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SYNTHESIS AND CHARACTERIZATION OF Ni(II) AND Cu(II) COMPLEXES OF QUINOXALINE-2,3-DIONE AND HYDROQUINONE

BY: GEREMEW KEBEDE

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April, 2018

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BY GEREMEW KEBEDE

April, 2018

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DECLARATION

I declare the work described in this Thesis was carried out by me under thesupervision of Dr. Negash Getachew at the Department of Chemistry, addis ababa university.I also declare the substance of this Thesis has neither been submitted elsewherenor is being concurrently submitted for any other degree.I further declare that the Thesis embodies the results of my own research or advanced studiesand that it has been composed by me. Where appropriate I had made acknowledgment to thework of others.

Name: Geremew Kebede Signature: _____

Place: Addis Ababa University, Addis Ababa.

Date of submission: _____

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LIST OF ABBREVIATIONS AND SYMBOLS

AAS =Atomic Absorption Spectroscopy

Dpq = dipyrido (3,2-d:2,3-f) quinoxaline.

DMF = dimethyl formamide.

Dmq = dimethylquinoxaline.

$DMSOd_6$ = dimethyl sulfoxide

DNA = deoxyribonucleic acid.

EMME = ethoxymethylenemalonate.

HQ = hydroquinone

HPAHS = heteroatom containing polycyclic aromatic hydrocarbons.

IR = Infrared.

KA = kanic acid.

LMCT = Ligand to metal charge transfer.

Mq = methyl quinoxaline.

NMDA = N-methyl-D-aspartic acid.

NMR = Nuclear magnetic resonance.

QdNO's = quinoxaline 1,4 di-N-oxides

QXD = 2,3-quinoxaline dione.

RT = room temperature

TNQX = 2,3,7-trichloro-5-nitroquinoxaline.

TLC = thine layer chromatography.

Tpphz = tetrapyridophenazine.

UV =ultra-violet.

FIGURE OF APPENDXIES.

IR spectra

UV-vis Electronic Spectrum

ABSTRACT

In this study the synthesis and characterization of two metal complexes of Ni(II) and Cu(II) are presented. New Hetrocyclic aromatic complexes of the type [ML_2], where M is Ni(II) or Cu(II) and L is $C_8H_6O_2N_2$ were synthesis by the template method from quinoxaline-2,3-dione, hydroquinone with the corresponding hydrated metal salt of $Ni(NO_3)_2.6H_2O$ and $CuCl_2.2H_2O$. The complexes were distinctly colored and stable to atmospheric conditions. The synthesized complexes were characterized by UV, IR, ^{1}HMR, AAS spectroscopic methods as well as by measurements of their respective molar conductance.The analysis result showed the formation of a square planar complexes of both metals with quinoxaline-2,3-dione.

1INTRODUCTION

1.1 Background of the study

Metal complexes are made up of a metal ion (the acceptor) and one or more ligands containing the donor atoms. Heterocycles can play the role of metal ligands by donating a pair (monodentate ligand) or more than one pair of electrons (polydentate ligand or chelating ligand) to the metal forming a coordinated. The heterocycles can be conveniently defined as cyclic organic compounds in which one or more of the ring carbon atoms have been replaced by another element such as N, O, or S. They may be either simple aromatic rings or nonaromatic rings. Heterocycles containing sulfur and/or nitrogen atoms are useful as components of functional materials since heteroatoms in their rings are helpful to stabilize ions or ion radical species, and extended π-conjugation decreases columbic repulsion. in addition, intermolecular interactions caused by heteroatom contacts can be expected to form novel molecular assemblies [1].

Heterocyclic chemistry is an inexhaustible resource of novel compounds. Since rings can be of any size, from three membered up wards andthe heteroatoms can be drawn in almost any combination from a large number of elements (though nitrogen, oxygen and sulfur are still by far the most commons). The number of possible heterocyclic systems is almost limitless, making available compounds with the most diverse physical, chemical and biological properties. Practical application includes dyestuffs, copolymers, solvents photographic sensitizers, antioxidants, vulcanization acceleration in the rubber industry, and valuable synthetic intermediates. Therefore, substantial attention has been paid to develop efficient and straightforward methods to synthesize heterocycles. The o-phenylenediamine and oxalic acid were used as starting material to react with hydroquinone. In this paper I report the synthesis of a new complex formed quinoxaline-2,3-dione with hydroquinone in the presence of metal ion.

1.2 Objectives

The trend toward design, synthesis, characterization and application of new heterocyclic aromatic compounds is undoubtedly increasing. Especially the heterocyclic aromatic compounds such as pharmaceuticals, agrochemicals, flavors and fragrances as well as invention of advanced materials straightforward. The objectives of this study focus on synthesizing, isolating, identifying, characterizing metal complexes.

1.2.1 General Objectives

The main general objectives are the following.

- Synthesis and Characterization of metal complexes.
- Characterizing compounds using analytical and spectral methods.
- Interpretation of spectroscopic datas, like IR, NMR, UV, ASS, etc..

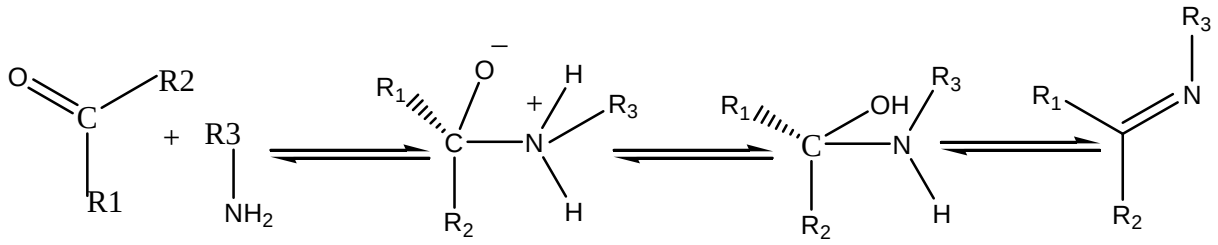
1.2.2 Specific Objectives

- Synthesis and isolation (purification) of quinoxaline derivatives- 1,4-quinoxaline-2,3-dione.
- Synthesis and characterization of Ni(II) and Cu(II) complexes.
- Chart- Explanation and discussion of their properties (e.g. melting point, thermal analysis, IR, NMR, UV,etc.)
- Elucidation and determination of structural formula on the basis of interpretation of physiochemical data and theoretical explanations from the literature survey

2. LITERATURE REVIEW

2.1 Schiff Bases

Many research reports made on the synthesis and characterization of metal binding with multidentate ligands. Several multidentate ligands possessing C=N or azomethine group are known as Schiff bases. Schiff base are compound containing an imine or azomethine group (R-C=N-) and usually prepared by the condensation of a primary amine with carbonyl group. The reaction is reversible, progress through a carbinol amine intermediate and removal of simple compound which is water [2].



Scheme 1: General mechanistic aspects of Schiff base preparation

R_1 and R_2 =H, aryl, R_3= alkyl, aryl, OH, NHR, OR, NH_2, SH etc. functional groups near the site of condensation of Schiff base form coordinating by forming five or six chelate ring on the reaction with metal ions. Schiff base have an important role in the development of coordination chemistry as it forms stable complexes with most transition metal such as zinc, copper, nickel, etc. The interest on Schiff base metal complexes has been growing in the area of bio-inorganic due to the role of complexes providing synthetic models metal containing sites in metalloprotiens and enzymes which is applicable for pharmaceutical and agrochemical works. A large number of Schiff bases differs in denticity, flexibility, nature of donor atoms and in electronic properties obtained from the condensation reactions [2-3].

2.1.1 Synthesis of Schiff's base ligand

In case of aldehyde is a salicylaldehyde derivative and amine is a diamine derivative, the condensation gives us interesting N_2O_2 Schiff base compounds. The salen ligands are very much similar to porphyrins. Even though the term salen was originally used to show only the tetradentate Schiff base derived from salicylaldehyde and ethylenediamine. Therefor the term salen -type is now used in the literature to explain the class of (O, N, N, O) tetradentate bis Schiff ligands.

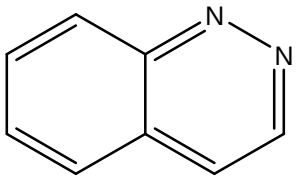
Stereogenic centers or other elements of chirality can be introduced in the synthetic forms of Schiff bases the common structural feature of this compound is the azomethine group with a general formula RHC=N-R' where R and R' are alkyl, aryl, cyclo alkyl or heterocyclic group which may be variously substituted. The presence of a lone pair of electrons in an sp2 hybridized orbital of nitrogen atom of the azomethine group is considerable chemical important and involve in chelating ability especially in combination with one or more donor atoms close to the azomethine group.

In the past two decades there were some of the most typical ligand in the field of coordination chemistry [4]. Especially a huge number of transition metal complexes of Schiff's base ligands derived from the condensation of salicylaldehyde and 2-hydroxyl-1-naphthaldehyde with many primary amines were the topic of contemporary research [5]. Those Schiff's base ligands may act as bidentate N,O-, tridentate N, O,O-, N, O, N-, N,O, S-, tetradentate N, N, O, O-, hexadentate N, N, O, O, S, S-donor ligands [6]etc., which can be described to yield mononuclear or binuclear complexes of one-dimensional(1D), two-dimensional (2D) and three-dimensional (3D) metal-

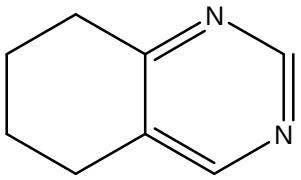
organic frameworks [7]. In addition to these,Schiff base macrocycles produced by self-condensation reaction of appropriate formyl- or Keto- and primary amine precursors and find wide applications in macrocyclic and supramolecular chemistry. Schiff bases easily form stable complexes with most transition metal ions and stabilize in much oxidation states for instant macrocycles are polydentate ligands which have at least three donor groups and a minimum of nine atoms with in macrocyclic ring [8]. The donors form coordinative bonds with metal centers to form highly stable macrocyclic complexes.

2.2 Chemistry of quinoxalines

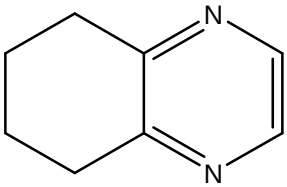
Quinoxaline is benzopyrazine which is heterocyclic compound containing ring complex of benzene ring and pyrazine ring. It is isomeric with other naphthyridines including quinazoline, phthalazine and cinnoline. Quinoxalines are important for the manufacture of dyes, pharmaceutical and antibiotics such as echinomycin, levomycin and actinoleutin. Researches were carried out in order to explain the antitumoral characteristics of quinoxaline compounds. Nearly the studies of quinoxalines and its analogs have been investigated as catalysts. The common properties of quinoxaline 1,4 di-N-oxides (QdNO's) can be associated with the production of free radicals. QdNO' s were first produced for highly antagonists of vitamin K activity, but the studies are un limited and extended for the application of dyes, efficient electroluminicent materials, and organic semiconductors. The oxidation of both nitrogen of quinoxaline ring highly diversify certain biological properties.



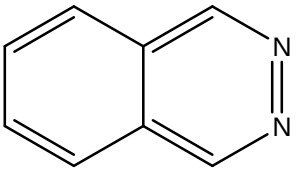
Cinnoline



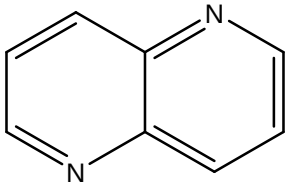
quinazoline



quinoxaline



phthalazine

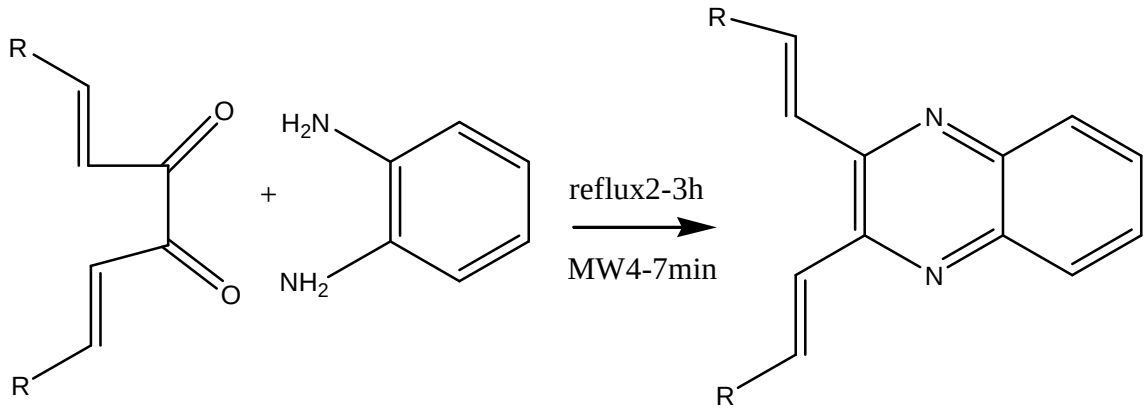


1,5-naphthyridine

Scheme 2: The chemical structures of selected aromatic compounds (diazanaphthalenes)

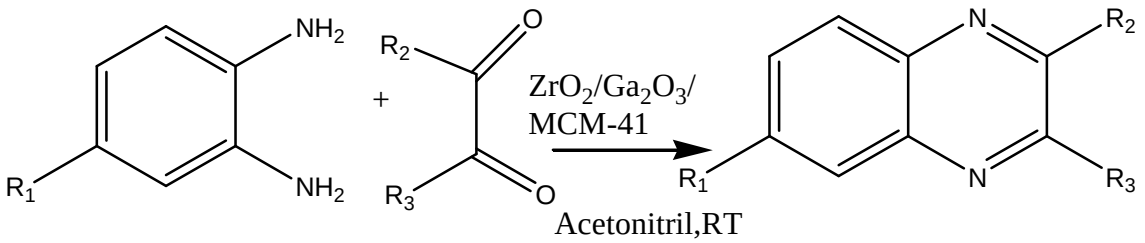
All of the above compounds have 10-π electrons that are formed in five molecular orbitals that can be regarded as linear combination of 2p-atomic orbitals, one atomic orbital and one π-electron coming from each atom of the ring skeleton. There are also two non-bonding orbitals that lie in the molecular plane and mostly confined to the nitrogen atoms, each of these orbitals contain an electron pair and these electrons are responsible for the basic characteristics of the group of compounds [9, 10]. The primary synthesis of Quinoxalines may be completed by cyclization of benzenesubstrates already bearing appropriate substituents; by cyclocondensation of benzene substrates with acyclic synthons to provide one or more of the ring atoms required to complete the pyrazine ring; by analogous processing of preformed pyrazine substrates; or by rearrangement, ring expansion/contraction, degradation, or modification of appropriate derivatives of other heterocyclic systems [11].

