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Synthesis and characterisation of Mo(IV) complexes of 2,3-dihydroxybenzaldehyde Schiff Bases and their activity against cancer cell lines

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ABSTRACT Schiff base ligands (SB) have been prepared by condensation of 2,3-dihydroxybenzaldehyde with aromatic amines in either absolute ethanol or methanol. The products reacted with $MoCl_5$ in MeCN in a 1:1 stoichiometry in the presence of triethylamine to afford $[MoCl_2(SB)_2]$. The Schiff bases and the molybdenum complexes have been characterized by elemental analysis, IR, ^1H NMR and ^{13}C NMR spectroscopic methods. The anti-tumour test was conducted on the ligands and the complexes. The tumour growth inhibitory activity of the Schiff bases and their derivatives are reported.

ABSTRAK Ligan Schiff bes (SB) disediakan melalui kondensasi 2,3-Dihydroxybenzaldehid dengan aromatik amina dalam etanol atau metanol. Hasilnya ditindakbalaskan dengan $MoCl_5$ dalam MeCN dengan stoikiometri 1:1 dengan kehadiran trietilamin menghasilkan $[MoCl_2(SB)_2]$. Bes Schiff dan kompleks molibdenum dicirikan secara mikroanalisis, spektroskopi IR, ^1H NMR dan ^{13}C NMR. Ujian anti-tumour telah dijalankan untuk mengetahui ketoksikan ligan dan kompleks. Aktiviti penghindaran ketumbuhan sel tumor bes Schiff dan derivatifnya dilaporkan di sini.

(Molybdenum complexes, Schiff base, 2,3-Dihydroxybenzaldehyde, Anti-tumour testing)

INTRODUCTION

The action of various drugs against anticancer are related to metal complexes. *Cis*-Diamminedichloroplatinum (II) (**cisplatin**) is one of the most effective oncoytic agents against cancers of the ovaries, bladder, head and neck. However, cisplatin has major drawbacks especially its severe toxicity and the drugs are very expensive to produce in a large scale. In this research, non-platinum compounds and complexes were synthesized and their biological activities were investigated.

In the present study, series of 2,3-dihydroxybenzaldehyde Schiff bases were prepared and three new Mo(IV) complexes were isolated. The ligands and the complexes were tested against human laryngeal carcinoma KB cell line. The ED_{50} value for each compound and complex was determined from the mortality curve.

MATERIALS AND METHODS

All chemicals were obtained from Fluka and Merck, and were used as received. Solvents such as MeCN, MeOH, EtOH and CH_2Cl_2 were distilled before used. The experiments were carried in the Schlenk glassware under nitrogen.

Infrared spectra were recorded on Perkin Elmer FT-IR Spectrometer Spectrum 2000 using KBr disk pellet. The ^1H NMR and ^{13}C NMR were obtained on Joel JNM LA 400 FT-NMR. Melting points were taken on a hot stage Electrothermal 9100 and were uncorrected. The elemental analysis was carried out in University Kebangsaan Malaysia (UKM) Bangi.

KB cell bioassay

The KB cells were grown in Earle's Medium 199 with Earle's salt supplemented with 10% Foetal Calf Serum, with a few modifications [1]. The method for measuring the damage caused to the cell culture was conducted according to the protocol described earlier [2]. The medium was changed a day before testing. The cells were washed with phosphate buffered saline (PBS) and treated with 0.25% trypsin. The Schiff bases and the complexes at the concentration of 1, 2, 10, 50 and 100 $\mu g\ mL^{-1}$ were added to the cells. The cells were then incubated at 37°C in a humidified atmosphere with 5% CO_2 for 72 hours. Neutral Red dye (1%) was added at the end of the incubation period and the cells were further incubated for 2-3 hours. The cells were lysed with 1.0% sodium dodecyl sulphate to release the dye taken up by healthy cells. The optical density was read at 540 nm on a UV/VIS spectrophotometer. The effective dose for 50% killing, ED_{50} value was determined from the mortality curve.

