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Synthesis, characterization and antimicrobial activity of copper(II), cobalt(III) and iron(III) complexes with acetylaceton and pyridine as ligands.

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ABSTRACT: the metal complexes of copper(II), $Cu(L^1L^2)_2$ Cobalt(III) $Co(L^1)_3$ and iron(III)$Fe(L^1)_3$ were synthesized with % yield of 76.20, 84.8 and 71.8 respectively and characterized by solubility , melting point molar conductivity, UV-visible spectrometry and FTIR spectroscopy. Susceptibility testing for the complexes was carried out using Agar well diffusion method. Both copper(II) $Cu(L^1L^2)_2$ complex and Cobalt(III) $Co(L^1)_3$ were found to be non-electrolyte with 0.00(µS) and 0.48 µS respectively but the iron(III) $(FeL^1)_3$ was electrolytic with 1464 µS. The mixed ligands copper(II) $Cu(L^1L^2)_2$ complex was non-polar (soluble only in chloroform) but the Cobalt(III) $Co(L^1)_3$ and iron(III) $Fe(L^1)_3$ were polar (soluble in polar solvent ethanol and methanol). UV-visible spectroscopy reveal that, $Cu(L^1L^2)_2$ complex had a maximum absorption wavelength λ_{max}(nm) within the ultraviolet region (259.0 nm) and the Cobalt(III) $Co(L^1)_3$ and iron(III) $Fe(L^1)_3$ complexes with λ_{max}(nm) within the visible region, 520 nm and 470 nm respectively. The FTIR for the complexes show the present of metal oxygen (ligand) bond νM-O which is absent the ligands. The νM-O bond for $Fe(L^1)_3$, $Co(L^1)_3$ and $Cu(L^1L^2)_2$ were found to be S559.50, S566.61 and S454.56 respectively. The present of ν(M-N) at M782.22 and ν(C-N) at M1189.13 confirmed the formation of $Cu(L^1L^2)_2$. The antimicrobial activity of the complexes were determined using agar well diffusion method, Gentamicin (10 µ/disc) and Ketoconazole 200mg/ml were used as control for antibacterial and antifungal Susceptibility Testing respectively. The complexes were tested against the following clinical isolates*Bacillus aureus, speudomona auregenosa, staphylococcus aureus,Escherichie Coli, Aspergillus,Nigga and candida albicans*. The effectiveveness of the complexes on the tested organism at low concentration of 20 mg/ml was in the following order copper(II), $Cu(L^1L^2)_2$> Cobalt(III) $Co(L^1)_3$> iron(III) $Fe(L^1)_3$.

I. INTRODUCTION

Bioinorganic Chemistry is a branch of inorganic chemistry that deals with metal complexes consisting ligand that are provided by nature, examples are chlorophyll complex found in green leaves (complex of Mg), and hemoglobin found in human blood (complex of Fe). It also deals with the application of transition metal complexes in the field of pharmacy and medicine. There are various definitions of transition metals. These are metals sandwich between group II and III of the periodic table. They have variable oxidation state for example Cu(I), Cu(II), Co(II) and Co(III), Fe(II) and Fe(III), etc, (Muthusamy S. 2016). Depending on the size of the metal, d-orbital configuration of the metal, geometry of the complex formed, nature and size of the ligand, transition metal complexes possess different chemical as well as physical properties.Coordination compounds or complexes are those chemical compounds form by the reaction between metals ions (Lewis acid) and the ligand (Lewis bases). Coordination compounds are inorganic in nature for the fact that they contained central metal atoms which are mostly transition metals. Some of the ligands are organic compounds for example Acetyl acetone, pyridine etc.

Acetyl acetone is a bidentate ligand containing two oxygen binding atoms. Therefore the acetyl acetone has the chemical formula $CH_3COCH_2COCH_3$ or $C_5H_8O_2$Acetyl acetone (2,4-pentanedione) exists in two isomeric forms the keto form and the enol form. These two interconvert with each other, but the process is slow such that an NMR spectrum will show signals from each separate isomer (Prodyut., *et al* 2017). The enol form of acetylacetone is reported to be more stable and it is stabilised by an internal hydrogen bond referred to as chelate enol. From the mid-IR signature of acetylacetone, it is indicated that the main tautomeric form is the chelated enol form but both the keto and enol forms coexist in both the liquid and gaseous states shown below (scheme 1).

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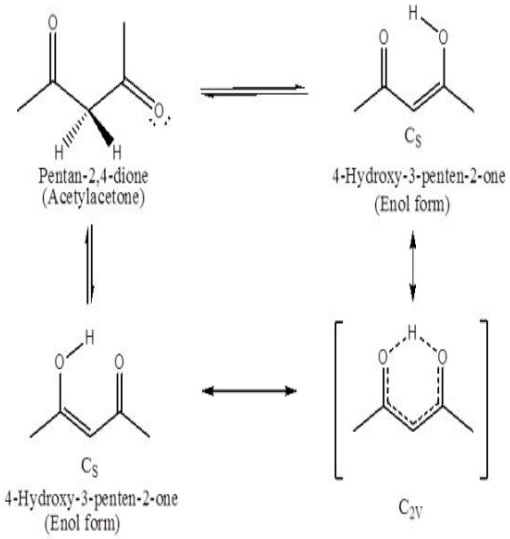


Scheme 1: Isomers of Acetyl Acetone(Prodyut, *et al* 2017)

Ataf *et al*., (2015) explained that, pyridine is a basic heterocyclic organic compound with the chemical formula C_5H_5N. The authors explained that, in many aspects it can be related to well established and very fundamental aromatic molecule, benzene, with one C-H group replaced by a nitrogen atom. Pyridine has a conjugated system of six π-electrons exactly as benzene has, that are delocalized over the heterocyclic ring. The molecule is planar in nature and follows Hückel criteria for aromaticity.

