



Metal Complexes Derived from 2'-hydroxyacetophenone Based Schiff base: (A-Review)

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ABSTRACT

In this review article, we try to cover various studies have been done on 2'-hydroxyacetophenone based Schiff bases and formed metal complexes such as antibacterial, antifungal, cytotoxicity, larvicidal, oxidation-reduction Schiff base Formation with different amine group containing compounds etc.

Keywords: 2'-hydroxyacetophenone, Schiff base, Metal Complexes.

INTRODUCTION

Schiff base are compound in which imine bond is present. Schiff base as ligand have been used to formed metal complexes because of its high stability in different conditions. 2'-hydroxyacetophenone based Schiff base metal complexes shows several important biological activities, therefore we reports various studies as following:

Antimicrobial and Antibacterial Studies

Ruthenium (III) complexes of 2-hydroxyacetophenone with ethylenediamine, propylenediamine, tetramethylenediamine, orthophenylenediamine teseted for antibacterial activities against *Escherichian feacalis* and *S.typh*¹. Co²⁺, Ni²⁺, Cu²⁺ and Zn²⁺ complex made with the acetylacetone and para-anisidine, had higher antibacterial activity than free ligand². Cu²⁺ complex of 2-hydroxyacetophenone N (4)-methyl-

4-phenylthiosemicarbazone and different amine like cyclohexyl amine/morphine/hexamethyleneimine with co-ligand, 2,2'-bipyridyl and 1,10-phenanthroline have been studied for antibacterial activities against *Escherichian coli*, *Staphylococcus aureus*³.

Antibacterial activity of 3d-transition metals M²⁺ and UO₂(IV) complexes of 2-hydroxy-5-methylacetophenone and glycine have been tested against *Escherichian coli*, *Shigella flexneri*, *Salmonella Typhi*, *Proteus vulgaris*, *Bacillus coagulans*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Salmonella typhimurium*, *Enterococcus faecalis*, *Staphylococcus epidermidis*, *Enterobacter aerogenes*⁴.

Antimicrobial studies of Co²⁺ and Cu²⁺ ions complexes of tetradentated Schiff base ligand made from o-phenylenediamine and 2-hydroxyacetophenone reveals that all the



synthesized complexes have higher activities against bacillus cereus, *Staphylococcus aureus* and *Escherichian coli* as compared to free ligand, whereas Co^{2+} complexes show best results than Cu^{2+} complex⁵. Mixed ligand complexes of different 3d-transition metal ions with bis(4-methoxybenzylidene)-ethylenediamine (4-methoxybenzaldehyde and ethylenediamine), N,N'-bis(2-hydroxyacetophenone)-ethylenediamine(2-hydroxyacetophenone and ethylenediamine), bis(4-methoxybenzylidene)-*o*-phenylenediamine(4-methoxybenzaldehyde and *o*-phenylenediamine) have been studied for biocidal studies against bacillus subtilis and *Escherichian coli*⁶. Trinuclear Schiff base complex of Cu^{2+} and Pb^{2+} ions have been made by 2-hydroxyacetophenone and 1, 3-propanediamine as Schiff base ligand⁷. Mixed Schiff base ligand complexes of Cu^{2+} , Ni^{2+} and Mn^{2+} ions derived from 4-chloroaniline-salicylaldehyde, benzaldehyde-2-aminophenol and 4-nitroaniline-2-hydroxyacetophenone characterized. Antibacterial activity of synthesized complexes and free ligand were evaluated by paper disc technique and found that free ligands show less activities as compared to their metal(II) complexes against *Staphylococcus aureus*, *KlebsHELLIA*, *Escherichian coli*, *bacillus subtilis*. Because of Electron releasing group in the Co^{2+} mixed Schiff base complexes, it's have higher antimicrobial activity than the other metal M^{2+} mixed ligand complexes⁸. Cyclic voltammogram studied suggested that almost all the synthesized mixed ligand complexes shows redox behavior in DMF using 0.1 M Tetrabutylammonium perchlorate as supporting electrolyte.

