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SCHIFF BASES: A SHORT REVIEW OF THEIR BIOLOGICAL ACTIVITIES

***[1]Radhika Prakash Karad, [2]Aakash Sanjeev Singare, [1]Nanda Sheshrao Korde[*]**

[1]Dayanand Science College, Latur, Maharashtra, India.
[2]Swami Ramanand Teerth Marathwada University, Nanded, Maharashtra, India.

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***Corresponding Author**
Radhika Prakash Karad
Dayanand Science College, Latur, Maharashtra, India.

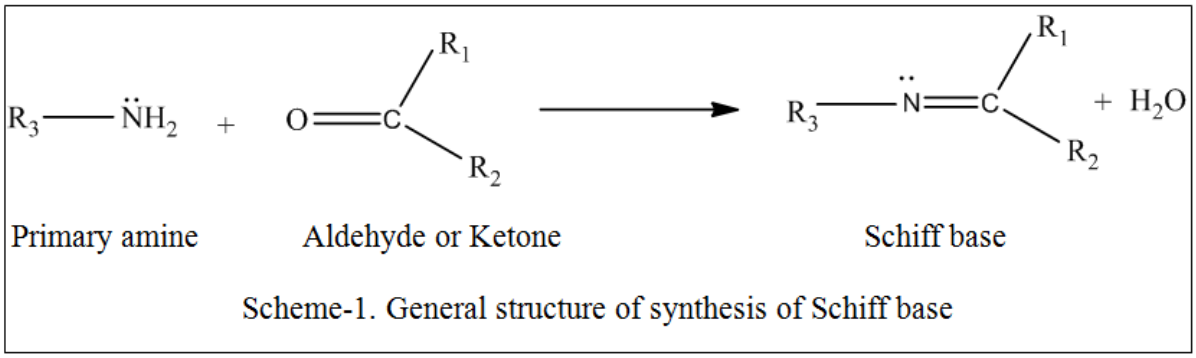
ABSTRACT

Schiff bases are considered as an important class of organic compounds due to their ability to form complex with transition metal ions. As schiff bases are easily synthesized by condensation reaction between aldehyde derivatives and imines, they act as special ligands. However their preparation method is simple; they have modest preparation technique and also their wide applications in the field of coordination chemistry, analytical chemistry, catalysis, pharmaceutical chemistry etc. make them unique compounds. Various biological activities, such as anticancer, antitumour, analgesic, antifungal, antioxidant, antimicrobial, anti-inflammatory etc. of schiff bases and their metal complexes have been studied. This review outlines the biotic significance and synthesis of various Schiff bases.

KEYWORDS: Schiff base, coordination chemistry, catalysis, biological activity, antitumour, analgesic.

INTRODUCTION

Schiff base was first reported by Hugo Schiff, when he reported the condensation of primary amines with carbonyl compounds.[1,2] Condensation reaction of aldehydes or Ketones with primary amines gives product containing azomethine group (HC=N), such compounds are known as schiff base. They are also known as azomethines or imines and are generally denoted by the formula $R_1R_2C=NR_3$ where R_1, R_2 and R_3 are alkyl or aryl groups.[3]