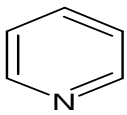


Fig 1: Structure of Pyridine (Ataf *et al*., 2015)

METAL-ORGANIC COMPLEXES

Metal-organic compounds are compounds containing both metals atoms and carbon atoms but lack covalent carbon-metal bond. In these types of complexes the metals are not directly bound to the carbon atoms instead they are bond with atoms such as N, O, S, or P which can form a dative bond with the metal. According to Warra., (2011) metal-organic complex plays an important role in the development of drugs, cosmetic formulation and in catalysis.

ANTIMICROBIAL ACTIVITY TRANSITION METALS COMPLEX

The antimicrobial activity of transition metal complex refers to the ability of the complex to stop the bacterial development either by inhibiting or killing the bacteria.

II. EXPIRAMENTAL

Materials and instrumentation

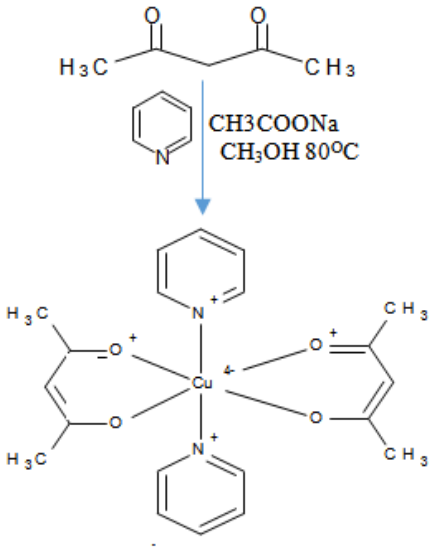
All chemicals and reagent used were of analytical grade obtained from chemistry and biochemistry laboratory of the Gombe State University and used without further purification.

IR spectra were recorded on Perking Elmer FTIR Spectrophotometer (4000– 400 cm^{-1}) in KBr pellets. UV–vis, spectra were determined in chloroform solvent for the copper(II) and the cobalt(III) complexes with concentration (1.0×10^{-3} M) using CE7400 AQUARIUM Spectrophotometer with 1cm quartz cell, in the range 100–800 nm.

A. SYNTHESIS OF $[Cu(acac)_2Py_2]$ COMPLEX

Procedure

Coper(II) chloride dihydrate ($CuCl_2.\ 2H_2O$)of 29.72 mmol was dissolved in 25 ml of distilled water over a period of 10 ml. A solution of 5ml acetyl acetone in 10 ml methanol was added with stirring over a period of 10 minutes. To the resulting mixture, 147.06 mmol sodium acetate in 15 ml of distilled water was added. Followed by the addition of 2.5 ml of pyridine the mixture was heated at 80^0C for 15 minutes and cooled in an ice path filtered and dried in an oven for 2 hours (Scheme 2) as reported by Glidewell, (2010), with little modificatio



Scheme 1: synthesis of $[Co(acac)_2Py_2]$

B. SYNTHESIS OF $[Co(acac)_3]$ COMPLEX

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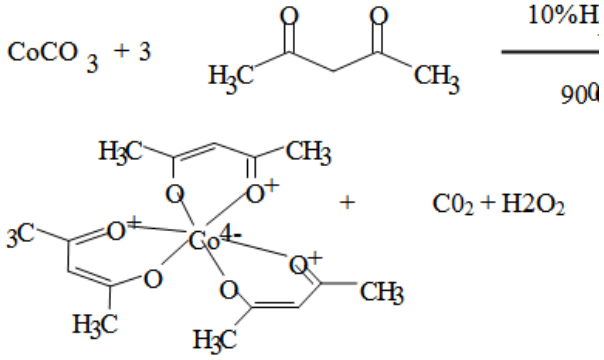
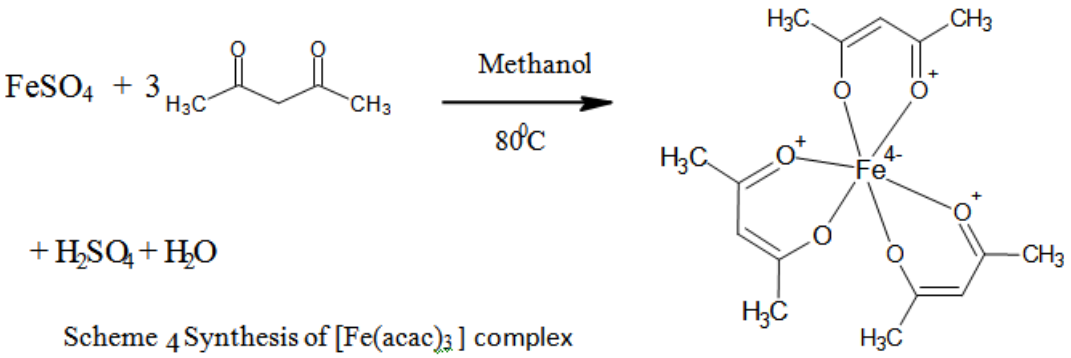
Procedure

Acetyl acetone (80 ml) was added to 31.5 mol of $CoCO_3$ and heated to 90^0C with stirring. While stirring 90 ml of 10%H_2O_2 solution was added within a period of 30 minutes. The mixture was further heated for 45 minutes and cooled in an ice path, filtered and dried in an oven for 1 hour (Scheme 2) as reported by Glidewell, (2010) with few modifications.