Quinoxalines are easily made from 1,2-dicarbonyl compounds and aromatic 1,2-diamines; i.e., the known method to produce quinoxaline is the reaction of o-phenylene diamine with a 1,2 – dicarbonyl compound [12]. Different methods have been developed for the synthesis ofsubstituted quinoxalines and well- known method relies on the condensation of an aryl 1,2-diamine with 1,2 dicarbonyl compound in refluxing with ethanol [13-18]. Thirumurugan et al. reported the easiest and common method for the synthesis of quinoxaline derivatives from cinnamils in water under reflux/microwave irradiation conditions (Scheme 3) and these quinoxaline derivatives show good photophysical properties and stable fluorescence [19].



Scheme 3: Synthesis of quinoxalines

Binary metal oxides catalyzed on Si-MCM- 41 mesoporous molecular sieves were used as catalysts in the synthesis of quinoxaline derivatives (Scheme 4) by the condensation of 1,2-diamine with 1,2 dicarbonyl compounds [20].

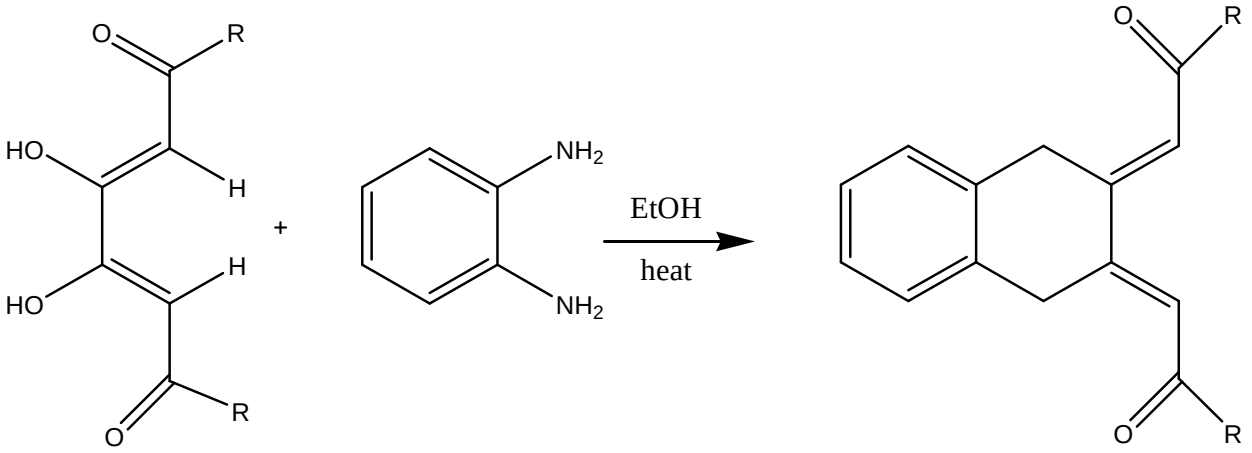


Scheme 4: Quinoxaline synthesis at RT

2.2.1 Quinoxalines derivatives

The quinoxaline derivatives emerging veryinteresting biological properties such as antibacterial, antiviral, anticancer, antifungal,antihelmintic, antileishmanial, anti-HIV, and insecticidal.

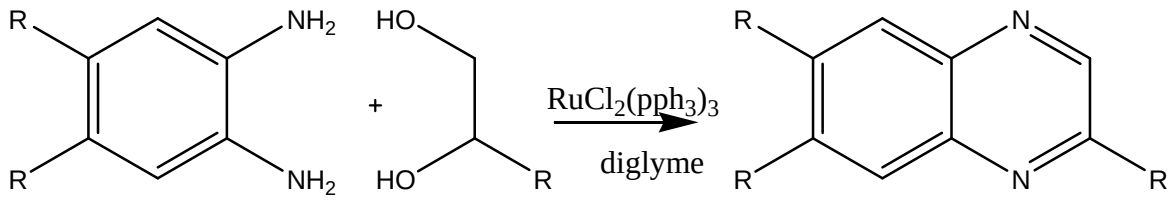
Different type of 2,3-bifunctionalized quinoxalines have been synthesized by thecondensation of 1,6-disubstitutedhexan-1,3,4,6-tetraones with*o*-phenylenediamine.



R =Ph, Pr, neo-pentyl, etc.

Scheme 5: synthesis of 2,3-bifunctionalized quinoxalines

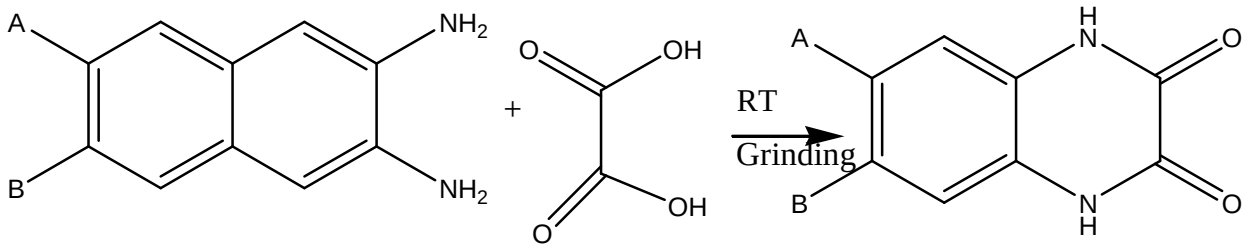
o-phenylenediamine reacts with an array of vicinal diols in diglyme in thepresence of a catalytic amount of a ruthenium complex along with potassium hydroxideto produce high yields quinoxalines.



R =H, Me

Scheme 6: synthesis of quinoxaline by array of vicinal diols

One pot efficient green synthesized substituted 1,4-dihydroquinoxaline-2,3-diones in one-pot reaction at room temperature from substituted o-phenylenediamines and oxalic acid (scheme-7).



Scheme 7: One-pot efficient green synthesis for derivatives of quinoxaline.

2.2.2 Quinoxaline derivative metal complexes

Spectrophotometric study of Co(II) and Ni(II) complexes with quinoxaline-2,3- dithiol has been reported by Ayres et al [21]. The studies revealed that the absorbing complex have polymeric structure in which the polymer chains consist of alternating metal ion and quinoxalinedithiolates. They also reported the spectrophotometric determination of platinum. It involves the reaction of platinum with 2,3-quinoxalinedithiol and complex formation [22]. Cu(II) halides form complexes of the type CuX_2L_2 (L is 2,3-diphenyl and 2-methylquinoxaline) and CuX_2L (L is 2,3-dimethyl quinoxaline) with substituted quinoxaline. The 2,3-diphenylquinoxaline complexes appear to be monomeric whereas the others are polymeric. The 2-methylquinoxaline complexes have halide bridges and the 2,3-dimethylquinoxaline complexes are square-planar with organic ligand bridges. The structures are deduced from reflectance, far-infrared spectra and molecular models [23].

Quinoxaline-2-carboxylic acid, 3-chloro and 3-hydroxy derivatives have been studied as analytical reagents. The solubility products, the optimum pH range for complete precipitation and the thermal behaviours of the metal complexes have been established. Quinoxaline-2-carboxylic acid allows the gravimetric determination of Cu(II), Cd(II), Co(II), Ni(II), Zn(II) and Pd(II) with 3-chloro and 3-hydroxy derivatives. Among these only Pd(II) could be precipitated quantitatively [24]. Billig et al reported a number of complexes of Ni(II) with quinoxaline (Q), 2-methylquinoxaline (Mq) and 2,3-dimethylquinoxaline (Dmq). Magnetic and spectral properties indicate that the complexes $MqNiX_2$ (X=Cl- or Br-) and $LNi(NO_3)_2$ (L=Q or Mq) have octahedral stereochemistry, while those of $MqNiCl_2$ and Dmq_2NiCl_2 have monomeric square planar structures. The octahedral halide complex $MqNiCl_2$ is considered to involve both bridging halide and bidentate organic ligands. The Co(II), Ni(II) and Cu(II) halide complexes of 2,3-di-(6-methyl-2-pyridyl) quinoxaline (dmpyq) were reported. The structures of the above complexes were assigned on the basis of magnetic and spectral data. For Co(II), the tetrahedralcomplexes CoX_2(dmpyq) (x=Cl-, Br- and I-) were isolated and for Ni(II), the complexes NiX_2(dmpyq) (X=Cl-, and Br-) were found to be distorted octahedral. Cu(II) complexes of stoichiometry CuX_2(dmpyq) were obtained [25].

2.3 Schiff base transition metal complexes

Metal complexes of the Schiff bases are generally prepared by treating metal salts with Schiff base ligands under suitable experimental conditions. However, for some catalytic application the Schiff base metal complexes are prepared in situ in the reaction system.

Alkoxides of earlytransition metals (M = Ti, Zr), are commercially available and easy to handle. Theuse of other alkoxide derivatives is not easy, particularly in the case of highlymoisture-sensitive derivatives of lanthanides. Metal amides $M(NMe_2)_4$ (M = Ti, Zr)are also employed as the precursors in the preparation of Schiff base metalcomplexes. The reaction occurs via the elimination of the acidic phenolicproton of the Schiff bases through the formation of volatile $NHMe_2$.

Other syntheticroutes include treatment of metal alkyl complexes with Schiff bases ortreatment of the Schiff base with the corresponding metal acetate under refluxconditions. The synthetic Schiff base is quiteeffective in obtaining salen-type metal complexes consists of a two-step reactioninvolving the deprotonation of the Schiff bases followed by reaction with metalhalides. Deprotonation of the acidic phenolic hydrogen can be effectively done byusing NaH or KH in coordinating solvents and the excess sodium or potassiumhydride can be eliminated by filtration. The deprotonation step is normally rapid atroom temperature, but heating the reaction mixture to reflux does not causedecomposition.

2.3.1 Schiff base transition metal complexes in catalysis

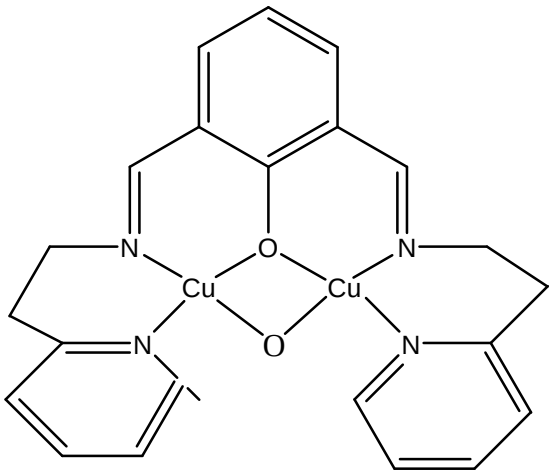
Schiff base complexes play a central role in various homogeneous catalytic reactions and the activity of these complexes varies with the type of ligands, coordination sites and metal ions. Literature reports reveal that a large number of Schiff base metal complexes exhibit catalytic

activities. Chiral Schiff base complexes are more selective in various reactions such as oxidation, hydroxylation, aldol condensation and epoxidation.

Oxidation reactions: The binuclear palladium Schiff base complex was found to be effectivecatalysts in direct oxygenation of unfunctionalized hydrocarbons and phenols [26]. Dinuclear Schiff base complexes of copper(II) ionswere used successfullyin hydroxylation of phenol.

Co(salen) and its analogues have been used for catalyzing theoxidation of phenols and alcohols with dioxygen as oxidant [27]. Reports onoxidation of alkenes also exists [28]. In order to efficiently bind dioxygen andto be catalytically active, Co(salen) needs an axial ligand. The dioxygenis coordinated orthogonally to the square planar coordination sphere of Co(salen).

The axial ligand is needed to fill the sixth coordination site, opposite to dioxygen.Pyridine is the most common axial ligand used in the Co(salen) catalyzed oxidationreactions. Other bases, for example, imidazole and pyrimidine have also beenused. An alternative way to provide an axial ligand is to use modified salenstructure, which has extra nitrogen, for intramolecular axial coordination in theligand frame.



Scheme8: Binuclear copper complex.

Epoxidation reactions:Potentially tetradentate binaphthyl N_2O_2 Schiff bases were prepared bythe condensations of aromatic aldehydes with amines like 2,2′-diamino-1,1′-binaphthyl or 2-amino-2′-hydroxy-1,1′-binaphthyl. Metal complexes of these Schiffbases have wide application in catalysis especially in asymmetric epoxidation ofunfunctionalized olefins.