Scheme-1. General structure of synthesis of Schiff base

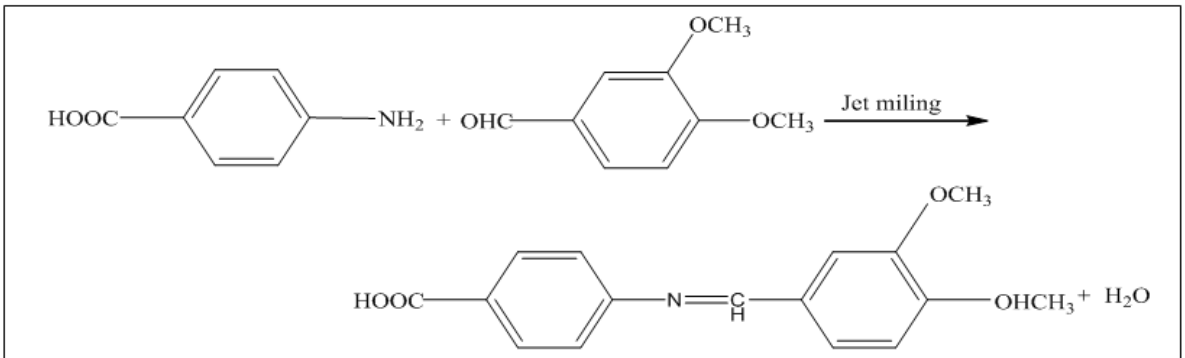
Impotance of Schiff base

Schiff bases are very good chelating ligands and transition metal could form highly efficient schiff base complexes.[4,5] The nature of metal ion in schiff base complexes decides the properties of the complexes. Various transition and inner transition metals combines with bi, tri and tetra dentate schiff bases containing nitrogen and oxygen donor atoms to form metal schiff base complexes.[6,7] Schiff base and its complexes also finds applications in medicine and catalyst. They are acknowledged to exhibit potent antibacterial, antiulcer and analgesic activities[8], In addition some schiff bases are known which show pharmacologically important activites like anti- tuberculosis, anti-cancer, and antioxidant activites.[9] Schiff bases play important function in biological systems in combination of enzymes such as tryptophan synthase, transaminses etc.[10-12] The imine group in schiff base is important in elucidating the mechanism of racemization and transamination reactions in biological system.[1-3,13-15] The schiff base compounds and their metal complexes also finds applications in asymmetric addition of cyanide to aldehydes,[16] enantioselective cyclopropanation of styrenes,[17] enantioselective epoxidation,[18,19] asymmetric aziridination of olefins.[18] The metal complexes of schiff bases are widely used in radiopharmaceuticals,[20] in degradation of organic substances,[21] their ability to reversibly bind oxygen[22]

and photochromic properties.[23] They are also used in polymers,[24] dyes[24] as well as they are applied in laser,[25] nanotechnology.[26] They have played essential role in the improvement of inorganic biochemistry and also in the progress of modern coordination chemistry, catalysis as well as in useful materials due to magnetic and optical properties.[27-29] As the schiff bases and their metal complexes have different functional groups, they also plays significant role in the areas of spectroscopy, stereochemistry, and magnetic fields.[30]

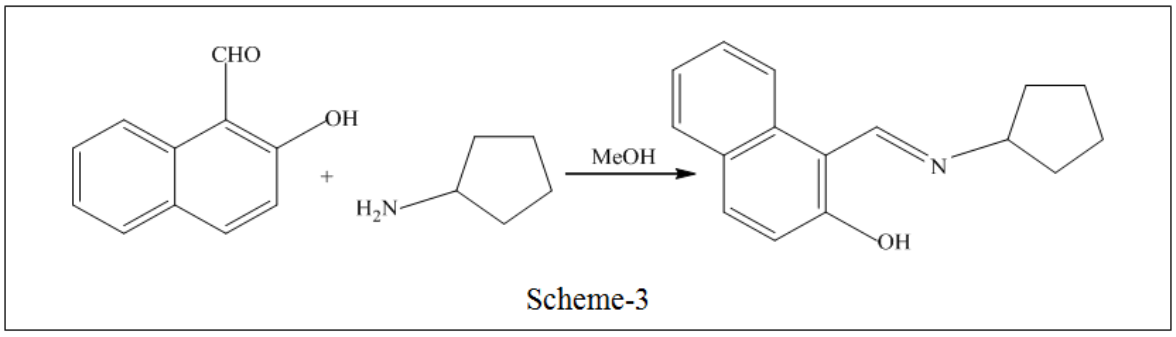
Previous Related Studies

Yan-Hua-Cai and Wen Luo[31] synthesized new schiff base obtained by the reaction between 3,4-dimethoxybenzaldehyde and *p*-aminobenzoic acid by supersonic speed gas impacting method (Scheme-2).

