**IJPSR (2018), Volume 9, Issue 7** **(Research Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 28 October, 2017; received in revised form, 15 December, 2017; accepted, 25 December, 2017; published 01 July, 2018

# ANTI-MICROBIAL AND ANTI-TUBERCULAR ACTIVITY EVALUATION OF NEWLY SYNTHESIZED ZINC COMPLEXES OF AMINOTHIOPHENE SCHIFF BASES

Ganesh More [1], Sakina Bootwala [*1], Sushma Shenoy [2], Joyline Mascarenhas [2] and K. Aruna [2]

Department of Chemistry [1], Department of Microbiology [2], Wilson College, Girgaon Chowpatty, Mumbai - 400007, Maharashtra, India.

**Keywords:**

Schiff base, *M. Tuberculosis*, Antimicrobial, Zinc complex, Antimicrobial, Gram-negative

**Correspondence to Author:**
**Dr. S. Z. Bootwala**

Associate Professor,
Department of Chemistry,
Wilson College, Girgaon Chowpatty,
Mumbai - 400007, Maharashtra, India.

**E-mail:** szbootwala@gmail.com

**ABSTRACT:** Tridentate Schiff bases were obtained in succession from the condensation of ethyl 2-amino-5,6-dihydro-4*H*-cyclopenta [*b*] thiophene-3-carboxylate and different aryl aldehydes in 1:1 molar ratio. Zinc chloride complexes of these new aminothiophene Schiff bases were prepared in 1:1 metal: ligand stichometry. These complexes were characterized using IR, UV-Visible, elemental analysis and molar conductivity. Schiff bases displayed monobasic tridentate coordination with central Zn (II) ion and formed tetrahedral complexes. These complexes were evaluated for their antimicrobial activity against gram-negative, multidrug-resistant Metallo- β-lactamase (MBL) and Extended Spectrum β-lactamase (ESBL) producing uropathogens and for their antitubercular activity against *Mycobacterium tuberculosis* (H37Rv strain) to observe improved biological activity compared to parent Schiff bases.

**INTRODUCTION:** The condensation reaction between primary amine and carbonyl compound was first reported by Hugo Schiff and the products possessing the characteristic azomethine group are often referred as Schiff bases [1]. Over last few decades, a tremendous upsurge has been observed in the study of Schiff bases and their metal complexes due to their variety in reactions, diversified industrial applications and a broad spectrum of biological activity coupled with ease of preparation [2, 3]. The azomethine linkage and the presence of N, S and O donor atoms play important role in the biological properties as well as in the coordination of the metal complex. Bonding of metal ions to such biologically active compounds may enhance their biological activities [4].

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.9(7).3029-35

Article can be accessed online on: www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.9(7).3029-35

Zinc is the most abundant essential trace mineral found in the human body after iron [5]. Zinc is necessary for the physiological growth, reproduction and normal functioning of the brain and central nervous system and plays a key role in the metabolism of RNA and DNA and for gene expression [6, 7].

Urinary tract infections (UTI) are one of the most common bacterial infections affecting millions of populace every year accounting for significant morbidity and high medical costs. Studies reveal that Women are more prone to UTIs than men and every fifth woman has a chance of developing a UTI during her lifetime. Approximately 25 % of women with an acute UTI reported with recurrent UTIs (RUTIs). Gram-negative bacteria *Escherichia coli* and *Klebsiella pneumoniae* are the most predominant uropathogens causing UTIs [8 - 10]. Infections caused by drug-resistant bacteria producing ESBLs (Extended spectrum β-lactamase) and MBL (Metallo- β-lactamase) have become a serious problem for the healthcare industry [11]. Another drug-resistant disease posing a major

global health hazard to mankind is Tuberculosis. WHO reports 46.5 % TB burden in South Asia region of which India alone accounts for 23 % of World TB cases. In 2015, 37 % multi-drug resistance TB cases were detected worldwide accounting for 250000 deaths. The evolution of drug-resistant strains combined with co-infection from HIV creates a major huddle in the treatment of TB [12]. Such situations demand a substantial need for the discovery of new compounds with enhanced activities to overcome the drug-resistant bacterial strains.