A number of pyridyl bis(imide) complexes and phenoxy imine complexesare used as catalysts in the polymerization of ethylene [29]. Pyridinebis(imine) complexes of iron(III) and cobalt(II) show significant activity in thepolymerization of ethylene and copolymerization of ethylene with

1-hexene [30].The salicylaldimine complexes of zirconium were found to be effective catalystsin ethylene polymerization and promoted radical decomposition in certain cases. Polymethylmethacrylate was prepared in presence of Cr(III) and Ni(II)salencomplexes as catalysts for the controlled radical polymerization of themethyl methacrylate monomer.

Hydrogenation reactions: A series of palladium(II) complexes of Schiff bases with the nitrogen ligandshave been synthesized and their catalytic activity in the hydrogenation of alkenesand alkynes in mild conditions (with 1 atm dihydrogen pressure at 40 °C) has beenstudied by Costa et al. [31].

2.4 Heterocycles

Chemistry of heterocyclic compounds is very wide to summarize in a single chapter their several ways of synthesis. However, from a conceptual point of view, it is possible to divide the preparation of polyfunctionalized heterocycles using two major strategies, or combination of both of these:

I. Incorporation of functional group in a pre-existing heterocycle.

II. Ring construction through cyclization of acyclic precursors.

Nowadays, formation of cyclic core followed by incorporation of further functionalization is a frequent method to access heterocycles. Electrophilic or nucleophilic substitution are often used, and recently organometallic C-H functionalization has been developed.

Even though these types of functionalization are extremely important, but, increasing the complexity of the system, regioselectivity remains a big problem to overcome. Presence of different heteroatoms, for example, could influence greatly the electronic feature of the ring, leading to low yield of desired products.

Naturally, it is not possible to say which approach is the best or the worst, but it all depends on the type of application it is needed. Nevertheless, it is possible to determine that a functionalization approach could be favorable for diversity oriented synthesis application, where starting from the same core it is possible to create several congeners. Instead, the cyclization approach could be extremely useful in target oriented synthesis, since several steps of protection/deprotection, reduction/oxidation and so on, could be avoided creating the heterocyclic core.

2.4.1 Heteroatom containing polycyclic aromatic hydrocarbons (HPAHs)

Heterocyclic compounds are organic compounds whose molecules contain oneor more rings of atoms with at least one atom (the heteroatom) being an element otherthan carbon, most frequently oxygen, nitrogen, or sulfur. Among the more than 20million registered chemical compounds nowadays, about one half of them containsheterocyclic systems. Heterocyclic compounds are becoming more and moreimportant in all aspects of biology, chemistry, physics and material sciences, not onlybecause of their abundance, but above all due to their biological, chemical, physical,and technical significance.

Heterocyclic compounds can be found in many naturalproducts, such as chlorophyll, vitamins, hormones, antibiotics, and alkaloids and theyalso constitute a very important part of the products in chemical industry like dyes,pharmaceuticals, and herbicides.

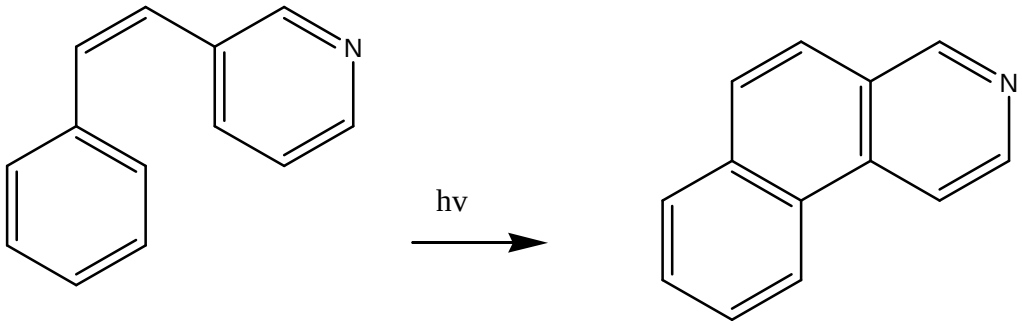
heteroatom containingpolycyclic aromatic hydrocarbons (HPAHs) are outnumbered by their all-hydrocarbonanalogs mentioned. Apparently, the embedding of heteroatoms, suchas nitrogen, oxygen or sulfur, into the graphitic structures will not only change themoptoelectronic and electronic properties but also offer the possibility to create novelPAHs based organometallic or ionic complexes. HPAHs areexpected to provide revolutionary organic functional materials and indeed haveattracted great attentions of chemists, physicists and material scientists.

2.4.2 Synthesis of heteroatom containing polycyclic aromatic hydrocarbons

Because of their unique structures, the synthetic methods of HPAHs aremore or less different from the way to obtain all-hydrocarbon PAHs. In the lastdecades, various approaches were developed to synthesize various HPAHs:

2.4.3.1 Photocyclization

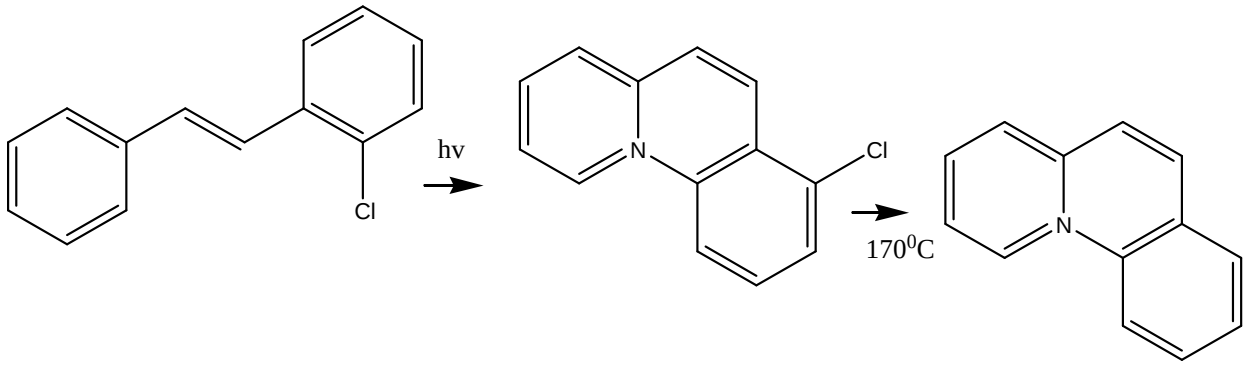
Photocyclization is one of the most widely used synthetic techniques to prepareHPAHs, especially with nitrogen atoms.



Scheme 9: The photolysis cyclization of stilbazoles

2.4.3.2 Intramolecular quaternization

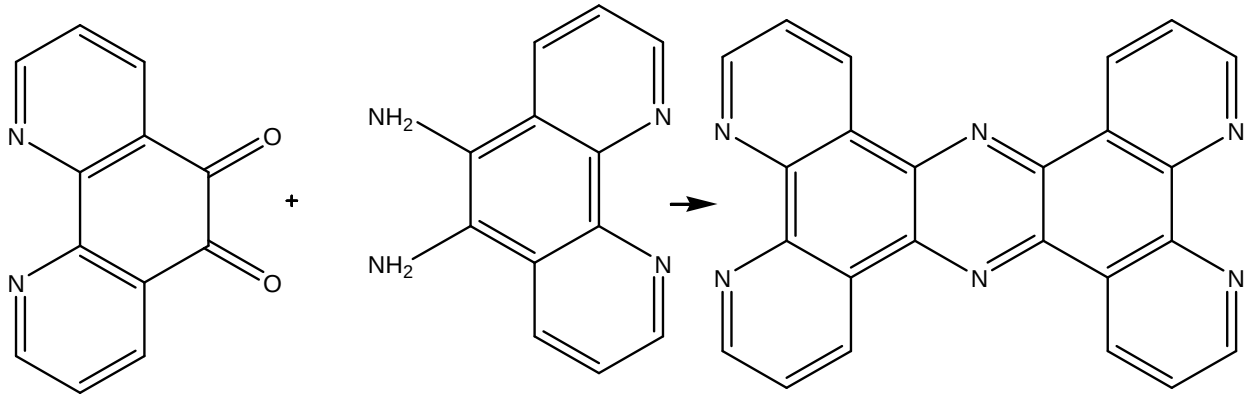
Intramolecular quaternization is a very efficient method to synthesize benzolizinium salts and its derivates



Scheme 10: Intramolecular quaternization HPAHS

2.4.3.3 Condensation

The condensation reactions between diketone and ortho-dianimo aromatic molecules were often used to produce tetrapyridophenazine (tpphz) and its derivates.



Scheme 11: synthesis of tpphz by condensation

From the nitrogenous heterocycles, naphthyridines and their derivatives represent an importantclass of organic molecules that attract the interest of both synthetic and medicinal chemists due to themexceptionally broad spectrum of biological activities as well as their use as important binding units inthe molecular design of synthetic receptors [32]. Naphthyridine derivatives have attracted considerableattention primarily due to the presence of a 1,8-naphthyridine skeleton in many compounds which havebeen isolated from natural substances and exhibit various biological activities.

As a heterocyclicmoiety, 1,8-naphthyridine also deserves special interest as in its molecule, the arrangement of thenitrogen atoms is optimal for chelation of various metal cations, including lanthanide ions.In parallel to the growing interest in the synthesis of 1,8-naphthyridines to

provide biologicallyactive molecules, a large number of publications have reported that several of their derivatives possessantibacterial, antimycobacterial, antitumor, anti-inflammatory, analgesic,antiplatelet, gastric antisecretary, local anaesthetic, anticonvulsant andantihypertensive activity [33], besides being associated with β-adrenergic blocking properties.

Some 1,8-naphthyridine compounds have been patented as fungicides, bactericides, insecticides,herbicides, anxiolytic, antihypertensives, antiarrhythmics and also as immunostimulants.In addition, has been recognized that attachment of a trifluoromethyl group into heterocycles can beused to modulate the physical, chemical and biological properties. It is well documented that theinfluence of the trifluoromethyl substituent on physiological activity is due mainly to the increasedlipophilicity of the molecules, causing greater cell permeability and resistance to enzyme degradation[34]. Consequently, synthetic methodology to incorporate fluorine and fluorous synthons must beimproved in order to prepare sophisticated fluoroorganic molecules on a practical scale. One of themost satisfactory methods for introducing a CF_3 group into heterocycles is via the trifluoromethylatedbuilding block approach. The trifluoroacetylation of enol ethers or acetals provided, in one step and ingood yields, β-alkoxyvinyl trifluoromethyl ketones which proved to be useful building blocks for thesyntheses of many series of heterocyclic compounds [35].

Since the 50s various diamino-ketoester condensations involving reactions of cyclic and acyclic β-ketoesters or diketones with aminopyridines or diaminopyridines have been studied in an attempt todevelop generalized predictions regarding the direction of ring closure to form diazepinones,naphthyridones, naphthyridines or pyrimidines. Whereas a literature review shows thatthe synthesis of trifluoromethylated naphthyridines and derivatives has been little explored and that1,8-naphthyridines trifluoromethylated described are associated with satisfactory biological activities [36], the incorporation of trifluoromethyl group in a variety of 1,8-naphthyridines would be expectedto provide highly desirable intermediates for the synthesis of new drug candidates. So, due to the greatbiological importance and employment of amino-naphthyridines as starting material for the synthesisof new tri and tetracyclic heterocycles, the development of new synthetic approaches remains an activeresearch area [37].

The use of diethyl ethoxymethylenemalonate (EMME), Conrad-Limpach, Knorr andSkraup methods have been particularly successful in the synthesis of certain quinolines. Theadaptation of these reactions to the synthesis of the corresponding naphthyridines by employingaminopyridines instead of anilines should furnish convenient methods for the preparation of thesetypes of compounds since aminopyridines are readily available [38].

In contrast to aniline derivatives, 2-aminopyridine derivatives may cyclize in two ways, one of whichleads to the formation of 1,8-naphthyridines and the other leads to the formation of pyrimidines, andthe latter course of reaction has is observed with more frequency [39]. In both types of cyclization, thepyridine ring functions as the electron donor and the carbonyl group in the side chain serves as theelectron acceptor.

2.5 Hydroquinone

Hydroquinone occurs naturally as a conjugate with beta-D-glucopyranoside in the leaves, bark and fruit of a number of plants, especially the ericaceous shrubs such as cranberry, cowberry, bearberry and blueberry. Hydroquinone and its glucose conjugate, 4-hydroxyphenyl-β-D-glucopyranoside (arbutin), are naturally present in many foods and beverages. Arbutin is reported to hydrolyze readily in dilute acidic solutions to yield D-glucose and hydroquinone. Ingested arbutin is expected to be converted to free hydroquinone in the stomach. It has been detected at low levels in coffee, tea, red wine, beer, cola soft drinks, 2% milk, orange juice, corn, wheat and rice cereals, wheat germ, and various fruits, including pears, oranges, cantaloupes, cherries, asparagus, apples, blueberries and cranberries [40]. It is also known to be present in the particulate fraction of cigarette smoke. Hydroquinone is one of the two primary reagents in the defensive glands of bombardier beetles, along with hydrogen peroxide (and perhaps other chemicals, depending on the species), which collect in a reservoir. The reservoir opens through a muscle-controlled valve onto a thick-walled reaction chamber. This chamber is lined with cells that secrete catalases and peroxidases. When the contents of the reservoir are forced into the reaction chamber, the catalases and peroxidases rapidly break down the hydrogen peroxide and catalyze the oxidation of the hydroquinone's into p-quinones.