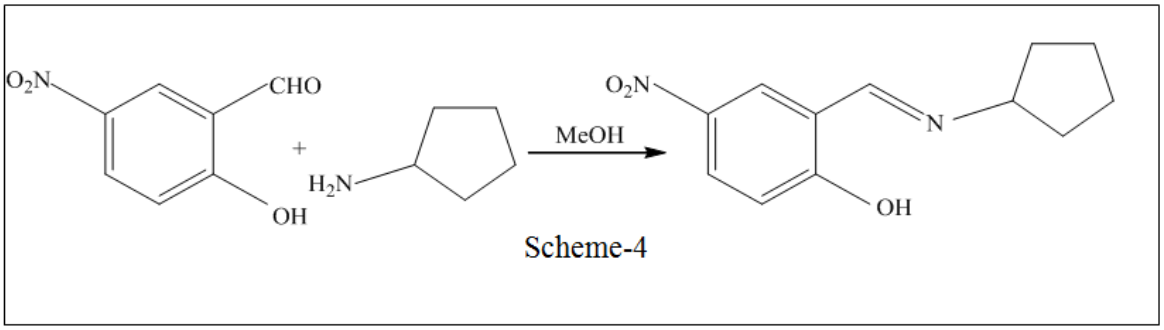


Scheme-2

Guo[32] has reported the synthesis of two novel schiff base namely 1-(cyclopentyliminomethyl)napthalen-2-ol and 4-nitro-2 (cyclopentyliminomethyl) phenol (Scheme-3 &4). These schiff bases were prepared by the reaction of cyclopentylamine with 2-hydroxy-1-naphthaldehyde and 5-nitrosalicyaldehyde , respectively in methanol. The Schiff bases exhibit stronger antibacterial activity against *E.coli* and *P. fluorescens* but weaker antibacterial activity against *B.subtilis* and *S.aureus* than Penicillin.