Present work is focused on the synthesis and characterization of Zn(II) complexes of our previously reported [13] aminothiophene Schiff bases derived from ethyl 2-amino-5,6-dihydro-4*H*-cyclo penta [*b*] thiophene-3-carboxylate and biological activity evaluation against gram-negative uropathogens and *Mycobacterium tuberculosis*.

**MATERIALS AND METHODS:** Analytical grade chemicals with purified and distilled solvents were used for synthesis and analysis. The elemental analysis was done by standard methods [14]. ELICO Digital conductivity meter was used for molar conductance measurement with DMF ($10^{-3}$M solution) as a solvent. The IR spectra were obtained from Perkin Elmer Model 1600 FTIR Spectrophotometer using KBr disc. Electronic spectra were obtained from a UV-Vis Jasco Spectrophotometer Model V-630. For calculation of magnetic susceptibility, Gouy balance was used along with $Hg[Co(SCN)_4]$ as a calibrant.

**Anti-microbial Activity:** For the evaluation of the antibacterial activity, the agar well-diffusion method was employed. Total ten isolates, five ESBL and five MBL uropathogens comprising five of each of the genera, Escherichia, Pseudomonas, Klebsiella, Proteus and Citrobacter (**Table 2**) were used in the studies. The bacterial cultures were procured from local medical facilities in Mumbai and characterized for ESBL and MBL production in our previous studies [15]. The Zn(II) complexes were dissolved in HPLC grade DMSO. The final concentration of 25 µg/mL of the test compound was used in the experiment. All the bacterial strains were inoculated in 10 mL of Brain Heart Infusion (BHI) broth and kept for incubation at a temperature of 37 °C for one day.

The cooled, sterilized molten Mueller-Hinton agar (20 mL) was poured into sterilized Petri dish of 9 cm diameter under the aseptic condition and permitted to solidify. The plates were seeded with 0.4 mL test culture (0.1 O.D. at 540 nm). The inoculation was allowed to cool with gentle shaking. Wells were ditched in the medium using sterile cork borer of 8 mm diameter. Test compounds (50 µl) were added to these wells and the plates were kept for incubation at a temperature of 37 °C for one day to obtain the zones of inhibition. Control wells were set up using 50 µl of solvent (DMSO) for each test isolate. The anti-microbial activity was evaluated in triplicate set for each compound [16].

**Antituberculosis Activity:** The entire test compounds were assessed for antitubercular activity against *M. tuberculosis* (H37Rv strain) by the MABA (Microplate Alamar Blue assay) method using pyrazinamide, ciprofloxacin and streptomycin as positive controls. The final drug concentration tested from 100 to 0.8 µg/mL. In the experiment, a 96 well plate covered with de-ionized water in outer perimeter was used. In each well, 100 µl of the Middle brook 7H9 broth solution along with the serial concentration of test compound was added. These plates were sealed with paraffin and kept for incubation at a temperature of 37 ºC for five days.

On the 6th day of incubation freshly prepared 25 µl of 1:1 mixture of Almar Blue reagent and Tween solution (10% and 80%) was added to each well and these plates were again kept for incubation for another one day. On 7th day plates were removed, to check the MIC (Minimum Inhibitory Concentration). The lowest concentration of the test compound which prevented blue colour change to pink was reported as MIC [17].

**Synthesis of Ligand:** The Schiff bases were prepared from the condensation of ethyl 2-amino-5,6-dihydro-4H-cyclopenta[b]thiophene-3-carboxy -late with o-hydroxyl aldehyde derivative in 1:1 molar proportion as per reported method [13].

