Heterocyclic Letters
Vol. 13| No.1|53-60|November -January|2023
ISSN : (print) 2231–3087 / (online) 2230-9632
CODEN: HLEEAI
http://heteroletters.org

ECOFRIENDLY MICROWAVE ASSISTED SYNTHESIS, CHARACTERIZATION AND ANTIBACTERIAL ACTIVITY OF NOVEL SCHIFF BASE LIGAND AND ITS METAL COMPLEXES DERIVED FROM 2-AMINO BENZOTHIAZOLE AND 3,5-DIMETHOXY-4- HYDROXY ACETOPHENONE.

S S Sonune[a], S P Moharir[b*], M G Undegaonkar[c], A S Kirdant[d].

[1,2]Department of Chemistry, Siddharth Art's, Commerce and Science College Jafrabad dist. Jalna.
[3]Department of Chemistry; ASC College Badnapur, Dist. Jalna (M.S) India.
[4]Department of Chemistry, Vasant college kaij, Dist. Beed (M.S) India.
Corresponding author: sharad9939moh@gmail.com.

ABSTRACT: Microwave assisted, Solvent Free, eco-friendly synthesis of novel Schiff base ligand was synthesize by using 2-amino benzothiazole with 3,5-dimethoxy-4-hhydroxy acetopheone and its transition metal complexes were prepared from Ni(II), Cd(II), Fe(III), Cu(II), Zn(II), Co(II), Ag(I) nitrate and Mn(II) chloride salts. The Schiff base ligand was characterized by elemental analysis, IR, ^{I}HNMR and LC-MS and its complexes were characterized by UV-Visible, FT-IR, and Thermo gravimetric analysis. The Schiff Base ligand and its metal complexes were screened for their antibacterial activity against *staphylococcus aureuss, salmonella Typhi* bacteria and *Aspergillus Niger* fungi. The result indicates that metal complexes exhibited good antibacterial activities.

KEYWORDS: 2 amino benzothiazole, Microware assisted, Solvent Free, eco-friendly, 3,5-dimethoxy-4-hydroxy Acetophenone.

1. INTRODUCTION:

Green Chemistry plays an important role in sustainable development and to protect the resources of nature. Now a day's solvent free & microwave assisted method is one of the most accepted tool for organic and inorganic reactions. For this higher Selectivity of reaction and less expensive reagents are used[i,ii]. Now a day's that are need to provide eco-friendly approach which comes from green chemistry used for avoiding environmental hazards[iii,iv]. Microwave assisted methodology is time saving[v] having simple reaction condition and gives larger yield[vi]. The ligand which is derived from an amino and carbonyl compound is an important class. The ligand was co-ordinate with metal ion through azomethine nitrogen[vii,viii]. The transition metal complexes formed from Schiff base ligand plays an important role in inorganic chemistry[ix]. Schiff base ligand have many applications in biological & analytical field[x] like plant growth inhibitors, anticancer[xi], antitubercular, antinflammatory[xii], antibacterial and pharmacological

activity[xiii], insecticides[xiv], antibiotics[xv] there is a wide range of application such as dyes, catalyst, intermediates & stabilizer[xvi] they also shows antiviral property and antibacterial property[xvii,xviii]. Many research proved that metal complexes exhibit more potency than ligand[xix]. We synthesized Schiff base from 2-amino benzothiazole and 3,5-dimethoxy-4-hydroxy acetophenone under microwave irradiation, due to this simple reaction condition & more yield in less time[xx].

2. MATERIAL AND METHOD:

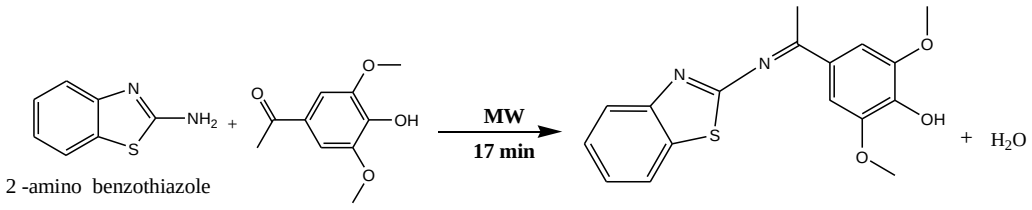
All chemicals used were of the analytical reagent grade [AR] and of higher purity available. The chemicals used included 2-amino benzothiazole and 3,5-dimethoxy-4-hybroxy acetophenone were purchased from sigma Aldrich. The metal salts used are Ni(II), Cd(II), Fe(III), Cu(II), Zn(II), Co(II), Ag(I) nitrate and Mn(II) chloride were obtained from Loba Chem and MERCK. DMSO, diethyl ether and ethanol all other organic solvents were spectroscopic pure from Loba chem and MERCK.

