Synthesis and antibacterial activity of the sulfonamide based schiff base and its transition metal (II) complexes

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Abstract: A Schiff base 3 has been synthesized by equimolar reaction (condensation) of sulfonamide i.e. sulfamethoxypyridazine 1 and substituted aromatic aldehyde i.e. 2-Hydroxy-1-Napthalene aldehyde 2. The synthesized Schiff base 3 and its Metal (II) complexes were characterized by its physical, analytical (CHN analysis) and spectral (UV & IR) analysis. The *Staphylococcus aureus* and *Escherichia coli bacterial strains* were used for antibacterial activity of Sulfamethoxypyridazine 1, its Schiff base 3 and its transition metal (II) complexes 4-8. All of them showed varied levels of activity.

Keywords: Schiff base, transition metal complexes, antibacterial activity

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INTRODUCTION

Schiff bases are organic compounds having azomethine (-HC=N-) as a functional group which can be synthesized by the condensation reaction between aldehydes or ketones with amines (Kumar *et al.,* 2009). Schiff bases are widely used for chemical purpose i.e. acting as a catalyst, used as important synthetic precursors in the synthesis of various dyes, pigments, as polymer stabilizers (Safoura, 2014) and in the synthesis of β-lactams (Fekri *et al.,* 2013). It is also used as a chelating agent in coordination chemistry (Souza *et al.,* 1985). Considering biological importance, Schiff bases can be used as antibacterial (Chohan *et al.,* 2010; Karia and Parsania, 1999; Amir *et al.,* 2002; More *et al.,* 2002), antifungal (Pandeyaa *et al.,*1999; Rajendran and Karvembu, 2002), antiviral (Pingnatello *et al.,* 1994; Girgaonkar and Shirodkar, 2012), anti-inflammatory (Jayakumarswamy *et al.,* 2011), anticonvulsant (Sridhar *et al.,* 2002), antitumor (Ren *et al.,* 2002; Kuz'min *et al.,* 2002), anti-HIV (Pandeyaa *et al.,*1999; Abdulghani and Abbas, 2011), anti-mosquito larvae agents (Meerana *et al.,* 2015) antipyretic properties (Venkateshwarlu *et al.,* 2012) and several other activities. Schiff bases synthesized from aromatic amine and benzaldehyde, salicylaldehyde, amoxicillin, pridoxil and sulphamethoxazole act as antibacterial agents (More *et al.,* 2002; Asiri and Khan, 2010). It has been reported that the biological properties of Schiff base ligands (Ls) are due to azomethine (–HC=N–) group (Ren *et al.,* 2002). Among the Schiff bases, the most studied Schiff bases are the ones derived from sulfonamide due to their unique structural representation and strong biological activities (Swamy and Parthasarathy, 2012). Looking one step ahead, metal complexes derived from Schiff base ligands have received considerable attention because they play an essential role in agriculture, pharmaceutical and industrial chemistry (Dhar and Taploo, 1982; Kumar *et al.,* 2009; Patel *et al.,* 2005). Many biochemical reactions depend on the presence of metal ions in a complexed form due to its function as facilitator or inhibitor of biochemical reactions. It is because **c**oordination of metal ions by different ligands that change the redox potential of a reaction, which facilitates or, in some case, makes it more difficult to take place (Basuli *et al.,* 1998). The formation of chelates with small amount of metal ions is related with the drug activity as evident by literature reports which describe the biological importance of transition metals complexes of Co (II), Cu (II) and Zn(II) with Schiff base (Punniyamurthy *et al.,* 1997; Chohan 2004; Chohan *et al.,* 2004). The research and the literature also prove that biological activities of the Schiff bases can be enhanced by complexes with transition metals (Chohan *et al.,* 2010). The antibacterial, antitumor, anti-inflammatory, antifungal and antiviral activity is due to the ability of the Schiff base to chelate with transition metals, especially Cu, Ni, Co and Zn (Nandi *et al.,* 1984; French *et al.,* 1974). It is largely described in the literature that transition metal complexes of Schiff base are more potent against bacterial strains. Since Schiff base and its metal complexes along with other chemical and biological significance, exhibit strong antibacterial activities which present themselves as a research area of immense interest. These facts also encourages us to present here the synthesis of a sulfonamide Schiff base as a ligand, its transition metal (II) complexes and their antibacterial activity with the aim of obtaining more potent antibacterial agents.

