

Synthesis, Characterization and Antimicrobial Studies of Transition Metal Complexes of Schiff Base derived from Salicylaldehyde and L-Tyrosine Amino Acid

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Abstract

Tridentate Schiff base Salicylidene-tyrosine (H₂L) of biological importance obtained from salicylaldehyde and L-tyrosine and their Mn(II), Fe(II), Co(II), Cu(II) and Ni(II) complexes have been synthesised in 1:1 stoichiometric ratio and characterised on the basis of their solubility, metal analysis, infrared, UV-Visible and magnetic measurements. The synthesised complexes have different shades of colour and decomposed at a temperature above 360°C. Salicylidene-tyrosine behaved as a tridentate ligand coordinating to the metals through the azomethine nitrogen atom, the oxygen atom of hydroxyl group of COOH and the phenolic oxygen to give an octahedral geometry. The electronic spectra were consistent with the proposed octahedral geometry around the metal ions. The metal complexes were screened for their antimicrobial activities against *Staphylococcus aureus* (ATCC 12600), *Escherichia coli* (ATCC 8739), *Pseudomonas aeruginosa* (ATCC 10145), *Bacillus subtilis* (ATCC 39090), *Salmonella typhi* (ATCC 6539), *Klebsiella pneumonia* (ATCC 35657), *Candida albicans* (ATCC 10231), *Penicillium notatum* (ATCC 20269), *Rhizopus stolonifer* (ATCC 14037) and *Aspergillus niger* (ATCC 16888). The copper complex [Cu(L)(H₂O)₃].H₂O exhibited the highest activity in all the organisms tested. It is active against all microorganisms tested at virtually all concentrations.

Introduction

Schiff bases have been used as organic chelating ligands in the synthesis of diverse transition metal complexes^{1,2}.

Amino acid Schiff base complexes are an area of increasing attention, it has been reported that they possess anticarcinogenic, antimicrobial and antitumor activity³⁻⁵.

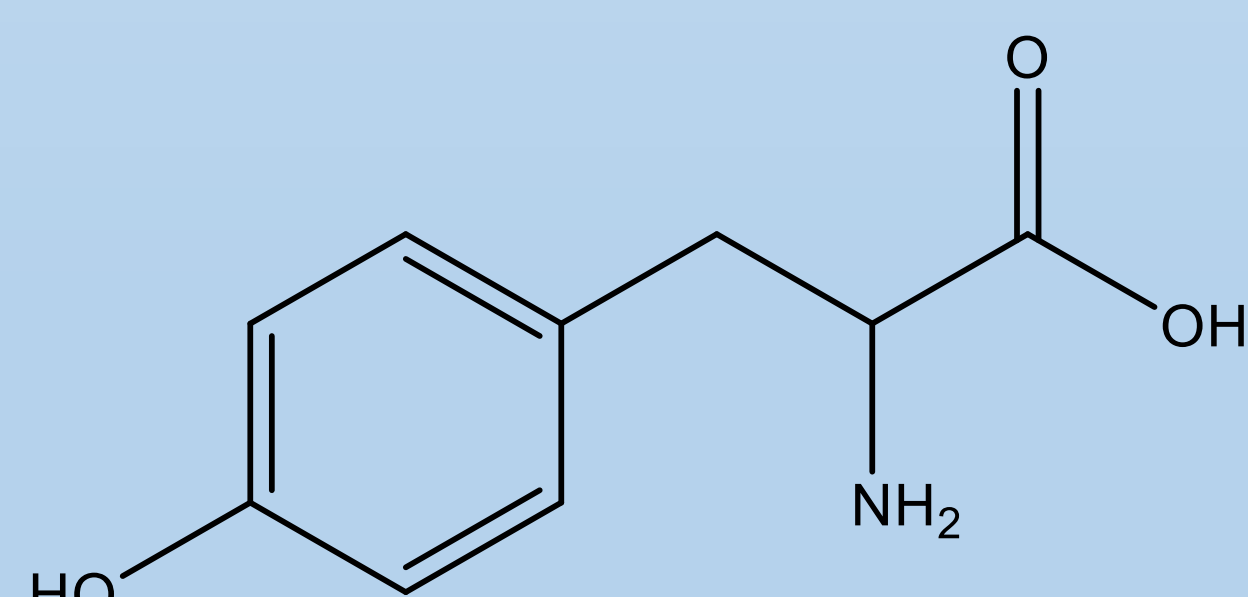


Fig. 1: L-tyrosine

Schiff bases containing L-tyrosine and their metal complexes exhibit a variety of interesting properties⁷.

L-Tyrosine (Tyr) (Fig. 1) is an aromatic amino acid, a hydroxylated derivative of L-phenyl alanine, needed to make melanine, dopamine, noradrenaline, adrenaline and thyroxine⁶.

