GREEN SYNTHESIS OF SILVER NANOPARTICLE USING *Dipteracanthus prostrata.*

Project work

Submitted to Christ College (Autonomous), Irinjalakuda (University of Calicut) in partial fulfilment of the requirements for the award of Degree of

BACHELOR OF SCIENCE IN

CHEMISTRY

Submitted by

ANMARY T A

Reg No: CCAVSCH028

2021-2024

P.G RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

(Nationally accredited at A++ level by NAAC & affiliated to university of Calicut)

CERTIFICATE

Certified that the project report entities "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide record of work at our laboratory (Christ college Irinjalakuda) by Miss. ANMARY T A, CCAVSCH028 - final semester B.Sc. Chemistry student of this institution under my supervision in partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry of Christ College (Autonomous), Irinjalakuda (University of Calicut).

IRINJALAKUDA

APRIL 2024

Dr. RANI VARGHESE
Department of chemistry
Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

Dr.RANI VARGHESE
ASSISTANT PROFESSOR
PG & RESEARCH DEPT. OF CHEMIS. RY
CHRIST COLLEGE, IRINJALAKUDA

DECLARATION

I hereby declare that this project report titled "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide work done by me and this work has not previously formed basis for the award of any other academic qualification, fellowship or other similar title of any other University or board.

Place : Irinjalakuda
Date 08-04-2024

ANMARY T A

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report

Submitted to

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the degree of

Bachelor of Science in Chemistry 2021-2024

by

ANNA ZAVIER

CCAVSCH029

under the guidance of

Dr. DIGNA VARGHESE

Assistant Professor

P.G and Research Department of Chemistry

Christ College (Autonomous), Irinjalakuda-680125

Thrissur , Kerala

April 2024

CHRIST COLLEGE (Autonomous), IRINJALAKUDA
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CERTIFICATE

This is to certify that the content of this project work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" is the original work done by **ANNA ZAVIER** under my supervision and guidance at the PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partially or fully to any other University for the award of any Degree/Diploma.

Place: Irinjalakuda
Date: 09/04/2024

Dr. DIGNA VARGHESE
Assistant Professor
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Christ College (Autonomous)
Irinjalakuda

Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

DECLARATION

I, ANNA ZAVIER(Reg.NoCCAVSCH029) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

Place: Irinjalakuda

Date: 09/04/2024

ANNA ZAVIER

Dr Bijoy P Mathew
Vimala College, TCR

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Digna Varghese, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment, and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

I express my sincere thanks to Dr. V T Joy, Head, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for granting permission to carrying my project. I would like to express my gratitude to all the faculty members in the Department of Chemistry for their inspiration and guidance in completing this work.

I wish to acknowledge my gratitude to Rev. Dr. Jolly Andrews, C.M.I, Principal of Christ College (Autonomous), Irinjalakuda, and the Library Of Christ College for providing the timely help and necessary facilities.

I cheerfully express my profound thanks to all my classmates for their support and cooperation.

Above all, I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavor.

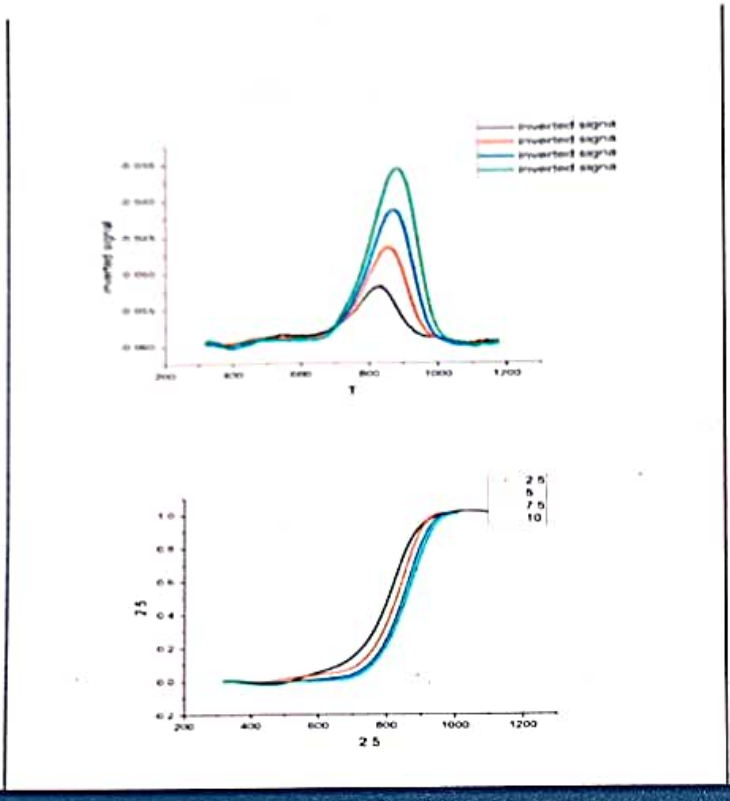
ANNA ZAVIER

CONTENTS

ABSTRACT

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

The project examines the synthesis and spectral characterisations of azine using different combinations. The synthesis of azines typically involves the condensation reaction between aldehydes/ketones with hydrazine. Infrared (IR) and ultraviolet-visible (UV-Vis) spectroscopy are commonly used techniques to identify and characterize azine compounds. Azine compounds typically exhibit characteristic absorption bands in the IR spectrum due to vibrations associated with the functional groups present in their structures. Azine compounds often display absorption bands in the UV-Vis spectrum resulting from π-π^* transitions associated with the conjugated π-electron systems in their aromatic ring structures. Analyzing the IR and UV-Vis spectra of a sample can gather valuable information about the functional groups, structural features, and electronic properties of azine compounds, aiding in their identification and analysis.



KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYSTS

ARAVINDH T T
CCAVSCH030

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

B.Sc. dissertation work

ARAVINDH T T
APRIL 2024

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

PROJECT REPORT SUBMITTED TO UNIVERSITY OF CALICUT
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

DEGREE OF

BACHELOR OF SCIENCE IN CHEMISTRY

By

ARAVINDH T T

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4th APRIL 2024

Certificate

This is to certify that the dissertation entitled *"KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST"* is an authentic record of project work carried out by Mr.Aravindh TT under my supervision, in partial fulfillment of the requirements for the degree of Bachelor of Science of Calicut University, and further that no part thereof has been presented before for any other degree.

Irinjalakuda,
4th APRIL, 2024

Dr. Robinson P Ponminiessary,
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Vimala College, TCR

DECLARATION

I hereby declare that the work presented in this thesis entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is entirely original and was carried out by me under the supervision of Dr. Robinson P Ponmaniessary, Department of Chemistry, Christ College, Irinjalakuda and has not been included in any other thesis submitted previously for the award of any degree.

ARAVINDH T T

Irinjalakuda,

4th APRIL, 2024

Acknowledgement

A project work is indeed an outcome of hard work and helps a lot in framing up a person in his/her career. At the outset, I convey my heartfelt gratitude and indebtedness to Prof. Robinson P Ponmaniessary, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for coordinating and supervising this work. My sincere thanks to Ms. Aleena Varghese and Ms. Greeshma K.V for their immense support. My thanks and gratitude also go to the Head of the Department and all the members of the Chemistry Department, Christ College, Irinjalakuda for their guidance and inspiration given during the B.Sc. career.

ARAVINDH T T

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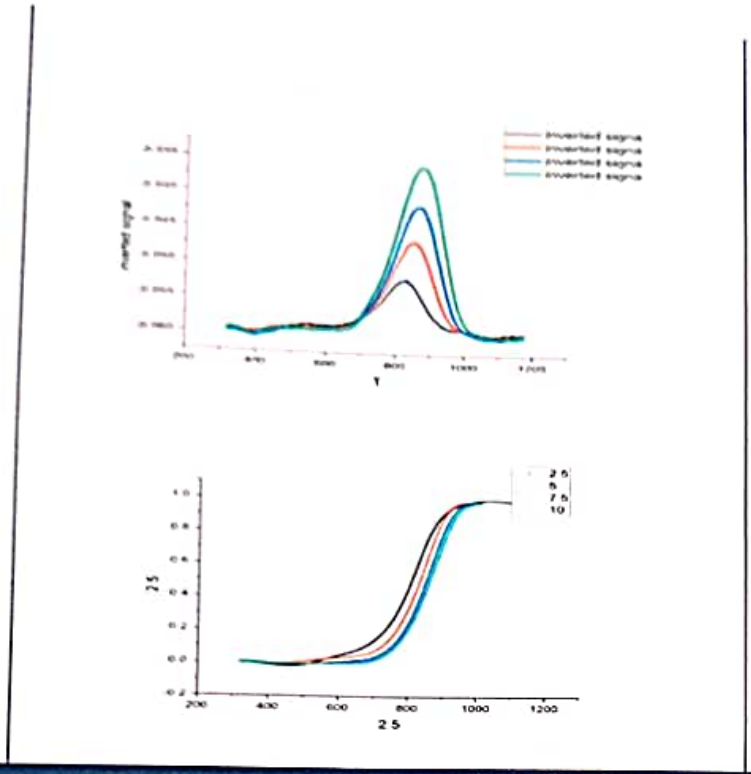

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYSTS

DEVINA M DASAN
CCAVSCH031

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

B.Sc. dissertation work

DEVINA M DASAN
APRIL 2024

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

PROJECT REPORT SUBMITTED TO UNIVERSITY OF CALICUT
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

DEGREE OF

BACHELOR OF SCIENCE IN CHEMISTRY

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Certificate

This is to certify that the dissertation entitled *"KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST"* is an authentic record of project work carried out by Ms. DEVINA M DASAN under my supervision, in partial fulfillment of the requirements for the degree of Bachelor of Science of Calicut University, and further that no part thereof has been presented before for any other degree.

Irinjalakuda,
4th APRIL, 2024

Dr. Robinson P Ponminiessary,
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Assistant Professor,
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Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

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Vimala College, TR.

DECLARATION

I hereby declare that the work presented in this thesis entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is entirely original and was carried out by me under the supervision of Dr. Robinson P Ponmaniessary, Department of Chemistry, Christ College, Irinjalakuda and has not been included in any other thesis submitted previously for the award of any degree.

DEVINA M DASAN

Irinjalakuda,

4th APRIL, 2024

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A project work is indeed an outcome of hard work and helps a lot in framing up a person in his/her career. At the outset, I convey my heartfelt gratitude and indebtedness to Prof. Robinson P Ponmaniessary, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for coordinating and supervising this work.My sincere thanks to Ms. Aleena Varghese and Ms. Greeshma K.V for their immense support. My thanks and gratitude also go to the Head of the Department and all the members of the Chemistry Department, Christ College, Irinjalakuda for their guidance and inspiration given during the B.Sc. career.

DEVINA M DASAN

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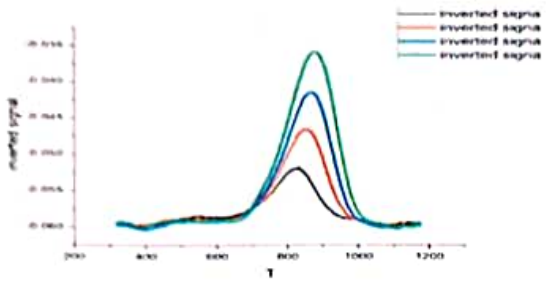

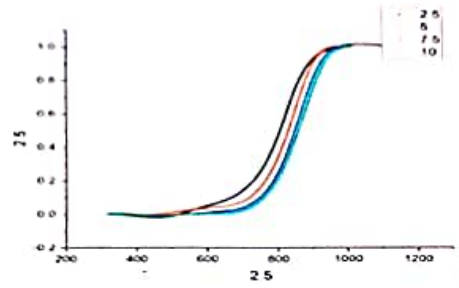

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYSTS

EVELYN BENNY
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KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

B.Sc. dissertation work

EVELYN BENNY
APRIL 2024

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

PROJECT REPORT SUBMITTED TO UNIVERSITY OF CALICUT
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BACHELOR OF SCIENCE IN CHEMISTRY

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This is to certify that the dissertation entitled *"KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST"* is an authentic record of project work carried out by Ms. EVELYN BENNY under my supervision, in partial fulfillment of the requirements for the degree of Bachelor of Science of Calicut University, and further that no part thereof has been presented before for any other degree.

Irinjalakuda,
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DECLARATION

I hereby declare that the work presented in this thesis entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is entirely original and was carried out by me under the supervision of Dr. Robinson P Ponmniessary, Department of Chemistry, Christ College, Irinjalakuda and has not been included in any other thesis submitted previously for the award of any degree.

Irinjalakuda,

EVELYN BENNY

4th APRIL, 2024

Acknowledgement

A project work is indeed an outcome of hard work and helps a lot in framing up a person in his/her career. At the outset, I convey my heartfelt gratitude and indebtedness to Prof. Robinson P Ponmaniessary, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for coordinating and supervising this work.My sincere thanks to Ms. Aleena Varghese and Ms. Greeshma K.V for their immense support. My thanks and gratitude also go to the Head of the Department and all the members of the Chemistry Department, Christ College, Irinjalakuda for their guidance and inspiration given during the B.Sc. career.

EVELYN BENNY

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SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Bachelor of Science in Chemistry 2021-2024

BY

GEO PAUL

CCAVSCH033

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

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Asst. PROFESSOR

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DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is an authentic record of study carried out by GEO PAUL (Reg. No. CCAVSCH033) as a part of BSc. Practical during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 06.04.2024

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Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

CERIFICATE BY THE GUIDE

This is to certify that the content of this project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is the original research work done by GEO PAUL under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or institution for the award of any Degree/Diploma.

Place: Irinjalakuda

Date : 6/4/2024

Dr. TITTO VARUGHESE

Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I hereby declare that the dissertation entitled, "**SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL**" is a genuine record of project work done by me under the guidance of Dr. Titto Varughese, Asst. Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date: 6/4/2024

GEO PAUL

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for his guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to Dr. V.T Joy, Head of Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non- teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

GEO PAUL

CONTENTS

ABSTRACT

SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

The project examines how to develop a chitosan from chitin with different composition and properties upon treatment with different compositions of chemicals. Chitosan has garnered much interest due to its properties and possible applications. Every year the number of publications and patents based on this polymer increase. Chitosan exhibits poor solubility in neutral and basic media, limiting its use in such conditions. Another serious obstacle is directly related to its natural origin. Chitosan is not a single polymer with a defined structure but of molecules with differences in their composition, size, and monomer distribution. These properties have a fundamental effect on the biological and technological performance of the polymer. Moreover, some of the biological properties claimed are discrete. In this review, we discuss how chitosan chemistry can solve the problems related to its poor solubility and can boost the polymer properties.

SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Bachelor of Science in Chemistry 2021-2024

BY

HARIGOVIND P

CCAVSCH034

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

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Asst. PROFESSOR

CHRIST COLLEGE, IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is an authentic record of study carried out by HARIGOVIND P (Reg. No. CCAVSCH034) as a part of BSc. Practical during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 6/4/2024

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

CERIFICATE BY THE GUIDE

This is to certify that the content of this project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is the original research work done by HARIGOVIND P under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or institution for the award of any Degree/Diploma.

