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# Synthesis, Spectral Characterization and Antimicrobial activity of two Novel Schiff bases Derived from Thiosemicarbazide and Mononuclear 3d Transition Metal Complexes

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**ABSTRACT**

Schiff bases are aldehyde or ketonic-like compounds in which an imine group replaces the carbonyl group and has been synthesized by condensing primary amines with an active carbonyl compound. Synthesis of two new Schiff base (NE)-N, 2-bis (2-methoxybenzylidene) hydrazine-carbothioamide and (2E)-N, 2-bis (3methoxybenzylidene) hydrazine-carbothioamide by Thiosemicarbazide with 2 methoxy benzaldehyde and 3 methoxy benzaldehyde via a condensation reaction. Metal complexes of synthesized Schiff bases have been synthesized via these Schiff base ligands with different metal ions. ($Cu^{2+}$, $Ni^{2+}$, $Fe^{2+}$, $Co^{2+}$ etc) These compounds have been synthesized by the reflux method and characterized by a Spectroscopic Technique i.e., FT-IR, UV, $^1$H-NMR and Mass (HRMS). The structure of the ligands was clarified by spectral studies which indicate the presence of two or four coordinating groups in ligands. Antimicrobial strain *Bacillus subtilis* fungi *Aspergillus niger* is used for testing the antimicrobial activity. Results also indicate that the metal complexes are expected to be more biologically active as compared to the precursor. The structure of the ligands was clarified by the above spectral studies, which indicates the presence of two or four coordinating groups in ligands.

**Keywords:** Thiosemicarbazide, Schiff base, Benzaldehyde, Antimicrobial activity, Spectroscopic technique.

## INTRODUCTION

Treatment modalities and strategies that utilize the latest antifungal medications are imperative[1]. Over a billion people are affected by fungi worldwide, killing more than 1.5 million. Since metallo-drugs can target multiple pathways to curb drug resistance[2]. They seem worthy of consideration among the various methods being pursued[3]. Sometimes, ligands protect or stabilize the metal ion or the metal by undergoing redox events which enhances the overall efficacy of the complex and sometimes the metal and the ligand(s) are mutually responsible for its biological activity[4]. Schiff bases are compounds containing the azomethine group (-HC=N-). They are condensation products of

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ketones or aldehydes with primary amines and were first reported by Hugo Schiff in 1864[5]. Formation of Schiff base generally takes place under acid or base catalysis or with heat. The common Schiff bases are crystalline solids, which are feebly basic but at least some form insoluble salts with strong acids. Schiff bases derived from Thiosemicarbazide were reported to possess antibacterial[6], antifungal[7], antiviral, antiprotozoal[8], and anthelmintic activities. They also exhibit significant anticonvulsant activity[9], apart from other pharmacological properties, and are used for the preparation of complex compounds[10]. Thiosemicarbazides are frequently used as intermediate compounds in the synthesis of bioactive heterocyclic compounds during several biological and clinical practices[11-12]. The importance of carbazides, carbazones, thiosemicarbazide, and their transition metal complexes has grown in a short period of time because of the discovery of their effects on flu, protozoa, variola (smallpox), certain types of tumors, and fungi[13-14] and their corresponding derivatives thiosemicarbazide are related to several essential antimicrobial activities[15]. Fungicidal, anthelmintic, anti-bacterial, activity[16]. Schiff bases derived from simple thiosemicarbazide and its derivatives are found to be very effective in the field of pharmacology and other imp medicinal fields[17]. Now a day fungal and bacterial infection is very common in every area of human and animal society, by using this simple base complexation makes it possible to overcome diseases induced to measure the biological activities of metal complexes[18], with different transition metals like Co(II), Ni(II), Cu(II), Zn(II), Pb(II), Cd(II) and Ag(I). This type of tactic would conceivably give compounds[19]. With superior biological activity in biochemical research[20]. In prepared Schiff base, one sulfur-containing moiety, the base makes more effective towards microorganisms basically for bacterial and fungal infections[21-22]. We have synthesized a novel series of Schiff base results from thiosemicarbazide[23]. More specifically, in order to better understand the ligand-metal complexation, antimicrobial study studies[24], were used to assess the new molecules the findings demonstrated the important biological potential of these compounds.