EXPERIMENTAL

Preparation of 1-(2,3-dihydroxy-benzylidene)-2-aminoantipyrine

This compound was prepared by mixing the solution of 2,3-dihydroxybenzaldehyde (0.5025 g 1.8 mmol) in absolute ethanol (50ml) with 2-aminoantipyrine (0.3965 g 1.9 mmol) in the absolute ethanol (50 ml). The solution was stirred before refluxed for 3 hours. It was left to cool overnight and the solution was evaporated to dryness and gave yellow product. The crude product was recrystallised from dichloromethane and yellow-brown crystals were obtained. The crystals were filtered and washed with diethyl ether. The yield was 85%. Mp. 200-202°C. IR (KBr): 3265.88 cm^{-1} (ν_{OH}), 1636.51 cm^{-1} ($\nu_{C=O}$), 1557.05 cm^{-1} ($\nu_{C=N}$), 1486.37 cm^{-1} ($\nu_{C=C}$), 1231.70 cm^{-1} (ν_{CN}), 754.73 cm^{-1} (ν_{CH3}) 730.09 cm^{-1} (ν_{CNCH3}). ^{1}H NMR: δ =13.76 ppm (2b,OH), δ =9.73 ppm (s,CH=N), δ = 9.73 ppm (m,C_6H_5), δ =3.12 ppm (s,C-CH_3), δ =2.34 ppm (s, N-CH_3). ^{13}C NMR: C-13=146.03 ppm, C-4= 155.25 ppm, C-7= 159.25 ppm. *Anal.* Found (Theory): C=66.85(66.87), H=5.44(5.47), N=13.16(13.00).

Preparation of Mo(IV) complex of 1-(2,3-dihydroxybenzylidene)-2-aminoantipyrine

$MoCl_5$ (0.2208 g 0.9 mmol) in MeCN solution (30ml) was stirred and refluxed for 1 hour. The Schiff base of 1-(2,3-dihydroxybenzylidene)-4-amino antipyrine (0.4416 g, 1.8 mmol) was added to $MoCl_5$ solution. The mixture was then stirred and refluxed for 1 hour. After cooling, Et_3N (10 ml) was added drop wise to the mixture and refluxed for another 2 hours. The resultant purple solution was evaporated to dryness. The purple product was recrystallised from dichloromethane. The complex was filtered and washed with diethyl ether and dried in vacuo and kept under nitrogen. The yield was 20%. Mp. 200-202°C. IR: 3390.91 cm^{-1} (ν_{OH}), 1654.76 cm^{-1} ($\nu_{C=O}$), 1597.09 cm^{-1} ($\nu_{C=N}$), 1543.56 cm^{-1} ($\nu_{C=C}$), 428.68 cm^{-1} (ν_{Mo-N}). ^{1}H NMR: δ =16.65 (s, CH=N), δ=9.49 (s N-CH_3), δ =10.42 (d,C-CH_3), δ =14.65 (m,C_6H_5)^{13}C NMR: C-13=149.73 ppm, C-4= 65.10 ppm, C-7= 25.10 ppm. *Anal.* Found (Theory): C =57.15(56.15), H=3.98(5.61), N=10.85(9.60).

