



Research Article

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Nd (III) complexes with schiff base ligands: Synthesis, characterization and antimicrobial studies

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ABSTRACT

The synthesis of Nd (III) complexes derived from Schiff base ligands. Obtained by the condensation of 1 naphthylamine with different aldehydes viz. 4 hydroxy benzaldehyde, 4 methoxy benzaldehyde, 3 nitro benzaldehyde, 4 chloro benzaldehyde were synthesized in alcoholic medium. The prepared Schiff bases and their Nd (III) complexes were characterized on the basis of elemental analysis, IR, ¹HNMR, Mass spectral studies. The compounds have been screened for Antimicrobial activity against the organisms *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, and *Basillus subtilis*. The antifungal Activities of complexes were tested using fungal species such as *Aspergillus Niger* and *Pencillium Crysogenum*. Some complexes showed good antibacterial activities against the tested bacteria therefore, the possible use of the Complexes as antibiotic can be suggested.

Keywords: Synthesis, Neodymium (III) Nitrate, Schiff base, physicochemical studies, Antimicrobial Activity.

INTRODUCTION

Schiff bases have often been used as chelating ligands in coordination Chemistry[1] Many Schiff bases and their complexes have been widely studied because of their industrial And biological applications[2-3]. Schiff base compounds (-RC=N-) are usually formed by the condensation of a primary amine with an active carbonyl [4]. The chemistry of the carbon-nitrogen double bond plays a vital role in the progress of chemistry science [5]. Schiff base metal complexes have played a key role in the development of coordination chemistry, resulting in an enormous number of publications, ranging from pure synthetic work to modern physicochemical and biochemically relevant studies of metal complexes [6]. Lanthanide Schiff base complexes have various applications in agriculture and medicine [7-8]. The Schiff base complexes having a wide range of applications in analytical Chemistry [9]. The Schiff base complexes are highly remarkable class of compounds having a wide range of applications in antibacterial [10], antifungal [11], antitumor [12] and anti-inflammatory [13] activities and they possess considerable physiological activities [14]. Some of Schiff base complexes are used as model molecules for biological oxygen carrier system [15]. Schiff's bases complexes continues to attract many researchers because of their wide application in food industry [16], dye industry [17].

EXPERIMENTAL SECTION

All the chemicals and solvents used were of A.R. grade. All chemicals used were of Merck and S.D. fine Ltd. The IR spectra were recorded on a PERKIN ELMER spectrophotometer in the frequency range 4000-400 cm⁻¹ in Nujol mull and as KBr pellets. ¹HNMR spectra were recorded on BRUKER AVANCE II 400 spectrometer with TMS as internal standard using DMSO as solvents. Mass Spectra were recorded on Q-TOF MICROMASS spectrometer.

Synthesis of Schiff base:

The following Schiff base ligands obtained and characterized.

- 1-(4-methoxy benzylidene) naphthyl amine (MBNA) (Fig. 1)
- 1-(4-hydroxy benzylidene) naphthyl amine (HBNA) (Fig. 2)
- 1-(4-chloro benzylidene) naphthyl amine (CBNA) (Fig. 3)
- 1-(3-nitro benzylidene) naphthyl amine (NBNA) (Fig. 4)

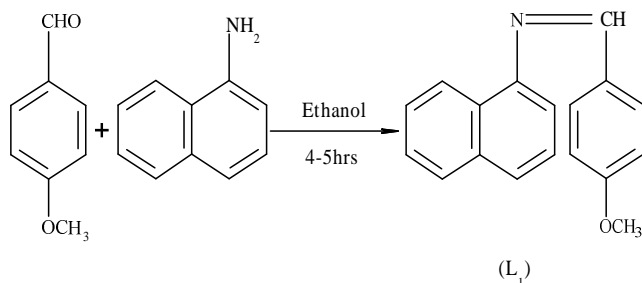


Fig.1 1-(4-methoxy benzylidene) naphthyl amine (MBNA)

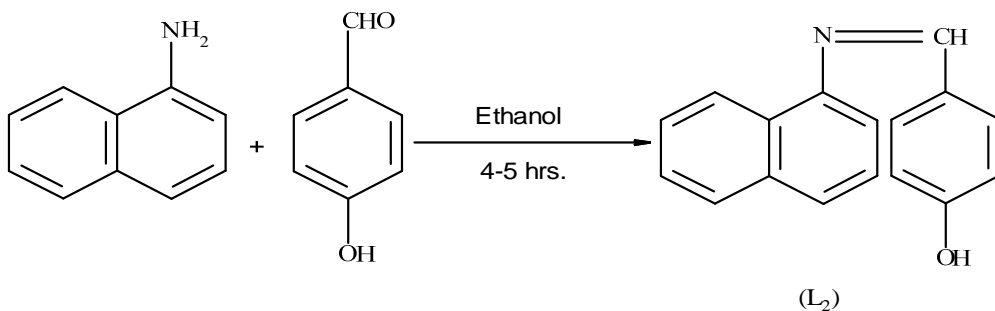


Fig.2 1-(4-hydroxy benzylidene) naphthyl amine (HBNA)

