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Full Paper

Evaluation of biological activity of some dioxouranium complexes of some Schiff base and dithiocarbamate ligands

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ABSTRACT: *A number of dioxouranium (VI), UO_2^{2+} complexes of Schiff base and monodithiocarbamate ligands have been synthesized and characterized. Antimicrobial activities of these complexes have been studied. The results of inhibition zones of the selected microorganisms showed that all complexes exhibited mild to prominent activities against the pathogens tested herein.*

Keywords: *Schiff base and dithiocarbamate ligands; uranium complexes; anti-microbial activity*

Introduction

Schiff bases are versatile ligands which are synthesized from the condensation of an amino compound with carbonyl compounds. These compounds and their metal complexes are very important as catalysts in various biological systems, polymers, dyes and medicinal and pharmaceutical fields. Their use in birth control, food packages and as an O_2 detector is also outlined. Transition metal complexes with Schiff base as ligand have been amongst the widely studied coordination compounds in the past few years, since they are found to be widely applicable in many fields such as biochemical and analytical fields. They have actively associated with antibacterial, antifungal, antitubercular and anticancer activities.

Antibacterial activity of complexes of Cu (II), Ni (II), Zn (II), Fe (II), Co (II), Mn

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(II), Vo (IV), Hg (II) and Cd (II) metal ions with Schiff base derived from salicylaldehyde and *o*-amino benzoic acid have been studied [1-3]. Antimicrobial activity of dithiocarbamate and their titanium complexes have also been studied [4].

Antibacterial activity of complexes of Cu (II), Ni (II), Zn (II), Fe (II), Co (II), Mn (II), Vo (IV), Hg (II) and Cd (II) metal ions with Schiff base derived from salicylaldehyde and *o*-amino benzoic acid have been studied [1-3]. Antimicrobial activity of dithiocarbamate and their titanium complexes have also been studied [4].

Dioxouranium (VI), UO_2^{2+}, is one of the most studied oxocations for which a large number of complexes with varying geometries ranging the coordination numbers from 7 to 12 are possible [5]. Dioxouranium (VI), UO_2^{2+} complexes of Schiff bases or dithiocarbamates are few. Patil and Shaikh [6] reported the synthesis, characterization and antibacterial studies of mixed ligand dioxouranium(VI) complexes prepared with 8-hydroxyquinoline as a primary ligand and amino acids. Chowdhury et al. prepared several new dioxouranium (VI) complexes of Schiff bases from salicylaldehyde, substituted salicylaldehydes, 2-hydroxy-1-naphthaldehyde with 2-aminothiophenol [7] and aniline [8]. Complexes with mono-dithiocarbamate $(dtcH)_2$ also ligands themselves have practical application in agriculture and in medicine as fungicide and pesticides [9]. Chowdhury et al. also studied synthesis and characterization of dioxouranium (VI), UO_2^{2+} complexes of bidentate monodithiocarbamate ligands [10]. Antimicrobial activities of uranium complexes have not been widely studied. The aim of this work is to study the possible biological antifungal and antibacterial activity of dioxouranium (VI), UO_2^{2+} complexes of the bidentate and tridentate Schiff bases and bidentate monodithiocarbamate ligands.

Material and Methods

Uranylnitrate hexahydrate, $UO_2(NO_3)_2.6H_2O$, was obtained from BDH Chemicals Ltd. Ethylenediamine, *N,N*-dimethylethylenediamine, *N,N*-diethylethylenediamine, 1,3-propanediamine, *N,N*-dibutyl-tri-methylenediamine, 1,6–hexanediamine, carbondisulphide, methanol, ethanol, chloroform, *N,N*-dimethylformamide were obtained from M/S. E . Merck, west Germany. Salicylaldehyde (Sal)/substituted salicylaldehyde, 5-chloro-salicylaldehyde (^{5}Cl-Sal), 5-bromo-salicylaldehyde (^{5}Br-Sal), 2-hydroxyacetphenone (HAP), 2-hydroxypropiophenone (HPP), 2-hydroxy-1-napthaldehyde (HNP), 2-aminothiophenol (OATP), aniline (Ani) and other chemicals used were obtained from the M/S Aldrich Chemicals Co. Ltd.

Preparation of monobasic bidentate Schiff base ligands, (LH)

Salicylaldehyde or substituted salicylaldehyde (Sal), 2-hydroxyacetphenone (HAP), 2-hydroxypropiophenone (HPP), 2-hydroxy-1-napthaldehyde (HNP) (10 mmol

each) were reacted with aniline (Ani) in a round bottom flask, containing 50 mL ethanol, fitted with a reflux condenser and a silica gel guard tube. Each mixture was refluxed for 30 min. with continuous stirring, using magnetic stirrer. The mixture was then cooled in ice-bath and kept over night where upon crystalline precipitate of respective ligands separated out. The product was filtered off, washed with ethanol and dried in vacuo over calcium chloride. Colour, yield and melting points of prepared Schiff base ligands are given in Table 1.

Table 1. Physical state, colour and melting point of the prepared monobasic bidentate Schiff bases.

Ligand	Physical state	Colour	Yield (%)	m.p.(°C)
Sal-AnilineH	Solid	Pale green	80	48
^{5}BrSal-AnilineH	Solid	Orange	85	112
^{5}ClSal-AnilineH	Solid	Orange	80	100
HNP-AnilineH	Solid	Deep orange	80	62
HAP-AnilineH	Liquid	Light yellow	-	-
HPP-AnilineH	Liquid	Light orange	-	-

Preparation of dibasic tridentate Schiff base ligand, L´H$_2$

10 mmol of salicylaldehyde, substituted salicylaldehydes (Sal), 2-hydroxyacetphenone (HAP), 2-hydroxypropiophenone (HPP) or 2-hydroxy-1-napthaldehyde (HNP) with 10 mmol of 2-aminothiophenol (OATP) were taken in a round bottomed flask, containing 50 mL of ethanol, fitted with a reflux condenser and a silica gel guard tube. The mixture was refluxed for 30 min. It was then cooled in an ice-bath and kept over night whereupon crystalline precipitate of the respective ligand was formed. The product was filtered off and washed with ethanol and dried in vacuo over calcium chloride. Colour, yield and melting points of the prepared Schiff base ligands are given in Table 2.

