SYNTHESIS OF 2,3-DIHYDROQUINOZOLINE-4(1H)-ONES USING NICKEL BASED NANAOCATALYST

Project Report Submitted To

MAHATMA GANDHI UNIVERSITY

In Partial Fulfilment of the Requirement for the Degree of

MASTER OF

SCIENCE IN CHEMISTRY

Submitted By

NEETHUMOL MATHEW

REG. NO: 200011010689

UNDER THE GUIDANCE OF

Dr. KANNAN V

DEPARTMENT OF CHEMISTRY

GOVERNMENT COLLEGE, KATTAPPANA

KERALA,

CERTIFICATE

This is to certify that the project work titled **"SYNTHESIS OF 2,3-DIHYDROQUINOZOLIN–4(1H) - ONES USING NICKEL BASED NANOCATALYST"** submitted to Mahatma Gandhi University in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry under the faculty of science is a sincere record of work carried out by **NEETHUMOL MATHEW (Reg.no.200011010689),** during the year 2020-2022, in the department of Chemistry, Pavanatma College, Murickessery under my supervision and guidance. It has not been submitted for the award of any degree to the university or institution.

Dr. Kannan V
Department of Chemistry
Gov. College, Kattappana

Place: Kattappana
Date: June 2022

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Murickassery
June 2022

Mr. Saji K Jose
Associate Professor & HOD
PG Department of Chemistry
Pavanatma College Murickassery

DECLARATION

I here by declare that the project work entitled **"SYNTHESIS OF 2,3-DIHYDROXYQUINAZOLINE-4(1H) - ONES USING NICKEL BASED NANOCATALYST"** is a sincere record of work carried out by me under the valuable guidance and supervision of Dr.Kannan V, Department of Chemistry, Government College Kattappana, in partial fulfillment of the requirements for the award of the degree of Master of Science in Chemistry is a record of original project work done in department of chemistry, Pavanama College Murickassery affiliated to Mahatma Gandhi University during the period of studies (2020-2022).

I also declare that this report has not been submitted to any other university or institution for the award of any other degree/diploma and this represents my independent work.

Murickassery

July 2022 **NEETHUMOL MATHEW**

ACKNOWLEDGEMENT

First of all I would like to thank the Lord Almighty for showering his blessing to fulfil my project without any hesitation obstacles and for giving me strength to complete my work.

I express my gratitude to **DR. KANNAN V, Principal of Government College Kattappana,** for giving me an opportunity to pursue my dissertation work at Government College, Kattappana for all guidance and support extended towards me throughout the period of the study and also I am for providing me such a wonderful platform to complete my project.

I would also like to appreciate **MR. SAJI K JOSE, Head of the Department of the Chemistry**, and faculties especially **Mrs. ARDRA C MATHEW, Asst. Professor of Department of Chemistry,** PAVANATMA COLLEGE MURICKASSERY, for their critical guidance and constant encouragement and support.

I would like to my family, lectures, well-wishers and friends without whose support was inexplicable for the success.

NEETHUMOL MATHEW

CONTENTS

1.INTRODUCTION

Catalyst are substances which speed up a chemical reaction without being consumed or changed itself. Currently nanoparticles are increasingly substituting conventional heterogeneous catalysts. The term nanocatalyst is defined as a material that has catalytic properties on at least one nanoscale dimension. Due to small sizes, nanoparticles have higher surface area and increased exposed active sites.They possess larger contact areas with reactants and are catalytically more active than conventional heterogenous catalysts.Also nanocatalyst tare easy to separate from the reaction mixture. Traditional commercial nanocatalysts such as enzymes, zeolites, and transition metal nanocatalysts represent about 98% of the global nanocatalyst market.

Nanocatalysts

- Mainly transition metals are used as nanocatalyst.
- Because they have variable oxidation state and possess good adsorption properties.
- Combination of these two properties make transition metal nanoparticles to act as electron conduits for the reactants adsorbed on the catalytic surface.
- Eg; enzymes, zeolite, transition metals.

There are many ways to prepare a catalyst with nanosized particles. The most common way to prepare catalyst is impregnation or incipient wetness technique. Different form of catalysts are used for different types of reaction. The functioning catalyst consist of a small nanosized crystallites supported on a porous metal oxide support.

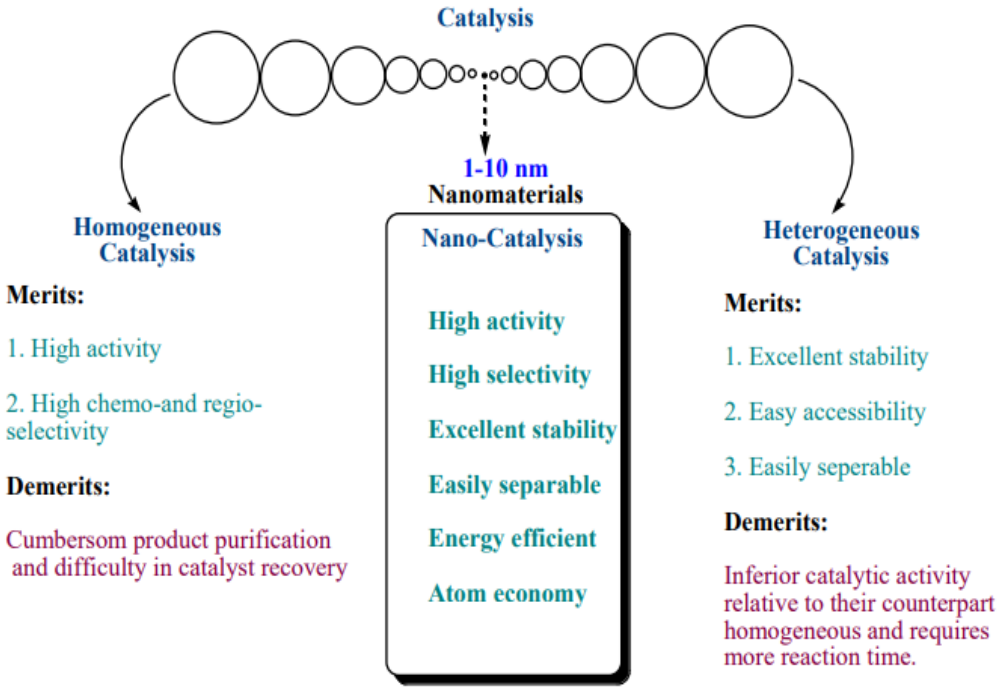
Eg: In the case of Pt, active catalyst is Pt and the support is aluminium oxide.

The porous support plays an important role ie, provide inexpensive but high surface area. Common supports are silica, alumina, activated carbon, crystalline zeolites,etc.

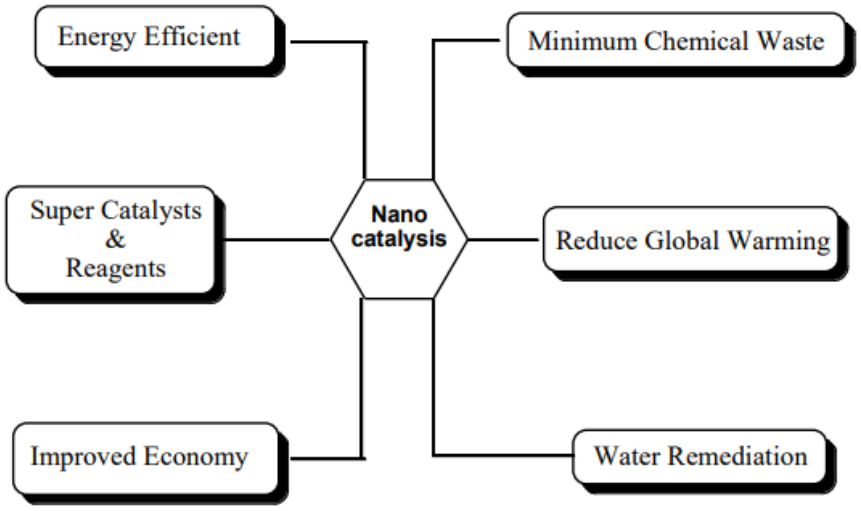
1.**1 NANO- CATALYSIS**

Catalysis is one of the pioneer applications of nanoparticles. Various elements and materials like aluminium, iron, titanium dioxide, clays, and silica all have been used as catalysts in nanoscale for many years. But appropriate explanation of its tremendous catalytic behaviour showing by NPs still has not been fully understood. Large surface area of nanoparticles has a straight forward positive effect on reaction rate and may also be a reasonable explanation of its catalytic activity. Structure and shape-based properties of any materials at its nanoscale size can also effect the catalytic activity of a material. All these advantages will enable

industrial chemical reactions to become more resource efficient, consume less energy, and produce less waste which help to counter the environmental impact caused by our reliance on chemical process. Nanoparticles are recognized as the most important industrial catalyst and have wider application ranging from chemical manufacturing to energy conversion and storage. Variable and particle-specific catalytic activity of nanoparticles is due to its heterogeneity and their individual differences in size and shape.