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MATERIALS AND METHODS

All the chemicals used were of analytical grade and were used as such. Sulfamethoxypyridazine (SMP) was obtained from Beijing Infoark Technology Development Co. Ltd and 2-Hydroxy-1-napthalene aldehyde from Sigma Aldrich. Manganese (II) Chloride, Cobalt (II) Chloride, Nickel (II) Chloride, Copper (II) Chloride and Zinc (II) Chloride were obtained from Acros Organic. The melting points of the ligand and of the corresponding metal (II) complexes were measured by Gallen Kamp Apparatus. The conductivity of the Schiff base ligand and its corresponding metal (II) complexes were measured by conductivity meter model InoLab Cond. Level 1 and were calculated in µS/cm at room temperature. DMF was used as a solvent (Sumrra, *et al.,* 2014). Electronic spectra of the ligands and their complexes in solution phase (0.001 moles) have been recorded in the region of 200-800 nm on IRMECO UV-Vis spectrophotometer Model U2020 (Germany). The infrared spectra of the ligands and complexes have been recorded using PerkinElmer, Spectrum 100 FT-IR Spectrometer.

Schiff base ligand synthesis

Schiff base ligand was prepared according to the procedure reported in the literature (Chohan *et al.,* 2010; Mohammed *et al.,* 2013). The general method employed are presented in scheme 1. Following the procedure, equimolar solutions of the sulfamethoxypyridazine 1 and 2-Hydroxy-1-napthaldehyde 2 (0.005 moles each) were prepared separately in hot ethanol (20mL). Then added the aldehyde 2 solution drop by drop to sulfamethoxypyridazine solution in the presence of inorganic acid with constant stirring. The clear solution formed on mixing of the two solutions, changed its color from bright yellow to deep dark yellow. The reaction mixture was then magnetically stirred and refluxed for 3-5 hours at 60^o-70^oC. Orange color precipitates were formed within 15-30 minutes of reflux. The solution was cooled in ice bath and precipitates were collected by vacuum filtration. The precipitates were recrystallized from DMF/Ether (2:1) and were washed three times with ethanol and petroleum ether for purification and then dried. The purity was checked by TLC, as single spot appeared and by M.P. The structure of the Schiff base 3 was elucidated by UV and IR analysis and was further supported by elemental analysis.

Preparation of transition metal (II) complexes

Hot solutions of the Schiff base ligand (0.004 moles) and (0.002 moles) that of the corresponding transition metal (II) chloride.xH_2O where x is 0, 2 or 6, were prepared in hot ethanol (20mL) separately. Then added the metal (II) chloride solution to the ligand solution dropwise in the presence of slightly basic media with constant stirring (a few drops of 5% KOH solution). The reaction mixture was then magnetically stirred and refluxed for 3-5 hours at 60^o-70^oC (Pethe *et al* 2015; Aliyo and Ado, 2011). The precipitated solution was cooled in ice bath and the precipitates were collected using vacuum filtration. The precipitates were recrystallized from DMF/Ether (2:1) and then washed thrice with ethanol and petroleum ether for further purification .Then all the complexes were dried using desiccator. Single spot of the prepared product on the TLC plate suggests the purity of the product. The structures of the transition metal (II) complexes were elucidated by UV and IR analysis and were further supported by elemental analysis.

RESULTS

In this study, initially we prepared a Schiff base ligand 3 (scheme 1) which was then chemically transformed (scheme 2) into following complexes: $C_{44}H_{40}N_8O_{10}S_2Mn$, $C_{44}H_{40}N_8O_{10}S_2Co$, $C_{44}H_{40}N_8O_{10}S_2Ni$, $C_{44}H_{40}N_8O_{10}S_2Cu$, $C_{44}H_{40}N_8O_{10}S_2Zn$. Ligand and its metal complexes were obtained in a yield ranging from 60-72 %, and were found stable and non-hygroscopic amorphous. The Physical characteristics and the solubility data of the ligand and its various metal (II) complexes are given in table 1 and table 2 respectively. Solubility for the ligand and its complexes were checked in different organic solvents and it was observed that the ligand was soluble in ethanol, DMF and DMSO on heating whereas the complexes were soluble in DMF and DMSO.