Preparation of 1-(2,3-dihydroxybenzylidene)-4-aminobenzoic acid

2,3-dihydroxybenzaldehyde (0.5022 g 1.8 mmol) in absolute ethanol (50 ml) was added to 4-aminobenzoic acid (0.2674 g 1.9 mmol) in ethanol (50ml). The mixture was stirred and refluxed for 2 hours and then left to cool at room temperature overnight. The solution was dried by rotary evaporation and recrystallised from dichloromethane. The crystals were filtered and washed thoroughly with diethyl ether and dried in vacuo. The yield was 78%. Mp.186-188°C. IR: 3685.39 cm^{-1} (ν_{CO2H}), 3370 cm^{-1} (ν_{OH}), 1683.72 cm^{-1} ($\nu_{C=O}$), 1633.62 cm^{-1} ($\nu_{C=N}$), 1467.23 cm^{-1} ($\nu_{C=C}$), 1218.64 cm^{-1} (ν_{CN}), ^{1}H NMR: δ =12.78 ppm (2b, OH), δ =10.20ppm (2b, COOH), δ =7.28 ppm (m, C_6H_4), δ =8.94 ppm (CH=N). ^{13}C NMR: C-13=165.28 ppm, C-4= 165.2 ppm, C-7= 166.8 ppm. *Anal.* Found (Theory): C=65.37(65.36), H=4.25(4.28), N=5.51(5.44).

Preparation of Mo(IV) complex of 1-(2,3-dihydroxybenzylidene)4-aminobenzoic acids

$MoCl_5$ (0.2674 g, 0.9 mmol) in 50ml MeCN was stirred and refluxed for 1 hour. After cooling,

Schiff bases ligand of 1-(2,3-dihydroxybenzylidene)-4-aminobenzioc acid (0.5348 g, 1.8 mmol) was added carefully and the mixture was stirred and refluxed for 1 hour under nitrogen. Triethylamine (10 ml) was added drop wise and upon completion, it was refluxed for 2 hours. The resultant purple solution was reduced in volume. The dark purple product was recrystallised from dichloromethane. The complex was filtered and washed with diethyl ether and dried in vacuo and kept under nitrogen. The yield was 15%. Mp. 200-202°C. IR: 3438.20 cm^{-1} (ν_{OH}), 1633.62 cm^{-1} ($\nu_{C=O}$), 1592.50 cm^{-1} ($\nu_{C=N}$), 1473.55 cm^{-1} ($\nu_{C=C}$), 463.46 cm^{-1} (ν_{Mo-N}). ^{1}H NMR: δ =12.12 ppm (2b,COOH), δ =8.59 -9.12 ppm (m,C_6H_4), δ =14.54 ppm (CH=N). ^{13}C NMR: C-13=145.11 ppm, C-4= 76.70 ppm, C-7= 46.00 ppm. *Anal.* Found (Theory): C=54.90(55.17), H=3.5(3.61), N=4.40(4.60).

Preparation of 1-(2,3-dihydroxybenzylidene)-benzhydrazide

A mixture of 2,3-dihydroxybenzaldehyde (0.5024 g 1.8 mmol) and benzhydrazide (0.2694 g 1.9 mmol) in absolute ethanol was stirred 5 minute and refluxed for 3 hours. The red solution was left to cool at room temperature. The volume was reduced by rotary evaporation. Dichloromethane was added to recrystallized. The crystals were filtered and washed with diethyl ether and dried in vacuo. The yield was 65%. Mp.112-114°C. IR 3293.80 cm^{-1} (ν_{OH}), 3059.25 cm^{-1} (ν_{NH}), 1662.70 cm^{-1} ($\nu_{C=O}$), 1616.11 cm^{-1} ($\nu_{C=N}$), 1544.66 cm^{-1} ($\nu_{C=C}$), 1463.90 cm^{-1} (ν_{CN}), ^{1}H NMR: δ =13.76 ppm (OH), δ =12.12 ppm (s, NH) δ =11.16 ppm (s,CH=N), δ =6.72- 6.96ppm (m,C_6H_4). ^{13}C NMR: C-13=145.58 ppm, C-4= 146.10 ppm, C-7= 145.6 ppm. Anal. Found (Theory): C 65.63(65.62), H 4.67(4.72), N 11.94(10.93).