Scheme 3 Synthesis of [Co(acac)3] co



Scheme 4 Synthesis of [Fe(acac)3] complex

C. **SYNTHESIS OF [Fe(acac)$_3$] COMPLEX**

Procedure

Iron(II) sulphate ($FeSO_4$) was dissolves in 25 ml of distilled water over a period of 15 minutes 4ml acetyl acetone in 10 ml methanol was added. 61.50 mmol of sodium acetate in 15 ml of distilled water was added to the resulting mixture and heated to 80^0C for 15 minutes cooled in an ice path filtered and wash with cold distilled water (Scheme 3) Glidewell, (2010) with few modifications.

III. ANTIMICROBIAL SUSCETIVILITY TESTING v

A. AGAR WELL DIFFUSION METHOD

The principle of the agar well diffusion is the same as that of the agar disk diffusion method. A standardized inoculum culture is spread evenly on the surface of gelled gar plates. Wells of between 6 and 8 mm are aseptically punched on the agar using a sterile cork borer allowing at least 30 mm between adjacent wells and the Petri dish. Fixed volumes of the known concentration of the complexes are then introduced into the wells. The plates are then incubated at 37^oC for 24 h for bacteria (Mbata *et al.*, 2008).

B. PREPARATION OF MC FARLAND STANDARD

Procedure

A $BaSO_4$ 0.5 Mc Farland standards were prepared as follows;

A 0.5 ml aliquot of 0.048 mol/L $BaCl_2$ (1.175% w/v $BaCl_2$. $2H_2O$) was added to 99.5 ml of 0.18 mol/L H_2SO_4 (1% v/v) with constant stirring to maintain a suspension. The correct density of the turbidity standard was verified by using a spectrophotometer with a 1-cm light path and matched cuvette to determine the absorbance. The absorbance at 625 nm was within the standard range (0.008 to 0.10) (Lalitha, 2004).

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C. **NORMAL SALINE**

The normal saline solution is simply the 0.85% Sodium chloride (NaCl) solution and was prepared by dissolving 0.85g Sodium chloride crystals in 100 ml of distilled water (Lalitha, 2004).

D. PREPARATION FOR STOCK SOLUTION OF COMPLEXES

0.1g/ml (W/V) of the synthesized compounds in DMSO was prepared as a stocks solution for antimicrobial susceptibility testing.

E. INOCULATION OF TEST PLATES

Optimally, within 15 minutes after adjusting the turbidity of the inoculums suspension, a sterile cotton swab was dipped into the adjusted suspension. The swab was rotated several times and pressed firmly on the inside wall of the tube above the fluid level to remove excess inoculum from the swab. (Lalitha, 2004)

The dried surface of a Müeller-Hinton agar plate was inoculated by streaking the swab over the entire sterile agar surface. This procedure was repeated by streaking two more times, rotating the plate approximately 60° each time to ensure an even distribution of inoculums (Lalitha, (2004).

F. **CONTROL**

Gentamicin (10 µ/disc) and Ketoconazole 200mg/ml were used as control for antibacterial and antifungal Susceptibility Testing respectively. The antimicrobial activity of the solvents dimethyl sulphure oxide (DMSO) was measured to know whether the antimicrobial activity was only associated with the complex and not the solvent(Yahaya Pindiga and Abubakar,2020).The percentage activity index was obtained using the equation below;

$$\%\text{Activity index} = \frac{\text{zone of inhibition by test compound diameter}}{\text{zone of inhibition of Antibiotic}} \times 100.\ \text{Was obtained}$$

IV. RESULT AND DISCUSSION

In all the table and discussion the ligands acetylaceton was represented as L^1 and pyridine as L^2 the corresponding metal complexes with acetylaceton ligand of cobalt(III) and iron(III) was represented as $Co(L^1)_3$ and $Fe(L^1)_3$. The mix ligand complex of copper(II) was represented as $Cu(L^1 L^2)_2$.

