**LITERATURE REVIEW**

**“W**hat is there in the name ?”,it’s a common satirical idiom, but the Co-ordination chemistry is the name which is enough to tell its importance in various scientific fields. Co-ordination chemistry concerned with the formation of compounds by interaction of ligands with the various metal ions. The condensation products of amino compounds and carbonyl compounds named ‘Schiff bases” have been attracted the attention of all organic ,inorganic and analytical chemist in the recent years. The reason behind this is that the Schiff bases are referred as so called “fortunate ligand’ for many transition and inner-transition metal ions, and such coordination compounds have been extensively proven useful in various research fields. The fascinating feature of this class of ligand is the presence of azomethine linkage, because of which it has many biomedical applications such as ,anticancer, diuretic, anti-tumour, anti-HIV agents[1-4] .

 Aromatic Schiff bases and its metal complexes catalysed the reaction on oxygenation, hydrolysed , electro-reduction and decomposition[5-7]. Some transition metal ions complexes of a polymer attached with Schiff bases proved catalytic property on decomposition of hydrogen peroxide and oxidation of ascorbic acid. It has also been found that cyanohydrins cobaltite have versatile catalytic applications[8].

 Series of transition metal complexes have been synthesized from ‘4-(1-4-(hydroxyl-3-methoxy-bezylidine –amino)phenyl)ethtylidene-amino)-1-pyrazole-3-one’.The study of these metal complexes have been shown that the co-ordination sites were Oxygen of the carbonyl group and Nitrogen of the Azomethine group. On complete study of all transition metal complexes Octahedral geometry have been recommended[9].

 New series of transition metal complexes of Cu(II), Co(II), Mn(II), Fe(II), Ni(II) and V(II) were prepared from the Schiff base which was synthesized from the condensation of 5-Bromo-2-hydroxy Benzaldehyde and Aniline in alcohol medium. All the prepared metal complexes were then analysed from the analytical data obtained from the NMR,IR. The prepared complexes were then subjected to the biological activity like ant-bacterial activity and these complexes exhibited good anti-bacterial properties[10].The proposed structure of metal complex of Schiff base is (Fig:1):



**Fig:1 The proposed structure of metal complex of Schiff base**

 A research paper entitled “Synthesis, Characterisation and biological properties of newly prepared Sc(III),Y(III),La(III), and Ce(III) complexes with the two ferrocenyl ligands of 1,1’-bis(2-thienylmethylidene)hydrazono-1-ethylferrocene and 1,1’-bis(2,3-dihydro-2-methyl benzothiazol-2-yl)ferrocene” mentioned that these organometallic compounds are potential ligands for lanthanide metals. All prepared complexes shows remarkable antibiotic activity. Scandium compounds have been found effective towards Salmonella Spp. and also found to have inhibition activity against *B.Subtillis* more than the standard drugs[11].‘

 ‘ Li-Hua Wang, Lei Liang, Peng-Fe Li’ have been synthesized a novel Eu(III) complex .This complex has been characterised on the basis of analytical data obtained from the NMR, IR , X-ray crystal diffraction methods and has good luminescence properties[12].

 Schiff bases obtained from the Salphamethoxazole and Salicylaldehyde and Thiophene -2-Aldehyde complexed with many inner-transition metal ions such as La(III), Ce(III), Pr(III), Nd(III), Gd(III), Dy(III), Ho(III) and Er(III) have been synthesized and characterised on the basis of IR,NMR,UV-Visible Spectroscopy and Molecular weight determinations. It has been found that the Schiff bases acts as Monobasic bidentate ligands and rendered the metal eight- coordinated .These complexes have also shown greater efficacy than the Schiff bases against insects such as Cockroaches[13]

 Macrocyclic Schiff bases are the new class of compounds which proved itself as a better mean for the trans-metalation with some transition elements. ‘KhaliL K Abid &David E.Fenton’ has been reported that the lanthanide complexes with the macrocyclic Schiff bases are sufficiently kinetically labile for trans-metalation reaction to occur with Cu(II)[14]. The structure depicted schematically as follows (Fig:2):



**Fig:2 Schematic representation of Macrocyclic Schiff bases and metal complex**

 Lanthanide complexes are well known for their luminescence properties and reported in many literatures. ‘Lada Puntus’ et.al .have been prepared the lanthanide complexes of Schiff base with 1:1 and 1:2 (Metal:Ligand) stoichiometric ratios by condensation of pyridoxal and Aspartic acid and L-Histidine .The lanthanoid Eu(III) was being used their optical spectroscopy and X-ray crystal diffraction techniques have been relieved that both these compounds have distorted square anti-prism environment formrd by the phenolic oxygen of pyridoxal, the nitrogen atom of carbon –nitrogen double bond, Oxygen atoms of the carboxylate groups of His and Asp and oxygen atoms of the water molecules. The complexes which were formed have tetrahedral geometry and serve as a good luminescence materials[15].