Place: Irinjalakuda

Date : 6/4/2024

Dr. TITTO VARUGHESE

Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

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Place: Irinjalakuda

Date: 6/4/2024

HARIGOVIND P

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for his guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to Dr. V.T Joy, Head of Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non- teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

HARIGOVIND P

CONTENTS

ABSTRACT

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The project examines how to develop a chitosan from chitin with different composition and properties upon treatment with different compositions of chemicals. Chitosan has garnered much interest due to its properties and possible applications. Every year the number of publications and patents based on this polymer increase. Chitosan exhibits poor solubility in neutral and basic media, limiting its use in such conditions. Another serious obstacle is directly related to its natural origin. Chitosan is not a single polymer with a defined structure but of molecules with differences in their composition, size, and monomer distribution. These properties have a fundamental effect on the biological and technological performance of the polymer. Moreover, some of the biological properties claimed are discrete. In this review, we discuss how chitosan chemistry can solve the problems related to its poor solubility and can boost the polymer properties.

MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES

Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

BACHELOR OF CHEMISTRY

IN

CHEMISTRY

Submitted by

JOSHUA SKARIAH THOMAS

Reg. No: CCAVSCH035

2021-2024

P.G AND RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

DECLARATION

I, JOSHUA SKARIAH THOMAS (Reg.No.CCAVSCH035) do hereby declare that, this dissertation work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of degree of Bachelor of Science was carried under the guidance of Dr.Arun S, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar title of recognition by any other university or institutions.

Place: Irinjalakuda, JOSHUASKARIAH THOMAS

Date: 25th March 2024

CHRIST COLLEGE (Autonomous), IRINJALAKUDA.
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Ref. CC/CHEM/AS/2023-24/01
Date: 25th March 2024

Dr.Arun S
Asst. Professor in Chemistry

CERTIFICATE

This is to certify that JOSHUA SKARIAH THOMAS (Reg.No.CCAVSCH035) has carried out a project work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institutions.

Dr.Arun S

Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

Dr. Bijy P Mathew
Vimala College, TCR

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr.Arun S, Department of chemistry, Christ College, Irinjalakuda for his valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to him for the completion of this work in the specified period.

I express my sincere thanks to Dr. V T Joy, Head, PG Department of Chemistry, for granting permission to carrying my project. I would like to express my gratitude to all the faculty members in the Department of Chemistry for their inspiration and guidance to complete this work.

I wish to acknowledge my gratitude to Rev. Dr. Jolly Andrews, C.M.I, Principal of Christ College, Irinjalakuda and Library staff of the Christ College for providing the timely help and necessary facilities.

I cheerfully express my profound thanks to all my classmates for their support and co-operation.

Above all I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavour.

JOSHUA SKARIAH THOMAS

CONTENTS

IN SILICO STUDIES ON THE INHIBITION EFFICIENCY OF SOME NATURALLY OCCURRING FLAVONOIDS AGAINST ALZHEIMER'S RECEPTORS

Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

BACHELOR OF SCIENCE

IN

CHEMISTRY

Submitted by

NANDANA T

Reg. No: CCAVSCH036

2021-2024

P.G AND RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

DECLARATION

I, NANDANA T (Reg.No.CCAVSCH036) do hereby declare that, this dissertation work entitled **"IN SILICO STUDIES ON INHIBITION EFFICIENCY OF SOME NATURALLY OCCURRING FLAVONOIDS AGAINST ALZHEIMER'S RECEPTORS"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr.Tom Cherian, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

NANDANA T

Place: Irinjalakuda,

Date: 31st March 2024.

Dr. Bijoy P Mathew
Vimala College, TCR

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Ref. CC/CHEM/TM/2023-24/01
Date: 31st March 2024

Dr. Tom Cherian
Asst. Professor in Chemistry

CERTIFICATE

This is to certify that NANDANA T (Reg.No.CCAVSCH036) has carried out a project work entitled **"IN SILICO STUDIES ON INHIBITION EFFICIENCY OF SOME NATURALLY OCCURRING FLAVONOIDS AGAINST ALZHEIMER'S RECEPTORS"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institution.

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Dr. Tom Cherian

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IRINJALAKUDA

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Tom Cherian, Department of chemistry, Christ College, Irinjalakuda for his valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to him for the completion of this work in the specified period.

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I cheerfully express my profound thanks to all my classmates for their support and co-operation.

Above all I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavour.

NANDANA T

CONTENTS

IN SILICO STUDIES ON THE INHIBITION EFFICIENCY OF SOME NATURALLY OCCURRING FLAVONOIDS AGAINST ALZHEIMER'S RECEPTORS

Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

BACHELOR OF SCIENCE

IN

CHEMISTRY

Submitted by

SANDRA MANOJ

Reg. No: CCAVSCH038

2021-2024

P.G AND RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

DECLARATION

I, SANDRA MANOJ (Reg.No.CCAVSCH038) do herchy declare that, this dissertation work entitled "**IN SILICO STUDIES ON INHIBITION EFFICIENCY OF SOME NATURALLY OCCURRING FLAVONOIDS AGAINST ALZHEIMER'S RECEPTORS**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr.Tom Cherian, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

SANDRA MANOJ

Place: Irinjalakuda.

Date: 31st March 2024.

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Ref. CC/CHEM/TM/2023-24/01
Date: 31st March 2024

Dr. Tom Cherian
Asst. Professor in Chemistry

CERTIFICATE

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P.G & Research Dept. of Chemistry
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Dr. Tom Cherian
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IRINJALAKUDA

ACKNOWLEDGEMENT

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Above all I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavour.

SANDRA MANOJ

CONTENTS

POROUS CARBON BASED ALKALINE SUPERCAPACITORS

Project submitted to the University of Calicut

in partial fulfilment of the Requirements for the Award of the Degree of

BACHELOR OF SCIENCE IN CHEMISTRY

By

SNEHA BABU

CCAVSCH039

March 2024

PG & RESEARCH DEPARTMENT OF CHEMISTRY

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Kerala - 680125

CERTIFICATE

This is to certify that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS,** submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a record of research work carried out by **Mr. SNEHA BABU CCAVSCH039 ,** during the academic year 2021- 2024 under my supervision.

Dr. V . T . Joy

Head, Dept. of Chemistry

Christ College (Autonomous)

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Dr. Joy V.T.
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Dr. Dijo Damien

Supervisor

Assistant Professor

Dept of Chemistry

Christ College(Autonomous)

Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I , **SNEHA BABU** , hereby declare that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS** , submitted to the University of Calicut, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a research work done by me under the supervision and guidance of **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

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ACKNOWLEDGEMENT

I express my gratitude to God Almighty for the endless blessings and intervention in helping me to complete my project without any hassles. I extend my gratitude to **Christ College (Autonomous),** Irinjalakuda, for giving me this opportunity to widen the horizons of my knowledge through this project. I am eternally grateful to **Rev Dr Jolly Andrews CMI**, the Principal, Christ College (Autonomous), Irinjalakuda, for the congenial research atmosphere he has always tried to foster during the course of my studies.

I thank **Dr V T Joy**, Head, Department of Chemistry, for his timely help and generous encouragement that enabled me to successfully complete this project work.

I am indebted to my supervisor, **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for extending his expertise and guidance in enhancing my research skills and knowledge.

I extend my gratitude to **Mrs. Krishnapriya K.M ,** Assistant Professor and all other faculty members of the Department of Chemistry for their enduring support and help during the course of my study.

I express my heartfelt gratitude to my parents, teachers, friends and all those who have helped me directly or indirectly, in the successful completion of the project work.

SNEHA BABU

CCAVSCH039

ABSTRACT

As high-performance energy storage devices that can support the rapid expansion of low-power electronics (such as wearable, portable electronics) and high-power military applications (such as guided missile techniques and highly sensitive naval warheads), supercapacitors (SCs) are attracting a lot of research interest. The electrochemical characteristics of the mixture of the electrode and electrolyte components can be used to evaluate the performance of SCs. Similarly, the choice of these materials can have a big impact on the charge storage capacities of SCs (e.g., via surface redox processes). So, tremendous efforts have been made to increase their competitiveness with currently available energy storage technologies, including rechargeable batteries. This article examines the most recent developments in SC technology with regard to electrode materials, electrolytes (such as 3D porous structures that resemble paper or fibre), and charge storage techniques. There is also discussion of the benefits and difficulties that come with commercializing SCs.

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POROUS CARBON BASED ALKALINE SUPERCAPACITORS

Project submitted to the University of Calicut

in partial fulfilment of the Requirements for the Award of the Degree of

BACHELOR OF SCIENCE IN CHEMISTRY

By

SREEHARI K

CCAVSCH040

March 2024

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Kerala - 680125

CERTIFICATE

This is to certify that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS,** submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a record of research work carried out by **Mr. SREEHARI K CCAVSCH040 ,** during the academic year 2021- 2024 under my supervision.

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Dr. Biju P Mathew
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DECLARATION

I ,**Sreehari K,** hereby declare that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS ,** submitted to the University of Calicut, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a research work done by me under the supervision and guidance of **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

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ACKNOWLEDGEMENT

I express my gratitude to God Almighty for the endless blessings and intervention in helping me to complete my project without any hassles. I extend my gratitude to **Christ College (Autonomous),** Irinjalakuda, for giving me this opportunity to widen the horizons of my knowledge through this project. I am eternally grateful to **Rev Dr Jolly Andrews CMI**, the Principal, Christ College (Autonomous), Irinjalakuda, for the congenial research atmosphere he has always tried to foster during the course of my studies.

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CCAVSCH040

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GREEN SYNTHESIS OF SILVER NANOPARTICLE USING *Dipteracanthus prostrata.*

Project work

Submitted to Christ College (Autonomous), Irinjalakuda (University of Calicut) in partial fulfilment of the requirements for the award of Degree of

BACHELOR OF SCIENCE IN

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Submitted by

AISWARYA K J

Reg No: CCAVSCH041

2021-2024

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CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

(Nationally accredited at A++ level by NAAC & affiliated to university of Calicut)

CERTIFICATE

Certified that the project report entities "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide record of work at our laboratory (Christ college Irinjalakuda) by Miss. AISWARYA K J, CCAVSCH041 - final semester B.Sc. Chemistry student of this institution under my supervision in partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry of Christ College (Autonomous), Irinjalakuda (University of Calicut).

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Dr. Bijoy P Mathew
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Dr.RANI VARGHESE
ASSISTANT PROFESSOR
PG & RESEARCH DEPT. OF CHEMISTRY
CHRIST COLLEGE, IRINJALAKUDA

DECLARATION

I hereby declare that this project report titled "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide work done by me and this work has not previously formed basis for the award of any other academic qualification, fellowship or other similar title of any other University or board.

Place : Irinjalakuda
Date 08-04-2024

AISWARYA K J

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Rani Varghese, Assistant Professor, Department of chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

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AISWARYA K J

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Submitted to Christ College (Autonomous), Irinjalakuda (University of Calicut) in partial fulfilment of the requirements for the award of Degree of

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Submitted by

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Reg No: CCAVSCH042

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(Nationally accredited at A++ level by NAAC & affiliated to university of Calicut)

CERTIFICATE

Certified that the project report entities "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide record of work at our laboratory (Christ college Irinjalakuda) by Miss. ALEENA BABU, CCAVSCH042 - final semester B.Sc. Chemistry student of this institution under my supervision in partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry of Christ College (Autonomous), Irinjalakuda (University of Calicut).

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ASSISTANT PROFESSOR
PG & RESEARCH DEPT. OF CHEMIS. RY
CHRIST COLLEGE, IRINJALAKUDA

Dr. Bijoy P Mathew
Vimala College, TCR

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Place : Irinjalakuda
Date 08-04-2024

ALEENA BABU

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Submitted by

ANANDHAKRISHNADAS K

Reg No: CCAVSCH043

2021-2024

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IRINJALAKUDA

APRIL 2024

Dr. RANI VARGHESE
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Dr.RANI VARGHESE
ASSISTANT PROFESSOR
PG & RESEARCH DEPT. OF CHEMIS . RY
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ANANDHAKRISHNADAS K

CONTENTS

1. Introduction

1.1. Nanoparticles

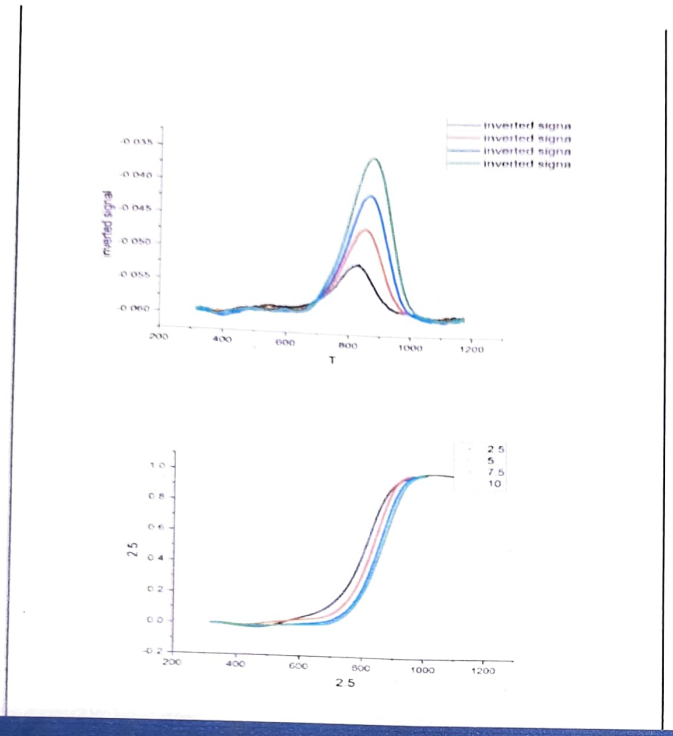
Nanoparticles are particles coming in 1 to 100 nanometers (nm) size range with a surrounding interfacial layer which is an integral part of nano scale matter, fundamentally affecting all of its properties. The interfacial layer typically consists of ions, inorganic and organic molecules. In nanotechnology, a particle is defined as small object that behaves as a whole unit with respect to its transport and properties.

Nanoparticle research is a fast-growing area of scientific research, due to the wide variety of their potential applications in biomedical, optical and electronic fields. Nanoparticles are of great scientific interest as they can act effectively as a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale it is not. Size dependent properties are observed such as quantum confinement in semiconductor particles, Surface Plasmon Resonance in some metal particles and super paramagnetic in magnetic materials.

The properties of materials change as their size approaches the nanoscale and as the percentage of atoms at the surface of a material becomes significant. For bulk materials larger than one micrometer the percentage of atoms at the surface is minuscule relative to the total number of atoms of the material.

Suspensions of nanoparticles are possible because the interaction of the particle surface with the solvent is strong enough to overcome differences in density, which usually result in a material either sinking or floating in liquid.