The result of the physical characterization of the synthesized complexes are shown in table 1

V. CHARACTERIZATION

Table 1Molar conductivity colour melting point and % yield of complexes

Complexes	Molar conductivity (µS)	Colour	Melting points	% Yields
$Cu(L^1L^2)_2$	0.00	Blue	245-250^{0}C	76.20
$Co(L^1)_3$	0.48	Violet	210-215^{0}C	84.80
$Fe(L^1)_3$	1464	Red	134-140^{0}C	71.80

The acetyl acetonate complexes were found to show similar melting point when compared to the work of Muhammad*et al.*,(2017) in which copper acetyl acetonate complex was reported to have meting point range of 283-285^{0}C.$Co(L^1)_3$and $Cu(L^1L^2)_2$ were stable to heat and non-electrolytic which suggest that the complexes were neutral. $Fe(L^1)_3$ is electrolytic which implies that, it is charge complexes and can therefore react with counter ions.The result of the percentage yield was compared with the work of Mehmet. **(**2001) in which the Co(II), Cu(II), Ni(II), Zn(II) and Cd(II) complexes with dibenzoylaceticacit-N-carboxymethylamide as ligand had percentage yield of 87, 78, 81, 64 and 78% respectively. Even though the ligand that was used in this work was different yet there was similarities in the percentage yield.

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TABLE 2 SOLUBILITY TESTING OF COMPLEXES

solv	Water	Chlor	Pet. Et	Me.toh	Et.oh	DMSO	Acet
$Cu(L^1L^2)_2$	IS	S	IS	IS	IS	SS	SS
$Co(L^1)_3$	SS	SS	SS	SS	S	SS	SS
$Fe(L^1)_3$	IS	SS	IS	S	SS	SS	IS

SS = slightly soluble. S=soluble. IS = insoluble, Chlor = chloroform Met.oh= methanol, Et.oh = Ethanol, pet. Et = petroleum ether, Acet = acetylacetone and solv = solvent.
From Table 2 copper complexes $Cu(L^1L^2)$ was non polar and therefore dissolved in non-polar solvent (chloroform). Chloroform was regarded as non-polar solvent based on the fact that, it is immiscible with water. $Co(L^1)_3$ and $Fe(L^1)_3$ were polarand therefore dissolves in alcohols which are polar solvent.

THE UV-VIS SPECTROSCOPY OF COMPLEXES

Table 3 Uv-Visible Spectrometry for Complexes

complexes	λ(nm) Abs					
$Cu(L^1L^2)_2$	196.0	219.5	236.5	259.0	274.5	
	-0.24	-0.17	-0.05	0.035	0.004	
$Fe(L^1)_3$	430	470	490	520	540	580
	0.14	0.17	0.15	0.14	0.12	0.08
$Co(L^1)_3$	430	470	490	520	540	710
	0.13	0.53	0.62	0.65	0.58	0.34
L^1	215.5	241.5	279.0	289.0	293.0	296.5
	0.126	0.855	2.852	0.854	0.668	1.318

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Figure 2. A Plot of Absorption against Wavelength for L^1

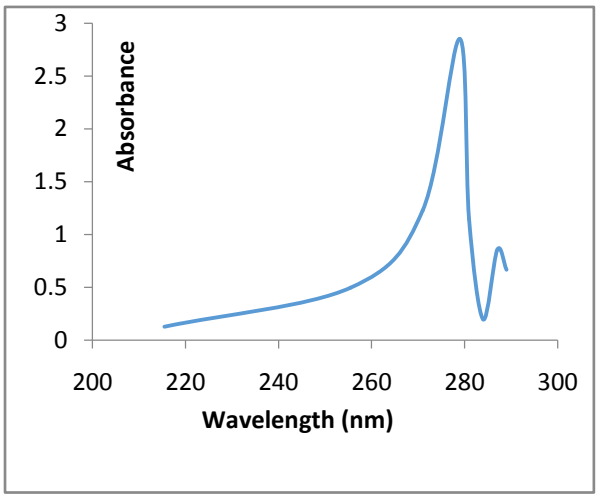


Figure 3. A Plot of Absorption against Wavelength for $Cu(L^1L^2)_2$

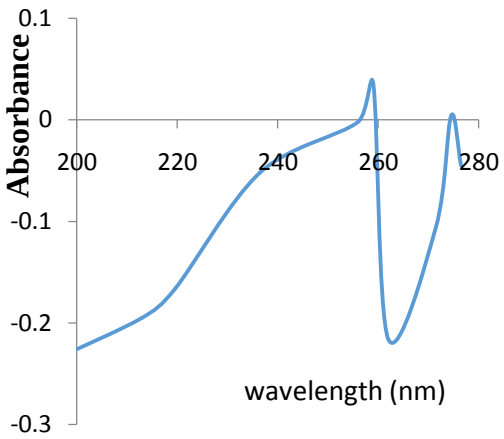


Figure 4A Plot of Absorbance against Wavelength For $Co(L^1)_3$Comple

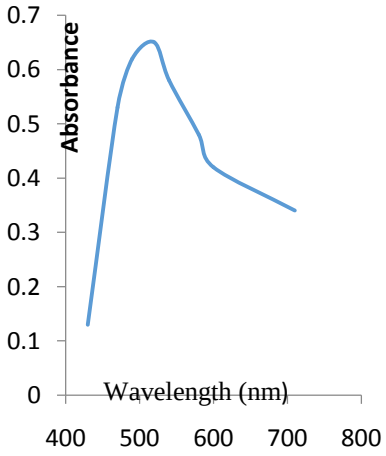
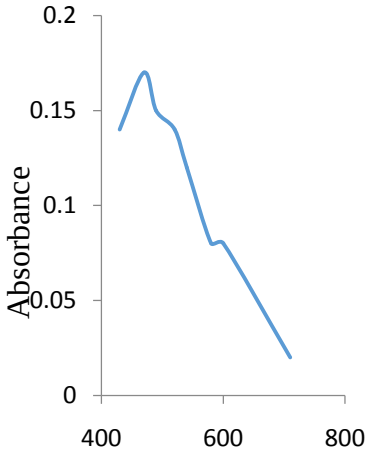


