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Antibacterial Evaluation and synthesis of Zn(II), Cd(II) and Hg(II) Metal Complexes

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By using elemental analysis, molar conductance, IR, NMR, and electronic spectrum data, a number of organic compounds and their Zn(II), Cd(II), and Hg(II) metal complexes have been created and described. Using the agar-well diffusion method, these compounds were tested for antibacterial activity against the bacteria *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella typhi*. All of the synthetic compounds have demonstrated good antibacterial and/or antifungal activity, which was typically enhanced upon complexation with metal ions.

Keywords: Antimicrobial, ligands, metal complexes, synthesis

INTRODUCTION

The introduction of the term “antibiotics” was the result of pioneering work by American microbiologist Selman Waksman and his team, who successfully isolated chemical substances from microorganisms capable of inhibiting the growth of other microbes (Clardy, 2009). An antimicrobial chemical that is effective against bacteria is called an antibiotic. It is the most significant class of antibacterial agent against bacterial infections, and antibiotic drugs are commonly used to treat and prevent these diseases. The illness that causes tuberculosis is caused by the bacteria *Mycobacterium tuberculae*, which is transmitted from person to person through the air. Combination therapy is widely used to treat tuberculosis (TB) efficiently (Menzies, 2011). As pharmacological agents can function to inactivate the cell walls of antibiotics, antibiotic resistance has existed for as long as antibiotics have been used clinically. Studies indicate that the molecular alteration of antibiotics could limit or restrict penicillinases’ (β-lactamases’) cleavage (D’Costa, 2006).

In the field of contemporary pharmacy, antibiotic-metal complexes (AMC) are becoming more and more significant. Since antibiotic resistance is associated with high rates of illness and mortality, it has emerged as a worldwide health concern. Due to multidrug resistance, it became more difficult to treat infections caused by Gram-positive and Gram-negative bacteria that could not be resolved with conventional antibiotics. Both before and after the invention of antibiotics, Clinical practice antibiotic efficacy has been severely impacted by resistance (Velez, 2016). Metal ion-containing antimicrobial compounds show great potential in this area. The only antituberculosis drugs available for treating tuberculosis are pills, capsules, liquids, and injectables (Harries, 2002). *Mycobacterium tuberculae*, the bacteria that causes tuberculosis, travels from person to person through the air. An antibiotic is a chemical or substance that stops the development of bacteria. 6 drug combinations are frequently used to effectively treat tuberculosis (TB) (Menzies, 2011). Only pills, capsules, liquids, and injectable antituberculosis medications are readily available to treat tuberculosis. In their many subgroups, sulfonamides exhibit antibacterial, insulin-releasing anti-diabetic, carbonic anhydrase inhibitory, high-roof diuretic, and antithyroid effects (Harries, 2002).

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MATERIALS AND METHODS

The following are the various tools, procedures, glassware, solvents, reagents, and techniques utilised in the production of sulfonamide compounds:

❖Bruker advance 300 MHz NMR

❖Perkin Elmer100 FT-IR spectrophotometer

❖Agilent 1100 MCD trap-5C Mass spectrometer

❖Digisun conductivity meter, DI 909 model

❖Perkin Elmer UV-Vis spectrophotometer. U.V lamp

Methodology

Synthesis of the Complexes

4-(2-Hydroxybenzylidene)amino) benzenesulfonamide [HBABS]

1.72 g (0.01 mol) of 4-aminobenzenesulfonamide (Merck) broke up in 100 ml of methanol in a 250 ml round base jar, 1.22 g (0.01 mol) of 2-hydroxy benzaldehyde (SD fine) was included and the substance were refluxed on a water shower for 2 hours. The arrangement, on cooling, gave a yellow hued compound, which was separated and recrystallized from ethanol. Yield (56%), MP:180°C (Li *et al.* 2003; Pandey *et al.* 2003).

4-(Furan-2-ylmethylene) aminobenzene sulfonamide [FMABS]

1.72g (0.01mol) of 4-aminobenzenesulfonamide (Merck) broke down in 100 ml of methanol in a 250 ml round base cup, was included with 0.96g (0.01 mol) of furan-2-carbaldehyde (Fluka) . The arrangement was refluxed on a water shower for 3 hours. The compound isolated was separated and recrystallized from methanol to give a dark hued strong. Yield (62%), MP:130°C.