**Synthesis of Metal Complexes:** To an ethanolic solution of the Schiff base ligand (0.01 mol) the Zinc chloride (0.01 mol) dissolved in minimum quantity of ethanol was added dropwise with constant stirring. The pH was adjusted to 6-7 and

the mixture was heated under reflux for 4 - 5 h on a water bath. A fine yellow precipitate of the solid complex formed was filtered by suction filtration and purified by washing with aqueous ethanol and ether and dried in vacuum.

**RESULTS AND DISCUSSION:** Physicochemical analysis indicated 1:1 metal-ligand stoichiometry of Zinc complexes. All the complexes are coloured, stable and are of good keeping quality. The complexes showed insolubility in common organic solvents apart from DMF and DMSO. The molar conductance values pointed towards the non-electrolyte nature of the complexes. The elemental analysis data is found in agreement with proposed molecular formula (**Table 1**).

**TABLE 1: PHYSICO-CHEMICAL DATA OF Zn (II) COMPLEXES**

| Complex | Colour | F.W. | Elemental analysis (%) found (calc.) | | | | | | Molar conductance in DMF ($\Omega^{-1}$ cm$^2$ mol$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| | | | C | H | N | S | Cl | Zn | |
| [Zn($L_1$)Cl] | Yellow | 415.24 | 48.77(49.13) | 3.66(3.85) | 3.21(3.37) | 8.03(7.71) | 9.02(8.54) | 15.47(15.75) | 5.20 |
| [Zn($L_2$)Cl] | Yellow | 449.69 | 45.90(45.37) | 3.21(3.34) | 3.01(3.11) | 7.00(7.12) | 15.42(15.77) | 14.23(14.55) | 1.10 |
| [Zn($L_3$)Cl] | Yellow | 494.14 | 41.71(41.28) | 3.11(3.04) | 2.80(2.83) | 6.34(6.48) | 6.98(7.18) | 13.50(13.24) | 1.30 |
| [Zn($L_4$)Cl] | Yellow | 465.30 | 53.78(54.16) | 3.76(3.87) | 2.96(3.01) | 6.97(6.88) | 7.49(7.62) | 14.56(14.06) | 6.30 |

The IR spectrum is an important tool for the identification of different functional groups present in the complex and their bonding mode with the central metal atom. The IR spectra of the free ligands and the zinc complex were compared, in order to understand the bonding of Schiff base with the central zinc atom. The important IR bands and their assignments are depicted in **Table 2**.

**TABLE 2: FTIR SPECTRAL DATA**

| Compound | υ(O-H) phenolic | υ(C=O) ester | υ(C=N) azomethine | υ(C-O) phenolic | υ(C=S) thiophene | υ(M←O) | υ(M←N) |
|---|---|---|---|---|---|---|---|
| $HL_1$ | 3200-3000 | 1682 | 1597 | 1310 | 616 | - | - |
| $HL_2$ | 3200-3000 | 1704 | 1598 | 1311 | 619 | - | - |
| $HL_3$ | 3200-3000 | 1708 | 1598 | 1311 | 626 | - | - |
| $HL_4$ | 3200-3000 | 1704 | 1598 | 1307 | 617 | - | - |
| [Zn($L_1$)Cl] | | 1644 | 1570 | 1338 | 615 | 515 | 432 |
| [Zn($L_2$)Cl] | | 1643 | 1579 | 1340 | 618 | 515 | 426 |
| [Zn($L_3$)Cl] | | 1642 | 1577 | 1341 | 627 | 519 | 422 |
| [Zn($L_4$)Cl] | | 1663 | 1577 | 1336 | 618 | 511 | 415 |

The phenolic –OH band at 3000-3200 cm$^{-1}$ present in the Schiff base ligand spectra does not appear in metal complexes spectra indicating the participation of phenolic oxygen in the coordination with central Zn(II) atom.

This is confirmed by the upward shifting of phenolic ν(C-O) band from the region 1307-1311 cm$^{-1}$ in Schiff base spectra to higher wave number by 28-30 cm$^{-1}$ in the metal complexes spectra.

