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SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF MIXED HYDROXYL – AMINE GROUP METAL DRUG COMPLEXES

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Abstract: A series of new mixed anthranilic acid – ethambutol complexes [Co(ETB)(Ant)Cl_2] (1), [Cd(ETB)(Ant)Cl_2] (2), and [Cu(ETB)(Ant)Cl_2] (3) where ETB= Ethambutol and Ant= Anthranilic acid, were synthesized by refluxing method and characterized using spectroscopic techniques such as infrared and ultraviolet/visible, elemental analysis, conductivity measurement and magnetic susceptibility. The ligands act as bidentate type coordinating to the central metal ion through the oxygen of the hydroxyl group and nitrogen of the amine group. Octahedral, square planar and tetrahedral geometry has been assigned to the Co(II), Cd(II) and Cu(II) complexes respectively. Towards the *in vitro* biological potentials, the ligands and the metal complexes were screened for antibacterial, antioxidant and antitubercular activities. The complexes were found to have an increased activity compared to their free parent ligands. This research work concluded that the mixed metal complexes of anthranilic acid – ethambutol showed promising activity against the selected organisms and as such exhibit candidates for treatment of ailments.

Keywords: *metal complexes; anthranilic; ethambutol; antibacterial; antioxidant; antitubercular.*

I. INTRODUCTION

The field of coordination complexes is a rapidly developing area at the fastest rate based on different possible structures obtainable when drug molecules acting as free ligands are fine-tuned upon complexation with a metal ion [1]. Coordination compounds have found various applications in the clinical and analytical chemistry. Furthermore, they play significant roles in catalysis and organic synthesis [2].

Many researches have been carried out to determine how central metal ion coordination affects the effectiveness of the drug. [3]. Metal drug complexes are gaining more ground in the design of drug upon chelation with the central metal ion. Effectiveness of some complexes has been known upon coordination; however, metal-based drug has been seen as an alternative for replacement for some of the present drugs.

In pharmaceutical chemistry, metal drug complexes have obtained a great attention in the production of anticancer drugs using platinum which has a great effectiveness and helped to reduce the harmful side effect [4]. The well- known potential employment of complexes in the therapeutic use provides important outlet for research in metal [5]. Coordination between central metal ions and ligands has attracted great attention and also help to relate their chemistry to establish whether coordination has effect on the pharmacological properties of the ligand [6,7]. Some biological effective compounds which are used as drugs exhibit pharmacological and toxicological potentials when taken in the form of metal-based compound [8, 9].

In the development for new alternative drug against parasites, the use of complexes has called a great attention in few years back [10-12].

Anthranilic complexes have various uses in our daily life where some are useful to human while some are toxic to human life [11]. It was observed that copper complexes of anthranilic acid could be active for sterilization of chest wound [12-15]. The aim of this research work is to synthesize and evaluate the *in vitro* antibacterial, antioxidant and antitubercular activities of new metal complexes which will be more active than their free ligands.

II. MATERIALS AND METHODS

All the chemicals and reagents used were purchased from BDH Sigma Aldrich. The ligands: Ethambutol and Anthranilic acid were also obtained from BDH Sigma Aldrich.

The melting point of the complexes was recorded using Gallen Kamp melting point apparatus. The molar conductivities were obtained from measurements on a HANNA instrument with cell constant 1.54. The elemental analysis of the complexes was carried out on Perkin Elmer 240C elemental analyzer. The ultraviolet-visible spectra were recorded on Aquamate V4.60 spectrophotometer at the Department of Chemistry, University of Ilorin. The magnetic susceptibility measurements were recorded on Guoy balance model 7550. The antibacterial activity screening was done using disc diffusion method. The strains of bacteria were collected from Microbiology Department, University of Ilorin Teaching Hospital, Ilorin Kwara state Nigeria. Fungal species were obtained from infected part of the potato dextrose agar. The fungi were cultured and purified by single spore isolation method.

