO ₄) ₂]Cl	295 ⁰	10.74 (10.65)	45.53 (45.50)	3.37 (3.30)	5.90 (5.80)	7.48 (7.39)	2.91	50	70
2	Diaquo-Glycine 2,4-di hydroxy benzaldehyde oxomolybdenum (V)chloride	[MoO(C ₉ H ₈ NO ₄) (H ₂ O) ₂]Cl ₂	305 ⁰	27.11 (27.00)	26.15 (26.10)	2.91 (2.85)	3.39 (3.31)	17.19 (17.00)	1.70	55	75
3	bis(alanine 2,4 di hydroxy benzaldehyde) vanadium (III) Chloride	[V(C ₁₀ H ₁₀ NO ₄) ₂]Cl	275 ⁰	10.14 (10.10)	47.77 (47.68)	3.98 (3.90)	5.57 (5.45)	7.06 (7.01)	2.98	65	80
4	Diaquo alanine 2,4-di hydroxy benzaldehyde oxomolybdenum (V) Chloride	[MoO(C ₁₀ H ₁₀ NO ₄) (H ₂ O) ₂]Cl ₂	300 ⁰	26.22 (20.68)	28.10 (29.82)	3.27 (2.10)	3.27 (3.00)	16.62 (15.16)	1.85	90	135
5	bis(valine 2,4 di hydroxy benzaldehyde) vanadium (III) Chloride	[V(C ₁₂ H ₁₄ NO ₄) ₂]Cl	280 ⁰	9.60 (9.68)	54.29 (54.69)	5.27 (5.49)	5.27 (5.00)	6.69 (24.36)	2.80	70	80
6	Diaquo valine 2,4-di hydroxy benzaldehyde oxomolybdenum (V) Chloride	[MoO(C ₁₂ H ₁₄ NO ₄) (H ₂ O) ₂]Cl ₂	310 ⁰	24.60 (19.41)	31.65 (29.16)	3.95 (2.83)	3.07 (2.84)	15.60 (14.31)	1.65	100	145

The low intensity bands spread over Ca 13000-14000 cm^{-1} region may be due to ${}^2B_2 \rightarrow {}^2E$ ($d_{xy} \rightarrow d_{xz}, d_{yz}$). The second band appeared at Ca 19000-20000 cm^{-1} due to the transition, ${}^2B_2 \rightarrow {}^2B_1$ ($d_{xy} \rightarrow dx^2-y^2$). The third peak lies at Ca 30000-22000 cm^{-1} and may be due to ${}^2B_2 \rightarrow {}^2A_1$ ($d_{xy} \rightarrow dz^2$)¹¹.

The electronic spectra of vanadium(III)

complexes exhibited bands at 16700 cm^{-1} with a shoulder at 21000-21500 cm^{-1} . The low energy band may be assigned to $3T_1g3T_2g$ while the high energy band to $3T_1g3T_1g(p)$ transitions respectively. These are characteristic of octahedral geometry¹⁷.

Based on these studies octahedral geometry may be suggested for all these complexes with distortion in the case of oxomolybdenum (V).



All the ligands and their V(III) and MoO(V) complexes were screened for their antimicrobial activity against *E. coli*, *Salmonella typhinurium*,

S. aureus and *A.niger*. The results revealed that the metal complexes are more potent antimicrobials than their corresponding ligands.

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