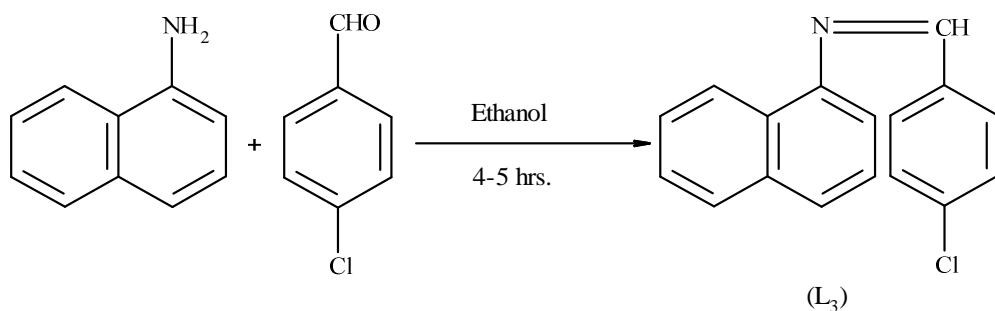


Fig.3 1-(4-chloro benzylidene) naphthyl amine (CBNA)

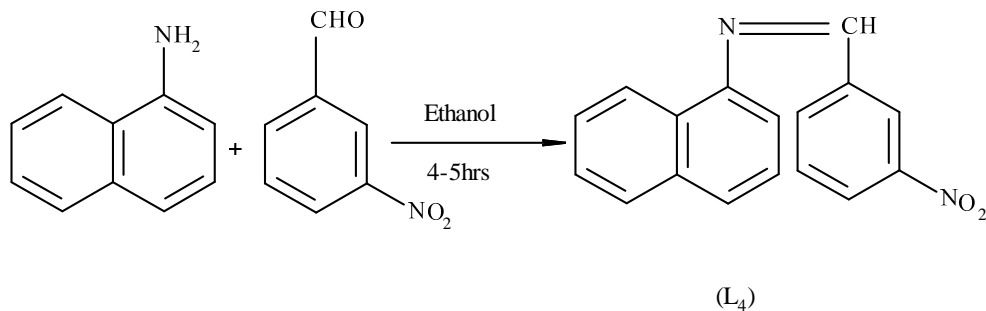


Fig.4 1-(3-nitro benzylidene) naphthyl amine (NBNA)

Synthesis of Schiff base ligands:

The Schiff base ligands were prepared by equimolar mixture of aldehyde derivatives (0.01mol) and 1 naphthyl amine (0.01mol) in ethanol for 4-5 hr. The reaction mixture was poured in ice cold water, On cooling the obtained crystalline precipitates were filtered, washed with ethanol and recrystallized from absolute ethanol and dried. They are light colored crystalline solids, stable at normal condition and soluble in DMSO, DMF; partially soluble in benzene and water.

Synthesis of Neodymium (III) complexes:

Neodymium (III) complexes were prepared by the following method:

To a hot solution of Schiff base (0.01 mole in 40ml of ethanol), 0.01 mole of metal salt dissolved in 25ml of ethanol was added drop wise. The contents were refluxed for four hours. The precipitated complex was further digested for one hour. The complex formed was filtered and washed with alcohol and followed by petroleum ether. It was dried in vacuum desiccators over calcium chloride.

RESULTS AND DISCUSSION**Physical Properties**

All the complexes are stable at room temperature and are non-hygroscopic. On heating,

They decompose at high temperatures. The complexes are insoluble in water but are soluble in DMSO.