Preparation of Mo(IV) complex of 1-(2,3-dihydroxybenzylidene)-benzhydrazide

Similar procedure was used to prepare the complex by dissolving $MoCl_5$ (0.2683 g, 0.9 mmol) in 50 ml MeCN. The mixture was stirred and refluxed for 1.5 hours. After cooling, 1-(2,3-dihydroxybenzylidene)-benzhydrazide (0.5366 g, 1.8 mmol) was added to $MoCl_5$ solution and refluxed for another 1 hour. Triethylamine (10 ml) was added drop wise and upon completion it was refluxed for 2 hours. The resultant purple solution was recrystallised from the same solvent. The complex was filtered and washed with diethyl ether and dried in vacuo and kept under nitrogen. The yield was 15%. Mp. 200-202°C. IR: 3423.22 cm^{-1} (ν_{OH}), 3273.80 cm^{-1} (ν_{NH}), 1644.05 cm^{-1} ($\nu_{C=O}$), 1603.71 cm^{-1} ($\nu_{C=N}$), 1541.31 cm^{-1} ($\nu_{C=C}$), 465.45 cm^{-1} (ν_{Mo-N}). ^{1}H NMR: δ =19.10 ppm (s,OH), δ =14.57 ppm (s,NH), δ =12.57 ppm (s,CH=N), δ =8.59-8.85 ppm (m,C_6 H_5). ^{13}C NMR: C-13=153.10 ppm, C-4= 131.98 ppm, C-7= 128.55 ppm. *Anal.* Found (Theory): C=56.50(55.26), H =4.15(3.95), N=10.12(9.21).

RESULTS AND DISCUSSION

The synthetic route of the preparation of the Schiff bases is conventional and employs published methods [3]. The complexes $[MoCl_2(SB)_2]$ (SB=Schiff base) were prepared by refluxing $MoCl_5$ in dry acetonitrile under a nitrogen atmosphere until HCl evolution had ceased. The appropriate Schiff bases and an equivalent amount of triethylamine was added and the mixture was further refluxed for a few hours until deep purple solution was obtained. Triethylamine was added as to avoid the adduct formation of the type $MoCl_4(SB)_2$ [4]. All the Schiff bases are stable to oxidation and hydrolysis in their solid state.

Infrared Spectra

The important IR bands of Schiff bases are given in Table 1 and the Mo(IV) complexes with their respective Schiff bases are summarised in Table 2. The very broad and weak absorption centred at 3300 cm^{-1} is due to phenolic OH band of the ligand. The imino group (νC=N) of the Schiff bases is observed as a strong band in the region of 1609-1635 cm^{-1}.

In the spectra of $[MoCl_2(SB1)_2]$ and $[MoCl_2(SB2)_2]$, The downward shift of ν(C=N) to lower frequencies within the range 1593-1604 cm^{-1} suggests that the ligand coordinates to the metal through the azomethine nitrogen. The presence of some new medium and weak bands observed in the range 463–465 cm^{-1} are assigned to ν(Mo-N) mode.

Table 1. Important IR bands of the Schiff Bases

No.	Schiff bases	ν(OH)	ν(C=N)
1	1-(2,3-dihydroxybenzylidene)-aniline	3377.77	1623.09
2	1-(2,3-dihydroxybenzylidene)-2-anicidine	3456.87	1620.00
3	1-(2,3-dihydroxybenzylidene)-4-anicidine	3450.91	1622.46
4	1-(2,3-dihydroxybenzylidene)-4-toluidine	3454.71	1620.07
5	1-(2,3-dihydroxybenzylidene)-4-nitroaniline	3499.77	1614.93
6	1-(2,3-dihydroxybenzylidene)-4-aminophenol	3363.31	1624.50
7	1-(2,3-dihydroxybenzylidene)-4-aminobenzonitrile	3370.78	1626.14
8	1-(2,3-dihydroxybenzylidene)-4-fluoroaniline	3490.63	1622.40
9	1-(2,3-dihydroxybenzylidene)-2-fluoroaniline	3320.00	1630.30
10	1-(2,3-dihydroxybenzylidene)-4-chloroaniline	3200.00	1625.38
11	1-(2,3-dihydroxybenzylidene)-2-aminobenzotrifluoride	2977.77	1619.39
12	1-(2,3-dihydroxybenzylidene)-2-aminobenzothiazole	3237.00	1609.76

Table 2. Important IR bands of $[MoCl_2(SB)_2]$ and their respected Schiff bases.

