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Efficient Synthesis of some benign Schiff's base Metal Complexes and their Anti-microbial activities

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ABSTRACT

In a more environmentally friendly procedure than the standard one, a Schiff base and its transition metal complexes of Ni^{2+}, Zn^{2+}, and Cu^{2+} were produced. Through elemental and spectroscopic investigations, the structures of novel compounds have been identified and clarified. Schiff bases with a functional group of imines or Azomethine (-C=N-) are flexible Pharmacophores. Due to their extensive uses in Pharmacology as Anti-viral, Anti-bacterial, Anti-fungal, Anti-malarial, Anti-tuberculosis, Anti-cancer, and Anti-HIV agents. Schiff base metal Complexes for the treatment of several diseases that are challenging to treat with previously used conventional methods. We focus on the Six compounds with Cu^{2+}, Zn^{2+}, Ni^{2+} content that have antimicrobial action against both gram-positive and gram-negative bacteria. None of these complexes have previously been reported. **Novelty:** The coordination of metal complexes with Streptomycin Drug (1000 mg/ml) creates a technique for the synthesized of novel drugs while also improving the activity of presently used Streptomycin. Current work Supports that Using Conventional new Solvent free Grinding & Using Solvent use Staring Method. These complexes might make it possible to lower the dosage of medication that is given to the body.

INTRODUCTION

Development of non-hazardous synthetic methodologies for organic synthesis is one of the latest challenges to organic chemists [1]. Metal Complexes Have a higher position in medicinal chemistry [2]. Metal Complexes and metal Ligand interactions have historically [3]. played a foundational role in many branches of chemistry beyond continue to be important in diverse research areas ranging from bioinorganic chemistry to molecular framework material to small molecule catalysis [4]. The advancement of Schiff base-metal complexes into Clinical trials has boosted the complexes recognition as metal-based medications in the pharmaceutical industry and encourages continued study in this new field [5]. Schiff bases generated from many sources, as well as their metal complexes, have antibacterial, antifungal, anticancer, and antiviral properties [6]. make them useful as therapeutic agents [7] for diseases like cancer, inflammation, and allergies [8]. The imine Group [-C=N-] in Schiff bases provides a distinct function in generating these molecules with wide biological activity [9]. Conventional synthesis is regarded as one of the most important [10] branches of green chemistry. Conventional reactions under free or less solvent conditions [11] are visually appealing, with little pollution, cheap cost, and great productivity, as well as simplicity of processing and handling. Multivalent Schiff base ligands easily form complexes with bidentate, tridentate, and tetra or polydentate metal ions at different oxidation states. Donor atoms (N, O, S) can be found in bidentate ligand (NN or ON), tridentate ligands (NNN, ONO, NNS or ONS), and tetradentate ligands (ONNO, NNNN, NSNO). Many metals ion Schiff base Complexes have a high catalytic activity. In process including oxidation, hydroxylation, aldol condensation and epoxidation, chiral Schiff base complexes are more selective [12]. To The Best of our Knowledge, neither a Solvent-free method [13] nor a microwave method has ever been used to report on this type of system in the Article. Metal-organic frameworks (MOFs) have been widely [14] employed in recent decades in the synthesis of organic and organometallic materials. In this study, Schiff bases were chosen as a continuation of our work on the use of various green chemistry [15] tools in the synthesis of

new compounds [16] because their compounds have the ability to interact with DNA [17] and act as anti-bacterial [18] anti-fungal, anti-cancer, and antioxidants as well as having many other uses as catalysts, polymers, and dyes. In our research, we tested these substances against diverse bacteria strains.

Materials & Methods

Benzaldehyde, Aniline, Methanol, Ethanol, DMSO, DMF, $NiSO_4.6H_2O$, $CuSO_4.5H_2O$, $ZnSO_4.6H_2O$ Were acquired from with high purity Sigma Aldrich Company.

Methods

Synthesis of Schiff base

The Schiff base were prepared by mixing equimolecular amounts of Aniline (10 mmol) and Bezaldehyde (10 mmol), add 4-6 drops of the Lemon juice. Lemon juice acts as acid catalyst. The mixture was added and the continues string 30 min at a room temperature. The product will be getting the solid form there will be a filter the product and drying and crystallized from absolute ethanol. The yield appearance of complexes and melting point are Recoreded.