A. Synthesis of the complexes

Solution of ethambutol (0.204 g) in 10 ml of distilled water and solution of anthranilic acid (0.137 g) in 10 ml of ethanol were prepared. Solutions of Co(II), Cd(II) and Cu(II) ions (0.129 g, 0.183 g, 0.134 g) respectively in 20 ml of distilled water each were also prepared and added to the mixed ligands solution. The clear solution obtained was refluxed at 78 ℃ for three hours and left to cool to room temperature. The precipitates formed were filtered and washed with mixed ethanol-distilled water to remove any unreacted ligands which might still be present. Precipitate was dried and kept in a desiccator over silica gel. It was observed that complexes maintain the color of the metal used and was stable in air.

B. Biological activity of the complexes

i) Antibacterial activities: The complexes were screened against some selected organisms (*Klebsiella pneumoniae, Bacillus subtilis Escherichia coli Staphylococcus aureus, Pseudomonas aeruginosa and Streptococcus faecalis*). 5 mg/ml of the complexes in Dimethyl sulfoxide was prepared for screening against antibacterial activity. The synthesized complexes were tested on seeded nutrient agar. The prepared nutrient agar was poured on the petri dish and hole was drilled out at the center with 1 cm diameter borer. 0.5 mL solution each of the ligands and metal complexes was introduced into the drilled hole and allowed to disperse evenly. It was incubated at 37 ℃ for 24 hours [16]. The activity was determined by measurement of the zone of inhibition that is formed around the hole of the agar. The percentage was evaluated based on the average diameter of the colony on the growth agar in relation to their controls according the following equation.

$$\% \text{ Inhibition} = \frac{A - B}{A} \times 100$$

A = Average diameter of the growth on the control
B =Average diameter of the growth on the screened plate.

ii) Antifungal activity: The complexes were tested against spore germination of each of the fungus species (*Aspergillus niger, Candida krusei, Candida parapsilosis, Candida salbicans* and *Cryptococcus neoformans*) as reported by Raman *et al*., 2001 [16]. The activity was done using disc diffusion technique. Dimethyl sulfoxide acts as control. The selected organisms were cultured on a medium of potato dextrose agar. The plate was prepared containing the agar and a hole was drilled by inoculating with the fungi. Solution of the complexes and their ligands were introduced into the hole with the use of micropipette and incubated for 72 hours at temperature of 37 ℃. The solution of the complexes and ligands diffused out and growth was observed. The zone of inhibition was determined.

iii) Antitubercular activity: The synthesized metal drug complexes were screened for antitubercular activity to determine their effectiveness when compared with their parent ligands as presented in **Table IX and X**. The complexes were screened against five strain of Mycobacterium tuberculosis (1191, 1192, 1373, 1272 and 2028) at concentration 5 µg/mL. They were inoculated together with the standard and the complexes. They were incubated at a temperature of 37 ℃ for about 4 weeks. The inspected bottles were noticed for growth twice a week for about 3 weeks. Results were observed at the end of the incubation period. The development of turbidity was found to be the bacterial growth which indicates resistance to the metal complexes. The bacterial growth was confirmed by the formation of a smear from the bottles and carried out a zinc stain. The tested complexes were compared with the antitubercular ligand (ethambutol) [17].

iv) Minimum Inhibitory Concentration: The procedure described by Ogunniran, *et al.,* 2016 [18] was adopted. The synthesized complexes were screened and evaluated against strain of antituberculosis H37Rv with the use of micro plate Alamar blue assay (MABA). A form of serial dilution

of the complexes (10 µg/ml) was prepared. The prepared plates containing the complexes were covered and incubated at a temperature of 37 ℃ for about four days. Immediately after incubation, about 10 ml of Alamar blue reagent and 15 % of tween 80 was mixed together and introduced into the plate. It was incubated for about 24 hours.