Concern about hydroquinone having carcinogenic properties is mostly related to industrial-grade materials and uses. In a study to determine the effect of the skin-depigmenting agent hydroquinone (HQ), it was found out that significant differences in its effect on DNA and RNA synthesis were observed between cell lines. HQ caused inhibition of cellular metabolism in all cells tested, but the dose that caused 50% inhibition of tritiated thymidine incorporation was approximately 30 times lower for melanotic cells. Titrated uridine incorporation was found to be 85 times more sensitive to HQ in the melanotic cells [41]. These results suggested that HQ exerts its depigmenting effect by selective action on melanocyte metabolism rather than a specific effect on melanin synthesis.

Among skin-lightening agents, hydroquinone (HQ) is one of the most widely prescribedagents in the world. However, with reports of potential mutagenicity and epidemics of ochronosis in African nations, there has been increasing impetus to find alternative herbaland pharmaceutical depigmenting agents [42]. A review of the literature reveals that numerous other depigmenting or skin-lightening agents are in use or in investigational stages. Some of these, such as kojic and azelaic acid, are well known to most dermatologists.

Side effectsof hydroquinone are mild when used in low concentrations of about 1% tinglingor burning on application and subsequent erythma and inflammable were observed in eight percent of patients using a two percent concentration and thirty two percent of patients using a five percent hydroquinone concentration. Higher concentrations frequently irritate the skin and if used for prolonged periods, cause disfiguring effects including epidermal thickening.

2.6 Nickel (II) complexes

The coordination chemistry of nickel spans a variety of geometries,coordination numbers, and oxidation states. Nickel complexes are known withoxidation states ranging from -1 to +4. However, the most common oxidation state is Ni(II) ([Ar]$3d^8$). The nickel ion in nickel(II) complexes exists in the coordinationnumber of 4, 5 and 6. Its octahedral, trigonal bipyramidal, quadratic-pyramidal andtetrahedral complexes are paramagnetic and have in the majority of cases a green orblue colour. The quadratic-planar nickel complexes are diamagnetic and mostly havea yellow, red or brown in colour. With regard to Lewis acidity, Ni(II) is considered tobe a borderline metal ion. This is because it binds to both soft and hard ligands andsometimes, albeit rarely, to both in the same complex [43].

The coordination of Ni(II) is relatively common with tetrahedral and square planar geometries representing the two extreme possibilities. Important feature of square planar Ni complexes is their ability to coordinate extra ligands in solution to set up equilibrium between four, five and six coordinate complexes. Thus, diamagnetic square planar complexes can be transformed to paramagnetic octahedral Ni(II) species in coordinating solvents or in the presence of extra ligands.

The electronic configuration of the Ni (II) is d^8. Octahedral Ni (II) complexes having $^3A_2$gground state are expected to have three spin allowed transitions $^3A_2g \rightarrow {}^3T_2g$, $^3A_2g \rightarrow {}^3T_1g(P)$ and $^3A_2g \rightarrow {}^3T_2g$ (F) in the range of 7000-13000, 11000-20000 and 19000-27000cm^{-1},respectively. In addition to these three transitions, two spin-forbidden transitions$^3A_2g \rightarrow {}^1Eg$ and $^3A_2g \rightarrow {}^1T_2g$ are also observed one at near the second spin-allowed transitionand another band between second and third spin-allowed transitions.

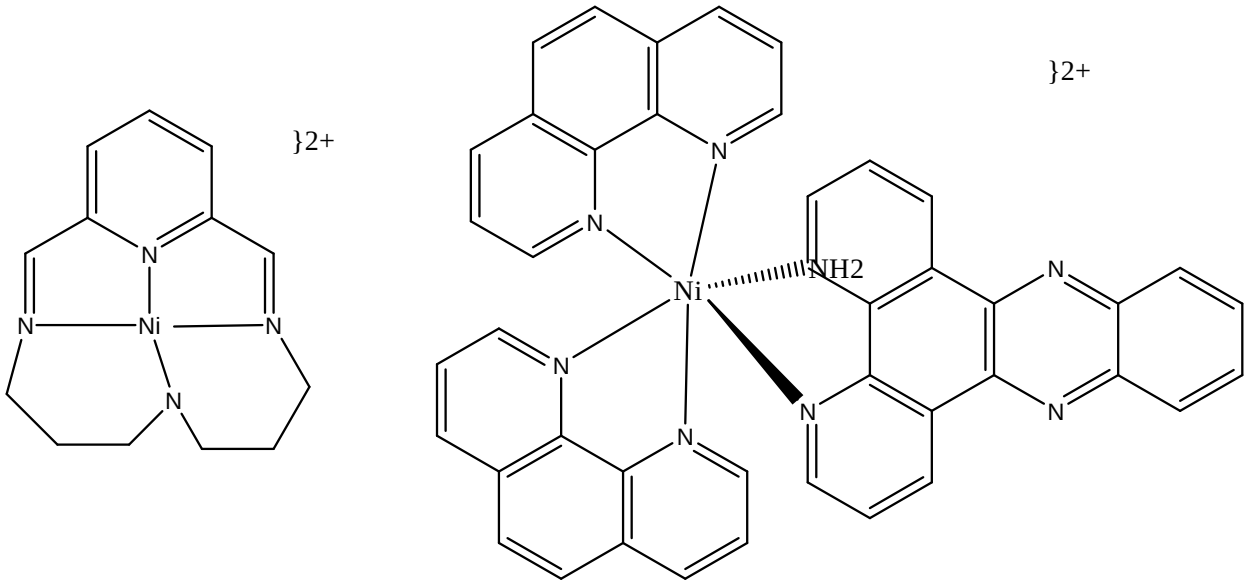
Five coordinate nickel (II) complexes have structures, which are generally near to one ofthe two limiting geometries, namely the square pyramid and the trigonal bipyramid. Theelectronic ground state of nickel (II) in the five coordinate complexes can be either a spinsinglet (low-spine) or a spin triplet (high-spin). Low –spin trigonal bipyramidal nickel(II) species, which exhibit three transitions, namely $^1A_1 \rightarrow {}^1B_1$, $^1A_1 \rightarrow {}^1E$ and $^1A_1 \rightarrow A_2$ lieinthe region 15000-18000, 21000-24000 and 27000-29000 cm^{-1}, respectively.

The majority of four coordinate nickel (II) complexes are square planar and diamagnetic,while other are pseudo tetrahedral nickel (II) complexes have spectraltransitions in the visible region with a much greater intensity than the octahedralones.Tetrahedral Ni (II) complexes with $3T_1$ ground state generally exhibit fourtransitions. They are $^3T_1 \rightarrow {}^3A_2$, $^3T_1 \rightarrow {}^1E$, $^3T_1 \rightarrow {}^3T_1$ (P) and $^3T_2 \rightarrow {}^1T_1$ [21]. The band$^3T_1 \rightarrow {}^3T_1$ (P) is a strong band of high intensity when compared with others. In squareplanar nickel (II) complexes, three spin allowed d-d bands corresponding to $^1A_1g \rightarrow {}^1A_2g$,$^1A_1g \rightarrow {}^1B_1g$ and $^1A_1g \rightarrow {}^1Eg$ transitions are expected. Majority of the square planar nickel (II)complexes exhibit strong absorptions in 15000-25000 and 23000-30000 cm-1 regions.The square planar nickel (II) complexes don’t have any absorption band below 10000

cm^{-1}, due to large crystal field splitting. Hence they can be clearly distinguished fromoctahedral and tetrahedral complexes.

The DNA binding ability of inert chiral transition metal complexes has attracted considerable interest. Recent studies have shown that a variety of transition metal complexes have significant potential as probes for sequence- and structure-specific DNA binding. Significant attention has centered upon metal complexes capable of binding DNA by intercalation, and, in particular, due to their luminescent properties and strong DNA binding affinity. Replacement of the hydrogen-bonded base pairing of natural DNA by alternative base pairing modes is expected to lead not only to expansion of the genetic alphabet but to novel DNA structures and functions based on the controlled and periodic spacing of the building blocks along the helix axis. In the majority of the complexes studied the metal ion serves as the oxidation agent while the ligand is responsible for DNA recognition.

The modes of recognition are primarily based upon intercalation, groove-binding and hydrogen-bonding interactions. Site-specific DNA modification has also been observed for transition complexes that are covalently linked to DNA-binding proteins. In contrast, platinum chemotherapeutic agents such as cis- $Pt(NH_3)_2Cl_2$ (cis-platin) interact specifically with duplex DNA by forming covalent bonds between the platinum metal center and N_7 of guanine. The mode of action of cis-platin is believed to involve the replacement of the two labile chloride ions with guanine resulting intrastrand cross-links. Nickel macrocyclic complexes that possess vacant or labile coordination sites may also ligate to DNA bases, and effect site-specific reactions with DNA.



Scheme 12: Nickel complexes

2.7 Copper (II) complexes

The Cu (II) ion with its d^9 configuration in octahedral and tetrahedral environment is highly susceptible to Jahn-Teller distortion. In tetrahedral arrangement, also Jahn-Tellerdistortion is operative, in spite of the fact that large spin-orbit coupling constants mightproduce sufficient splitting of $^2T_2$ ground state. Octahedral complexes without anydistortion are expected to have only one d-d absorption band corresponding to $^2Eg \rightarrow {}^2T_2g$transition. For distorted octahedral complexes,several weak absorption bands are observed around 1600 cm^{-1} and often a broad band inthe near IR region. In the axially elongated tetragonal distortion three absorption bandscorresponding to the transitions $^2B_1g \rightarrow {}^2A_1g$, $^2B_1g \rightarrow {}^2B_2g$ and $^2B_1g \rightarrow {}^2Eg$ are observed.Tetrahedral complexes are expected to give a single, broad band corresponding to$^2T_2 \rightarrow {}^2E$ transition in the near IR region.The ground term in the square planar geometry is ^2B_1g and three d-d bands correspondingto the transitions $^2B_1g \rightarrow {}^2B_2g$, $^2B_1g \rightarrow {}^2A_1g$ and $^2B_1g \rightarrow {}^2Eg$ are observed. In both square planarand tetragonal geometries the transitions are not well resolved.

However, in parallel withnickel (II) copper (II) systems with square planar stereochemistry will have no electronicabsorption below 10000 cm^{-1}. Similarly tetrahedral copper (II) will absorb primarily inthe red and near IR.

3EXPERIMENTAL

3.1 Chemicals and reagents

The following analytical grade label chemicals were used for different stages of the research work.These includes: ortho-phenylenediamine (OPD), oxalic acid dihydrate ($C_2H_2O_4$),1,4-dihydroxybenzol ($C_2H_6O_2$), nickel nitrate hexahydrate ($Ni(NO_3)_2.6H_2O$), copper chloride dihydrate ($CuCl_2.2H_2O$), sliver nitrate ($AgNO_3$). Reagents like con HNO_3, conc. HCl and solvents such as ethanol, methanol, acetone, dimethylsulphoxide, hexane, chloroform, distilled water dimethylformamide, dimethylether, were used for various purposes.

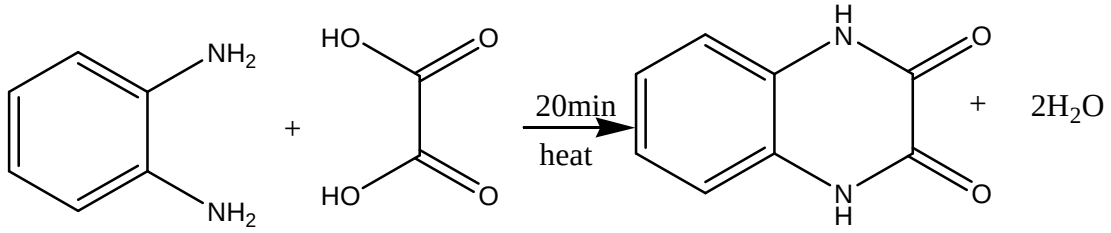
3.2 Apparatus and Instrument

Chloride testof these compounds dissolved in nitric acid were subjected to chloride identification. The presence of chloride in the sample was confirmed by the formation of white precipitate on the addition of $AgNO_3$ (0.1N) the purity of the complexes was checked using thine layer chromatography (TLC). The melting point was determined using electrothermal IA 9200 Digital melting point apparatus. The IR spectra of the products were taken in KBr discs with Perkin spectrum 65 FTIR spectrometer in the range of 4000-400 cm^{-1}. The Uv-Vis spectrum were recorded (india).^{1}H and ^{13}C NMR recorded on BRUKER advance 400 MHz spectrometer with TMS internal reference in $DMSOd_6$. Molar conductance measured with JENWAY 4330 conducting and PH meter using 10-3 molar solution of each complex in DMF at room temperature (21°C). Flame atomic absorption spectrometer was used to measure the amount of metals (µg/ml) in prepared solution.