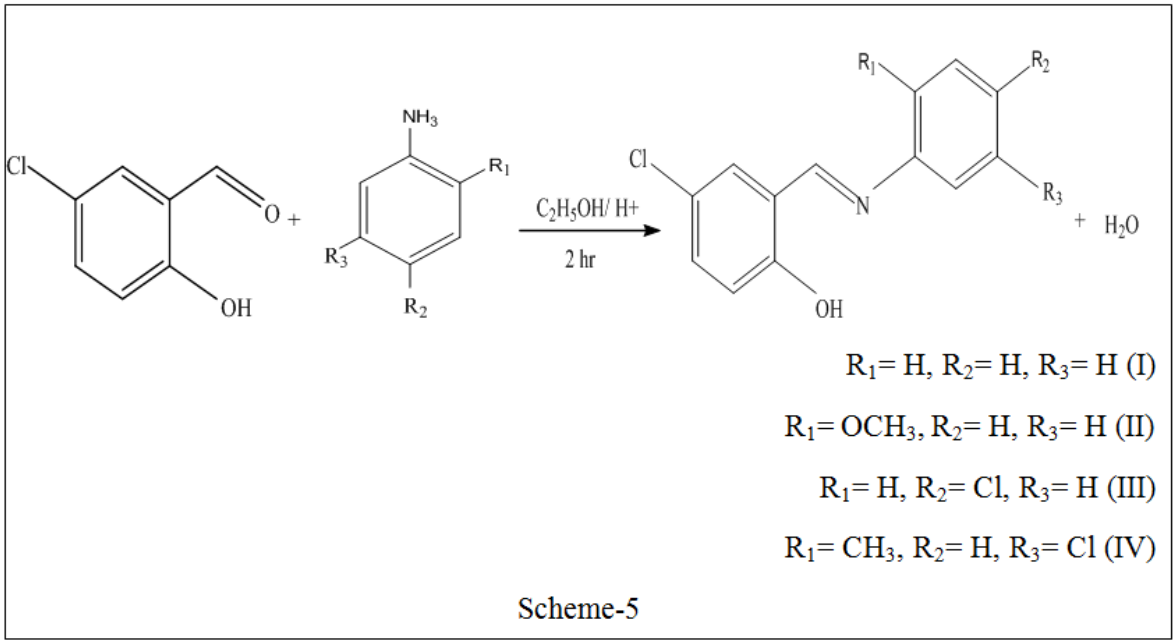


Scheme-3



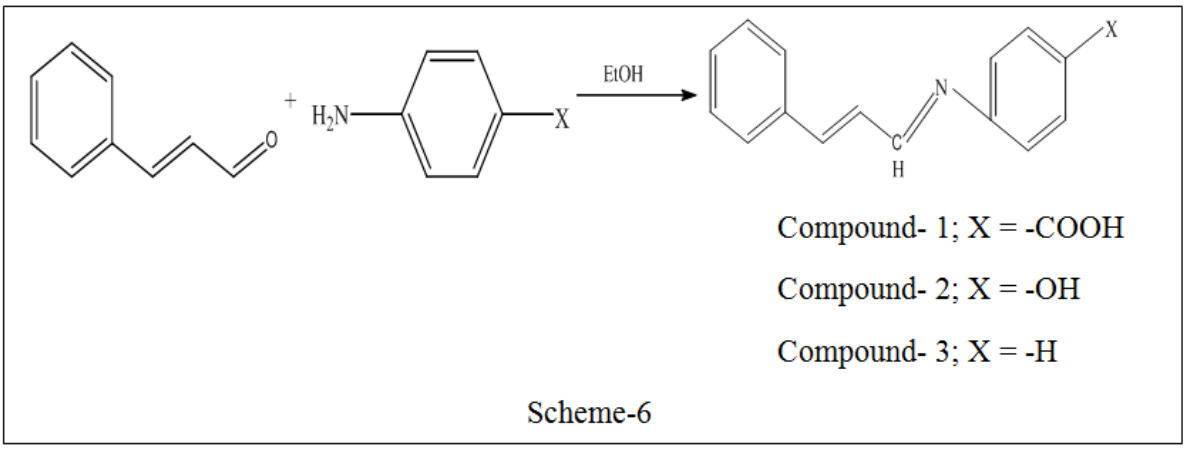
Scheme-4

Synthesis and antimicrobial activity of schiff bases derived from 5-chlorosalicyaldehyde with substituted aniline were reported by Abidemi Iyewumi Oloyede-Akinsulere, Simon Olonkwoh Salihu, Jelili Olalekan Babajide and Helen Shnada Auta[33] (Scheme-5).

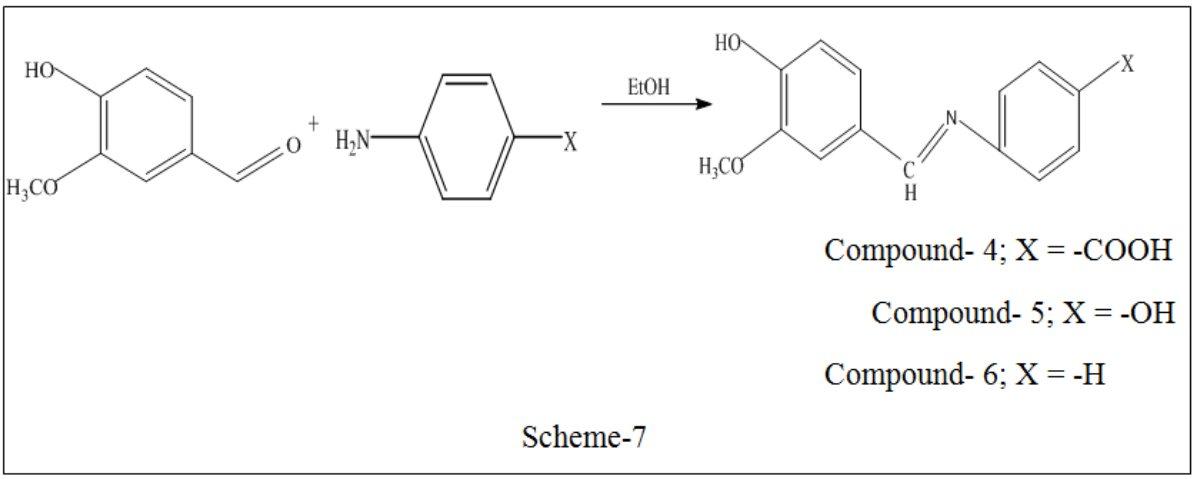


Scheme-5

S. Chigurupati[34] has reported the synthesis of six new schiff bases (Scheme-6&7). The schiff bases were investigated for in vitro acetylcholinesterase (AChE) inhibition and antioxidant activities. Compound 1 and 4 were exhibited better result as compared to other compounds in both AchE enzyme inhibition and antioxidant assays.