## EXPERIMENTAL
## MATERIALS AND METHODS

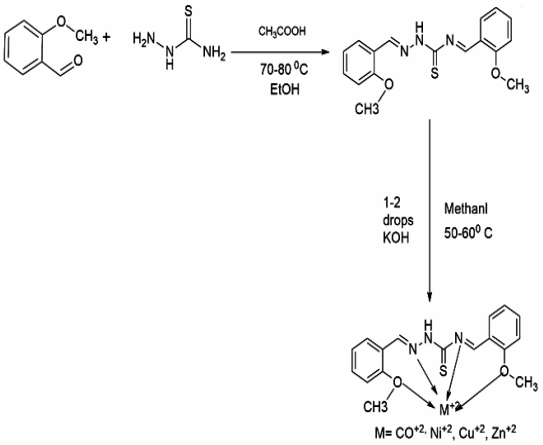
All the reagents and chemicals used for the synthesis were of analytical grade and were purchased from commercial sources. They were used as received without further purification both aldehydes and thiosemicarbazide were purchased from Fluka, Sigma Aldrich, and metal nitrates were purchased from Merck and Spectrochem. Microanalyses (C, and N) were carried out with melting point apparatus used to determine the melting point of the synthesized compounds. The FT-IR IR spectra of the compounds were recorded using a BRUKER FT-IR Spectrophotometer, and all spectra of synthesized compounds were recorded as KBr pellets. The UV/Vis spectra of synthesized Schiff bases and their metal complexes were detected in Thermos Scientific (Multiskan Go) Spectrophotometer by using DMSO solvent under 200-800nm wavelength. $^1$HNMR spectra were recorded on a Bruker (400 MHz) spectrometer. Chemical shifts were reported as $\delta$ in ppm relative to tetramethyl silane (TMS) ($\delta$ 0.00 singlet) in deuterated dimethyl sulfoxide (DMSOd6) for compounds and deuterated chloroform ($CDCl_3$) for compound 1 g. HRMS spectra were recorded. Solvents are used in analytical grades. For the preparation of metal complexes of corresponding Schiff bases, the nitrate salts of metals were used for the synthesis of metal complexes. By using silica-coated aluminum plates the progress of the reaction was monitored in the UV chamber. By using an open capillary, the melting point of all the compounds was resolute. Mass spectra were learned on Bruker Compass Data Analysis 4.0.

**General synthetic procedure for ligands**-by condensing 2 Methoxybenzaldehyde and 3 Methoxybenzaldehyde (2.0mmol) in ethanol (15 mL) with Thiosemicarbazide (1mmol) in ethanol (15 mL) were dissolved separately and aldehyde was added to the amines under stirring. The resulting mixture was stirred for 30 min at room temperature. Additionally, for enhancing the rate of the reaction 2-3 drops of dilute acetic acid were added to the reaction mixture followed by refluxing at 70-80$^0$C for 5-8 h and the completion of the reaction was observed by TLC, using hexane and ethyl acetate (9:1v/v) as eluent. Under Scheme 1 after completion of the reaction, the reaction mixture was allowed to cool at room temperature, the remaining precipitate was filtered, then wash with diethyl ether/ethanol (2:1) then put under a vacuum. For the synthesis of metal complexes of the above Schiff bases, the condensation refluxing method was acquired in

which 0.01 M of metal (nitrate) of Co(II), Ni(II), Fe(II), Cu(II), Ag(I), with 0.02 M of synthesized Schiff base in methanol is allowed to react in magnetic stirrer for 2-4 hours. 1 Equiv. For making a slight basic medium a catalytic amount of KOH [1-2 drops] was added. Precipitation of complexes seemed which be filtered on, and washed with ethanol and petroleum ether.

**Synthesis of $KL^{-1}$: (NE)-N,2-bis(2-meth -oxybenzylidene)hydrazine-carbothioamide-m.p.; 168** Yield (0.024 g) 76%; White powder, Chemical Formula $C_{17}H_{17}N_3O_2S$ (MW, 327.40).; Elemental analyses: Calculated; C, 62.36; H, 5.32; N, 12.83; O,9.77; S, 9.79 %; Observed; C, 63; H, 5.22; N, 12.78; S, 9.72; IR (selected vibrations; $cm^{-1}$); FT-IR Spectroscopy ($cm^{-1}$): 3402.21, 3283.77, them obtained stretching frequency at 1684.38 which is basically responsible for the confirmation of Schiff base (stretch, –C=N– imino), lowing of this transition because of presence of Thio and methoxy electron-withdrawing groups, The IR spectra of Schiff base ligand ($KL^{-1}$) exhibits strong band at 3402.21, 3283.77, 1684.38 due to (stretch, –C=N– imino), the C-H stretching and bending vibrations appear at 1455.34, 1281.64 (aromatic–C=C– ), 1007 $cm^{-1}$ ($\nu$(N-N) group,1234.86 (C–O–C stretch(E,E)-1,3-bis (2-methoxybenzylidene)thiourea. $^1$H NMR (DMSO-d6,$\delta$,ppm) The $^1$HNMR spectra of ligand were recorded in DMSO. The $^1$HNMR spectrum of $KL^{-1}$ shows a signal at 8.31 $\delta$ indicating the presence of azomethine (HC=N) proton. However, the multiple in the region 7.10 7.6 $\delta$ indicates the presence of phenolic protons; 6.6 (s. 1H) 7.4 7.3 (d, 1H), the important bands were observed at ~3.9 $\delta$ assigned for methyl (O–$CH_3$); Mass Spectroscopy (ESI-MS): 302 $[M+H_2O+H]^+$ anal for $C_{15}H_{12}N_2O_3S$. UV/Vis; 301nm, 270nm.