No.	*Complex*	ν(OH)	ν(C=N)
1	1-(2,3-dihydroxybenzylidene)-4-aminobenzoic acid **(SB1)**	3370.00	1633.62
2	$[MoCl_2(\mathbf{SB1})_2]$	3438.20	1592.50
3	1-(2,3-dihydroxybenzylidene)-benzhydrazide **(SB2)**	3293.80	1616.11
4	$[MoCl_2(\mathbf{SB2})_2]$	3423.22	1603.71
5	1-(2,3-dihydroxybenzylidene)-2-aminoantipyrine **(SB3)**	3265.88	1557.05
6	$[MoCl_2(\mathbf{SB3})_2]$	3390.91	1597.09

^{1}H and ^{13}C NMR spectroscopy

^{1}H NMR spectra of Schiff bases and complexes were recorded in $CDCl_3$ and the important peaks are listed and assigned in Tables 3 and 4. The azomethine proton of the Schiff base ligand appears as a sharp singlet in the range of 8.53-8.87 ppm. In the complexes, this band exhibited a downfield shift indicating coordination of the azomethine nitrogen to the molybdenum atom. The complete absence of signals due to the a downfield shift indicating coordination of the azomethine nitrogen to the molybdenum atom. The complete absence of signals due to the hydroxyl protons in the complexes suggests deprotonation and coordination of the phenolic oxygen to the metal centre. The numbering scheme for carbon nuclei of the ligand is shown in Fig 1.

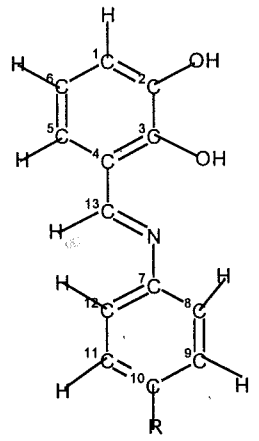


Fig. 1. N-phenyl(2,3dihydroxybenzylideneimine) indicating the atom numbering scheme.

Table 3. ^{1}H and ^{13}C NMR of Schiff Bases

No.	Schiff Bases	^{1}H NMR (ppm)		^{13}C NMR (ppm)
		δ (CH=N)	δ (OH)	C-13
1	1-(2,3-dihydroxybenzylidene)-aniline	8.56	9.66	162.31
2	1-(2,3-dihydroxybenzylidene)-2-anicidine	8.87	9.73	161.20
3	1-(2,3-dihydroxybenzylidene)-4-anicidine	8.63	9.67	159.15
4	1-(2,3-dihydroxybenzylidene)-4-toluidine	8.63	13.35	163.35
5	1-(2,3-dihydroxybenzylidene)-4-nitroaniline	8.63	12.90	163.35
6	1-(2,3-dihydroxybenzylidene)-4-aminophenol	8.63	13.54	159.05
7	1-(2,3-dihydroxybenzylidene)-4-aminobenzonitrile	8.53	12.94	150.80
8	1-(2,3-dihydroxybenzylidene) 4-fluoroaniline	8.88	9.77	165.50
9	1-(2,3-dihydroxybenzylidene) 2-fluoroaniline	8.63	13.59	160.00
10	1-(2,3-dihydroxybenzylidene) 4-chloroaniline	8.77	9.87	168.55
11	1-(2,3-dihydroxybenzylidene) 2-aminobenzotrifluoride	8.56	12.92	159.55
12	1-(2,3-dihydroxybenzylidene) 2-aminobenzothiazole	8.77	13.55	148.50
13	1-(2,3-dihydroxybenzylidene) 2-furoic acid hydrazide	8.58	16	153.90