The involvement of ester carbonyl group in the bonding is indicated by the downward shifting of the absorption band in the region 1682-1708 cm$^{-1}$ in the Schiff base spectra due to ν(C=O) to lower wave number region by 38-66 cm$^{-1}$ in the metal complexes spectra.

Further prominent band due to azomethine group 1597-1598 cm$^{-1}$ in the Schiff base spectra is shifted to lower frequency by 19-27 cm$^{-1}$ in metal complexes spectra confirming the involvement of azomethine nitrogen in coordination with zinc atom.

The stretching vibrations due to υ(C=S) band showed no significant change in the complex spectra, indicating non-participation of thiophene sulfur in the coordination.

The presence of the two medium intensity non-ligand band around 511-519 cm$^{-1}$ and 415-432 cm$^{-1}$ due to ν(M-O) and to ν(M-N) stretching vibrations respectively confirms the coordination of phenolic oxygen and azomethine nitrogen atoms with the zinc atom.

The far IR spectra of [Zn(L1)Cl] complex exhibited a non-ligand peak due to ν(M-Cl) at 366 cm$^{-1}$ indicating coordination of chlorine atoms to the metal ion.

In the zinc complex electronic spectra, the π→π* transitions were slightly red-shifted **Fig. 1**

compared to Schiff base spectra indicating the coordination of ligand to the zinc atom with no change in the structural arrangement of ligand [18]. The Zn(II) complexes are diamagnetic with $d^{10}$ configuration and do not show any d-d transitions, hence the tetrahedral geometry of the ligand molecules around Zn(II) can be proposed [19].

On the basis of FTIR, elemental analysis, molar conductance, electronic spectra and magnetic susceptibility, the proposed structures of the Zn(II) complexes are shown in **Fig 2**.

**Antimicrobial Activity:** For the evaluation of the antimicrobial activity of all zinc complexes, Kirby Bauer method was employed using gram-negative uropathogens [ESBL and MBL strains]. Multidrug resistance profile of these uropathogens against mainline drugs is shown in **Table 3**. The antimicrobial activity against these multidrug resistance uropathogens using DMSO as a solvent is depicted in **Table 4**. Schiff bases exhibited antimicrobial activity against isolate Ec-10, Kp-7 85 and 135, while zinc complexes showed antimicrobial activity against all the test isolates. In addition, Schiff bases $HL_2$ and $HL_3$ were also sensitive against uropathogen 220 and Schiff base $HL_3$ against isolate - 618. All other isolates were resistant to Schiff bases but their metal complexes exhibited higher zones of inhibition (10-18.5 mm). Schiff base $HL_3$ and $HL_2$ exhibited higher zones of inhibition while isolate-135 was the most sensitive (14-18.5 mm) among all test isolate. The higher antimicrobial activity of zinc complex can be liked to chelate formation. As per chelation theory and cell permeability concept, penetrating power of complex increases with the lipophilicity. In chelate, the positive charge of the metal ion is shared by ligand donor atoms, resulting in π electrons delocalization over the whole chelate ring. This delocalization favors lipophilicity of metal complex through lipid layer allowing easy binding and penetration of the complex in the cellular structure resulting in the growth inhibition or cell death of the pathogens [20].