2.1 INSTRUMENTATION:

The melting point of all the newly synthesized Schiff base ligand and their metal complexes were found by using electro thermal melting point apparatus. ^{1}HNMR spectral data were recorded on a Bruker [400 MHz, 100 MHz] spectrometer. Chemical Schiff is measured in ppm for this Tetra methyl silane is used as internal standard. The synthesized compounds find out the molecular weight using LC-MS, Carbon, hydrogen and nitrogen were analysed using CHN/S/O analyser Perkin Elmer, Series II, 2400. The FT-IR measurements were recorded on shimadzu-8300 spectrophotometer in the range of [4000-400 cm^{-1}] as KBr disc. Electronic spectra were recorded using UV-Vis Spectrophotometer type CECIL with quartz cell of [1cm] path length in range [200-800] nm in ethanol at room temperature. TGA analyses were done in dynamic nitrogen atmosphere for this Perkin Elmer thermal analyzer was used.

2.2 SYNTHESIS OF SCHIFF BASE LIGAND:

The Schiff base has been synthesized by using 2-amino benzothiazole [1mmol] and 3,5-dimethoxy-4-hydroxy acetophenone [1mmol]. The reaction was carried out in microwave oven for 17 minutes. The product was confirmed by color change and TLC. The irradiated product was then washed with dry ether and filtered. The Final Product was then recrystallized from ethanol. Pale yellow crystals of compound were obtained. The yield was 95% and M.p.is 110^{0}C.



3',5'-Dimethoxy-4'-hydroxyacetophenone 4-(1-(benzo[*d*]thiazol-2-ylimino)ethyl)-2,6-dimethoxyphenol

2.3 SYNTHESIS OF METAL COMPLEXES:

The Schiff base ligand and salts were mixed in a grinder 1:2 [metal:ligand] ratio. The reaction mixture is then irradiated in scientific microwave oven. The reaction was completed 10 minutes that is very short time. The product was confirmed by color change and TLC. Each metal complex was recrystallized from ethanol and ether.

3. RESULT AND DISSCUSSION:

In present study of the microwave assisted synthesiss, it was noted that all reactions are completed in very short time and gives better yield of product. All the metal complexes are

colored, Solid and show stability towards air and moisture at room temperature. The sharp melting point was shown by all products.

3.1 ELEMENTAL ANALYSIS OF NOVEL SCHIFF BASE LIGAND:

Table 1

Novel-Ligand	Mol. Wt.	Found (Calculated)%				
		C	H	N	S	O
$C_{17}H_{15}NSO_3$	313.29	63.73 (65.16)	5.61 (4.8)	4.04 (4.46)	10.00 (10.21)	16.62 (15.37)

3.2 PHYSICAL PROPERTIES:

Table 2 the details of physical properties of novel ligand and its metal complexes

Sr. No	Formula of ligand / complex	Symbol	Colour	M.P.[^{0}C]	Yield [%]
1	$C_{17}H_{15}NSO_3$	L_4	Pale yellow	110	95
2	$C_{17}H_{15}NSO_3Mn$	L_4Mn	Light green	125	98
3	$C_{17}H_{15}NSO_3Fe$	L_4Fe	Brown	135	84
4	$C_{17}H_{15}NSO_3Cu$	L_4Cu	Green	210	80
5	$C_{17}H_{15}NSO_3Zn$	L_4Zn	White	198	82
6	$C_{17}H_{15}NSO_3Ni$	L_4Ni	Pale yellow	119	86
7	$C_{17}H_{15}NSO_3Co$	L_4Co	Violet	340	87
8	$C_{17}H_{15}NSO_3Cd$	L_4Cd	Silver	140	83
9	$C_{17}H_{15}NSO_3Ag$	L_4Ag	Up White	155	90

3.3 INFRARED SPECTRAL STUDY:

Table 3 Selected infrared frequencies [cm^{-1}] of ligand and its complexes.

