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SYNTHESIS AND EFFICACY OF DIVALENT METAL COMPLEXES WITH LIGAND DERIVED FROM 2,2-DIHYDROXYINDANE AND AROMATIC DIAMINOBENZENES AGAINST FUNGI.

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ABSTRACT

Keeping in mind the demand of new,more effective and more economical fungicides , a new series of divalent copper, nickel, iron and cobalt complexes were prepared templately with 2,2-dihydroxyindane-1,3-dione and isomeric diaminobenzenes..The motivation for this was through the literature survey,which showed that the complexes of these metals have an antimicrobial tendencies. The complexes are characterized as distorted octahedral by elemental analyses, molar conductance, electronic spectra and IR spectral data. The origination of –C=N in the IR spectral data confirms cyclization. Oxidation followed by volumetric analysis confirms the presence of a divalent metal. The value of molar conductance indicates them to be non-electrolytes. Efficacy of these complexes was studied against Alternaria alternate and Fusarium oxysporum. These were compared with the standard indofil M-45 and bavisitin**.** Two isomers of the diaminobenzene (1,2 &1,3) were taken and it was found that the yield of 1,2 isomer was more but 1,3 isomers was found having more fungicidal properties.

Keywords: 2,2-dihydroxyindane-1,3-dione, magnetic moments, Electronic spectra, efficacy, ED_{50} values,Octahedral,molar conductance, electronic excitation

INTRODUCTION

Macrocycles are generally synthesized from smaller, usually linear, molecules. To create a ring, either an intermolecular reaction, where two or more molecules come together in a reaction to form a ring, or an intramolecular reaction. The chemical properties of macrocyclics complexes can be terminal to force metal ions to adopt unusual co-ordination geometry[1-2].Macro cyclic complexes find versatility in their applications. Transition metal macrocycle complexes resemble with natural proteins like hemerythrin and enzymes[3.] The macrocyclic complexes can be used for Removal of heavy metals from aqueous solution for water purification. Macrocycles have been in use for several decades as synthetic dyes[4]. Phthalocyanine is a porphyrin analogue, which is arguably the most useful, in uses as dyes and pigments since their discovery in 1928, due to their dark blue colour. There are however many other uses for them. Their name comes from their synthetic precursor, phthalodinitrile.[5] They can be used as Organic light-emitting diodes (OLEDs), Chelation therapy, cellular receptors and Recognition of peptides[6] and Small molecules. In this paper the complexes of 2,2-dihydroxyindane-1,3-dione and isomeric diaminobenzenes are prepared and Efficacy of these complexes was studied against Alternaria alternate and Fusarium oxysporum and compared with the standard fungicides indofil M-45 and bavisitin**.** The fungus was extracted from the leaves and roots of the cotton plant respectively.

EXPERIMENTAL

Isolation of metal Complexes:

The free macrocyclic ligand was separated to observe the condensation of the starting materials but the yield of the ligand was too small as compared to the yield of the templately synthesized complex. Hence all the complexes were obtained by template synthesis.

1,2-diaminobenzene /1,3-diaminobenzene dissolved in minimum quatity of MeOH (0.4 M) and 2,2-dihydroxyindane-1,3-dione dissolved in minimum quatity of methanol (0.4 M) was refluxed for one hour.To this divalent metal salt (0.4 M) was dissolved in minimum quality of methanol was added. The solution was refluxed at 85°C for 8-10 hr. (Cu/Ni =8 hrs. Co/Fe =10 hr). The extra MeOH was distilled out slowly and the mother liquor was subjected to crystallization in a desiccators for 3 days. The complexes were filtered slowly without vacuum to avoid disintegration of the complexes due to pressure. The filtered complexes were washed with acetone and cold methanol and dried *in vacuo*; yield 40%-65%. The complexes are soluble in Dimethylformamide and Dimethylsulphoxide. But are insoluble in common organic solvent and water. They are thermally stable upto ~220°C. The different colours of the crystal were obtained for different metal ions.