The conductivity of the Schiff base ligand and its corresponding metal (II) complexes were measured by conductivity meter model InoLab Cond. Level 1 at room temperature. As a result, ligand was having 0.3 (µS/cm) while the complexes (4-8) displayed 0.6, 0.5, 0.4, 0.9 1.2 (µS/cm) respectively. Elemental analysis of the ligand and its transition metal (II) complexes was performed and the date obtained are presented in table 3. For further structural confirmation of the prepared ligand and complexes, UV and IR spectral analysis were performed and the data obtained are presented in table 4 and 5 respectively.

To check the antibacterial activity, the ligand and its corresponding transition metal (II) complexes have been tested against one Gram-positive (*Staphylococcus aureus*) and one Gram-negative (*Escherichia coli*) bacterial strains using agar well diffusion (Valgas1*et al.,* 2007; Iqbal *et al.,* 2007). Obtained results are summarized in table 6.

DISCUSSION

The present work began by preparing the Schiff base ligand 3 from their corresponding amine 1 and aldehyde 2 in equimolar quantities, as presented in scheme 1. The resultant ligand 3 was then coordinated with the five different transition metal salts (Manganese (II) Chloride, Cobalt (II) Chloride, Nickel (II) Chloride, Copper (II) Chloride and Zinc (II) Chloride) using 2:1 ratio of ligand to the metal salt, according to the procedures discussed earlier and the reaction shown in scheme 2. Ligand and its metal complexes were achieved in good overall yield and formed varied in colors.

Conductivity of the ligand and its transition metal (II) complexes

The conductance of the ligand and its corresponding metal (II) complexes ranged from 0.3-1.2μS/cm showing its non-electrolytic behavior. By investigating the conductance of the Schiff base complexes, conductance ranging from 0.38-6.79μS/cm was found to indicate its non-electrolytic behavior (Holm and Eichorn, 1974; Joshi *et al.,* 1997; Belsky *et al.,* 1968; Albanus *et al.,* 1975).

Elemental analysis

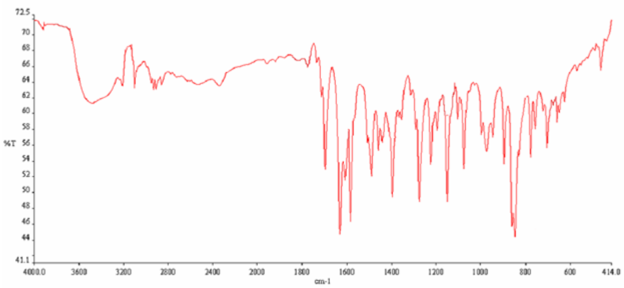
Elemental analysis of the ligand and its transition metal (II) complexes given in table 3 shows the percentage data of carbon, hydrogen and nitrogen (CHN) of the base ligand and its corresponding metal (II) complexes. The data, thus obtained in percentage were compared with the calculated percentage (in bracket) and were found in good agreement with small variation (±0.02-0.08) which is acceptable and give evidence of the formation of ligand and its metal (II) complexes.