Figure 5 A Plot of Absorbance against Wavelength For $Fe(L^1)_3$Complex



The UV-Vis spectra of transition metal complexes arise as a result of electronic transitions just as they do in organic compounds. There can be more than one type of electronic transition, or excitation, taking place depending upon the nature of the chromophore(s) involved. The spectrum that you see is the combination of the different types of transitions as they occur within the compound. For instance, where a complex has a ligand that is an organic compound containing saturated bonds, such as with pyridine, the ligand will be excited and absorb UV radiation in the same way as it would do on its own. The absorption due to the pyridine ligand therefore forms part of the spectrum for the particular complex.The electronic transitions that principally give rise to absorption in the visible region and are therefore responsible for the colour of transition metal complexes, are known as *d*→*d* transitions and relate to excitation of the metal ion itself. Transition metals are often defined as forming one or more stable ions with incompletely filled d orbitals. It is believed that these are involved in generating colour.

The UV-Visible spectroscopy data of acetylacetone ligand was compared with those of the complex $Cu(L^1L^2)_2$. From table 3 the electronic spectra of the ligand L^1 (acetylacetone) show the maximum absorption band in the UV region (279.0 λmax). Upon coordination, with metals the absorption bands was shifted. The maximum absorption $Cu(L^1L^2)_2$, $Co(L^1)_3$ and $Fe(L^1)_3$ are 259λmax, 520λmax and 470λmax respectively. This indicates that, the copper complex has a maximum absortion wavelength within the ultraviolet region which implies that the complex is Centro symmetric (molecule or ion possessing acentre of symmetry)

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Therefore the colour of the complexes $Cu(L^1L^2)_2$ was attributed to n→π* transition and not d→d transition since the maximum absorption wavelength is within the ultraviolet region and not the visible region. This indicate that the complex obeyed LaPorte rule or the Orbital rule which states that, in a molecule or ion possessing a centre of symmetry, transitions are not allowed between orbitals of the same parity, for example d to d. In other words, there must be change in parity (Δl=±1), i.e. the orbital quantum number should differ by 1. The forbidden transitions are s → s, d → d, p → f. etc. The geometries affected by this rule include octahedral and square-planar complexes. The rule is not applicable to tetrahedral complexes as it they do not contain a center of symmetry.

The difference in λmax between the ligands and the metals complexes can be explained as, when ligands bond to a transition metal ion to form a complex, electrons in the ligands and electrons in the five d orbitals of the metal ion repel each other. As a result the energies of the d orbitals are raised; and split into two groups of differing energy. For instance when white light is passed through a solution of the Cu^{2+} ion, some of the energy is used to promote (or excite) an electron from an orbital in the lower group to an available orbital in the upper group. The energy that is absorbed is equal to the energy gap between the two groups. The size of the energy gap between the two groups of d orbitals will vary with the transition metal ion, its oxidation state and the nature of the ligands. The further apart the groups are split, the greater the energy required to promote an electron (and the shorter the wavelength).

$Co(L^1)_3$ and $Fe(L^1)_3$ complexes had maximum absorption wavelength within the visible region Therefore the colour of the complexes $Co(L^1)_3$ and $Fe(L^1)_3$ was attributed to d→d transition and not n→π* hence they do not obey the LaPorte rule.

The UV-visible spectroscopy results were compared with the work of Tripathi, and Aarti, (2015) in which the author obtained values of maximum absorption wavelength (λmax (nm)) within the ultraviolet (UV) region for complexes of copper(II) with L-Asparginine, L-Histidine, L-Lysine as ligand ($[Cu (asp) 2]^{2+}$ = 257 λmax (nm), $[Cu (his) 2]^{2+}$ = 288 λmax (nm), $[Cu (lys) 2]^{2+}$ = 364 λmax (nm)). Although the author used a different ligand yet the maximum absorption wavelength (λmax) values were similar to ones obtained in this research. From table 3, $Cu(L^1L^2)_2$ = 259 λmax (nm)

Table 4 FTIR Data of the Complexes

Ligands and complexes	functional groups						
	νC=O	ν C=C	CH_3 str.	νC-H	ν M-O	ν(M-N)	ν(C-N)
L^1	S1645.26	-	W2926.64	S1364.43	-	-	-
L^2	-	-	-	S1440.75	-	-	-
$Cu(L^1L^2)_2$	S1538.04	S1531.76	W2922.1	S1415.99	S454.56	M782.22	M1189.13
$Co(L^1)_3$	S1613.49	S1519.79	W2924.70	S1462.77	S566.61	-	-
$Fe(L^1)_3$	S1573.69	S1424.48	W2920.44	S1422.20	S559.50	-	-

S = Strong, W = Weak M = medium

From FTIR Result for Cu $(L^1L^2)_2$Complex table 4, the νC-N vibration frequency with medium absorption at 1189.13 confirmed the present of pyridine in the complex.

