



# Synthesis, Characterization and Antibacterial Activity of Metal(II) (Mn(II) Fe(II) Co(II) Ni(II) and Cu(II)) Complexes of Schiff Base Derived from 1-(4-Chlorophenyl) Ethanone, m-Hydroxyaniline and Phenylethanone

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## ABSTRACT

Schiff base metal Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes derived from 1(4-Chlorophenyl) ethanone and m-Hydroxyaniline (HL<sup>1</sup>) and Phenylethanone and m-Hydroxyaniline (HL<sup>2</sup>) were synthesized using reported methods. Complexes and the ligands were characterized using solubility, melting point, molar conductance and spectra compares of FTIR and Uv-visible. The solidity shows that the best solvents for all the complexes is DMSO and sparingly soluble in methanol and ethanol. The melting points of the complexes were higher than the parent ligands. The molar conductance reveals that all the metal complexes are non-electrolytes. The IR data for the HL<sup>1</sup> shows that its coordination with metal ions in monodentate manner *via* the azomethine N-Donor site whereas the HL<sup>2</sup> has coordinated to the metal ions in monodentate manner too *via* the azomethine N-Donor site. The and Uv-visible spectra data hinted a significant information concerning the geometry and structure of the complexes which indicated that some of the complexes are octahedral and others are square planer in shape. The following bacteria *Staphylococcus aureus*, *Salmonella typhi*, *Klebsiella pneumonia* and *Helicobacter pylori* were screened with the Schiff base free ligand and their complexes, their activity confirmed that chelation increase antibacterial activity.

**Keywords:** Schiff base; Antibacterial activity; Metal (II) complexes; Ligands; Sparingly soluble

## INTRODUCTION

Schiff base complexes had drawn the attention and interest of many researchers around the world ever since their discovery by Hugo 1864. Schiff base has received tremendous attention due its wide variety of its applications among which are chelation due to its flexible and special property of N=C group, biological activity (antitumor, antibacterial antifungal, anticancer, and herbicidal activity) [1-3].

Ajay et al. reported Co (II) complex of Schiff base derived from 2-amino-4-nitrophenol-N-salicylidene with some amino acids. The structural characterization of Schiff base and cobalt complexes were done on the basis of their melting point, solubility, elemental analyses, conductivity measurements, GC-MS, FTIR, NMR, UV-Visible spectroscopy, magnetic susceptibility, and X-ray diffraction studies and the morphology of mixed ligand Co(II) complexes was studied by Scanning Electron Microscopy (SEM). The complexes together

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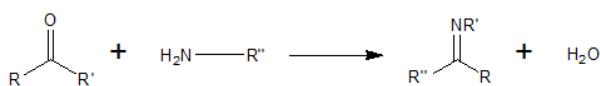
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with the ligands were also scanned against *S. typhi*, *S. aureus*, *A. niger* which indicated to have an activity towards the microbes.

Muhammad et al., (2011) in like manner study three new series of biologically active amino substituted Schiff bases with general formula,  $R_1N=CHR_2$ . Here  $R_1=2$ -amino-benzthiazole, 4-amino-salicylic acid and 4-aminophenol.  $R_2=4$ -chloro-benzaldehyde, 2-chloro-benzaldehyde, salicylade

-hyde, vanillin and benzaldehyde were synthesized by the reaction of three different amino substituted compounds and substituted aldehydes in ethanol. The compounds were characterized by different physico-chemical techniques like, melting point, elemental analysis, multinuclear NMR ( $^1H,^{13}C$ ). The free ligands and their metal complexes have been screened for their *in vitro* biological activities against bacteria, fungi and yeast on which the metal complexes show more potent activities compared with its free Schiff base ligands.

According to GAO Though the formation of Schiff bases is reversible, due to the hydrolysis of the imine under certain conditions, it is still straight forward for the reaction to succeed. It is still unknown what type of Schiff base is stable in the presence of water even with acidic solution, while others are very sensitive to water and easily hydrolyze back to aldehyde. To overcome this potential hydrolysis, the reaction of Schiff bases should be done under dried solvent conditions or using some additional procedure to remove the side product, water, in the imine formation. General method of synthesizing Schiff base (Figure 1) [4-7].



**Figure 1:** General schematic method of Schiff base synthesis.

There are three methods of synthesizing Schiff bases as reported Zhaoqi and Pinhau, which are: I) Microwave method: Where the reactants are irradiated for some time and cooled before recrystallization process. II) Reflux method: Where the reactants are refluxed with a suitable solvent at certain temperature, cool and recrystallized. III) Stirring method: Where the reactants are stirred at room temperature before recrystallizing.