Spectral data of the ligand and its transition metal (II) complexes

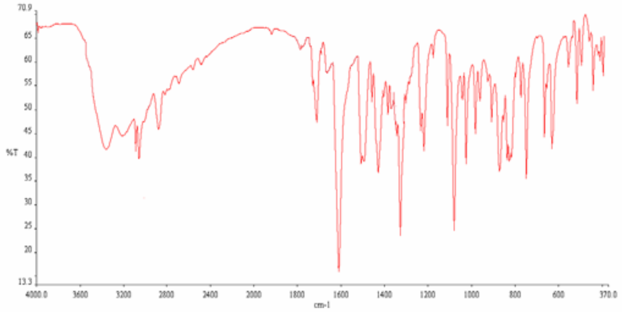
Initially, UV analysis was performed. Organic ligands show absorption in the ultraviolet region and in some cases these bands extend to higher wavelength region due to extended conjugation. Upon complex formation with transition metal ions, changes in the electronic properties of the ligands take place. New bands in the visible region due to d-d absorption and charge transfer from metal to ligand (M→L) or ligand to metal (L→M) can be observed which can be used as a useful tool for obtaining the information regarding the structure and geometry of the complexes. Thus, in the present work, electronic data of the ligand show high intensity bands at 34333cm^{-1}, 28901cm^{-1} and 37425 cm^{-1} and λ max at 256nm, 292nm, 348nm respectively. These bands may be due to π-π* and n-π* transitions of both pyradizine and azomethine system. The n-π* transition (less intense) band may be due to the non-bonding electrons present on the transition of C=N group in pyradizine ring or in azomethine group. The electronic data of the Mn(II) complex show bands at 39205cm^{-1}, 31150 cm^{-1} and 21640 cm^{-1} and λmax at 250nm, 321nm and 462nm assignable to intraligand transition and M→L charge transfer spectra and the bands at 18870 cm^{-1} and 13890 cm^{-1} and λmax at 530nm and 720nm are due to $A_1g \rightarrow T_1g$ (^6S) transitions. The electronic spectra of the Co(II) complex displays bands at 37465 cm^{-1}, 30120 cm^{-1}, 22435 cm^{-1} and 18500 cm^{-1} and λmax at 256nm, 332nm, 452nm and 540nm . The former band corresponds to intraligand transition of the organic moiety while the latter corresponds to $A_2g+T_1g+T_2g$ (^4F), suggesting octahedral geometry of this complex. The Ni(II) complex shows absorption bands at 39064 cm^{-1}, 30120 cm^{-1}, 23200 cm^{-1} and 15900 cm^{-1} and λmax at 255nm, 332nm, 431nm and 629nm. The high intensity bands at 39064 cm^{-1} and 30120 cm^{-1} are relatively attributed to L→ M charge transfer transitions, whereas the band at 23200 cm^{-1} and 15900 cm^{-1} may be due to $A_2g+T_1g+T_2g$ (^3F). The Cu(II) complex displays bands at 33976 cm^{-1}, 24915 cm^{-1}, 14773 cm^{-1} and 11230 cm^{-1} and λmax at 292nm, 401nm, 678nm and 890nm. The first 2 bands are attributed to intraligand transition and the latter band at 14773 cm^{-1} and 11230 cm^{-1}, corresponds to $Eg \rightarrow T_2g$ (^2D) i.e. $dxy \rightarrow dx^2\text{-}y^2$ and $dz^2 \rightarrow dx^2\text{-}y^2$. The Zn(II) complex displays high intensity bands at 38283cm-1 and 36774cm-1 and λmax at 261nm and 272nm due to intraligand transition while the band at 22222cm-1 and λmax at 450nm may be due to charge transfer from ligand →metal. The UV values of the ligand and its complexes are shown in table 5.

Considering the IR spectral data for our work, it was used as an effective tool and used as evidence for the formation of the complexes and also for the determination of the mode of coordination of ligands with the metal ions during complex formation. IR spectrum of the schiff base given in table 6 indicate broad band at 3410-3420cm^{-1} and strong band 1630 cm^{-1} assigned to phenolic hydroxyl group and azomethine (C=N) stretching respectively whereas, S=O stretching has been observed at 1375 cm^{-1} and the pyradizine C=N showed strong stretching band at 1665 cm^{-1}. IR spectrum also shows band at 3200 cm^{-1} resulting from NH stretching of pyradizine moiety. The band at 2920 cm^{-1} is assigned to C-H bond. Other stretching bands observed at 1250-1300 cm^{-1} and 1416 cm^{-1} are the characteristics of C-O and C=C bonds respectively.

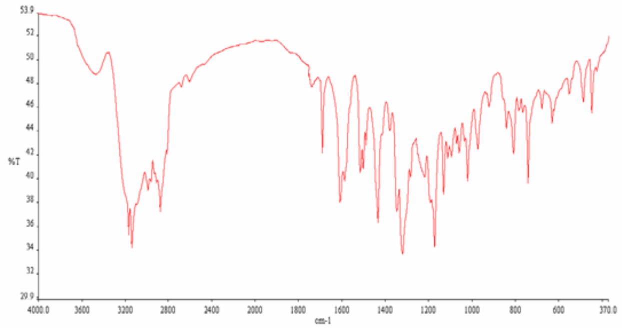
In complexes, the peak observed at 1600-1610 cm^{-1} is due to azomethine (HC=N) stretching in Schiff base is shifted to lower frequency in complexes of Mn, Co, Ni, Cu and Zn indicating the coordination of azomethine nitrogen with metals during complexation. Also, disappearance of the phenolic OH stretching of the Schiff base during complexation and the appearance of C-O stretching at 1335-1350 cm^{-1} suggest the involvement of phenolic OH group in coordination during complex formation with metals. Further evidences for the complex formation have been established by far IR spectra due to the appearance of new weak frequency bands at 535-540 cm^{-1} and 455-460cm^{-1} corresponding to metal-oxygen (M-O) and metal-nitrogen (M-N) vibration respectively confirming the participation of HN=C and OH moiety in coordination with metals during complex formation. The stretching frequencies due to S=O about 1365-1375 cm^{-1} and NH in range of 3200-3210 cm^{-1} of sulfamethoxypyradizine moiety of the Schiff base have been found unchanged in the complexes suggesting that these groups are not involved in coordination with metals. This was also confirmed by the unchanged C-S and S-N vibration at 833, 980 cm^{-1} respectively. The ring nitrogen (=N) of the Schiff base does not take part in coordination which is supported by the unchanged band at around 1595 cm^{-1}. From the data given in table 5, it is clear that the Schiff base coordinates through phenolic oxygen and azomethine nitrogen with metals and is thus a bidentate ligand. The peaks at 3410-3440 cm^{-1} suggest coordination of water molecules with the metals. The IR spectral data are summarized in table 5.