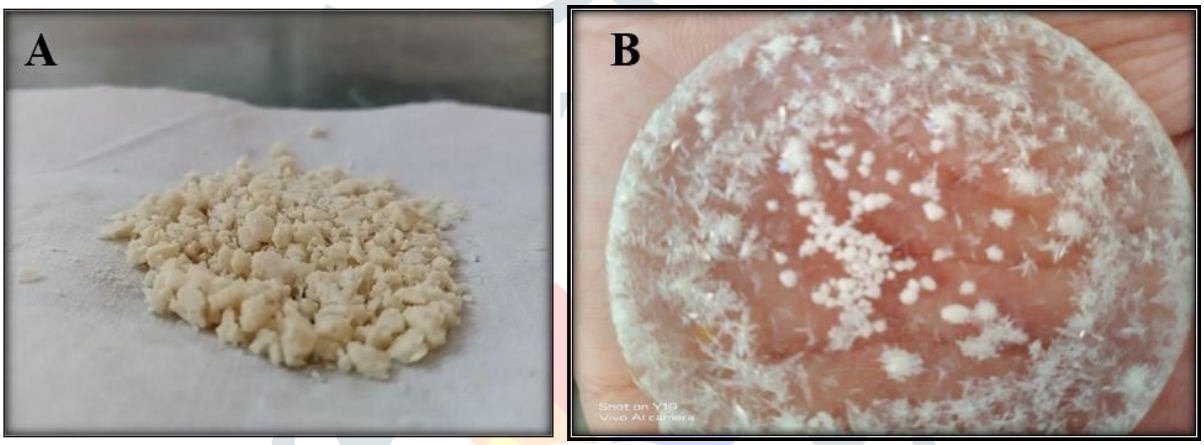


Figure 1: (A) Schiff base Using Acid Catalyst, (B) Crystallization of Schiff base

- Schiff base metal complexes using solvent method.

From a Cu^{+2}, Zn^{+2}, and Ni^{+2}ion, create a Schiff base metal complex. The Schiff base (1.5 mmol) is Dissolved in ethanol and $NiSO_4.6H_2O$, $CuSO_4.5H_2O$, $ZnSO_4.6H_2O$ (5 mmol) also Dissolved in 15ml ethanol, at a Room temperature. The colors changes immediately. The appropriate metal salt solution is added right away. Then continuous stirring at a room temperature at one hour. The colors changes Precipitation of the Schiff base Metal complex results in the solid compound collection. The complex's yield and aesthetics are noted.

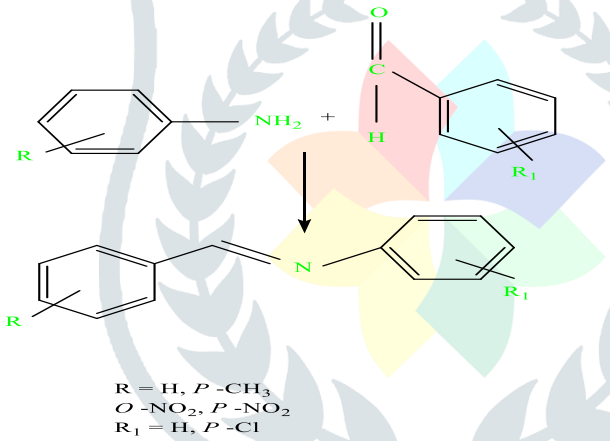
- Schiff base metal complexes using solvent free method.

Using mortar and Pestle, Schiff base (1.5m mol) and Metal sulphate $NiSO_4.6H_2O$, $CuSO_4.5H_2O$, $ZnSO_4.6H_2O$ (5mml) proper Grinding after mixing, Both Solid powders Grinding proper within 10min. The colors changes immediately. The complex's yield and aesthetics are noted.