3.3 Experimental procedures

3.3.1 Synthesis of 1,4-dihydroquinoxaline-2,3-dione

A solution of oxalic acid dihydrate (5000 mg, 39.7 mmol) in H_2O (20 ml) was heated to 100 °C and 1 ml concentrated HCl was added, followed by O-phenylendiamine (3670mg, 34mmol). whitemixture formed with stirring, temperature was maintained at 100 °C for 20 min and the mixture cooled by addition of ice. the precipitate was formed and washed with waterproduct was recrystalized from ethanol. The product was filtered, washed several times with ethanol and dried in air, finally white green crystal weighted 2.23 g (29.6 % yield) was formed [46]. The reaction is given by the following scheme 14



O-phenylene diamine Oxalic acid 1,4-dihydroquinoxaline-2,3-dione

Scheme 14: synthesis of 1,4-dihydroquinoxaline-2,3-dionefrom o-phenylene diamine and oxalic acid

3.3.2 synthesis of Ni(II) complex

An aqueous solution of $Ni(NO_3)_2.6H_2O$(228.8 mg, 1 mmol), ethanoic solution (10ml) of 1,4-dihydroquinoxaline-2,3-dione (324 mg, 2 mmol) was added and it formed yellow mixture. The mixture was stirred and kept in a boiling water bath for 10 min. To this hot solution an ethanoic solution (10 ml) of 1,4-dihydroxybenzol (220 mg, 2 mmol) was added and it formed white gray mixture. With constant stirring the mixture was again heated at 100 °C in a water bath for 4h the complexes were obtained by raising PH of the reaction added drop of dilute NH_3 the color changed to brown solution then cooled in ice bath. The product was filtered and washed several times with ethanol and driedin air. The brown powder Ni(II) complex weighted 1.23 g (68.7 % yield) was formed.

3.3.3 Synthesis ofNi(II)-1,4-dihydroquinoxaline-2,3-dione complex

An aqueous solution of $Ni(NO_3)_2.6H_2O$ (228.8 mg,1 mmol), (10 ml)ethanoicsolution (10 ml) of 1,4-dihydroquinoxaline-2,3-dione (324 mg, 2 mmol) was added and it formed white gray mixture and that was refluxed in water bath with constant stirring at 100 °C for 4h.White green

mixture was obtained then cooled in ice bath. The product was filtered, washed several times with ethanol and dried in air. The white gray crystal has weighted 0.85 g (73.91% yield) was formed.

3.3.4 Synthesis ofNi(II)-1,4-dihydroxybenzol complex

An aqueous solution of $Ni(NO_3)_2.6H_2O$ (228.8 mg,1 mmol), was added to the mixture of 1,4-dihydroxybenzol (110 mg, 1 mmol) and sodium hydroxide (80 mg, 2 mmol). The gray colored mixture formed was heated on hot plate at 100 °C for 4h the color changed to dark then cooled in ice bath. The product was filtered, washed several times with ethanol and dried in air. A dark crystal of 0.75 g mass (35.21% yield) was formed.

3.3.5 Synthesis of Cu(II)complex

An aqueous solution of $CuCl_2.2H_2O$ (171 mg, 1 mmol), ethanoic solution (10 ml) of 1,4-dihydroquinoxaline-2,3-dione (324 mg, 2 mmol) was added and it formed gray yellow mixture. The mixture was stirred and kept in a boiling water bath for 10 min. To this hot solution an ethanoic solution (10 ml) of 1,4-dihydroxybenzol (220 mg, 2 mmol) was added and it formed yellow mixture,With constant stirring.The mixture was again heated at 100 °C in water bath for 4 h the complexes were obtained by raising PH of the reaction added a drop of NH_3 the color changed to white yellow solution then cooled in ice bath. The product was filtered, washed several times with ethanol and driedin air. Gray yellow powder of Cu(II) complex weighted 1.15 g (63.88% yield) was formed.

3.3.6 Synthesis ofCu(II)-1,4-dihydroquinoxaline-2,3-dione complex

An aqueous solution $CuCl_2.2H_2O$ (171 mg,1 mmol) and ethanoic solution (10 ml) of 1,4-dihydroquinoxaline-2,3-dione (324 mg, 2 mmol) was added it form gray yellow color mixtureand that was refluxed in water bath with constant stirring at 100 °C for 4 h white yellow solution was obtained then cooled in ice bath. The product was filtered, washed several times with ethanol and dried in air. The white gray crystal has weighted 0.75 g (67.2% yield) was formed.

4 RESULTS AND DISCUSSION

The Synthesis, characterization, and structural determination are the core steps that enable a chemist to acquire adequate knowledge of chemistry in laboratory practical work. The heterocyclic aromatic complexes of the nickel and Copper metal ions were synthesized and the products were characterized by different physical and instrumental techniques.

4.1 Physical properties and complexes

Determination of melting points

The melting points of synthesized compounds were determined in open capillary tubes using melting points apparatus. A few crystals of the synthesized products were placed in a thin walled capillary tube 10-15 cm long, about 1 mm inside diameter, and closed at one end. The capillary was then inserted in to melting point apparatus to determine melting points of the products.

Table 1. Physical properties of QXD and Ni and Cu complexes

compounds	Mol. formula	Mol. Weight (g/mol)	Color and state	M.p (°C)	Yield (%)	Calculated (found %) C H N O M
QXD	$C_8H_6O_2N_2$	162	Whitegray powder	Above 350 ^{0}C	29.6%	59.33.7017.2819.75---- ---- ---- ----- ----- ----
Ni-complex	$C_{16}H_{10}O_4N_4Ni$	380.7	Brown powder	320 ^{0}C	68.72%	50.42.6314.716.8115.42 ----- ----- ---- ----- ------
Cu-complex	$C_{16}H_{10}O_4N_4Cu$	385.5	Gray yellow powder	340 ^{0}C	63.88%	49.82.5914.5216.6016.47 ----- ---- ---- ----- -----
Ni(QXD)$_2$	$C_{16}H_{12}O_4N_4Ni$	382.7	Gray powder	Above 350 ^{0}C	73.91%	50.2 3.1414.6316.7215.34 ----- ------ ---- ---- -----
Ni(HQ)$_2$	$C_{12}H_{10}O_4Ni$	276.7	Dark brown crystal	Above 350 ^{0}C	17.14%	52.03.61 ---23.23 21.21 ----- --- --- ----- -----
HQ	$C_6H_6O_2$	110	White crystal	172 °C	-----	65.5 5.45 --- 29.09 ----- ------ --- ---- ------ ----

The composition of the metal complexes and the ligands were only calculated from the possible or expected structure. The physical properties such as colours and melting points of the QXD, HQ and metal complexes which were mentioned in the above table were different. They indicate the possible formation of the complexes.

4.2 Solubility of the ligands and complexes

Table 2 solubility check for the QXD and Ni(II) and Cu(II) complexes

compounds	Ethanol	Methanol	water	chloroform	DMSO	DMF	acetonitrile
QXD	Partially soluble	Partially soluble	insoluble	insoluble	soluble	soluble	insoluble
HQ	soluble	soluble	Very soluble	-----	soluble	soluble	------
Ni-complex	insoluble	insoluble	insoluble	insoluble	soluble	soluble	soluble
$Ni(QXD)_2$	insoluble	insoluble	insoluble	insoluble	soluble	soluble	insoluble
$Ni(HQ)_2$	insoluble	insoluble	insoluble	insoluble	Partially soluble	Partially soluble	insoluble
Cu-complex	insoluble	insoluble	insoluble	insoluble	soluble	soluble	insoluble

The synthesizedNi(II), Cu(II) complexesand the ligand QXD are all soluble in polar aprotic solvents but insoluble in non-polar solvents.

4.3 Qualitative Test

4.3.1 TLCTest

The purity of the synthesized complexes was checked by usingthin layer chromatography (TLC). The pre- coated TLC plates (20×20 cm) with silica gel and gypsum binder wereactivated by heating in oven 100 °C before loading the samples. The sample solutions in methanol were applied on the activated TLC plates in a line 2cm above the bottom of the plate. Oven dried loaded TLC plates were developed in rectangular glass chambers with ground-in-lids by ascending technique. To obtain reproducible results the development chambers were per-saturated with solvent before use. When development proceeded for about 6-8 cm of the plates, they were removed from the chamber. The spots on TLC plates were visualized in UV light at 254 nm.

All the synthesized Ni(II) and Cu(II) complexesmigrated as single spots. The result showed that all products were pure. Developing solvents used were hexane: ethyl acetate (8: 2 v/v).

4.3.2 ChlorideTest

The synthesized complexes dissolved in nitric acid were subjected to chloride identification. Samples of the two synthesized complexes were well digested in concentrated nitric acid through hot plate. When 0.1N solution of silver nitrate was added to cooled acid solutions and left overnight, there was no any precipitate in each solution. This suggests that chloride is neither coordinated nor exist as a counter anion in complexes. This observation leads to the conclusion that the complexes do not contain any chloride in their structures.

4.4 Molar conductivity of the metal complex

One mmole of the synthesized metal complexes were added in twoflasks that contains 25 ml of DMF and molar conductance were recorded. The molarconductance's of both complexesare below $5\Omega^{-1}cm^2mol^{-1}$. This molar conductivity value show that the non-electrolytic nature of both synthesized metal complexes.

4.5 Atomic absorption spectroscopy of metal complexes

The metal contents were determined in the synthesized complexes spectroscopically using atomic absorption spectroscopy (AAS). The metal percentage with C, H, O and N percentages was used to determine the metal-ligand ratios in the complexes formed. The experimental percentages of the metals in the complexes were obtained from the AAS data using the relation:

$$M\ (\%) = \frac{Concentration\ (ppm)\ x\ volume\ \ diluted\ x\ 1000}{Mass\ of\ sample\ taken\ x\ 1000}$$

10 mg each of Ni(II) and Cu(II) complexes which were placed in two differentclean and dry beakers, 10 mL of conc. HNO_3 were added and the complexes were heated gentlyin a hood until a few drops remained in each beaker. Then 5 ml more of conc. HNO_3 wasadded to each beaker and heated slowly until a few drops remained. The latter procedure wasrepeated for three times until all the organic portion of the complexes presumed to bedecomposed. Then the residue was dissolved and diluted using deionized water in 50 ml flask up to the mark. These solutions were subjected to atomic absorption spectroscopy(AAS) studies after a series of appropriate dilutions and drawing a calibration curve ofabsorbance versus concentration for each metal ion. Based onthe absorbance data theunknown concentrations of Ni(II) and Cu(II) in the complexes were calculated.

$$\%\,0f\ Ni = \frac{absorbance\ (ppm)\ x\ volume\ diluted\ x\ 100}{Mass\ of\ sample\ taken\ x\ 1000}$$

$$\%\ of\ Ni = \frac{13.66\ x\ 0.05\ x\ 100}{0.01\ x\ 1000}$$

$$= 6.83\%$$

$$\%\ of\ Cu = \frac{9.1\ x\ 0.05\ x100}{0.01\ x\ 1000}$$

$$= 4.55\%$$

Table 3 percentage composition of metal in complexes

metal	% of metal		metal complexes
	Cal.	Ex.	
Ni	15.42	6.83	Ni-complex
Cu	16.47	4.55	Cu-complex

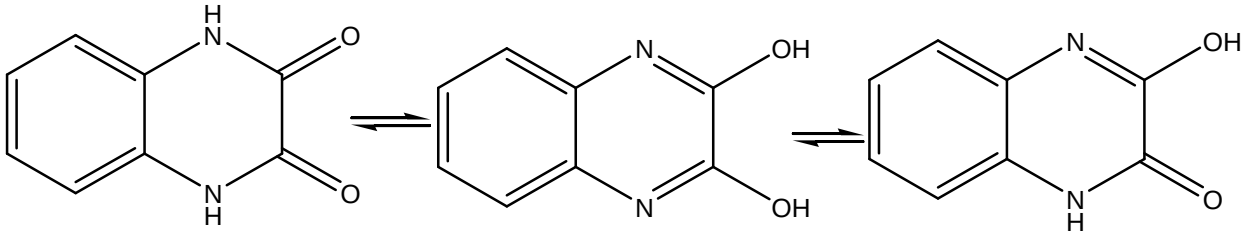
As it can be seen from the above table shown that the experimental valuesdeviate from the theoretical expectations.

4.6 IR (FTIR) spectra

IR spectrum of QXD shows bands at 3443 cm^{-1} (NH/OH), 3159,3049, 2968 cm^{-1} (aromatic sp2 C-H stretch), 1682 cm^{-1} (C=O stretch) 1502 cm^{-1} (aromatic C=C stretch) and 1392 cm^{-1}(C-N stretch). Note that QXD exhibits tautomeric forms so that weak broad band at 3443 cm^{-1} is due to both NH and O-H stretching.

The IR spectra features of Ni(II) and Cu(II) complexes show good complexation with in free QXD spectrum, the expect that υ(NH + OH)band at (3443 cm^{-1}) in QXD is modified as sharp band at (3360 and 3361 cm^{-1}) in Ni(II) and Cu(II) complexes and theυ(C=O) band at (1682 cm^{-1}) in QXD is shifted to higher frequency at (1688 cm^{-1}) in Ni(II) and (1689 cm^{-1}) in Cu(II) in the complexes.

This shows that the tautomer C of QXD is preferentially binding to metal ions in there complexes and HQ is not take part in metal binding. In other words the presence of HQ is promoting the formation of $M(QXD)_2$ complexes where, M= Ni(II) or Cu(II) preferentially with the tautomer C.



A B C

Scheme 15 Tautomeric forms of quinoxaline-2,3-dione

The absence of $NO3^-$ and Cl^- in the complexes and non-electrolytic nature of thus complexes supports deprotonation of -OH from tautomer C and monobasic nature of the ligand. A prominent band appearing in the spectra of Ni(II) and Cu(II) complexes at (1193 cm^{-1}, 1192 cm^{-1}) supports the presence of C-O due to deprotonation.