Nanoparticles often have unexpected visible properties because they are small enough to confine their electrons and produce quantum effects for example, gold nanoparticles appear deep red to black in solution. Nanoparticles have a very high surface area to volume ratio. This provides a tremendous driving force for diffusion, especially at elevated temperatures. The large surface area to volume ratio also reduces the incipient melting temperature of nanoparticles.



KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYSTS

GAYATHRI T
CCAVSCH044

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

B.Sc. dissertation work

GAYATHRI T

APRIL 2024

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

PROJECT REPORT SUBMITTED TO UNIVERSITY OF CALICUT
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

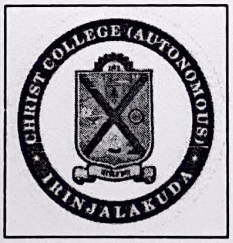
DEGREE OF

BACHELOR OF SCIENCE IN CHEMISTRY

By

GAYATHRI T

Reg: No: CCAVSCH044



DEPARTMENT OF CHEMISTRY
CHRIST COLLEGE
IRINJALAKUDA 680 0125

4th APRIL 2024

Certificate

This is to certify that the dissertation entitled *"KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST"* is an authentic record of project work carried out by Ms. GAYATHRI T under my supervision, in partial fulfillment of the requirements for the degree of Bachelor of Science of Calicut University, and further that no part thereof has been presented before for any other degree.

Irinjalakuda,
4th APRIL, 2024

Dr. Robinson P Ponmaniessary,
(Supervising Guide)
Assistant Professor,
CHRIST COLLEGE,
IRINJALAKUDA

Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I hereby declare that the work presented in this thesis entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is entirely original and was carried out by me under the supervision of Dr. Robinson P Ponmoniessary, Department of Chemistry, Christ College, Irinjalakuda and has not been included in any other thesis submitted previously for the award of any degree.

GAYATHRI T

Irinjalakuda,

4th APRIL, 2024

Acknowledgement

A project work is indeed an outcome of hard work and helps a lot in framing up a person in his/her career. At the outset, I convey my heartfelt gratitude and indebtedness to Prof. Robinson P Ponminiessary, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for coordinating and supervising this work.My sincere thanks to Ms. Aleena Varghese and Ms. Greeshma K.V for their immense support. My thanks and gratitude also go to the Head of the Department and all the members of the Chemistry Department, Christ College, Irinjalakuda for their guidance and inspiration given during the B.Sc. career.

GAYATHRI T

Table of Contents

POROUS CARBON BASED ALKALINE SUPERCAPACITORS

Project submitted to the University of Calicut

in partial fulfilment of the Requirements for the Award of the Degree of

BACHELOR OF SCIENCE IN CHEMISTRY

By

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March 2024

PG & RESEARCH DEPARTMENT OF CHEMISTRY

Christ College (Autonomous), Irinjalakuda

Kerala - 680125

CERTIFICATE

This is to certify that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS,** submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a record of research work carried out by **Mr. VAISHNAV S CCAVSCH045 ,** during the academic year 2021- 2024 under my supervision.

Dr. V . T . Joy

Head, Dept. of Chemistry

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Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
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Dr. Dijo Damien

Supervisor

Assistant Professor

Dept of Chemistry

Christ College(Autonomous)

Irinjalakuda

Dr. Bijoy P Matheo
Vimala College, TCR

DECLARATION

I , **VAISHNAV S** , hereby declare that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS** , submitted to the University of Calicut, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a research work done by me under the supervision and guidance of **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

VAISHNAV S

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I express my gratitude to God Almighty for the endless blessings and intervention in helping me to complete my project without any hassles. I extend my gratitude to **Christ College (Autonomous),** Irinjalakuda, for giving me this opportunity to widen the horizons of my knowledge through this project. I am eternally grateful to **Rev Dr Jolly Andrews CMI**, the Principal, Christ College (Autonomous), Irinjalakuda, for the congenial research atmosphere he has always tried to foster during the course of my studies.

I thank **Dr V T Joy**, Head, Department of Chemistry, for his timely help and generous encouragement that enabled me to successfully complete this project work.

I am indebted to my supervisor, **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for extending his expertise and guidance in enhancing my research skills and knowledge.

I extend my gratitude to **Mrs. Krishnapriya K.M ,** Assistant Professor and all other faculty members of the Department of Chemistry for their enduring support and help during the course of my study.

I express my heartfelt gratitude to my parents, teachers, friends and all those who have helped me directly or indirectly, in the successful completion of the project work.

VAISHNAV S

CCAVSCH045

ABSTRACT

As high-performance energy storage devices that can support the rapid expansion of low-power electronics (such as wearable, portable electronics) and high-power military applications (such as guided missile techniques and highly sensitive naval warheads), supercapacitors (SCs) are attracting a lot of research interest. The electrochemical characteristics of the mixture of the electrode and electrolyte components can be used to evaluate the performance of SCs. Similarly, the choice of these materials can have a big impact on the charge storage capacities of SCs (e.g., via surface redox processes). So, tremendous efforts have been made to increase their competitiveness with currently available energy storage technologies, including rechargeable batteries. This article examines the most recent developments in SC technology with regard to electrode materials, electrolytes (such as 3D porous structures that resemble paper or fibre), and charge storage techniques. There is also discussion of the benefits and difficulties that come with commercializing SCs.

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

BY

ABHINI.C.J.

CCAVSCH001

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

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(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is an authentic record of study carried out by ABHINI.C.J. (Reg. No. CCCAVSCH001) as a part of BSC Project during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 11-04-2024

Dr. V.T JOY

Associate Professor

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Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
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DECLARATION

I hereby declare that the dissertation entitled, "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is a genuine record of project work done by me under the guidance of Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date : 11-04-2024

Abhini

ABHINI.C.J.

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to all other teaching and non teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

ABHINI.C.J.

CONTENTS

ABSTRACT

Hydrogen production by membrane water splitting teachnologies is a sustainable method to synthesis hydrogen and provides an alternative to hydrogen production instead of conventional process of synthesizing hydrogen from steam methane reforming.Currently Nafion is mainly used as membrane for water splitting.However,the high cost of purchasing Nafion membrane and inability to execute electrolysis operational above 90^0C has sparked interest in developing membrane with good thermal stability.In this project a new graphene proton conducting polymer memebrane was developed and tested for water splitting in acid electrolyzer.

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

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(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is an authentic record of study carried out by ABHIRAMI N S(Reg. No. CCAVSCH002) as a part of BSC Project during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 11-04-2024

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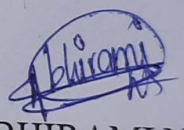
Place: Irinjalakuda

Date : 11-04-2024



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CONTENTS

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

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DECLARATION

I hereby declare that the dissertation entitled, "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is a genuine record of project work done by me under the guidance of Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date : 11-04-2024

AGNA DAVIS

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to all other teaching and non teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

AGNA DAVIS

CONTENTS

GREEN SYNTHESIS OF SILVER NANOPARTICLE USING *Dipteracanthus prostrata.*

Project work

Submitted to Christ College (Autonomous), Irinjalakuda (University of Calicut) in partial fulfilment of the requirements for the award of Degree of

BACHELOR OF SCIENCE IN

CHEMISTRY

Submitted by

ANGEL MARIYA JAMES

Reg No: CCAVSCH005

2021-2024

P.G RESEARCH DEPARTMENT OF CHEMISTRY

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THRISSUR-680125

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

(Nationally accredited at A++ level by NAAC & affiliated to university of Calicut)

CERTIFICATE

Certified that the project report entities "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide record of work at our laboratory (Christ college Irinjalakuda) by Miss. Angel Mariya James Reg. No.- CCAVSCH005 - final semester B.Sc. Chemistry student of this institution under my supervision in partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry of Christ College (Autonomous), Irinjalakuda (University of Calicut).

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Vimala College, TCR

DECLARATION

I hereby declare that this project report titled "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide work done by me and this work has not previously formed basis for the award of any other academic qualification, fellowship or other similar title of any other University or board.

Angel.

Place : Irinjalakuda
Date 08-04-2024

ANGEL MARIYA JAMES

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Rani Varghese, Assistant Professor, Department of chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

I express my sincere thanks to Dr. V T Joy, Head, PG and Research Department of Chemistry, for granting permission to carry out my project. I would like to express my gratitude to all the faculty members in the Department of Chemistry for their inspiration and guidance to complete this work.

I wish to acknowledge my gratitude to Rev. Dr. Jolly Andrews, C.M.I, Principal of Christ College (Autonomous), Irinjalakuda and Library staff of the Christ College for providing the timely help and necessary facilities.

I cheerfully express my profound thanks to all my classmates for their support and co-operation. Above all I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavor.

ANGEL MARIYA JAMES

CONTENTS

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report

Submitted to

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the degree of

Bachelor of Science in Chemistry 2021-2024

by

ANN MARIYA LIMPSON

CCAVSCH006

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CERTIFICATE

This is to certify that the content of this project work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" is the original work done by **ANN MARIYA LIMPSON** under my supervision and guidance at the PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partially or fully to any other University for the award of any Degree/Diploma.

Place: Irinjalakuda
Date: 9/04/2024

Dr. DIGNA VARGHESE
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DECLARATION

I, ANN MARIYA LIMPSON (Reg.NoCCAVSCH006) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

Place: Irinjalakuda

Date: 9/04/2024

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ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Digna Varghese, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment, and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

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ANN MARIYA LIMPSON

CONTENTS

ABSTRACT

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

The project examines the synthesis and spectral characterisations of azine using different combinations. The synthesis of azines typically involves the condensation reaction between aldehydes/ketones with hydrazine. Infrared (IR) and ultraviolet-visible (UV-Vis) spectroscopy are commonly used techniques to identify and characterize azine compounds. Azine compounds typically exhibit characteristic absorption bands in the IR spectrum due to vibrations associated with the functional groups present in their structures. Azine compounds often display absorption bands in the UV-Vis spectrum resulting from π-π^* transitions associated with the conjugated π-electron systems in their aromatic ring structures. Analyzing the IR and UV-Vis spectra of a sample can gather valuable information about the functional groups, structural features, and electronic properties of azine compounds, aiding in their identification and analysis.

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report

Submitted to

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the degree of

Bachelor of Science in Chemistry 2021-2024

by

ANRIYA GEORGE

CCAVSCH007

Under the guidance of

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CERTIFICATE

This is to certify that the content of this project work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" is the original work done by **ANRIYA GEORGE** under my supervision and guidance at the PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partially or fully to any other University for the award of any Degree/Diploma.

Place: Irinjalakuda
Date:13/04/2024

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Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I, ANRIYA GEORGE (Reg.NoCCAVSCH007) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

ANRIYA GEORGE

Place: Irinjalakuda

Date: 13/04/2024

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Digna Varghese, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment, and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

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Above all, I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavor.

ANRIYA GEORGE

CONTENTS

ABSTRACT

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

The project examines the synthesis and spectral characterisations of azine using different combinations. The synthesis of azines typically involves the condensation reaction between aldehydes/ketones with hydrazine. Infrared (IR) and ultraviolet-visible (UV-Vis) spectroscopy are commonly used techniques to identify and characterize azine compounds. Azine compounds typically exhibit characteristic absorption bands in the IR spectrum due to vibrations associated with the functional groups present in their structures. Azine compounds often display absorption bands in the UV-Vis spectrum resulting from π-π^* transitions associated with the conjugated π-electron systems in their aromatic ring structures. Analyzing the IR and UV-Vis spectra of a sample can gather valuable information about the functional groups, structural features, and electronic properties of azine compounds, aiding in their identification and analysis.

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report

Submitted to

UNIVERSITY OF CALICUT

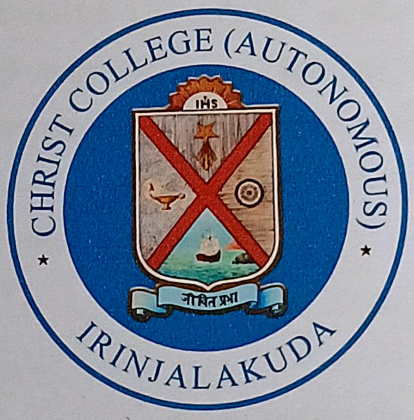
In partial fulfilment of the requirements for the degree of

Bachelor of Science in Chemistry 2021-2024

by

ANU JOSE

CCAVSCH008



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April 2024

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CERTIFICATE

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DECLARATION

I, ANU JOSE (Reg.NoCCAVSCH000) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

Place: Irinjalakuda

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ANU JOSE

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ANU JOSE

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SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report

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Bachelor of Science in Chemistry 2021-2024

by

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Place:Irinjalakuda
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Vimala College, TCR

DECLARATION

I, ANVY VINCENT(Reg.NoCCAVSCH009) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRALSTUDIES OF AZINE"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

Place: Irinjalakuda

Date: 09/04/2024

ANVY VINCENT

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr.Digna Varghese, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakudafor her valuable and inspiring guidance, critical assessment, and constantencouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

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I cheerfully express my profound thanks to all my classmates for their support and cooperation.

Above all, I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavor.

ANVY VINCENT

CONTENTS

ABSTRACT

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

The project examines the synthesis and spectralcharacterisations of azine using different combinations. The synthesis of azines typically involves the condensation reaction between aldehydes/ketones with hydrazine.Infrared(IR) and ultraviolet-visible (UV-Vis)spectroscopy are commonly used techniques to identify and characterize azine compounds.Azine compounds typically exhibit characteristic absorption bands in the IR spectrum due to vibrations associated with the functional groups present in their structures. Azine compounds often display absorption bands in the UV-Vis spectrum resulting from π-π^* transitions associated with the conjugated π-electron systems in their aromatic ring structures. Analyzing the IR and UV-Vis spectra of a sample can gather valuable information about the functional groups, structural features, and electronic properties of azine compounds, aiding in their identification and analysis.

SYNTHESIS AND SPECTRAL STUDIES OF AZINE

Project Report Submitted

to

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry 2021-2024

by

ANWIN S.VADAKKAN

CCAVSCH010

Under the guidance of

Dr. DIGNA VARGHESE

Assistant Professor

P.G and Research Department of Chemistry

Christ College (Autonomous), Irinjalakuda-680125

Thrissur , Kerala

April 2024

CHRIST COLLEGE (Autonomous), IRINJALAKUDA.
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CERTIFICATE

This is to certify that the content of this project work entitled "**SYNTHESIS AND SPECTRAL CHARACTERISTICS OF AZINE**" is the original work done by **ANWIN S.VADAKKAN** under my supervision and guidance at the PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partially or fully to any other University for the award of any Degree/Diploma.

Place: Irinjalakuda

Date: 9/4/24

Dr. DIGNA VARGHESE
Assistant Professor
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Christ College (Autonomous)
Irinjalakuda

Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

Dr Bijoy P Mathew
Vimala College, TCR

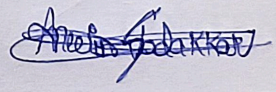
DECLARATION

I, ANWIN S.VADAKKAN(Reg.NoCCAVSCH010) do hereby declare that this dissertation work entitled "**SYNTHESIS AND SPECTRAL STUDIES OF AZINE**" submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of the degree of Bachelor of Science was carried under the guidance of Dr. Digna Varghese, Assistant professor, PG & Research Department of Chemistry, Christ College (Autonomous), Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar titles of recognition by any other university or institutions.