4-(Thiophene-2-ylmethylene)amino benzenesulfonamide [TMABS]

1.72g (0.01mol) of 4-aminobenzenesulfonamide (Merck) disintegrated in 100 ml of methanol in a 250 ml round base cup, 1.22 g (0.01 mol) of thiophene-2-carbaldehyde (Fluka) was included. The arrangement was refluxed on a water shower for 3 hours. The compound isolated was separated and recrystallized from methanol to give a light yellow shaded strong. Yield(82%), MP: 140°C (Chen *et al.* 2000).

(Thiophen-2-ylmethylidinene) pyridine-4-carbohydrazide [TMPCH]

1.23g (0.01m) of pyridine-4-carbohydrazide (Finar) disintegrated in 100 ml of methanol in a 250 ml round base cup, 1.22 g (0.01 mol) of thiophene - 2-carbaldehyde (Fluka) was included. The arrangement was refluxed on a water shower for 3 hours. The compound isolated was sifted and recrystallized from methanol to give a light yellow shaded strong. Yield (86%), MP: 130°C.

(Thiophen-2-ylmethylidinene) pyrazine-2-carboxamide [TMPCA]

1.24g of pyrazinamide (Hi media) in 100 ml of ethanol in a 250 ml round base carafe was included with 1.12 g (0.01mol) of thiophene-2-carbaldehyde. The substances were refluxed on a water shower for 2 hours. The compound isolated was separated and recrystallized from methanol to give a light yellow shaded solid. Yield (68%), MP:178-180°C (Brown, 2002).

Arrangement of the Metal Complexes

The Zn(II), Cd(II) and Hg(II) buildings with all the ligands were readied and utilized.

Zn(II) buildings

An aliqout of the ligand in hot methanol was included gradually, with mixing, to $Zn(OAc)_2.2H_2O$ arrangement in methanol and the blend was refluxed on a high temp water shower. It was concentrated compelled to two-third the first volume and cooled. The strong that isolated out was separated, washed with water, hot methanol and ether and was vacuum dried over melded $CaCl_2$.

Cd(II) edifices

An aliquot of the ligand in hot methanol was

included gradually, with blending, to $Cd(OAc)_2.2H_2O$ in methanol and the blend was refluxed on a high temp water shower. It was concentrated compelled to two-third the first volume and cooled. The strong that isolated out was sifted, washed with water, hot methanol and ether and was vacuum dried over intertwined $CaCl_2$.

Hg(II) edifices

To a fluid methanolic arrangement of mercuric chloride ($HgCl_2.2H_2O$), a hot methanolic arrangement of the ligand was included gradually with blending. The blend was refluxed on a boiling water shower. It was concentrated compelled to two-third the first volume and cooled. The strong that isolated out was separated, washed with water, hot methanol and ether and was vacuum dried over combined $CaCl_2$.

Antimicrobial Screening Procedure

A grouping of 5 mg/mL of each compound was set up in DMSO that had no impact on the microbial development. Bacterial species: The accompanying Gram +ve and Gram – ve culture of human pathogens were utilized to test the antibacterial movement of the mixes.

Gram + ve	:	*Staphylococcus aureus and Bacillus subtilis*
Gram –ve	:	*Salmonella typhi* and *Escherichia coli*

Agar cup plate technique

Antibacterial activity was determined by agar cup plate technique (Desta, 2005).A normalized 1 to 2 x 107 cfu/ml 0.5 MC Furland standard was presented onto the outside of a sterile agar plate and equitably circulated inoculums by utilizing a sterile glass spreader. All the while, 6 mm wells were cut from the plate utilizing a sterile plug borer. 80 ml arrangement at a grouping of 5 mg/ml of the mixes was presented vigorously at 37 ^oC. After 24 hrs, the hindrance zones were estimated with a ruler and contrasted and the control well containing just DMSO and 5 mg/ml of streptomycin as the norm.

RESULTS AND DISCUSSION

In the present study, 4-aminobenzene sulfonamide has been condensed with 2-hydroxy-benzaldehyde, furan-2-carbaldehyde and thiophene-2-carbaldehyde; pyridine-4-carbo hydrazide with thiophene-2-carbaldehyde and pyrazine-2-carboxamide with thiophene-2-carbaldehyde and the accompanying Schiff base ligands acquired and portrayed as below:

4-((2-Hydroxybenzylidene)amino) benzenesulfonamide (HBABS) (Fig. 1)
4-((Furan-2-ylmethylene)amino) benzenesulfonamide (FMABS) (Fig. 2)
4-((Thiophen-2-ylmethylene)amino) benzenesulfonamide (TMABS) (Fig. 3)
N -(Thiophen-2-yl-methylidene)- pyridine-4-carbohydrazide (TMPCH) (Fig. 4)
N-(Thiophen-2-ylmethylidene)- pyrazine-2-carboxamide(TMPCA) (Fig. 5)