 Two new Schiff bases containing olefin linkages were prepared from condensation of o-substituted aromatic amines with dicinnamoylmethane under special conditions .The existence of Schiff base ligands predominantly in the intramolecular hydrogen bonding with keto-enamine group [16].

 In the research article by ‘Sadeem M.Al-Barody & Hasina Ahmad’ , the novel Schiff base N,N’-di-(4’-pentyloxy benzoate –salicylidene -)1’,3’-diamino propane and their lanthanide complexes have been prepared. Investigation study shown the existence of two forms of ligands one is bidentate through the deprotonated phenolic oxygen and azomethine nitrogen competed seven co-ordinated which revealed that stoichiometry of the compounds depend on the number and different lengths of the terminal chains.[17].

 ‘Kavitha Andiappan , Amandhavelu Sanmugam , Dhanasekaran Vikraman’, prepared novel Schiff base ligand “N2,N3-bis (Anthracene-9-ylmethylene) pyridine-2,3 –diamine through the condensation of 2,6-diaminopyridine & Anthracene-9-Carbaldehyde” in 1:2 ratio. The analytical data obtained from FT-IR spectroscopy shown that the ligand was neutral bidentate ligand and bounded to the metal ions via two azomethine Nitrogens. Their lanthanide complexes with Pr, Er revealed that these compounds possess excellent anti-cancer activity against Vero, MCF7, and Hela cancer cells. Therefore these complexes can be a novel anti-tumour agents for humans[18].

 Lanthanide complexes of Eu(III), Gd(III), Nd(III), Sm(III), and Tb(III) with the Schiff base derived from glcylglycine and 4-nitrobenzaldehyde were synthesized and characterized by various physico-spectral techniques. These complexes were then screened for anti-bacterial activity and anticancer activity. IR data shown that Schiff base ligand acts as tri-dentate monobasic ligand co-ordinated through azomethine nitrogen ,Peptide nitrogen, carboxylato Oxygen atoms. The Nd(III) complex has shown better efficacy against the gram negative bacteria such as *E.coli* as compared to the other complexes and free ligand. DNA cleavage study of the complexes has shown that the Eu(III) and Nd(III) complexes completely cleaved the DNA. Instead they did not have greater efficiency as compared to the well-known anti-cancer agents such as Cis-platin but can be acts as a potent anticancer agents on the cancerous cells[19].

 Fluorescence study of Lanthanide complexes with the novel Schiff base have been reported. It was observed that under the excitation the Nd and Er complexes shows characteristic fluorescence[20].

 Research paper by ‘Hitesh Patel, S .Bhutadiya, Jabli. J. Vora , Toral H.Yadav’ synthesized inner-transition metal complexes of La(III), Ce(III), Pr(III) with the Schiff base derived from the Anthranillic acid and Salicyaldehyde .These complexeses were then subjected for IR, UV-Visible ,NMR ,Magnetic moments and Thermal conductivity. TGA Study shown the higher activation energy indicating these complexes have good catalytic properties. These were also subjected for the antibacterial activity and result obtained revealed that these complexes increased antimicrobial activity as compared to the Schiff base Drug Ciprofloxacin was used as a standard[21]..The probable structure for the various lanthanide Schiff base complexes are as follows (Fig-3 ,4,):



**Fig 3:Cerium complex of Schiff base**



**Fig 4:Praesodynium complex of Schiff base**

 Napthalene Schiff based compounds were synthesized by a condensation reaction of 1,5-Diamino naphthalene and 2-Hydroxy -3-Methoxy benzaldehyde. The inner-transition metals such as La(III) and Er(III) were chosen for complexing with the prepared Schiff base .The outcome from the data suggested that the complexes have tricapped trigonal prismatic geometry . The ligation through the Oxygen atom of –OH and azomethine nitrogen and five water molecules were out of the co-ordination sphere. The coordination number assigned was 9.These complexes were also screened for the antimicrobial activities and these complexes has shown excellent bactericidal potency and can be used as potent bactericidal agent[22].

 ‘Alessia Cataleno’ et al. had reviewed various advancements of metal complexes with Schiff bases as Anti-proliferative agents. This paper explained that Schiff base ligands with different metal ions serve as potent pharmaceutical tool for modification of various drugs and improve their efficacy over the original one. Schiff bases have been known as privileged ligands in Organic synthesis. This paper also enlighten the utility of lanthanides and actinides as anticancer ,anti-tumour agents. Recently these complexes has been suggested a prominent drug candidate for the treatment of liver cancer, because of showing high anti-proliferative activity against hepatocellular carcinoma [23].