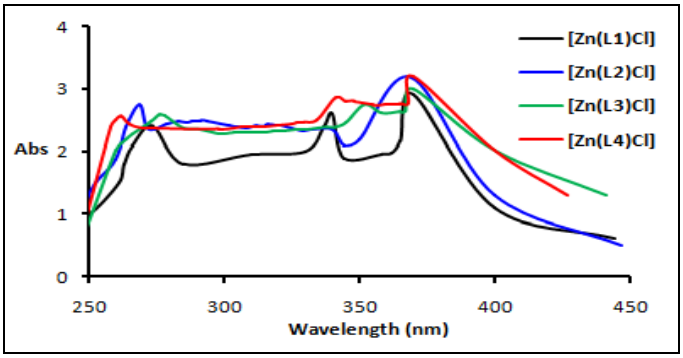


FIG. 1: ELECTRONIC SPECTRUM OF Zn(II) COMPLEXES

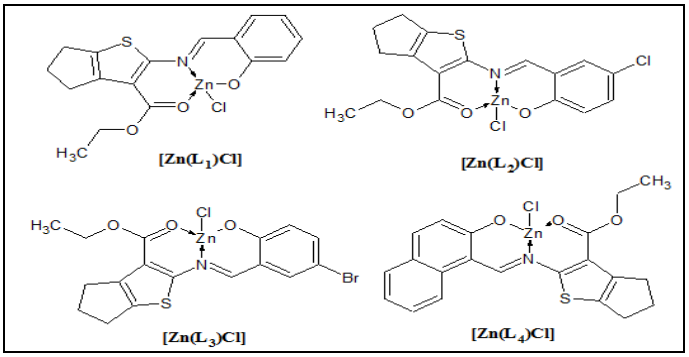


FIG. 2: PROPOSED STRUCTURES OF Zn(II) COMPLEXES

**TABLE 3: ANTIBIOTIC RESISTANCE PROFILE OF ESBL AND MBL PRODUCERS**

| Cultures code name | Full form | Antibiotic sensitivity test | | |
|---|---|---|---|---|
| | | Sensitive | Intermediate | Resistant |
| | | **ESBL Producers** | | |
| Citro-2 | *Citrobacter diversus-2* | AS, BA, CH, RC, TE | CI, CF | CF, PC, ZN, GM, AK, GF, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |
| Ec- 10 | *Escherichia coli- 10* | CH, GM, AK, GF | PB, AS | BA, CF, PC, RC, CI, TE, ZN, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG |
| Kp | *Klebsiella pneumoniae* | GM, AK | - | AS, BA, CF, PC, CH,RC, CI, TE, ZN, GF, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |
| Kp-7 | *Klebsiella pneumoniae- 7* | - | OX, TE | AS, BA, CF, PC, CH,RC, CI, ZN, GM, AK, GF, TT, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |
| Pro- 7 | *Proteus mirabilis- 7* | CP, AS, PC, AK | RP, NA, CF, RC, GM, GF | BA, CH, CI, TE, ZN, TT, OX, ZX, CB, NX, AG, CU, FG, PB |
| | | **MBL Producers** | | |
| 85 | *Pseudomonas aeruginosa* | AK, GF, PB | RC, CF, PC | AS, CI, TE, ZN, GM, TT, OX, RP, ZX, CB, BA, CH, NA, NX, AG, CU, CP, FG, |
| 135 | *Citrobacter* | CH, PB | AK | AS, BA, CF, PC, RC, CI, TE, ZN, GM, GF, |

| | | | | |
|---|---|---|---|---|
| | *amalonaticus* | | | TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, CB, AS |
| 220 | *Escherichia coli* | CH, AK, GF | AS, ZN | BA, CF, PC, RC, CI, TE, GM, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |
| 607 | *Proteus mirabilis* | - | CH, GM | AS, BA, CF, PC, RC, CI, TE, ZN, AK, GF, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |
| 618 | *Klebsiella pneumoniae* | - | - | AS, BA, CF, PC, CH,RC, CI, TE, ZN, GM, AK, GF, TT, OX, RP, ZX, CB, NA, NX, AG, CU, CP, FG, PB |

TT -Ticarcillin/clavulanic acid, OX- Oxytetracycline, RP – Ceftriaxone, ZX - Cefepime, CB - Cefuroxime, NA - Naladixic acid, NX- Norfloxacin, AG - Amoxycillin/clavulanic acid, CU - Cefadroxil,CP - Cefoperazone, FG - Ceftazidime, PB - Polymixin B, AS - Ampicillin, BA - Co-trimaxazole, CF - Cefotaxime, PC- Pipperacillin, CH - Chloramphenicol, RC - Ciprofloxacin, CI - Ceftizoxime, TE - Tetracycline, ZN - Ofloxacin, GM - Gentamicin, AK -Amikacin, GF - Gatifoxacin