Table 4. ^{1}H and ^{13}C NMR of Mo(IV) Complexes with their Schiff Bases

No	Complexes	^{1}H NMR (ppm)		^{13}C NMR (ppm)
		δ (CH=N)	δ (OH)	C-13
1	1-(2,3-dihydroxybenzylidene) 4-aminobenzoic acid **(SB1)**	8.94	12.78	165.28
2	$[MoCl_2(SB1)_2]$	14.54	-	145.11
3	1-(2,3-dihydroxybenzylidene) benzhydrazide **(SB2)**	8.59	12.12	145.58
4	$[MoCl_2(SB2)_2]$	12.57	-	153.10
5	1-(2,3-dihydroxybenzylidene) 2-aminoantipyrine **(SB3)**	9.73	13.76	146.03
6	$[MoCl_2(SB3)_2]$	16.65	-	149.73

The ^{13}C NMR spectra of both Schiff bases and the molybdenum complexes are listed in Tables 3 and 4. The spectra of the Schiff bases, **SB2** and **SB3** display C–13 resonance at 145.58 and 146.03 ppm respectively. As a result of coordination via azomethine nitrogen atom, the downfield shifts are observed on their complexes and the peaks appear at 153.10 and 149.79 ppm. However, the C-13 resonance of the complex $[MoCl_2(SB1)_2]$ is shifted to higher field by *ca.* 20 ppm. This could be due to the C-O bonds of the carboxyl group have enhanced their double bond ppm. This could be due to the C-O bonds of the carboxyl group have enhanced their double bond character and increased the electron density on the aromatic ring [5]. As a result, the C-13 is shielded and resonate at higher field region. On the basis of the foregoing spectral data, the structure in Fig. 2 is proposed for the newly synthesized complexes.

Cytotoxicity Results

All the synthesised Schiff bases and the molybdenum complexes show cytotoxicity on KB cells even at low concentration as shown in Table 5. With increasing concentrations, represented graphically in Figure 3, the Schiff bases of 2,3-dihydroxybenzaldehyde with aniline, aminophenol and the complex $[MoCl_2(SB3)_2]$ display strong tumour growth inhibitory effect. This could be due to strong interactions between the aromatic substituents with amino acids of DNA molecules through intermolecular hydrogen bondings [6]. The ED_{50} data in Table 6 shows that the cytotoxicity of (2,3-dihydroxybenzylidene)-4-chloroaniline (ED_{50} 3.50) is more potent than the cisplatin (ED_{50} 3.85). This study demonstrates that some of these Schiff bases and the complex will be a promising anti-cancer agent that can be combined with conventional therapies for enhanced cytotoxicity effects.