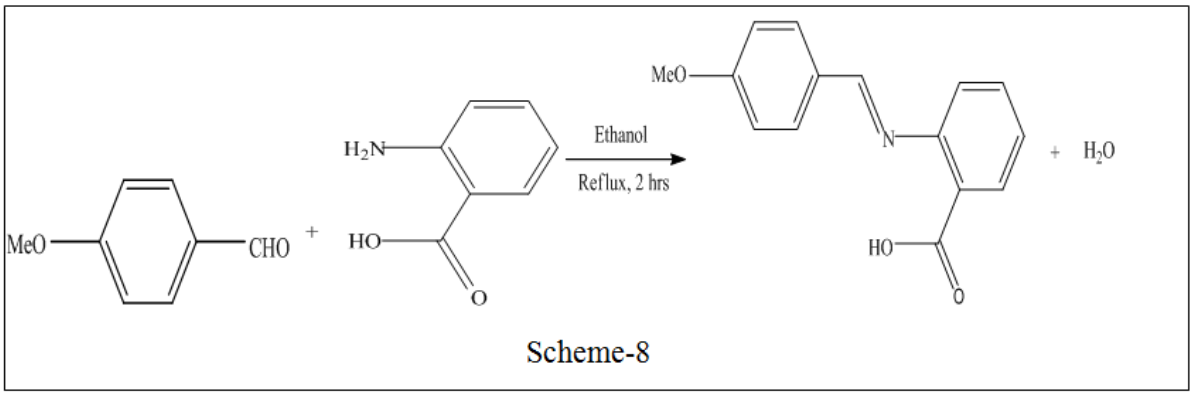


Scheme-6



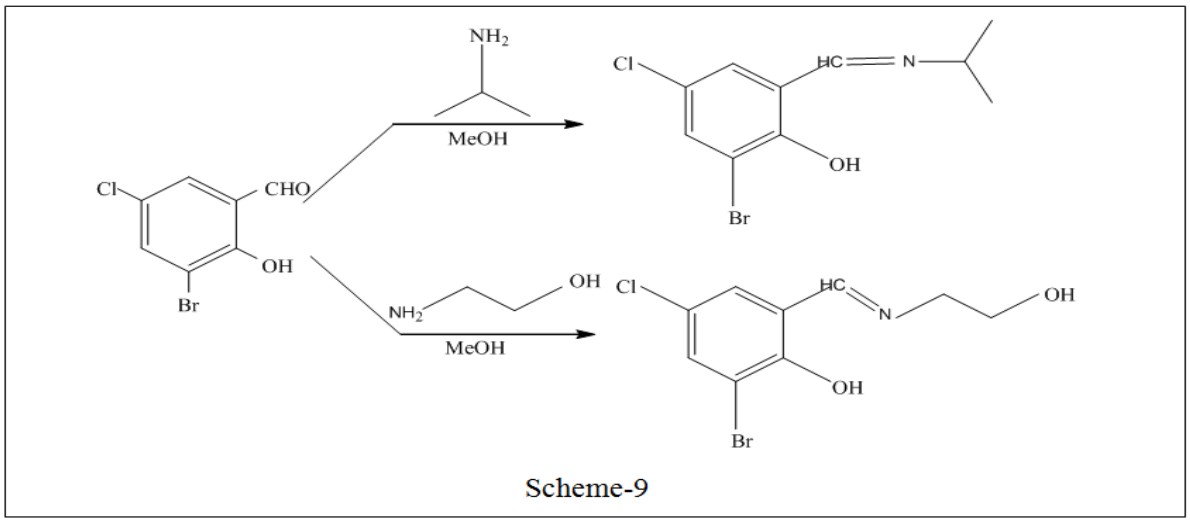
Scheme-7

Abubakar Abdullahi Ahmed, Hassan Usman Ali, Abdullahi Idi Mohammed[35] synthesized schiff base derived from 4-methoxybenzaldehyde and *o*-aminobenzoic acid (Scheme-8).



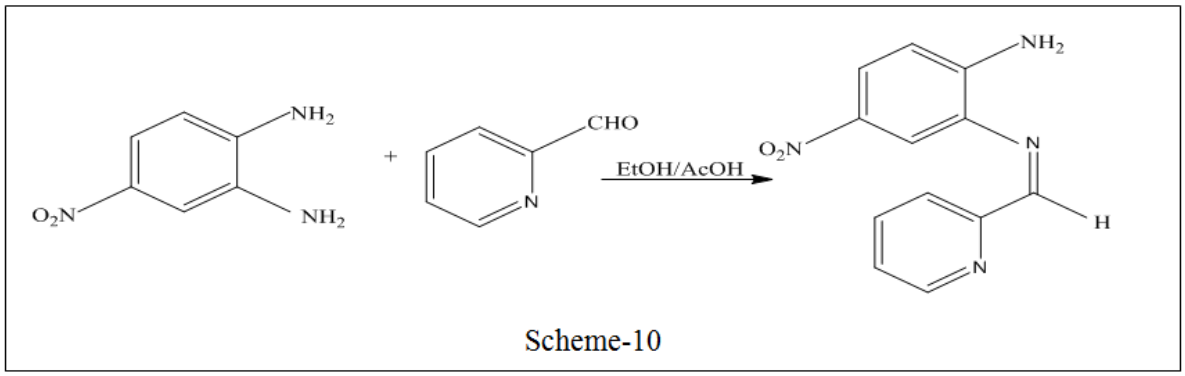
Scheme-8

Synthesis of two novel schiff bases was done by Cai[36] (Scheme-9).



Scheme-9

Synthesis of schiff base by the reaction between 2-pyridinecarboxaldehyde and 4-nitro-o-phenylenediamine was reported by Mohammad Habibi[37] (Scheme-10). Tridentate nature of schiff base was shown by this study.