**Synthesis of KL-2: (2E)-N,2-bis(3meth -oxybenzylidene)hydrazine-carbothioamide-m.p.;158$^0$C** Yield 0.022 g (84%); light yellow powder, Chemical Formula: $C_{17}H_{17}N_3O_2S$ (MW,327.40) Elemental analyses: 62.37; H, 5.28; N, 12.87;O,9.76; S,9.79 %; Observed; C, 63; H,5.22; N, 12.78; S, 9.72; IR (selected vibrations; $cm^{-1}$); FT-IR Spectroscopy ($cm^{-1}$): FT-IR spectrum of ligands showed a band at a region of 1587.78 which is due to –(C=N– stretching) frequency is a key feature of Schiff base. Some strong IR peaks are 1529.31 (C=C aromatic) 1453.46 ($CH_3$ bend), 1035.06 (C–O–C– Stretch) 1261.40. As the ligand shows particular bands at a particular region, the same band is obtained for complexes also, we can say generally, via coordination bonds ligand complex suggesting that ligands have combined with the metal through coordination. the bands in the region of 640-660 $cm^{-1}$ and 418 $cm^{-1}$, are accredited to $\nu$(M–O) and $\nu$(M–N) stretching vibrations respectively, compatible coordination with Schiff bases.




**Scheme 1. Synthesis of $KL^{-1}$ Ligand and synthesis of metal complexes**

**General synthetic procedure for [M ($KL^{-1}$)$^2$]:** By using metal(II) nitrates complexes of (NE)-N, 2-bis (2-methoxybenzylidene) hydrazinecarbothioamide have been synthesized. To a stirring methanolic solution of $KL^{-1}$ and $KL^{-2}$ (1.0mmol, 0.287 g/0.332 g) and KOH (1.0 mmol, 0.056g), a methanolic solution of metal (II) nitrates (1.0 mmol) were added dropwise at room temperature, then the resulting reaction mixture was extra stirred for 30 minutes. The reaction mixture was refluxed at 50-60°C for 2-4 h and the accomplishment of reaction was observed by TLC. Cooling the reaction content resulted in a precipitate which was filtered, washed with methanol (10 mL) and finally dried at room temperature or vacuum[25].

**(2E,NE)-N,2-bis(2-methoxybenzylidene) hydrazinecarbothioamide-nickel(II) salt nickel [Ni($KL^{-1}$)$^2$](1):** Have been synthesis, Green powder, Yield: 0.308 g,(80%), m.p.-136°C, Chemical formula; [Ni($C_{17}H_{17}N_3O_2S^{2+}$], (MW; 386.1),Exact Mass; 385.0 Elemental Analysis: C, 52.88; H, 4.44; N, 10.88; Ni, 15.20; O, 8.20; S, 8.30.32; Found; C, 52.82; H, 4.42; N, 10.12; Ni, 14.30; O;8.13; S, 8.10; IR (selected vibrations; $cm^{-1}$); 1619.54 (C=N), 3325.09 (N-H), 1364.33, 604.13 , 817-811.21 (C S). UV/Vis ($\lambda_{max}$);

250-255nm, Mass spectrometry (ESI MS): 624.3 [M]+ anal for [Ni($C_{17}H_{17}N_3O_2S^{2+}$].

**(2E, NE)-N, 2-bis (2-methoxybenzylidene) hydrazinecarbothioamid, copper(II) salt(2) [Cu($KL^{-1}$)$^2$]:** Dark green, Yield 0.504 g, (78%) m.p.-160°C Chemical Formula;[$C_{17}H_{17}CuN_3O_2S_2$;] Exact Mass: 390.03 (Molecular Weight): 390.95, Elemental Analysis: C, 52.23; H, 4.38; Cu, 16.25; N, 10.75; O, 8.18; S, 8.20; Found; C, 52.12; H, 4.27; Cu, 16.22; N, 10.69 O, 8.16 S, 8.17; IR (selected vibrations; $cm^{-1}$); UV/Vis ($\lambda_{max}$); 287nm, Mass spectroscopy (ESI-MS): [M]+ anal for; [$C_{17}H_{17}CuN_3O_2S_2$;] m/z: 195.01 (100.0%), 196.01 (49.3%), 195.52 (18.7%), 196.52 (8.5%), 197.01 (2.2%), 196.02 (2.2%), 195.51 (1.9%), 196.51 (1.7%), 197.02 (1.0%).