**TABLE 4: ANTIMICROBIAL ACTIVITY**

| S. no. | Cultures used | | Zone of Inhibition (mm) of Cu/Zn complex | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DMSO | $HL_1$ | $[Zn(L_1)Cl]$ | $HL_2$ | $[Zn(L_2)Cl]$ | $HL_3$ | $[Zn(L_3)Cl]$ | $HL_4$ | $[Zn(L_4)Cl]$ |
| 1 | Citro-2 | E | 0 | 0 | 13 | 0 | 11 | 0 | 11.5 | 0 | 11.5 |
| 2 | Ec- 10 | S | 0 | 11 | 14 | 11 | 10.5 | 10 | 11 | 10 | 13 |
| 3 | Kp | B | 0 | 0 | 13.5 | 0 | 11.5 | 0 | 11 | 0 | 12 |
| 4 | Kp-7 | L | 0 | 11 | 12 | 12 | 12 | 10 | 13 | 12 | 12 |
| 5 | Pro- 7 | | 0 | 0 | 13 | 0 | 9 | 0 | 10 | 0 | 12 |
| 6 | 85 | M | 0 | 12 | 12 | 15 | 15.5 | 15 | 14.5 | 15 | 15 |
| 7 | 135 | B | 0 | 16 | 18.5 | 17 | 17 | 15 | 18 | 15 | 15 |
| 8 | 220 | L | 0 | 0 | 12.5 | 11 | 11 | 11 | 10 | 0 | 10 |
| 9 | 607 | | 0 | 0 | 14 | 0 | 10.5 | 0 | 11 | 0 | 10.5 |
| 10 | 618 | | 0 | 0 | 13 | 0 | 11 | 10 | 11 | 0 | 11 |

**Antitubercular Activity:** Antitubercular activity against *M. tuberculosis* (H37Rv) was evaluated using Microplate Alamar Blue Assay (MABA) method. pyrazinamide, ciprofloxacin and strepto-mycin were used as standard drugs **Fig. 3** and **Table 5**. For the determination of MICs (Minimum Inhibitory Concentration) the lowest concentration at which a pink color was changed to blue color was considered.

All Schiff bases exhibited similar antimicrobial activity at MIC of 25.0 µg/mL. The activity of Schiff base may be attributed to the presence of azomethine bridging with substituted aromatic aldehydes and thiophene heterocyclic ring in the ligand structure. Only two zinc complexes ($[Zn(L_2)Cl]$ and $[Zn(L_3)Cl]$) have displayed enhanced anti-tubercular activity (MIC = 12.5 µg/mL) compared to parent ligand.

This improved activity of zinc complex is the effect of chelation due to which amphiphilic nature of the complex increases resulting in deeper penetration of metal complex into the test isolates leading to growth restriction [21].

**TABLE 5: ANTITUBERCULAR ACTIVITY OF SCHIFF BASES AND ZINC COMPLEXES**

| Test compound | MIC (µg/ml) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100 | 50 | 25 | 12.5 | 6.25 | 3.12 | 1.60 | 0.80 |
| $HL_1$ | S | S | S | R | R | R | R | R |
| $HL_2$ | S | S | S | R | R | R | R | R |
| $HL_3$ | S | S | S | R | R | R | R | R |
| $HL_4$ | S | S | S | R | R | R | R | R |
| $[Zn(L_1)Cl]$ | S | S | S | R | R | R | R | R |
| $[Zn(L_2)Cl]$ | S | S | S | S | R | R | R | R |
| $[Zn(L_3)Cl]$ | S | S | S | S | R | R | R | R |
| $[Zn(L_4)Cl]$ | S | S | S | R | R | R | R | R |
| Streptomycin* | S | S | S | S | S | R | R | R |
| Pyrazinamide* | S | S | S | S | S | S | R | R |
| Ciprofloxacin* | S | S | S | S | S | S | R | R |