Ndahi and Nasiru studied the Co(II), Ni(II) and Zn(II) complexes of Schiff bases derived from condensation of 4-anisaldehyde with anisidine (AAN). The compounds have been characterized using elemental analysis, electronic spectra, and molar conductance measurements. The infrared data revealed that the ligand, AAN behaved as a tridentate ligand.

The aim of the study is to synthesize, characterize and evaluate the antibacterial activity of Mn(II), Fe(II) Co(II) Ni(II) and Cu(II) complexes of Schiff base ligands from 1-(4-chlorophenyl) ethanone, m-hydroxyaniline and Phenylethanone. Through the following objectives:

- To synthesis a Schiff base having N donor ligand using the derivatives of 1-(4-chlorophenyl) ethanone, m-hydroxyaniline, m-hydroxyaniline, and Phenylethanone.
- To synthesis Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes using the ligands synthesized.
- To characterize the prepared ligands and metal Schiff base complexes using spectra/analytical techniques such as Fourier Transform Infrared (FTIR), UV/Visible spectrophotometer, solubility and the molar conductance and melting point.
- To determine their antibacterial activity using agar disc diffusion method.

## MATERIALS AND METHODS

### Materials

**Chemicals/Reagents:** All chemicals and solvents used were of analytical grade and were used as supplied. The transition metal (II) salts used are Manganese (II) Chloride Tetrahydrate ( $MnCl_2 \cdot 4H_2O$ ) Iron (II) tetraoxosulphate (VI) heptahydrate ( $FeSO_4 \cdot 7H_2O$ ), Cobalt (II) acetate tetrahydrate ( $(CH_3CO_2)_2Co$ ) Nickel acetate tetrahydrate ( $(CH_3CO_2)_2Ni \cdot 4H_2O$ ) Copper(II) acetate dehydrate, ( $Cu(CH_3CO_2)_2$ ) m-hydroxyaniline, ( $C_6NH_7O$ ), 1-(4-chlorophenyl) ethanone ( $C_8ClH_8O$ ), distilled water.

The organic solvents include Methanol, Ethanol, Benzen, petroleum ether, Dimethylsulphoxide (DMSO).

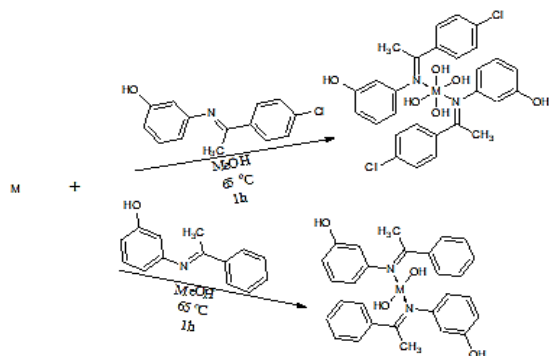
**Instruments/equipments:** The optical/equipment used include digital conductivity meter AVI, Gallenkamp melting point apparatus with a thermometer range ( $0^\circ C - 350^\circ C$ ), Perkin Elmer Spectrum version 10.03.09 Fourier Transform Infrared Spectrophotometer (FTIR), 752 UV-VIS spectrophotometer ranging from 180 nm-900 nm [8-11].

### Synthesis Methods

**Synthesis of ligands (HL<sup>1</sup> and HL<sup>2</sup>):** The ligands are prepared by taking equimolar ratio of a hot solution ( $65^\circ C$ ) 1-(4-chlorophenyl) ethanone (1.09 g, 10 mmol) and m-Hydroxyaniline (1.55 g, 10 mmol) in methanol (HL<sup>1</sup>) and The ligands are prepared by taking equimolar ratio of a hot solution ( $65^\circ C$ ) Phenylethanone (1.20 g, 10 mmol) in 20 cm<sup>3</sup> of methanol was mixed with a hot solution ( $65^\circ C$ ) of m-Hydroxyaniline (1.55 g, 10 mmol) in the same methanol (HL<sup>2</sup>) both the mixture of (HL<sup>1</sup> and HL<sup>2</sup>) was reflux for 1 hour, the solids formed was filtered and purified by recrystallizing with ethanol then washed with cold petroleum ether and then dried in a desiccator over anhydrous calcium chloride the method as adapted by Jisha and Isac.

**Preparation of Schiff base metal complexes:** The metal complexes were prepared by adding aqueous solution of Manganese (II) Chloride tetra hydrate ( $MnCl_2 \cdot 4H_2O$ ) Iron (II) tetraoxosulphate (VI) heptahydrate, Cobalt(II) acetate tetra hydrate, Copper(II) acetate dehydrate, to the ligands in methanol in 1:2 molar ratio and was reflux for 1 hour at  $65^\circ C$ . The precipitated solids was

washed with ethanol and cold petroleum ether and finally dried in desiccators over anhydrous calcium chloride (**Figure 2**).