The estimation of cobalt and nickel was done by complexometeric titration where as copper was estimated of Iodometrically and iron was titrated permangnometrically. For complexometeric titration; 0.1 g of the complex was taken and oxidized with HNO_3 to release the metal and volume of the solution made to 100 ml. This solution was titrated with .01 molar EDTA solution to have a colour change from yellow to violet. The same solution was titrated with .01 molar Potassium permanganate solution to have a appearance of pink colour .For copper, 10ml of 10% KI was added to the oxidised solution, followed by titration with 0.01M sodium thiosulphate, through freshly prepared starch solution as an indicator.

The scheme of synthesis of the complexes may be shown by the following reaction:

$$2C_9H_6O_4 + 2\,C_6H_8N_2 + MBr_2 \xrightarrow{\text{reflux 10hrs}} [M\,(C_{30}H_{16}\,N_4\,O_2)\,Br_2\,] + 6H_2O$$

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

RESULTS AND DISCUSSION

The analytical data show the formula for macrocyclic complexes as: $[M(C_{30}H_{16}N_4O_2)Br_2]$ where M = Co(II), Ni(II), Fe(II) and Cu(II)

The tests for anions are positive only after decomposing the complexes with conc. HNO_3, indicating their presence inside the coordination sphere. All macrocyclic complexes are dark coloured solids and are freely soluble in Dimethylformamide and Dimethylsulphoxide. The measurements of molar conductance in Dimethylsulphoxide show that these chelates are non-electrolyte (conductance ~11-13 $ohm^{-1}\,cm^2\,mol^{-1}$, Table-1). All complexes give satisfactory elemental analyses results as shown in the Table-2.

Infrared spectra

In the Infrared spectra of all complexes, appearance of a strong band at ~1720 cm^{-1} may be assigned to carbonyl >C =O group which is formed by dehydration of geminal hydroxyl groups due to heating. It was noted that a pair of peak ~3200 and 3250 cm^{-1} corresponding to $-NH_2$ group present in Infrared spectra of diaminobenzene is absent in spectra of all complexes. Furthermore, a new strong peak has appeared in spectra of all complexes at ~1595-1645, which may be assigned to azomethine group (-C=N), indicating the formation of macrocyclic frame due to condensation of $-NH_2$ groups of diaminobenzene with >C=O groups of ninhydrin. The bands present in the range ~1350-1000 cm^{-1} in all complexes are assigned to ν(C-N) stretching. The presence of stretching bands at 1462 and 1500 cm^{-1} may be assigned to >C=C< of benzenoid rings and a peak at 721 cm^{-1} is the C-H deformation of meta substitution. In ortho diamino benzenes of value of C-H deformation has changed to 771 cm^{-1}. [7]

Far Infrared Spectra

The far Infrared spectra show bands in the region ~425-460 cm^{-1} corresponding to ν(M-N) vibrations bands present at 305-310 cm^{-1} may be assigned as being due to (M-Cl) vibration[8-10]. Vibrations bands present between 220-210 cm^{-1} may be assigned to (M-Br) vibration. The absence of (M-O) vibrations rules out the possibility of coordination through oxygen.[8-12]

Magnetic and Electronic Spectral measurements

The compounds were also confirmed by the supporting ultra violet –visible spectrum run at the band width of 2.0 nm with measurement range 1100 - 200 nm and scanning speed of 1000 nm/min given in Table-2. The magnetic moments and electronic transitions are discussed below.

***Cobalt (II) Complexes*:** At room temperature the magnetic moments of the cobalt (II) complexes lie in the range 4.97-5.01 B.M. indicating $3d^7 4s^0$ as the electronic configuration. Various spectral bands (8070-9060 cm^{-1}, 14000 cm^{-1}, 21900 cm^{-1}) present in electronic spectra of cobalt complexes may be assigned to the transitions, respectively.
$^4T_{1g}$ (F) $\rightarrow$ $^4T_{2g}$ (F) (ν_1) $\rightarrow$ 8070-9060 cm^{-1}
$^4T_{1g}$(F) $\rightarrow$ $^4A_{2g}$ (ν_2) $\rightarrow$ 14000 cm^{-1}
$^4T_{1g}$(F) $\rightarrow$ $^4T_{1g}$(P) (ν_3) $\rightarrow$ 21900 cm^{-1}.