Table 2. Colour, yield and melting point of the prepared dibasic tridentate Schiff bases.

Ligand	Colour	Yield (%)	m.p. (°C)
Sal – OATPH$_2$	Yellow	80	139
^{5}BrSal – OATPH$_2$	Yellow	80	137
^{5}ClSal – OATPH$_2$	Yellow	80	144
HNP – OATPH$_2$	Pale yellow	90	136
HAP – OATPH$_2$	Light green	60	90
HPP – OATPH$_2$	Green	60	76

Preparation of some diamine-monodithiocarbamates, (dtcH)

Diamine or their substituted diamine(150 mmol) in 50 mL methanol was introduced in a 250 mL conical flask and the mixture was allowed to cool in a freezing mixture of ice and salt (0 ^{o}C). To this carbondisulphide (140 mmol; a bit less to protect formation of bis-derivative) was added drop-wise over a period of about half an hour with constant stirring, immediately white oily precipitate was formed. The precipitate was allowed to stand for about 5 hours in the ice-salt bath and thereafter filtered off and

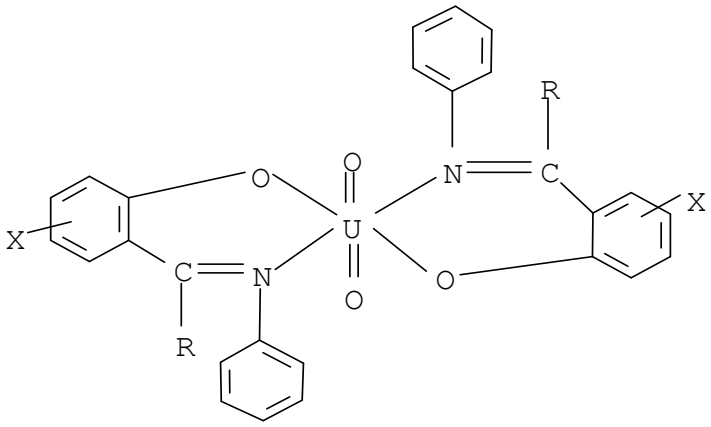
washed with methanol and dried over calcium chloride in a vacuum desiccator. Colour, yield and melting points of the prepared Schiff base ligands are given in Table 3.

Table 3. Colour, yield and melting points of the prepared Dicarbamate ligands

Sl. No.	Ligands	Physical state	Color	% Yield	MP °C
1	en-mono-dtc	Solid	White	85	178
2	dme-en-mono-dtc	Solid	White	85	135
3	det-en-mono-dtc	Solid	Light yellow	80	140
4	1,3-pn-mono-dtc	Solid	White	80	192
5	dbtt-tda-mono-dtc	Solid	White	75	98
6	Had-mono-dtc	Solid	White	80	128

Preparation of complexes, UO_2L_2

The ligand (2 mmol) was taken in a round flux. Ethanol (15 mL) and distilled water (10 mL) were added to this. The mixture was refluxed at 60°C in a paraffin bath and was stirred for a few minutes by a magnetic stirrer. Then uranylnitrate hexahydrate, $UO_2(NO_3)_2.6H_2O$ (1 mmol) was added to this solution. The colour of the solution was changed into orange–red. The mixture was refluxed at 60 °C for half an hour with constant stirring when yellow precipitate separated out. The precipitate was filtered and washed with ethanol and finally dried under vacuum over $CaCl_2$. Colour, yield and melting points of the prepared complexes are given in Table 4.



$[UO_2L_2]$

X= Br, Cl,4,5-fused phenyl

R= H, CH_3, CH_3CH_2,

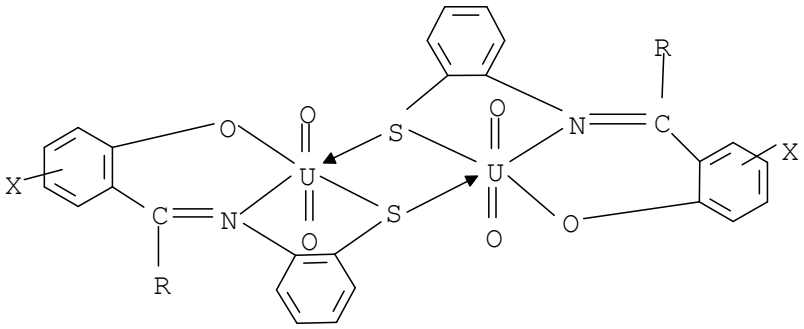
Figure 1. Proposed structure of complexes of monobasic bidentate Schiff base Ligands, (LH).

Table 4. Analytical and some physical data for the of the prepared dioxouranium (VI) complexes with monobasic bidentate Schiff bases

Sl. No	Complexes	Colour	Yield (%)	m.p. (°C)	% M*
1	UO_2(Sal- Aniline)$_2$	Orange	85	250	34.49 (35.93)
2	UO_2(^{5}BrSal- Aniline)$_2$	Orange	70	247	27.92 (29.02)
3	UO_2(^{5}ClSal-Aniline)$_2$	Deep yellow	75	250	31.83 (32.55)
4	UO_2(HNP- Aniline)$_2$	Orange	85	270	30.86 (31.21)
5	UO_2(HAP- Aniline)$_2$	Deep orange	75	208	33.02 (34.47)
6	UO_2(HPP- Aniline)$_2$	Yellow	40	150	32.45 (33.13)

Preparation of complexes, $[UO_2L´]_2$

4 mmol of respective ligand ($L´H_2$) was taken in a round bottomed flask containing 20 mL of a 10:1 mixture of dichloromethane and ethanol. When hot $UO_2(NO_3)_2.6H_2O$ (4 mmol) was added to this with continuous stirring, colour changed immediately. The mixture was refluxed for one and half hour on water bath when coloured precipitate came out. The precipitate was filtered in a sintered funnel, washed with the same solvent and was dried in vacuo over calcium chloride. Colour, yield and melting points of the prepared complexes are given in Table 5.