* Standard, S - Sensitive, R – Resistant

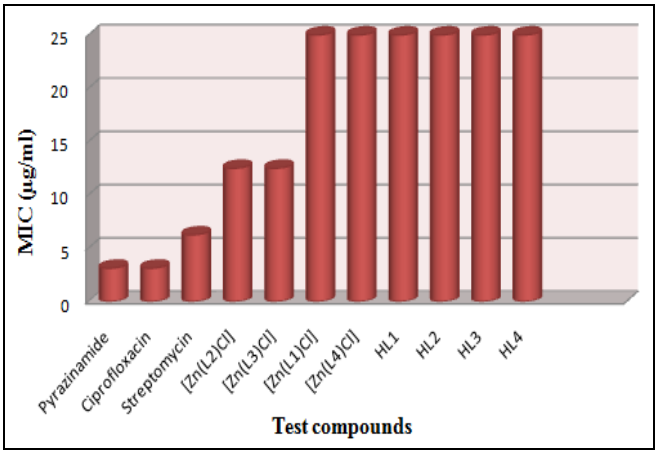


**FIG. 3: ANTITUBERCULAR ACTIVITY PROFILE**

**CONCLUSION:** Zinc (II) metal complexes from Schiff bases were synthesized and characterized. Schiff base ligand coordinated to central zinc atom through carboxylic oxygen, azomethine nitrogen and phenolic oxygen in tridentate fashion. On the basis of the spectroscopic investigation, tetrahedral geometry for Zn(II) complexes was assigned. Zinc complexes showed superior anti-bacterial and anti-tubercular activities compared to parent ligands.

This study may provide a stepping stone for the future development of potential zinc complex from the aminothiophene Schiff bases.

**ACKNOWLEDGEMENT:** The authors are thankful to Dr. Kishore Bhat for providing antiTB activity and Dr. Paresh More for ESR analysis. Authors also wish to thank Dr. Mustapha Mandewale and Dr. Vijay Veer for FTIR spectra.

**CONFLICT OF INTERESTS:** The authors declare that there is no conflict of interests regarding the publication of this paper.