v) Antioxidant Activity: Procedure followed by Benziea, *et al.,* 1996 [19] was adopted to determine the antioxidant activity. The activity of the metal drug complexes were determined as their ability to decrease the Tripyridyl-*s*-triazine –Fe(III) compound to Tripyridyl-*s*-triazine–Fe(II) compound. It is a very reliable method. Solution of ferric reducing antioxidant power was prepared by measuring 15 ml of 5 mM Tripyridyl-*s*-triazine solution in 20 mM HCl, 15 mM $FeCl_3.6H_2O$ and 10 ml of 0.25 M acetate buffer at pH of 4.0. About 20 ml of 0.25 mM of the solution of the complexes and 1.0 ml of ferric reducing antioxidant reagent were mixed together and incubated for about 20 minutes at 37 ℃. Absorbance of Fe(II)-Tripyridyl-*s*-triazine was determined at 625 nm. Anthranilic acid acts as a standard. The procedure was repeated three times. They are evaluated as the mean and standard deviation.

III. RESULTS

i) Physicochemical properties and antioxidant activity of the ligands and their complexes

The mixed metal complexes of ethambutol and anthranilic acid has been synthesized and characterized. The melting points of the complexes are higher than their parent free ligands when compared with different melting point within 160-173 ℃ as presented in Table I and Table II. Cd(II) and Cu(II) complexes show low yield of 35% and 30% respectively except Co(II) which yield 52 %. Cd(II) complex revealed the highest conductivity of 6.31 followed by Co(II) complex with 4.20 and Cu(II) complex with 3.71. The elemental analysis of the complexes (Experimental/Theoretical) obtained were found to be in good agreement with each other.

$MCLn + L_1 + L_2 = [ML_1L_2]Cln$

Where; L_1 = Ethambutol, L_2 = Anthranilic acid, M = Co(II), Cd(II) and Cu(II) while n=2

ii) Infrared spectra of the ligands and their complexes

The Infrared spectra of the ligands and their synthesized complexes were recorded and compared as presented in Table III and Figure 1. This was observed that the parent free ligands coordinated through the oxygen of the hydroxyl group and nitrogen of the amine group. There is shift to higher frequencies in all the metal complexes. New bands around 536-581 cm^{-1}which were originally absent in the free ligands were assigned to the metal-ligand bond.

TABLE I: PHYSICOCHEMICAL PROPERTIES OF THE LIGANDS AND THEIR COMPLEXES

Ligand/ complexes	Melting point (℃)	Yield (%)	Conductivity $\Omega^{-1}cm^{-1}mol^{-1}$
ETB	87-88	80	-
Ant	135-137	65	-
Co(II) complex	167-169	52	4.20
Cd(II) complex	171-173	35	6.31
Cu(II) complex	160-162	30	3.71

TABLE II: ELEMENTAL ANALYSIS AND ANTIOXIDANT ACTIVITY (AA) OF THE LIGANDS AND THEIR COMPLEXES

Ligand/ complexes	Elemental Analysis (%) (Experimental/Theoretical)				AA (1mmol/ 100 g)
	C	H	N	M	
ETB	-	-	-	-	-
Ant	-	-	-	-	600
Co complex	43.54/ 43.31	6.23/ 6.58	8.31/ 8.92	12.06/ 12.53	526
Cd complex	38.00/ 38.93	5.16/ 5.92	8.32/ 8.02	21.32/ 21.37	417
Cu complex	43.17/ 43.40	6.49/ 6.60	8.37/ 8.94	12.27/ 12.34	436