**Figure 2:** Formation of schiff base metal(II) complexes.

Where M=Mn(II), Fe(II), Co(II), Ni(II) and Cu(II).

### Antibacterial Activity

The bacteria culture for *Staphylococcus aureus*, *Salmonella typhi*, *Klebsiella pneumonia* and *Helicobacter pylori* were obtained from pharmacy department of Gombe state university. The bacteria cultures were incubated at 37°C for 24 hours by incubation into a nutrient agar. The Schiff bases HL<sup>1</sup>, HL<sup>2</sup> and all the Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) synthesized complexes were stored dried at room

temperature and 20 mg/ml of all the Schiff base and metal(II) ion complexes were dissolve in Dimethyl Sulfur Oxide (DMSO). Antibacterial activities of each compound were evaluated by the agar disc diffusion method. A Mueller Hinton agar media (15 cm<sup>3</sup>) kept at 45°C was poured in a Petri dish and allowed to solidify. The prepared petri plates were incubated with 50 micro liters of normal saline solution of *Staphylococcus aureus*, *Salmonella typhi*, *Klebsiella pneumonia* and *Helicobacter pylori* (105-106 bacteria per ml). Disc impregnated with the prepared Schiff bases HL<sup>1</sup>, HL<sup>2</sup> and all the Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) (50 micro litres) were applied on the solid agar medium by pressing it slightly. The Petri dish was incubated at 37°C for 24 hours. At the end of the period the inhibition zones formed on the media were measured with a zone reader in millimetres [12,13].

## RESULTS

### General Results

The following physiochemical parameters were carried out: percentage yield, melting point, molar conductance, solubility test, UV-Visible and IR spectra are discussed in this chapter with the antibacterial activity. The results are summarized in the below **Table 1**.

**Table 1:** Molecular formula and molecular weight of the Schiff base and their complexes.

Compound	Colour	M.P (°C)	Texture	(%) Yield	Conductivity Scm <sup>2</sup> /Mol	Cal.M. Mass (g/ Mol)
C <sub>14</sub> ONH <sub>12</sub> (HL <sup>1</sup> )	Brown	47-49	Crystalline	46	-	245.5
C <sub>14</sub> ONH <sub>13</sub> (HL <sup>2</sup> )	Dark brown	78-80	Powder	72	-	211
Mn(HL <sup>1</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub>	Black	49-50	Powder	63	5	572.9
Fe(HL <sup>1</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Ash	51-53	Powder	52	3	614.8
Co(HL <sup>1</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Blue	100-104	Powder	49	16.8	617.9
Ni(HL <sup>1</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub>	Ash	100-102	Powder	43	3	581.7
Cu(HL <sup>1</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Greenish-brown	>250	Powder	73	3	586.5
Mn(HL <sup>2</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub>	Brown	174-175	Powder	66	23	508.9
Fe(HL <sup>2</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Dark brown	155-157	Powder	54	3	545.8
Co(HL <sup>2</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Grey	>250	Powder	49	18.7	548.9
Ni(HL <sup>2</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub>	Dark brown	125-127	Powder	58	4	512.7
Cu(HL <sup>2</sup> ) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub>	Black	>250	Powder	67	8	612.4

The synthesized complexes showed a very good yield having Fe(II) complexes with the least 43% while Co(II) complexes has the highest with 73% yield compared to the yield of 57%Cu(II), 59%Co(II), and 55%Ni(II) similar to the yield reported. The metal Schiff base complexes synthesis which are Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) are all coloured, non-

electrolytes and stable at room temperature similarly to what Ektar, reported.

The solubility test of the Mn(II), Fe(II), Co(II), Ni(II) complexes dissolved in Dimethylsulphuroxide (DMSO) and sparingly soluble in other organic solvents such as methanol, ethanol,

benzene, petroleum Ether, dichloromethane. From the spectral data it shows that the HL<sup>1</sup> and HL<sup>2</sup> act as bidentate ligands similar to what Ektar reported.

**Physical appearance:** The solid, coloured complexes of Mn(II), Fe(II),Co(II), Ni(II) and Cu(II) as indicated by visual observation, molecular weight, percentage yield are listed in the **Table 2** with their calculated molecular weight too.

**Melting point determination:** The ligands and their complexes melting point were determined by taking a small portion of samples into a one end closed capillary tube and placed it in a melting point apparatus and temperature at melting point was recorded as shown in **Table 2**.