Table 4 fundamental IR bands of the ligands and their complexes

compounds	υ(NH)sym/(OH) cm^{-1}	υ(C-H) cm^{-1}	υ(C-N) cm^{-1}	υ(C=O) cm^{-1}	υ(C-O) cm^{-1}	υ(C=C) cm^{-1}	υ(M-O) cm^{-1}
QXD	3443	3047	1392	1682	1126	1502	------
Ni-complex	3361	3051	1320	1688	1193	1521 1410	470
Cu-complex	3360	3049	1321	1689	1192	1520 1410	470

4.7NMR Spectra of Quinoxaline 2,3-Dione

In the proton NMR spectra of quinoxaline-2, 3-dione four different protons observed with different chemical shift which are multiplate ^{1}H-NMR seen from7.04-7.16 ppm is due to the two-different proton of aromatic benzene ring, non-integrated peak around 12ppm is the –OH proton due to its tautomer and singlet around 3.5 is responsible to the hydrazine –NH proton of the ring as well as a singlet around 2.5 ppm is the proton of the solvent DMSO.

When we come to^{13}C NMR of quinoxaline-2, 3-dione four different types of carbon observed. Peak at 155.64 ppm is carbon bonded to carbonyl oxygen, signals at 126ppm is carbon bonded to cyclic nitrogen; signal at 123 ppm is the middle carbon of benzene ring as well as peak at 115 ppm is the end carbon of the benzene ring. This NMR result show that the formation of quinoxaline-2,3-dione.

4.8 Electronic Spectra

The electronic absorption spectra are usually very useful in the evalution of results furnished by other methods of structural investigation.The electronic spectra measurements were used for assigning the stereochemistries of metal ions in the complexes based on the positions and number of d-d transition peaks. The electronic absorption spectra of Ni(II) and Cu(II) complexes were recorded. The Ni(II) complex shows bands at 536 nm, 314 nm, 280.5 nm, 279 nm and Cu(II) complex shows bands at 339.5 nm, 338 nm, 335 nm, 330.5 nm, 325.5 nm indicate metal-ligand complex formation.

Table 5 Electronic Spectra data of metal complexes

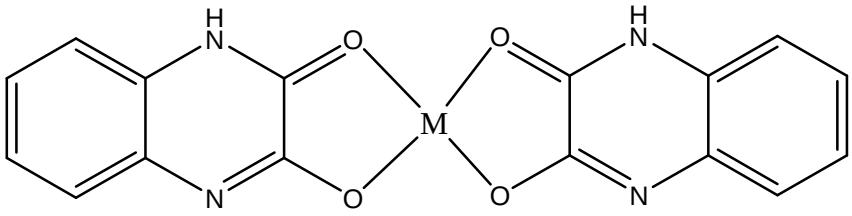
complexes	Absorption bands λ(nm)	transitions
Ni-complex	279-536	LMCT
Cu-complex	276-339.5	LMCT

5SUMMARY AND RECOMMENDATION

New heterocyclic aromatic complexes of Ni(II) and Cu(II) prepared from the template condensation of quinoxaline-2,3-dione, hydroquinone and corresponding metal salts which were $Ni(NO_3)_2.6H_2O$ and $CuCl_2.2H_2O$ in the preparation of complexes with quinoxaline-2,3-dione, hydroquinone and metal salts in the molar ratio of 2:2:1. From the atomic absorption spectroscopy data the experimental value deviates from the theoretical expectation can not confirms the ratio 2:2:1. Thus complexes of different type can be obtained ML_2, where M is Ni(II) or Cu(II), L is $C_8H_6O_2N_2$.

The IR spectra data gave supportive evidence for the successful formation of the complexes and some of the physical data obtained from the melting points, solubility determination and thine layer chromatography suggested the purity of both complexes.The molar conductivity measurements pointed out the non-electrolytic nature of the complexesindicate the absence of NO_3^- and Cl^-in the complexes support deprotonation of -OH from tautomeric quinoxaline-2,3-dione and monobasic nature of the the ligand. The presence of HQ is promoting the formation of $M(QXD)_2$ complexes, where M=Ni(II) and Cu(II)square planarcomplexes were synthesized, though the target was a mixed ligand.

I recommend forfurther studies and work on the synthesis, characterization using different techniques by changing the procedures to obtain the required result and further study for their diverse application of transition metal complexes.



M =Ni(II) or Cu(II).

Scheme 16: The proposed metal complexes.

6REFERENCE

1.Yohannes Misskire (2007). Synthesis and characterization of metal complexes of a new

Heterocyclic Ligand; Master Thesis, submitted to Addis Ababa University.

2. T. Susela, PhD Thesis, structural studies in Transition metal complexes, Osmania University, 1996.

3. http://en.Wikipediaorg/wiki/schiffbase.

4. Feng, X., X. Liu, D. Shang, J. Xin, X. Yang and X. Zhou, 2008. Highly enantioselective

Hydrophosphonylation of aldehydes catalyzed by tridentate Schiff base aluminum(III)complexes. Angew. Chem. Int. Ed., 47:392-394.

5. Mikuriya, A., K. Sah, and T. Tanase, 2006. Tri-and tetranuclear copper(II) complexes consisting of mononuclear Cu(II) chiral building blocks with a sugar-derived Schiff's base ligand. Inorg. Chem., 45:2083-2092.

6. Kume, H., T. Kuroda-Sowa, M. Maekawa, M. Munakata, T. Okubo, Zhong Yu, 2009. Effects of metal doping on the spin-crossover properties of an iron(II)complex with extended π-conjugated Schiff-base having an N_4O_2 donor set. Bull. Chem. Soc. Jpn., 82:333-337.

7. Ali, O.A., S.M. E1-Medani and R.M. Ramadan, 2005. Photochemical Reactions of Group 6

Metal Carbonyls with N-salicylidene-2-hydroxyaniline and Bi(salicylaldehyde)

Phenylenediamine. J. Mol. Struct.,738:171-177.

8. Lindoy, L. F., 1990. The Chemistry of Macrocyclic Ligand Complexes; Cambridge University press.

9. Acheson, R.M., An Introduction to the chemistry of Heterocyclic compounds, John Wiley and sons Inc., USA, 1976, 410

10. Gupta, R.R., Gupta, V. and Kumar, M., Heterocyclic chemistry, Benzofused six -membered aromatic heterocycles, Springer, Germany, 47, 1998

11. Brown, D.J., Primary Synthesis, Quinoxalines: Supplement II, Chemistry of Hetrocyclic Compounds, John Wiley and Sons, Inc. Volume 61, 2004, 1-92

12. Young, D.W., Heterocyclic Chemistry, Longman Inc., London, 1975, 107-108

Kim, S.K., A Facile Synthesis of Quinoxaline-2,3-diones as NMDA Antagonists,

Molecules, 1, 1996, 37-40

Fitchett, C. M. and Steel, P.J., Chiral heterocyclic ligands. Metal complexes of a pyrazine

ligand derived from camphor, ARAKIVOC 2006, 3, 218-225

13. Vogel's Textbook of Practical Organic Chemistry, 5th ed., 1989.

14. D.J. Brown, Quinoxalines: supplements II. In the Chemistry of Heterocyclic Compounds

15. E. C. Taylor, Wipf, P., Eds.; John Wiley and Sons: New Jersey, 2004

16. D.J. Brown, in: E.C. Taylor, P. Wipf (Eds.), The Chemistry of Heterocyclic Compounds, John

Wiley and Sons, New Jersey, 2004.

17. A.E.A. Porter, In Comprehensive Heterocyclic Chemistry; A.R. Katritsky, C.W. Rees, Eds.;

Pergamon: Oxford, 1984, pp 157–197.

18. G.H.C. Woo, J.K. Snyder, Z-K. Wan. Progress in Heterocyclic Chemistry, 14 (2002) 279-309.

19. P. Thirumurugan, D. Muralidharan. P.T. Perumal, Dyes and Pigments 81 (2009) 245–253

20. S. Ajaikumar, A. Pandurangan. Applied Catalysis A: General 357 (2009) 184–192

21. Ayres G.H. and Annand R.R., Spectrophotometric Study of Cobalt and Nickel Cornplexes with 2,3-

Quinoxaline dithiol, Anal Chem, 35, 33 (1963)

22. Ayres G.H. and Mc Corry R.W., Spectrophiotometric Determination of Platinum with 2,3-Quinoxalinedithiol, Anal Chem, 36, 133 (1964)

23. Billing D.E., Underhill A.E., Adams D.M., Morris D.M., Journal of the Chemical Society A: Inorganic, Physical, Theoretical. 902 (1966)

24. Dutt N.K., Sanayal G.S. and Nag K., Anal Chim Acta, 41, 331 (1968)

25. Geary W.J., Transition-metal complexes of the 2,3-dipyridylquinoxalines. Part II. Cobalt(II), nickel(II), and copper(II) halide derivatives of 2,3-di-(6-methyl-2- pyridyl) quinoxaline, J Chem Soc A: Inorg Phys and Theo Chem, 2118 (1969)

26. E.K. Beuken, P.W.N.M. Leeuwen, P.H.M. Budzelaar, N. Veldman, A.L. Spek, B.L. Feringa. Journal of Chemical Society, Dalton Transactions, (1996) 3561-3569.

27. J. Bozell, B. Hames, D. Dimmel. Journal of Organic Chemistry, 60 (1995) 2398-2404.

28. L. Simandi. Advances in Catalytic Activation of Dioxygen by Metal Complexes, Kluwer Academic Publishers, Dordrecht, Chapter 6, 2003.

29. Y. Nakayama, H. Bando, Y. Sonobe, T. Fujita. Journal of Molecular Catalysis A. Chemical, 213 (2004) 141-150.

30. M.A Mekewi. International Journal of Polymeric Materials, 55, (2006) 219- 234.

31. M. Costa, P. Pelagatti, C. Pelizzi, D. Rogolino. Journal of Molecular Catalysis A: Chemical 178 (2002) 21–26.

32. Goswami, S.; Mukherjee, R.; Mukherjee, R.; Jana, S.; Maity, A.C.; Adak, A.K. Simple and efficient synthesis of 2,7-difunctionalized-1,8-naphthyridines. Molecules 2005, 10, 929-936.

33. Bouzard, D.; DiCesare, P.; Essiz, M.; Jacquet, J.P.; Ledoussal, B.; Remuzon, P.; Kessler, R.E.; Fung-Tomc, J. Fluoronaphthyridines as antibacterial agents. 4. Synthesis and structure-activity relationships of 5-substituted-6-fluoro-7-(cycloalky1amino)-l,4-dihydro-4-oxo-1,8 naphthyridine-34. Smart, B.E. Fluorine substituent effects (on bioactivity). J. Fluorine Chem. 2001, 109, 3-11.

35. Druzhinin, S.V.; Balenkova, E.S.; Nenajdenko, V.G. Recent advances in the chemistry of α, β-unsatured trifluoromethyl ketones. Tetrahedron 2007, 63, 7753-7808.

36. Ferrarini, P.L.; Mori, C.; Badawneh, M.; Calderone, V.; Calzolari, L.; Loffredo, T.; Martinotti, E.; Saccomanni, G. Synthesis of l,8-naphthyridine derivatives: Potential antihypertensive agents –Part VII. Eur. J. Med. Chem. 1998, 33, 383-397.

37. Naik, T.R.R.; Naik, H.S.B.; Raghavendra, M.; Naik, S.G.K. Synthesis of thieno [2,3-*b*] benzo [1,8] naphthyridine-2-carboxylic acids under microwave irradiation and interaction with DNA studies. ARKIVOC 2006, xv, 84-94.

38. Litvinov, V.P.; Roman, S.V.; Dyachenko, V.D. Naphthyridines. Structure, physicochemical properties and general methods of synthesis. Russ. Chem. Rev. 2000, 69, 201-220.

39. Bonacorso, H.G.; Righi, F.J.; Rodrigues, C.A.; Cechinel, C.A.; Costa, M.B.; Wastowski, A.D.; Martins, M.A.P.; Zanatta, N. New efficient approach for the synthesis of 2-alkyl(aryl)substituted 4*H*-pyrido[1,2-*a*] pyrimidin-4-ones. J. Heterocycle. Chem. 2006, 43, 229-233.

40. Yetunde, M., Ayesha, O., Ayanlowo, S., Onyekonwu, O. and Nyomudim, E. (2008). Complications of chronic use of skin lightening cosmetics. International journal of Dermatology 7:344-353.

41. Bongiorno M. R and Arico. M (2005). Exogenous Ochronosis and Striae Atrophicae following

the use of Bleaching Creams. International journal of Dermatology.44: 112-115.

42. Engasser P. and Maibach H (2003). Cosmetics and dermatology. Journal of the American academy of Dermatology 5: 143-147.