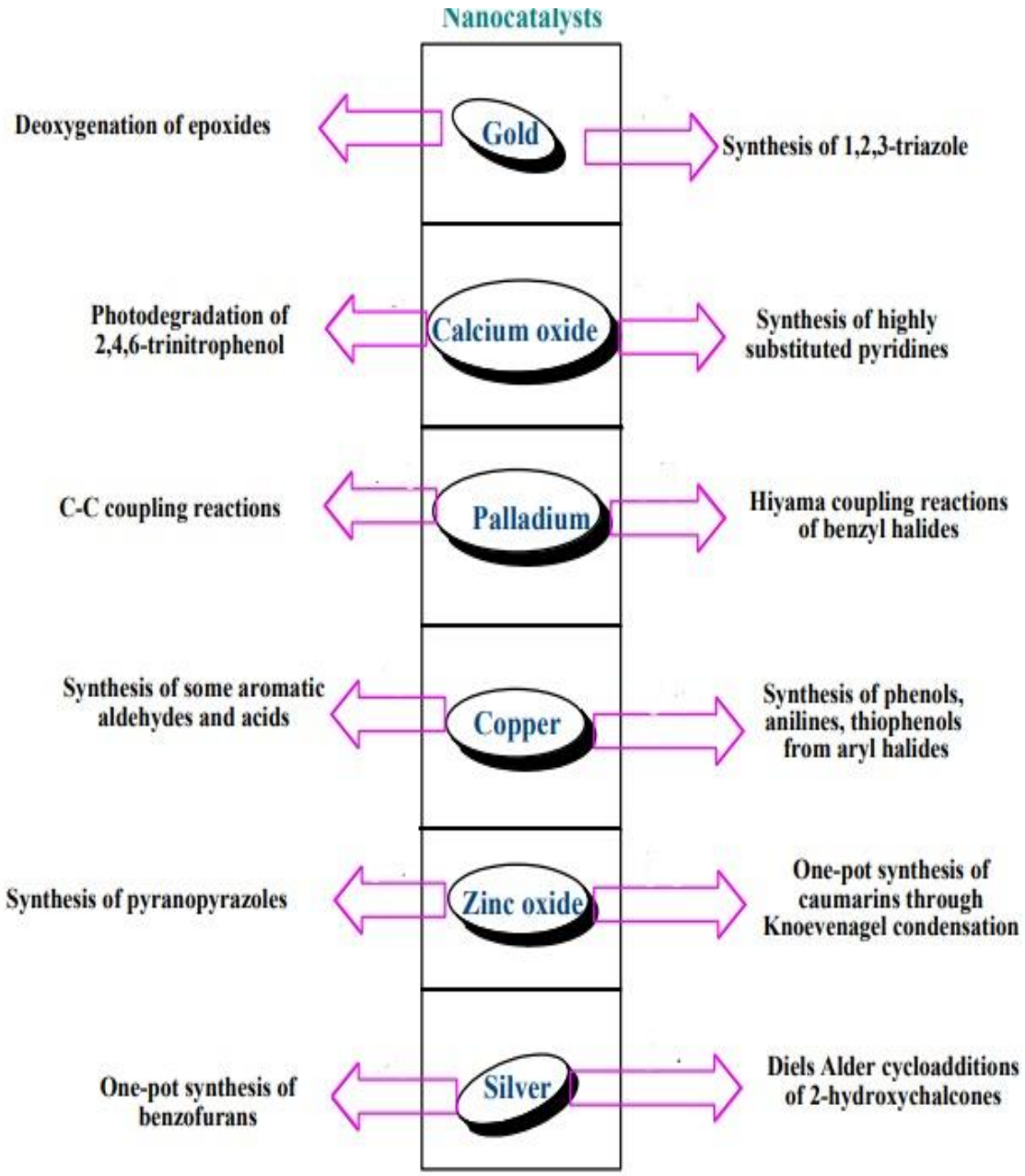
By precisely controlling the size, shape, spatial distribution, surface composition and electronic structure, and thermal and chemical stability of the individual nano components, it can be widely used in catalysis with newer properties and activity. Nanostructured catalysts have been the subject of considerable academic and industrial research attention in recent times due to the numerous potential benefits that can accrue through their use.



Benefits of Nano catalysis

One of the most interesting scientific and technological challenges associated with the use of nanoparticles as catalysts is the understanding of how the composition and atomic-scale structure of nanoparticles produce the best catalytic activity. The second challenge is to synthesize these particles with maximum control over the composition and structure. Modern nanotechnology methods clearly offer a great potential for future developments in both characterization and synthesis of heterogeneous catalysts based on supported nanoparticles

Few selective nano – catalysed reactions are summarized below, which highlights the application of nano catalyst in organic synthesis.



1.2 BIMETALLIC NANOCATALYSTS

Bimetallic catalysts are one of the main categories of metal catalysts due to the tunability of electronic and geometric structures through alloying a second metal. The integration of a second metal creates a vast number of possibilities for varying the surface structure and composition of metal catalysts toward designing new catalysts.

Bimetallic materials are important catalysts due to their numerous advantages. For example, composition (at large scale), coordination environment of the metal atom (on the atomic scale), and electronic state of the parent metal can be tuned systematically due to the spectacular success in the synthesis of bimetallic nanoparticles in the recent decade. As heterogeneous catalysis is performed on the surface of a catalyst, the surface structure and chemistry of a bimetallic catalyst in term of geometric and electronic structures of metal atoms on the surface are the most important parameters which determine the catalytic performance ofa bimetallic catalyst. It is well acknowledged that the differences in catalytic behaviour between bimetallic catalysts and monometallic catalysts or between two bimetallic catalysts with different compositions and structures result from two effects: electronic and geometric effects.

In the bimetallic system, the incorporation of second metal changes the bond lengths between metals and hence influences the geometric and electronic structure of catalyst.Thus, bimetallic NPs wth distinctive morphology possess different catalytic activity.

Bimetallic iron-nickel based nano catalysts are perhaps the most active for the oxygen evolution reaction in alkaline electrolytes. Recent developments in literature have suggested that the ratio of iron and nickel in Fe-Ni thin films plays an essential role in the performance and stability of the catalysts.

Nickel iron oxide is considered as the bench mark catalyst and it has a binary composition and exihibits then over frequencies upto about 0.5 S^{-1} at an overpotential of 300 ev .Nickel iron oxide nano materials have great potential for use In the field of optics,water oxidation catalysis and biomedical application. This is due to the abundance of Fe and Ni in the earth crust.

$NiFe_2O_4$ nanoparticles with an average size of nearly 10 nm was studied for electrochemical water splitting. It showed bifunctional activity for both oxygen and hydrogen

evolution reaction. The electro catalytic activity of $NiFe_2O_4$ is comparable with benchmark electrocatalyst IrO2/C. Similarly, $NiFe_2O_4$ also shows superior HER activity in 1 M KOH. The enhanced bifunctional activity of $NiFe_2O_4$ high surface area and stability leading to high electrical conductivity.