Place: Irinjalakuda

Date: 9/4/24

ANWIN S.VADAKKAN



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ANWIN S.VADAKKAN

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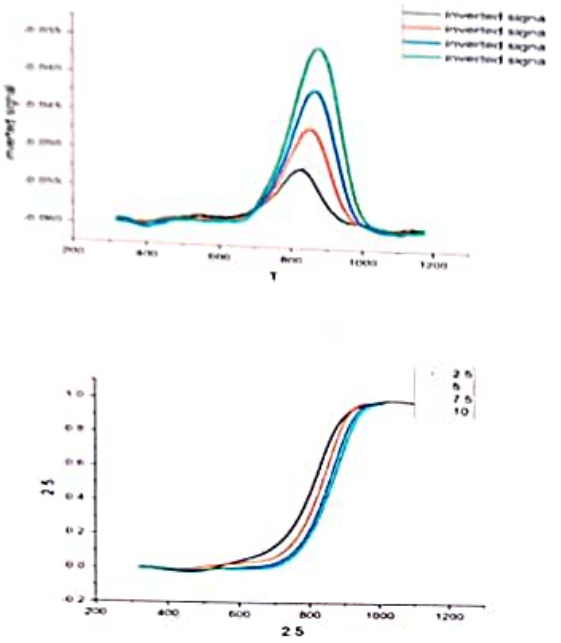

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYSTS

ASIKA B LAKSHMI
CCAVSCH011

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

B.Sc. dissertation work

ASIKA B LAKSHMI
APRIL 2024

KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST

PROJECT REPORT SUBMITTED TO UNIVERSITY OF CALICUT
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

DEGREE OF

BACHELOR OF SCIENCE IN CHEMISTRY

By

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4th APRIL 2024

Certificate

This is to certify that the dissertation entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is an authentic record of project work carried out by Ms. ASIKA B LAKSHMI *under my supervision, in partial fulfillment of the requirements for the degree of Bachelor of Science of Calicut University, and further that no part thereof has been presented before for any other degree.*

Irinjalakuda,
4th APRIL, 2024

Dr. Robinson P Ponmaniessary,
(Supervising Guide)
Assistant Professor,
CHRIST COLLEGE,
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for'

Dr.RANI VARGHESE
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Research and P.G. Department of Chemistry
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Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I hereby declare that the work presented in this thesis entitled "KINETICS OF TEMPERATURE PROGRAMMED REDUCTION OF NiO/MCM-41 CATALYST" is entirely original and was carried out by me under the supervision of Dr. Robinson P Ponmniessary, Department of Chemistry, Christ College, Irinjalakuda and has not been included in any other thesis submitted previously for the award of any degree.

Irinjalakuda,

ASIKA B LAKSHMI

4th APRIL, 2024

Acknowledgement

A project work is indeed an outcome of hard work and helps a lot in framing up a person in his/her career. At the outset, I convey my heartfelt gratitude and indebtedness to Prof. Robinson P Ponmaniessary, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for coordinating and supervising this work. My sincere thanks to Ms. Aleena Varghese and Ms. Greeshma K.V for their immense support. My thanks and gratitude also go to the Head of the Department and all the members of the Chemistry Department, Christ College, Irinjalakuda for their guidance and inspiration given during the B.Sc. career.

ASIKA B LAKSHMI

Table of Contents

SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Bachelor of Science in Chemistry 2021-2024

BY

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CCAVSCH012

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UNDER THE GUIDANCE OF

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Asst. PROFESSOR

CHRIST COLLEGE, IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is an authentic record of study carried out by GLADWIN V J (Reg. No. CCAVSCH012) as a part of BSc. Practical during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 6/4/2024

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

CERIFICATE BY THE GUIDE

This is to certify that the content of this project work entitled **"SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL"** is the original research work done by GLADWIN V J under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or institution for the award of any Degree/Diploma.

Place: Irinjalakuda

Date : 6/4/2024

Dr. TITTO VARUGHESE

Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

I hereby declare that the dissertation entitled, "**SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL**" is a genuine record of project work done by me under the guidance of Dr. Titto Varughese, Asst. Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date: 6/9/2024

GLADWIN V J

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for his guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to Dr. V.T Joy, Head of Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non- teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

GLADWIN V J

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The project examines how to develop a chitosan from chitin with different composition and properties upon treatment with different compositions of chemicals. Chitosan has garnered much interest due to its properties and possible applications. Every year the number of publications and patents based on this polymer increase. Chitosan exhibits poor solubility in neutral and basic media, limiting its use in such conditions. Another serious obstacle is directly related to its natural origin. Chitosan is not a single polymer with a defined structure but of molecules with differences in their composition, size, and monomer distribution. These properties have a fundamental effect on the biological and technological performance of the polymer. Moreover, some of the biological properties claimed are discrete. In this review, we discuss how chitosan chemistry can solve the problems related to its poor solubility and can boost the polymer properties.

SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Bachelor of Science in Chemistry 2021-2024

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CCAVSCH013

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Place: Irinjalakuda

Date: 06·04·2024

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

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Place: Irinjalakuda

Date : 6/04/2024

Dr. TITTO VARUGHESE

Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

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Place: Irinjalakuda

Date: 06.04.2024

GOKUL MOHAN C

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SOLUBILITY STUDIES OF CHITOSAN PREPARED FROM SHRIMP SHELL

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Bachelor of Science in Chemistry 2021-2024

BY

HARSHA C P

CCAVSCH014

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

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CHRIST COLLEGE, IRINJALAKUDA

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Place: Irinjalakuda

Date: 06.04.2024

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
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Place: Irinjalakuda

Date : 6/4/2024

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Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

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Date: 6/4/2024

HARSHA C P

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MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES

Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

BACHELOR OF CHEMISTRY

IN

CHEMISTRY

Submitted by

HENIN JOHNSON

Reg. No: CCAVSCH015

2021-2024

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CHRIST COLLEGE, IRINJALAKUDA

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DECLARATION

I,HENIN JOHNSON(Reg.No.CCAVSCH015) do hereby declare that, this dissertation work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of degree of Bachelor of Science was carried under the guidance of Dr.Arun S, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar title of recognition by any other university or institutions.

Place: Irinjalakuda,

Date:25th March 2024

HENIN JOHNSON

CHRIST COLLEGE (Autonomous), IRINJALAKUDA.
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Ref. CC/CHEM/AS/2023-24/01
Date: 25th March 2024

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HENIN JOHNSON

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Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

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IN

CHEMISTRY

Submitted by

HRIDYA BIJU

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I,HRIDYA BIJU(Reg.No.CCAVSCH016) do hereby declare that, this dissertation work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of degree of Bachelor of Science was carried under the guidance of Dr.Arun S, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar title of recognition by any other university or institutions.

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Date: 25th March 2024

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Dr.Arun S
Asst. Professor in Chemistry

CERTIFICATE

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Dr.Arun S

Research and P.G. Department of Chemistry
Christ College, Irinjalakuda -680125

Dr. Bijoy P Matheo
Vimala College, TCR

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HRIDYA BIJU

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Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

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IN

CHEMISTRY

Submitted by

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Reg. No: CCAVSCH017

2021-2024

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THRISSUR-680125

DECLARATION

I, JITH JESUS JOSE (Reg.No.CCAVSCH017) do hereby declare that, this dissertation work entitled "**MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES" s**ubmitted to the University of Calicut in Partial Fulfilment of the requirement for the award of degree of Bachelor of Science was carried under the guidance of Dr.Arun S, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar title of recognition by any other university or institutions.

Place: Irinjalakuda, JITH JESUS JOSE

Date: 25th March 2024

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Date: 25th March 2024

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Asst. Professor in Chemis

CERTIFICATE

This is to certify that JITH JESUS JOSE (Reg.No.CCAVSCH017) has carried out a project work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institutions.

Dr. Arun S

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JITH JESUS JOSE

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Chapter 1
Part A: Chemistry of Multicomponent Reactions

1.1. Introduction

Current advances in our understanding of molecular biology, organic electronics and sensors have fuelled an increased need for tightly defined and highly functionalized structural scaffolds[1]. The controlled synthesis of such materials however imposes major synthetic challenges. Moreover, manmade materials have struggled to achieve the superb structural and functional properties of natural molecules, such as proteins, DNA or sugars. Recognizing these limitations, synthetic chemistry researchers have been continuously searching for well-defined synthetic strategies that can be effectively used for functional scaffold developments.

Driven by the needs to improve our capability to synthesize molecules in more facile and efficient as well as economic ways, the paradigms of organic synthesis have shifted from the traditional concept of efficiency in terms of chemical yields to one that also considers economic and ecological values. The efficiency of a chemical reaction generally means the ability to assemble the target molecule from readily available building blocks in relatively few operations that require only minimal amounts of resources (raw material, energy, labour etc.) and generate minimal amounts of waste. While selectivity and atom economy issues were considered the sole criteria that judge the efficiency of a chemical synthesis in the past, efficiency criteria regarding the reaction processing are being equally emphasized now[2] (Figure 1.1). Multicomponent reactions (MCR) [3] have attracted considerable interest owing to their exceptional synthetic efficiency [4]. The bond forming efficiency (BFE) [5] that is the number of bonds formed in one process is an important measure to determine the quality of a multicomponent reaction. Unlike the usual stepwise formation of the individual bonds in the target molecule the utmost attribute of MCRs is the inherent formation of several bonds in one operation without

isolating the intermediates, changing the reaction conditions, or adding further reagents.

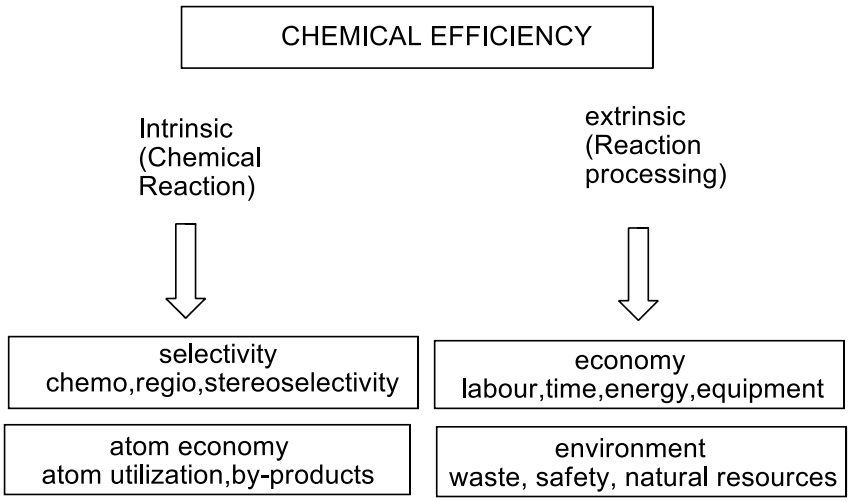


Figure. 1.1. Key criteria for chemical efficiency

It is obvious that the adoption of such strategies would allow minimization of both waste production and expenditure of human labour. The products are formed just by pooling their collections of corresponding starting materials (Figure 1.2).

Since the products carry portions of all employed reactants in their structure, MCRs with high attendant bond-forming efficiency (BFE) assure a marked increase in molecular complexity and diversity. Upon wide variations of the starting materials, opportunities arise for the synthesis of compound libraries [3, 6]. The transferability to as many available starting materials as possible is an indispensable characteristic for a general application. Multicomponent reactions thus address the requirements for efficient high-throughput synthesis of new drug candidates in a cost and time effective manner.

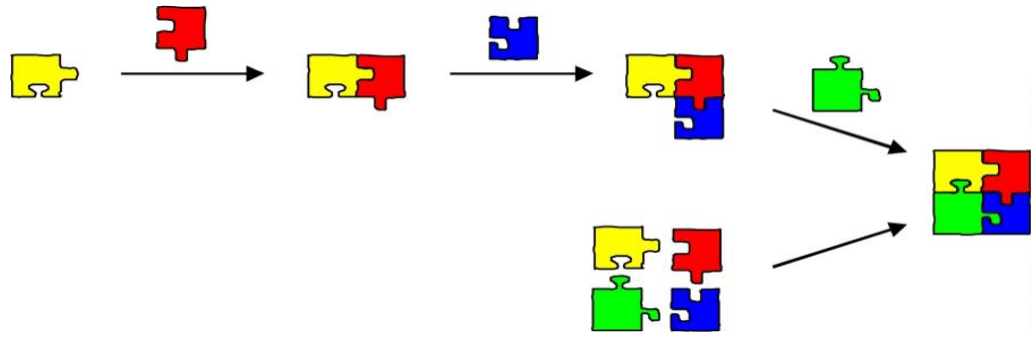


Figure 1.2. Multi-step vs. Multicomponent synthesis of same compound

Traditional combinatorial libraries results in low diversity in biological as well as chemical terms and this has led to the diversity oriented synthesis developed by Stuart Schreiber[7] based on MCRs. Consequently, diversity oriented synthesis (DOS) became one of the paradigms in the process of modern drug discovery. This has spurred research in those fields of chemical investigation that lead to the rapid assembly of not only molecular diversity, but also molecular complexity. As a consequence, multi-component as well as domino or related reactions are witnessing a new spring. Using this technique, more complex, and natural product like structures are assembled in few steps with high yield. The derivatization and randomization of these structures afford highly diverse compound libraries for screening purpose. Similarly, many biotech and large pharma companies are now working to exploit MCR chemistry to generate chemical diversity. Organic chemists are increasing their efforts to obtain improved control of the outcome of MCRs by introducing novel catalysts and reaction conditions. MCR can often be extended into combinatorial, solid phase or flow syntheses promising manifold opportunities for developing novel lead structures of active agents, catalysts and even novel molecule-based materials.

The greatest challenge for synthetic chemists is the improvement of overall efficiency by using atom-, step-, and energy-economic procedures that proceed with high yield and selectivity. This goal can be achieved by focusing on bond construction and functional-group compatibility in the development of new reaction types. Multicomponent reactions (MCRs)[8] are important tools for the accomplishment of this goal as they inherently involve the formation of several bonds in one operation. As such, MCRs are convergent step-efficient procedures that can take place with

remarkably high atom economy and E factors, by reducing the number of functional-group manipulations and thus avoiding the use of protecting groups.

MCRs have already had an important role in drug development, from lead discovery to lead optimization to production, even before the advent of combinatorial technologies as demonstrated by the identification of Nifedipin (Adalat®), (Figure 1.4) a highly active calcium antagonist, by means of a Hantzsch reaction or by the synthesis of piperazine-2-carboxamide, the core structure of the HIV protease inhibitor Crixivan, (Figure 1.3) by a Ugi-4CR.