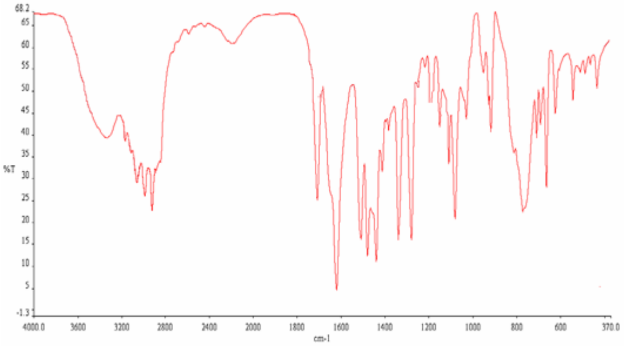
1: IR Spectra of the Schiff Base (Ligand) 1



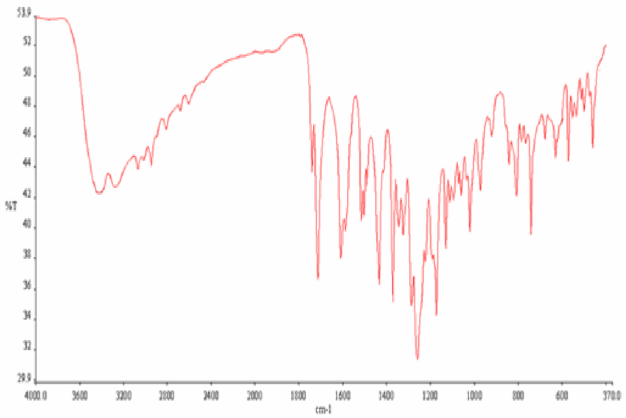
2: IR Spectra Manganese (II) Complex of Schiff Base 4



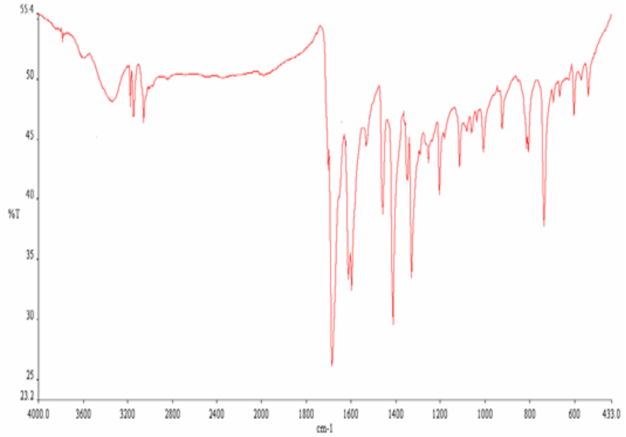
3: IR Spectra of the Cobalt (II) Complex of Schiff Base 5



4: IR Spectra the Nickel (II) Complex of Schiff Base 6



5: IR Spectra of the Copper (II) Complex of Schiff Base 7



6: IR Spectra of the Zinc (II) Complex of Schiff Base 8

Antibacterial activity

The antibacterial acitivity results obtained for the ligand and its corresponding transition metal (II) complexes (table 6) were compared with the starting material sulfamethoxypyridazine and standard drugs (Ciprofloxacin, Imipenum). All the prepared compounds were found active and showed good activity against the bacterial strains. It was observed that all the compounds exerted higher activity against *E. coli* bacterial cell as compared against *Staphylococcus aureus* bacterial cells. It was also observed that the bioactivity of sulfamethoxypyridazine is less than the Schiff base ligand and transition metal (II) complexes due to azomethine (–C=N–) functional group. Transition metal (II) complexes (due to coordination) showed better activity than Schiff base ligand against *E. coli*, whereas the standard drugs showed better activity than the ligand and its transition metal (II) complexes. Among complexes, the Mn(II) complex showed less activity while Zn(II) complex indicated higher activity whereas the Cu(II) complex showed proximate efficiency with sulfamethoxy-pyridazine. The complexes showing higher activity than Schiff base are presumed to be good drugs than their Schiff base and vice versa. The results are presented in table 6 as well as in graphical form in (fig. 1) and (fig. 2).