Different transition metal complexes of 2-hydroxyacetophenone with N,N'-dimethylethyl-diamine and 4-(2-aminoethyl)morpholine have been tested for Antibacterial studies against *Acinetobacter baumannii*, Methicillin-resistant-*Staphylococcus aureus*, *Pneumonia* and *Pseudomonas aeruginosa* and formed compounds not show antimicrobial activities against *Klebsiella pneumonia*⁹.

3-(substituted phenyl)-4-amino-5-hydrazino-1,2,4-triazole and 2-hydroxyacetophenone Schiff base and their Zn^{2+} complex have been studied for antimicrobial and bactericidal activities¹⁰.

Tetradentated unsymmetrical ligand and Mn^{2+} , Co^{2+} , Ni^{2+} , Cu^{2+} , Cr^{2+} complexes derived from ethylenediamine with *o*-hydroxyacetophenone and

Fe^{3+} complexes were synthesized with ethylenediamine with 5-chloro-2-hydroxyacetophenone, characterized by different techniques. And found that all the complexes was semiconducting in nature and homogenous phase material. Almost all the formed complexes exhibited regular octahedral geometry except Ni^{2+} complexes which is having square planer geometry and Cu^{2+} Complexes is having distorted octahedral geometry. Antimicrobial activities of unsymmetrical ligand and the complexes carried out against *Staphalococcus aureus*, *Bacillus subtilis*, *Salmonella typhimurium*, *Escherichia*. Observation reveals that all the complexes have higher activities with their parent ligand which is explained by chelation theory¹¹.

Complexes of Co^{2+} , Cr^{3+} and Fe^{3+} ions shows good antibacterial activities against selected *Gram-positive* bacterial strains and Mn^{2+} , Ni^{2+} and Fe^{3+} complexes were show good resistance against *Escherichia coli*¹².

Mixed ligand complex of Co^{2+} ion with 5-chloro-2-hydroxyacetophenone N (4) methylthiosemicarbazone and heterocyclic base have been studied for antibiological and antioxidant activity¹³.

Different 3d-transition metal complexes of *o*-hydroxyacetophenone, 5-chloro-2-hydroxyacetophenone and ethylenediamine have been tested for antimicrobial activities against *Gram+ve* bacteria, *Gram-ve* bacteria¹⁴.

Antimicrobial activity of polymeric Schiff base and it's Mn^{2+} , Co^{2+} , Ni^{2+} , Cu^{2+} and Zn^{2+} complexes screened against *Escherichian Coli*, *Bacillus subtilis*, *Staphalococcus aureus*, *Pseudomonas aeruginosa*, *Salmonella typhimurium* and their antifungal activity also tested against *Candida albicans*, *Microsporium canis* and *Aspergillus niger*. Antimicrobial activity results showed that polymer complex of Cu^{2+} ion have higher activity in comparisons to other formed polymer metal complexes. Cu^{2+} and Zn^{2+} metal polymer complexes showed significant antifungal activity while other complexes showed moderate antifungal activity. Cu^{2+} complex have more activities against selected bacterial strains and fungi explained by higher stability constant of Cu^{2+} ion causes stronger interaction with donor atoms of Schiff base ligand, which reduced the polarity and increase

lipophilic nature of Cu^{2+} ions, which favor its greater penetration through bacterial cell wall to kill the microorganism effectively³⁰.

Mixed ligand of 2-hydroxyacetophenone and glycine amino acid with N-donor ligands and its Cu^{2+} complexes tested for antibacterial activities against *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Streptococcus pneumoniae* and *Staphylococcus aureus* and found that the free ligand does not show any activities against the selected microbes¹⁵.