$[UO_2L]_2$

X= Br, Cl,4,5-fused phenyl

R= H, CH_3, CH_3CH_2,

Figure 2. Proposed structure of complexes of dibasic tridentate Schiff base Ligand, $L´H_2$.

Table 5. Analytical and some physical data of the prepared dioxouranium (VI) complexes with dibasic tridentate Schiff bases

Sl. No	Complexes	Colour	Yield (%)	m.p. °C	% M*
1	$[UO_2(Sal\text{-}OATP)]_2$	Dark brown	50	>250	46.27 (47.89)
2	$[UO_2(^5BrSal\text{-}OATP)]_2$	Deep yellow	70	166	40.01 (41.31)
3	$[UO_2(^5ClSal\text{-}OATP)]_2$	Green	60	162	44.04 (44.76)
4	$[UO_2(HNP\text{-}OATP)]_2$	Deep orange	80	208	43.27 (43.49)
5	$[UO_2(HAP\text{-}OATP)]_2$	Dark violet	50	>250	45.91 (46.55)
6	$[UO_2(HPP\text{-}OATP)]_2$	Black	50	>250	44.21 (45.31)

Preparation of complexes, UO_2dtc_2

4 mmol of respective ligand (LH) was taken in a round bottom flask containing 20 mL of mixed solvent of dichloromethane and ethanol by 10:1 (v/v). At reflux $UO_2(NO_3)_2.6H_2O$ (2 mmol) was added to this with continuous stirring when colour changed immediately. The mixture was refluxed for one and half an hour on water bath when coloured precipitate came out. Mixture was then kept overnight. The precipitate was filtered in sintered funnel, washed with same solvent, and dried in vacuo over calcium chloride. Colour, yield and melting points of the prepared complexes are given in Table 6.

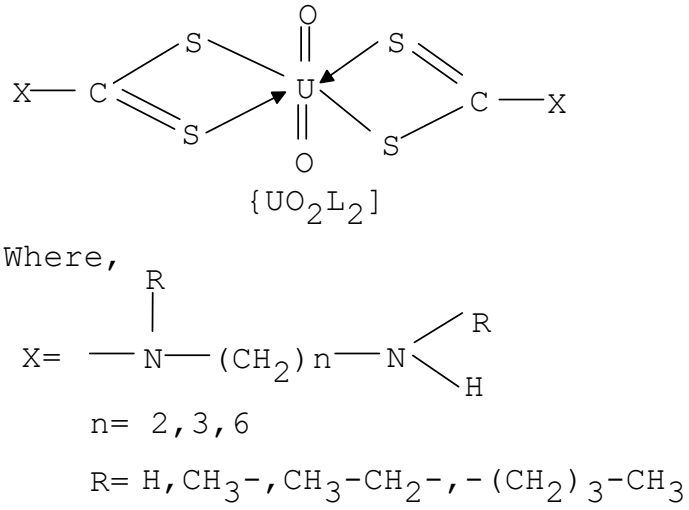


Figure 3. Proposed structure of the complexes of diamine-monodithiocarbamate ligands, (dtcH).

Table 6. Analytical and some physical data of the complexes of diamine-monodithiocarbamate ligands

Sl. No.	Complexes	Color	Yield (%)	MP °C	M (%)*
1	UO_2(en-mono-dtc)$_2$	yellow	70	>250	43.20 (44.04)
2	UO_2(dme-en-mono-dtc)$_2$	yellow	75	>250	38.13 (39.90)
3	UO_2(det-en-mono-dtc)$_2$	yellow	75	>250	35.45 (36.47)
4	UO_2(1,3-pn-mono-dtc)$_2$	yellow	75	>250	40.60 (41.88)
5	UO_2(dbtt-tda-mono-dtc)$_2$	yellow	65	>250	29.30 (30.02)
6	UO_2(Had-mono-dtc)$_2$	yellow	65	>250	35.60 (36.49)

M.P. = melting point, dia = diamagnetic
* Values in parentheses indicate calculated values.

Characterization of the complexes

All the prepared complexes have been synthesized and characterized by some physico-chemical studies; elemental, spectral (IR, UV, NMR), magnetic and conductance analyses [7, 8, 10].

Evaluation of the prepared complexes against bacteria

For the detection of antibacterial activities and sensitivity spectrum analysis, the disc diffusion method by Bauer et al. [4, 11] was followed. Nutrient Agar (NA) was used as basal medium for culture of test bacteria and N, N-dimethylformamide (DMF) was used as the solvent to prepare the desired solution (1%) of the compounds initially.

Nutrient Agar (NA) medium was prepared using the composition Beef extract, Peptone, NaCl, Agar and Distilled water. 1000 mL of distilled water was taken in a beaker and 15 g of agar powder, 3 g of beef extract, 5 g of peptone and 0.5 g of NaCl were added slowly in and they were mixed thoroughly with a glass rod and then heated to boiling for 10 min. After 10 min. of boiling, the medium was transferred in 250 mL conical flasks at the rate of 200 mL per flask. The conical flasks were closed with the cotton plugs and autoclaved at 121 °C and 15 psi pressure for 15 min. and then culturing of different micro-organisms was performed.

Sensitivity spectrum analysis: Paper discs of 5 mm diameter were soaked with 10 μL of 2% solution of the test complexes. 0.2 mL of the suspension of test organism was taken in sterilized glass Petri plates of 100 cm diameter and then the molted and cooled (45 ^{o}C) NA medium was poured at the rate of 10 mL per Petri plate and shaked gently. Then the discs with test complexes were placed on the seeded agar plate. A control plate was also maintained in each case with solvent. The plates were kept firstly for 24 hours at low temperature (4 ^{o}C) and the test complex diffused from the disc to the surrounding medium by this time. The plates were then incubated at 35±2 ^{o}C for growth of test organisms and were observed at 24 hours interval for two days. The activity was determined by measuring the diameter of the zone of inhibition in mm.