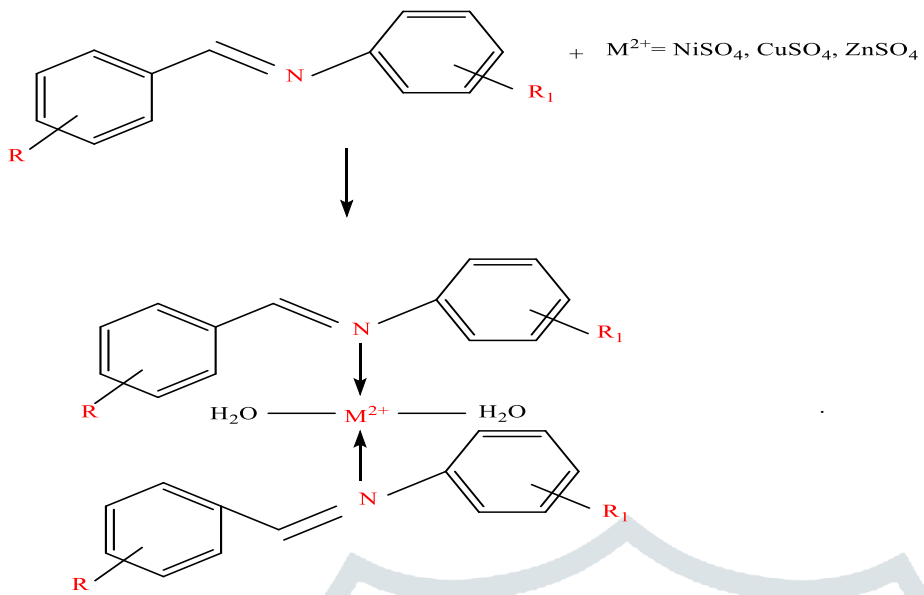
1 2 3 4 5 6 7

Fig.3 Schiff Base and Metal Complexes Compound

1. Zn^{2+} Solvent Free metal complexes
2. Zn^{2+} Solvent used Metal complex
3. Ni^{2+} Solvent Free metal complexes
4. Schiff base
5. Ni^{2+} Solvent used metal complexes
6. Cu^{2+} Solvent free metal complexes
7. Cu^{2+} Solvent used metal complexes



Schiff base Reaction

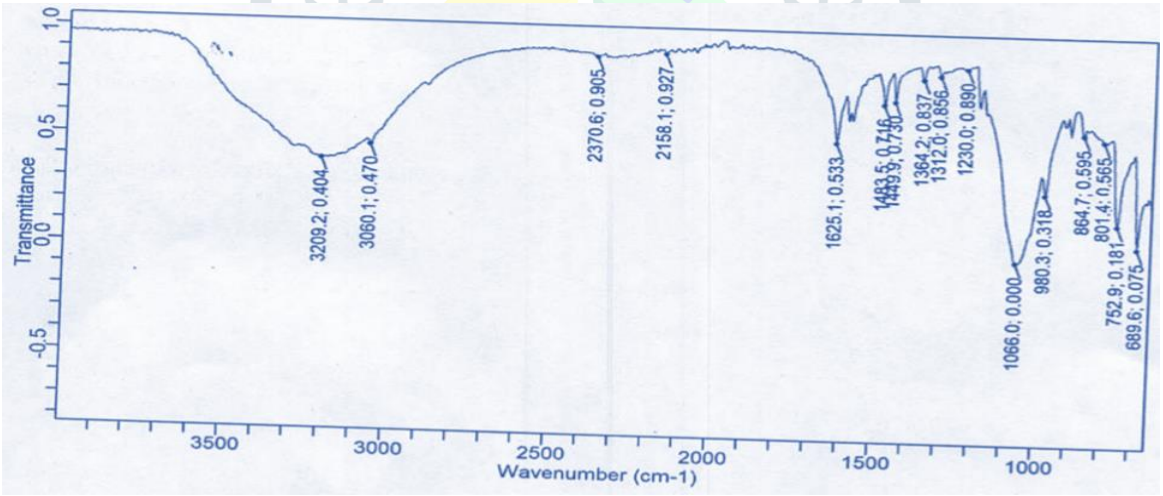


Schiff base Metal Complexes Reaction

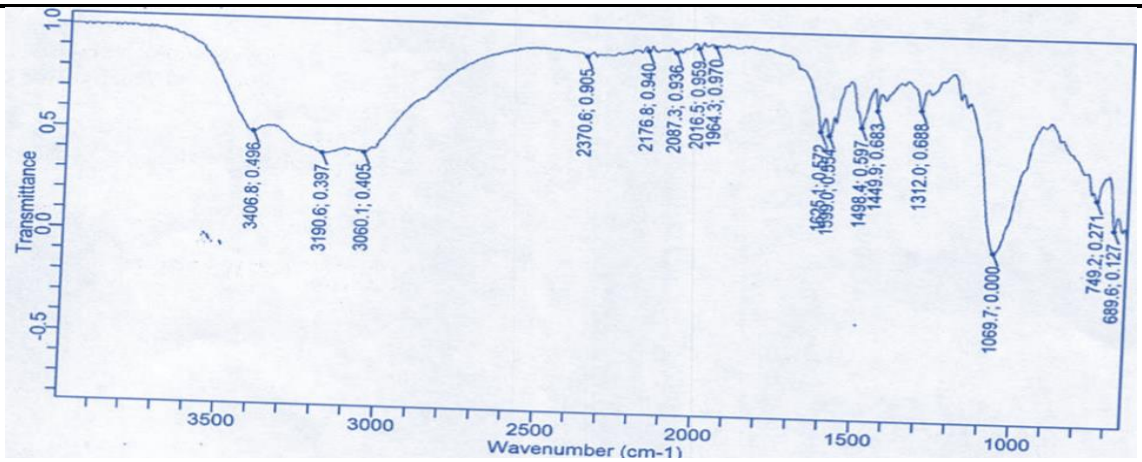
Results and Discussions

The spectral analysis of Schiff base and their complexes have been analyzed by FTIR Spectroscopy.