**(2E,NE)-N,2-bis (2-methoxybenzylidene) hydrazinecarbothioamide, cobalt(II) salt; [Co($KL^{-1}$)$^2$]:** Colour; Pink Yield; (0.316 g) 82 Molecular Weight: (386.3), m.p.-168°C Chemical Formula: [$C_{17}H_{17}CoN_3O_2S^{2+}$]; Exact Mass: 386.0; Elemental Analysis: Calculated; C, 52.85; H, 4.44; Co, 15.25; N, 100.88; O, 8.28; S, 8.30; Found: C, 52.84; H, 4.43; Co, 15.23; N, 10.86; O, 8.26; S, 8.37; IR (selected vibrations; in $cm^{-1}$) 3283, 2310.80, 1618.13, 1450.81, 1304.86, 1032.02 m/z: 193.0 (100.0%), 193.5 (20.6%), 194.0 (6.9%), 194.5 (1.1%).

**(2E,NE)-N,2-bis(2-methoxybenzy-lidene) hydrazinecarbothioamide, zinc(II) salt [Zn($KL^{-1}$)$^2$] (3):** White powder obtained, Yield: 0.456 g, (71%), m.p.-178°C. Chemical Formula:[Zn ($C_{17}H_{17}N_3O_2S)_2$] (MW, 392). Elemental analyses: Calculated; C, 51.98; H, 4.36; N, 10.70; O, 8.15.; S, 8.16.; Zn, 16.65. Found; C, 5-1.90; H, 4.32; N, 10.55; O, 8.13; S, 8.15; Zn, 16.40.IR (selected vibrations; $cm^{-1}$); 3337, 1630, 1327, 547. $^1$HNMR (DMSO-d6, $\delta$, ppm); 8.59 (2H), 8.36 (2H), 8.18 (2H), 8.06 (2H), 7.91 (2H), 7.86 (2H), 7.61 (2H), 7.535(2H), 7.28 (2H); UV/Vis ($\lambda_{max}$); 279nm, Mass spectrometry (ESI-MS): m/z: 195.5 (100.0%), 196.5 (64.3%), 197.5 (44.4%), 197.0 (21.3%), 196.0 (20.6%), 198.0 (9.2%), 197.5 (4.1%)

**(2E, NE)-N, 2-bis (2-methoxybenzylidene) hydrazinecarbothioamide, silver(I) salt(4)-[Ag($KL^{-1}$)]:** Have been synthesis, Black colour; Yield (0.332 g) 78; m.p.-158°C. Chemical Formula: $C_{17}H_{17}AgN_3O_2S_2$ Exact Mass: 434.0 Molecular Weight: (435.3), m/z: 217.0 (100.0%), 218.0 (99.8%), 217.5 (20.6%), 218.5 (20.2%), 219.0 (6.6%), 219.5 (1.0%) Elemental Analysis: Calculated; C, 46.91; H, 3.94; Ag, 24.78; N, 9.65; O, 7.35; S, 7.37, Found; C, 46.81; H, 3.74; Ag, 24.68; N, 9.63; O, 7.32; S, 7.375, IR (selected vibrations; $cm^{-1}$); 2922.78, 1618.76, 2851.23, 1524.20, 1777.64, 1034.07, 2366.76, 1361.50, 795.59, 547.24.

**(2E,NE)-N,2-bis(2-methoxybenzylidene) hydrazinecarbothioamide,cadmium(II)Salt(5) salt(5) [Cd($KL^{-1}$)$^2$]:**Colour; White; Yield; (0.352 g) 80; m.p.-163°C Chemical Formula: [$C_{17}H_{17}CdN_3O_2S^{2+}$] Molecular Weight:(439.8); Exact Mass: 441.0; Elemental Analysis: calculated; C, 46.42; H, 3.90; Cd, 25.56; N, 9.55; O, 7.28; S, 7.29; Found; C, 46.40; H, 3.90; Cd, 25.52; N, 9.54; O, 7.26; S, 7.27; IR (selected vibrations; 2921.46, 1359.20, 1591.42, 1040.77, 1121.23, 855.24, 545.87 m/z: 220.5 (100.0%), 219.5 (83.5%), 220.0 (55.1%), 219.0 (46.5%), 218.5 (38.0%), 221.5 (29.2%), 221.0 (21.3%), 222.0 (5.7%), 216.5 (3.8%), 217.5 (3.0%), 222.5 (1.7%)

**(2E,NE)-N,2-bis(2-methoxybenzylidene) hydrazinecarbothioamide, lead(II) salt [Pb($KL^{-1}$)$^2$] (6);** Colour; Creamy white; Molecular Weight: 534.6; Yield; (0.406)76%; m.p.176°C Chemical Formula:[$C_{17}H_{17}N_3O_2PbS^{2+}$]; Exact Mass: 535.1; Elemental Analysis: Calculated; C, 38.19; H, 3.21; N, 7.86; O, 5.99; Pb, 38.76; S, 6.00; Found.; C, 38.17; H, 3.20; N, 7.84; O, 5.97; Pb, 38.75; S, 6.00; IR (selected vibrations; in $cm^{-1}$) -3284, 1617, 1450, m/z: 267.5 (100.0%), 267.0 (46.2%), 266.5 (41.3%), 268.0 (21.5%), 268.5 (6.7%), 265.5 (2.4%), 269.0 (1.0%)