The Zn(II), Cd(II), and Hg(II) edifices of these Schiff base ligands have been created and generally described on the basis of fundamental research, conductance, warm, attractive, infrared, electronic, and ESR ghostly data. Relevant conclusions about the geometry of the structures have been made in light of the knowledge gained. The designer integrated and depicted metal Schiff base structures built of sulfonamide, carbohydrazide, pyrazinamide, and other aldehydes because of the relevance of this class of aggressors. In preparation for the testing, the ligands and a portion of their metal structures that have been created for organic action have been screened. In the current study, thiophene-2-carbaldehyde, pyridine-4-carbohydrazide, pyrazine-2-carboxamide, and the associated Schiff base ligands were condensed using 4-aminobenzenesulfonamide. These reactions were identified and shown in Figs. 1-5.

The Zn(II), Cd(II), and Hg(II) structures of these Schiff base ligands have been built and broadly described based on fundamental research, conductance, warm, attractive, and infrared data, electronic data, and ghostly ESR results. On the basis of the knowledge gained, pertinent deductions concerning the geometry of the structures have been made. All of the ligands are

stable and non-hygroscopic at room temperature. They are somewhat soluble in methanol and $(CH_3)_2CO$ and truly solvent in hot methanol and dimethylformamide. They are insoluble in water. The ligands have been described horrifyingly by investigative, mass, ^1H NMR, and IR data.

Antimicrobial activities

The inhibition properties of the complexes were evaluated at different concentration against *Salmonella typhi*, *Staphylococcus aureus*, *Bacillus subtillus*, and *Escherichia coli* and results are represented as MIC values (Fig 6). Against the bacterial strains, MIC values lies between 0.0426 – 0.0659 µmol/mL. There are previous reports of antimicrobial activities of metal complexes and ligands (Santos *et al*. 2014; Pasder *et al*. 2017).

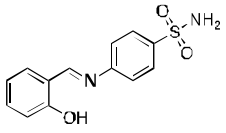

Fig. 1. 4-((2 Hydroxybenzylidene)amino)benzenesulfonamide (HBABS)

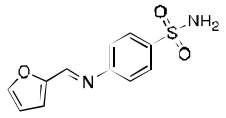

Fig. 2. 4-((Furan-2-ylmethylene)amino)benzenesulfonamide (FMABS)

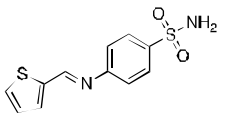

Fig. 3. 4-((Thiophen-2-ylmethylene)amino)benzenesulfonamide (TMABS)

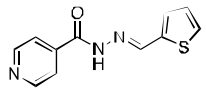

Fig. 4. N'-(Thiophen-2-yl-methylidene)- pyridine-4-carbohydrazide (TMPCH)

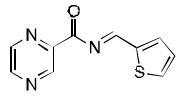

Fig. 5. N-(Thiophen-2-ylmethylidene)- pyrazine-2-carboxamide (TMPCA)

CONCLUSION

The structures of Zn(II), Cd(II), and Hg(II) complexes with five different compounds have been represented using distinct physico-substance information. Transition metals Zn(II), Cd(II), and Hg(II) have been combined with mixed ligands to form complexes. Infrared spectroscopy, electric conductivity, melting point, and solubility are used to characterise the complexes in various ways. The antibacterial activity of the complexes was directed against *Salmonella typhi*, *Staphylococcus aureus*, *Basillus subtilis*, and *Escherichia coli*.

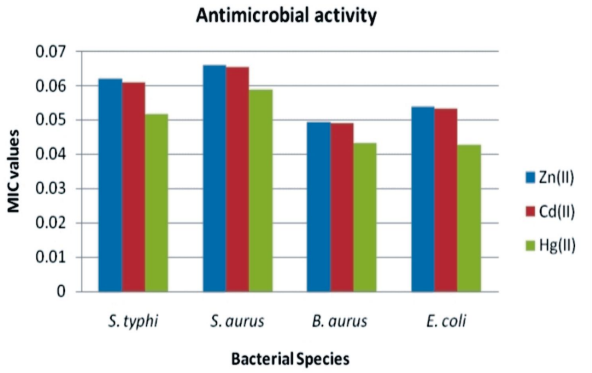

Fig. 6 . Antibacterial activities of metal complexes against different bacteria species.

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DECLARATION

Conflict of Interet. Authors declare no conflict of interest.

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