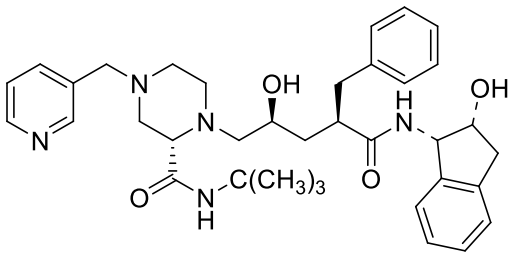


Figure 1.3. Crixivan

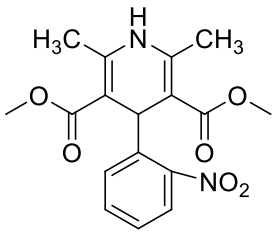


Figure 1.4. Nifedipin (Adalat)

Natural products have proved to be a rich source of drug candidates in the past, as highlighted by comparing the ratio of known natural products with synthetic molecules[7]. However, the ability to produce these compounds synthetically was problematic for hits found by the screening of either pure natural products or natural-product mixtures. Often, traditional classical synthesis schemes for these molecules are too long or too expensive. MCRs can provide an alternative to this problem, either by using MCRs to synthesize the natural product, or by generating molecules that are 'artificial' but that bear a similar high density of the structural features that make natural products unique in the chemical universe of small molecules. The latter concept yields natural-product-like molecules.

A recent comparison of the structural features of commercial drugs and natural products showed that the latter tend to have fewer H-bond donors and fewer nitrogen atoms, but more oxygen atoms per molecule. The discovery of novel MCRs clearly follows this idea, exploring methods to build such non-nitrogen-containing molecules to arrive at new chemical structure spaces.

In practical terms, MCRs also facilitate the generation of very large compound libraries. For example, by using a particular four-component reaction and only 100 starting materials for each component, a library of 10^8 products can be generated, exceeding the size of all existing compound libraries. Several MCRs share the same starting materials, offering the opportunity to create different chemical scaffolds by reusing the same building blocks in different synthetic routes. This concept of varying the reactions rather than the starting materials enables simultaneous variation of both the chemical scaffold and its substituents in the same chemical library; something that has been impossible with previously used combinatorial chemistry methods.

Another major characteristic of MCRs is their high exploratory power: the exploration of a very big chemical space with exceptional synthetic efficiency. The structure of the reaction product can easily be diversified by systematic variation of each input. The outcome of an MCR is crucially dependent on the nature of the solvents, catalysts, concentrations and excess of reagents used. In multistep synthesis the temporal and preparative complexity increases in proportional to the number of steps in the first approximation. It is refluxed in many isolation and purification operations, such as crystallization, extraction, distillation or chromatography.

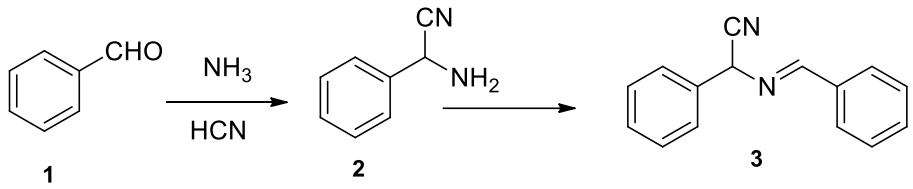
The unparalleled atom efficiency as well as the often very mild reaction conditions makes MCRs a green chemical method and therefore comes under the environmentally friendly group of reactions. Most interestingly, multicomponent reactions have accompanied the field of organic chemistry since the early days, particularly in heterocyclic chemistry, but have not been recognized as a fundamental principle until Ugi's groundbreaking extension of the Passerini reaction and the conclusions he drew from this.

1.2 History of MCRs

Reactions that build up carbon-carbon bonds and at the same time introduce nitrogen-containing functionalities into the structural frame work are especially attractive for the rapid construction of organic molecules. Consistently, the majority of MCRs developed to date relate to the amino alkylation of carbonyl compounds[9a], a

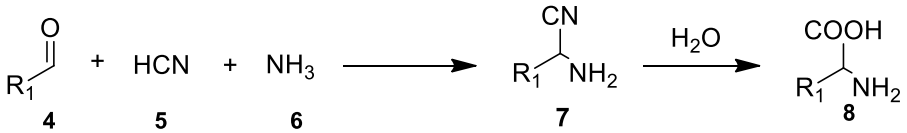
powerful synthetic tool that exploits the paired electrophilic and/or nucleophilic (enolizable position) reactivity of imines (or enamines) for the synthesis of amine-bearing compounds.

The first product of an MCR was introduced in 1838 by Laurent and Gerhardt[9b], who converted bitter almond oil and ammonia into a crystalline product of "benzoylazotide" **3** from an MCR of the twice reacting benzaldehyde **1**, ammonia, and hydrogen cyanide. (Which together form amino benzyl cyanide **2**) whose Schiff base with benzaldehyde was called benzoylazotide. (Scheme 1)



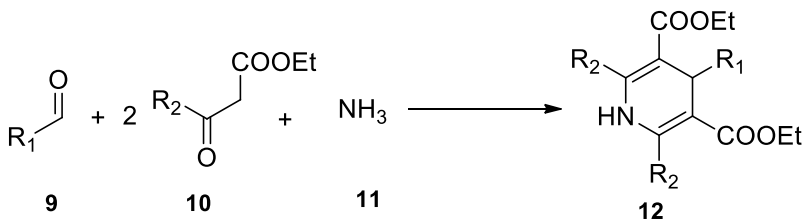
Scheme 1 Formation of benzoylazotide via strecker reaction

The chemistry of the MCRs officially began twelve years later; i.e.; in 1850, When Strecker[9c] introduced the general formation of α-amino cyanides **7** from ammonia **6**, hydrogen cyanide **5** and carbonyl compounds **4**, which is subsequently hydrolyzed to give the desired amino-acid **8** (Scheme 2)



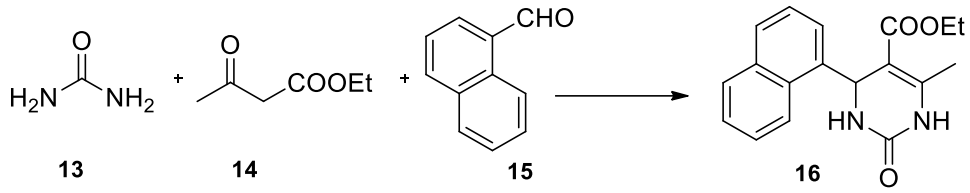
Scheme 2 strecker synthesis of amino acids

Further progress of multicomponent chemistry can be attributed to the work of Hantzsch in 1882. He synthesized symmetrically substituted dihydropyridines **12** from aldehydes **9**, two equivalents of *β*-ketoesters **10**, and NH_3 **11**

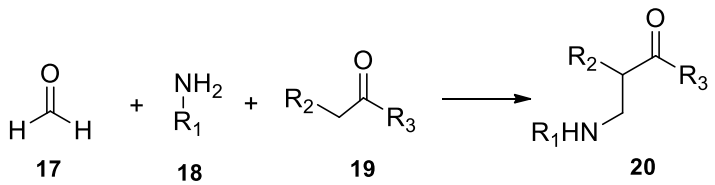


Scheme 3 Hantzsch multi component synthesis of dihydropyridine

Other very famous and useful MCRs are the Biginelli and the Mannich reactions discovered in 1891 and 1912. The Biginelli reaction affords 3, 4-dihydropyrimidin-2(1H)-ones starting from ethylacetoacetate **14**, an aldehyde **15** and urea **13**. The Mannich reaction consists of an amino alkylation of an acidic proton placed next to a carbonyl functional group **19** with formaldehyde **17** and ammonia or any primary or secondary amine **18**; the final product is a β-aminocarbonyl compound also known as a Mannich base **20**.



Scheme 4. Biginelli symthesis of 3, 4- dihydropyrimidin-2(1H)-ones



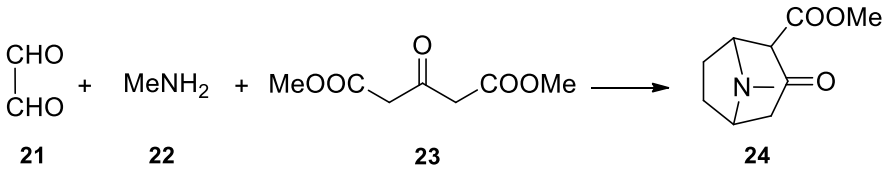
Scheme 5. Synthesis of β-aminocarbonyl compound by Mannich reaction

The preparation of heterocyclic compounds by MCRs was introduced in the early 1880s. Since then, many "name reactions" of MCRs were developed. This ended in 1960, when Hellmann and Opitz published the α-Aminoalkylierung book where they demonstrated that all of these classical name reactions are α-aminoalkylations of nucleophiles, including the preparations of heterocyclic products by MCRs that are α-aminoalkylations and subsequent ring-forming reactions of further bifunctional educts.

A further important MCR is the Bucherer-Bergs reaction (BB-4CR). It can be understood as an extension of the Strecker-3 Component Reaction (S-3CR) using an additional component (CO_2). Whereas the Strecker 3-CR is an equilibrium reaction and often delivers the product in unsatisfactory yields, the BB-4CR is practically

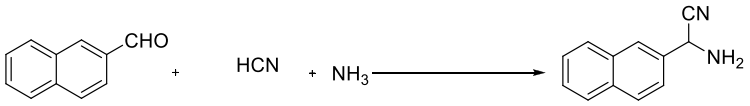
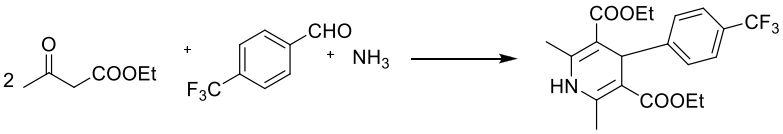
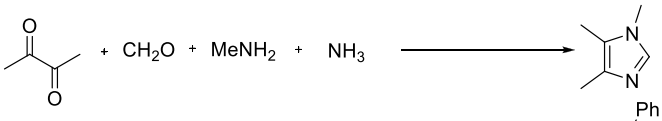
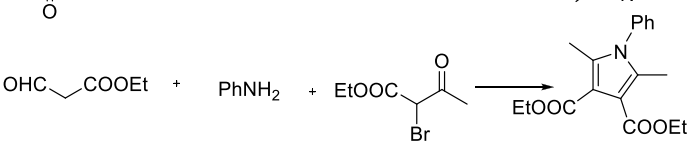
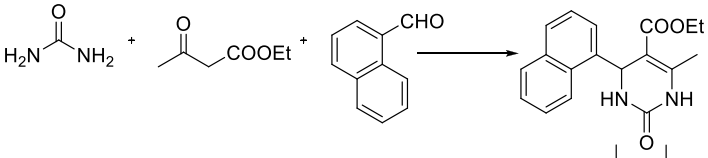
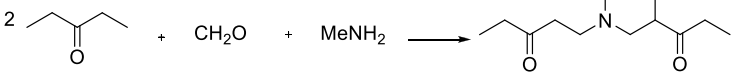
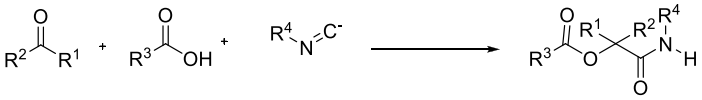
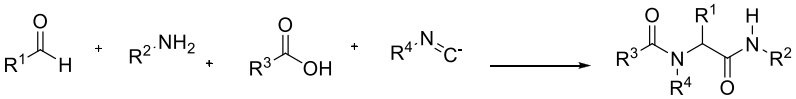
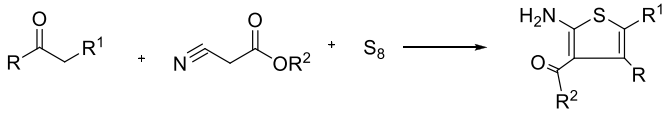
irreversible upon addition of CO_2. It still is an important method for the synthesis of unnatural α-amino acids.

The first important application of MCRs in natural product synthesis was the Robinson synthesis of alkaloid tropinone **24** from oxalaldehyde **21** methyl amine **22** and dimethylacetone dicarboxylate **23**. The reaction was carried out in 1917 and is the first important application of MCRs in natural product synthesis.



Scheme 6 Robinson synthesis of tropinone alkaloid

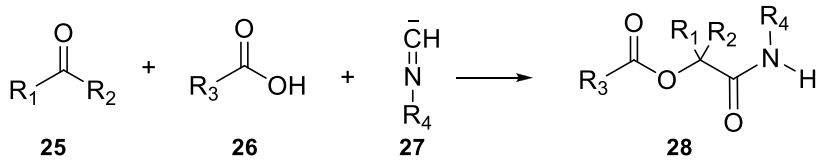
Table 1 Some historically important MCRs

Name of the reactions	Examples
1. Strecker synthesis	
2. Hatzsch dihydro pyridine synthesis	
3. Radziszewe-wski imidazole synthesis	
4. Hantzsch -pyrrole synthesis	
5. Biginelli reaction	
6. Mannich reaction	
7. Passerini reaction	
8. Ugi reaction	
9. Bucherer Berg reaction	

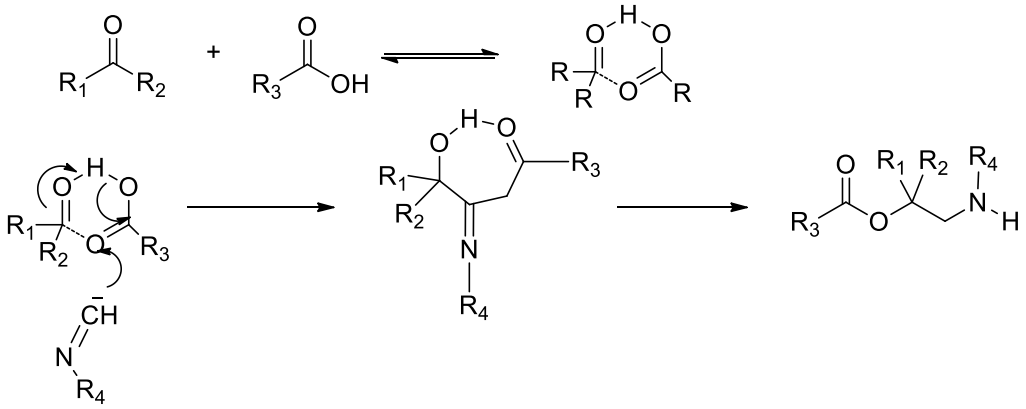
1.3 Isocyanide based MCRs

Isocyanides, formerly known as isonitriles are compounds with an extra ordinary functional group [3h]. Its unusual valence structure and reactivity were discussed for over one and a half centuries. They are the only class of organic compounds with a formally divalent carbon C^{II}. In exothermic reactions, C^{II} is oxidized to C^{IV}. This was already noted in 1892 by Nef. Owing to its reactivity, the isocyanide group differs fundamentally from other functional groups.

The isocyanide chemistry began with the effort of Lieke for the formation of allyl isocyanide from allyl iodide and silver cyanide. Eight years later, Gautier formed alkyl isocyanides thus generally, and at the same time Hofmann introduced the formation of isocyanides from primary amines, chloroform, and potassium hydroxide. For a whole century, only twelve isocyanides had been produced. One of the first MCRs using isocyanides was the Passerini reaction[10].