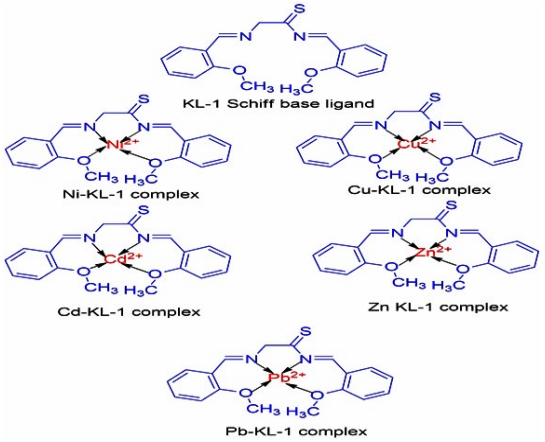
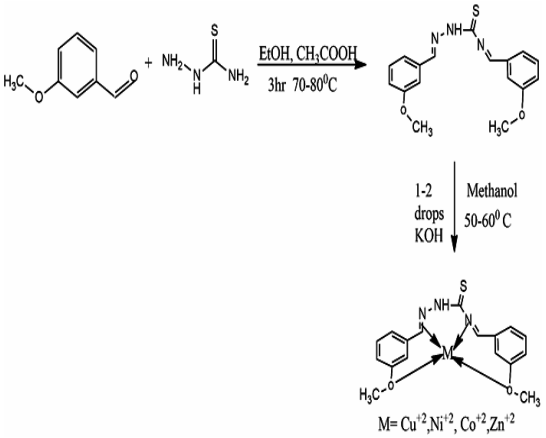



**Fig. 1. Proposed structure of $KL^{-1}$ (ligand) and their metal complexes**




**Scheme 2. Synthesis of $KL^{-2}$ Ligand and synthesis of metal complexes**

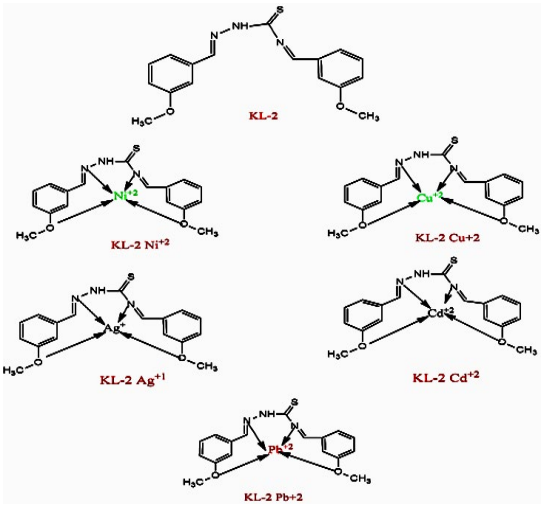
**Synthesis of (2E)-N,2-bis(3-methoxybenzylidene) hydrazine carbothioamide, nickel(II) salt (2)-Colour**; Dark green (powder),; Yield; (0.03 g) 78,; m.p.-158; Chemical Formula: $C_{17}H_{17}N_3NiO_2S^{2+}$, Mass; 385.0,; Molecular Weight: 386.1; Elemental Analysis: Calculated-C, 52.88; H, 4.44; N, 10.88; Ni, 15.20; O, 8.29; S, 8.30 Observed; C,52.83; H,4.42; N,10.85, Ni, 15.20; O, 8.25; S,8.28; IR (selected vibrations; in cm-1)-m/z: 192.5 (100.0%), 193.5 (45.5%), 193.0 (20.6%), 194.0 (10.7%), 194.5 (8.5%), 195.5 (1.8%), 195.0 (1.7%)

**Synthesisof(2E)-N,2-bis (3-methoxy -benzylidene) hydrazinecarbothioamide, copper(II) salt-(1) Colour;** Green, (powder) Yield 80% (0.031 g), m.p.-145, Mass: 390.0, Chemical Formula: $C_{17}H_{17}CuN_3O_2S^{2+}$, Elemental Analysis: Calculated-C, 52.23; H, 4.38; Cu, 16.25; N, 10.75; O, 8.18; S, 8.20 Observed-C, 52.21; H, 4.37; Cu, 16.22, N, 10.72; O, 8.16; S, 8.18. m/z: 195.0 (100.0%), 196.0 (51.5%), 195.5 (20.6%), 196.5 (10.3%), 197.0 (3.2%).