**Molar conductance:** Molar conductance of electrolytes at a particular dilution is the conductivity of the solution containing one mole of the electrolyte when placed between two large electrodes 1 cm apart. The molar conductance at 200 mMole may be too low to cause the dissociation of the complexes in DMSO, therefore the Mn(II), Fe(II),Co(II), Ni(II) and Cu(II) complexes were considered to be non-electrolytes as indicated from the molar conductance value recorded in **Table 2**.

**Table 2:** The relevant infrared frequency of HL<sup>1</sup> and HL<sup>2</sup> ligands and their metal complexes.

Compound	V(O-H)	V(C=N)	V(C=C)	V(C-Cl)	V(M-N)
HL <sup>1</sup>	3361 sh	1654 m	1507 m	841 sh	-
Mn(HL <sup>1</sup> ) <sub>2</sub>	3361 sh	1606 m	1507 m	841 s	687 w
Fe(HL <sup>1</sup> ) <sub>2</sub>	3361 sh	1603 sh	1507 m	841 sh	687 m
Co(HL <sup>1</sup> ) <sub>2</sub>	3376 sh	1603 m	1512 m	846 m	741 s
Ni(HL <sup>1</sup> ) <sub>2</sub>	3361 sh	1633 sh	1538 m	841 sh	687 m
Cu(HL <sup>1</sup> ) <sub>2</sub>	3424 b	1627 m	1511 m	847 s	617 s
HL <sup>2</sup>	3671 w	1678 w	1592 w	-	-
Mn(HL <sup>2</sup> ) <sub>2</sub>	3361 w	1679 w	1556 w	-	632 w
Fe(HL <sup>2</sup> ) <sub>2</sub>	3557 w	1678 w	1600 w	-	666 w
Co(HL <sup>2</sup> ) <sub>2</sub>	3584 w	1660 w	1507 w	-	666 w
Ni(HL <sup>2</sup> ) <sub>2</sub>	3361 w	1677 m	1592 w	-	688 w
Cu(HL <sup>2</sup> ) <sub>2</sub>	3471 b	1660 w	1599 w	-	572 b

### Infrared Spectra

The relevant infrared frequencies of the ligands (HL<sup>1</sup> and HL<sup>2</sup> Schiff bases) with Mn(II), Fe(II),Co(II), Ni(II) and Cu(II) complexes are presented in **Table 3** to enable study the binding mode of the Schiff base ligands with the metal (II). The Schiff base infrared spectrum was compared with the corresponding spectra of the Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes, a strong band was observed at 1654 cm<sup>-1</sup> for the Schiff base ligand HL<sup>1</sup> and at 1678 cm<sup>-1</sup> for the Schiff base ligand HL<sup>2</sup> characteristic of the azomethine bond C=N stretching vibration while in the metal Schiff base complexes the band responsible for the azomethine were shifted to 1606 cm<sup>-1</sup> for Mn(HL<sup>1</sup>)<sub>2</sub>, (H<sub>2</sub>O)<sub>2</sub> 1603 cm<sup>-1</sup> for Fe(HL<sup>1</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>, 1603 cm<sup>-1</sup> for Co(HL<sup>1</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub> 1633 cm<sup>-1</sup> for Ni(HL<sup>1</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub> 1627 cm<sup>-1</sup> for Cu(HL<sup>1</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub> 1679 cm<sup>-1</sup> Mn(HL<sup>2</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>1679 cm<sup>-1</sup>

for Fe(HL<sup>2</sup>)<sub>2</sub> 1678 cm<sup>-1</sup> for Co(HL<sup>2</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>1677 cm<sup>-1</sup> for Ni(HL<sup>2</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>1660 cm<sup>-1</sup> for Cu(HL<sup>2</sup>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>. The shift observed was an indication for the azomethine nitrogen atom participation in coordinating with the metal ions, which is in agreement with what Gehad, Sumathi et al. reported. The bands are summarized in **Table 2** [14-16].

From the IR spectra data all the two Schiff base synthesis are considered to be neutral monodendated ligands where the HL<sup>1</sup> has coordinated with the metal ions through azomethine N atoms and the HL<sup>2</sup> also coordinated with the metals through azomethine N atom which is in concordance to what.