Evaluation of chemicals against fungi

The antifungal activities of the test complexes were studied against four plant pathogenic fungi. Potato Dextrose Agar (PDA) was used as basal medium for culture of test fungi. Dimethyl formamide (DMF), was used as solvents to prepare the desired solution (2%) of the test complexes. Proper control was maintained with DMF in each case of fungi. The materials and methods of the present work is described below in detail.

Preparation of the PDA (Potato Dextrose Agar) medium: PDA (Potato Dextrose Agar) medium was used throughout the study. The compositions of PDA medium are as Potato 200 g, dextrose 20 g, Agar 15 g, Distilled water 1000 mL. 200 g of sliced potato was boiled in 500 mL distilled water and the extract was decanted after proper boiling. The extract was taken in a 1000 mL beaker and the solution was made up to the mark with distilled water and 20 g dextrose was added in the solution, then 15 g of agar powder was added in the solution and they were mixed thoroughly with a glass rod. After 10 min. of boiling, the medium was transferred to a 250 mL conical flask. Then the medium was autoclaved at 121 °C and 15 psi pressure for 15 minutes.

Preparation and Maintenance of cultures: Glass petri plates were sterilized and the molted sterilized PDA medium was poured at the rate of 10 mL per petri plate. After solidification of the medium, the small portions of mycelium of each fungus were placed carefully at the centre of each PDA plate with the help of sterilized needles. Thus each fungus was transferred to a number of PDA plates. Test tube slants of PDA medium were prepared for the maintenance of cultures. Small portions of mycelia of the collected pathogens were transferred to the test tubes separately from old cultures with the help of sterilized needles. A number of test tubes were freshly prepared for each fungal pathogen. The inoculated slants were incubated at room temperature under laboratory conditions.

Efficacy of the Chemicals: Efficacy of the chemicals was tested by "poison food

technique" [12]. The petri plates of 70-90 mm in diameter were used throughout this experiment. 0.01 mL of test complexes with definite concentration (2%) was taken in sterilized glass petri plates and then molted sterilized PDA medium was poured at the rate of 10 mL per petri plate. Proper control was maintained separately with sterilized PDA medium without complex but in the presence of solvent. After solidification of the medium, the fungal inoculums (5 mm mycelia block) were placed at the center of each petri plate. All the plates were inoculated at room temperature on the laboratory desk for five days. The linear growth of fungal colony was measured in two directions at right angle to each other after five days of incubation. The percentage inhibition of mycelia growth of test fungi was calculated as follows:

$$I = [C\text{-}TIC] \times 100$$

Where, I =Percentage of inhibition; C = Diameter of fungal colony in control; T = Diameter of fungal colony in treatment.

The test tube cultures of the fungal pathogens were prepared in the pathology laboratory of the Department of Microbiology, University of Chittagong. Table represents the identification no. and name of the synthetic compounds used and microrganisms.

Table 7. Identification no. and name of the synthetic compounds used and microganisms used for the evaluation microbial activity

Sl No.	ID no.	Name of the complex	*Selected bacteria*	*Fungal pathogens*
1	M_1	$[UO_2(Sal\text{-}OATP)]_2$	*Bacillus cereus* *Bacillus subtilis* *Bacillus megaterium* *Salmonella paratyphi* *Salmonella typhi* *Shigella dysenteriae* *Staphylococcus aureus* *Pseudomonas aeruginosa* *INABA ET (Vibrio)* *Escherichia coli*	*Fusarium equiseti (Corda) Sacc.* *Curvularia lunata (Wakker) Boedijn* *Macrophomina phaseolina (Maubl) Ashby.* *Botrydiplodia theobromae Pat.*
2	M_2	$[UO_2(^5BrSal\text{-}OATP)]_2$		
3	M_3	$[UO_2(^5ClSal\text{-}OATP)]_2$		
4	M_4	$[UO_2(HNP\text{-}OATP)]_2$		
5	M_5	$[UO_2(HPP\text{-}OATP)]_2$		
6	M_6	$[UO_2(HAP\text{-}OATP)]_2$		
7	M_7	$UO_2(Sal\text{-}Aniline)_2$		
8	M_8	$UO_2(HAP\text{-}Aniline)_2$		
9	M_9	$UO_2(HPP\text{-}Aniline)_2$		
10	M_{10}	$UO_2(HNP\text{-}Aniline)_2$		
11	M_{11}	$UO_2(^5BrSal\text{-}Aniline)_2$		
12	M_{12}	$UO_2(^5ClSal\text{-}Aniline)_2$		
13	T_1	$UO_2(en\text{-}mono\text{-}dtc)_2$	*Bacillus megaterium* *Shigella sonnei* *Shigella dysenteriae* *Salmonella typhi* *Bacillus cereus*	*Collectorichum corchori* *Curvularia lunata* *Fusarium equiseti* *A. niger* *A.funiculosus*
14	T_2	$UO_2(dme\text{-}en\text{-}mono\text{-}dtc)_2$		
15	T_3	$UO_2(det\text{-}en\text{-}mono\text{-}dtc)_2$		
16	T_4	$UO_2(1,3\text{-}pn\text{-}mono\text{-}dtc)_2$		
17	T_5	$UO_2(dbu^t\text{-}tda\text{-}mono\text{-}dtc)_2$		
18	T_6	$UO_2(Had\text{-}mono\text{-}dtc)_2$		

Results and Discussion

Effects of the tested complexes the selected bacteria

The results of inhibition zones of the selected bacteria due to the prepared complexes T_1-T_6 showed that all of these complexes exhibited mild to prominent antibacterial activities against the pathogenic bacteria tested herein.