This suggests that the environment around the cobalt ion is octahedral[13]. The spectra of complexes shows a band in the visible region, which is split due to the presence of low symmetry fields, assuming the effective symmetry to be D_{4h}[14-16]
***Nickel (II) complexes*:**The magnetic moments of nickel complexes lie in the range 2.96-2.98 B.M. values indicating the presence of two unpaired electrons with electronic configuration as $3d^8$, $4s^0$. The configuration of such type is of high spin octahedral complexes. The various electronic spectral bands (8,500-8,600, 16,680-17,060 cm^{-1}, 27,760-28,220 cm^{-1}) may be assigned to the following transitions as:
$^3A_{2g}$ (F) $\rightarrow$ $^3T_{2g}$(F) (v_2) (8,500-8,600cm^{-1})
$^3A_{2g}$ (F) $\rightarrow$ $^3T_{1g}$(F) (v_2) (16,680-17,060 cm^{-1})
$^3A_{2g}$ (F) $\rightarrow$ $^3T_{1g}$(P) (v_3) (27,760-28,220 cm^{-1})

The first two bands result from the splitting of one band, v_1 and are in the range Ca.9730-10,500 and 11,810-12,340 cm^{-1}, which can be assigned to $^3B_{1g}$ $\rightarrow$ ^3E_g and $^3B_{1g}$ $\rightarrow$ $^3B_{2g}$, assuming the effective symmetry to be D_{4h} (component of $^3T_{2g}$ in Oh symmetry) [17]

***Copper (II) Complexes*:** The value of magnetic moment indicates the presence of one unpaired electron (1.99-2.01 B.M). This suggests that the electronic configuration of copper in the complex is $3d^9$, $4s^0$. The complexes are low spin. Hence electronic spectral bands (17,840-19,660 cm^{-1} a broad band and 14,630-16,070 cm^{-1} a shoulder band) may be assigned to the transitions, respectively, as follows:
$^2B_{1g}\rightarrow{}^2A_{lg}$ (dx^2-$y^2\rightarrow dz^2$) ν_1, (17,840-19,660 cm^{-1})
$^2B_{1g}\rightarrow 2E_g$ (dx^2-$y^2\rightarrow$ dz^2, d_{yz}) ν_1 (17,840-19660 cm^{-1})
$^2B_{1g}\rightarrow{}^2B_{2g}$($dx^2$-$y^2$ $\rightarrow$ dz^2) ν_2, (14,630-16,070 cm^{-1})

The third band is usually not observed as a separate band in tetragonally distorted geometry.This all is supportive of distorted octahedral geometries of Cu (II) complexes.[14-17] The amount of distortion form the normal value depends on the nature of ligand.The complexes of Cu(II) exhibit an anisotropic e.s.r spectrum characteristic of tetragonal copper g-values are $g_{\parallel}$ = 2.1769 and $g_{\perp}$=2.0637.

Iron (II) Complexes: The value of magnetic moment indicates the presence of two unpaired electron (BM=5.1-5.5). This suggests that the electronic configuration of Iron in the complex is $3d^6$, $4s^0$. The

complexes are high spin. Hence electronic spectral bands (10,510 cm^{-1} , and 12,200 cm^{-1}) may be assigned to the transitions, respectively, as follows:
$^1A_{1g} \rightarrow {}^1T_{1g}$(10,510 cm^{-1})
$^1A_{1g} \rightarrow {}^1T_{2g}$(12,200 cm^{-1})
This all is indicative of octahedral geometries[15]

Efficacy of synthesized complexes against fungi: The compounds were tested on two fungi – Alternaria alternata, which affects the leaves of the cotton plants and Fusarium oxysporum, which affects the roots of the cotton plants. ***Fusarium oxysporum***, also referred to as **Panama disease** or **Agent Green**, is a fungus that causes *Fusarium wilt* disease in more than a hundred species of plants. It does so by colonizing the water-conducting vessels (xylem) of the plant. As a result of this blockage and breakdown of xylem, symptoms appear in plants such as leaf wilting, yellowing and eventually plant death.