Sr. No.	Ligand / Complexes	υ(C=N) Azomethine	υ(N-H) Imidazole	υ(C=C)	υ(M-N)	υ(M-S)	υ(H20)
1	L_4	1666	3379	1543	-	-	-
2	L_4Ni	1642	3324	1369	490	422	3605
3	L_4Co	1660	3277	1505	470	430	3595
4	L_4Cd	1680	3314	1370	480	430	3607

The IR spectrum of novels Schiff base ligand shows characteristic band at 1666cm^{-1} which indicates(C=N) stretching vibration of azomethine group[xxi,xxii]. The vibrational band at 3379cm^{-1} assigned to N-H stretching in the ligand. The band observed at 1543cm^{-1} correspond to (C=C) stitching. This confirms the formation of ligand.

IR spectral study of metal complex L_4Ni - The band appear at 1642cm^{-1} corresponding to an azomethine (C=N) stretching, whereas same band is observed at 1666cm^{-1} in ligand. This indicates coordination of ligand with metal ion. The band observed at 3324cm^{-1} assigned to (N-H) stretching where as in spectrum of ligand it is observed at 3379cm^{-1}. The vibration observed at 1369cm^{-1} due to aromatic (C=C) stretching in metal complex and it is 1543cm^{-1} in ligand. The band at 422cm^{-1} indicates (M-S) stretching[xxiii]. Band at 3605cm^{-1} in metal complex assigned to υ(H_2O). The characteristics (M-N) vibration seen at the band value 490cm^{-1} due to this the coordination of metal ion and azomethine get confirmed. This band is not appearing in the spectrum of ligand that confirms the formation of metal complex with stable metal ligand bonding.

IR spectral study of metal complexes of L_4Co - This metal complex of cobalt shows most characteristic azomethine (C=N) stretching vibration at1660cm^{-1}. This stretching vibration of novel Schiff base ligand observed at 1666cm^{-1}.The (N-H) stretching vibration of metal complex is observed at 3277cm^{-1} while for novel Schiff base ligand this is at 3379cm-1.The (C=C) stretching vibration of aromatic ring is observed at 1505cm^{-1} this is observed at 1543cm^{-1} for the novel Schiff base ligand. The (M-S) stretching vibration observed at 430cm^{-1} for metal complex. The characteristic M-N stretching vibration of metal complex of cobalt observed at the 470cm^{-1} which is absent in the novel Schiff base ligand. From this the formation of metal complex confirmed.

IR spectral study of metal complexes of L_1Cd - This metal complex shows the azomethine stretching vibration at 1680cm^{-1}.This value is less than the azomethine stretching vibration of novel Schiff base ligand which is at1666cm^{-1}. The (N-H) stretching vibration for complex of Cd observed at 3314cm-1 which is also less than the (N-H) stretching vibration of novel Schiff base ligand which is at 3379cm^{-1}.The (C=C) stretching vibration of carbons of aromatic benzene ring is observed at 1370cm^{-1} for this metal complex but this (C=C) stretching vibration is observed at 1543cm^{-1} in novel Schiff base ligand. The metal complex also shows the (M-S) stretching vibration at 430cm^{-1}.The most characteristic (M-N) stretching vibration of metal complex is observed at 480cm^{-1} which is absent in the novel Schiff base ligand. This value indicates the linking of metal with nitrogen. From this it is confirmed that the formation of metal complex.

3.4 ^{1}HNMR SPECTRAL STUDY OF NOVEL SCHIFF BASE LIGAND:

Table 4 Observed ^{1}HNMR peaks (ppm) of novel Schiff base ligand.