1.3 HETEROCYCLIC COMPOUNDS

Heterocyclic compounds are present in abundance in our surroundings. They owe their importance in the biological system due to uniqueness in their structural skeleton parts. They are naturally found in nucleic acid , vitamins, antibiotics, hormones etc. Nitrogen containing heterocyclic compounds are an important class of heterocyclic compounds that has paid significant contribution towards medicinal chemistry. The types of compounds depend upon number of nitrogen atoms and their position.

Heterocyclic compounds, also called heterocycles, are part of a major class of organic chemical compounds characterized by the fact that some or all of the atoms in their molecules are joined in rings containing at least one atom of an element other than carbon. Organometallic chemistry plays an important role in modern approaches for the synthesis of heterocycles. Heterocyclic compounds include many of the biochemical materials that are essential to life. Modern society is dependent on synthetic heterocycles for use as drugs with anticancer agents and antibiotics.

Heterocyclic compounds are very important for human survival too. They are important information carrier. These are used in neurotransmitter and pyrimidines; nucleoside is a part of genetic material that transfers information from one generation to other. Heterocyclic compounds are predominantly used as pharmaceuticals, as agrochemicals and as veterinary products. They also find applications as sanitizers, developers, antioxidants, as corrosion inhibitors, as copolymers, dye stuff. They are used as vehicles in the synthesis of other organic compounds.

1.4 NITROGEN CONTAINING HETEROCYCLIC COMPOUNDS

N-heterocycles are important, not only because of their abundance, but above all because of their chemical, biological and technical significance. They play an important role in biological investigation such as anticancer, anti-inflammatory, antibacterial, antiviral, anti-tumor, antidiabetic, etc.

Nitrogen-containing heterocyclic compounds, such as quinoline, indoles, pyrroles and pyrrolidines (and their alkylated homologues) are of high industrial interest, for applications as intermediates to produce pharmaceuticals, herbicides, fungicides, dyes, etc. Currently, most of these compounds are recovered by distillation of coal tar, although this source is no longer able to cover the market demand. Alternatively, they can also be obtained by well-known liquid-phase syntheses which, however, have many important drawbacks, such as use of hazardous reaction conditions, expensive or toxic feeds, large waste production, etc.Increasing attention is being focused on vapour phase syntheses of nitrogen-containing compounds with heterogeneous catalysts that exhibit significant advantages in comparison to homogeneous catalysts.

Nitrogen-based heterocyclic chemistry is an important and unique class among the applied branches of organic chemistry, with a significant amount of research dedicated to the development of novel molecules and composites. These molecules have received increasing attention over the past two decades. They contributed to the development of numerous organic synthesis protocols and found abundant applications in the chemical sciences . Many N-heterocyclic compounds that are broadly distributed in Nature, possess physiological and pharmacological properties and are constituents of many biologically important molecules, including many vitamins, nucleic acids, pharmaceuticals, antibiotics, dyes and agrochemicals, amongst many others . Moreover, they form an integral part of many pharmacologically active molecules. The base pairs of DNA and RNA (guanine, cytosine, adenine, and thymine) are also made up of N-heterocyclic compounds, namely purines, pyrimidines, etc. These nitrogen-containing heterocyclic molecules with distinct characteristics and applications have gained prominence in the rapidly expanding fields of organic and medicinal chemistry and the pharmaceutical industry . Furthermore, the electron-rich nitrogen heterocycle is not only able to readily accept or donate a proton, but it can also easily establish diverse weak interactions. Some of these intermolecular forces, such as like hydrogen bonding formation, dipole-dipole interactions, hydrophobic effects, van der Waals forces and π-stacking

interactions of nitrogen compounds have increased their importance in the field of medicinal chemistry and allows them to bind with a variety of enzymes and receptors in biological targets with high affinity due to their improved solubility. The structural features of their derivatives are beneficial since they exhibit broad bioactivities.

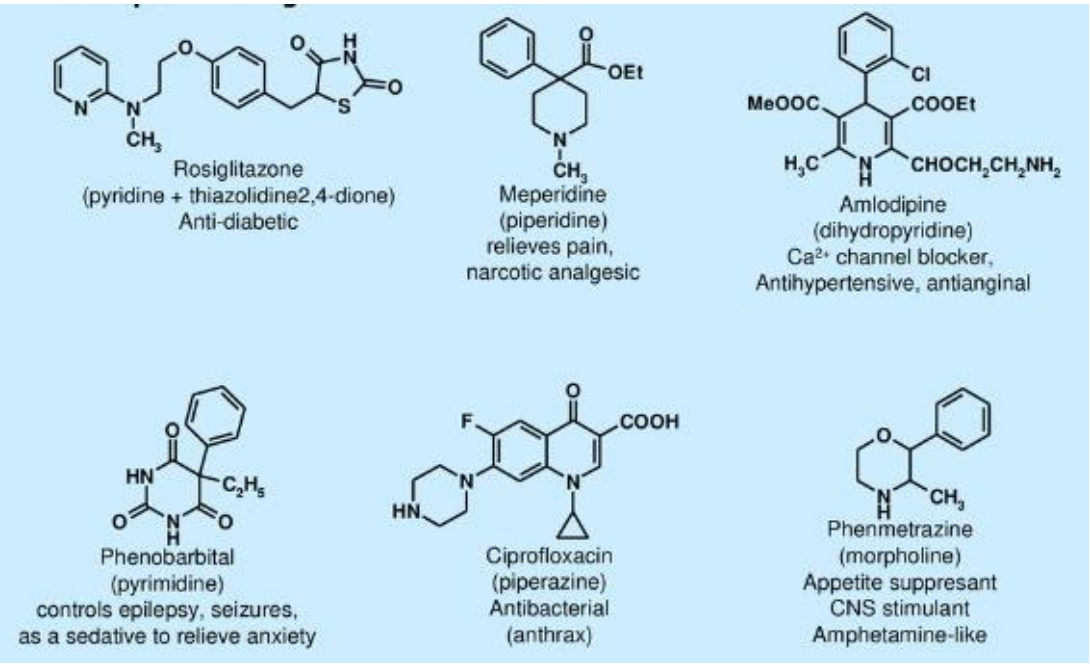
A glance at the FDA databases reveals the structural significance of nitrogen-based heterocycles in drug design and engineering of pharmaceuticals. Nearly 75% unique small-molecule drugs contain a nitrogen heterocycle. The N-heterocyclic skeletons feature significantly various classes of therapeutic applications and are used as the building blocks of a number of new drug candidates, due to the ability of the nitrogen atom to easily form hydrogen bonding with biological targets . For example, pyrimidine derivatives have various therapeutic applications in medicinal chemistry and pyrimidine skeleton of thymine, cytosine, and uracil are essential building blocks of nucleic acids, DNA and RNA . A vast number of nitrogen-containing heterocyclic compounds are known to exhibit a wide range of pharmacological activities including anticancer, anti-HIV, antimalaria, anti-tubercular, anti-microbial and diabetic activities.The utility of N-heterocyclic compounds is a hot spot in medicinal chemistry and chemical science.

The nitrogen-containing four-membered ring heterocycles have proved their biological importance in medicinal chemistry and have further increased their biological significance. Among the heterocyclic compounds, the four-membered cyclic amide ring system of β-lactams has evolved as the scaffold of choice in the design of many antibiotics and it is also a valuable building block in organic synthesis. It is recognized as a vital component for the bioactivity profile of antibiotics.

The five-membered heterocyclic motifs are known as 1,2,3-triazoles, imidazoles, pyrazoles, oxadiazoles, oxazoles, isoxazoles and thiazoles. Which are important pharmocophores in medicinal chemistry due to its exhibits broad spectrum of biological activities.The 1,2,3-triazole moiety is the main pharmacophore system among the nitrogen-based molecules and is a privileged building block in the discovery of various new biological targets.