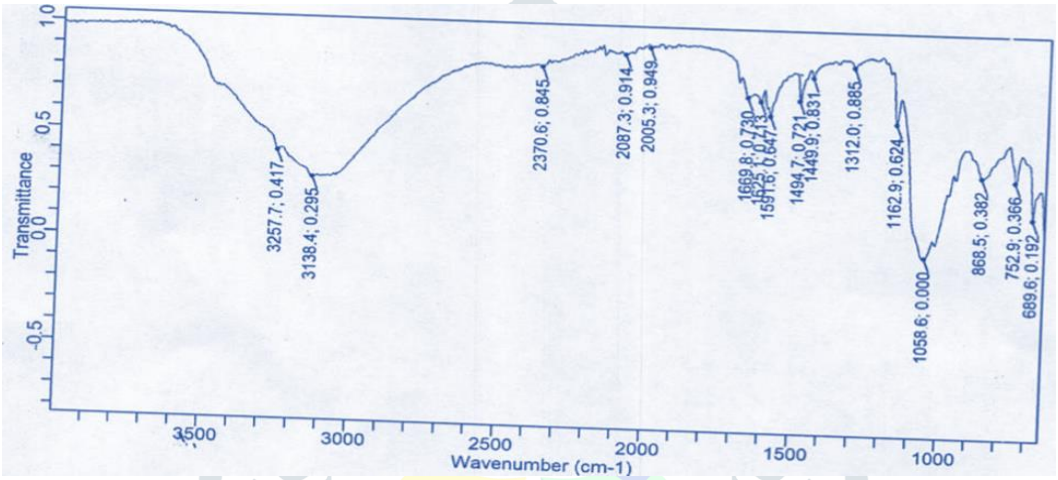
p-benzylideneaniline light yellow color compound, m.p. 110-112 °C**.** IR: 3000 (Ar-CH) Stretching, 1625 (C=N) cm^{-1}.



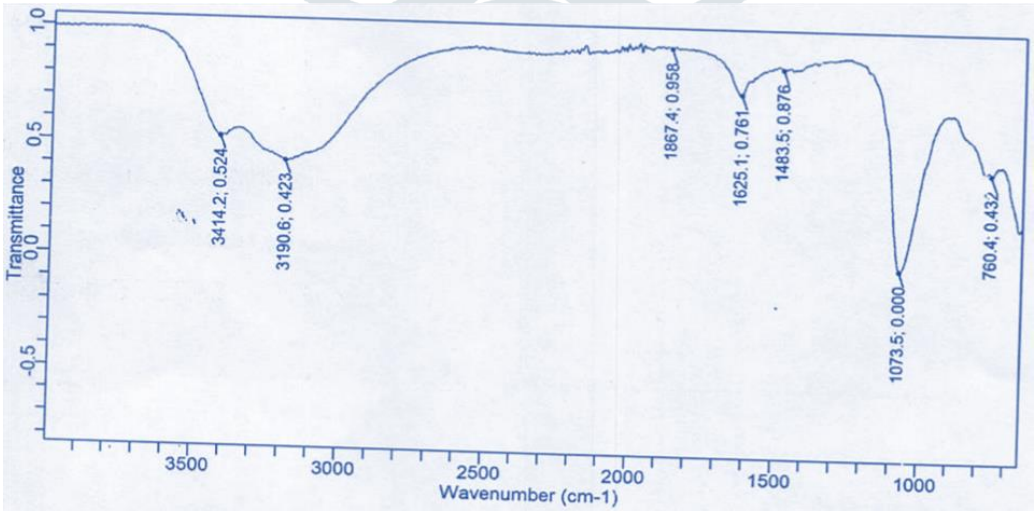
p-tolybenzylamine white color compound, m.p. 130-112 °C**.** IR: 3000 (Ar-CH) Stretching, 2900 (C-H) Stretching, 1636 (C=N) cm^{-1}.