Ligand	H from benzene ring (ppm)	H from –OH (ppm)	H from O-CH_3 (ppm)	H from CH_3 (ppm)
L_4	7.007-7.661	6.988	3.841	2.549

The ^{1}HNMR spectra of the Schiff base ligand were recorded in DMSO. The Chemical shifts [δ] are given in ppm down field from Tetramethylsilane. The spectrum shows peaks between 7.007 to 7.661 ppm is due to C-H proton of substituted benzene and peak at 6.988 ppm is due to substituted -OH. The proton from methoxy (O-CH_3) shows peak at 3.841 ppm and peak due to CH_3 is observed at 2.549 ppm.

3.5 MASS SPECTRAL STUDY:

The fragmentation pattern seen in mass spectrum of novel Schiff base ligand evidently displays molecular ion peak at m/z 313, which equates to its molecular weight 313.29 of the novel Schiff base ligand.

3.6 UV-VISIBLE SPECTRAL STUDY:

Table 5 Electronic spectral data and probable geometry of the metal complexes

Sr. No.	Complexes	U.V.-Visible Major bands absorption Maxima cm-1 [nm]	Assignment	Proposed Geometry
1	L_4Mn	270 320	π→ π* n→π*	Octahedral
2	L_4Ni	280 320 350	π→ π* n→ π*	Octahedral

The electronic spectrum of metal complexes shows absorption bands, these transition may be attributed to the charge transfer band which proves the coordination of the ligand to the metal ion.

Electronic spectrum of L_4Mn - L_4Mn complex shows absorption maxima at 270nm and 320nm assign to $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions respectively indicating that complex possess octahedral geometry.

Electronic spectrum of L_4Ni - L_4Ni complex shows absorption maxima at 280nm, 320nm and 350nm transitions respectively indicating that complex were possess octahedral geometry[xxiv].

3.7 THERMO GRAVIMETRIC ANALYSIS:

Table 6

TGA data for L_4Mn		TGA data for L_4Ni	
Weight loss %	Temperature °C	Weight loss %	Temperature °C
0	30.50	0	34.80
10	199.00	10	180.00
20	254.50	20	234.80
30	34210	30	280.90
40	358.90	40	329.50
50	388.00	50	355.80
60	445.01	60	387.70
70	471.00	70	426.50
79.50 (Total weight loss)	500	80	450.18
		80.10 (Total weight loss)	500

Thermo gravimetric analysis of Complexes was carried out in the temperature range from room temperature to 500℃. The heating is carried out in the dynamic nitrogen atmosphere. Heating rate was controlled at 10℃ min^{-1}.

The L_4Mn complex thermogram clearly shows, total weight loss of 79.50%. In First step water of crystallization get removed in the range of 30.20℃ to 199℃ with 10% weight loss. After this weight loss of water of crystallization loss of organic moiety took place with total weight loss of 79.50% up to 500℃. A Stable curve indicates formation of stable manganese oxide.

The L_4Ni complex thermogram clearly shows, total weight loss of 80.10% in first step water of crystallization get removed in the range of 34.80^0C to 180^0C with 10% weight loss. After this weight loss of water of crystallization loss of organic moiety took place with total weight loss of 80.10% up to 500^0C. A stable curve indicates formation of nickel oxide.

3.8 ANTIBACTERIAL ACTIVITY STUDY:

Table 7 Zone of inhibition of ligand and its metal complexes

Sr. No.	Compounds	Zone of inhibition [mm]		
		Salmonella Typhi	Staphylococcus Aureus	Aspergillus Niger
1	L_4	6.8	Nz	11.8
2	L_4Mn	9.8	8.2	15.2
3	L_4Fe	9.2	8.3	11.6
4	L_4Ni	9.3	11.4	11.5
5	L_4Co	14.4	13.1	12.2
6	L_4Cd	15.8	14.3	15.1
7	L_4Ag	14.5	12.2	22.3
8	L_4Cu	8.8	8.9	8.2

9	L_4Zn	15.3	9.8	8.0

Metals have very long history for being used as antimicrobial agents. Some of these now have been studied widely as pharmaceutical agents. The report shows that there is an extensive investigation in the field of metal complexes. The antimicrobial activities of Schiff base ligand and their metal complexes were checked in vitro, using disc diffusion method against gram positive bacteria staphylococcus aureus, gram negative bacteria salmonella typhi and Aspergillus Niger Fungi. The antimicrobial activity of the Schiff base ligand and its metal complexes were determined by the agar well diffusion assay[xxv]. Disc size 6 mm used. Culture used is gram positive staphylococcus aureus strain NCIM 2079, gram negative salmonella Typhi Strain MTCC 3224 and Aspergillus Niger Fungi Strain NCIM 52485 is used. The culture of microorganism is collected from NCIM- National Collection of Industrial Microorganism, national chemical laboratory [NCL] Pune 411008 [India].