The heterocyclic compounds have a great importance in medicinal chemistry. One of the most important heterocycles in medicinal chemistry are quinazolines possessing wide spectrum of biological properties like antibacterial, antifungal, anticonvulsant, anti-inflammatory, anti-HIV, anticancer and analgesic activities.

Examples :



1.5 QUINAZOLINES

Quinazolines are nitrogen-containing six-membered heterocyclic compounds that contain a benzene ring system fused to a pyrimidine at two adjacent carbon atoms. Quinazolines and their analogs possess a wide range of biological activities.The molecular formula of quinazoline is $C_8H_6N_2$.It is a light yellow crystalline solid that is soluble in water. Also known as 1,3- diazanaphthalene, quinazoline derived its name from being an aza derivative of quinoline. Though the parent quinazoline molecule is rarely mentioned by itself in technical literature, substituted derivatives have been synthesized for medicinal purposes such as antimalarial and anticancer agents. Quinazoline is a planar molecule. It is isomeric with the other diazanaphthalene of the benzodiazine subgroup: cinnoline, quinoxaline, and phthalazine. Over 200 biologically active quinazoline and quinoline alkaloids are identified.

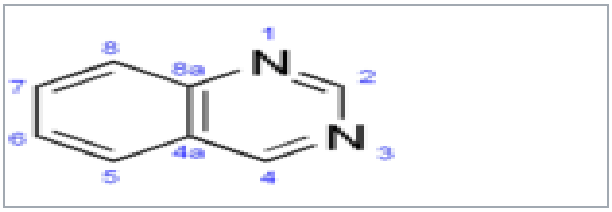
Other names

1. 1,3- diazanaphthalene
2. Benzopyrimidine
3. Phenmiazine
4. Benzo- 1,3- diazine

The synthesis of quinazoline was first reported in 1895 by August Bischler and Lang through the decarboxylation of the 2-carboxy derivative (quinazoline-2-carboxylic acid). In 1903, Siegmund Gabriel reported the synthesis of the parent quinazoline from *o*-nitrobenzylamine, which was reduced with hydrogen iodide and red phosphorus to 2-aminobenzylamine. The reduced intermediate condenses with formic acid to yield dihydroquinazoline, which was oxidized to quinazoline.

Properties	
Chemical formula	$C_8H_6N_2$
Molar mass	130.150 g·mol^{-1}
Appearance	light yellow crystals
Density	1.351 g/cm^3, solid
Melting point	48 °C (118 °F; 321 K)
Boiling point	243 °C (469 °F; 516 K)
Solubility in water	Soluble
Acidity	3.51

QUINAZOLINE



Quinazoline and quinazolinones represent a diverse class of biologically active nitrogen heterocyclic compounds with immense therapeutic potential. Their ease of synthetic accessibility and flexibility in structural modifications and functionalization further adds to their appeal in medicinal chemistry. A number of currently available drugs are based on quinazoline/quinazolinone scaffold. It is interesting to note that, among the recent patents available, a lot of them focus on the promising anticancer activity of quinazoline and quinazolinone containing compounds. However their biological activity is certainly not limited to anticancer only, they are also known to elicit a number of other biological and physiological effects in vitro and in vivo respectively. The interest in quinazolines and quinazolinones is ever growing , since they offer a fairly diverse chemical space for exploration of medicinal potential.

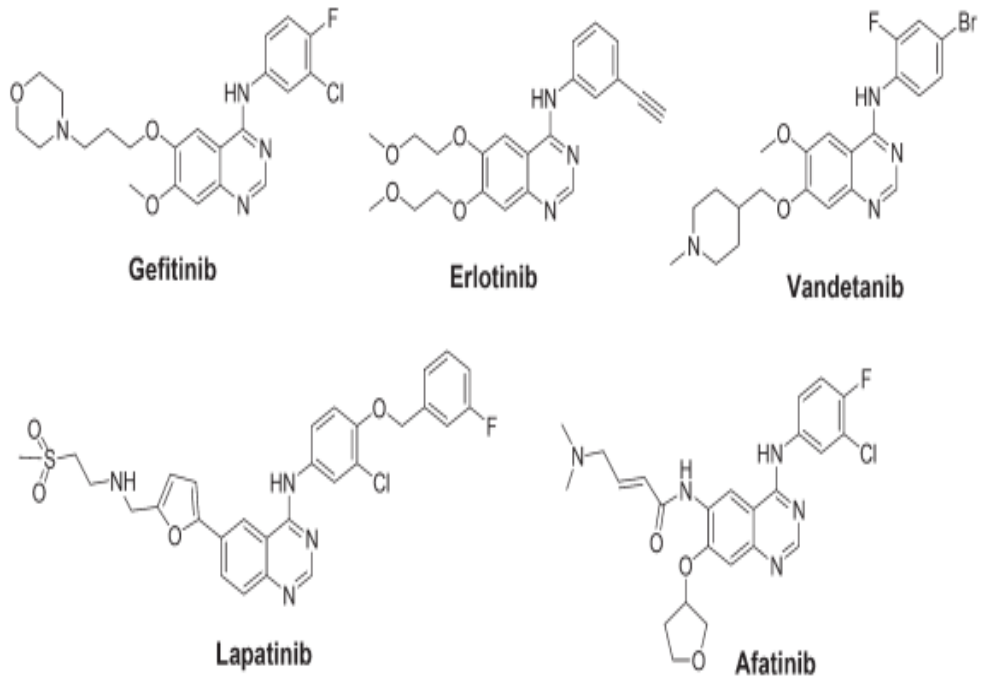
Many natural compounds are also associated with quinazoline moiety. The tautomeric effect makes the molecule more reactive and facilitates a wide spectrum of activity. The quinazolinone ring is stable for oxidation, reduction and hydrolysis reaction.

Nitrogen-containing heterocyclic compounds are the most abundant and integral scaffolds that occur ubiquitously in a variety of synthetic drugs, bioactive natural products, pharmaceuticals and agrochemicals. Owing to their widespread applications, these skeletons have long been a subject of immense interest, and substantial efforts have been made to the development of synthetic strategies which could lead to the discovery of new bioactive compounds in medicinal chemistry . Indeed, with particular reference to the pharmaceutical industry, heterocyclic motifs are especially prevalent with over 60% of the top retailing drugs containing at least one heterocyclic nucleus as part of the overall topography of the compound.

Quinazoline and quinazolinone derivatives have attracted significant attention due to their diverse pharmacological activities such as antimicrobial , antimalarial , anti-inflammatory , antihypertensive , anticonvulsant , anti-diabetic , anticancer , cholinesterase inhibition , dihydrofolate reductase inhibition , and kinase inhibitory activity . Quinazolines also exhibit a wide variety of biological functions like cellular phosphorylation inhibition , ligands for benzodiazepine and GABA receptors in the central nervous system , and some of them have acted as DNA binding agents . They also act as effective adrenergic blocker, prazosin , bunazosin and doxazosin , are useful medicines for antihypertensives, proquazone and fluproquazone as non-steroidal anti-inflammatory drugs, afloqualone as muscle relaxant, and diproqualone with sedative analgesic effects. KF31327 was developed as a heart disease remedy and an impotence medicine . In a recent report, 3,4- dihydroquinazoline derivatives have been found to perform excellent T-type calcium channel blocking activity. Quinazolinone and their derivatives are also building block for approximately 150 naturally occurring alkaloids isolated from a number of families of the plant kingdom, from microorganisms and animals.

The heterocycles are widely investigated bioactive molecules and are considered important synthetic targets for the development of novel therapeutic agents. Quinazoline is one of the heterocycles for which considerable research has been done in order to examine its biomedical applications. In a number of biologically active compounds and drug molecules, the quinazoline nucleus is used as a basic framework. Due to their broad range of pharmacological activities, which include antimicrobial,antimalarial, anti-inflammatory,anticonvulsant,antihypertensive,antioxidant,antiviral,anti-HIV and anticancer, quinazoline and its derivatives have attracted the attention of biologists and medicinal chemists. Quinazoline and its derivatives have been identified as a new class of cancer chemotherapeutic agents with significant therapeutic efficacy against solid tumors.