TABLE III: INFRARED SPECTRA DATA OF THE LIGANDS AND THEIR COMPLEXES

Ligand/ complexes	υ(O-H)	υ (CN)	υ (NH)	υ(M-O)	υ (CO_2H)
Ant	3303	1236	3108	-	3124
ETB	3361	1242	3148	-	-
Co complex	3398	1291	3264	548	3247
Cd complex	3391	1287	3286	536	3218
Cu complex	3376	1281	3263	581	3263

iii) Ultraviolet/ visible spectra of the ligands and their complexes

The Ultraviolet/visible spectra of the ligands and their free ligands are presented in Table IV. Their complexes have been assigned and interpreted in terms of charge transfer transitions of the central metal ions to the antibonding orbital of the ligand. According to the result obtained, Cobalt complex indicate three absorption bands which are attributed to $^3T_1g(F) \rightarrow {}^3T_2g$, $^3T_1g(F) \rightarrow {}^3T_2g(P)$ and $^3T_1g(F) \rightarrow {}^3A_2g$ transitions respectively. These assignments are in high spin octahedral geometry with magnetic

moment of 4.59 B.M. The Cd(II) complex with two absorption band at 228 nm and 231 nm are assigned to $\pi - \pi^*$ and $\pi - \pi^*$ with magnetic moment of 3.04 B.M. Cu complexes indicate two absorption bands of 449 nm and 376 nm. They are attributed to $^2B_1g \rightarrow {}^2A_1g$ and $^2B_1g \rightarrow {}^2E_1g$.

TABLE IV: ELECTRONIC SPECTRA AND MAGNETIC MOMENT

Ligands/ complexes	Wavelength (nm)	Assignment	U_{eff} (B.M)
Ant	237	$\pi - \pi^*$	-
	246	$\pi - \pi^*$	
ETB	229	$\pi - \pi^*$	-
	241	$\pi - \pi^*$	
Co complex	409	$^3T_1g(F)$-^3T_2g	4.59
	323	$^3T_1g(F) \rightarrow {}^3T_2g(P)$	
	336	$^3T_1g(F) \rightarrow {}^3A_2g$	
Cd complex	228	$\pi - \pi^*$	3.04
	231	$\pi - \pi^*$	
Cu complex	449	$^2B_1g \rightarrow {}^2A_1g$	1.79
	376	$^2B_1g \rightarrow {}^2E_1g$	

iv) Antibacterial activity of the ligands and their complexes.

The study of *in vitro* activity of the parent free ligands and their complexes are presented in Table V and Table VI. The results showed that the metal complexes were found to be more effective than their parent ligands against the selected organisms. Anthranilic acid showed a very low zone of inhibition at 2.15 mm against *Staphylococcus aureus* while the complex (1) indicated the highest inhibition zone of 36.85 mm.

TABLE V: ANTIBACTERIAL ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

Ligand/ Complexes	*S. aureus*	*P. aeruginosa*	*S. faecalis*
	Zone of inhibition (mm)		
Ant	2.15	5.00	0
ETB	4.76	2.53	2.49
Co complex	31.52	15.70	36.85
Cd complex	23.64	33.52	21.07
Cu complex	14.30	25.18	32.56
DMSO	-	1.06	-

Note: (Table V is Continuing to Table VI)

TABLE VI: ANTIBACTERIAL ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

Ligand/ Complexes	*K. pneumoniae*	*B. subtilis*	*E. coli*
	Zone of inhibition (mm)		
Ant	7.32	5.17	0
ETB	8.05	5.00	7.38
Co complex	16.38	27.06	29.11
Cd complex	29.34	20.47	35.78
Cu complex	34.41	25.79	27.95
DMSO	0.96	1.18	-

Key: ***K= Klebsiella B= Bacillus E= Escherichia***

v) Antifungal activity and Minimum Inhibitory Concentration of the ligands and their complexes.

Anthranilic acid and ethambutol (ligands) show very low zone of inhibition against the selected organisms in Table VII and Table VIII. Ethambutol has the lowest inhibitory zone of 1.79 mm against *Cryptococcus neoformans*. The agar well-diffusion method was used for the evaluation of zone of inhibition and minimum inhibitory concentration. According to the results, the complexes were compared favourably with the ligands used. The nucleophilic character of nitrogen in the complexes and the charge that occur in the molecules might help to assist in the penetration through the wall of the fungi cell wall. Increase in the polarity of the compounds can also assist the compounds to relate more easily through the cell membrane. The minimum inhibitory concentrations (MIC) for the complexes were observed between 15.76 – 40.35 mm, while that of their ligands ranges between 2.39 – 40 mm.