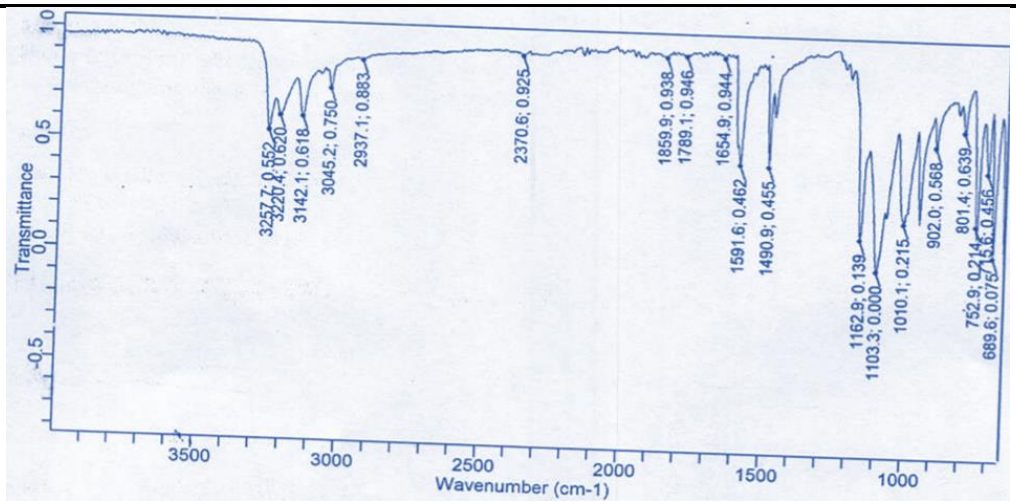


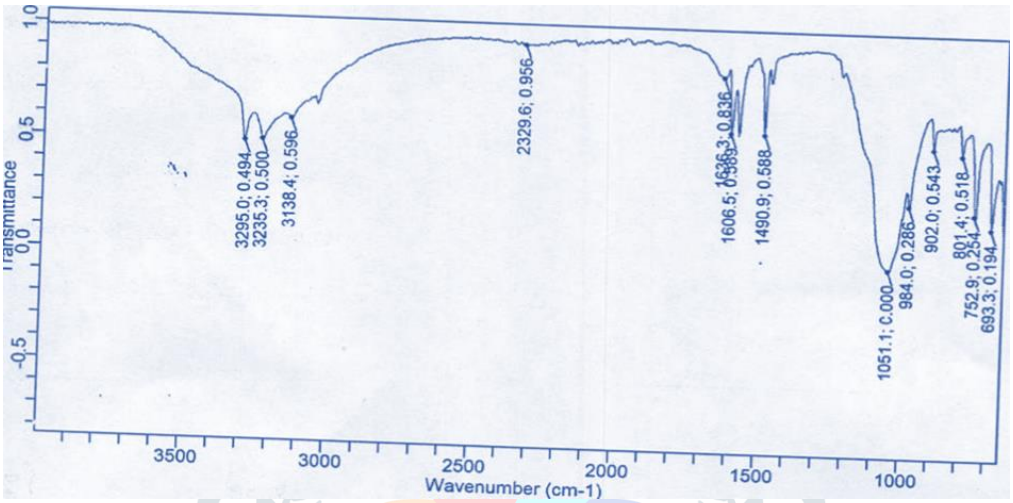
1 nitro-4(1 imino, Orth nitrophenyl) benzene orange color compound, m.p. 170-172 °C**.** IR: 3000 (Ar-CH) Stretching, 1625 (C=N), 1498 (N-O) Stretching cm^{-1}.



p-chlorobenzylidineaniline white color compound, m.p. 158-160 °C**.** IR: 3000 (Ar-CH) Stretching, 1606 (C=N), 752 (C-Cl) Stretching cm^{-1}.







Antimicrobial activity

Table 1 shows the antibacterial and antifungal properties of Schiff bases and their metal complexes. Figure 3 depicts the antibacterial activity as the inhibition zone diameter. The Schiff base is biologically inactive, and its metal complexes, which become more active during chelation, qualify for Tweedy's chelation theory. Due to the positive charge of the metal being partially shared with the nitrogen and oxygen atoms present on the free Schiff base L, the chelation process reduces the polarity of the metal atoms, and there is electron delocalization throughout the entire complex ring. This makes the metal more lipophilic and facilitates its permeabilization via the lipid layers of microbial membranes. Some metal complexes are seen to have poor activity. The low lipophilicity of the metal complex, which reduces its capacity to permeate the lipid membrane, may be to blame for the poor inhibitory performance. Additionally, by disrupting the cell's structural integrity, the bacterium is eliminated. Gram-positive and Gram-negative bacteria are both susceptible to Zn^{2+}, Cu^{2+}, and Ni^{2+} complexes with moderate to high inhibition zone diameters.

Procedure of Testing Antibacterial Activity.