## REFERENCES:

1. Cohen AB: The interaction of α-1-antitrypsin with chymotrypsin, trypsin and elastase. Biochimica et Biophysica Acta (BBA)-Enzymology 1975; 391(1): 193-200.
2. Prakash A and Adhikari D: Application of Schiff bases and their metal complexes-A Review. International Journal of Chemical Technology Research 2011; 3(4): 1891-96.
3. da Silva CM, da Silva DL, Modolo LV, Alves RB, de Resende MA, Martins CV and de Fátima Â: Schiff bases: A short review of their antimicrobial activities. Journal of Advanced research 2011; 2(1): 1-8.
4. Nisha VP, Subhadrambika N, Swathy SS and Mohanan K: Synthesis, spectroscopic characterization, thermal decomposition and antimicrobial studies of manganese (III), iron (III) and cobalt (III) complexes with Schiff base derived from thiophene-2-carboxaldehyde and 2-amino-benzoic acid. Journal of the Indian Chemical Society 2012; 89(6): 761-70.
5. Gubler CJ, Lahey ME, Cartwright GE and Wintrobe MM: Studies on copper metabolism. IX. The transportation of copper in blood. Journal of Clinical Investigation 1953; 32: 405.
6. Frassinetti S, Bronzetti GL, Caltavuturo L, Cini M and Della Croce C: The role of zinc in life: a review. Journal of Environmental Pathology, Toxicology and Oncology 2006; 25(3): 597-610.
7. Bitanihirwe BK and Cunningham MG: Zinc: the brain's dark horse. Synapse 2009; 63(11): 1029-49.
8. Behzadi P, Behzadi E, Yazdanbod H, Aghapour R, Cheshmeh MA and Omran DS: A survey on urinary tract infections associated with the three most common uropathogenic bacteria. Maedica 2010; 5(2): 111.
9. Ejrnæs K: Bacterial characteristics of importance for recurrent urinary tract infections caused by *Escherichia coli*. Dan Med Bull 2011; 58(4): B4187.
10. Tajbakhsh E, Tajbakhsh S and Khamesipour F: Isolation and molecular detection of gram negative bacteria causing Urinary Tract Infection in patients referred to Shahrekord Hospitals Iran. Iranian Red Crescent Medical Journal 2015; 17(5).
11. Latifpour M, Gholipour A and Damavandi MS: Prevalence of extended-spectrum beta-lactamase-producing *Klebsiella pneumoniae* isolates in nosocomial and community-acquired urinary tract infections. Jundishapur Journal of Microbiology 2016; 9(3).
12. Bending the curve - ending TB: Annual report 2017. India: World Health Organization, Regional Office for South-East Asia; 2017.
13. More G, Raut D, Aruna K and Bootwala S: Synthesis, spectroscopic characterization and antimicrobial activity evaluation of new tridentate Schiff bases and their Co(II) complexes. Journal of Saudi Chemical Society 2017; DOI: https://doi.org/10.1016/j.jscs.2017.05.002
14. Vogel AI: Vogel's, Text Book of Quantitative Inorganic Analysis, Longman, New York, Edition 5, 1989; 454.
15. Mobashshera T and Aruna K: Phenotypic and Molecular characterization of MBL genes among uropathogens isolated in Mumbai city. British Microbiology Research Journal 2015; 5(4): 368.
16. Aruna K, Tariq M, Bootwala S and More G: Cadmium and mercury complexes of a Schiff base ligand: Synthesis, spectral characterization, thermal and antimicrobial properties. International Journal of Pharmaceutical Research and Bio-Science 2014; 5: 222.
17. Lourenço MC, de Souza MV, Pinheiro AC, Ferreira MDL, Gonçalves RS, Nogueira TCM and Peralta MA: Evaluation of anti-tubercular activity of nicotinic and isoniazid analogues. Arkivoc 2007; 15: 181-91.
18. Aruna K Tariq M Bootwala S and More G: Palladium and platinum complexes of 2-amino-N'-[(1E,2Z)-2-(hydroxy-imino)-1-phenylethylidene]-4,5,6,7-tetrahydro-1 benzothio phene-3-carbohydrazide: synthesis, structure, spectral properties and antimicrobial activity. World Journal of Pharmacy and Pharmaceutical Sciences 2014; 3(10): 784-93.
19. Bootwala SZ: Synthesis, Spectroscopic Characterization and thermal study of some transition metal complexes of 2-Amino-N'-[(1E, 2Z)-2-(hydroxyimino)-1-phenylethylid ene]-4, 5, 6, 7-tetrahydro-1-benzothiophene-3-carbohydra zide. Asian Journal of Chemistry 2012; 24(9): 3849.
20. Bajju GD, Sharma P, Kapahi A, Bhagat M, Kundan S and Gupta D: Oxovanadium (IV) complexes with nitrogen donors: synthesis, characterisation, and Biological

activities. Journal of Inorganic Chemistry 2013; DOI: http://dx.doi.org/10.1155/2013/982965

21. Mandewale MC, Kokate S, Thorat B, Sawant S and Yamgar R: Zinc complexes of hydrazone derivatives bearing 3, 4-dihydroquinolin-2 (1H)-one nucleus as new anti-tubercular agents. Arabian Journal of Chemistry 2016. DOI: http://dx.doi.org/10.1016/j.arabjc.2016.07.016

**How to cite this article:**
More G, Bootwala S, Shenoy S, Mascarenhas J and Aruna K: Anti-microbial and anti-tubercular activity evaluation of newly synthesized zinc complexes of aminothiophene Schiff bases. Int J Pharm Sci & Res 2018; 9(7): 3029-35. doi: 10.13040/IJPSR.0975-8232.9(7).3029-35.