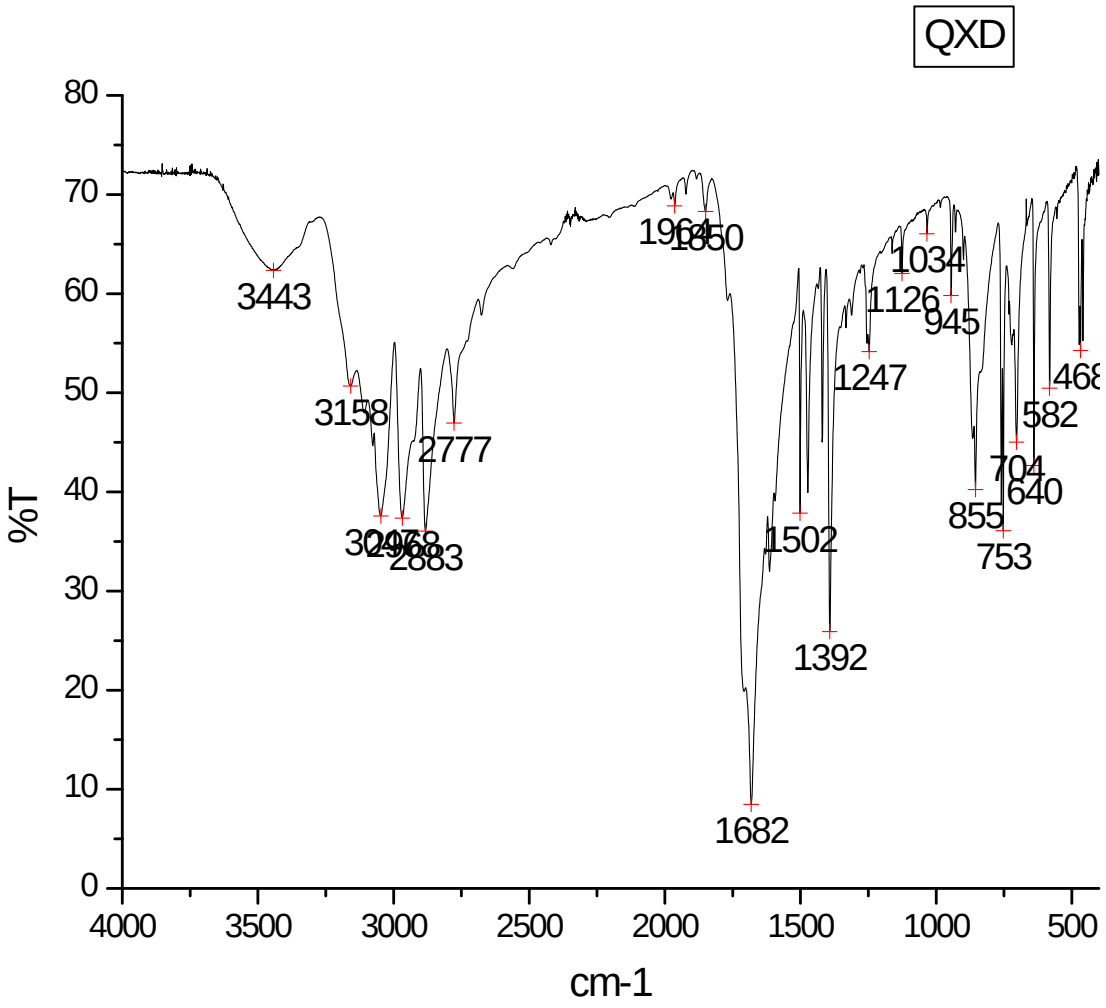
43. J.R. Lancaster, Ed., 'The Bioinorganic Chemistry of Nickel', VCH Publishers,

Inc.: New York (1989).

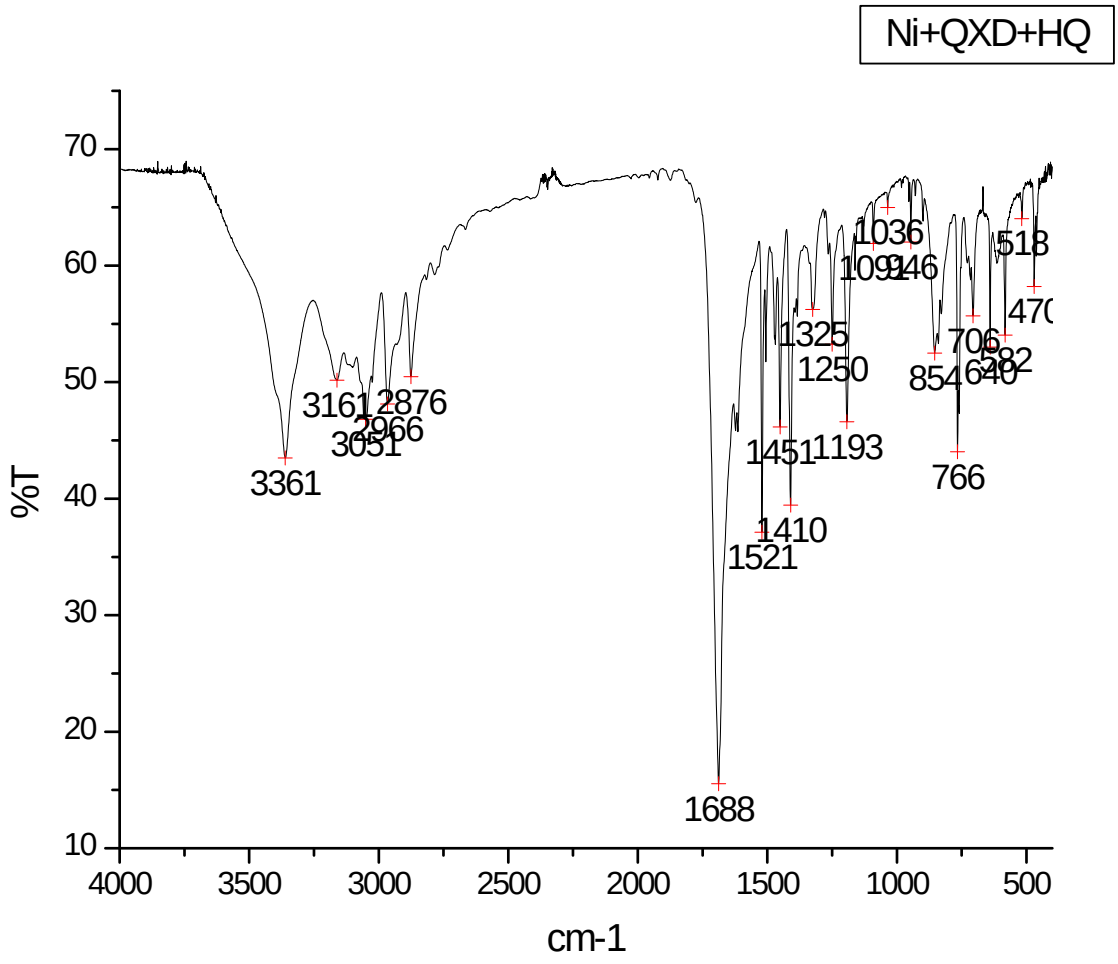
44. Yosef Alemayehu, 2006. Metal complexes of a new-n-Hetrocyclic ligand structural studies, M. Sc. Project paper, A. A. U.

45. Chakravarty, A. R., Dhar, S., Gupta, T., Nathaji, M. and Patra, A.K, Effect of copper–sulphur bond on the DNA photo-cleavage activity of 2-(methylthio) ethylpyridine-2-carbaldimine copper (II) complexes, J. Chem. Sci., Vol. 117, No. 2, 2005 123–132.

46.Ratnadeep V. Ghadage and Pramod J. Shirote Synthesis and anticonvulsant activity of Schiff's base A journal of the Bangladesh, pharmacol, 2011.



IR Spectrum of quinoxaline-2,3-dione.


Ni+QXD+HQ
%T
cm-1
70
60
50
40
30
20
10
4000
3500
3000
2500
2000
1500
1000
500
3361
3161
2876
2966
3051
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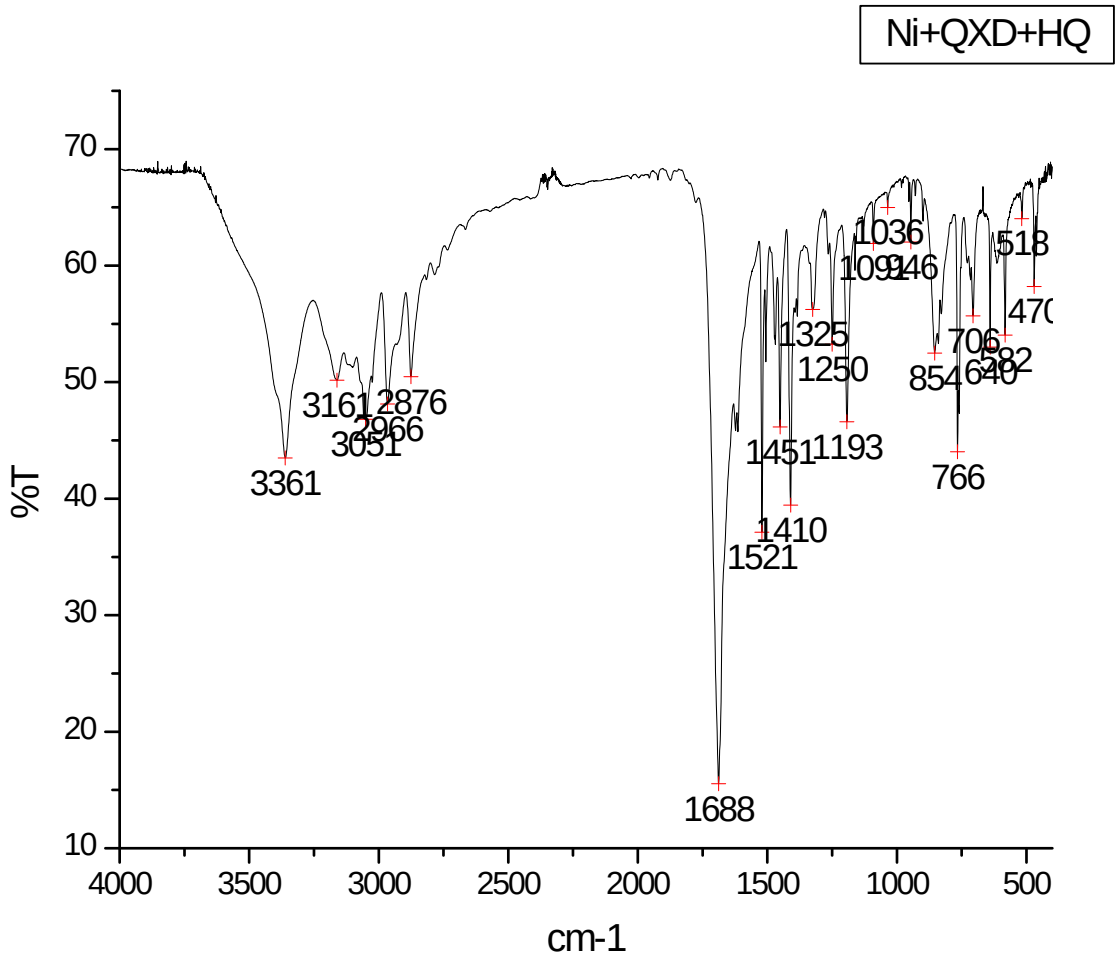
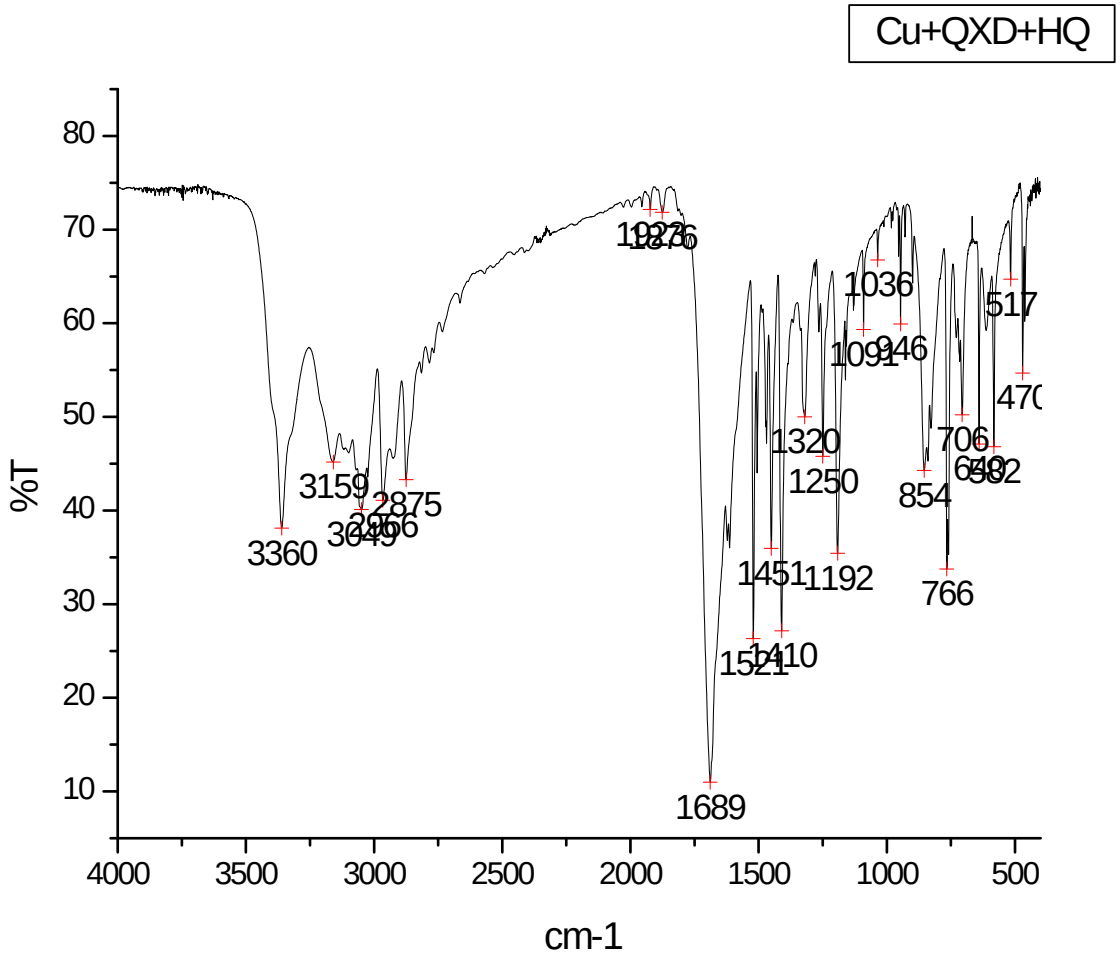
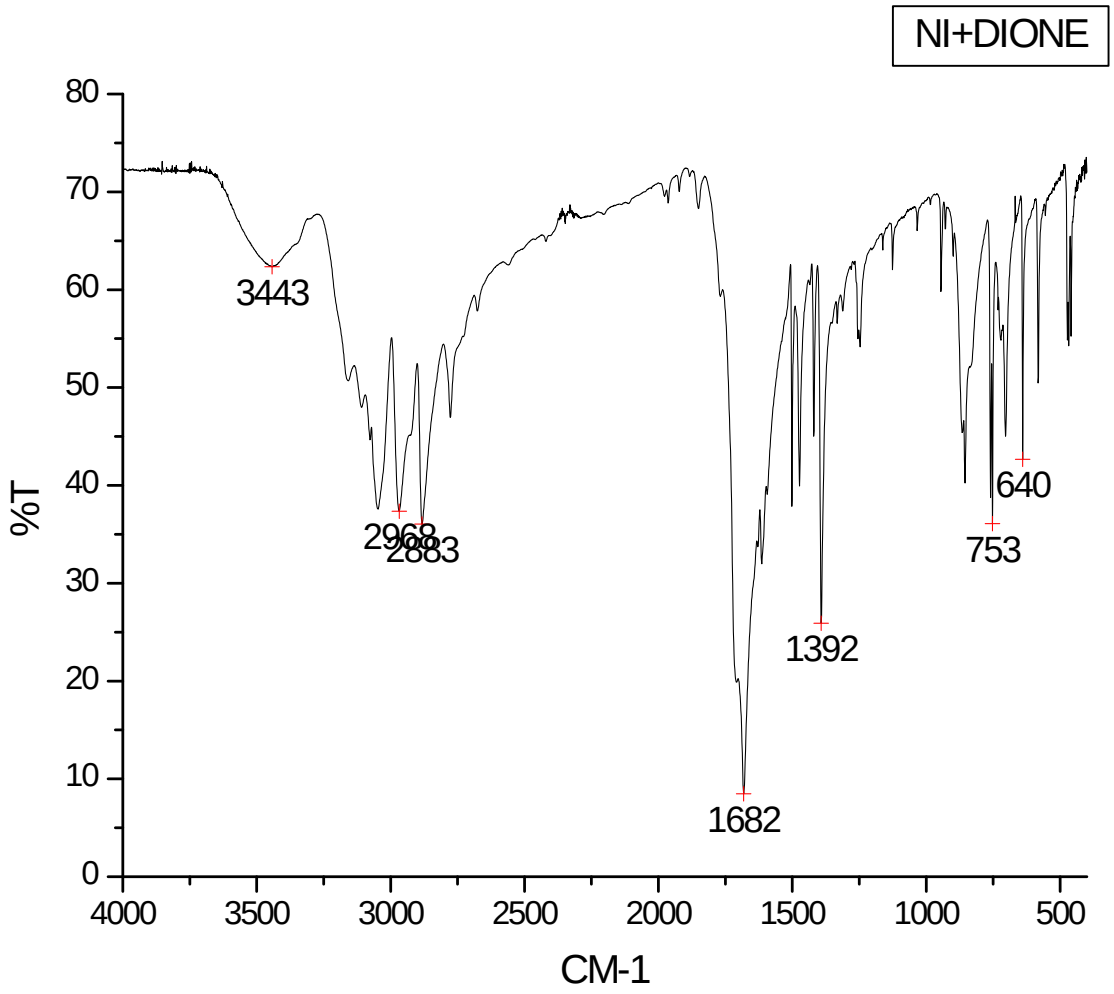