The antibacterial activity of the titled compounds against E. coli, Pseudomonas aeruginosa and Bacillus Subtilis, Bacillus cereus was determined using the diffusion method using solvent (DMSO), The Concentration of the compound in this exposure was (10^{-3} M) by Using disc sensitivity test. The medium was sterilized at 121ºC for 30 minutes. After mixing with distilled water, the nutrient agar was homogeneously dispersed. The entire medium was transferred to the petri plates containing the filter paper discs. The compounds were placed one by one in separate discs of filter paper and left at 37ºC for 24 hours. The complexes properties created definite inhibitory

zones in the shape of circles. Each compound zones were measures in millimeters. Streptomycin was used as the reference medicine when comparing the outcomes of the compounds following the establishment of zones.

Table 1. **Anti-Microbial Activity Analysis of Metal Complexes**

Sr No.	Metal complexes compound	Zone of inhibition in mm Bacterial Strains			
	Concentration Of Compound 100mg/ml	B. subtills	P. aeruginosa	B. cereus	E. coli
1	Cu^{2+}	20	15	18	11
2	Zn^{2+}	19	24	17	16
3	Ni^{2+}	17	18	20	21
4	Standard Drug (Streptomycin 1000mg/ml)	30	31	27	33

Fig 1. **The Anti-Bacterial Activity of Compounds Against E. coil**

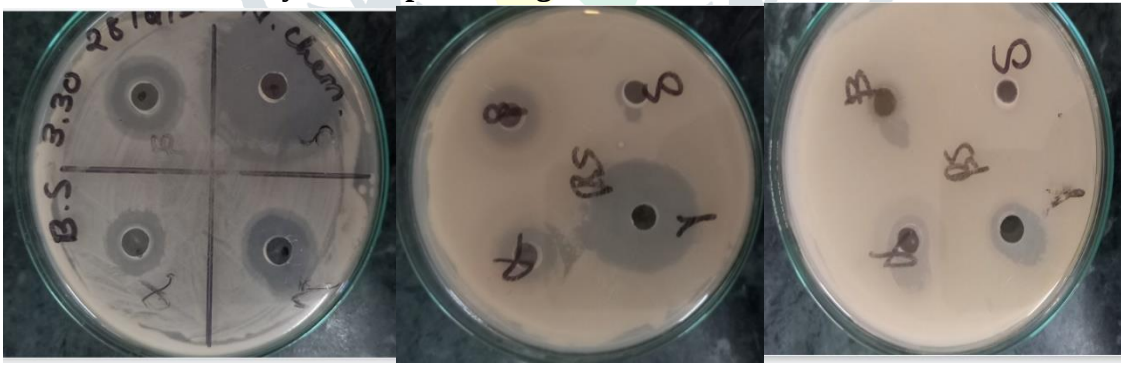


Fig.2 **The Anti-Bacterial Activity of Compounds Against B. subtills**

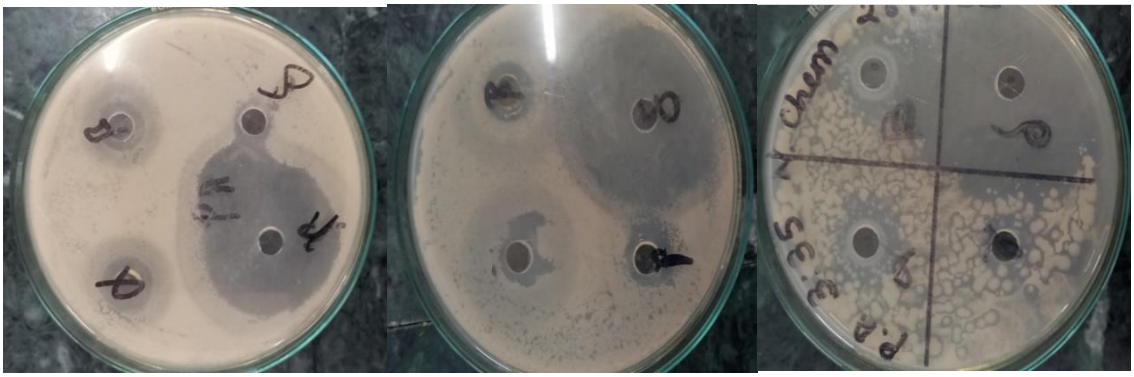


Fig.3 **The Anti-Bacterial Activity of Compounds Against P. aeruginosa**

Fig.4 **The Anti-Bacterial Activity of Compounds Against B. cereus**

Result

The Schiff base and its metal complexes were synthesized using Room Temperature and conventional Grinding. The Schiff base and its metal complexes isolated under Room Temperature conditions have the same physical properties (color, shape, time, condition, yield) as those synthesized using Grinding. A comparison of the yield and time required to prepare the Schiff base and its complexes. The synthesized Schiff base metal complexes were soluble in methanol, acetone, acetonitrile, chloroform, DMF, and DMSO at room temperature and also soluble in hot ethanol. The prepared Schiff base and its metal complexes are stable at room temperature.