The results of inhibition zones of the selected bacteria due to the prepared complexes in figures 4 and 5 showed that all complexes exhibit mild to prominent antibacterial activities against the pathogenic bacteria tested herein. The complexes M_5, M_6, M_{11} and M_{12} were found to be more effective than the others. So, the prepared dioxouranium(VI) complexes specially M_5, M_6, M_{11} and M_{12} can be used as antibacterial agents.

From Figure 4 it is appeared that the complexes M_5 and M_6 were found to be very active against all of the selected bacteria except *Bacillus megaterium* which was found less sensitive to the compound M_6. The largest zone of inhibition (30 mm in diameter) was recorded against *Pseudomonas aeruginosa* to the compound M_5 and the largest zone of inhibition (30 mm in diameter) was recorded against *Escherichia coli* to the compound M_6.

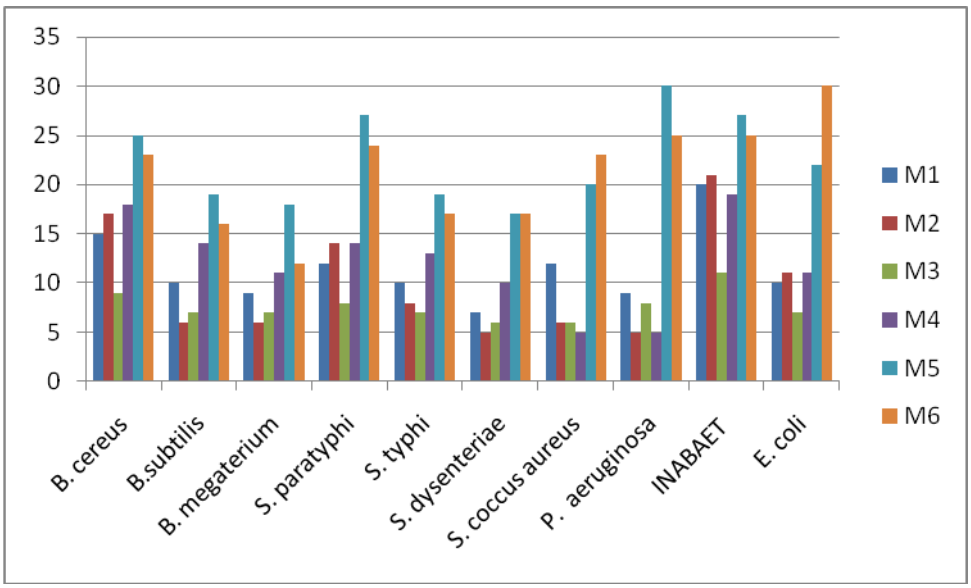


Figure 4. Zone of inhibition produced by the tested complexes M_1-M_6 against the selected organism (bacteria).

Complexes M_7, M_9, M_{11} and M_{12} as shown in Figure 5 were found to be more active against the bacteria *Bacillus cereus*, *Salmonella paratyphi*, *Pseudomonas aeruginosa* and INABA ET (vibrio); M_8 and M_{10} were found to be more active against the bacteria *Bacillus cereus*, *Pseudomonas aeruginosa* and INABA ET (vibrio); M_1, M_2 and M_4 were found to be more active against *Bacillus cereus* and INABA ET (vibrio) than the other selected bacteria.

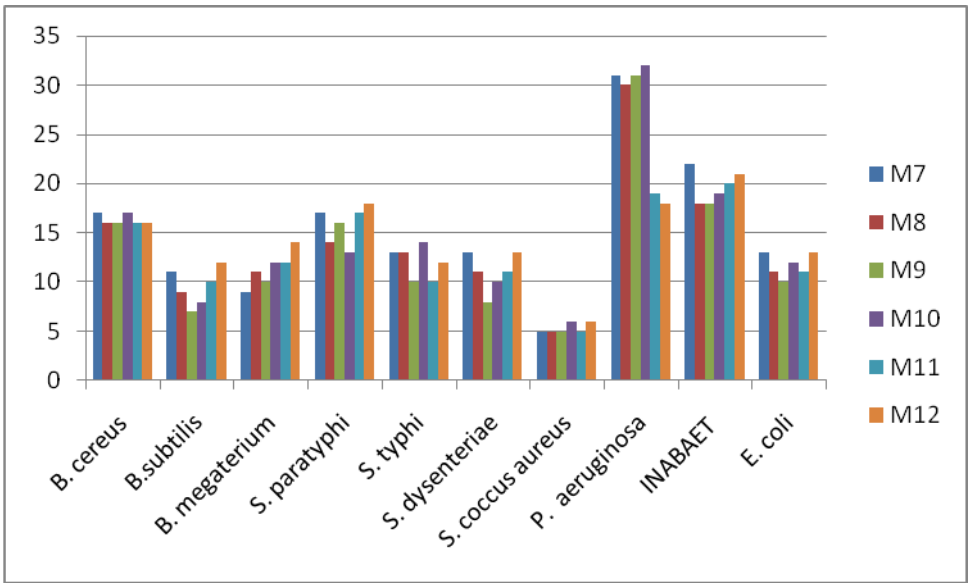


Figure 5. Zone of inhibition produced by the tested complexes M_7-M_9 against the selected organism (bacteria).

The largest zones of inhibition were recorded to the compounds M_1 (20 mm in diameter), M_2 (21 mm in diameter), M_3 (11 mm in diameter) and M_4 (19 mm in diameter) against the bacteria INABA ET (vibrio); compounds M_7 (31 mm in diameter), M_8 (30 mm in diameter), M_9 (31 mm in diameter) and M_{10} (32 mm in diameter) against the bacteria *Pseudomonas aeruginosa*; and compounds M_{11} (20 mm in diameter) and M_{10} (21 mm in diameter) against the bacteria INABA ET (vibrio).