Scheme 7. Representation of Passerini reaction



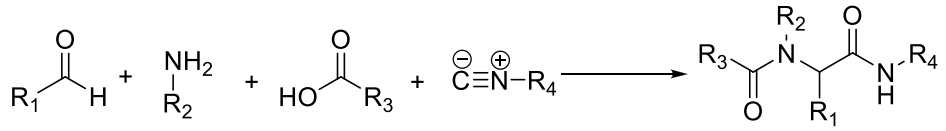
Scheme 8. Mechanism of Passerini reaction

The driving force is the oxidation of C^{II} to C^{IV} leading to more stable compounds. In Passerini reaction, carbonyl compounds **25**, carboxylic acids **26**, and isocyanides **27** afforded α-acyloxy carboxamides **28** in a one-pot procedure. The mechanism involves two steps. Firstly, the acid attacks at the aldehyde to form a transition state and secondly this transition state reacts with the isocyanide to form the proposed compound. Several catalysts including chiral lewis acids were reported for this reaction. Later in 1961, Ugi and Steinbruckner described the libraries of U-4CR products and the reaction was referred to as "Ugi reaction" in1962 [10, 11]. Even though it was mentioned again in 1971, for many decades, nobody had been interested in libraries until 1982 when Furka formed peptide libraries by the solid phase method of

Merrifield, and since then it was increasingly applied. Libraries of other compounds also were subsequently formed by multistep solid phase procedures.

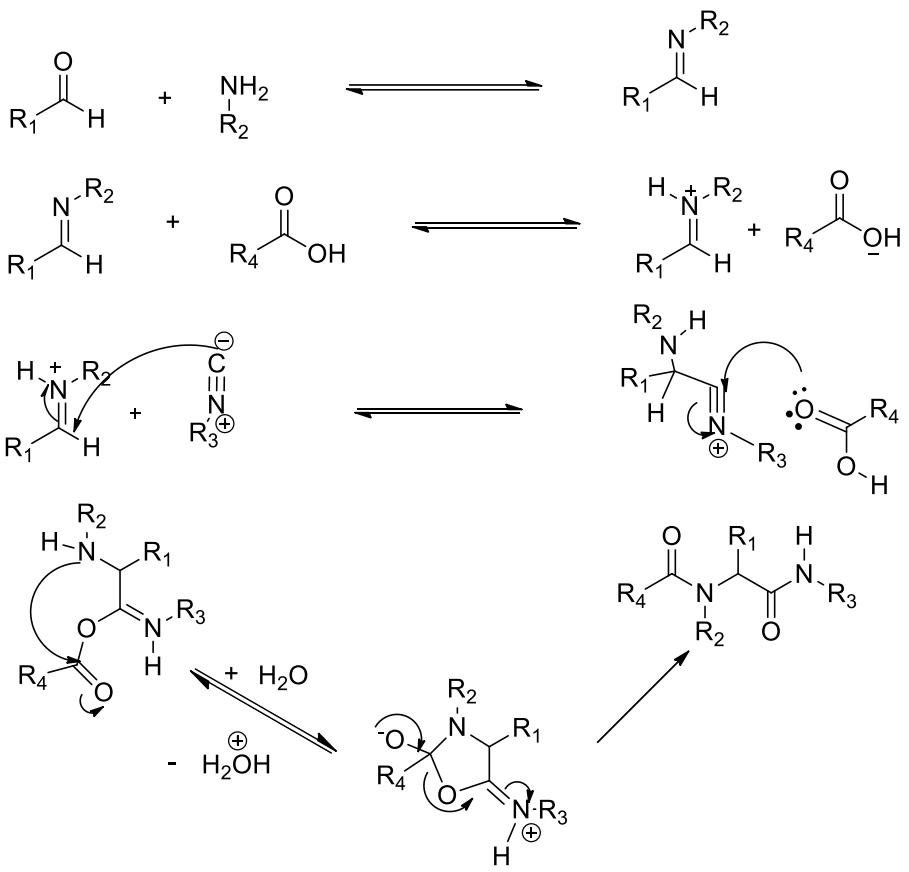
The Ugi reaction, which is an extension of the Passerini three component reactions, is of particular importance in the area of isocyanide MCRs[12] due to the wide utility for the formation of rapid assembly of functionalized intermediates. The additional advantages of this reaction is that the intermediates can be further transformed by the Diels Alder reactions, Heck cyclizations, Ring Closing Metathesis (RCM), dipolar cycloadditions, nucleophilic aromatic substitutions and other reactions to generate a number of heterocyclic structures. The reaction can be used to produce a large number of libraries which can then be tested with enzymes or living organisms to find new active pharmaceutical substances. One draw back is the lack of chemical diversity of the products. But this can be overcome by combining Ugi reaction with other reactions.

In fact, Ugi reactions constitute a homogeneous group of reactions in which a carbonyl compound **29**, an amino component **30,** an acid **31** and an isocyanide **32** react together. Amines usually used are a primary amine, less often ammonia or a secondary amine. The carbonyl compound can be aldehyde or ketone.



29 **30** **31** **32** **33**

Scheme 9. Representation of Ugi 4-component reaction



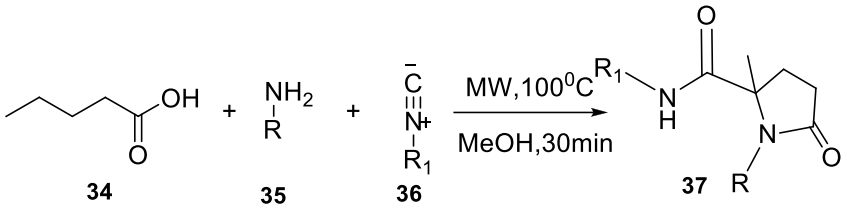
Scheme 10. Mechanism of Ugi reaction

The nature of the components may vary widely; for example, the acid component may be HN_3, HNCO, HNCS, HNCSe, $H_2S_2O_3$ or H_2Se, a thiocarboxylic acid, a phenol or water (the reaction between aqueous formaldehyde, 2,6-xylyl isocyanide and diethyl amine affords the famous local anesthetic Xylocain). The amino group may belong to hydrazine, hydrazides, urea, semicarbazide, monohydrazones, sulfonamides, hydroxylamine etc. A single component may arise from the reaction among more reactants; for example, carbonic acid mono methyl ester is generated insitu by reacting carbon dioxide with methanol (MeOH) (employed as the solvent). Thus, the number of components may be more than four. In addition, different functional groups may belong to the same reactant, and this allows Ugi reactions to be performed in an intramolecular fashion or post-condensation modifications to be achieved, spontaneously or upon adding suitable reagents.

The general reaction mechanism involves the formation of an iminium (often called imonium) ion, which gives a α-addition onto the carbenoid carbon of the

isocyanide. The adduct may be the final product or may rearrange to a final stable product.

A variation in the starting material may also lead to totally new scaffolds such as in the following reaction, in which levulinic acid simultaneously play the role of carboxylic acid and carbonyl compound.



Scheme 11. Formation of oxo pyrrolidine carboxamide scaffolds **37** via three component reaction of levulinic acid **34** , amine **35**, and isocyanide **36**

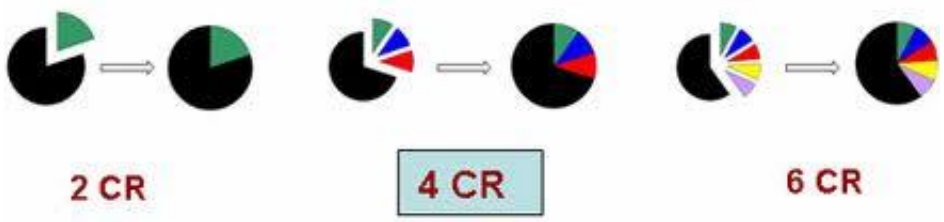
Major advances in the scope of the Ugi reaction have occurred only within the last 20 years, mainly because of the limited availability of isocyanides and poor stereocontrol. In the mid 1900's, only a few isocyanides were available. Today, about 380 isocyanides are commercially available[13]. Development of stereocontrol has been difficult due to incomplete knowledge of the reaction mechanism. Despite the similarities between the Passerini and Ugi reactions, methods of stereocontrol have not been interchangeable. Techniques used in attempts to control enantioselectivity in the Ugi reaction have included Lewis acid catalysts and chiral auxiliaries[14]. Since a variety of functionality can be incorporated into the products, concurrent reactions are possible. Pre- and post-condensation modifications, including other multicomponent reactions (MCRs), can be performed to yield a variety of heterocyclic compounds. These compounds can then serve as scaffolds for the synthesis of natural products, therapeutic agents, and combinatorial libraries.

Both Passerini and Ugi reactions lead to interesting peptidomimetic compounds which are potentially bioactive and constitute interesting lead compounds for further developments into more active compounds. Both reactions offer an inexpensive and rapid way to generate compound libraries. Since a wide variety of isocyanides are commercially available, an equivalently diverse spectrum of products may be obtained.

1.4 TYPES OF MCRs

Definition

In an MCR, a product is assembled according to a cascade of elementary chemical reactions. Thus, there is a network of reaction equilibria, which all finally flow into an irreversible step yielding the product. The challenge is to conduct an MCR in such a way that the network of pre-equilibrated reactions channel into the main product and do not yield side products. The result is clearly dependent on the reaction conditions: solvent, temperature, catalyst, concentration, the kind of starting materials and functional groups. Such considerations are of particular importance in connection with the design and discovery of novel MCRs



Schematic representation of 2-component reaction, and 4- and 6- component reactions.

With regard to the classification of MCRs, three different types are often distinguished in the literature.

MCRs of type I are collections of equilibria between all participating sub reactions, including the last step which forms the final product[8, 15]. In type II the educts and intermediate products equilibrate, but the final product results from a practically irreversible final reaction step. MCRs of type III correspond to sequences of irreversible reactions that all proceed towards the product.

The MCRs of type I are usually three component reactions (3CRs) that form their products from ammonia or amines, carbonyl compounds and neutral nucleophilic compounds or anions of weak acids, like the Strecker reaction (S-3CR) introduced in 1850 or the later introduced Mannich reaction.

Two kinds of MCRs of type II are known: In 1882 Hantzsch and Radziszewski introduced the formation of heterocycles by MCRs of type II from bi-functional educts. Shortly later Biginelli also prepared related heterocycles. In the

1920s Bucherer and Bergs made hydantoin derivatives by the BB-4CRs, which led to the industrially preferred method of preparing α-amino acids as these compounds can be obtained in much higher yields via the hydantoin-route than by the S-3CR. In 1956 Asinger et al. published the preparation of thiazole derivatives by the Asinger MCR of three or four components. The MCRs of the isocyanides are also type II reactions whose irreversible step is always an α addition of a cation and an anion onto the C^{II} of the isocyanides. Subsequently their α - adducts rearrange into their final products.

Table 2. Various types of multicomponent reactions

MCR TYPE	General Scheme
1	A+B ⇌ C ⇌ O ⇌ P
2	A+B ⇌ C ⇌ D ----O ⇌ P
3	A → B + C → D → ------O → P

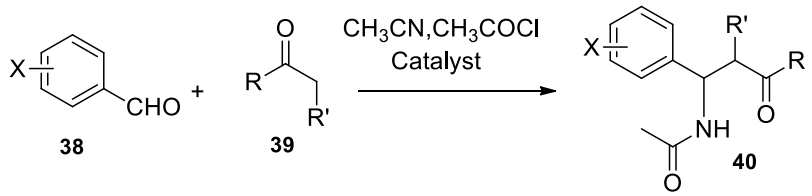
In preparative chemistry rather few MCR of type III are known, whereas in living cells most products are formed by biochemical MCRs of type III. They are sequence of irreversible elementary reactions.

Part B Chemistry of N- substituted *β*-amido carbonyl compounds

The *β*-amino ketone subunit is an important structural intermediate in the synthesis of many pharmaceutically and biologically active compounds, examples

being for the preparation of 1, 3-amino alcohols, antibiotic nikkomycins or neopolyoximes[16-18]. Therefore, the synthesis of *N*-substituted *β*-amido carbonyl compounds continues to be a challenging endeavor. Mannich-type reactions provide one of the most efficient approaches to the synthesis of the *β*-amino ketone skeleton and considerable efforts have been devoted to the improvement of this methodology.

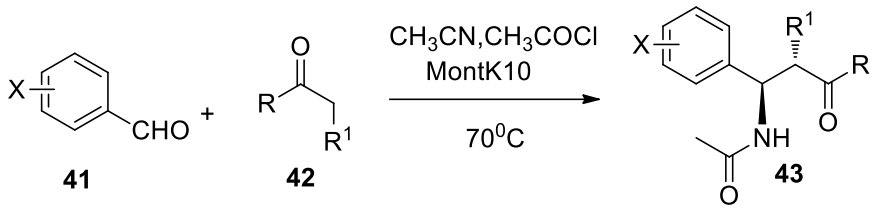
As a result, several strategies have been developed for the preparation of *β* amido ketones and the best known method for the synthesis of these compounds is the Dakin-West reaction which is a condensation reaction between an α-amino acid, and acetic anhydride in the presence of a base providing the acetamido ketones[19a]. A recent attraction in the field of synthesizing *β*-amido ketones is the emergence of a 3 component coupling process based on the use of a nitrile as the nitrogen source instead of an amine in the conventional Mannich protocols. Pioneering work by Iqbal et al. has established this reaction as a new tool for the construction of Mannich-Type *β*-aminated carbonyl compounds. Following this method, a variety of *β*-acetamido ketones with structure **40** were prepared in high yields under mild condition via a three component coupling of aromatic aldehydes **38**, enolizable ketone **39** and a nitrile in presence of various catalysts (Scheme12).



Scheme 12. *β*-acetamido ketones via a three component coupling of aromatic aldehydes, enolizable ketones and nitriles in presence of catalyst

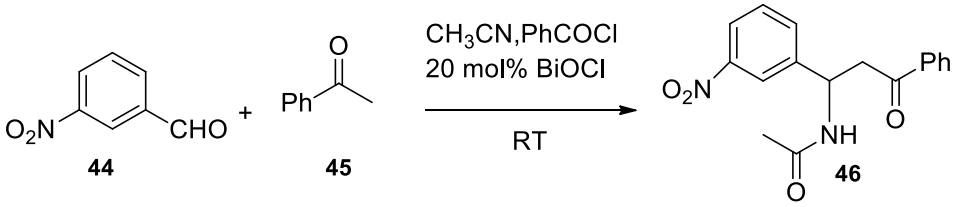
A new era in the Chemistry of *β*-amido ketone was opened up in 2003 from the report of the use of an inexpensive alumino silica material (Mont K10)[19b] for the stereoselective synthesis of this type compounds. In this process, an aldehyde **41** and a Ketone **42** in equimolar ratios were stirred for 7 h at 70^{o}C in acetonitrile with 4 equiv. acetyl chloride in presence of Mont K10 clay to afford the *β*-acetamido ketones **43** in excellent yields (Scheme13). The attraction of this process is the achievement of some sort of chemoselectivity in which the hydroxyl group remain intact and

without get into the acylation. The Mont K10 process was found to be very effective for the inclusion of various benzaldehyde derivatives and ketones such as ethylmethyl Ketone, propiophenone, cyclohexanone or other enolizable ketones. The same group have also reported the use of $CoCl_2$ [19c] for the β-amino acid derivatives.