The Food and Drug Administration (FDA) has approved several quinazoline derivatives for clinical use as anticancer drugs. These include gefitinib, erlotinib, lapatinib, afatinib, and vandetanib.



FDA approved quinazoline derivatives as anticancer drugs.

Gefitinib was approved by the FDA in 2003 for the treatment of locally advanced or metastatic non-small-cell lung cancer (NSCLC) in patients after failure of both platinum-based and/or docetaxel chemotherapies. In 2004, erlotinib was approved by the FDA for treating NSCLC. Furthermore, in 2005, the FDA approved erlotinib in combination with gemcitabine for the treatment of locally advanced, unrespectable, or metastatic pancreatic cancer. Erlotinib acts as a reversible tyrosine kinase inhibitor. Lapatinib was approved by the FDA in 2012 for breast cancer treatment. It inhibits the activity of both human epidermal growth factor receptor-2 (HER2/neu) and epidermal growth factor receptor (EGFR) pathways. Vandetanib was approved by the FDA in 2011 for the treatment of metastatic medullary thyroid cancer. It acts as a kinase inhibitor of a number of cell receptors, mainly the vascular endothelial growth factor receptor (VEGFR), EGFR, and rearranged during transfection (RET)-tyrosine kinase (TK). Afatinib was approved by the FDA in 2013 for NSCLC treatment. It acts as an irreversible covalent inhibitor of the receptor tyrosine kinases (RTK) for EGFR and erbB-2 (HER2).

Sun and co-workers designed and synthesized two series of novel tricyclic oxazine and oxazepine fused quinazolines. The synthesized derivatives were assessed for their in vitro antitumor effect on N87, A431, H1975, BT474 and Calu-3 cell lines. Erlotinib and gefitinib

were used as standard compounds. From the careful observation of results, it was revealed that several compoundfoundto demonstrate more potent antitumor activities as compared to the standard drugs.

2. OBJECTIVE

1. Preparation of 2,3-Dihydroquinozoline – 4(1H) – ones using Ni based Nano catalysied.

2. To assess the catalytic activity of NF nano particles.

3. To study the effect of solvent.

4. To check the reusabity of the catalyst in the synthesis.

5. The characterization of the prepared compound.

3. EXPERIMENTAL SECTION

3.1 PREPARATION OF $NiFe_2O_4$ (NF) NANOCATALYSTS

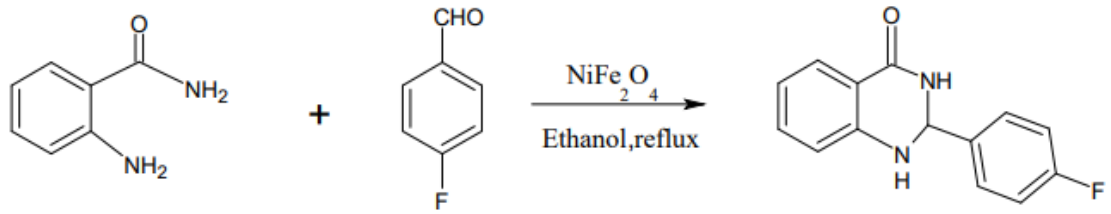
For the synthesis of $NiFe_2O_4$ nanoparticles (NF), iron nitrate (1.0 M), and nickel nitrate (0.5 M) (2:1 molar ratio) solutions were mixed thoroughly with citric acid (2.2 M) to get a clear solution. A small amount of ammonia is added carefully to the solution to adjust the pH value to 7. The solution was continuously stirred and kept at a temperature of 90^{o}C until gel forms. Then heated to 150^{o}C to initiate a self-propagating combustion process. The loose powder was crushed well and calcined at 55^{o}C for 4 h to form the spinal phase.

3.2 CATALYTIC STUDIES

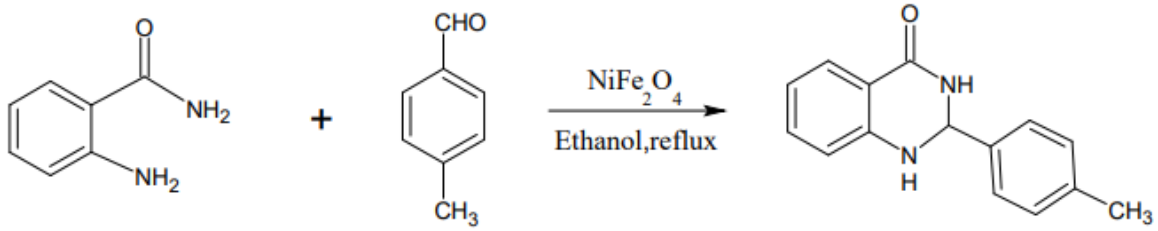
Synthesis of 2,3-dihydroquinazolin-4-(1H)-ones using $NiFe_2O_4$as catalyst

A mixture of aryl aldehyde (1 mmol), anthranilamide (1 mmol) and $NiFe_2O_4$ (20 mg) in ethanol (5 ml) was stirred under reflux conditions. The progress and completion of the reaction were monitored by TLC. The reaction mixture was centrifuged to remove the insoluble catalyst and evaporated the solvent in vacuum followed by column chromatography over silica gel using the solvent mixture of petroleum ether-ethyl acetate (7:3) to get the pure product.

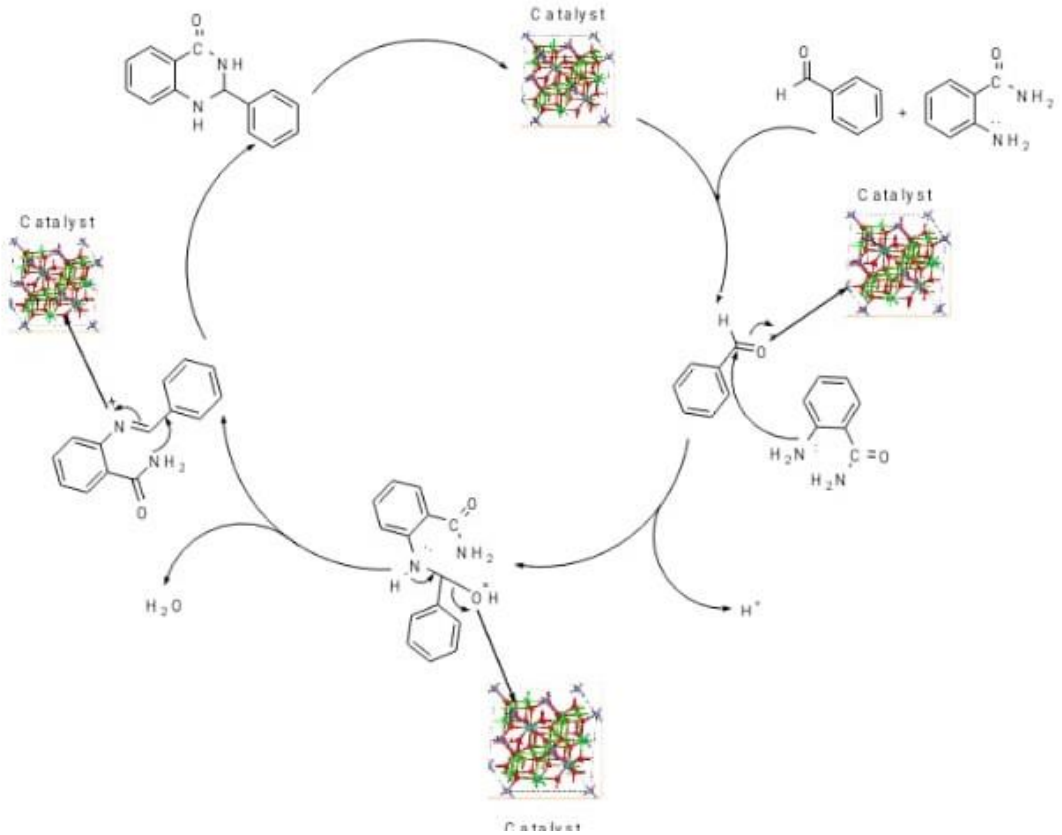
Reaction: 1



Reaction:2



3.2.1 Mechanism for the synthesis of 2,3-dihydroquinazolin-4(1H)- ones using NF nanoparticles



3.3 SEPARATION METHODS

1. COLUMN CHROMATOGRAPHY

It is a precursory technique used in the purification of compounds based on their hydrophobicity or polarity. In this chromatography process, the molecule mixture is separated depending on its differentials partitioning between a stationary phase and a mobile phase. The principle behind column chromatography is adsorption, in which a mixture of components dissolved in the mobile phase is introduced in to the column and the components move depending on their relative affinities. The choice of the solvent depends on the solubility characteristics of the mixture.