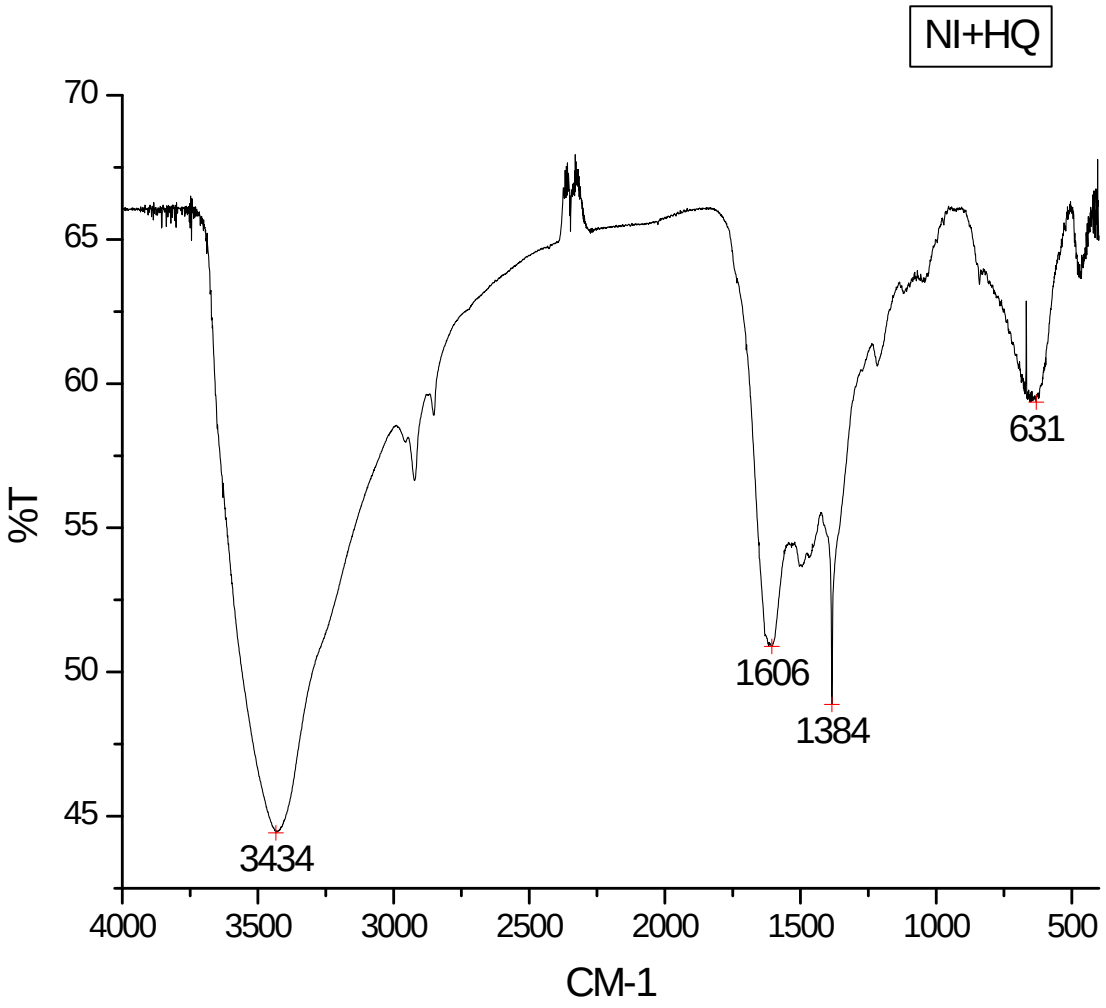
IR Spectrum of Ni(II) complex



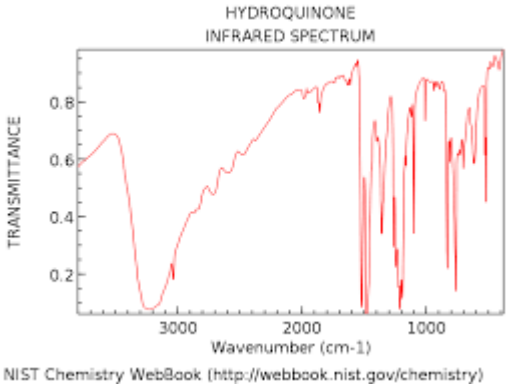
IR Spectrum of Cu(II) complex



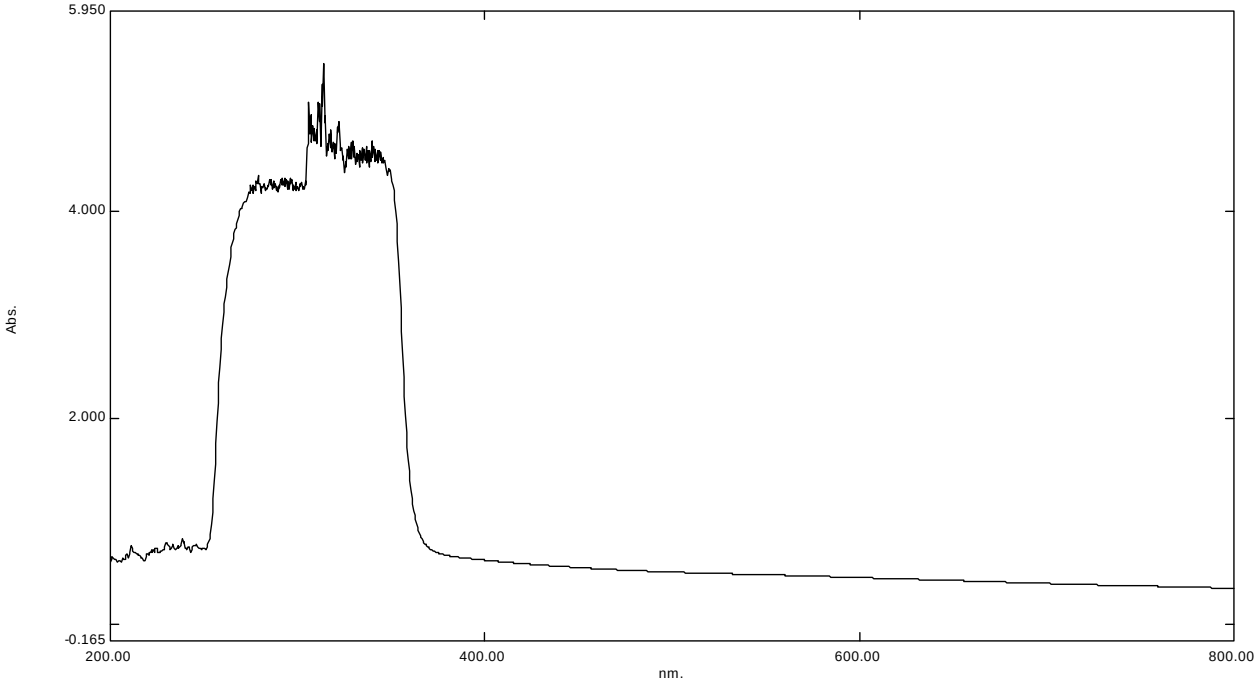
IR Spectrum of Ni + QXD



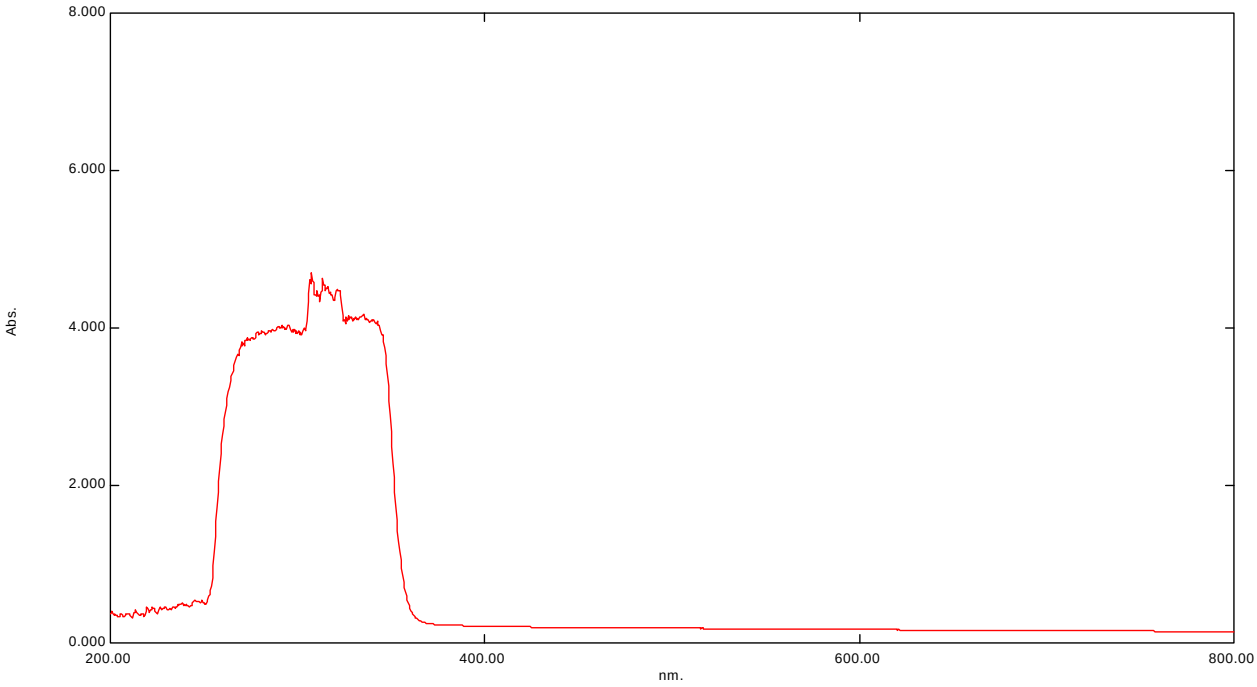
IR Spectrum of Ni + HQ



IR Spectrum of HQ



Electronic spectrum of Ni(II) complex



Electronic spectrum of Cu(II) complex