Different transition metal complexes of Schiff base (*o*-hydroxyacetophenone and L-cystein with ethylenediamine) have been studied for antimicrobial activities and larvicidal activities against *C. quinquefasciatus*¹⁶. Antimicrobial studies of Co^{2+} and Cu^{2+} ions complexes of tetradentate ligand made by *o*-phenylenediamine and 2-hydroxyacetophenone reveals that all the synthesized complexes have higher activities against *Bacillus cereus*, *Staphylococcus aureus* and *E. coli* as compared to free ligand whereas Co^{2+} ion complex show best results than Cu^{2+} ion complex¹⁷. Cu^{2+} and Ni^{2+} ions Schiff base complex of 3,5-dichloro-2-hydroxyacetophenone and 4, 5-dichloro-*o*-phenylenediamine studied for antimicrobial activity against *Bacillus subtilis* and *Pseudomonas*.

N,N-dimethylethylenediamine with 2-acetylpyridine and 2-hydroxyacetophenone Schiff base and its complexes antibacterial activity potential have been checked against Methicillin-Resistant *Staphylococcus aureus*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* Screened by Disc Diffusion Assay. and found that Cu^{2+} and Ni^{2+} ions metal Schiff base Co-ordinated complexes shows moderate inhibition against Methicillin-Resistant *S. Aureus* and weak antibacterial activity against *A. baumannii*, *P. aeruginosa* in the disc diffusion test and then further analyzed results from MIC value showed that both the complexes were active against Methicillin-Resistant *Staphylococcus aureus* and have resistant to *Acinetobacter baumannii* and *Pseudomonas aeruginosa*. Zinc(II) Complexes have more resistance activity than its ligand, which is explained by chelating theory²².

Antimicrobial activity of Cu^{2+} , Ni^{2+} and Zn^{2+} ions complexes 3-(2-aminophenyl) quinazolin-2-methyl-4(3H)-one and 2,4-dihydroxyacetophenone have been done against Methicillin resistant *S. aureus*²⁵.

Study of antibacterial activities of Fe^{3+} , Ni^{2+} , Cd^{2+} ions Schiff base complexes making with *o*-hydroxyacetophenone and propane-1, 2-diamine reveals that Cd^{2+} and Fe^{3+} ions complexes against examined human pathogenic bacteria²⁶.

Antifungal studies

Antifungal activities against *alternaria triticina* and *Puccinia recondite* have been done on Cu^{2+} and Ni^{2+} mixed Schiff base complex derived from 7-formyl-8-hydroxyquinoline, 2-hydroxyacetophenone, ethylenediamine Schiff base ligand¹⁸. Co^{2+} Schiff base complex of 2-hydroxyacetophenone and its N-phenyl derivative have been formed to check its antifungal activity against *Alternaria alternate*, *Fusarium oxysporum* and *Myrothecium roridum* by spore germination inhibition method¹⁹.

Tetradentate unsymmetrical Schiff base derived from ethylenediamine with *o*-hydroxyacetophenone and its Mn^{2+} , Co^{2+} , Ni^{2+} , Cu^{2+} , Cr^{3+} and Fe^{3+} ions complexes were synthesized by ethylenediamine with 5-chloro-2-hydroxyacetophenone, studied for antifungal activity by using potato dextrose agar medium containing starch against *Aspergillus oryzae* and *Fusarium species*¹¹.

Transition metal complexes of *o*-hydroxyacetophenone, 5-chloro-2-hydroxyacetophenone and ethylenediamine have been also studied for antifungal activities against *Aspergillus oryzae* and *Fusarium species*^{14,20}.

Cytotoxicity studies

Different transition metal complexes of N,N'-dimethylethyldiamine and 4-(2-aminoethyl) morpholine with 2-hydroxyacetophenone have been tested for cytotoxicity on MCF-7 cells⁹.