TABLE 1: ELEMENTAL ANALYSIS OF SCHIFF BASE Nd (III) COMPLEXES

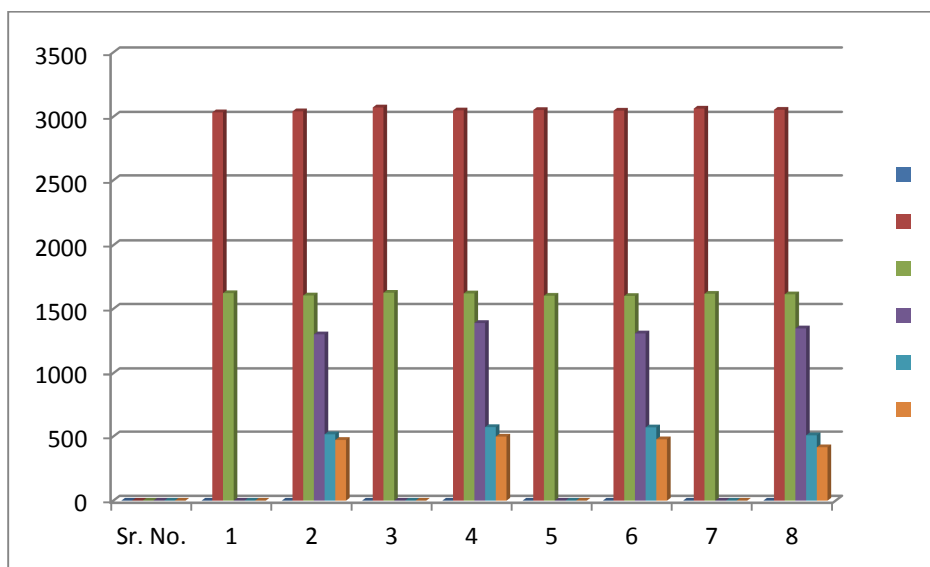
Compound	Molecular Formula	Molecular weight	Cal.(Exp.)%		
			C	H	N
[Nd(L1)(NO ₃)(H ₂ O)]NO ₃	C ₁₈ H ₁₇ N ₃ O ₈ Nd	523	41.30(41.33)	3.25(3.26)	8.03(8.10)
[Nd(L2)(NO ₃)(H ₂ O)]NO ₃	C ₁₇ H ₁₅ N ₃ O ₈ Nd	528	38.63(38.65)	2.84(2.86)	7.95(7.99)
[Nd(L3)(NO ₃)(H ₂ O)]NO ₃	C ₁₇ H ₁₄ N ₃ O ₇ ClNd	508	40.15(40.18)	2.75(2.77)	8.26(8.28)
[Nd(L4)(NO ₃)(H ₂ O)]NO ₃	C ₁₇ H ₁₄ N ₄ O ₉ Nd	538	37.91(37.97)	2.60(2.63)	10.40(10.43)

IR Spectra:

The characteristic bands of the Schiff base and the complexes are given in Table 2. The ligand and complexes shows a strong band at 1600-1640 cm⁻¹ characteristic of ν (C=N) stretching vibration [18]. In nitrate complexes, presence of uncoordinated nitrate ion is confirmed by a very strong band between 1300-1390cm⁻¹ [19]. The appearance of two strong bands at 530-510 cm⁻¹ and at 480-440 cm⁻¹ are assignable to ν (M-N) and ν (M-O) vibrations respectively [20-21].

TABLE 2: IR SPECTRAL DATA OF SCHIFF BASE AND NEODYMIUM (III) COMPLEXES

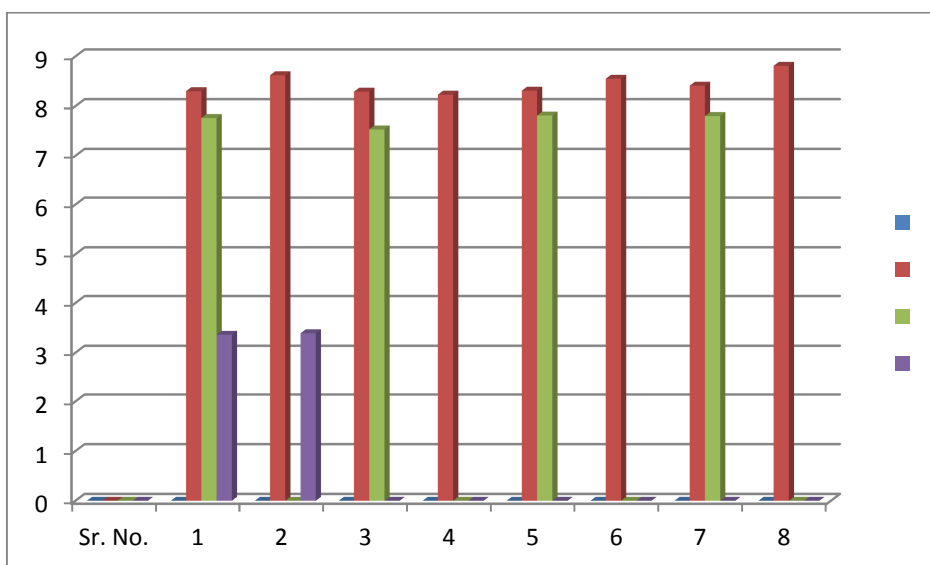
Sr. No.	Compound	(Ar-H)	(CH=N)	(-NO ₃)	(M-N)	(M-O)
1	L1	3034	1622	-	-	-
2	[Nd(L1)(NO ₃)(H ₂ O)]NO ₃	3042	1604	1302	517	473
3	L2	3072	1625	-	-	-
4	[Nd(L2)(NO ₃)(H ₂ O)]NO ₃	3049	1620	1390	573	499
5	L3	3052	1602	-	-	-
6	[Nd(L3)(NO ₃)(H ₂ O)]NO ₃	3047	1600	1309	571	478
7	L4	3063	1617	-	-	-
8	[Nd(L4)(NO ₃)(H ₂ O)]NO ₃	3054	1613	1348	509	416