**Table 3:** The maximum wave length (nm) of HL<sup>1</sup> and HL<sup>2</sup> with their complexes.

Compound	λ <sub>max</sub> (nm)	Band assignment
HL <sup>1</sup>	300	π—π <sup>*</sup>
Mn(HL <sup>1</sup> ) <sub>2</sub>	350	n—π <sup>*</sup>

Fe(HL <sup>1</sup> ) <sub>2</sub>	400	n—π <sup>*</sup>
Co(HL <sup>1</sup> ) <sub>2</sub>	300	π—π <sup>*</sup>
Ni(HL <sup>1</sup> ) <sub>2</sub>	300	π—π <sup>*</sup>
Cu(HL <sup>1</sup> ) <sub>2</sub>	500	n—π <sup>*</sup>
HL <sup>2</sup>	300	π—π <sup>*</sup>
Mn(HL <sup>2</sup> ) <sub>2</sub>	350	n—π <sup>*</sup>
Fe(HL <sup>2</sup> ) <sub>2</sub>	350	n—π <sup>*</sup>
Co(HL <sup>2</sup> ) <sub>2</sub>	350	n—π <sup>*</sup>
Ni(HL <sup>2</sup> ) <sub>2</sub>	400	n—π <sup>*</sup>
Cu(HL <sup>2</sup> ) <sub>2</sub>	400	n—π <sup>*</sup>

### UV-Visible spectra

The UV/Visible spectrophotometer data for the ligands and the metal complexes are shown in the Table 3. While Figures 3-8 shows the summary of the λ<sub>max</sub> of the ligands and their metal complexes. From the spectra data, the ligands HL<sup>1</sup> and HL<sup>2</sup> showed a broad band at 300, respectively which is assigned to π—π<sup>\*</sup> a transition of the C=N chromosphere. And on complexation there was shift to a lower wave length which is assigned which indicate coordination with the metal ions.

The Cu(HL<sup>1</sup>)<sub>2</sub> complexes happens to show more absorption than others this is due to its molar absorptivity difference which cause the spectrum to be intensify such complexes may also said to cause a hyper chromic shift which is similar manner to the report of Lakhe and Mangaonkar. The UV-Visible absorption spectra of all the complexes indicated that, six of the complexes are of the same structure (octahedral) which are the Fe(HL<sup>1</sup>)<sub>2</sub>Cu(HL<sup>1</sup>)<sub>2</sub> Fe(HL<sup>2</sup>)<sub>2</sub> Co(HL<sup>1</sup>)<sub>2</sub> Cu(HL<sup>2</sup>)<sub>2</sub> Co(HL<sup>2</sup>)<sub>2</sub> and slight change with the Cu(II) complexes may due to the Jahn-Teller effect, the remaining complexes showed similar structure (square planner) Mn(HL<sup>1</sup>)<sub>2</sub>, Mn(HL<sup>2</sup>)<sub>2</sub> Ni(HL<sup>2</sup>)<sub>2</sub> and Ni(HL<sup>2</sup>)<sub>2</sub> (Table 4).

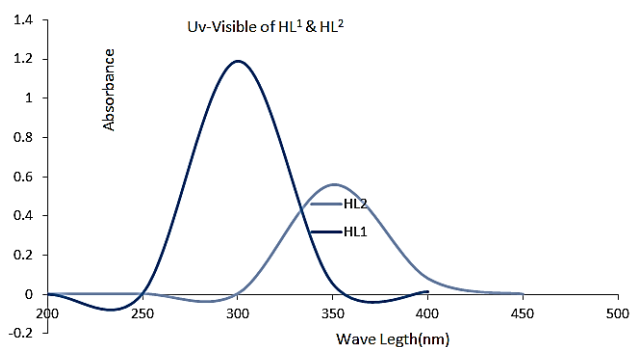


Figure 3: Uv-visible of spectra of HL<sup>1</sup> and HL<sup>2</sup>.

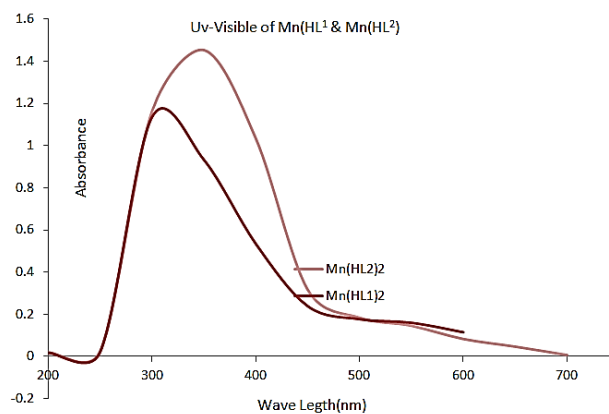


Figure 4: Uv-Visible of spectra of Mn(HL<sup>1</sup>) and Mn( HL<sup>2</sup>).