Schiff base complexes of Copper²⁺, Manganese²⁺, Nickel²⁺ and Zinc²⁺ ions formed by N,N-dimethylethylenediamine with 2-acetylpyridine and 2-hydroxyacetophenone in the presence of Cl^- , N^3 - and SCN^- ions were characterized by different parameters. Cytotoxicity of prepared complexes were

checked against human breast cancer cell MCF-7 which revealed that prepared complexes showed very weak cytotoxicity in comparison to available anticancer drugs²².

Cu²⁺ and Co²⁺ metal ions complexes of Schiff bases formed by 1, 8-dimionaphthalene with 4-chloroacetophenone, 2-hydroxy-3-methoxy-benzaldehyde and characterized through physicochemical techniques. The magnetic susceptibility data reveals paramagnetic properties of Cu²⁺ is because of one unpaired electron, formed tetrahedral or square planar geometry. Co²⁺ shows paramagnetic property is because of three lone pair and formed tetrahedral geometry. Neurotoxicity screening results revealed that schiff base ligands and its complexes were non-toxic to the neuroblastoma SH-SY5Y all lines. Almost All the formed compounds enhance the growth of these cells at concentration about 1mM²³.

Cu²⁺, Mn²⁺, Ni²⁺ and Zn²⁺ ions complexes with 2-hydroxyacetophenone and 4-(2-aminoethyl) morpholine studied for their cytotoxicity activities on MCF-7 breast cancer cell line and WRL68 normal liver cell line²⁴.

Oxidation and Reduction properties

Oxidation reaction of cyclooctene and tetraline have been catalyzed by ruthenium (III) Schiff base complex of ethylene1,2-diamine with 2-hydroxyacetophenone²⁷.

6-(3'-N-pyrrolpropoxy)-2-hydroxyacetophenone and ethylenediamine Schiff base copper (II) complex have electro-oxidation properties against methanol, ethanol and benzyl alcohol, isopropyl alcohol³².

Schiff base has been derived by the 5'-(N-methyl-N-phenylamino-methyl)-2'-hydroxyacetophenone with ethylenediamine and 5'-chloromethyl-2'-hydroxyacetophenone with N-methylaniline, Refluxing with Ni(II)acetate tetrahydrate to form catalyst for the reduction of 1-iodooctane²⁸.

Electrochemical behavior of ferrocenic Cu(II) Complex was also explored which formed by 5-chloromethyl-2-hydroxyacetophenone, N-ferrocenemethylaniline with 1,2-diaminoethane Schiff base³⁴.

Thermodynamic Studies

Non-symmetric (N)₃O-tetradentate Schiff base complex of Cu²⁺ ion with 2-hydroxyacetophenone, 1,2-diamino-2-methylpropane and pyrrole carboxaldehyde were synthesized for the study of kinetic template effect and result showed that due to kinetic template effect 3d-Cu (II) ion complex is formed and no other ions were prepared²⁹.

Polymer metal (II) complexes of Mn²⁺, Co²⁺, Ni²⁺, Cu²⁺ and Zn²⁺ metal ions synthesized with polymeric Schiff base, with formaldehyde and monomeric Schiff base of 2'-hydroxyacetophenone and o-phenylenediamine. Thermo gravimetric studies of polymeric Schiff base ligand and their complexes reveal that complexes are more thermal stable than ligand. Cu(II) complex was most thermally stable than other formed metal(II) based complexes, which Zn(II) complex also have good thermal stability³⁰.

Antioxidant properties

Mixed ligand complex of Co²⁺ ion complexes with 5-chloro-2-hydroxyacetophenone N(4)methylthiosemicarbazone and heterocyclic base (Pyridine, 2,2'-bipyridine, β-picoline, 1,10-phenanthroline, α-picoline)¹³ and complexes of Schiff base (o-hydroxyacetophenone and L-cystein with Ethylenediamine) have been studied for antioxidant activities¹⁶. Co²⁺ and Ni²⁺ ions Schiff base complexes with tryptamine and 5-methoxy-2-hydroxyacetophenone, 5-methyl-2-hydroxyacetophenone and 2-hydroxyacetophenone were also formed to check their anti-oxidant properties³¹.