The nutrient agar [Hi Media] – Microbiological media used for both bacteria and potato dextrose agar [Hi-Media] used for fungi. The suspension containing species of the microorganism was added to freshly prepare nutrient agar medium contain in petri dish and kept it for set. Then the solution of the antibiotics was introduced with various concentrations of antibiotics and their metal complexes in methanol were placed on the culture media and incubated for 24hrs at 37^0C[xxvi]. Activities were determined by measuring diameter of the zone of inhibition [mm]. The antibiotics and their metal complexes that showed a zone of inhibition were further assayed. The result shows that both ligand and complexes shows antibacterial activity against staphylococcus aureus, salmonella typhi & Aspergillus Niger Fungi. The metal complex L_4Ag show excellent antibacterial activity against Aspergillus Niger Fungi as compared to its parent ligand and other metal complexes. Whereas L_4Co, L_4Cd, L_4Ag and L_4Zn are show good antibacterial activity against salmonella typhi bacteria. The complexes L_4Cd, L_4Ag and L_4Zn show good antibacterial activity against Staphylococcus aureus bacteria. The complexes L_4Mn, L_4Co and L_4Cd show good antibacterial activity against Aspergillus Niger fungi.

4. CONCLUSION

In the present work, we developed 4-(1-(benzo[d]thiazol-2-ylimino)ethyl)-2,6-dimethoxyphenol. Metal complexes were prepared L_4Mn, L_4Fe, L_4Ni, L_4Co, L_4Cd, L_4Ag, L_4Cu & L_4Zn. The metal ions were coordinate by imine [H-C=N] atom. Spectroscopic and structural data shows that all complexes are six co-ordinated metal complexes. All the metal complexes and novel Schiff base ligand shows good antibacterial activity against Staphylococcus aureus, Salmonella typhi and Aspergillus Niger.

REFERENCES:

i. V. Polshettiwar; Royal society of chemistry; 2010, ISBN-978-1-84973-038-9 Cambridge UK.
ii. Pali P.; Ramakanth J.; S. meshram; J. cocvd chem.; 2010, **63**(2), 323-329.
iii. B. L. Hayer; Aldrich Chimica Acta; 2004, **37**(2), 66-76.
iv. Anjali Jha; Microwave assisted synthesis of organic compounds and nanomaterial's. https://doi.org/10-5772/interhpen98224.
v. Sadashiv N. Sinkar; Mahesh G. Undegaonkar; Sharad P. Moharir; Sunil R. Mirgane; Solvent free Synthesis, Characterization & biological activity of transition metal complex of Schiff base ligand derived from 2-amino benzothiazole with 4,4-

dibrobenzil; Letters in Nano bioscience; 2022, **11**(3), 3838-3842. https://doi.org/10.33263/LIANB5113.38343842

vi. K. Mahajan; N. Fahmi; R. V. Singh; Indian J. Chem.; 2007, **46**, 12-21.

vii. Hasan A. Mohammed; Nishad Ismial Taha; International Journal of organic chemistry; 2017, **7**, 412-419.

viii. Mishra A.; Purwar H.; Jain R.; Gupta S.; Microwave Synthesis, Spectral, Thermal and Antimicrobial Studies of Some Co(II), Ni(II) and Cu(II) Complexes Containing 2-Aminothiazole Moiety; E-Journal of Chemistry; 2012, **9**(4), 77-85.

ix. Bell S. C.; Corklin G. L.; Childress S. J.; J. Am. chem. Soc.; 1963, **18**, 2868-2869.

x. S. S. Bhitar; H. D. Juneja; I. J. Paliwal; RJPBCS; 2013, **4**(4), 556-564.