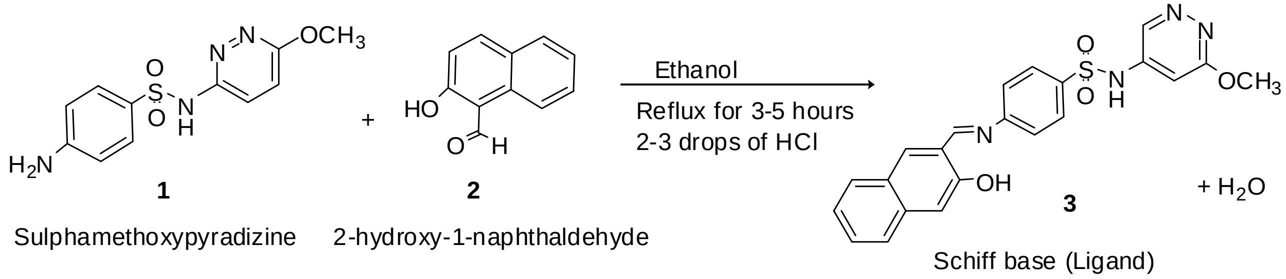
Table 1: Physical characteristics of the ligand and its transition metal (II) complexes

Ligand/Complex	Molecular Formula	Molecular Weight (gm/mol)	Physical State	Colour	Melting Point (°C)	Yield (%)
$C_{22}H_{18}N_4O_4S$(L)	$C_{22}H_{18}N_4O_4S$	434	Amorphous	Bright orange	247-249	72
$MnL_2(H_2O)_2$	$C_{44}H_{40}N_8O_{10}S_2Mn$	959.8	Amorphous	Black	263-265	65
$CoL_2(H_2O)_2$	$C_{44}H_{40}N_8O_{10}S_2Co$	963.8	Amorphous	Golden rod	257-259	63
$NiL_2(H_2O)_2$	$C_{44}H_{40}N_8O_{10}S_2Ni$	962.7	Amorphous	Alloy orange	253-255	60
$CuL_2(H_2O)_2$	$C_{44}H_{40}N_8O_{10}S_2Cu$	967.5	Amorphous	Brass	243-245	70
$ZnL_2(H_2O)_2$	$C_{44}H_{40}N_8O_{10}S_2Zn$	969.3	Amorphous	Red orange	254-256	65

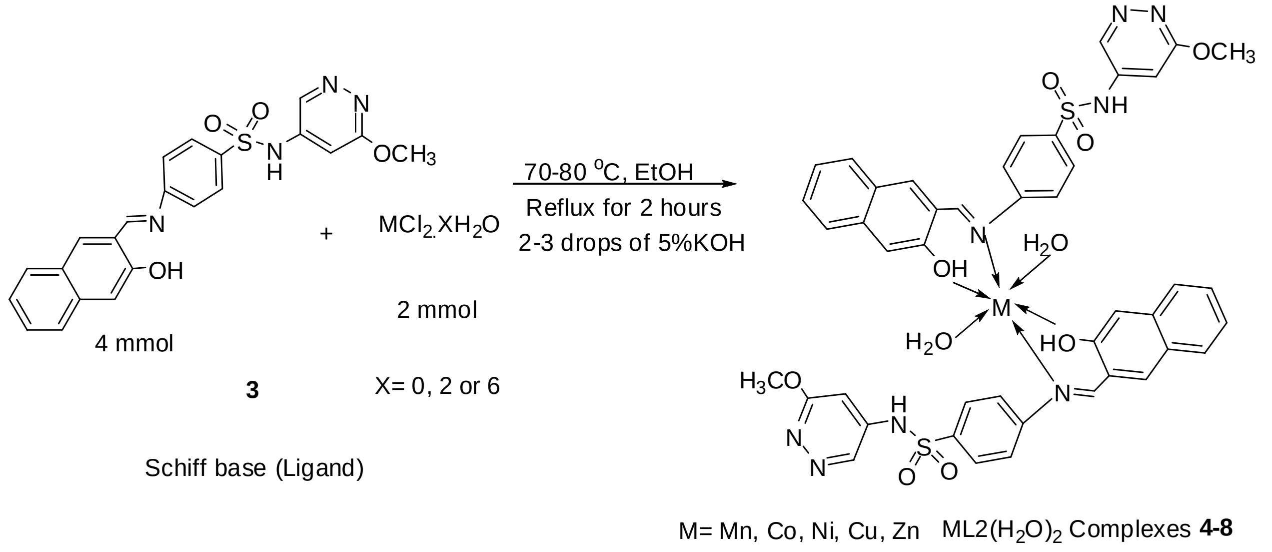
Table 2: Solubility data of the ligand and its transition metal (II) complexes