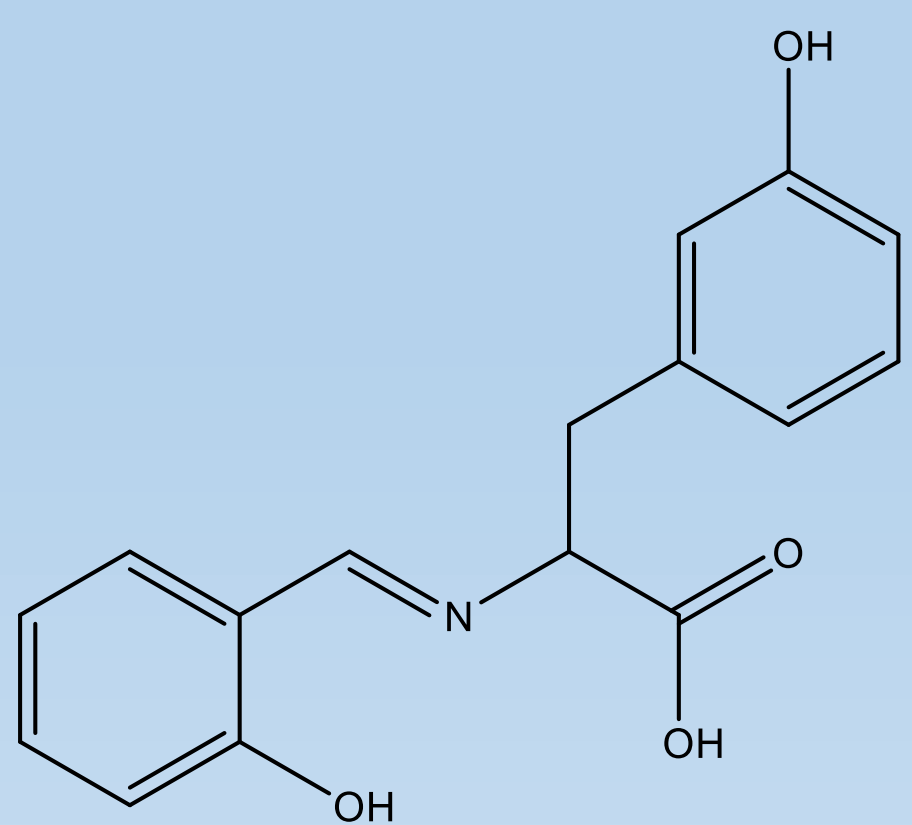


Fig.2: Salicylidene-tyrosine Schiff base (H₂L)

Here, we report a Schiff base (H₂L) (Fig. 2) formed from the reaction of salicylaldehyde and L-tyrosine amino acid, their coordination complexes, and their antimicrobial studies.

Materials and methods:

All chemicals and reagents were obtained from Sigma Aldrich and used without further purification.

Physical measurements The electronic spectra of the complexes in DMSO were recorded on a Perkin-Elmer Lambda 25 Spectrophotometer and infrared spectra were recorded using nujol on a Perkin-Elmer BX II FT-IR spectrometer 4000–370 cm⁻¹. The room temperature magnetic susceptibilities at 303K were measured on Sherwood Susceptibility Balance MSB Mark 1 and diamagnetic corrections were calculated using Pascal's constant, and melting points were determined with Stuart SMP10 Melting point apparatus.