Formation of different complexes of 2'hydroxy-acetophenone

A. Via, Electrosynthesis

Electrosynthesis of Cu¹⁺ ion complex with 2'-hydroxy-5'-methyl-acetophenone and triphenylphosphine have been done in CH₃CN using Pt-Cu electrode³³.

B. With Unsymmetric or mixed Schiff bases

Tetradentate Schiff base of 2-hydroxyacetophenone and ethylenediamine react with chromium and molybdenum carbonyls to form Schiff base complex³⁵.

Unsymmetric tetradentate Schiff base derived from N-(2-hydroxyacetophenone)-1-amino-2-phenyleneimine as a half part with

salicylaldehyde, 2-hydroxy-1-naphthaldehyde, 2-pyrrolicarboxaldehyde and 2-pyridinecarboxaldehyde and their Ni²⁺ and Cu²⁺ ions complexes were synthesized and characterized by different physicochemical technique³⁶.

Chromium, Molybdenum and Ruthenium complex of bidentate 2-hydroxyacetophenone propylimine and tetradentate bis-(2-hydroxyacetophenone)ethylenediimine have been formed³⁷.

Cu(II) complexes of mixed ligand have been synthesized with conjugated heterocyclic nitrogen base i.e. 1, 10-phenanthroline, N-phenyl-*o*-hydroxyacetophenimine and N-phenyl-2,4-dihydroxyacetophenonimine and characterized by different physicochemical methods. The data of magnetic moments and molar conductance of suggested its monomeric and ionic nature³⁸.

Different ligand complex of Cu²⁺ ion with salicylaldehyde-2-hydroxyacetophenone and ethylenediamine have been synthesized³⁹.

Cu²⁺ and Ni²⁺ ions complexes of mixed ligand of salicylaldehyde and 2-hydroxyacetophenone with ammonia, ethylenediamine, propylenediamine have been formed⁴⁰.

Mixed ligand complex of Cu²⁺ and Ni²⁺ ions of 2-hydroxypropiophenone with salicylaldehyde or 2-hydroxy-1-naphthaldehyde have been formed⁴¹.

Cu²⁺ ion mixed ligand complex of 2-hydroxyacetophenone and acetylacetone, with ammonia, methyl amine or ethyl amine, ethylenediamine, propylenediamine have been formed⁴².

Cu(II) mixed Schiff base complex of salicylaldehyde, ethylenediamine and 2-hydroxyacetophenone have been synthesized in the presence of H₂S gas⁴³.

C. With optically active schiff base Ligand

2-Hydroxyacetophenone with different chiral diamines, 1,2-diaminocyclohexane, 1,2-diphenylethylenediamine and 2,2'-diamino-1,1'-binaphthalene in different reaction condition have been formed and Tetranuclear Cu²⁺ ion Schiff base complex of 2-hydroxyacetophenone and 1,3-propanediamines with adduct sodium perchlorate

where 2-hydroxyacetophenone act as guest and acetonitrile solvent molecule also formed⁴⁴.

D. With Different Amino Acids

Schiff base complexes of Cu(II) of different hydroxyketones (2-hydroxyacetophenone, 5-methyl-2-hydroxyacetophenone 5-chloro-2-hydroxyacetophenone with tryptamine⁴⁵ and Palladium(II) and platinum(II) complex of substituted *o*-hydroxyacetophenone with glycine have been formed²¹.

Mixed ligand of 2-hydroxyacetophenone and glycine amino acid with N-donor ligands (pyridine, piperidine, pyrrolidine, hydrazine, imidazole, benzimidazole, 8-hydroxyquinoline and nicotinamide) and its Cu²⁺ ion complexes have been formed¹⁵.

Co²⁺ and Ni²⁺ ions Schiff base complexes with tryptamine and 5-methoxy-2-hydroxyacetophenone, 5-methyl-2-hydroxyacetophenone and 2-hydroxyacetophenone were formed³¹.