Scheme-10

Synthesis, characterization, antibacterial, antifungal and cytotoxic activity of schiff base with substituted benzylidine aminobenzoic acid were reported by Govindaraj V, Ramanathan S, Murgasen S[38] (Figure-1&2).

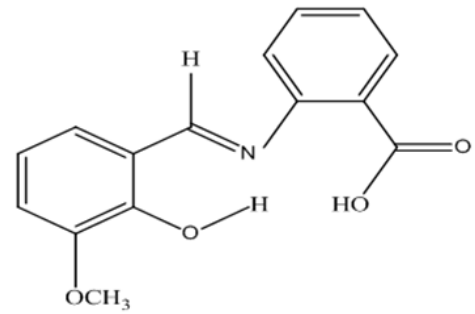


Figure 1: Structure of Ligand L^1 2-((2-hydroxy-3-methoxybenzylidene) amino) benzoic acid.

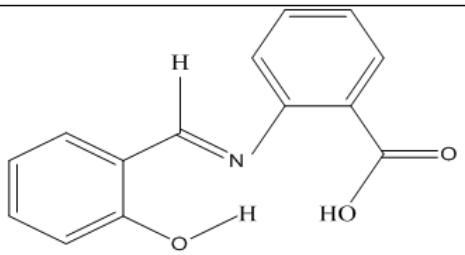
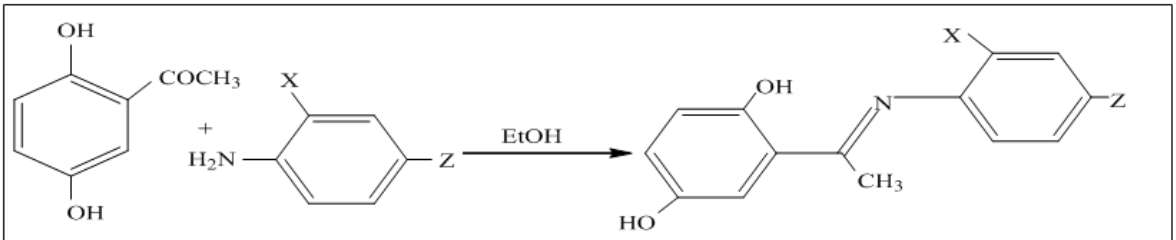


Figure 2: Structure of Ligand L^2 2-((2-hydroxybenzylidene) amino) benzoic acid

Nassar M. Y., Ahmed I. S., Dessouki H. A. and Ali S. S.[39] synthesized Three schiff bases from 2,5-dihydroxyacetophenone (Scheme-11). The antibacterial activities of these schiff bases were checked against one gram positive bacteria *(S. aureus*), three gram negative bacteria (*E.coli, K. pneumonia and P. vulgaris*) and also antifungal activity was checked against one yeast (*C.albicans*). First and second compound showed better activity than the third one.



Compound (L_1); X= -H, Z= -CH_3

Compound (L_2); X= -OH, Z= -H

Compound (L_3); X= -OCH_3, Z= -H

Scheme-11

CONCLUSION

Schiff bases are the important class of chemical compounds because of their ability to form metal complexes, their pharmacological properties, industrial and medicinal applications. However, these compounds encourage further research due to their biological activities .This literature study proved that schiff bases shows better biological activity. Hence we decided to synthesize 2-(salicylideneamino) benzoic acid and it's metal complexes for the future study of biological activities such as antibacterial and anti-fungal activities.