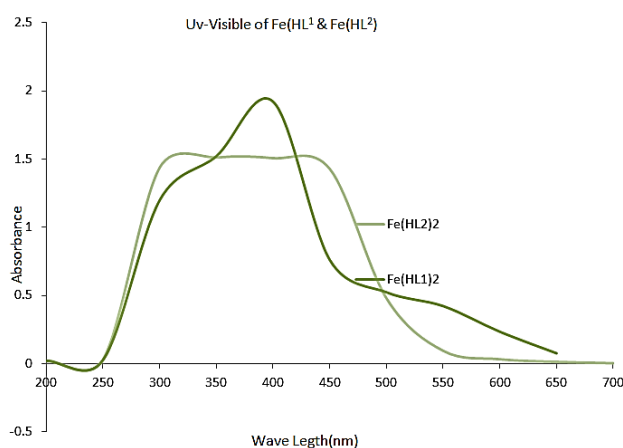


Figure 5: Uv-Visible of Spectra of Fe(HL<sup>1</sup>) and Fe( HL<sup>2</sup>)  
Uv-visible of Co(HL<sup>1</sup>) and Co(HL<sup>2</sup>).

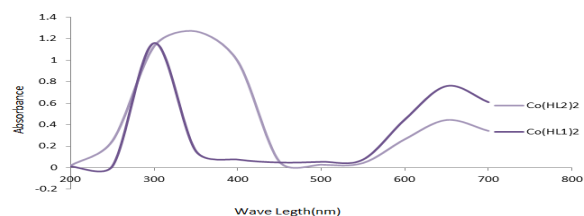


Figure 6: Uv-Visible of Spectra of Co (HL<sup>1</sup>) and Co (HL<sup>2</sup>).

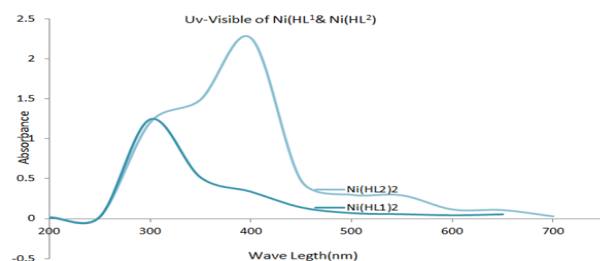


Figure 7: Uv-Visible of spectra of Ni (HL<sup>1</sup>) and Ni (HL<sup>2</sup>).

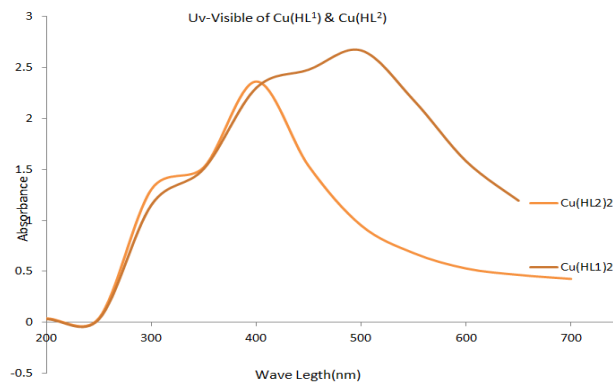


Figure 8: Uv-Visible of spectra of Cu(HL<sup>1</sup>) and Cu(HL<sup>2</sup>).

Table 4: The antibacterial activities of HL<sup>1</sup> and HL<sup>2</sup> and their metal complexes.

Compounds	<i>S. typhi</i>	<i>K. pneumoniae</i>	<i>S. aureus</i>	<i>H. pylori</i>
HL <sup>1</sup>	8.04	7.29	14.9	7.9
HL <sup>2</sup>	8.92	9.53	15.99	9.36
Mn(HL <sup>1</sup> ) <sub>2</sub>	12.82	9.06	10.58	6.66
Fe(HL <sup>1</sup> ) <sub>2</sub>	6.38	8.4	7.08	6.98
Co(HL <sup>1</sup> ) <sub>2</sub>	8.8	11.82	9.19	13.38
Ni(HL <sup>1</sup> ) <sub>2</sub>	11.87	13.84	18.46	10.72
Cu(HL <sup>1</sup> ) <sub>2</sub>	6.75	7.77	24	6.32
Mn(HL <sup>2</sup> ) <sub>2</sub>	9.9	9.6	9.04	33.83
Fe(HL <sup>2</sup> ) <sub>2</sub>	8.39	7.04	8.82	6.84
Co(HL <sup>2</sup> ) <sub>2</sub>	17.78	19.08	21.78	11.77
Ni(HL <sup>2</sup> ) <sub>2</sub>	16.52	16.26	17.23	19.6
Cu(HL <sup>2</sup> ) <sub>2</sub>	8.48	12.04	25.43	9.73
standard	22.32	24.21	20.46	37.64

Standard: Ceftriaxone and suibactam; 6-10: weak; 11-15: Moderate; >16: significant