2. THIN LAYER CHROMATOGRAPHY (TLC)

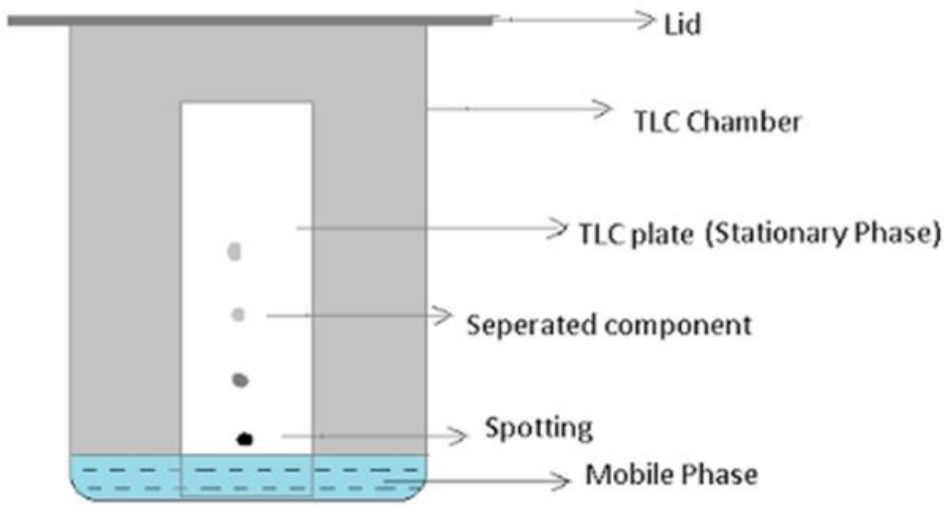
TLC is one of the simplest, fastest, and least expensive of several chromatographic techniques used in qualitative and quantitative analysis to separate organic compounds and to test the purity of compounds.

TLC is a form of liquid chromatography consist of :

- A mobile phase (developing solvent, here Hexane–ethyl acetate)
- A stationary phase (a plate or strip coated with a form of silica gel)
- Analysis is performed on a flat surface under atmospheric pressure and room temperature.

How to run thin layer chromatography

- Step: 1 Prepare the developing container
- Step: 2 Prepare the TLC plate
- Step: 3 Spot the TLC plate
- Step: 4 Develop the plate
- Step: 5 Visualize the spots.


Lid
TLC Chamber
TLC plate (Stationary Phase)
Seperated component
Spotting
Mobile Phase

4. RESULTS AND DISCUSSION

4.1 FTIR SPECTRA ANALYSIS

Fig 1 shows the FTIR spectra of NF nanoparticles in the range 350-4000 cm^{-1}. It is evident from Fig. that NF nanoparticles displayed their fingerprint peaks at around 350-590 cm^{-1}, which is ascribed to stretching vibration of metal-oxygen bonds in tetrahedral and octahedral sites. For NF nanoparticles, Ni^{2+}- O^{2-} octahedral stretching peak appeared at 396 and 411 cm^{-1} respectively and the splitting in absorption bands due to local lattice deformation is evident from the spectra.

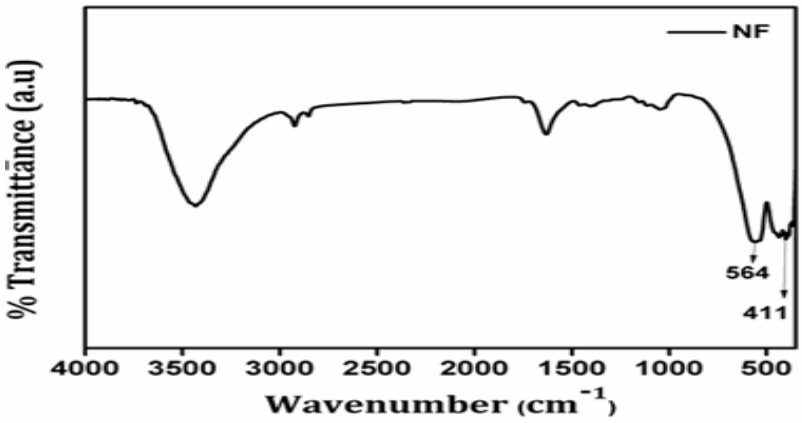


Figure 1. FTIR spectra of NF nanoparticles.

4.2 Microstructure studies

SEM is a widely used technique to characterize the morphology, topology, and detailed surface structure of solid materials. . Agglomerated uniform nano-metric particles of NF, could be observed in Fig. 2.

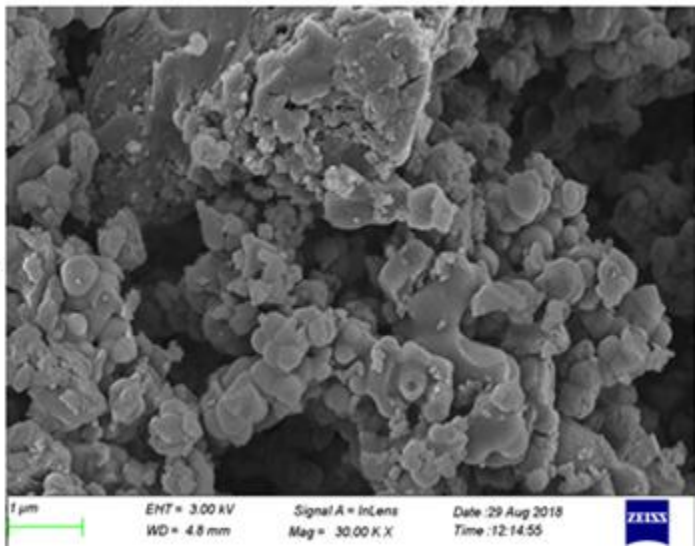


Figure 2. SEM image of NF nanoparticles.

TEM is a technique that uses an electron beam to image a nanoparticle sample. TEM is the preferred method to directly measure nanoparticle size, grain size, size distribution and morphology. TEM micrographs of nanocrystalline NF nanoparticles are presented in Fig 3.

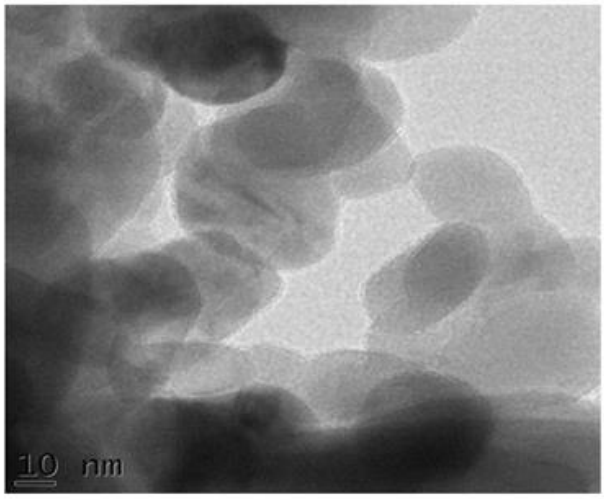


Figure 3. TEM image of NF nanoparticles.