**¹H NMR Spectra:**

The ¹H NMR spectrum of the Schiff bases and its Nd(III) complexes taken in DMSO exhibits resonance at 8.2-8.8 ppm due to the azomethine proton. The sharp multiplet signals of the phenyl protons are found in the region 7.1-7.8 ppm. The methyl protons of the ligand are observed as a sharp peak at 3.3 ppm. ¹H NMR spectra of ligands and complexes are presented in Table 3.

TABLE 3: ¹H NMR SPECTRA DATA OF SCHIFF BASE AND NEODYMIUM (III) COMPLEXES

Sr. No.	Compound	(CH=N)	(Ar-H)	(-CH ₃)
1	L1	8.30	7.76	3.36
2	[Nd(L1)(NO ₃)(H ₂ O)]NO ₃	8.62	7.3-7.7	3.39
3	L2	8.29	7.53	-
4	[Nd(L2)(NO ₃)(H ₂ O)]NO ₃	8.23	7.2-7.6	-
5	L3	8.31	7.81	-
6	[Nd(L3)(NO ₃)(H ₂ O)]NO ₃	8.55	7.1-7.5	-
7	L4	8.41	7.80	-
8	[Nd(L4)(NO ₃)(H ₂ O)]NO ₃	8.81	7.3-7.7	-

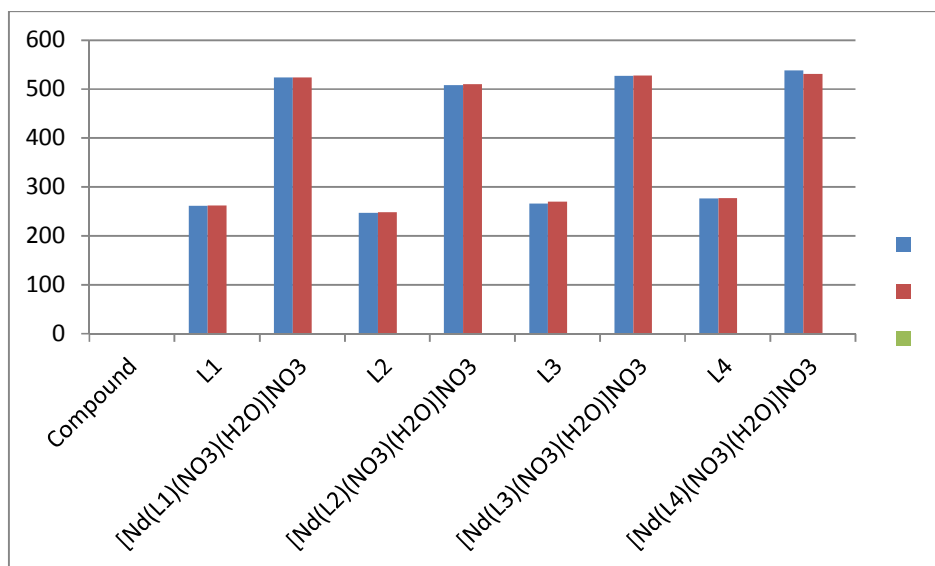


Mass spectra:

The mass spectral data of Schiff base ligand and its metal complexes are given in Table 4. The mass spectrum of ligand L1, L2, L4 gives a peak at m/Z 262, 248 and 277 and are assigned as [M+1] peak. The mass spectrum of ligand L3 gives a peak at m/Z 270 and is assigned for [M+4] peak. All Nd(III) complexes gives molecular ion peaks at 523, 508, 528 and 531 m/Z respectively and are assigned as [M+], [M+2], [M+1], [M-7] peak respectively.