Mixed ligand complexes of Co²⁺, Cu²⁺, Ni²⁺, Zn²⁺ and Fe²⁺ ions were formed by 2-hydroxyacetophenone and tyrosine as first ligand with 4-diamethylaminobenzaldehyde and 2,4-dinitrophenylhydrazine as second ligand⁴⁶.

Cu²⁺ ion complex of 2-hydroxyacetophenone N(4)-methyl-4-phenylthiosemicarbazone and different amine like cyclohexyl amine/morphine/hexamethyleneimine with co-ligand 2,2'-bipyridyl and 1,10-phenanthroline³.

Different transition metal complexes of 2-hydroxyacetophenone with N,N'-dimethylethyl-diamine and 4-(2-aminoethyl) morpholine⁹ and Copper, Manganese, Nickel and Zinc complexes with 2-hydroxyacetophenone and 4-(2-aminoethyl) morpholine have been formed²⁴.

Cu(II) mixed ligand complex of 2-hydroxyacetophenone and acetylacetone, with ammonia, methyl amine or ethyl amine, ethylenediamine, propylenediamine have been formed⁴².

Cu²⁺ ion complex of 2-hydroxyacetophenone N (4)-methyl-4-phenylthiosemicarbazone and

different amine like cyclohexyl amine/morphine/hexamethyleneimine with co-ligand 2,2'-bipyridyl and 1,10-phenanthroline have been synthesized³.

E. With thiosemicarbazide

Schiff base of 4-phenylthiosemicarbazide and 2-hydroxyacetophenone have been formed⁴⁷.

X-ray diffraction studies of 2-hydroxyacetophenone N-(4)-cyclohexylthiosemicarbazone have been done⁴⁸.

Mixed ligand complex of Co²⁺ ion complexes with 5-chloro-2-hydroxyacetophenone N (4) methylthiosemicarbazone and heterocyclic base (Pyridine, 2,2'-bipyridine, 1,10-phenanthroline, α -picoline, β -picoline) have been made¹³.

Dinuclear Cu (II) complex of 2-hydroxyacetophenone-N (4)-cyclohexylthiosemicarbazone and 2-hydroxyacetophenone-N (4) phenylthiosemicarbazone have been made⁴⁹.

Formation of Schiff base complex of Cu²⁺ and Ni²⁺ by amine exchange reaction between Cu²⁺-Ni²⁺ ions solution of 2-hydroxyacetophenimine and ethylenediamine and propylenediamine have been done⁵⁰.

F. With *o*-hydroxyacetophenone oxime

Different transition metal (II) ion complexes of *o*-hydroxyacetophenone oxime Schiff base have been made⁵¹. Some trivalent lanthanides complexes with *o*-hydroxyacetophenone oxime have been studied⁵².

G. With Adduct

Cu(II) complex of salicylaldehyde, 1,3-propanediamine and 2-hydroxyacetophenone, with adduct sodium perchlorate have been made⁵³. Copper (II)- Manganese(II) complex of 1,3-propanediamine and 2-hydroxyacetophenone Schiff base ligand with three different polyatomic anions adduct with three different polyatomic anions adduct azide, cyanate or thiocyanate have been made⁵⁴. Tetranuclear adduct of Cu(II) of 2-hydroxyacetophenone and 1,3-propanediamines Schiff base complex sodium perchlorate where 2-hydroxyacetophenone act as guest too and acetonitrile solvent molecule also in it⁵⁵. Cu(II)-Ni(II) complex and Cu(II)-Zn(II) complex of salicylaldehyde, 2-hydroxyacetophenone and

1,3-propanediamine have been made with different adduct⁵⁶.

Azido bridged Cu²⁺ ion complex of di-Schiff base ligand made by 2-Hydroxyacetophenone and 1, 3-propanediamine have been studied⁵⁷.