 ‘Sathiyanarayanan et al.’ reported a series of Lanthanide(III) complexes with Schiff base particularly Pr, Sm, & Yb . In Vitro activity studies by MTT assay have been shown that compounds were active against Hela tumour cells. These compounds being the most active with an IC50 values equal to 34 microgram/millilitre[24].

 Lanthanide complexes with Schiff bases have been extensively studied for their thermal and electrochemical properties. Cyclic voltammetry have been employed for the study of electrochemical properties. The influence of pH on cyclic voltamograms indicated that there is increase in the nucleophilicity of organic compounds and anti-oxidant properties is thermodynamically favoured with the increase in pH . These complexes also shown promising results for the antibacterial and antifungal activities[25].

 ‘Jing Xie et al’ have isolated two novel complexes of lanthanides ( La,Ce) with hydrazone Schiff base. The results obtained indicates that the two complex exerts considerable cytotoxic activity against three cancer cell lines i.e. Human lung cancer cell line A549, and human gastric cancer cell lines BGC823 and SGC7901. Therefore these complexes may be a useful tools for biomedical applications such as human cancer therapeutic fields[26].

 The review paper by ‘Wali A.Z’., focused the biological activities of Schiff base and their complexes. This paper enlighten the use of Schiff bases in the synthesis of many organic compounds. This review paper also includes various antimicrobial activities such as anti-fungal, anti-malarial, anti-inflammatory, anti-viral and anti-pyretic properties[27] .

 Stability constant also play a vital role in complex formation and their biological activities. ‘S.G.Shankarwar et.al.’ have carried out a promising work on the stability constant of lanthanide (III) complexes with Schiff base. Schiff base obtained from Salicyalhydrazid with 4-Methoxy benzaldehyde,3,4,5 trimethoxybenzaldehyde and furfuraldehyde have been studied. The stability constants of such lanthanides have been determined potentiometrically in 40%THF-Water mixture and 0.1 M sodium perchlorate. It is seen that lanthanides form 1:1 and 1:2 complexes with all the Schiff bases and log k shows a break at Gadollinium. From the relevant study ,it is seen that Rare earth metal ions binds predominantly to Oxygen and weakly to Nitrogen of Schiff bases[28].

 ‘S.Vidya Sagar Babu , K.S.V Krishnarao ,Yong Ill Lee’, studied the luminescence and DNA binding properties of Ln(III)-Schiff base family. They synthesized penta-dentate Schiff base ligand containing N3O2 donor set. The Schiff base complexed with rare earth metals such as Pr, Nd, Sm and Eu. The analytical data obtained suggests that the ligand binds through two naptholic oxygen atoms, two azomethine nitrogen atoms, and one primary amine. IR study revealed that the nitrate groups present as ionic and co-ordinating ligands. Two water molecules are also incorporated in the co-ordination sphere. The complex are found to have good chelating ability and acts as a chromophore and can be used to absorb and transfer energy to lanthanide ions. These complexes also proved better binding capacity with DNA ,therefore regarded as efficient intercalators of DNA[29].

 ‘Ahmed A. El-Sherif, Taha M.A.Eldebss’, have been synthesized a novel Schiff base ligand and complexed with transition metal ions such as Cu(II), Ni(II), Mn(II), Co(II) and Zn(II). They have been concluded that the metal ions are co-ordinated through azomethine Nitrogen and phenolic oxygen atoms via deprotonation forming stable six membered heterocyclic ring. This study also revealed that the formation of complexes was spontaneous , exothermic and entropically favourable. Molar conductance studies suggested that complexes were of non-electrolytic in nature. The synthesized complexes have been subjected for the antimicrobial properties and results shown that these exhibits better inhibition activity as compared to the parent ligand[30].The suggested structure of Schiff base ligand and its metal complexes where M=Cu(II), Ni(II), and Zn(II) (Fig:5)



**Fig 5:The suggested structure of Schiff base ligand and its metal complexes where M=Cu(II), Ni(II), and Zn(II).**

 Two novel Schiff bases containing benzothiazole derivative have been prepared. These Schiff bases then complexed with the inner-transition elements Ce(III), Nd(III) and Pr(III). It has been found that central metal ion was eight co-ordinated by two units of ligands where both are co-ordinating in tetra-dentate fashion. Furthermore these complexes were examined against cytotoxic pathogens such as S.aureus cell culture which indicates that complexes with positive charge interacted with the bacterial cells and their complexes shows anti-bacterial activity for skin infections and food poisoning . Ligands and complexes have been examined against gram –positive and gram-negative microbial culture and shows excellent results against pathogenic microbes[31]. Structure of some metal complexes have been depicted as follows (Fig-6,7,8):



**Fig-6 :Ce metal complex** **Fig-7:Pr metal complex**



**Fig-8:Nd metal complex**

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