Table 2. Yield, Reaction Time, Physical properties, Reaction Condition Solvent based Complexes

Schiff base Solvent Use Metal Complexes

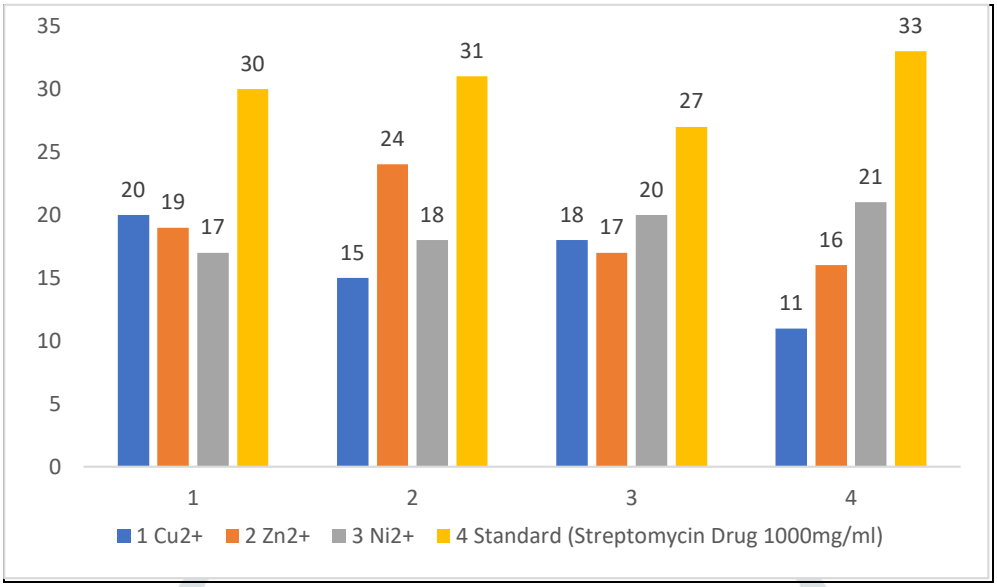
Sr. No	Condition	Name of Metal	Time	Color	Yield %	Solvent
1	Room Temp Staring	Cu^{2+}	60 min	Green	80	Ethanol
2	Room Temp Staring	Zn^{2+}	60 min	White	74	Ethanol
3	Room Temp Staring	Ni^{2+}	60 min	Blue	78	Ethanol

Table 3. Yield, Reaction Time, Physical properties, Reaction Condition Solvent Free Complexes

Schiff base without Solvent Use Metal Complexes

Sr. No	Condition	Name of Metal	Color	Time	Yield %
1	Grinding	Cu^{2+}	Dark Green	10 min	94
2	Grinding	Zn^{2+}	Off White	15 min	87
3	Grinding	Ni^{2+}	Blue	20 min	91

Inhibition diameter of metal complexes against gram positive & gram-negative bacteria



CONCLUSION

This Article Involved Preparation of Schiff base, and their new metal complexes of Ni (II),Zn(II), and Cu (II) incorporating Schiff base were synthesized using conventional condition method. It was demonstrated by the antibacterial activity of Schiff bae and its metal complexes against bacterial strains that Schiff base metal complexes is physiologically active. Metal complexes, which are more active upon, are inactive Chelation is attributed to Tweedy's chelation theory. Antimicrobial agents with a moderate to strong inhibition zone diameter are Cu^{2+}, Ni^{2+}, and Zn^{2+} complexes exhibited the maximum activity against streptomycin as a reference drug. Further Studies on the Anti-Cancer and Anti-Tuberculosis activity of these complexes are planned in future.

REFRENCES

[1] S. Patil, S.D. Jadhav, U.P. Patil, Natural acid catalyzed synthesis of Schiff base under solvent free condition: As a green approach, *Archives of Applied Science Research, 2012 4(2),1074-1078.*

[2] K. HariPrasath, B. Deepthi, I. Sdheer Babu, P. Venkatesh, S. Sharfuddin, V. Soumya, Metal complexes in drug Research, Journal of Chemical and Pharmaceutical Research., 2010, 2(4):496-499.