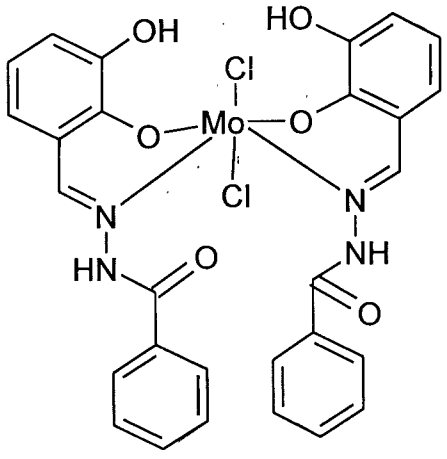


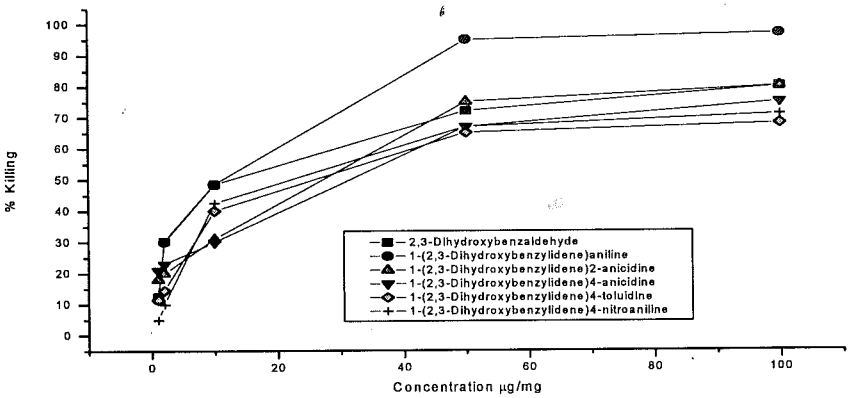
Figure 2. The proposed structure for the Mo(IV) complex, $\{MoCl_2(SB2)_2$.

Table 5. Percentage Killing In Different Concentration of Schiff Bases and Mo(IV) Complexes

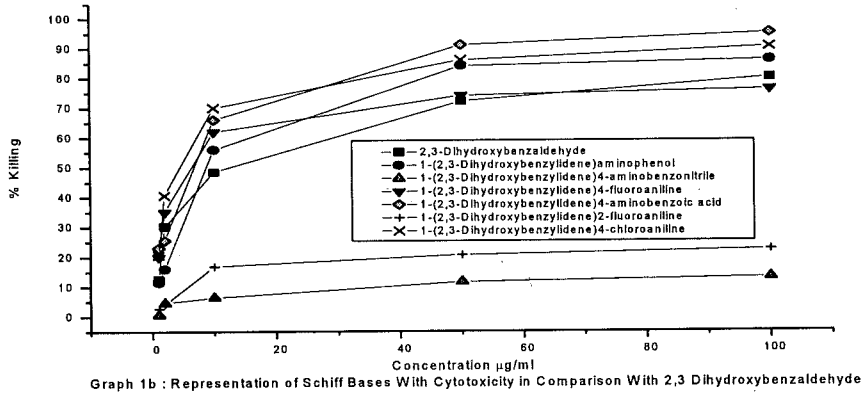
Ligands / Complexes	Concentrations				
	1μg/ml	*2μg/ml*	*10μg/ml*	*50μg/ml*	*100μg/ml*
2,3-Dihydroxybenzaldehyde	12.50	30.20	48.50	72.10	80.00
1-(2,3-dihydroxybenzylidene) aniline	11.50	30.00	48.50	95.00	97.00
1-(2,3-dihydroxybenzylidene) 2-anicidine	18.00	20.00	31.00	75.00	80.00
1-(2,3-dihydroxybenzylidene) 4-anicidine	21.00	23.00	30.00	67.00	75.00
1-(2,3-dihydroxybenzylidene) 4-toluidine	11.50	14.50	40.00	65.00	68.00
1-(2,3-dihydroxybenzylidene) 4-nitroaniline	5.00	10.00	42.50	67.00	71.00
1-(2,3-dihydroxybenzylidene) 4-aminophenol	11.50	16.00	56.00	84.00	86.00
1-(2,3-dihydroxybenzylidene) 4-aminobenzonitrile	3.00	23.00	32.00	58.00	65.00
1-(2,3-dihydroxybenzylidene) 4-fluoroaniline	20.00	35.10	62.00	74.00	76.00
1-(2,3-dihydroxybenzylidene) 4-aminobenzoic acid	23.00	25.5	66.00	91.00	95.00
1-(2,3-dihydroxybenzylidene) 2-fluoroaniline	8.4	12.6	50.4	61.80	67.20
1-(2,3-dihydroxybenzylidene) 4-chloroaniline	20.60	40.60	70.00	86.00	90.40
1-(2,3-dihydroxybenzylidene) 2-aminobenzotrifluoride	17.00	27.50	54.00	72.00	74.00
1-(2,3-dihydroxybenzylidene) benzhydrazide	15.00	30.00	55.00	70.00	74.00
1-(2,3-dihydroxybenzylidene) 2-aminobenzothiazole	22.00	29.00	56.00	76.00	78.00
1-(2,3-dihydroxybenzylidene) 2-furoic acid hydrazide	20.00	32.00	60.00	87.00	90.00
1-(2,3-dihydroxybenzylidene) 2-aminoantipyrine	6.50	43.00	65.00	84.00	86.00
$[MoCl_2(\mathbf{SB1})_2]$	11.00	14.00	45.00	66.00	80.50
$[MoCl_2(\mathbf{SB2})_2]$	13.50	16.50	50.00	73.00	84.00
$[MoCl_2(\mathbf{SB3})_2]$	10.50	15.50	53.00	80.50	85.00