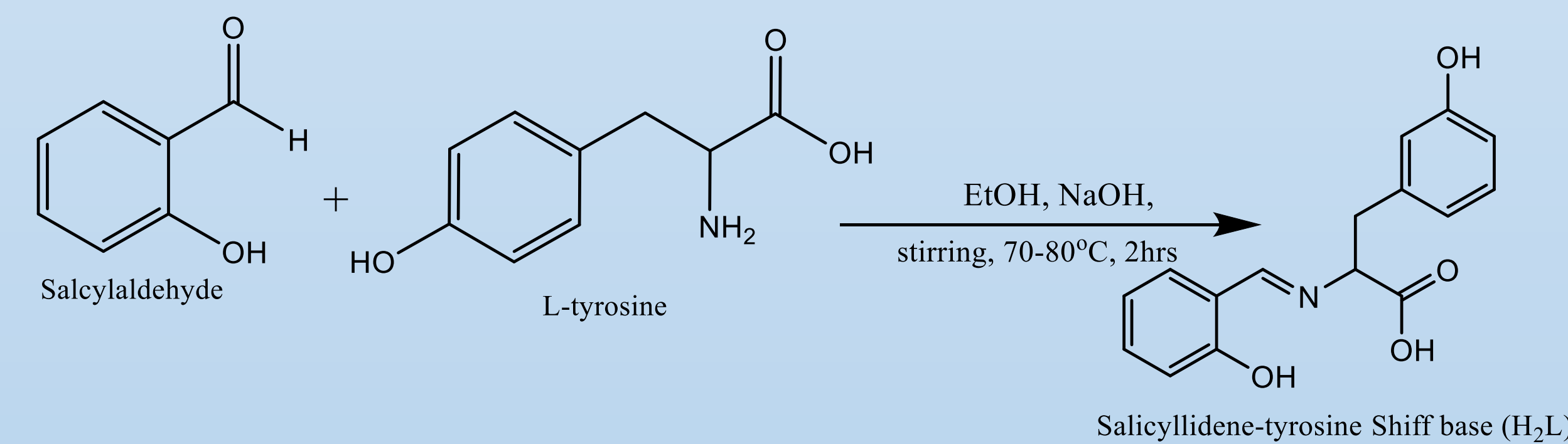
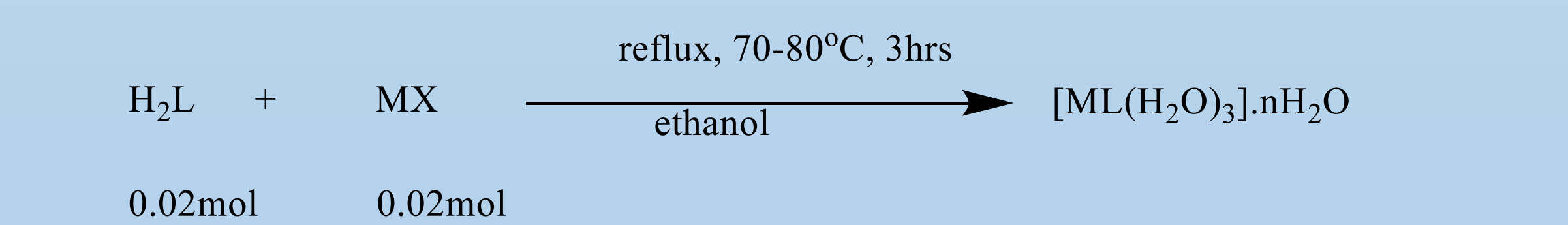


Fig 3.: Synthesis of Salicylidene-tyrosine Schiff base (H₂L)



where L= Salicylidene-tyrosine Schiff base; M = Ni(II), Co(II), Cu(II), Mn(II); X = Cl/NO₃/acetate

Fig 4.: Synthesis of Metal(II) complexes of Salicylidene-tyrosine

Antimicrobial Studies: The salicylidene-tyrosine Schiff base (H₂L) and their complexes were tested against standard strains of bacteria and fungi such as: *Staphylococcus aureus* (ATCC 12600), *Escherichia coli* (ATCC 8739), *Pseudomonas aeruginosa* (ATCC 10145), *Bacillus subtilis* (ATCC 39090), *Salmonella typhi* (ATCC 6539), *Klebsiella pneumonia* (ATCC 35657), *Candida albicans* (ATCC 10231), *Penicillium notatum* (ATCC 20269), *Rhizopus stolonifer* (ATCC 14037) and *Aspergillus niger* (ATCC 16888) using the agar diffusion method.

Results and discussions

The condensation of salicylaldehyde and L-tyrosine resulted in the formation of salicylidene-tyrosine Schiff base (H₂L). Metal complexes of salicylidene-tyrosine Schiff base are stable at room temperature exhibiting variety of colours with good yields in the range 68-81%. They decompose on melting above 360°C.