[3] S.M. Wilkinson, T.M. Sheedy, Elizabeth J. New, Synthesis and Characterization Of Metal Complexes with Schiff Base Ligands, Journal Of Chemical Education, 2015 93(2), 351-354.

[4] C. Boulechfar, H. Ferkous, A. Delimi, A. Djedouani, A. Kahlouche, A. Boublia, A.S. Darwish, T. Lemaouti, R. Verma, Y. Benguerba, Schiff bases and their metal Complexes: A Review on the history, synthesis, and applications, Inorganic Chemistry Communications, 2023, Volume 150, 110451

[5] T. Ashraf, B. Ali, H. Qayyum, M.S. Haroone, G. Shabbir, Pharmacological aspects of Schiff base metal complexes: A critical review, Inorganic Chemistry Communications, 2023, Volume 150, 110449.

[6] M.N. Uddin, S.S. Ahemed, S.M. Rahatul Alam, Biomedical application of Schiff base metal complexes, Journal of Coordination Chemistry, 2020 73(23) 3109-3149.

[7] M.W. Khan, B. Patel, K. Channani, S. Patel, R.P. Mishra, Schiff base complexes as versatile pharmacophores of metallo pharmaceutical interest-A review, International Journal of Research in Engineering and Science, 2021, 9(10) 56-63

[8] J. Agyett and R.A. Richardson, Overview on guide Schiff base complexes and their functionalization *Analyst, 1980, (105), 1118.*

[9] C. Boulechfar, H. Ferkous, A.Delimi, A. Djedouani, A. Kahlouche, A. Boublia, A.S. Darwish, T. Lemoui, R. Verma, Y. Benguerba, Schiff bases and their metal complexes: A review on the history, synthesis, and applications, Inorganic chemistry Communications, 2023(150) 110451.

[10] Ali M. Hassan, A.O. Said, B.H. Heakal, A. Younis, W.M. Aboulthana, M.F. Mady, Green Synthesis Characterization, Antimicrobial and Anticancer Screening of New Metal Complexes Incorporating Schiff base, ACS Omega Journal, 2022, 7, 32418-32431.

[11] A. Younis, Ali. M. Hassan, M.F. Mady, El-Haddad AF, Yassin FA, M. Fayad, Microwave-Assisted One-Pot Synthesis of Novel Polyaryl pyrrole Derivatives of Expected Anticancer Activity, Der Pharma Chemica, 2017, 9(3) 33-44.

[12] K.C. Gupta, A.K. Sutar, Catalytic activities of Schiff base transition metal complexes,

Coordination Chemistry Reviews, 2008(252),1420-1450.

[13] A.M. Hassan, B.H. Heakal, A.O. Said, W.M. Aboulthana, M.A. Abdelmoaz, Comparative Study For Synthesis of Novel Mn (II), Co(II), Ni(II), Cu(II), Zn(II) and Zr(IV) Complexes under Conventional Methods and Microwave Irradiation and Evaluation of their Antimicrobial and Anticancer Activity, Egyptian Journal of Chemistry, 2020, 63, 2533-2550.

[14] A.M. Hassan, A.O. Said, Importance of the Applicability of O-Vanillin Schiff base Complexes: Review, Advanced Journal of Chemistry-Section A, 2021, 4(2),87-103.

[15] A.M. Hassan, A.O. Said, B.H. Heakal, A.Younis, M.A. Abdelmoaz, M.M. Abdrabou, Conventional and microwave-assisted Synthesis, Antimicrobial and Antitumor Studies of Tridentate Schiff Base Derived From O-vanillin and Phenyl Urea and its complexes, Advanced Journal of Chemistry-Section A, 2020, 3(5), 621-638.

[16] K.M. Wahdan, E.S. Zarie, Z.I. Elbialy, Ali.M.H. Wahba, B.H. Heakal, A.O. Said, Antimicrobial and antioxidant evalution of newly synthesized nanomaterial of potential anticorrosion properties based on Co(II), Ni(II), Cu(II), Zn(II) nano complexes of N-(p-methyl phenyl)- N'Benzoyl thiorea, Egyptian Journal of Chemistry,2022, 65, 1253-1268.

[17] M. Vainala, S. Jyothi, S. Shamili, Schiff base metal complexes: Synthesis characterisation, and antibacterial properties, Indian Journal of Chemistry, 2023, 62, 714-719.

[18] M.S. Sinicropi, J. Ceramella, D. lacopetta, A. Catalano, A. Mariconda, C. Rosano, C. Saturnino, H.El-Kashef, P. Longo, Metal Complexes with Schiff Bases: Data Collection and recent studies on biological activities, International Journal of Molecules Sciences, 2022, 23(23) 14840.