Fusarium oxysporum

Alternaria alternata has been recorded causing leaf spot and other diseases on over 380 host species. It is opportunistic pathogen on numerous hosts causing leaf spots, rots and blights on many plant parts. It also causes upper respiratory tract infections in AIDS patients and asthma in people with sensitivity. *Alternaria alternata* is a fairly common indoor mould also. It is considered one of the most important fungal allergens. *Alternaria alternata* has been implicated as the cause of allergic diseases in people exposed to wood and sawdust during paper production in paper mills. It is regarded as the main cause of allergy and asthma in children aged 6–11 years.

Alternaria alternata

Compounds were screened for their antifungal activity by spore germination inhibition technique (Nene and Thapliyal) [18].

Isolation and maintenance:
From experimental areas of Punjab Agricultural University, Ludhiana, diseased samples of cotton leaves and roots were collected and washed with running tap water for 5-10 minutes. The infected parts were cut into small pieces using a sterlized blade.these samples were then sterilized with mercuric chloride solution (0.1%) for one minute followed by three washings with the sterlized distilled water.Sterlized infected pieces were transferred to dextrose agar (PDA) medium (200g peeled patato,20g dextrose and 20g agar in 1litre water) slants under aseptic conditions. Inorder to get good growth of the fungi, test tubes were incubated at 25 $\pm 1^{o}$C.The culture so obtained were purified and maintained by further sub culturing on PDA slants and keeping them in refrigerator.

Prepartion of stock solution : The stock solution of each compound and two standard fungicide viz. indofil M-45(75% manganese ethylene bis dithiocarbamate + 2% zinc ion) and Bavistin 50WP(methyl benzimidazol-2-yl carbamate) were prepared by dissolving each chemical (20mg) in DMSO and volme was made to 10ml with sterilized water. Tween-20 was added to get a clear solution. The stock solution of 2000 ppm of each chemical thus prepared on active ingredient basis was kept in refrigerator till use. The required dilution of 1000, 500, 250, 100, 50, 25 and 10 ppm were subsequently made from the stock solution by adding distilled water as and when required.

Spore germination and Inhibition technique : Ten-day old cultures of fungi were taken from PDA slants and sterilized distilled water was added to form the suspension of spores. After shaking the tube thoroughly, the suspension was filtered through three layers of sterilized cheese cloth under aseptic conditions to remove mycelial and agar bits. Standardized spore suspension (1 X 10^{6} spores/ml) was made with the help of haematocytometer. Double strength concentration of the compounds was prepared and used as desired.

Small droplets (0.02 ml) of the spore suspension in equal quantity with solution of the test compound were seeded in the cavity of cavity slides. These slides were placed in petriplates lined with moist filter paper. The petriplates containing cavity slides were incubated at 25 $\pm 1^{o}$C for 24 hours .the germination of the spores was calculated by the following formula:

$$\%\ \text{spore germination inhibition} = \frac{\text{spore germination in control} - \text{spore germination in treatment}}{\text{spore germination in control}} \times 100$$

indofil M-45 and Bavistin 50WP were used as check to compare the activity of the compounds. The antifungal activity has been expressed in terms of ED_{50}values i.e effective dose to inhibit 50% spore germination.