H. With different Metal ions

Schiff base complexes of La³⁺, Pr³⁺ and Nd³⁺ were made by *o*-hydroxyacetophenone with the same ratio of 2-hydroxyethylamine and 2-hydroxy-n-propylamine in benzene⁵⁸. Some trivalent lanthanides complexes with *o*-hydroxyacetophenone oxime have been studied⁵².

Mg²⁺, Ca²⁺, Sr²⁺, Ba²⁺ ions complex of mixed ligand of 5-chlorosalicylaldehyde, 2-hydroxyacetophenone and/or 2-hydroxypropionophenone have been made⁵⁹.

IR spectral data of stable Schiff base complexes of uranyl (VI) complexes made with 2-hydroxyacetophenone-1, 2-diaminoethane and 2-hydroxyacetophenone-2-aminophenol reveals that N, N-bis(*o*-hydroxyacetophenone)1,2-diaminoethane ligand is tetradentate and *o*-hydroxyacetophenone-2-aminophenol ligand is tridentate⁶⁰.

UO₂(II) and Th (IV) Schiff base complex of *o*-hydroxyacetophenone and *o*-aminoacetophenone have been studied on testicular atrophy in albino rats⁶¹.

Bis (5'-bromo-2'-hydroxyacetophenone) oxovanadium (IV) complex have been studied for spermicidal activity against human sperm⁶².

Trinuclear Schiff base complex of Cu(II) and Pb(II) have been synthesized by 2-hydroxyacetophenone and 1,3-propanediamine as Schiff base ligand⁷. Tripalladium complex of Pd(II) with 2-hydroxyacetophenone, hydrazine hydrate and propylisothiocyanate have been formed⁶³.

I. Nitration and Bromination Reactions of Cu (II) complexes

Nitration of the Cu²⁺ ion complexes of Schiff base ligand of 2-hydroxyacetophenonimine with acetylacetone, benzoylacetone, or dibenzolmethane have been done⁶⁴. Bromination and nitration of Cu²⁺ ion Schiff base complexes of salicylaldehyde, 2-hydroxy-1-naphthaldehyde with ethylenediamine have been done⁶⁵.

J. Heterometallic Complexes

Tetra nuclear heterometallic complex of Cu(II)–Cd(II) of Schiff base 1, 3-propanediamine and 2-hydroxyacetophenone have been made⁶⁶. Heterometallic Copper(II)-mercury(II) complex of Schiff base ligand of 1,3-propanediamine and 2-hydroxyacetophenone have been made and structure studies done on three formed complexes (1) [(CuL-CH₃).HgCl₂], (2) [CuL-CH₃)₂.HgCl₂ and (3) [CuL-CH₂-HgCl)₂]⁶⁷.

Copper (II)-Nickel(II) complexes have been made in the presence of polyatomic anions adduct dicyanamide or thiocyanate with 1,3-propanediamine and 2-hydroxyacetone ligand⁶⁸.

Trinuclear Cu(II)-Co(II) complex of salicylaldehyde, 2-hydroxyacetophenone and 1,3-propanediamine adduct with dicyanamide Bridge⁶⁹.

Homo and hetero binuclear Schiff base complex of Cu²⁺-Cu²⁺ ions and Cu²⁺-Ni²⁺ ions made by 3,5-dichloro-2-hydroxyacetophenone with o-phenylenediamine and also biological activity have been checked against *Staphylococcus aureus*, *Bacillus*

and *Escherichia coli*, *Proteus*⁷⁰. Heterobinuclear Cu(II)-Ni(II) complex of 4-chloro-o-phenylenediamine and 3,5-dichloro-2-hydroxyacetophenone have been made and studied for antibacterial activities against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Bacilli* and for anticancer activities on human breast cancer cell⁷¹.

DISCUSSION

Metal complexes containing 2-hydroxyacetophenone based Schiff base have various important biological activities but still there is need to find more properties and to form new complexes.

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Conflict of interest

No Conflict of interest.

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