The FTIR results for $Fe(L^1)_3Co(L^1)_3$complexes were compared with the work of Olga,(2008) and was found to have different values. The absorption due to M-O stretching vibration in $Fe(L^1)_3$and $Co(L^1)_3$ were found to be S559.50 and S566.61 respectively. Olga,(2008) reported 435 (S) and S466 as values for the absorption due to M-O stretching vibration in Fe and Co complexes. Although the author also used acetylacetone as ligand the variation arises due to the solvent used in the synthesis and the reaction conditions.

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FTIR SPECTRAL FOR THE COMPLEXES

Figure 6 FTIR spectral for $Cu(L^1L^2)_2$ complex

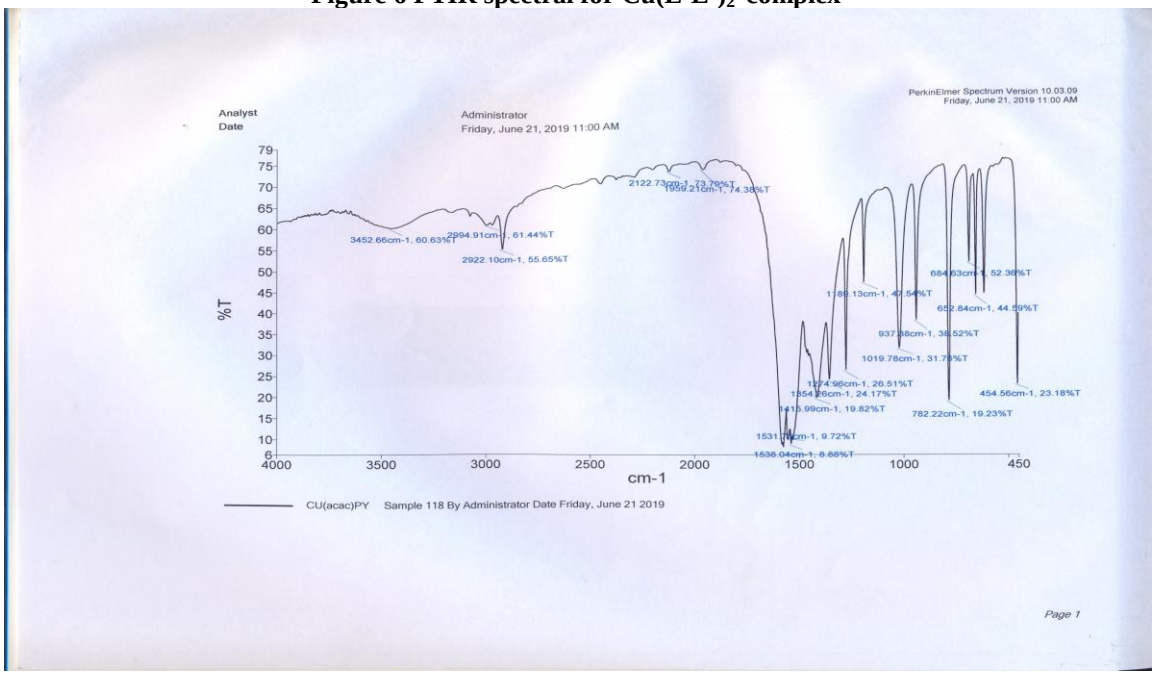

Figure 7 FTIR spectral for $Co(L^1)_3$ complex

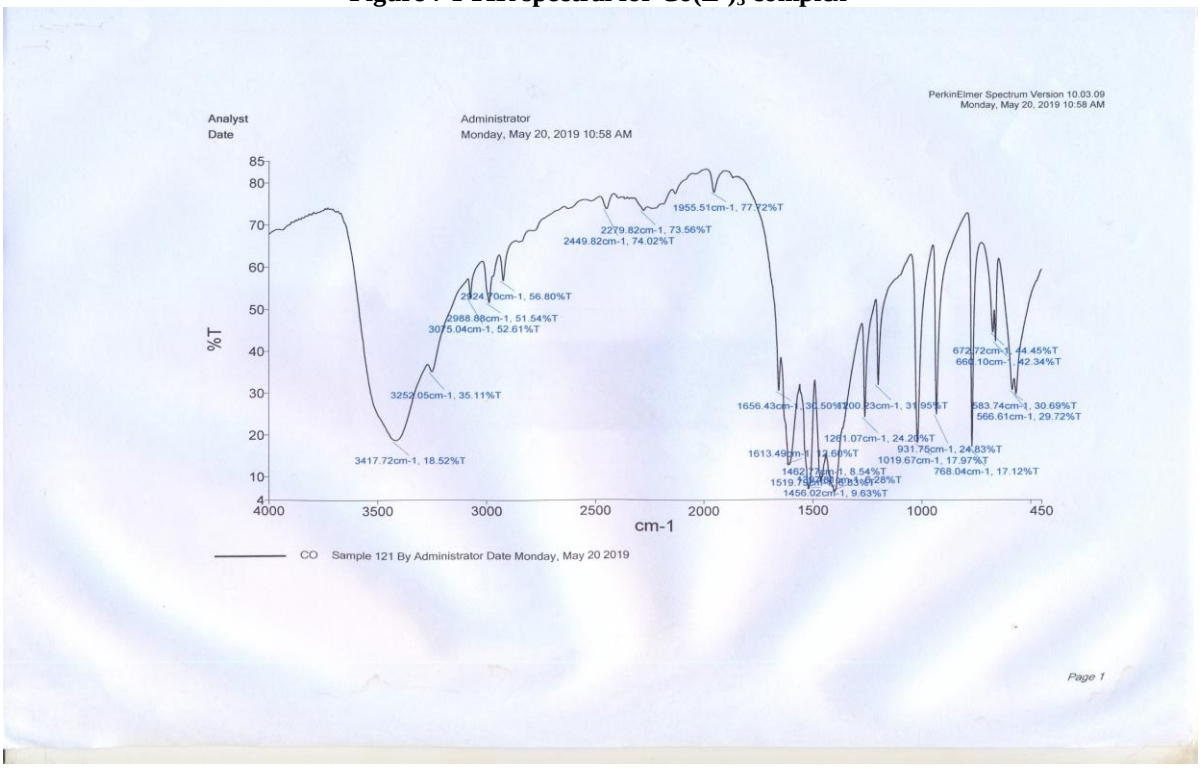

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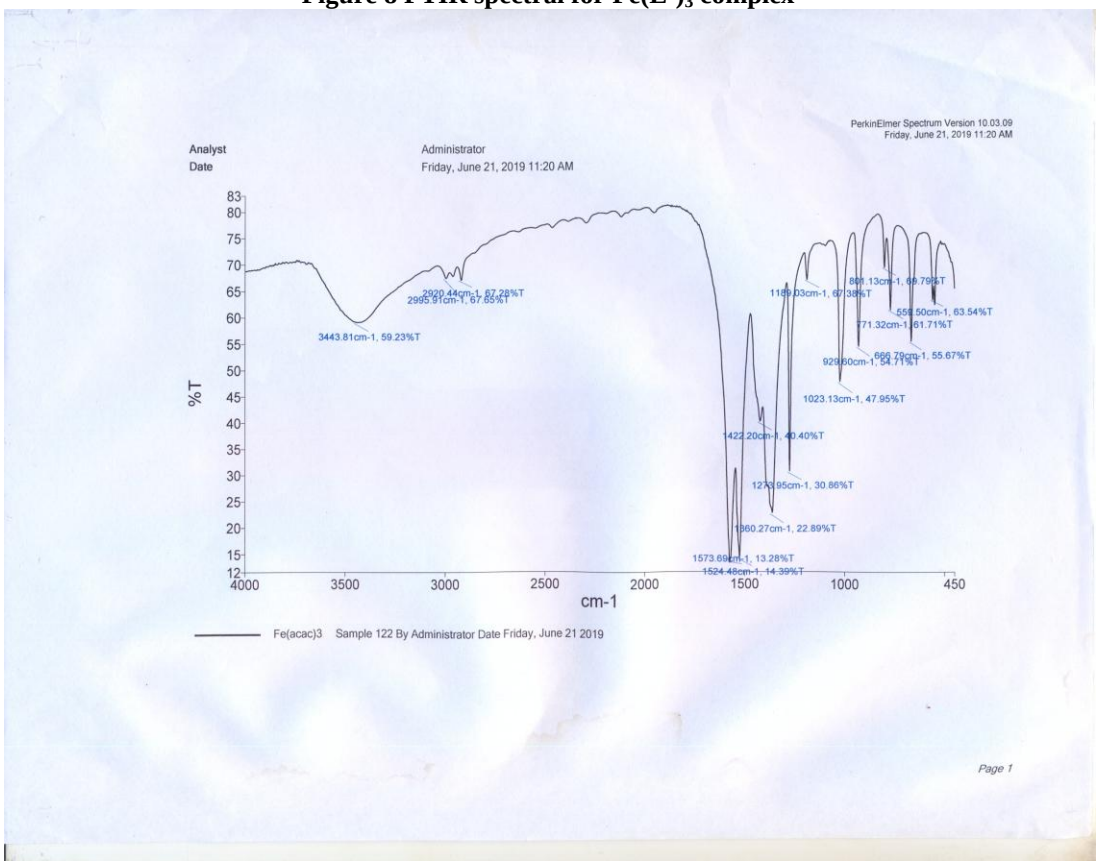
Figure 8 FTIR spectral for $Fe(L^1)_3$ complex



ANTIMICROBIAL SUPSEPTIVITY TESTIN

Table 5 Antimicrobial Activity of $Cu(CuL^1L^2)_2$ Mean ZI (mm)
