Table 3: *In vitro* antimicrobial activity of the schiff base and its complexes

Compound	Antibacterial activity				Antifungal activity	
	Diameter of Inhibition zone (millimeters)				Diameter of Inhibition zone (millimeters)	
	Strepto	Bacillus	Pseud	E.coli	Fusarium	Aspergillus
CHTSC	9	11	8	8	7	-
Mn(II)	21	17	19	22	15	13
Co(II)	12	9	13	15	9	-
Ni(II)	13	19	15	16	12	14
Cu(II)	16	16	18	21	15	12
Ciprofloxacin	27	25	24	25		
Ketoconazole					23	25

Antibacterial activity of chalcone N(4)-methyl(phenyl)thiosemicarbazone and its complexes

The antibacterial activity of the compounds was tested against a set of clinically important species of two - Gram positive and two - Gram negative bacteria by disc diffusion method. After incubation, the diameter of zone of inhibition was measured in millimeter and the results obtained are presented in Table 3 and Fig 3. A comparative study indicates that the metal complexes exhibit higher activity than the free ligand.

Antifungal activity of chalcone N(4)-methyl(phenyl)thiosemicarbazone and its complexes

The antifungal activity of the ligand and its metal complexes was tested against two species, *Fusarium, and Aspergillus* by disc diffusion method. After incubation, the compounds yielded clear zone of inhibition around the discs. The results are as shown in Table 3 and Fig 4.

The studies revealed that the compounds are active towards the four bacterial strains in different manners. Accordingly, the complexes are found to have maximum bactericidal activity with zone of inhibition in the range 15-22 mm. The complexes of Mn(II), Ni(II) and Cu(II) showed moderate activity against the fungal species. The mode of higher biological activity of the complexes can be explained on the basis of Tweedy's chelation theory [23, 24]. According to this theory, the polarity of the metal ion is reduced considerably due to chelation. This is because of the partial sharing of the positive charge of the metal ion with the donor group and due to p-electron delocalization over the whole chelate ring. This inturn enhances the lipophilic character of the chelates. The higher lipophilicity is expected to enhance the antimicrobial properties as well. Thus the lipophilic cell wall with lipids and polysaccharides as some of the essential constituents, favours the passage of metal chelates into the cells. This leads to the blocking of the metal binding sites in the microbial enzymes and thereby interfering with the normal cell metabolic processes and thus restricts further growth of the organism. The inhibitive action of these metal chelates on the growth of the tested microorganisms is due to the presence of highly liposoluble azomethine groups as donor sites. Moreover, the form of inhibitive action of the complexes may involve the hydrogen bond formation through the coordinated anions and azomethine group with the active centers in the cell [23, 24].

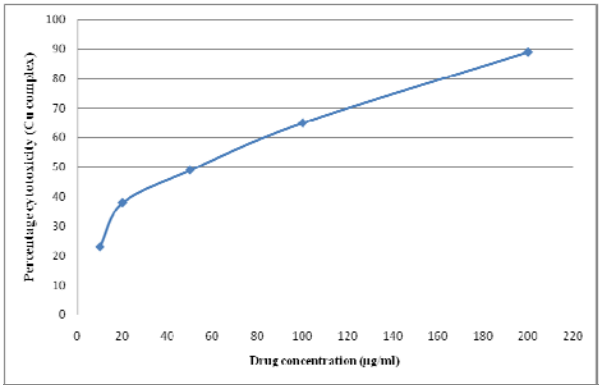

Fig 2: Cytotoxic action of the copper complex of chalcone N(4)-methyl(phenyl) thiosemicarbazone

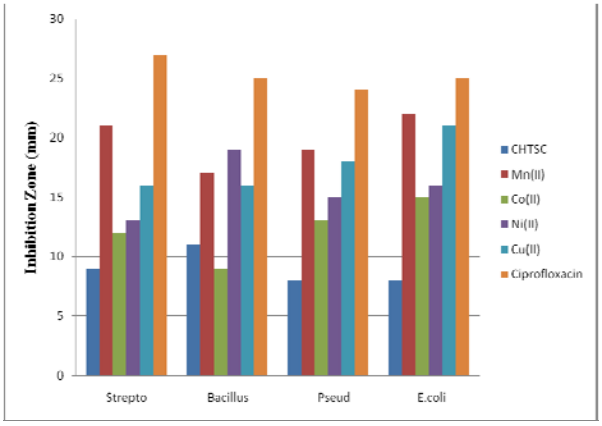

Fig 3: Antibacterial activity of CHTSC and its complexes

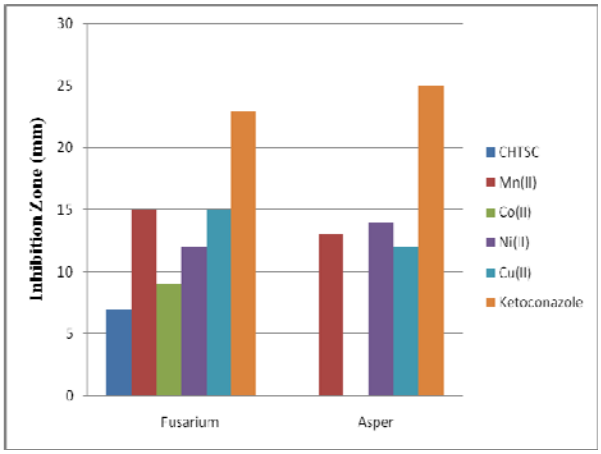

Fig 4: Antifungal activity of CHTSC and its complexes

CONCLUSION

A Novel ligand, chalcone N(4)-methyl(phenyl)thiosemicarbazone and its mononuclear complexes of Cu(II), Co(II), Mn(II) and Ni(II) were synthesized and characterized. Based on the elemental analysis and spectral data, the nature of coordination of the ligand in these metal(II) complexes was determined. The spectral data revealed the bidentate behaviour of the ligand, bonding to the metal ion using the iminic C=N nitrogen and thiolato/thione sulphur atom. The mononuclear octahedral complexes corresponding to the general formulae $[M(LH)_2Cl_2]$ (M: Mn(II) or Cu(II)) and $[ML_2(H_2O)_2]$ (M:Co(II) or Ni(II)) were formed. The *in vitro* cytotoxic studies of the compounds revealed their potentiality as anticancer agents. It was found that the metal complexes were more cytotoxic than the free ligand against EAC cell line. The free thiosemicarbazone showed 65% cytotoxic activity. The IC_{50} for the copper(II) complex was 48µg/ml. The metal complexes exhibited moderate to strong antibacterial activity than the free ligand, but less active than Ciprofloxacin (positive control). Comparing their activity, we found that Mn(II) complex exhibited a higher activity towards bacterial species than the other metal complexes. The Mn(II), Ni(II) and Cu(II) complexes appeared to have moderate antifungal activity against *Fusarium sp*. when compared with the ligand and the Co(II) complex. Hence the current work indicates that chalcone N(4)-methyl(phenyl)thiosemicarbazone ligand and its metal(II) complexes can be considered as novel and promising ones in the medicinal and biological fields.

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