CONCLUSION

Based on the above discussion on the results obtained by the analyses of the synthesized complexes, It is proposed that the metal is trivalent and a big cyclic ligand is attached coordinately to these divalent metals .Structures (Fig. 1) may be proposed for these complexes. It was found that the antifungal compounds[19] have similar type of structure. Hence on subjection to antifungal activity Most of the compound inhibit growth to a very less extent. Their ED_{50} values are very high but some complexes e.g [Fe $(C_{30}H_{16}N_4O_2)Br_2$] 1,2 Isomer, [$Fe(C_{30}H_{16}N_4O_2)Br_2$] 1,3 Isomer, [$Cu(C_{30}H_{16}N_4O_2)Br_2$] 1,2 Isomer, [$Cu(C_{30}H_{16}N_4O_2)Br_2$] 1,3 Isomer ,show anti fungal activities .They inhibit the growth of Fusarium Oxysporium (Table-3,4).

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REFERENCES

1. R.R. Fenton, R. Gauci, P.C. Junk, L.F. Lindoy, R.C. Luckay, V. Meehan, J.R. Price, and P. Tumer, *J. chem. Soc, Dalton Trans*, 2185 (2002) .
2. R.D. Jons, D.A. Summer vile and F. Basolo, *Chem. Rev.*, **79**, 139 (1979).
3. R.R. Gagne, C.I. Spiro, T.J. Smith, W.R. Hamanu, W.R. Thies. *J. Am. Chem. Soc.*, **103**, 4073 (1981).
4. G. Cross and J.P. Costs, *Acad. CRSC*, Paris, **294**, 173 (1982); M.F. Huzen Kamp, A.C. Stucke, E. Cavolli and H.V. Godle, *J. Chem. Soc.*, *Dalton Trans*, 2755 (1992).
5. Melson, G.A., Ed. (1979). *Coordination Chemistry of Macrocyclic Compounds*. New York: Plenum Press
6. Jung, J.E.; Seung, S.Y., *Bulletin of the Korean Chemical Society* , **23(10)** 1483-1486 (2002).
7. K. Nakamoto, *"Infrared spectra of inorganic and coordination compounds"* part B, 5th edition, Wiley Inter Science, New York (1997).
8. M. Shamir, K.S. Islam, A.K. Mohamed, M. Shagufta and S.S. Hassan, *Transition Met. Chem.,* **24**, 577 (1999).
9. N. Nawar , M. A. Khattab ,M. M. Bekheit and A. H. El-Kadda ,*Indian J. Chem.* , **35A** , 308 (1996).
10. S. Chandra and L.Gupta, *Transition Met.Chem.*, **30**, pp. 630–635 (2005)
11. D.P. Singh, N. Shishodia, B.P. Yadav and V.B. Rana, *polyhedron*, **16,** 2229-2232 (1997).
12. M. Shakir, K.S. Islam, A.K. Mohamad, M. Shagufta and S.S. Hassan, *Transition Met. Chem.*, **24,** 577 (1999).
13. S. Chandra and R. Kumar, *Transition Met. Chem.*, **29**, 269 (2004).
14. V.B. Rana, D.P. Singh, P. Singh and M.P Teotia, *Transition Met. Chem.,* **6**, 136 (1981); *Polyhedron*, 1, 377 (1982).
15. Lokesh Kumar Gupta, Usha Bansal and S. Chandra *Spectrochimica Acta Part A: Molecular and Biomolecular spectroscopy*, **66,** 972–975, (2007)
16. S. Chandra and Anil Kumar *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, **68**, 1410–1415 (2007)
17. Sulekh Chandra and Archana Gautam ,*Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*,**70,** 1001–1005, (2008)
18. Y.L Nene and P.N Thapliyal., *Fungicides in plant disease control,* 525(1993).
19. Jong Chul Byun, Chang Hoon Yoon, Dae Hun Mun, Ki Ju Kim, and Yu Chul Park ,Bull. Korean Chem. Soc. **27 (5)** ,687(2006).