### Antibacterial Activity

Schiff base complexes had been reported to have a very good antibacterial activity due to the interaction between the azomethine nitrogen atoms with metals on chelation. This study just like others examined the antibacterial activity of Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes and most of the metal Schiff bases complexes showed a remarkable significant antibacterial activity while others showed a moderate activity and few indicated no activity towards the bacteria. The inhibition zones were measured in millimetre (mm) it as shown in Table 4. The Schiff base (HL<sup>1</sup> and HL<sup>2</sup>) showed a moderate activity toward *Saphylocoecus aureus*, less active on *Salmonella typhi*, *Klebsiella pneumonia* and

*Helicobacter pylori* while Mn(HL<sup>2</sup>)<sub>2</sub> showed the highest activity towards *Helicobacter pylori* and the two Cu(HL<sup>1</sup>)<sub>2</sub> Cu(HL<sup>2</sup>)<sub>2</sub> complexes similar to report of Tajudeen and Kannappan which showered a very good activity towards *Staphylococcus aureus* more than even the standard drugs, followed by Co(HL<sup>2</sup>)<sub>2</sub>, Ni(HL<sup>1</sup>)<sub>2</sub> complexes. The activity of the complexes has been summarized using Figure 9 [17].

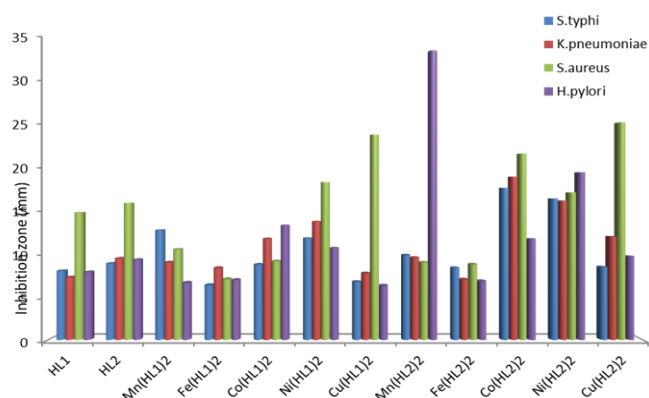


Figure 9: Antibacterial chat.

## DISCUSSION

The synthesis of Schiff base Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complex derived from Phenylethanone, m-hydroxaniline and 1-(4-chlorophenyl)ethanone. The ligands were synthesis by refluxing them in the present of alcohol for 1 hour whre a solid stable coloured Schiff bases HL<sup>1</sup> and HL<sup>2</sup> and (Mn(HL<sup>1</sup>)<sub>2</sub>, Fe(HL<sup>1</sup>)<sub>2</sub>, Co(HL<sup>1</sup>)<sub>2</sub> Ni(HL<sup>1</sup>)<sub>2</sub> Cu(HL<sup>1</sup>)<sub>2</sub>, Mn(HL<sup>2</sup>)<sub>2</sub>, Fe(HL<sup>2</sup>)<sub>2</sub> Co(HL<sup>2</sup>)<sub>2</sub> ,Ni(HL<sup>2</sup>)<sub>2</sub> Cu(HL<sup>2</sup>)<sub>2</sub> complexes were formed with the following percentage yield 46% HL<sub>1</sub>, 72% HL<sub>2</sub>, 63% (Mn(HL<sup>1</sup>)<sub>2</sub>, 52% Fe(HL<sup>1</sup>)<sub>2</sub>, 49% Co(HL<sup>1</sup>)<sub>2</sub>, 43% Ni(HL<sup>1</sup>)<sub>2</sub>, 3% Cu(HL<sup>1</sup>)<sub>2</sub>, 66% Mn(HL<sup>2</sup>)<sub>2</sub>, 54% Fe(HL<sup>2</sup>)<sub>2</sub> 49% Co(HL<sup>2</sup>)<sub>2</sub>, 58% Ni(HL<sup>2</sup>)<sub>2</sub> 67% Cu(HL<sup>2</sup>)<sub>2</sub> respectively and they are all soluble in Dimethylsulfoxide (DMSO) and among other organic solvents, methanol and ethanol are good solvent for the two ligands HL<sup>1</sup>, HL<sup>2</sup> and Co(HL<sup>1</sup>)<sub>2</sub> complex and sparingly soluble in other organic solvents like petroleum ether, benzene, dichloromethane and even the universal solvent water so also the remaining complexes Mn(HL<sup>1</sup>)<sub>2</sub>, Fe(HL<sup>1</sup>)<sub>2</sub>, Ni(HL<sup>1</sup>)<sub>2</sub> Cu(HL<sup>1</sup>)<sub>2</sub>, Mn(HL<sup>2</sup>)<sub>2</sub>, Fe(HL<sup>2</sup>)<sub>2</sub> Co(HL<sup>2</sup>)<sub>2</sub>, Ni(HL<sup>2</sup>)<sub>2</sub> Cu(HL<sup>2</sup>)<sub>2</sub> are sparingly soluble. All the synthesis complexes were characterized by molar conductance, UV-visible spectra data, solubility, IR and screen for antibacterial activity. The molar conductance of the synthesis metal complexes were found to be non-electrolytes and from the Uv-Visible spectra data the Schiff bases absorption occurred at 300 nm which is assigned to π-π\* transition corresponding to C=N chromophore while in the complexes the band shifted to a longer wave length with increasing intensity and also indicated that following complex Fe(HL<sup>1</sup>)<sub>2</sub>Cu(HL<sup>1</sup>)<sub>2</sub> Fe(HL<sup>2</sup>)<sub>2</sub>Co(HL<sup>1</sup>)<sub>2</sub> Cu(HL<sup>2</sup>)<sub>2</sub> Co(HL<sup>2</sup>)<sub>2</sub> are octahedral the slight change with the Cu(II) complexes from the UV-Visible spectra data may due to the Jahn-Teller effect and Mn(HL<sup>1</sup>)<sub>2</sub>, Ni(HL<sup>2</sup>)<sub>2</sub>, Mn(HL<sup>2</sup>)<sub>2</sub>, Ni(HL<sup>2</sup>)<sub>2</sub> showed square planner shape. The infrared spectra data gave a vital information concerning the complexation of the Schiff base HL<sup>1</sup> and HL<sup>2</sup> as bands of the azomethine were observed at 1654 cm<sup>-1</sup> and 1678 cm<sup>-1</sup> respectively which were shifted to a lower frequency, symbolizing the coordination with the metal (II) ions. Some of the metal complexes showed a significant inhibition zones such as the Ni(HL<sup>2</sup>)<sub>2</sub> complexes which indicated a significant inhibition zones from 16 mm and above towards the four sample bacteria *Staphylococcus aureus*, *Salmonella typhi*,