TABLE VII: ANTIFUNGAL ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

L&C	*A. niger*	*C. krusei*	*C. parapsilosis*	*C. albicans*
	Zone of inhibition (mm)			
Ant	5.06	2.39	7.35	0
ETB	3.12	7.61	4.05	9.05
Co complex	27.05	22.37	20.45	21.73
Cd complex	35.04	23.52	29.04	34.60
Cu complex	40.35	15.76	18.73	26.18
DMSO	-	-	-	-

Key: **L&C = Ligand & Complexes**

Note: (Table VII is Continuing to Table VIII)

TABLE VIII: ANTIFUNGAL ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

L&C	*C. neoformans*	MIC (µg/mL)	IC_{50} x 10 (µg/mL)	SI (IC_{50}/ MIC)
	Zone of inhibition (mm)			
Ant	2.71	1.02±0.86	1.75	1.71
ETB	1.79	0.58±0.26	0.87	1.50
Co complex	30.32	0.92±0.34	1.76	1.91
Cd complex	21.45	0.62±0.86	1.04	1.67
Cu complex	29.52	0.77±0.47	1.88	2.44
DMSO	0.75	-	-	-

vi) Antitubercular activity of the ligands and their complexes.

Anthranilic acid and Ethambutol were used as reference ligands against the five selected resistant strains of *Mycobacterium tuberculosis* as presented in Table IX and Table X. This activity was done for four weeks. The rate of growth was monitored continuously to evaluate the resistance of the strains against the complexes. Cu(II) complex indicated significant resistant and were found to be the most effective drug against all the strains. Cd(II) complex also exhibited four weeks resistance against the three strains (1191, 1373 and 2028).

TABLE IX: ANTITUBERCULAR ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

L&C	Anthranilic acid (G.A)	Ethambutol (G.A)	(1) (G.A)
Strain			
1191	1 (1 week)	17 (1 weeks)	26 (3 weeks)
1192	3 (1 week)	13 (1 weeks)	31 (3 weeks)
1272	1 (1 week)	21 (1 weeks)	24 (3 weeks)
1373	2 (1 week)	15 (1 weeks)	27 (3 weeks)
2028	1 (1 week)	23 (1 weeks)	31 (3 weeks)

Key: Gestational Period

Note: (Table IX is Continuing to Table X)

IV. DISCUSSION

i) Chemistry of the ligands and their synthesized complexes: The physicochemical properties of the ligands and complexes are presented in Table I and Table II. Based on the elemental analysis data, the complexes are in good agreement with each other confirming the stoichiometric ratio 1:1. The complexes were found to be stable in air and having a high melting point within the range of 160-173 ℃ when compared with the ligand due to complexation. The high melting point is due to increase in molecular weight of complexes [20]. The conductivity values obtained showed the complexes to be non-electrolytic in nature.

TABLE X: ANTITUBERCULAR ACTIVITY OF THE LIGANDS AND THEIR COMPLEXES

L&C	(2) (G.A)	(3) (G.A)	Control (G.A)
Strain			
1191	32 (4 weeks)	29 (4 weeks)	3 (1 week)
1192	20 (4 weeks)	35 (4 weeks)	7 (1 week)
1272	27 (4 weeks)	29 (4 weeks)	5 (1 week)
1373	38 (4 weeks)	31 (4 weeks)	2 (1 week)
2028	34 (4 weeks)	35 (4 weeks)	2 (1 week)