4.3 XRD analysis

X ray diffraction is the principal method used to identify the phases present in a solid state materials. As the dimension of the material reduces the diffraction peaks broaden and in a very small crystallite there may not be enough plane to diffract. The size of the particles can be found by using Scherrer formula. The size of NF nanoparticles was found to be 12 nm.

$$D = \kappa . \lambda / (\beta . \cos\theta)$$

The Scherrer formula describes the broadening of a peak at a particular diffraction angle (θ). Where (D) is the crystalline domain size and (β) is the width of the peak at half of its height. The Scherrer constant, (κ) is typically considered to be 0.91 but can vary with the morphology of the crystalline domains, (λ) is the wavelength of X-rays used.

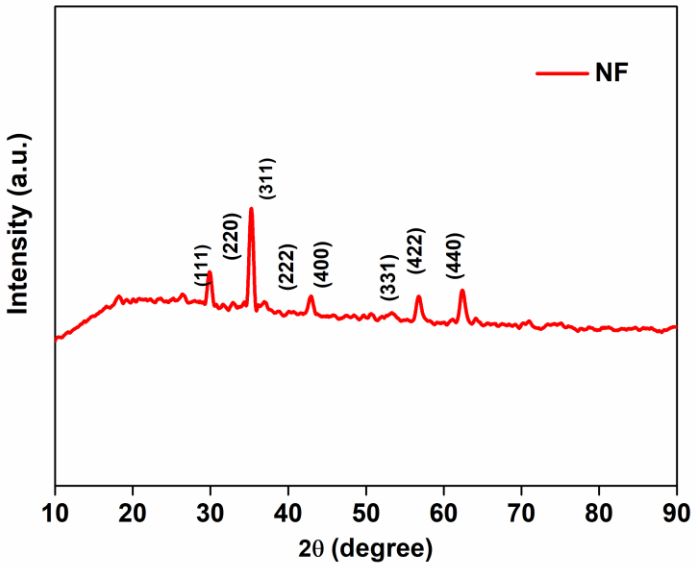
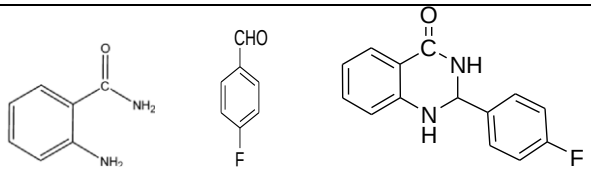
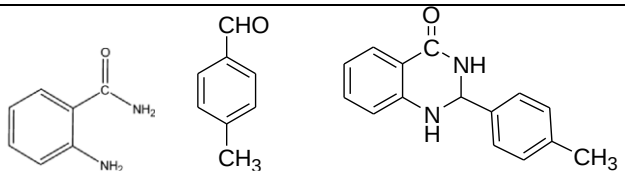


Figure 4 X-ray diffraction pattern of NF nanoparticles.

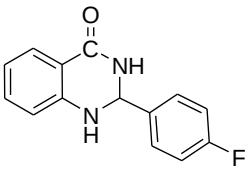
3.4 Catalytic activity studies

To assess the catalytic activity of NF nanoparticles, they were used as catalysts in the synthesis of 2, 3-dihydroquinazoline-4(1H)-ones. To optimize the reaction conditions intermolecular cyclization between antranilamide and aryl aldehydes is chosen as the standard reaction. This method has advantages such as less reaction time, good yields, simple workup procedure, shorter reaction time and use of eco-friendly solvent.

NO.	ANTHRANILAMIDE	ALDEHYDE	PRODUCT	TIME (min)	M.P (^{0}C)	YIELD %
1				69	86	218
2				71	72	220

The characterization of the products can be done by NMR. The NMR of the products are given below.

1.



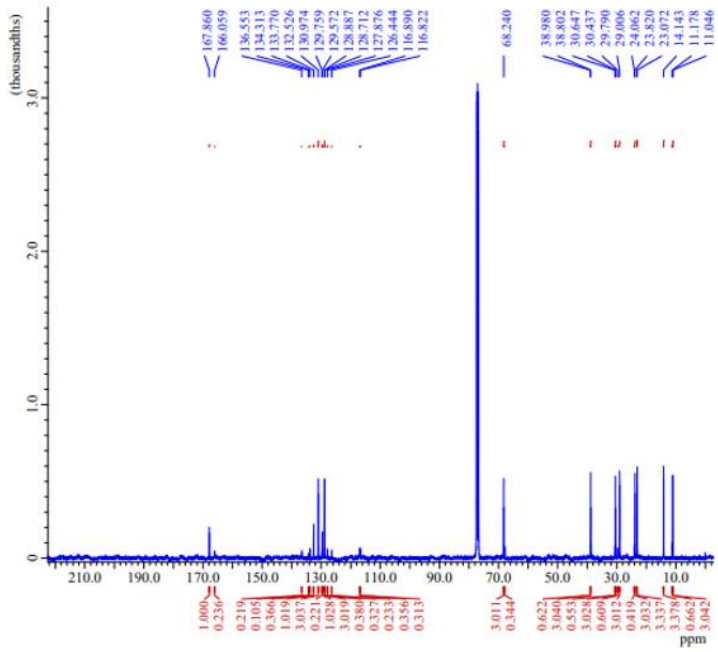
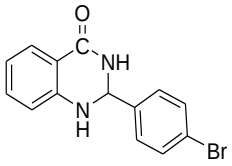
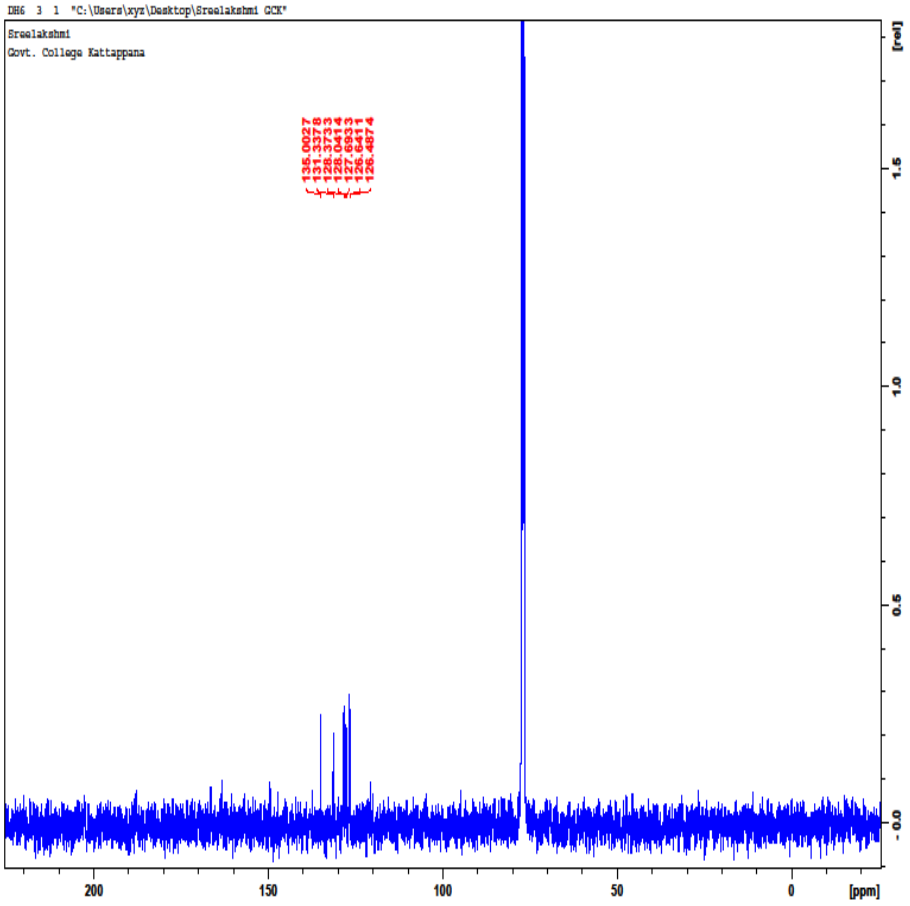


Figure: The C13NMR

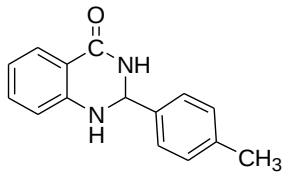
From the above data, the peaks in the range 116ppm to 136 ppm indicates the presence of aromatic carbons. The highest peak at the range 170 ppm represents the carbonyl carbon of this compound. The signal obtained at the range of 79 ppm to 80 ppm indicates the presence of Sp^3 hybridised carbon which is lies in between the two nitrogen atoms in the compound.