**(2E)-N,2-bis(3-methoxybenzylidene) hydrazinecarbothioamide, silver(I) salt(4)** -Colour; dark black powder; Yield (0.036)85%, m.p.-190°C Chemical Formula: $C_{17}H_{17}AgN_3O_2S^{+2}$ Molecular Weight: 435.3; Elemental Analysis: Calculated-C, 46.91; H, 3.94; Ag, 24.78; N, 9.65; O, 7.35; S, 7.37, Observed-Elemental Analysis: C, 46.90; H, 3.92; Ag, 24.75; N, 9.64; O, 7.32; S, 7.36m/z: 434.0 (100.0%), 436.0 (99.8%), 435.0 (20.6%), 437.0 (20.2%), 438.0 (6.6%), 439.0 (1.0%)1584.05,1487.97, 1338.45, 1258.49, 759.86 683.24 525.01.

**(2E)-N,2-bis(3methoxybenzylidene) hydrazinecarbothioamide, cadmium(II)salt-(5)** Colour; white powder; Yield (0.352 g) 80%, m.p.-196°C; Mass: 441.0 Chemical Formula: $C_{17}H_{17}CdN_3O_2S^{2+}$, Elemental Analysis: (Calculated) C, 46.42; H, 3.90; Cd, 25.56; N, 9.55; O, 7.28; S, 7.29; Observed; C, 46.42; H, 3.82; Cd, 25.53; N, 9.54; O, 7.27; S, 7.27; IR (selected vibrations; in $cm^{-1}$)-m/z: 220.5 (100.0%), 219.5 (83.5%), 220.0 (55.1%), 219.0 (46.5%), 218.5 (38.0%), 221.5 (29.2%), 221.0 (21.3%), 222.0 (5.7%), 216.5 (3.8%), 217.5 (3.0%), 222.5 (1.7%)

**Synthesis of (2E)-N,2-bis (3methoxyben -zylidene)hydrazine-carbothioamide, lead(II) salt-(3) Colour;** Creamy white; Yield (0.041 g) m.p.-200-78,Chemical Formula: $C_{17}H_{17}N_3O_2PbS^{2+}$, Mass: 535.1; Elemental Analysis: Calculated-C, 38.19; H, 3.21; N, 7.86; O, 5.99; Pb, 38.76; S, 6.00; Observed-C, 38.18; H, 3.19; N, 7.84; O, 5.94; Pb, 38.74; S, 6.00; IR (selected vibrations; in $cm^{-1}$)-1401.82,667.19, 505.91 m/z: 267.5 (100.0%), 267.0 (46.2%), 266.5 (41.3%), 268.0 (21.5%), 268.5 (6.7%), 265.5 (2.4%), 269.0 (1.0%)




The proposed structure of $KL^{-2}$(ligand) and their metal complexes

## RESULTS AND DISCUSSION

Mixed ligand Complexes (Schiff bases) $KL^{-1}$ and $KL^{-2}$ were synthesized by reaction of 2-methoxy benzaldehyde and 3-methoxy benzaldehyde with thiosemicarbazide in a 2:1 ratio in Ethanol in the presence of the catalytic amount of dilute acetic acid (Scheme 1). Metal complexes of corresponding Schiff bases were prepared by using nitrate salt. The

resulting metal complexes were neutral, colored, air-stable, and remarkably soluble in DMF and DMSO Table 1 Summarize the Physicochemical properties of ligands and their metal complexes, and Table 2 and Table 3 summarize the antibacterial and anti-fungal activity of the ligands and corresponding metal complexes. By using the Spectroscopic technique and elemental analysis all synthesized compounds were characterized. i.e., IR, UV/Vis, $^1$HNMR, and mass spectrometry. FT-IR Spectroscopy ($cm^{-1}$); 3402.21, 3283.77 they obtained stretching frequency at 1684.38 which is basically responsible for the conformation of Schiff base (stretching–C=N–imino), lowing of this transition because of the presence of Thio and methoxy electron-withdrawing groups.The IR spectra of Schiff base ligand ($KL^{-1}$) shows strong band at 3402.21, 3283.77, 1684.38 due to (stretch, –C=N–imino), 1455.34 ($CH_3$ bend), 1281.64 (aromatic–C=C–), 1234.86 (C-O-C stretch) 3402.21 (strong N-H stretch), 3283.77 (CH H stretch) $^1$HNMR: of $KL^{-1}$ in (DMSO-d6, $\delta$, ppm) 8.2-7.5 (m,4H,J=1.36 Hz), 6.6 (s. 1H) 7.4 7.3 (d, 1H), 3.68 (m, 5H), 2.54 (s, 3H), 2.48 (m, 4H) Mass Spectroscopy (ESI-MS): 302 [M+$H_2O$+H] anal for $C_{15}H_{12}N_2O_3S$. UV/Vis; 301nm, 270nm. Reaction progress was determined by using the thin-layer chromatographic technique[26]. Here we are using a conventional method which is to report an effectual practical technique (reflux) for the synthesis of a Schiff base (Scheme 1).