Determination of minimum inhibitory concentration (MIC) studies

Among the twelve prepared complexes, M_5, M_6, M_{11} and M_{12} showed promising antibacterial activity against some selected bacterial strains tested herein. So, an attempt was made to determine the minimum inhibitory concentration (MIC) values of the highly active compounds (M_5, M_6, M_{11} and M_{12}) against the highly sensitive bacterial strains. The active samples M_5, M_6, M_{11} and M_{12} were subjected for testing using different two fold concentrations by disc diffusion technique. The MIC values of the complex M_5 were found 12.5, 12.5, 12.5, 6.25, 6.25 and 25 (in μg/disc) against *Bacillus cereus*, *Salmonella paratyphi*, *Staphylococcus aureus, Pseudomonas aeruginosa*, INABA ET (Vibrio) and *Escherichia coli* respectively. The lowest MIC 6.25 μg/disc was recorded against *Pseudomonas aeruginosa* and INABA ET (Vibrio). The MIC values of the complex M_6 were found 6.25, 6.25, 6.25, 12.5, 6.25 and 6.25 (in μg/disc) against Bacillus cereus, *Salmonella paratyphi*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, INABA ET (Vibrio) and *Escherichia coli* respectively. The lowest MIC 6.25 μg/disc was recorded against *Bacillus cereus, Salmonella paratyphi, Staphylococcus aureus, Escherichia coli* and INABA ET (Vibrio). The MIC values of the complexes M_{11} and M_{12} were found 6.25 μg/disc against INABA ET (Vibrio).

Effects of chemicals on mycelial growth of the selected fungi:

i. *Fusarium equiseti:* The radial mycelial growth inhibition of *Fusarium equiseti* due to the prepared complexes were found to be very effective (figures 6, 7). So we can use all of these complexes except T_4 as antifungal agents. All the complexes were found to be more active than the standard antifungal antibiotic Nystatin.

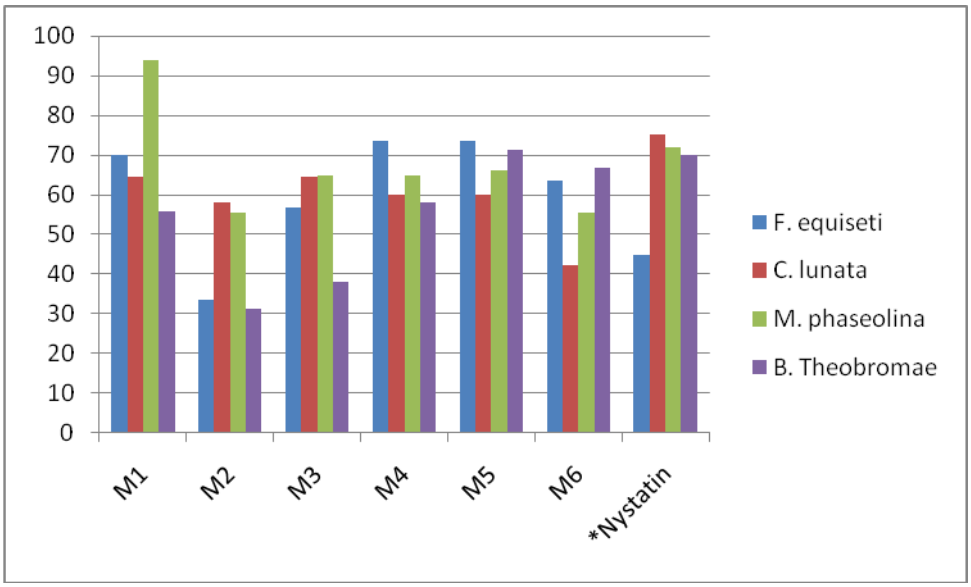


Figure 6. Antifungal activities of the synthesized test samples M_1-M_6 and standard antifungal antibiotic Nystatin against selected fungi.

ii. *Curvularia lunata:* From the (figures 6-8), the inhibition radial mycelial growth of *Curvularia lunata* for all of these complexes were found to be very effective. Complex M_6, T_1, T_4 were found to be less effective than the others. All of these complexes can be used as novel antifungal agents against this organism. Antifungal antibiotic Nystatin was found to be active against the organism compared to the complexes M_7 (77.78%), M_{11} (98.09%), M_{12} (75.56%), T_2 (44.33%) and T_3 (52.43%).

iii. *Macrophomina phaseolina:* From the figures 6-7, the complexes were found to be very effective against *Macrophomina phaseolina.* So, all of these complexes also can be used as antifungal agents. From the inhibitions of mycelial growths of these complexes, M_8 and M_9 were found to be less effective than the others. M_1 (93.85%) and M_7 (81.54%) were found to be more active than the standard antifungal antibiotic Nystatin.

iv. *Botrydiplodia theobromae:* The complexes (except M_8) in figures 6-7 were found to be very effective against *Botrydiplodia theobromae*. These complexes also can be used as antifungal agents. Complex M_5 (71.11%) was found to be more active than the standard antifungal antibiotic Nystatin.

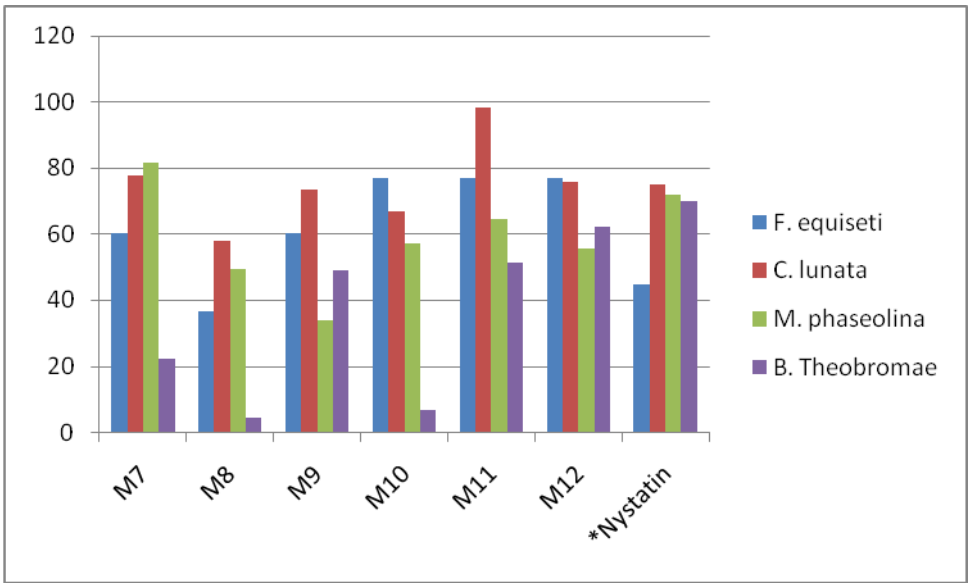


Figure 7. Antifungal activities of the synthesized test samples M_7-M_9 and standard antifungal antibiotic Nystatin against selected fungi.