The sharp peaks in the range 7 to 8 ppm indicates the presence of aromatic protons. The peak at 6 ppm represents a 1H triplet. The peaks at 5ppm and 6.8 ppm represents 1H doublets respectively.

2.



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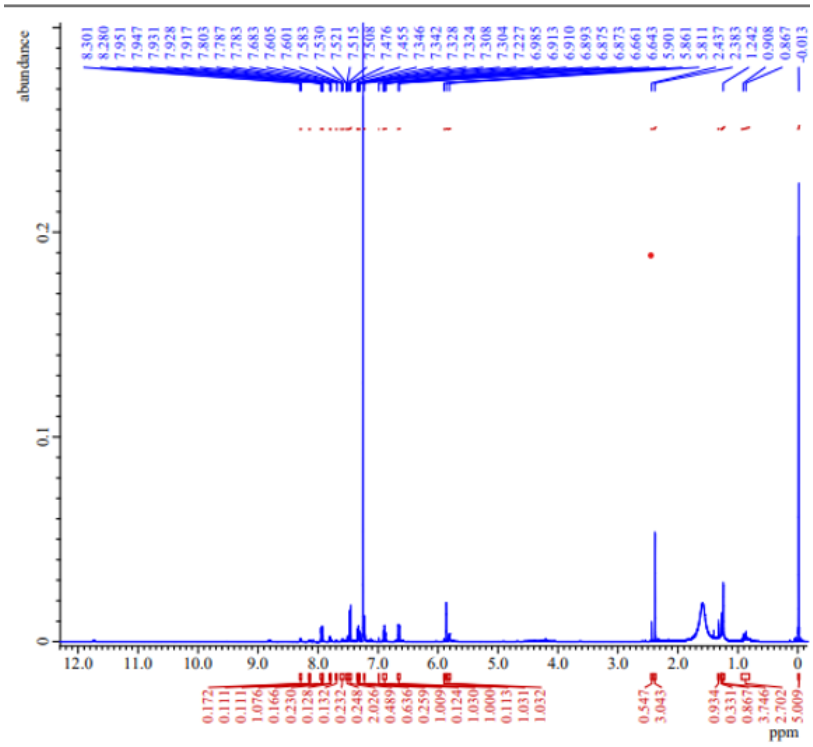


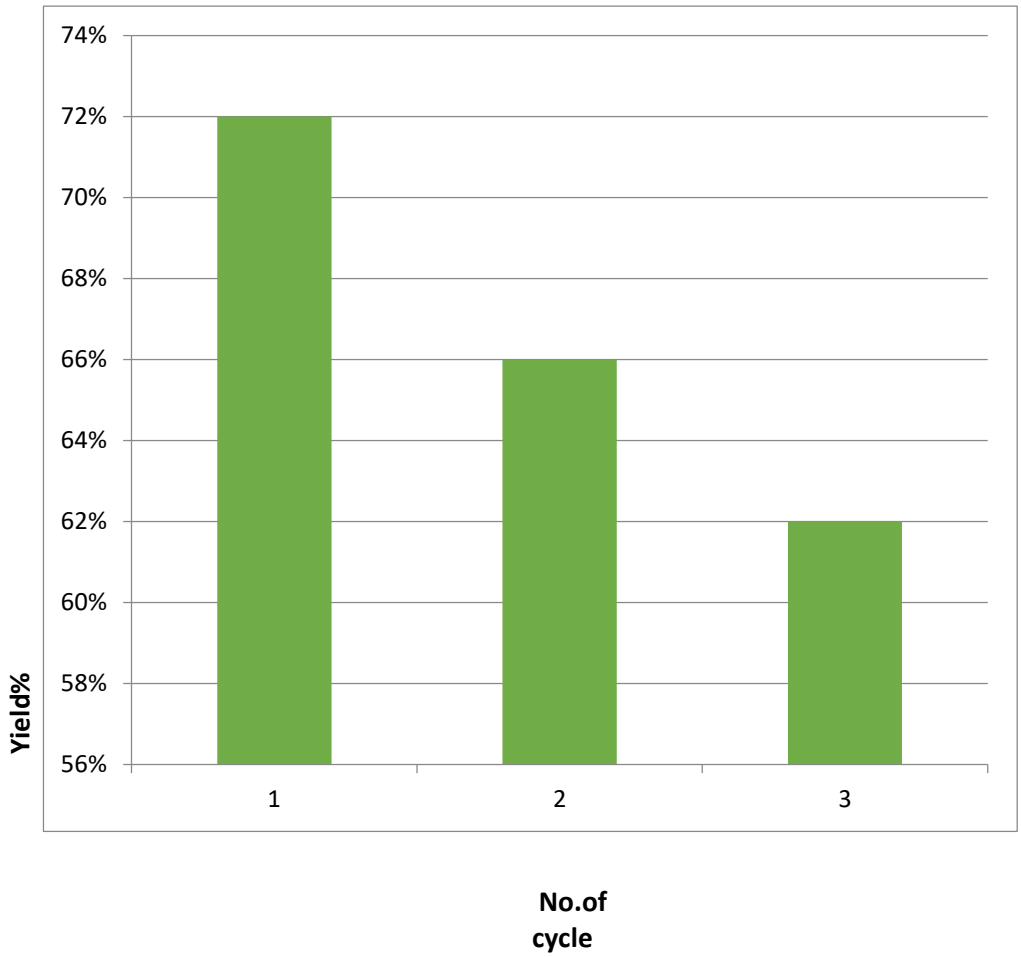
Figure: The H^1 NMR

The sharp peak obtained at the range 2.5 ppm represents the methyl protons. The peak at the range of 6.9 to 8 ppm indicates the presence of aromatic hydrogens. The peak at 5.8 ppm represents a 1H triplet. The peaks at 5.7 ppm and the 6.6 ppm represents 1H doublets respectively.

4.5 RECYCLABILITY STUDIES

Recyclability is one of the important criteria in the research areaof catalytic materials. In order to save the cost of the process, recyclability of the catalytic materials far consecutive cycles are highly recommended. The catalyst is regenerated by filtering followed by washing with ethanol andreused several times with only a slight decrease in its catalytic activity.

Variation in % yields with no of cycles



5.CONCLUSION

In this project we tried to syntesis 2,3-dihydroquinazoline-4(1H)-ones from the intermolecular cyclization between antranilamide and aryl aldehydes using $NiFe_2O_4$ nanocatalyst. Nanoparticles are widely used catalysts in organic synthesis. Metal nanoparticles possess significant catalytic activity.The advantages of using $NiFe_2O_4$ catalysts are less reaction time, good yields, easy workup procedure and use of eco friendly solvents.This project is also aimed to study the effect of solvents such as DCM,ethanol,water and toluene.It is found that among these solvents ethanol gave 72% yield.The $NiFe_2O_4$ catalyst can be regenerated by filtering followed by washing with ethanol.

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