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REFERENCES

1. T.M. Fasina, R.O.Dada, Substituent effect on electronic absorption and biological properties of schiff bases derived from aniline , Journal of Chemical and Pharmaceutical Research, 2013; 5: 177-181.
2. V.Gupta, S. Singh, Y.K. Gupta, Synthesis and Antimicrobial Activity of some Salicyaldehyde Schiff bases of 2-aminopyridine, Research Journal of Chemical Sciences, 2013; 3: 26-29.
3. C.U. Dueke-Eze, T.M. Fasina, N. Idika, Synthesis, electronic spectra and inhibitory study of some Salicyaldehyde Schiff bases of 2-aminopyridine, African Journal of Pure and Applied Chemistry, 2011; 5.
4. Clarke B, et al. Transition-metal Schiff-base complexes as ligandsin tin chemistry. Part7. Reactions of organotin (IV) Lewis acids with [M(L)] 2 [M-Ni,Cu and Zn; H2LN, N-bis (3-methoxysalicylidene) benzene-1,3-diamine and its -1,4-diamine analog. J Organomet Chem, 1998; 559: 55-64.
5. Patti A, et al. Synthesis and characterization of some chiral metal-salen complexes bearing a ferrocenophane substituent . Molecules, 2009; 14: 4312-4325.
6. Complexes of Some 3d metals with Schiff bases derived from 5-Acetamido-1,3,4-Thiadiazole-2-Sulphonamide and their Biological Activity, Malik Suman, Ghosh Suparna, Mitu Liviu, Journal of the Serbian Chemical Society, 2011; 76.
7. Synthesis, Spectral Characterization and DNA Cleavage Study of Heterocyclic Schiff base metal complexes, N.Raman, S. Johnson Raja, J.Joseph and J. Dhaveethu Raja, Journal of the Chilean Chemical Society, 2007; 52.
8. Mehmet G , Mehmet S, Ismet B, Synthesis, Characterization, and antimicrobial activity of a new pyrimidine Schiff base and its Cu(II), Ni(II), Co(II), Pt(II), and Pd(II) complexes. *Turk J Chem*, 2012; *36: 189-200.*
9. Parashar, RK, Sharma RC, Mohan G Biological activity of some Schiff bases and their metal complexes. *Biol Trace Elem Res*, 2005; *23: 145-50.*
10. A.Muhammad, A. Itrat, A. Nighat, T.H. Muhammad, M. Rashad, H. Ajaz, Y. Sammer, I. Lubana, I. Samina, K. Inamullah, Synthesis, X-ray Crystallography, Molecular Docking and Biological Screening of 2-aminophenol Based Schiff bases, J. Chil. Chem. Soc., 2013; 58: 1867-1871.
11. M.I. Khan, A. Khan, I. Hussain, M.I. Khan, S. Gul, M. Iqbal, Inayat-Ur-Rahman, Spectral, XRD, SEM and biological properties of new mononuclear Schiff base transition metal complexes, Inorganic Chemistry Communicatios, 2013; 35: 104-109.
12. M. Ikram, S. Rehman, A. Khan, R.J. Baker, T.S. Hofer, F. Subhan, M. Qayum, Faridoon, C. Schulze, Synthesis, Characterization, antioxidant and selective xanthine oxidase inhibitory studies of transition metal complexes of novel amino acid bearing Schiff base ligand, Inorganica Chimica Acta, 2015; 428: 117-126.
13. A.A.A. Aziz, A.N.M. Salaem, M.A. Sayed, M.M. Aboaly, Synthesis, Structural Characterization, thermal studies, catalytic efficiency and antimicrobial activity of some M(II) complexes with ONO tridentate Schiff base N-salicylidene-o-aminophenol (saphH2), Journal of Molecular Structure, 2015; 1010: 130-138.
14. T.M. Fasina, F.N. Ejiah, C.U. Dueke-Eze, N. Idika, Synthesis and Antimicrobial Activity of Schiff bases Derived from substituted Salicyaldehyde with 2-aminophenol and 2-aminothiophenol, Journal of Sci, Res. Dev., 2013; 14: 95-98.
15. F.N. Ejiah, T.M. Fasina, O.B. Familoni, F.T. Ogunsola, Substituent effect on spectral and antimicrobial activity of Schiff bases derived from aminobenzoic acids, Advances in Biological Chemistry, 2013; 3: 475-479.
16. ZH Yang, LX Wang, ZH Zhou, et al. Synthesis of new chiral Schiff bases and their application in the asymmetric trimethylsilylcyanation of aromatic aldehydes. *Tetrahedron: Asymmetry*, 2001; 12(11): 1579–1582.
17. M Qiu, G Liu, X Yiao. *Chin J Catal*, 2001; 22: 77.
18. JO Kenneth, JW Shiow, JB Cynthia. Alkene aziridination and epoxidation catalyzed by chiral metal salen complexes. *Tetrahedron Letters*, 1992; 33(8): 1001–1004.
19. EJ Jacobsen, W Zhang, ML Guler. Highly enantioselective epoxidation catalysts derived from 1, 2–diaminocyclohexane. *J Am Chem Soc*., 1991; 113(18): 7063–7064.
20. MA Green, H Luo, PE Fanwick. Synthesis and Structure of a Novel Cu (II) Complex with a Monoprotic Tetradentate Schiff Base Ligand. *Inorganic Chemistry*, 1998; 37(5): 1127–1130.
21. YK Choi, WS Kim, KI Chung, et al. Catalytic effect of transition metal(II)–N,N′-bis(naphthaldehyde) diimines on reduction of thionyl chloride. M*icrochemical Journal*, 2000; 65(1): 3-15.
22. RD Jones, RD Summerville, F Basolo Synthetic oxygen carriers related to biological systems. *Chem Rev*., 1979; 79(2): 139–179.
23. JD Margerum, LJ Miller. Photochromism. New York: Interscience Wiley, 1971; 569.
24. S. Kumar, D. Nath Dhar, P.N. Saxena, J. Sci. Ind. Res. (India), 2009; 68: 181-187.
25. S .M. Kim, J.-S. Kim, D.-M. Shin, Y.K. Kim, Y. Ha, Bull. Korean Chem. Soc., 2001; 22(7): 743-747.
26. A.A. Jimoh, A. Helal, M.N. Shaikh, Md A. Aziz, Z.H. Yamani, A. Al-Ahmed, J.-P. Kim, J. Nanomaterials, 2015; 1-8.
27. J. Tisato, F. Refosco, F. Bandoli, Coord. Chem. Rev., 1994; 135: 325.