Concentration (mg/ml)/(% activity index)

	10	15	20	CONTR
SA	15(74.3)	16(80)	16(80)	21
BA	11(126)	12(133.3)	13(146.2)	9
EC	15(88.2)	15(88.2)	15.6(91.8)	17
PA	12.6(74.1)	16.6(97.6)	17.4(102)	17
AN	13(88)	15(100)	15(100)	15
CA	11(81.4)	12(85.7)	12(90)	14

BA = *Bacillus aureus*,PA=*speudomona auregenosa* SA= *staphylococcus aureus*,EC = *Escherichie Coli*,AN=*Aspergillus,Nigga*,CA= *candida albicans*and ZI=zone of inhibition.
(Yahaya Pindiga and Abubakar,2020)

From Table 5 at a maximum concentration of 20 mg/ml for (CuL^1L^2)
The complex $Cu(L^1L^2)_2$ was found to have intermediate antimicrobial properties toward *E.coli, staphylococcus aureus and candida albecan*. *Bacillus aureus, speudomona auregenosa and Aspergillus* was found to be susceptible by CuL^1L^2 as compared to controls the significant antimicrobial proper observe with this complex was mainly due to aromatic N=C in pyridine as it attaches to the central metal (copper) the result was compared with the work of (Bhushan *et al*.,2019).