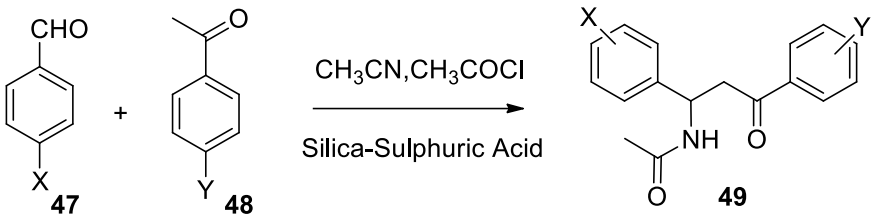
Scheme 13. β-aminoacid derivatives synthesized using Mont K10

Following this protocol, variety of new heterogeneous catalysts was reported by various research groups. Ghosh[19d] et al described a one pot synthetic protocol for the synthesis of β-acetamido ketones via multicomponent condensation route using a less toxic (LD50 rate (oral) 22g/kg) $BiCl_3$ which is an in situ catalyst generated from BiOCl and CH_3COCl. The speciality is that it has got a very low toxicity level. Various combinations of oxo compounds have been used with benzonitrile or acetonitrile (Scheme 14). Acetonitrile is probably incorporated in the aldehyde-derived intermediate with subsequent acetate migration and coupling with the ketone enolate, following a pathway similar to that proposed by Iqbal *et al.* in a $CoCl_2$-catalyzed reaction.



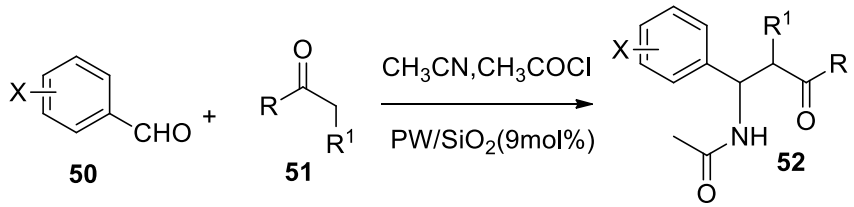
Scheme 14. Synthesis of β- acetamido ketones using BiOCl

Yakaiah et al. synthesized β-acetamido ketones via multicomponent condensation route using sulfuric acid on silica gel as an inexpensive catalyst (Scheme15) and the catalyst was recycled without loss of activity [19e]. Here the reaction of an equimolar mixture of substituted aromatic aldehyde and substituted acetophenone together with acetyl chloride and acetonitrile in the presence of dried silica sulfuric acid at reflux temperature of CH_3CN afforded the β-acetamido ketones.



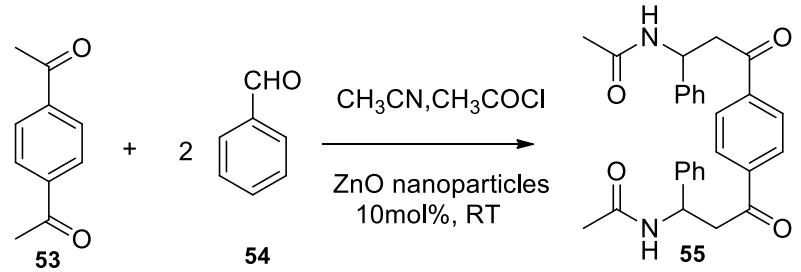
Scheme 15. β-amino acid derivatives using Silica sulphuric acid.

Heteropoly acid such as $H_3PW_{12}O_{40}$ (PW) supported on silica (PW/SiO_2) has also been reported as an efficient catalytic system for a three component coupling process for the synthesis of β-acetamido ketones[19f]. This method offers several advantages, such as high yield, short reaction time, mild conditions etc (Scheme 16).



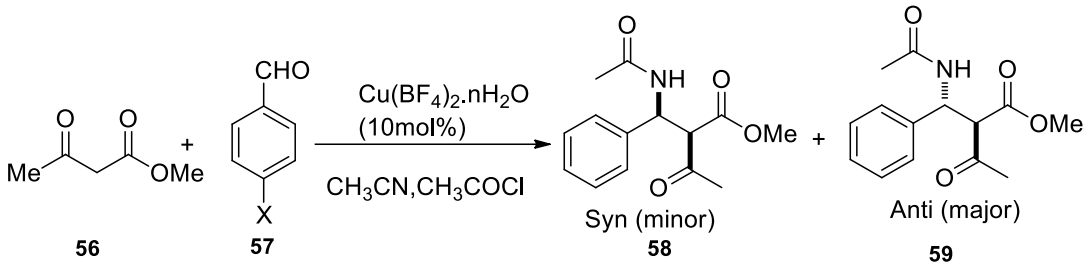
Scheme 16. Silica supported $H_3PW_{12}O_{40}$ catalyzed synthesis of β-acetamido ketones

Nano materials have also been used for the synthesis of β-amido carbonyl compounds. Example being the use of ZnO nano particles as an inexpensive and effective catalyst for the Mannich type reaction [19g]. The reaction was carried out under room temperature without the use of solvents. The mild reaction temperature, cost-effective catalyst, simple product separation and catalyst recyclability were the notable achievements of this method (Scheme 17).



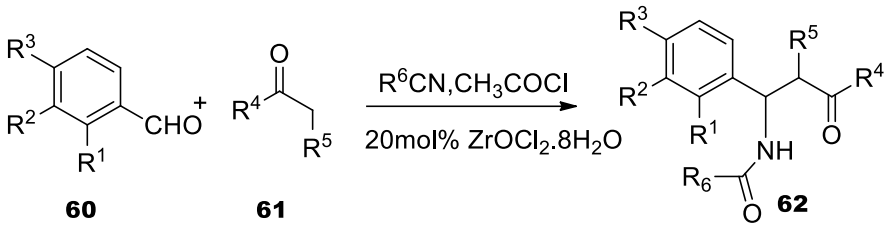
Scheme 17. ZnO nano particle catalyzed synthesis of β-acetamidoketone reaction

Recently, transition metal catalyzed reactions have gained considerable attention in the area of organic synthesis. Accordingly, transition metal catalysis was also adapted to β-amido carbonyl compound chemistry. A variety of β-acetamido ketones and keto esters were synthesized in high yield under extremely mild conditions via three component coupling of aromatic aldehydes, enolizable ketones or β-ketoesters and nitriles in presence of 10 mol % copper (II) tetrafluoroborate [19h] and a stoichiometric amount of acetyl chloride. A solution of 10 mol % of Cu $(BF_4)_2$ in acetonitrile provides a convenient reaction medium to carry out a three component reaction under mild conditions. Interestingly, methylacetoacetate reacted effectively with benzaldehyde in the presence of acetyl chloride and acetonitrile to furnish the corresponding β-acetamido ketone derivatives in good yields and with moderate diastereoselectivity. (Scheme 18)



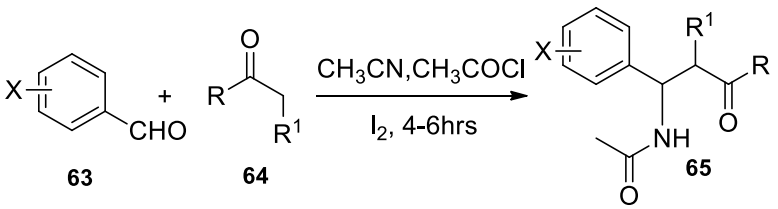
Scheme 18. Preparation of β-acetamido ketones using Cu $(BF_4)_2.nH_2O$

Due to the easy availability in the earth's crust and low toxicity, Zr compounds such as $ZrCl_4$, $ZrOCl_2.8H_2O$ [19i] and Zr $(HSO_4)_4/SiO_2$ have received considerable attention in various organic reactions. These salts act as an efficient Lewis acid catalyst for acylation of alcohols, phenols, amines, thiols and thio phenols. The efficiency of these catalysts to act as an activator for the one pot synthesis of β-acetamidoketones is also investigated. $ZrOCl_2.H_2O$ found to be very effective for catalysing this reaction. A mixture of benzaldehyde, acetophenone and acetyl chloride in the presence of $ZrOCl_2.8H_2O$ in acetonitrile afforded the title compounds (Scheme 19).



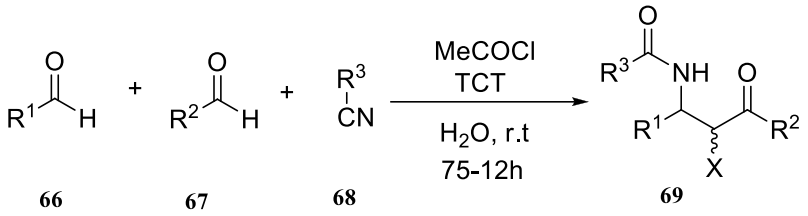
Scheme 19. $ZrOCl_2$ catalyzed β-amino acid derivatives

Last one decade witnessed the emergence of iodine [19j] as an effective catalyst for various organic transformations. On the application of this catalyst for the development of various useful synthetic methodologies, Das et al. have demonstrated an iodine catalyzed process for the synthesis of β-acetamido ketone at room temperature (Scheme20). Different aromatic aldehyde and acetophenones have been utilized for the preparation of these compounds. When propio phenones were used in the reaction, both anti and syn products were formed, in which the anti isomer was the major one. β-acetamido ketones were also prepared from β-keto esters by the reaction of aromatic aldehydes, acetonitrile and acetyl chloride in the presence of iodine. The limitation of this process is the requirement of nitrogen atmosphere to avoid the formation of α, β unsaturated carbonyl compounds (Knoevenagel reaction product).



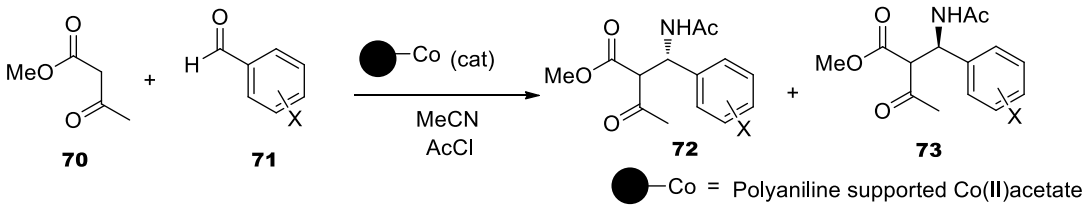
Scheme 20. Use of Iodine as catalyst in the preparation of β–acetamido ketones

Das et al reported the use of cyanuric chloride [19k] as catalyst for the one component synthesis of β-acetamido ketone since they are cheap, easy to handle, safe and also the cyanuric chloride by-product formed during the reaction was removed during the aqueous work up.



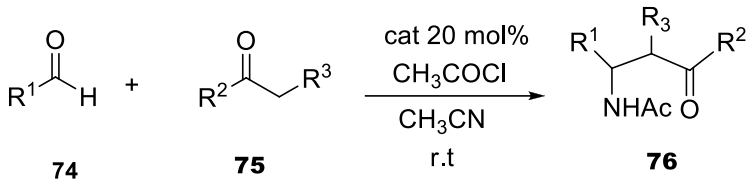
Scheme 21. Cynuric acid catalyzed synthesis of β-acetamido ketone derivatives.

Polymer supported metal catalysts [19l] are another important variety of green catalysts useful for the synthesis of small drug like molecules by a combinatorial approach. The increasing prominence of such catalysts is due to the fact that the reactions carried out under the assistance of such supported metal frame work render high level of selectivity during the bond formation and they offer high economical benefits as reusable catalysts. Since it requires a non aqueous work up, they can be effectively used for reactions yielding water sensitive and soluble by products. Prabhakaran et al put forward a poly aniline supported cobalt catalyst to use these properties and also to broaden the scope of the Cobalt (II) chloride catalytic method which they have reported earlier [19c]. The coupling between methyl aceto acetate **70**, aldehyde **71**, and acetonitrile provides a general synthetic route to β-amino acid derivatives.



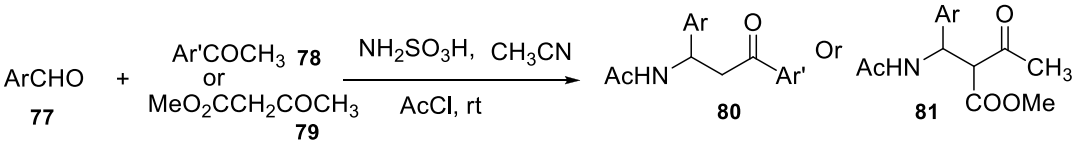
Scheme 22. Poly aniline supported Co (II) acetate catalyzed reaction

Use of Metal hydrogen sulphates have also been reported due to their wide utility in a broad range of reactions including deprotection, oxidation, and various bond forming reactions. Momeni [19m] et al reported two such metal sulphates; Zr $(HSO_4)_4$ and Mg $(HSO_4)_2$ as a new method to efficiently catalyze the one pot synthesis of β-acetamido ketones. Reaction proceeded with 20 mol% of the catalyst for the duration of 0.5-1.5 hours. Use of $NaHSO_4.H_2O$ has also been reported by another group but with longer reaction time and higher mol% of the catalyst.



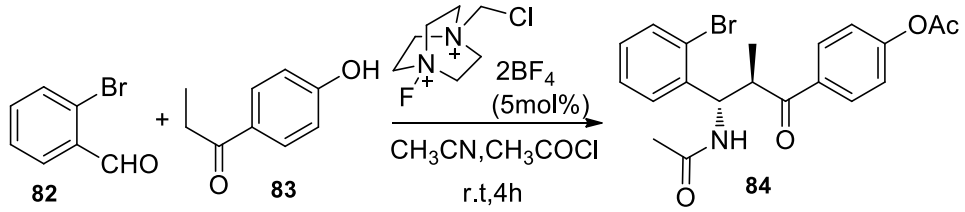
Scheme 23. use of metal hydrogen sulphate as catalyst in the synthesis of β-acetamido ketone derivatives

In addition to this, some metal contained acids (solid acids) are also used for the β-amino acid derivative synthesis, but their scope is very limited due to the ungreen nature of the catalysts and is replaced with more ecofriendly variations. For this, Heravi[19n] et al reported the use of Sulphamic acid catalyst, which is a non volatile, inexpensive and non corrosive inorganic acid.