28. A. Staykov, M. Watanabe, T. Ishihara, K. Yoshizawa, J. Phys. Chem. C., 2014; 118 (47): 27539-27548.
29. C.A. Barboza, J.C. Germino, A.M. Santana, F.J. Quites, P.A.M. Vazquez, T.D.Z. Atvars, J. Phys. Chem. C, 2015; 119(11): 6152-6163.
30. T. Yamada, T. Ikeno, Y. Ohtsuka, S. Kezuka, M. Sato, Sci. Technol. Adv. Mater, 2006; 7: 184-196.
31. Yan-Hua-Cai and Wen Luo, "Preparation of Schiff base derived from 3,4-Dimethoxybenzaldehyde and *p*-Aminobenzoic acid by Supersonic Speed Gas Impacting Method," Hindawi Publishing Corporation, Journal of Chemistry, 2014. Article ID 218376.
32. Guo Y. N., Synthesis, crystal structures, and antibacterial activities of Schiff base Zinc (II) complexes [Zn(L1)2] and [Zn(L2)2]. *Rus. J. Coord. Chem.*, 2012; *38*(2): 121-125.
33. Abidemi Iyewumi Oloyede-Akinsulere, Simon Olonkwoh Salihu, Jelili Olalekan Babajide and Helen Shnada Auta, "Synthesis and Antimicrobial Activity of Schiff bases derived from 5-Chlorosalicyaldehyde with Substituted Aniline,"Elixir International Journal, 2016; 101: 43578-42581.
34. Chigurupati S., Selvaraj M., Mani V., Mohammad J. I., Selvarajan K. K., Akhtar S. S., Marikannan M., Raj S., Teh L. K. And Salleh M. Z., Synthesis of azomethines derived from cinnamaldehyde and vanillin: in vitro acetylcholinesterase inhibitory, antioxidant and insilico molecular docking studies. *Med. Chem. Res.*, 2018; 27: 807-816.
35. Abubakar Abdullahi AHMED, Hassan Usman ALI, Abdullahi Idi MOHAMMED, "Synthesis and physicochemical study on Ni (II) complex of Schiff base derived from 4-methoxybenzaldehyde and *o*-Aminobenzoic acid," Journal of Analytical Sciences and Applied Biotechnology, 2021; 3(2): 97-102.
36. Cai L. F., Copper(II) complexes of monocondensed N,O-donor Schiff base ligands: synthesis, crystal structures and antibacterial activity. *Rus. J. Coord. Chem.*, 2017; 43(8): 535-539.
37. Habibi M., Beyramabadi S. A., Allameh S., Khashi M., Morsali A., Pordel M. And Khorsandi-Chenarboo M., Synthesis, experimental and theoretical characterizations of a new Schiff base derived from 2-pyridincarboxaldehyde and its Ni (II) complex. *J. Mol. Struct.*, 2017; 1143: 424-430.
38. Govindaraj V, Ramanathan S, Murgasen S, "Synthesis, Characterization, Antibacterial, Antifungal and Cytotoxic activity of Schiff base Ni (II) complexes with Substituted Benzylidine Aminobenzoic acid," Pelagia Research Library- Der Chemica Sinica, 2018; 9(3): 736-745.
39. Nassar M. Y., Ahmed I. S., Dessouki H. A. And Ali S. S., Synthesis and characterization of some Schiff base complexes derived from 2,5-dihydroxyacetophenone with transition metal ions and their biological activity. *J. Basic Environ. Sci.*, 2018; 5: 60-71.