Key: Gestational Period

ii) Antioxidant activity of the ligands and their complexes: The antioxidant activity of the ligands and their complexes are presented in Table II. The activity was determined using Ferric reducing antioxidant power assay technique. The assay was determined as standard antioxidant. Anthranilic acid at 1 mmol/100g. Based on the data obtained, it was observed that all the metal drug complexes possessed a reducing antioxidant power. Co(II) complex has a relatively high antioxidant activity among other complexes when compared [21]. The order of activity is as follows: Co(II) complex > Cu(II) complex > Cd(II) complex > anthranilic acid > ethambutol. The antioxidants potential values have helped to search for the effects of complexes and their free ligands to improve the activity. Based on their structure and the oxidative stress, the compounds act as antioxidants. It will also be based on a new way to synthesize antioxidant metal complexes.

iii) Infrared spectra of the ligands and their complexes: The IR spectra of the ligands and their metal complexes are presented in Table III and Figure 1. The band at 3124 cm^{-1} in the spectra of anthranilic acid ligand is attributed to (COOH). It was prominent in all the complexes which correspond to previous studies [22]. The (N-H) stretching band of anthranilic and ethambutol occur at 3108 cm^{-1} and 3148 cm^{-1} respectively. They were shifted to higher frequencies in all the complexes around 3263 cm^{-1}- 3286 cm^{-1}. This indicated that in anthranilic acid, coordination

occurs through the oxygen of the hydroxyl group and nitrogen of the amine group [23]. New bands around 536 cm^{-1} - 581 cm^{-1} in the complex spectra which were conspicuously absent in the ligands were assigned to the metal to oxygen in all the complexes. In ethambutol, coordination occurs through the oxygen of the hydroxyl group and nitrogen of the amine group. The band at 3148 cm^{-1} is attributed to (N-H) bending in ethambutol which was shifted to higher frequency 3264 cm^{-1}, 3286 cm^{-1}, 3263 cm^{-1} in Co(II), Cd(II), Cu(II) respectively [24].

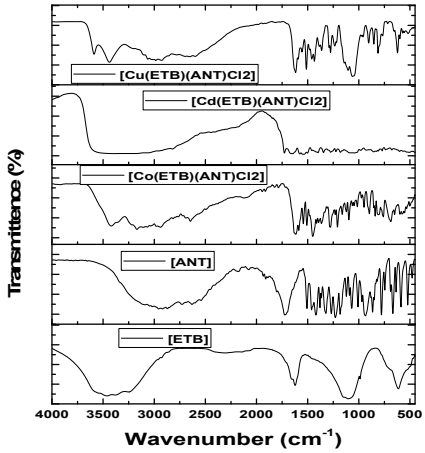

Figure 1. Infrared spectra of the ligands and their complexes.

iv) Ultraviolet/visible spectra of the ligands and their complexes: The UV spectra of the ligands and their complexes in DMSO solution are presented in Table IV and Figure 2. The UV spectra of cobalt complex showed three absorption bands 409 nm, 323 nm and 336 nm are assigned to $^3T_1g(F) \rightarrow {}^3T_2g$, $^3T_1g(F) \rightarrow {}^3T_2g(P)$ and $^3T_1g(F) \rightarrow {}^3A_2g$ transitions respectively. These absorption band are showed to be in high spin octahedral geometry and exhibit magnetic moment of 4.59 B.M. Cd(II) complex showed two absorption band at 228 nm and 231 nm which are attributed to $\pi - \pi^*$ and $\pi - \pi^*$. This indicates that they are found to be in square planar geometry [25] with magnetic moment of 3.04 B.M. Cu complexes showed two absorption bands which are observed at 449 nm and 376 nm. The two bands are attributed to $^2B_1g \rightarrow {}^2A_1g$ and $^2B_1g \rightarrow {}^2E_1g$ possessing tetrahedral geometry. Its magnetic moment is 1.79 B.M which is found to be mononuclear in nature which is due to contribution of orbital and spin orbit coupling [26].