TABLE 4: MASS SPECTRA DATA OF SCHIFF BASE AND NEODYMIUM (III) COMPLEXES

Compound	Calculated mass m/Z	Obtained mass m/Z	Peak assigned
L1	261	262	M+1
[Nd(L1)(NO ₃)(H ₂ O)]NO ₃	523	523	M+
L2	247	248	M+1
[Nd(L2)(NO ₃)(H ₂ O)]NO ₃	508	510	M+2
L3	266	270	M+4
[Nd(L3)(NO ₃)(H ₂ O)]NO ₃	527	528	M+1
L4	276	277	M+1
[Nd(L4)(NO ₃)(H ₂ O)]NO ₃	538	531	M-7

**TABLE 5: ANTIMICROBIAL ACTIVITY TESTS OF SCHIFF BASES AND THEIR NEODYMIUM (III) COMPLEXES**

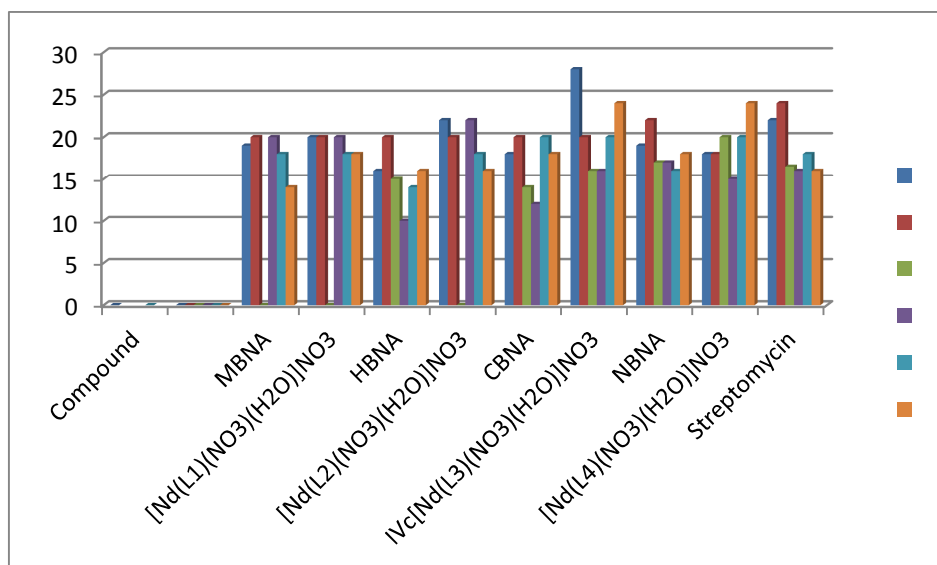
Compound	Antibacterial				Antifungal	
	<i>E. coli</i>	<i>S. aureus</i>	<i>B. subtilis</i>	<i>S. typhi</i>	<i>A. niger</i>	<i>P. Crysoygenum</i>
MBNA	19	20	R	20	18	14
[Nd(L1)(NO ₃)(H ₂ O)]NO ₃	20	20	R	20	18	18
HBNA	16	20	15	10	14	16
[Nd(L2)(NO ₃)(H ₂ O)]NO ₃	22	20	R	22	18	16
CBNA	18	20	14	12	20	18
IVc[Nd(L3)(NO ₃)(H ₂ O)]NO ₃	28	20	16	16	20	24
NBNA	19	22	17	17	16	18
[Nd(L4)(NO ₃)(H ₂ O)]NO ₃	18	18	20	15	20	24
Streptomycin	22	24	16.5	16	18	16

(Diameter of inhibition zone in mm)

Antimicrobial activity:

The Schiff base and their corresponding metal complexes were screened in vitro for their antibacterial activity against two Gram-negative (*Escherichia coli* and *Salmonella typhi*) and two Gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) bacterial strains and antifungal activity against organisms *A.niger* and *P.Crysoygenum* using agar well diffusion method using Streptomycin as standard. The results of antibacterial studies are presented in

Table 4. A comparative study of the ligand and their metal complexes indicates that most of the metal complexes exhibit higher antimicrobial activity than that of the free ligand. Hence complexation increases antimicrobial activity



In Table 5-

R	: Resistant (10.0 mm and below)
S	: Sensitive (10.0 mm and above)
Slightly sensitive	: (10.0 mm above to 15.0 mm)
Moderately sensitive	: (15.0 mm above to 20.0 mm)
Highly sensitive	: (20.0 mm above)

CONCLUSION

In this paper, the synthesis of novel Schiff base ligand and its Nd (III) metal complexes derived from condensation of 1-naphthyl amine with different aldehydes have been described. The biological activity of ligand is lower than the metal complexes. This means that metal chelation is significantly effective than the antimicrobial behavior of the organic ligand and metal complexes.

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