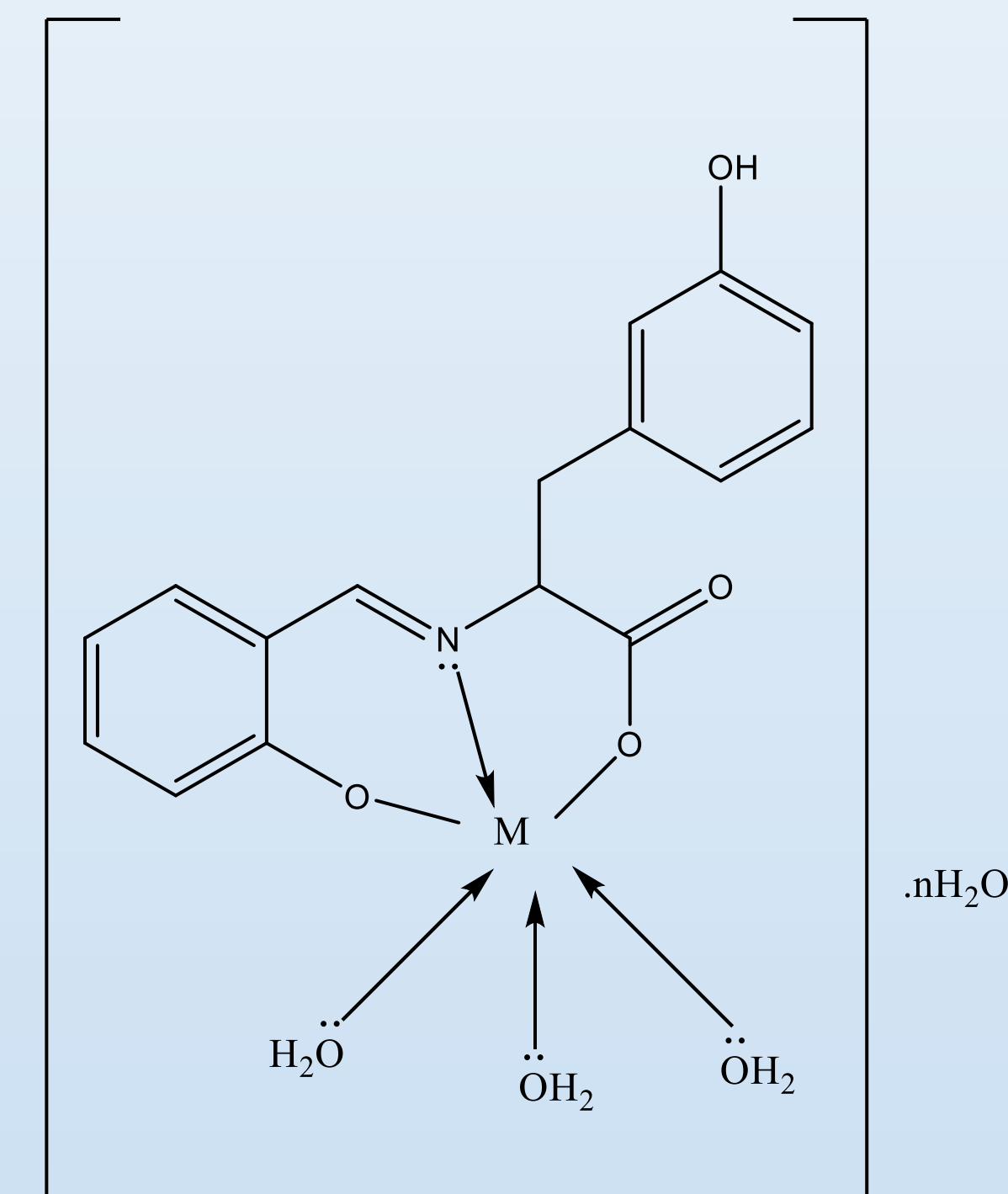
IR studies

All the complexes exhibit broad bands in the range of 3352–3552 cm⁻¹, attributed to coordinated water molecules⁸. A shift to lower frequency of 1633 cm⁻¹ (νC=N) in free salicylidene-tyrosine ligand (H₂L) to 1632-1599 cm⁻¹ in the complexes suggests the coordination to the metal ion through nitrogen atom of azomethine group⁹. The involvement of oxygen atom of hydroxyl group of COOH group in bonding with metal ions was evident from the difference of maxima positions as observed for ν_{asy}(COO) and ν_{sym}(COO) from 1530 and 1515cm⁻¹ in H₂L to 1514-1456cm⁻¹ and 1455-1357cm⁻¹ complexes¹⁰. Also ν(Ph-O) (Phenolic) stretching frequency was shifted from 1277cm⁻¹ in H₂L to 1202-1138cm⁻¹ in the complexes indicative of bonding through phenolic oxygen¹¹. In addition, the new bands at about 607-532 cm⁻¹ and 525-460 cm⁻¹ showing presence of M-N and M-O vibrations¹².

Electronic spectra and magnetic moment: The room temperature magnetic moment of Metal (II) and electronic spectra data indicated that the complexes have octahedral geometries which is slightly distorted in the acetylated copper(II) complex.

Antimicrobial studies: Antimicrobial screening of the complexes showed that [Cu(L)(H₂O)₃].H₂O is the most active of the complexes against all the tested microorganisms at all concentrations.

Conclusion: The Schiff base salicylidene-tyrosine (H₂L) obtained by condensation reaction of L-tyrosine and salicylaldehyde and its metal (II) complexes of Cu, Co, Mn, Ni and Fe have been characterised by spectroscopic methods. From the analytical and spectral data the salicylidene-tyrosine ligand acts as a tridentate ligand and was found to coordinate to the metal ions through the azomethine nitrogen atom, the oxygen atom of hydroxyl group of COOH and phenolic oxygen to give an octahedral geometry. Antimicrobial screening of the complexes showed that [Cu(L)(H₂O)₃].H₂O is the most active of the complexes against all the tested microorganisms at all concentrations.



where M = Fe(II), Co(II), Cu(II), Ni(II) and Mn(II); n = 1 or 3

Fig.5.: Proposed structures of M(II) complexes of Salicylidene-tyrosine Schiff base (H₂L)

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