Ligand/Complex	Ethanol	Ether	Chloroform	EtOAc	DMF	DMSO
$C_{22}H_{18}N_4O_4S$(L)	S	IS	IS	IS	S	S
$MnL_2(H_2O)_2$	IS	IS	IS	IS	S	S
$CoL_2(H_2O)_2$	IS	IS	IS	IS	S	S
$NiL_2(H_2O)_2$	IS	IS	IS	IS	S	S
$CuL_2(H_2O)_2$	IS	IS	IS	IS	S	S
$ZnL_2(H_2O)_2$	IS	IS	IS	IS	S	S

* IS= Insoluble S= Soluble



Scheme 1: Synthesis of schiff base ligand.



Scheme 2: Synthesis of transition metal (II) complexes

Table 3: CHN analysis data of the ligand and its transition metal (II) complexes

Ligand/Complex	% C Found/(Calculated)	% H Found/(Calculated)	% N Found/(Calculated)
$C_{22}H_{18}N_4O_4S$(L)	60.79 (60.82)	4.14 (4.18)	12.88 (12.90)
$MnL_2(H_2O)_2$	55.24 (55.29)	3.78 (3.80)	11.69 (11.72)
$CoL_2(H_2O)_2$	54.98 (55.06)	3.75 (3.78)	11.62 (11.67)
$NiL_2(H_2O)_2$	55.04 (55.07)	3.72 (3.78)	11.63 (11.68)
$CuL_2(H_2O)_2$	54.73 (54.79)	3.72 (3.76)	11.58 (11.62)
$ZnL_2(H_2O)_2$	54.67 (54.69)	3.71 (3.75)	11.57 (11.60)

Table 4: UV spectral data of the ligand and its transition metal (II) complexes

Ligand/complex	Wave number /wavelength (cm^{-1} /nm)	Electronic transitions	Geometry
$C_{22}H_{18}N_4O_4S$(L)	37425/256 34333/ 292	$\pi \rightarrow \pi^*$	
	28901/348	$n \rightarrow \pi^*$	
$MnLi_2\ (H_2O)_2$	39205 /250 and 31150/321 21640/462	n, $\pi \rightarrow \pi^*$	Octahedral
	18870/530 13890/720	$A_1g \rightarrow T_1g\ (^6S)$	
$CoLi_2(H_2O)_2$	37465 /265 30120/332	n, $\pi \rightarrow \pi^*$	Octahedral
	22435/452 18500/540	$A_2g+T_1g+T_2g(^4F)$	
$NiLi_2(H_2O)_2$	39064/ 255 30120/332	n, $\pi \rightarrow \pi^*$	Octahedral
	23200/431 15900/629	$A_2g+T_1g+T_2g(^3F)$	
$CuLi_2(H_2O)_2$	33976/292 24915/401	n, $\pi \rightarrow \pi^*$	Octahedral
	14773/678 11230/890	$Eg \rightarrow T_2g(^2D)$	
$ZnLi_2(H_2O)_2$	38283/ 261 36774/272	n, $\pi \rightarrow \pi^*$	Octahedral
	22222/450	$A_1g \rightarrow T_1g\ (^1S)$	