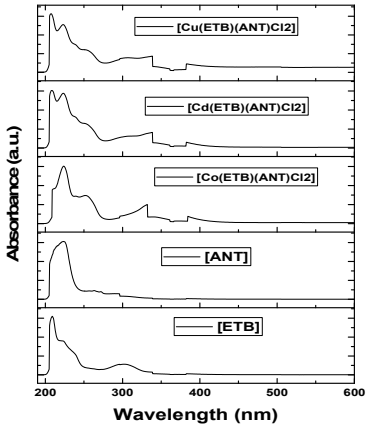

Figure 2. Electronic spectra of the ligands and their complexes

v) Antibacterial activity

The ligands and their metal complexes were screened for their antibacterial activities against some selected organisms: *Klebsiella pneumoniae, Bacillus subtlis, Escherichia coli*, *Staphylococcus aureus, Pseudomonas aeruginosa* and *Streptococcus faecalis*. The results are presented in Table V and Table VI. The zones of inhibition of the metal complexes are significantly higher than their free ligand. From the results, it is evident that the metal complexes are more effective in inhibiting the bacterial growth than the free ligands. This feat can be likened to coordination effect which may have increased permeation by facilitating the ability of a compound to cross a membrane [27]. Cu(II) complex was observed to be less active among the complexes against *staphylococcus aureus.* This is as a result of the ability of the organism to develop efflux mechanism against the complex. This could also be the effect of the complexation on the active site in the complex [28].

vi) Antifungal activity of the ligands and their complexes: The antifungal activities of the ligands and their complexes as presented in Table VII and Table VIII indicate $Cu(Ant)(Eth)Cl_2$ complex having the highest activity with zone of inhibition of 40.35 mm. This confirmed that the bioactivity of the central metal ions rises upon coordination [29]. Increase in the zone of inhibition on complexation could be demonstrated by Overtone's concept and chelation therapy [30]. The lipid membrane found around the cell favor the passage of lipid soluble material and lipid solubility which help to control the antimicrobial activities. During complexation, polarity of the central metal ions decreases as a result of overlap of the ligand orbital and sharing of the positive charge of

the metal with the donor atoms of the ligands. Increment in the lipophilic character of the complexes, allowing it to permeate the lipid membrane of the fungus [31]. The minimum inhibition of the ligands is low when compared with the complexes. This indicates that the antifungal activity of the complex increases during the complexation.

vii) Minimum inhibitory concentration of the ligands and their complexes

The minimum inhibitory concentration (MIC) of the ligands and complexes are presented in Table VIII. Based on the data obtained, the synthesized complexes possessed high activity of 0.62-0.92 µg/ml with MIC than their parent free ligands. Based on the result obtained, Cd(II) complexes with MIC of 0.62 µg/ml is more potent than other complexes. They might be harmful than ethambutol. Co(II) was found to be the least active with MIC of 0.92 µg/ml [32].

viii) Antitubercular activity of the ligands and their complexes

Based on the antitubercular activity result as presented in Table IX and Table X, it was observed that Cd(II) and Cu(II) were retarded for 4 weeks against all the five strains while Co(II) complex was retarded for 3 weeks. This indicated that they have the capability to resist the development of the organisms. This confirm that they can be used to synthesize new alternative drugs that will exhibit more antitubercular activity. This could also confirm an increased activity of the metal drug complexes against the selected strain indicating a clear enhancement upon complexation. It was observed that the parent ligands showed less active against the selected strains. Absence of any activity by the free ligands can be attributed to low absorption [33]. The anti-tubercular activities of the complexes indicate a new way to the synthesis of prospective potential compounds for the treatment of some bacterial infections [34].

V. CONCLUSION

The mixed complexes of ethambutol and anthranilic acid were successfully synthesized and found to be stable in air. The spectral data revealed that the Co(II) complex has an octahedral geometry, Cd(II) had square planar geometry, and Cu(II) complex exhibited tetrahedral geometry. The ligands were coordinated through the oxygen of the hydroxyl group and nitrogen of the amine group. The biological activities were carried out towards confirming their effectiveness of the complexes against the organisms. Based on the antioxidant activity, the complexes exhibited a reducing power. The compounds showed a broad spectrum of antibiological activities.

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