v. *Collectorichum corchori:* As shown in Figure 8 complexes T_2, T_5 are mild effective whereas T_4 highly effective against the organism. The remaining two shows less activity than standard.

vi. *A. niger:* As shown in Figure 8 complexes *T_2, T_{4-6}* more whereas remaining two showed less activity against the tested fungi.

vii. *A. funiculosus:* As shown in Figure 8 complexes T_{1-3},T_6 are effective and remaining less effective against *A. funiculosus.*

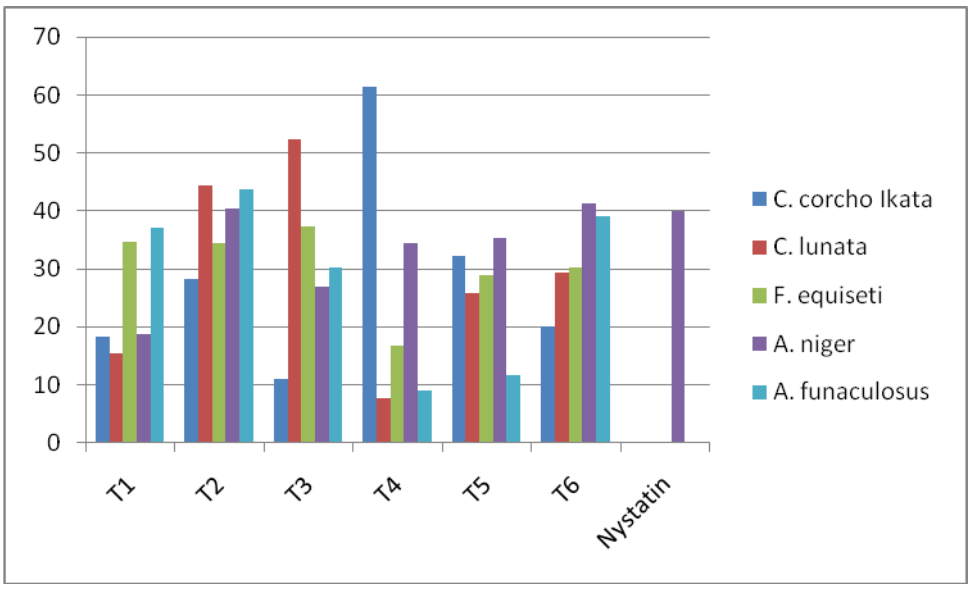


Figure 8. Antifungal activities of the synthesized test samples T_1-T_6 and standard antifungal antibiotic Nystatin against selected fungi.

The antimicrobial activity of complexes was tested in vitro against selected bacteria and fungi. The metal chelates have higher antibacterial activity than the control against the same microorganism under identical experimental conditions. This different

effect of the compounds against microorganism may be because of the structure of the compound, types of ligands and also the nature of solvent. The diffusion capacity of the compounds varies with the employed solvent, which may be because of the polarity of the solvent.

Such enhanced activity of metal chelates is due to increased lipophilic nature of the metal ions in complexes. The increase in activity with concentration is due to the effect of metal ions on the normal process. The antibacterial activity of these complexes varies with the nature of ligands and it follows the order L´> L >dtc. This high antibacterial activity of complexes can be attributed due to the chelation trends to make a liquid more potential bacterial agent. The increased activity depends upon chelation is attributed to the positive charge of the metal partially shared with donor atom present on the Ligand and possible π-electron delocalization over the whole chelate ring. This, in turn, increases the lipophilic character of the metal chelate and favours its permeation through the lipid layer of the bacterial membranes. Inhibition was found to increase with increasing the concentration of metal complex.

The Figure 9 indicates the zone of inhibition produced by the tested complexes M_1-M_6 against the selected organism (bacteria) and figures 10 and 11 shows the antifungal activities of the synthesized test samples M_7, M_9 and T_4, T_5, respectively against selected fungi.