Table 6. ED_{50} Values of Schiff Bases and Mo(IV) Complexes

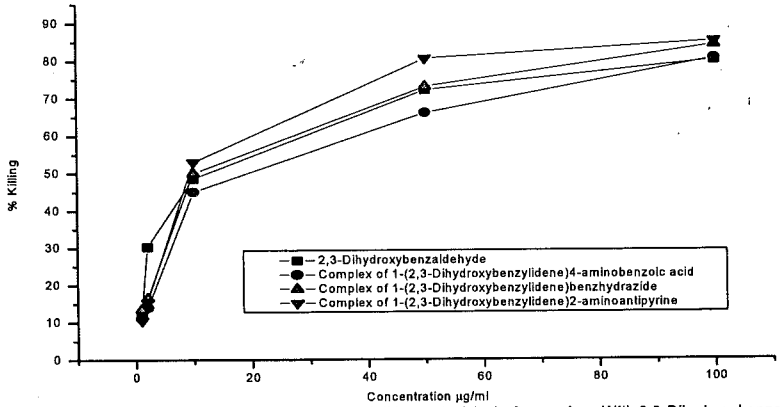
Ligands / Complexes	ED_{50} (μg/ml)
1-(2,3-dihydroxybenzylidene) 4-chloroaniline	3.50
Cisplatin	3.85
1-(2,3-dihydroxybenzylidene) 4-fluoroaniline	4.50
1-(2,3-dihydroxybenzylidene) 2-aminoantipyrine	5.00
1-(2,3-dihydroxybenzylidene) 2-furoic acid hydrazide	6.50
1-(2,3-dihydroxybenzylidene) 2-fluoroaniline	7.00
1-(2,3-dihydroxybenzylidene) 4-aminobenzoic acid	7.50
1-(2,3-dihydroxybenzylidene) 2-aminobenzothiazole	7.90
1-(2,3-dihydroxybenzylidene) 4-aminophenol	8.50
$[MoCl_2(\mathbf{SB3})_2]$	9.00
1-(2,3-dihydroxybenzylidene) 4-aminobenzonitrile	9.50
1-(2,3-dihydroxybenzylidene) benzhydrazide	9.50
1-(2,3-dihydroxybenzylidene) 2-aminobenzotrifluoride	10.00
$[MoCl_2(\mathbf{SB2})_2]$	10.00
2,3-Dihydroxybenzaldehyde	10.50
1-(2,3-dihydroxybenzylidene) aniline	11.25
1-(2,3-dihydroxybenzylidene) 4-nitroaniline	12.50
$[MoCl_2(\mathbf{SB1})_2]$	12.50
1-(2,3-dihydroxybenzylidene) 4-toluidine	15.00



Graph 1a : Representation of Schiff Bases with Cytotoxicity in comparison with 2,3-Dihydroxybenzaldehyde



Graph 1b : Representation of Schiff Bases With Cytotoxicity in Comparison With 2,3 Dihydroxybenzaldehyde



Graph 1d : Representation of Schiff Bases Complexes With Cytotoxicity in Comparison With 2,3-Dihydroxybenzaldehyde

Figure 3. Graphical representation of the cytotoxicity of the Schiff bases and complexes at different Concentrations.

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