*Klebsiella pneumonia* and *Helicobacter pylori* followed by Ni(HL<sup>2</sup>)<sub>2</sub> which showed a moderate activity against all the four bacteria, Co(HL<sup>2</sup>)<sub>2</sub> complex showed as significant response towards all the four bacteria except *Helicobacter pylori* where it shows moderate action against it. Cu(HL<sup>1</sup>)<sub>2</sub> and Cu(HL<sup>2</sup>)<sub>2</sub> showed significant activity towards *S.aureus* with 25.43 mm and 24.00 mm inhibition zone respectively as compared with the standard drugs (Ceftriaxone and suibactam) which showed an inhibition zone of 20 mm but indicated a weak activity towards *Salmonella typhi*, *Klebsiella pneumonia* and *Helicobacter pylori* similarly Mn(HL<sup>2</sup>)<sub>2</sub> showed significant inhibition zone towards *H. pylori* while Mn(HL<sup>1</sup>)<sub>2</sub> indicated a moderate activity against *Salmonella typhi* and *S. aureus* displayed weak activity towards *Klebsiella pneumonia* and *Helicobacter pylori* more so HL<sup>1</sup> and HL<sup>2</sup> indicated a moderate activity toward *S. aureus* and finally the two complexes Fe(HL<sup>1</sup>)<sub>2</sub> and Fe(HL<sup>2</sup>)<sub>2</sub> indicated a weak activity towards the four sample bacteria and the reason to their activity may be due to their geometry, present of an imine groups.

## CONCLUSION

In conclusion, two neutral monodendated Schiff base ligands m-hydroxanil-1-(4-chlorophenyl) ethanimine (HL<sup>1</sup>) from the condensation reaction of 1-(4-chlorophenyl)ethanone (1.09 g, 10 mmol) with m-Hydroxyaniline (1.55 g, 10 mmol) in the present of alcohol and m-hydroxanilphenylethanamine (HL<sup>2</sup>) from the condensation reaction of Phenylethanone (1.20 g, 10 mmol) with m-Hydroxyaniline (1.55 g, 10 mmol) in the presence of alcohol and to ascertain the product formed TLC was conducted. The metal Schiff base complexes were synthesis by taking 1:2 ratio of metal to ligand and refluxed for 1-2 hours in the present of alcohol which produced a stable complex a good yield.

The physical properties of the metal complexes such as solubility, melting point, and molar conductance were determined and complexes indicated to be non-electrolytes.

The following characterization techniques IR, Uv-Visible spectra data justify the metal complexation through the azomethine bond with the metals.

Most of the complexes showed a significant activity towards the following bacteria *Salmonella typhi* and *S. aureus* *Klebsiella pneumonia* and *Helicobacter pylori* compare to their parent ligands. Therefore the aim which is to synthesis, characterize and screen for antibacterial activity of Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes has been achieved.

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