**Table 1: Physico-chemical properties of ligand (L) and complexes**

| Compound No. | Colour | Molecular formula | Mo. Weight | Yield% | m.p.$^0$C |
|---|---|---|---|---|---|
| $KL^{-1}$ | White powder | $[C_{17}H_{17}N_3O_2S]$ | 327.40 | 76% | 168 |
| 1 | Green | $[Ni(C_{17}H_{17}N_3O_2S^{2+}]$. | 386.1 | 80 | 136 |
| 2 | Dark green | $[CuC_{17}H_{17}N_3O_2S_2]$ | 390.95 | 78 | 160 |
| 3 | Pink | $[CoC_{17}H_{17}N_3O_2S^{2+}]$ | 386.3 | 82 | 169 |
| 4 | White | $[Zn(C_{17}H_{17}N_3O_2S)]$ | 392 | 71 | 178 |
| 5 | Black | $[AgC_{17}H_{17}N_3O_2S_2]$ | 435.3 | 78 | 158 |
| 6 | White | $[CdC_{17}H_{17}N_3O_2S^{2+}]$ | 439.8 | 80 | 163 |
| 7 | Creamy-white | $[PbC_{17}H_{17}N_3O_2S^{2+}]$ | 534.6 | 76 | 176 |
| $KL^{-2}$ | Light yellow | $[C_{17}H_{17}N_3O_2S]$ | 327.40 | 84 | 158 |

**Antimicrobial activity**

**Antifungal activity (*In vitro*)**

*Aspergillus niger* was obtained from the Department of Microbiology, Dr. Harisingh Gour University, Sagar, MP, and maintained on a Czapek dox medium at 28°C. Antifungal activity[27]. of all compounds was conducted on a solid Czapek dox medium using a well diffusion method against *A. niger*. Spores of *A. niger* was collected using a wet cotton swab followed by spreading these on the Czapek dox medium. Wells (6mm in diameter) were formed in the solid agar plates containing Czapek dox medium using a sterilized cork borer. 100 µL test sample was poured into a well and plates were transferred to incubate at 30°C for 48 hours.[28-29]

**Antibacterial activity**

Similarly, the antibacterial activity was assessed against *Bacillus subtilis. B. Subtilis* was grown and maintained on a nutrient agar medium. *In vitro* antibacterial activity was evaluated by the well diffusion method as described by Mukherjee *et al.,*. The overnight old bacterial culture ws centrifuged at 10000 g for 10 minute. The bacterial pellet was washed by suspended in sterile distilled water (20 mL) followed by centrifugation at 10000 g then resuspended in sterilized distilled water and used for the assay. The suspension containing bacterial cells was spread on a solid agar plate and wells (6mm in diameter) were formed in the solid nutrient agar plates using a sterilized cork borer. 100 µL test sample was poured into a well and plates were transferred to an incubator at 37°C for 24 hours.[30] After incubation, the zones of inhibition were recorded as the total diameter of the zone of inhibition minus the diameter of the well. All test runs were conducted in triplicate and the average value of inhibition was presented as activity.