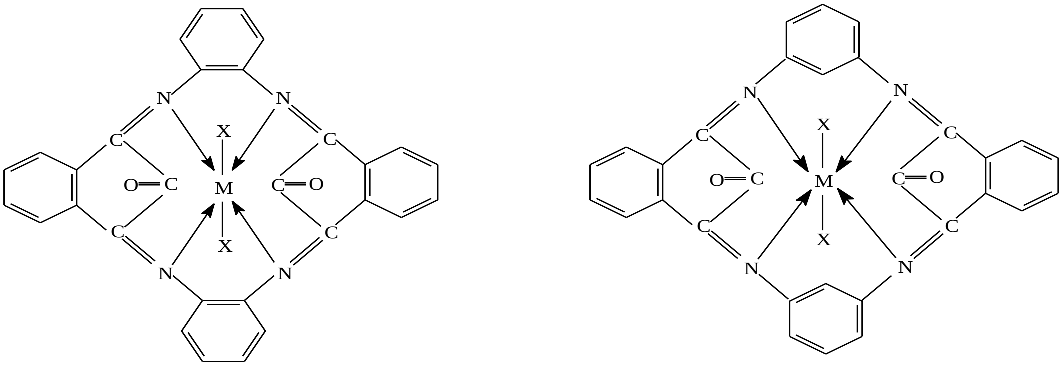

Fig.-1: Proposed structure of the complexes
Where M = Co(II) , Ni(II), Cu (II),Fe(II); X = Br

Table-1: Analytical data of divalent Cu, Co, Ni &Fe complexes derived from 2,2-dihydroxyindane-1,3-dione and isomeric diaminobenzene

S. No.	Complexes	Colour	Molar Conductance (ohm^{-1}cm^{2} mol^{-1})	Yield of complexes	Magnetic moment
1.	[Co ($C_{30}H_{16}N_4O_2$)Br_2]1,2 Isomer	Shiny yellow	12.91	47%	5.01
2.	[Co($C_{30}H_{16}N_4O_2$)Br_2]1,3 Isomer	Black powder	12.91	63%	5.02
3.	[Cu($C_{30}H_{16}N_4O_2$)Br_2]1, 2 Isomer	Shiny light green	12.50	45%	2.01
4.	[Cu($C_{30}H_{16}N_4O_2$)Br_2]1,3 Isomer	Black brown powder	12.50	50%	2.01
5.	[Ni($C_{30}H_{16}N_4O_2$)Br_2]1, 2 Isomer	Shiny bottle green	11.20	40%	3.00
6.	[Ni($C_{30}H_{16}N_4O_2$)Br_2]1, 3 Isomer	Black green powder	11.20	53%	3.01
7.	[Fe($C_{30}H_{16}N_4O_2$)Br_2]1, 2 Isomer	Shiny light green	11.8	43%	5.2
8.	[Fe($C_{30}H_{16}N_4O_2$)Br_2]1, 3 Isomer	Greenishbrown Powder	11.8	45%	5.3

*1,2 Isomer stands for 1,2-diaminobenzene; 1,3 Isomer stands for 1,3-diaminobenzene

Table-2: Analytical data of the divalent Cu, Co, Ni &Fe complexes derived from diaminobenzene and 2,2-dihydroxyindane-1,3-dione.

	Complexes With Metal	Percentages : Observed (Calculated)				
		C	H	N	M	Mol.wt
1	[Co ($C_{30}H_{16}N_4O_2$)Br_2] 1,2 Isomer	51.8(52.7)	2.6 (2.3)	8.1 (8.2)	8.2(8.4)	683
2	[Co ($C_{30}H_{16}N_4O_2$)Br_2] 1,3 Isomer	52.0(52.7)	2.5 (2.3)	8.1 (8.2)	8.2(8.4)	683
3	[Ni ($C_{30}H_{16}N_4O_2$)Br_2] 1,2 Isomer	52.1(52.7)	2.2 (2.3)	8.1 (8.2)	8.0(8.3)	682
4	[Ni ($C_{30}H_{16}N_4O_2$)Br_2] 1,3 Isomer	52.1(52.7)	2.3 (2.3)	8.0 (8.2)	8.0(8.3)	682
5	[Cu ($C_{30}H_{16}N_4O_2$)Br_2] 1,2 Isomer	59.0(52.3)	2.0 (2.1)	8.1 (8.1)	9.0 (9.2)	687.5
6	[Cu ($C_{30}H_{16}N_4O_2$)Br_2] 1,3 Isomer	59.0(52.3)	2.0 (2.1)	7.9(8.1)	9.1 (9.2)	687.5
7	[Fe ($C_{30}H_{16}N_4O_2$)Br_2] 1,2 Isomer	52.1(52.9)	2.0 (2.3)	8.0 (8.2)	8.1 (8.2)	680
8	[Fe($C_{30}H_{16}N_4O_2$)Br_2]1,3 Isomer	52.3(52.9)	2.1(2.3)	8.1 (8.2)	8.1 (8.2)	680