xi. B. R. Thorat; P. Kamat; D. Khandekar; S. Lele; M. Mustapha; S. Sawant; R. Jadhav; S. Kolekar; R. Yanga; R. G. Atram; J. Chem. Pharm. Res.; 2011, **3**(6), 1109-1117.

xii. Osowole A.; Ott I.; Ogunlana O.; Synthesis, Spectroscopic, Anticancer, and Antimicrobial Properties of Some Metal(II) Complexes of (Substituted) nitro phenol Schiff Base; International Journal of Inorganic Chemistry; 2012, **12**(7), 1-6.

xiii. Pahlavani E.; Kargar H.; Sepehri Rad N.; A Study on Antitubercular and Antimicrobial Activity of Isoniazid Derivative; Zahedan Journal of Research in Medical Sciences; 2014, **17**(7), 7-10.

xiv. Johari R.; Kumar G.; Kumar D.; Singh S.; Synthesis and Antibacterial activity of M [II] Schiff base complex; J. and council chem.; 2009, **26**(1), 23-27.

xv. Kiruthikajothi K.; Chandramohan G.; Synthesis and evaluation of insecticide efficiency of copper complexes against eriophyid mite, Aceria guerreronis; International journal of current microbiology and applied sciences; 2013, **2**, 24-28.

xvi. Kumar J.; Rai A.; Raj V.; A Comprehensive Review on the Pharmacological Activity of Schiff Base Containing Derivatives; Int. J. of Organic & Medicinal Chem.; 2018, **1**(3), 5-20.

xvii. I. K. Kareem; F. Y. Waddi; G. S. Abbaj; J. pharm Sci. and Res.; **1**(II), 119- 124.

xviii. Pocrnic M.; Kontrec D.; Miljanic S.; Soldin Z.; Budimir A.; Galic N.; Gallium(III) complexes of aroylhydrazones derived from nicotinic acid hydrazide in solid state and in solution; J. Mol. Struct.; 2021, **1227**, 129564. https://doi.org/10.1016/j.molstruc.2020.129564.

xix. S. P. Moharir; M. G. Undegaonkar; S. N. Sinkar; S. R. Mirgane; Green and Efficient Synthesis, Characterization and Antimicrobial Activity of Transition Metal complexes of Novel Schiff base ligand derived from 2-hydrazino Benzothiazole and Benzil; Journal of Chemistry and Chemical Sciences; 2021, **11**(4), 43-51.

xx. H. Elafy; A. Hassan; E. Shawky; A. E. Khattan; B. H. Heakl; Egyptian J. of chemistry; 2018, **6**(4), 569-580.

xxi. Venugopal P.; Krishnakuty K.; Synthesis and characterization of cobalt-nickel, copper- and Zinc(II) complexes of morin; J. Indian Chem. Soc.; 1997, **74**, 562-563.

xxii. Mohammed Fakruddin Ali Ahmed; Microwave synthesis and Antibacterial Activity of some Heterocyclic Schiff's base Metal Complexes of First Transition Series; RJPBCS; 2014, **5**(5), 912-919.

xxiii. Dharmaraj N.; Viswanathamurthi P.; Nataragan K.; Ruthenium (II) complexes containing bidentate Schiff bases and their antifungal activity; J. Transition Met. Chem.; 2001, **26**, 105-109.

xxiv. Mishra A. P.; Rajendra K. Jain; Conventional and microwave synthesis, spectral thermal and antimicrobial studies of some transition metal complexes containing 2-

amino-5-methylthiazole moiety; Journal of Saudi chemical society; 2014, **18**, 814-824. https://doi.org/10.1016/jjscs2011.09.013.

xxv. Banfi E.; Scialino G.; Monti-Bragadin C; Journal of Antimicrobial Chemotherapy; 2003, **52**, 796-800. https://doi.org/10.1093/jac/dkh439.

xxvi. Paul A.; Anbu S.; Sharma G.; Synthesis, DNA binding cellular DNA lesion and cytotoxicity of a series of new benzimidazole-based Schiff base copper (II) complexes; Dalton Trans; 2015, **44**(46), 19983-19996.

Received on September 20, 2022.