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Table 6 Antimicrobial Activity of $Co(L^1)_3$Mean ZI (mm)
Concentration (mg/ml)/(% activity index)

	10	15	20	CONTR
SA	6.6(30)	6.6(30)	15(68)	22
BA	16.2(135)	18(150)	18(150)	12
EC	7.8(43.3)	9.6(53.3)	13.2(73.3)	18
PA	13(76.5)	13(76.5)	14(82.4)	17
AN	13(86.7)	13(86.7)	14(93)	15
CA	13(76.5)	15(88.2)	15(88.2)	17

BA = *Bacillus aureus*,PA=*speudomona auregenosa* SA= *staphylococcus aureus*,EC = *Escherichie Coli*,AN=*Aspergillus,Nigga*,CA= *candida albicans*and ZI=zone of inhibition
(Yahaya Pindiga and Abubakar,2020)
From table 6 at a maximum concentration of 20mg/ml for CoL^1complex

Bacillus aerius was susceptible by $Co(L^1)_3$ and had intermediate antimicrobial property toward *staphylococcus aureus, E.coli, Pseudomonasaeruginnosa, Aspergillus and candida albicans.* The result was compared with the work of Podunavac-Kuzmanović et al, (2008) in which the results of the antibacterial studies of the cobalt(II) complexes with benzylbenzimidazole derivatives as ligandsdisplayed in vitro antimicrobial activity against very persistent micro-organisms. The investigated complexes were found to be more active against Gram-positive than Gramnegative bacteria (*Pseudomonas aeruginosa*). Likewise in Table 6 above the cobalt complex even though with a different ligand were found to be more active against Gram-positive (*Bacillus aerius*) than Gram negative (*Pseudomonas aeruginosa and Escherichie Coli*). In this regard it was suggested that, $Co(L^1)_3$ complex kill or inhibit the bacterial growth through the cell wall of the bacteria.

Table 7 Antimicrobial Activity of$Fe(L^1)_3$Mean ZI (mm)
Concentration (mg/ml)/(% activity index)

	10	15	20	CONTR
SA	9(40.9)	9(43.6)	10(46.4)	22
BA	8(80)	11.4(114)	12(120)	10
EC	7(36.8)	8(42.1)	10(52.6)	19
PA	12.6(74.1)	13.2(77.6)	15(88.2)	17
AN	13(86.7)	14(93.3)	15.6(104)	15

BA = *Bacillus aureus*,PA=*speudomona auregenosa* SA= *staphylococcus aureus*,EC = *Escherichie Coli*,AN=*Aspergillus,Nigga*. and ZI=zone of inhibition
(Yahaya Pindiga and Abubakar,2020)
From table 7 at a maximum concentration of 20mg/ml for $Fe(L^1)_3$:

Bacillus aerius was susceptible by $Fe(L^1)_3$, while intermediate antimicrobial was observed with *E.coli, pseudomonas aureginosa and candida albicans*. *Staphylococcus aureus* tend to resistant the complex ($Fe(L^1)_3$) at maximum concentration of 20mg/ml. The result was compared with the work of Piedad, (2008) in which the iron complexes with 2-methyl-imidazolium and 2,2-bipyridine as ligands were found to had antibacterial activity, through according to the author "they are cytotoxic to human cells". However, they could possibly be used as disinfectants since after being applied to a surface and later washed away; the toxicity would be very low".

Table 8 Antimicrobial Activity of DMSO Mean ZI (mm)

Concentration (%)/(% activity index)

	100	75	50	CONTR
PA	00(00)	00(00)	00(00)	20
KP	00(00)	00(00)	00(00)	20
BA	00(00)	00(00)	00(00)	20
EC	10(50)	00(00)	00(00)	20
CA	00(00)	00(00)	00(00)	17
AN	00(00)	00(00)	00(00)	15

PA= *speudomona auregenosa,* KP= *Klebsiella Pneumoniae,* BA= *Bacillus aureus,* EC= *Escherichie Coli,* AN=*Aspergillus,Nigga,*CA= *candida albicansand* ZI = zone of inhibition
(Yahaya Pindiga and Abubakar,2020)

Antimicrobial activity of dimethyl sulphure oxide (DMSO) was investigated to know whether there was solvent contribution to the observed antimicrobial properties. *Pseudomonas auregenosa, Klebsiella pneumonia Bacillus aerius,Aspergillus,Nigga* and *candida albicans*were found to be 100% resistance to DMSO. A zone of inhibition of 10mm was observed with *E. coli* at 100% DMSO concentration. It therefore means that as for the *E.coli* DMSO has contributed a little for the antimicrobial activity that was observed. The result was compared with the work of Hendric., *et al* (2010) in which the author was able to identified several Bacterial isolates capable of growth on DMS as a sole source of carbon and energy.

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