Table 5: IR spectral data of the ligand and complexes

Ligand/complex	IR Data (cm^{-1})
$C_{22}H_{18}N_4O_4S$(L)	OH about 3410-3420, Azomethine at C=N 1630, S=O at 1375, pyridizine at C=N 1665, N-H at 3200, C-H at 2920, C-O at 1250-1300, C=C at 1416
$MnL_2(H_2O)_2$	OH 3410-3440, Azomethine C=N 1610, S=O 1372, pyridizine C=N 1655, N-H 3210, C-H 2925,C-OMe 1250-1300, Mn-N 450, Mn-O 520
$CoL_2(H_2O)_2$	OH 3420-3440, Azomethine C=N 1605, S=O 1370, pyridizine C=N 1660, N-H 3200, C-H 2930, C-OMe 1250-1300, Co-N 465, Co-O 515
$NiL_2(H_2O)_2$	OH 3420-3440, Azomethine C=N 1600, S=O 1370, pyridizine C=N 1660, N-H 3205, C-H 2925, C-OMe 1250-1300, Ni-N 415, Ni-O 530
$CuL_2(H_2O)_2$	OH 3415-3430, Azomethine C=N 1605, S=O 368, pyridizine C=N 1665, N-H 3205, C-H 2920, C-OMe 1250-1300, Cu-N 440, Cu-O 525
$ZnL_2(H_2O)_2$	OH 3415-3430, Azomethine C=N 1600, S=O 1365, pyridizine C=N 1665, N-H 3200, C-H 2925, C=C, C-OMe 1250-1300, Zn-N 430, Zn-O 530

CONCLUSIONS

We prepared sulfamethoxypyridazine derived Schiff base ligand and its five transition metal (II) [Mn, Co, Ni, Cu, Zn] complexes. Physical characteristics, elemental analysis, UV and FTIR spectral data confirmed the suggested coordination mode of ligand as bidentate and linked through azomethine group and –OH group of the

Table 6: Antibacterial activity of the ligand and its transition metal (II) complexes; (1mg/mL of DMSO) Zones of inhibition (mm)

Ligand/Complexes	*Staphylococcus aureus*	*Escherichia coli*
$C_{22}H_{18}N_4O_4S$(L)	17	15
$MnL_2(H_2O)_2$	12	14
$CoL_2(H_2O)_2$	18	20
$NiL_2(H_2O)_2$	16	18
$CuL_2(H_2O)_2$	13	14
$ZnL_2(H_2O)_2$	24	24
Sulfamethoxypyridazine	11	13
Ciprofloxacin	25	27
Imipenum	28	28

*>20: Significant, 15-19: Moderate, <15: Weak

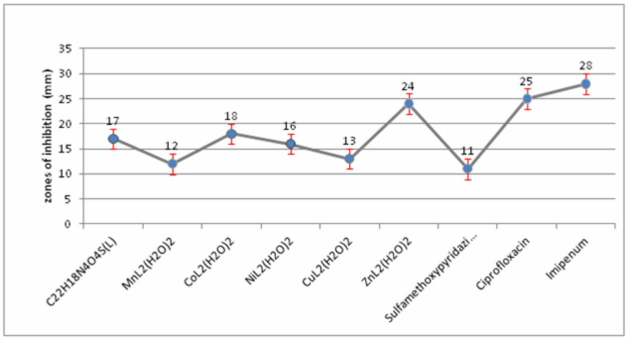


Fig. 1: Zones of inhibition against *S. aureus*

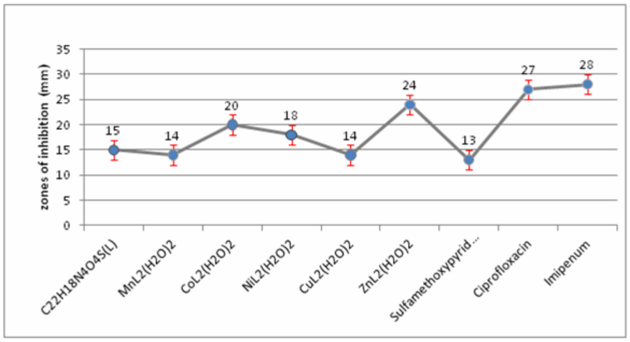


Fig. 2: Zones of inhibition against *E. coli*

naphthyl group forming stable chelate. The data also suggested octahedral geometry for all the complexes. Antibacterial activity data against Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) bacterial strains showed that the ligand and its complexes exerted better activity against *E .coli* cells than against *Staphylococcus aureus* bacterial cells. It was also observed that the activity of sulfamethoxypyridazine was less than the Schiff base ligand and transition metal (II) complexes. It was also observed that almost all the complexes exhibited better activity than the ligand against *E. coli*.. Furthermore, it is the first ever report about antibacterial activity of the complexes 4-8, to the best of our knowledge.

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