*1,2 Isomer stands for 1,2-diaminobenzene; 1,3 Isomer stands for 1,3-diaminobenzene

Table-3: Eficacy of synthesized of the divalent Cu, Co, Ni and Fe complexes derived from diaminobenzene and 2, 2-dihydroxyindane-1,3-dione complexes against Alternaria alternata

S.No	Compound	Percent inhibition in mg/l						ED_{50}
		1000	500	250	100	50	25	(mg/l)
1.	$[Co(C_{30}H_{16}N_4O_2)Br_2]$ 1,2 Isomer	48	34	22	17	11	7	*
2.	$[Co(C_{30}H_{16}N_4O_2)Br_2]$ 1,3 Isomer	54	44	41	33	16	8	*
3.	$[Ni(C_{30}H_{16}N_4O_2)Br_2]$ 1,2 Isomer	38	30	21	20	12	5	*
4.	$[Ni(C_{30}H_{16}N_4O_2)Br_2]$ 1,3 Isomer	40	36	29	20	12	5	*
5.	$[Cu(C_{30}H_{16}N_4O_2)Br_2]$ 1,2 Isomer	35	24	20	14	12	6	*
6.	$[Cu(C_{30}H_{16}N_4O_2)Br_2]$ 1,3 Isomer	36	22	19	13	13	4	*
7.	$[Fe(C_{30}H_{16}N_4O_2)Br_2]$1,2 Isomer	39	36	26	24	20	10	*
8.	$[Fe(C_{30}H_{16}N_4O_2)Br_2]$ 1,3 Isomer	36	24	20	17	10	0	*
	INDOFIL M-45	100	100	95	77	62	40	37

Table-4: Eficacy of synthesized of the divalent Cu, Co, Ni and Fe complexes derived from diaminobenzene and 2, 2-dihydroxyindane-1,3-dione complexes Fusarium Oxysporium

S. No	Compound	Percent inhibition in mg/l								ED_{50}
		1000	500	250	100	50	25	10	5	(mg/l)
1	$[Co(C_{30}H_{16}N_4O_2)Br_2]$1,2 Isomer	37	13	11	10	8	5	0	0	*
2	$[Co(C_{30}H_{16}N_4O_2)Br_2]$1,3 Isomer	35	21	18	17	10	7	0	0	*
3	$[Ni(C_{30}H_{16}N_4O_2)Br_2]$1,2 Isomer	36	19	17	14	10	4	0	0	*
4	$[Ni(C_{30}H_{16}N_4O_2)Br_2]$1,3 Isomer	35	16	16	12	10	5	0	0	*
5	$[Cu(C_{30}H_{16}N_4O_2)Br_2]$ 1,2 Isomer	80	63	54	37	26	12	11	3	270
6	$[Cu(C_{30}H_{16}N_4O_2)Br_2]$1,3 Isomer	93	80	64	62	50	49	35	10	70
7	$[Fe(C_{30}H_{16}N_4O_2)Br_2]$1,2 Isomer	82	41	30	26	21	11	6	3	600
8	$[Fe(C_{30}H_{16}N_4O_2)Br_2]$ 1,3 Isomer	60	29	12	11	10	6	0	0	860
	Bavisitin	100	100	100	100	92	75	60	42	7

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