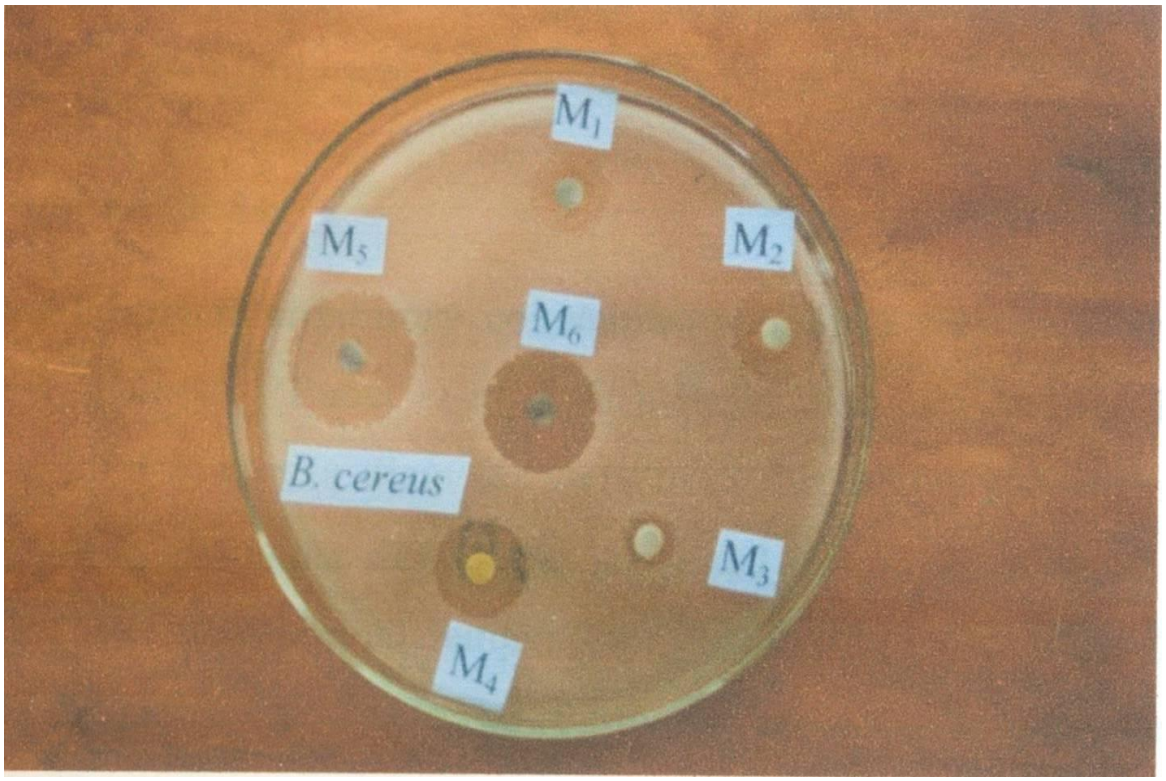


Figure 9. Zone of inhibition produced by the tested complexes M_1-M_6 against the selected organism (bacteria).

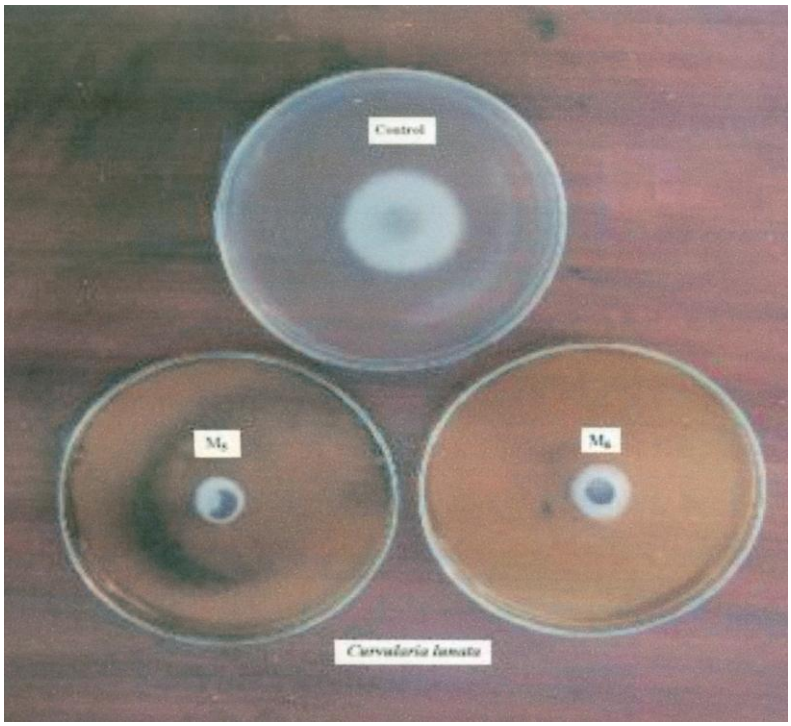


Figure 10. Antifungal activities of the synthesized test samples M_7, M_9 and standard antifungal antibiotic Nystatin against *Curvularia lunata*.

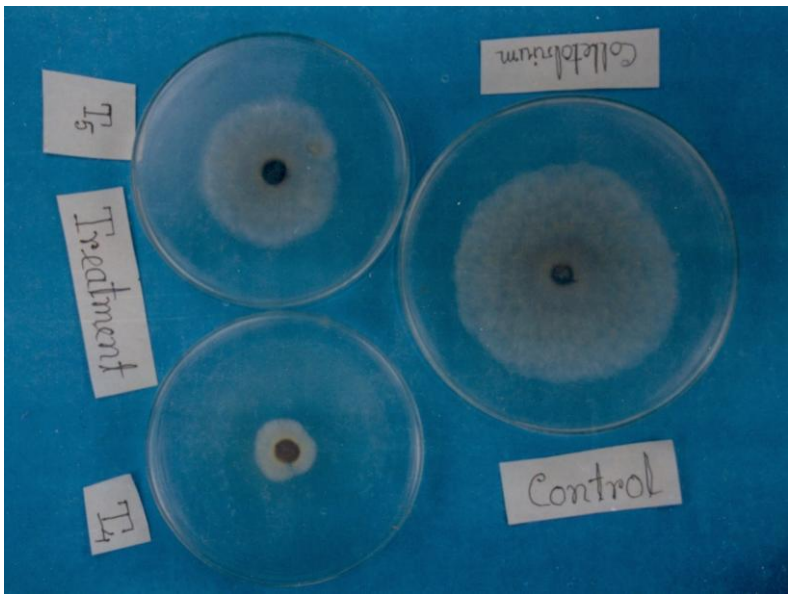


Figure 11. Antifungal activities of the synthesized test samples T_4, T_5 and standard antifungal antibiotic Nystatin against *Curvularia lunata.*

Conclusion

The chemistry of Schiff bases and carbamates is a field that is being noticed. These ligands are considered privileged ligands because they are easily prepared. Their metal complexes had a variety of applications including clinical, analytical, industrial they also play important roles in catalysts. The biological activities of uranium complexes have been summarized. It can be deduced from these results that the different response of the synthesized ligands arises because of their structural differences.

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