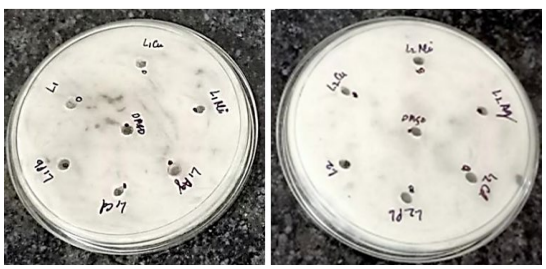


**Fig. 2. Anti-bacteria activity of $KL^{-1}$ and $KL^{-2}$**

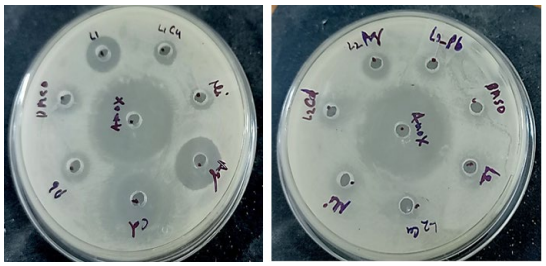


**Fig. 3. Representation of antimicrobial activity of $KL^{-1}$ and $KL^{-2}$ and their metal complexes**

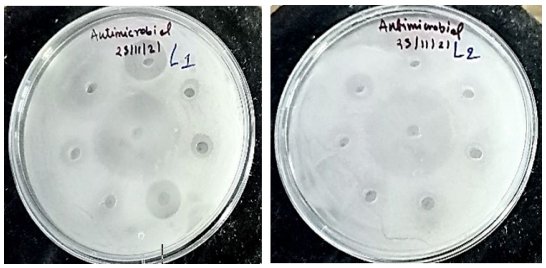


**Fig. 4. Anti-fungal activity of $KL^{-1}$ and $KL^{-2}$**

**Table 2: Antimicrobial data of [zone of inhibition] of $KL^{-1}$**

| S. No | Dilution coding | Zone of inhibition (in mm) | |
|---|---|---|---|
| | | *Bacillus subtilis* | *Aspergillus Niger* |
| 1 | $KL^{-1}$ | 7 | 8 |
| 2 | $KL^{-1}$ Cu | 9 | 7 |
| 3 | $KL^{-1}$ Ni | 8 | 11 |
| 4 | $KL^{-1}$ Ag | 10 | 14 |
| 5 | $KL^{-1}$ Pb | 9 | 9 |
| 6 | $KL^{-1}$ Cd | 11 | 15 |
| 7 | Standard drug | 16 | 17 |

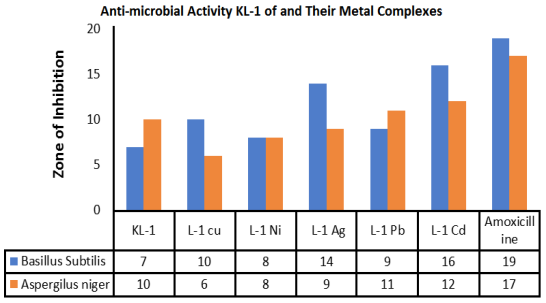



**Fig. 5. Graphical representation of $KL^{-1}$ and their metal complexes**

**Table 3: Antimicrobial data of [Zone of inhibition] of $KL^{-2}$**

| S. No. | Dilution coding | Zone of inhibition (in mm) | |
|---|---|---|---|
| | | *Bacillus subtilis* | *Aspergillus niger* |
| 1 | $KL^{-2}$ | 8 | 8 |
| 2 | $KL^{-2}$ Cu | 9 | 7 |
| 3 | $KL^{-2}$ Ni | 8 | 11 |
| 4 | $KL^{-2}$ Ag | 10 | 14 |
| 5 | $KL^{-2}$ Pb | 9 | 9 |
| 6 | $KL^{-2}$ Cd | 11 | 15 |
| 7 | Standard drug | 16 | 17 |

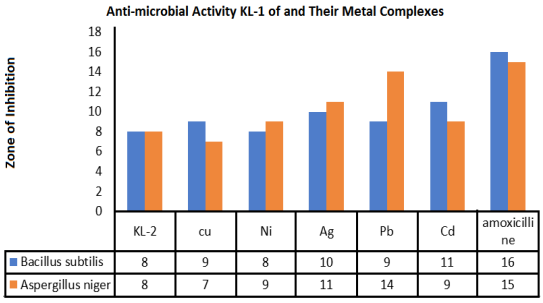



**Fig. 6. Graphical representation of $KL^{-2}$ and their metal complexes**

Order of antimicrobial activity in used different metal complexes-Cd>Pb>Ag>Ni>Cu

## CONCLUSION

An antifungal and anti-bacterial evaluation of a series of metal complexes formed from Schiff base tetradentate ligands was performed. Two novel Schiff base derivatives were synthesized from different aldehydes and thiosemicarbazide. The structures of Schiff base ligands and metal complexes were supported by different spectroscopic techniques such as FT-IR, $^1$H-NMR and high-resolution mass spectrometry (HRMS). By using the conventional method[3]. We have synthesized some thiosemicarbazide-derived Schiff base and their metal complexes by the green conventional method [Reflux method]. Preparation of Schiff base by using reflux method was completed within 5-7 h, high yields and all the product obtained were moderate to moral yields, and such type of methodology condensed the time and creation of by-products. Synthesis is simple and eco-friendly and can be used as an alternative to the existing conventional heating method[31]. From the results of anti-bacterial and anti-fungal studies,[32]. It was concluded that the tested compounds exhibited significant antibacterial activities against both *Bacillus subtilis* fungi and *Aspergillus niger* organisms. Among the tested compounds, compounds with Ag(I), Pb(II), and Cd(II) display promising antibacterial and antifungal activities[33]. Such analysis ascribed the greater electronic attractiveness which favors greater diffusion through the microbial membrane.The results of this study revealed that these complexes have a targeted activity, although, other modes of action cannot be ruled out because metal complexes are known to target multiple pathways to evade drug resistance[34].

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**Conflict of Interest**

Praise authorship contributing statement-Karuna Chourasia-Scheme, methodology, Conception, Characterization, Application part, writing, Bhanu Pratap Prajapati-Anti-microbial activity, Mithun Kori-Editing, data correction, the original draft Kaushal Kumar-Data correction, Ritu Yadav-Supervision.

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