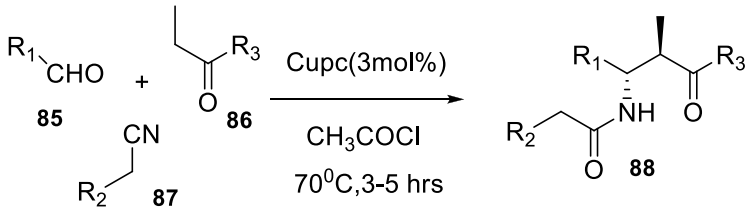
Scheme 24. Sulphamic acid catalyst for various acetamido ketones.

In a recent literature, there are reports about the application of Selectfluor^{TM} as an efficient green catalyst for performing various organic transformations[19o]. Its stability, non-volatility, commercial availability, and user-friendliness make it as an ideal green reagent and the toxicology studies revealed that Selectfluor^{TM} is relatively harmless and did not show any signs of mutagenic or carcinogenic activity. Our group used this catalyst for the stereoselective synthesis of various acetamido ketones and all the reactions afforded the corresponding β-amido ketone in good to excellent yields irrespective of the position of the substituents in the oxo component.



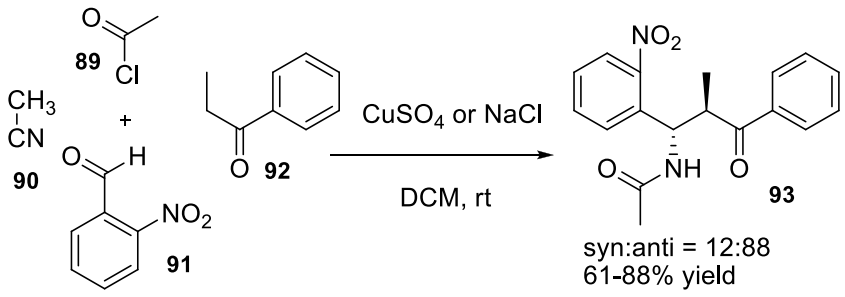
Scheme 25. Synthesis of β-acetamidoketones using Selectfluor ^{TM} as catalyst

Metallophthalocyanines were another important group of compounds which has been extensively studied due to their potential applications in developing materials for advanced technologies. Shinu et al [19p] studied the catalytic efficiency of different metallophthalocyanines which includes Copper phthalocyanines, zinc phthalocyanines, and aluminium phthalocyanine chloride at two different temperatures; 70^0c and at room temperature. They observed that the yield was good at 70^0c and negligible at room temperature. Among the different phthalocyanines, Copper phthalocyanine was proved to be the best catalyst since only this one gave the maximum yield, consuming minimum amount of catalyst. The studies with α-substituted ketones revealed that the reactions proceeded well with 90% anti diastereoselectivity, irrespective of the substituent patterns present in aldehydes and ketones.



Scheme 26. Cupc catalyzed formation of β-Propionamido ketone derivatives

. One recent method is the use of readily available salts such as NaCl and Copper sulphate as introduced by Bahulayan etal[19q]. The group developed an efficient multicomponent process to access stereodefined β-aminoacid derivatives and studied the catalytic efficiency of these salts and observed that the new method is highly convenient for the diastereoselective construction of scaffold diversity.



Scheme 27. $CuSO_4$ or NaCl catalyzed anti- selective formation of β-amino carbonyl compound Scaffolds

In summary, development of new specific catalysts and exploring their catalytic activity is a field of increasing demand and several catalysts have been used. Newer methodologies are still introducing towards the easy, cheap and safe synthesis of β-amido ketone structural scaffolds. One such attempt is the use of boronic acid derivatives.

Chapter 2

MULTICOMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES

2.1 Introduction

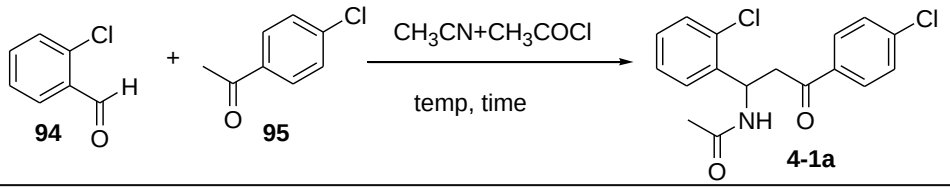
The escalating rates of petrochemicals and increase of energy and raw material consumption is forcing the traditional chemistry to gain a greener look. As a consequence, chemical industry demands the development of newer reaction methodologies to obtain novel compounds in a fast, clean and efficient way [20]. The same thing is happening in the realm of MCRs and scientists practicing MCRs are constantly engaged in the search for new catalysts and processes. The chemistry of *β*-amido carbonyl compounds is also subjected to such a change and consequently, large numbers of new catalysts are available for this process. This includes $SnCl_4/SiO_2$ [21a], Cu $(OTf)_2$ and $Sc(OTf)_3$[21b], $Mn(bpdo)_2Cl_2$/MCM-41[21c], $CeCl_3 \cdot 7H_2O$ [21d], iron (III) chloride [21e] etc. Even though these chiral Lewis acids have proven to be efficient for many reactions, a major drawback is that most Lewis acids are unstable in presence of water and some of them are even moisture sensitive and also the multi-step program demands high synthetic skill. On regarding the new methodologies, some are efficient and provide the practical means for the synthesis of *β*-acetamido ketones, but some of the reported methods suffer draw backs such as longer reaction times, tedious work up, higher temperatures, expensive catalysts, lower yields and feasible only under an inert atmosphere.

Until recently, the scope of this three component process was limited to the synthesis of *β*-acetamido carbonyl compounds. Recent developments in this area, particularly from our laboratory, revealed the potential of this protocol as an economic way for the efficient synthesis of highly functionalized organic intermediates [19 o-q]. Therefore, the introduction of new and efficient methods is still necessary for this reaction. Towards this goal, and in continuation of our investigations on the synthesis of highly functionalized structural scaffolds in a cost-effective, environmentally friendly and more importantly, for the development of a process which requires less operational skill and infrastructure, we were prompted to explore new methods for the incorporation of a large variety of substrates in mild conditions. For this, we decided to explore the possibility of zinc sulphate as Catalyst in this reaction.

2.2 Result and Discussions

We have initiated our studies with the synthesis of the β-acetamido ketone derivatives using zinc sulphate **1A** and optimization of the reaction conditions. In the first round optimizations, the reaction between 2-chlorobenzaldehyde **94** and 4-chloro acetophenone **95** was selected as the model reaction for the screening purpose. Optimizations were carried out in terms of the amount of catalyst, reaction time and temperature while keeping acetonitrile as solvent in all the cases. Taking into account of our previous experiences with Mont K10 [19b] and Selectfluor™ [19o], we decided to carry out the screening experiments at room temperature and at the boiling point of acetonitrile. We found that a room temperature reaction with 20 mol% of the catalyst gives the maximum yield- 83% (Table 3, entry 4). With 20 mol % of the catalyst, the reaction reached completion in 4 hours as indicated by TLC. Here the nitrile source acted as both reagent and solvent. FT-IR spectroscopy is very useful for following the reaction. In the FT-IR spectrum, the disappearance of the aldehyde peak followed by the appearance of amide peak at 1650 cm^{-1} is a clear indication about the commencement of the reaction. The structure of the product was further confirmed via ^1H NMR and mass spectral studies. The reaction yielded clean products that can be directly used for analysis. The reaction conditions were mild and avoided the use of environmentally hazardous chemicals.

Table 3. Optimization of reaction conditions



Entry	Catalyst	Loading(mol%)	T/^{0}C	Time	Yield(%)
1	1A	5	rt	4h	76
2	1A	10	rt	4h	78
3	1A	15	rt	4h	79
4	1A	20	rt	4h	83
5	1A	20	70	4h	76

Interestingly, we found that aliphatic ketones react under these conditions, but produce the corresponding *β*-acetamido ketones in low yields and the isolation procedure required column chromatography.

2.3 Spectroscopic identification of molecules

For a general discussion, compound **4-1a** is taken as the representative compound.

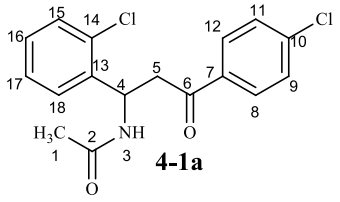


Figure 2.1

The molecule is numbered as shown in Figure.2.1. The FT-IR spectrum of the compound **4-1a** gave major absorptions at 3287.07, 1682.59, 1647.88 and 1550.49 cm^{-1}(Figure 2.3).The band at 3287.07 cm^{-1} is due to the NH stretching vibration of the acetamido group. The amide I band, i.e., the band due to the C=O stretching vibration occurs at 1647.88 cm^{-1} and the amide II band which arises from the interaction

between the N-H bending and the C-N stretching of the C-N-H group is obtained at 1550.49 cm^{-1}. The absorption at 1682.59 cm^{-1} is due to the C=O stretching vibration of the ketone part.

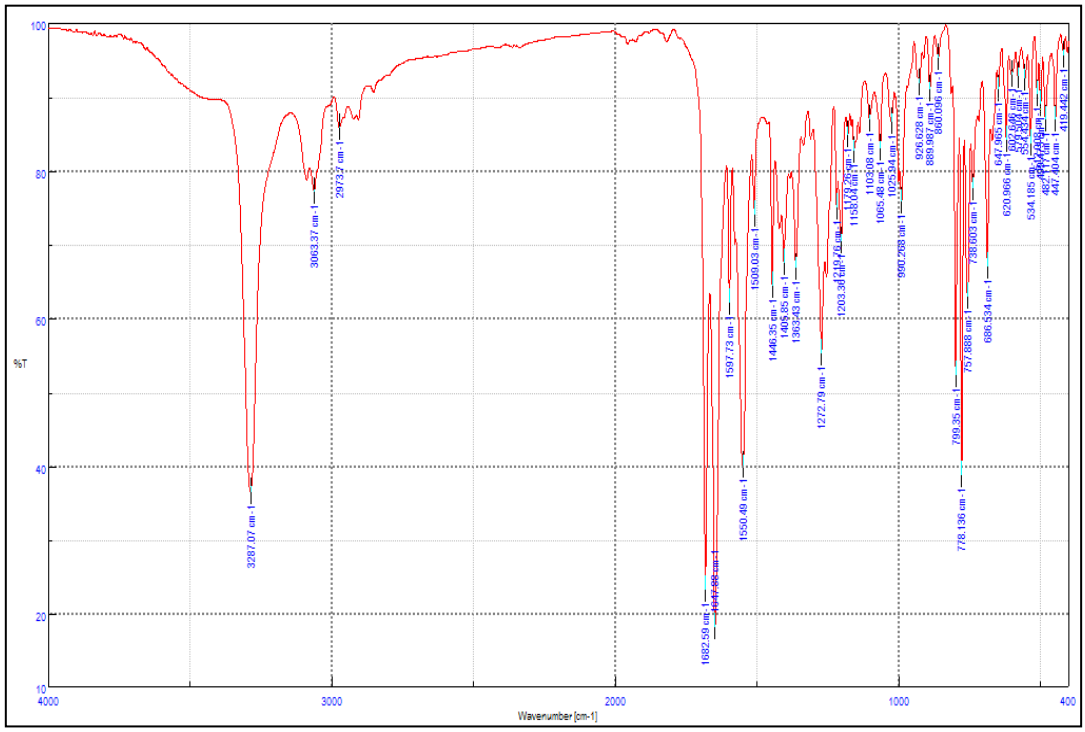


Figure 2.2 FT-IR spectrum of compound **4-1a**

In the ^1H NMR spectrum, (Figure 2.3) a doublet obtained at δ = 8.39-8.37 is due to the NH proton of the acetamido group. A multiplet obtained between 7.60-7.28 is attributed to the presence of aromatic protons of the two benzene rings. The two protons on C_5 are in different chemical environments due to the presence of the adjacent chiral carbon C_4. In the ^1H NMR spectrum, these two proton signals are observed between δ 3.49-3.44 and between δ 3.31-3.25 respectively. Both these signals observed as doublet of doublets with approximately equal coupling constants (20 and 24 Hz) and the splitting of signals is occurred due to the spin-spin couplings of the protons of the same carbon and of the adjacent carbon C_4. The CH proton at position 4 is observed as a singlet at δ 5.68. Finally, the methyl protons at position 1 are observed as a singlet at δ 1.74.

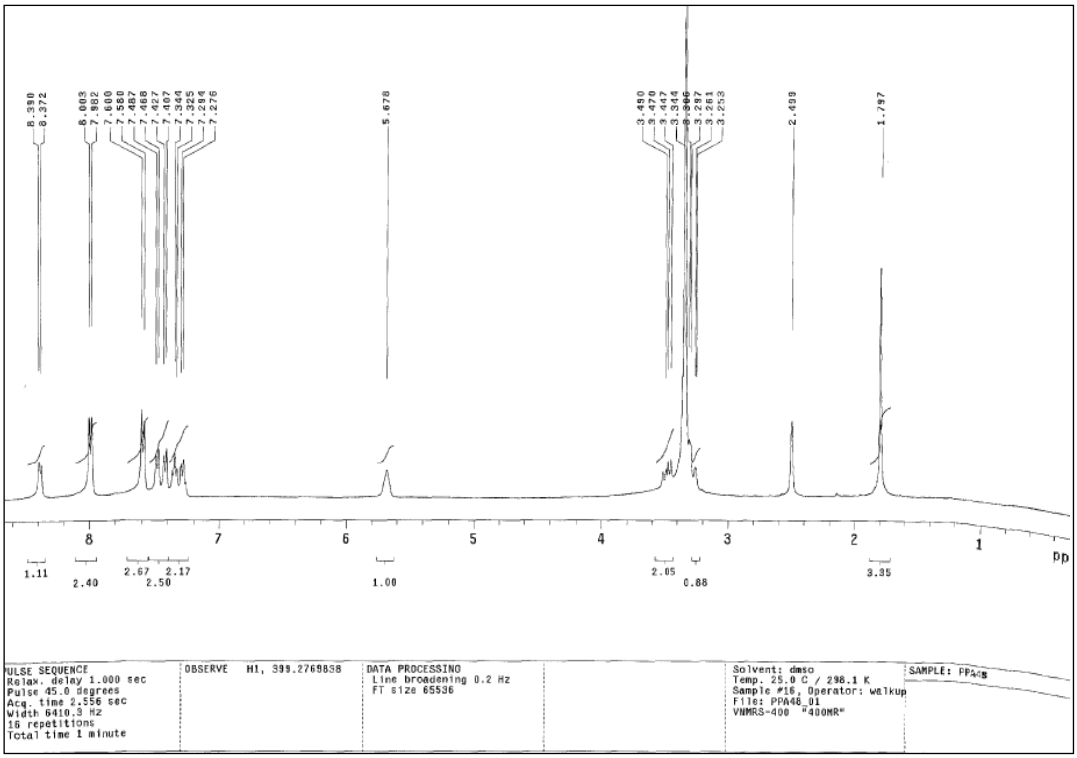


Figure 2.3 ^{1}H NMR spectrum of compound **4-1a**

The structure is further confirmed by the mass spectral analysis. The M^+ peak is observed at m/z 334.3 (Figure 2.5). The peak at 336.2 is the (M+2) peak.

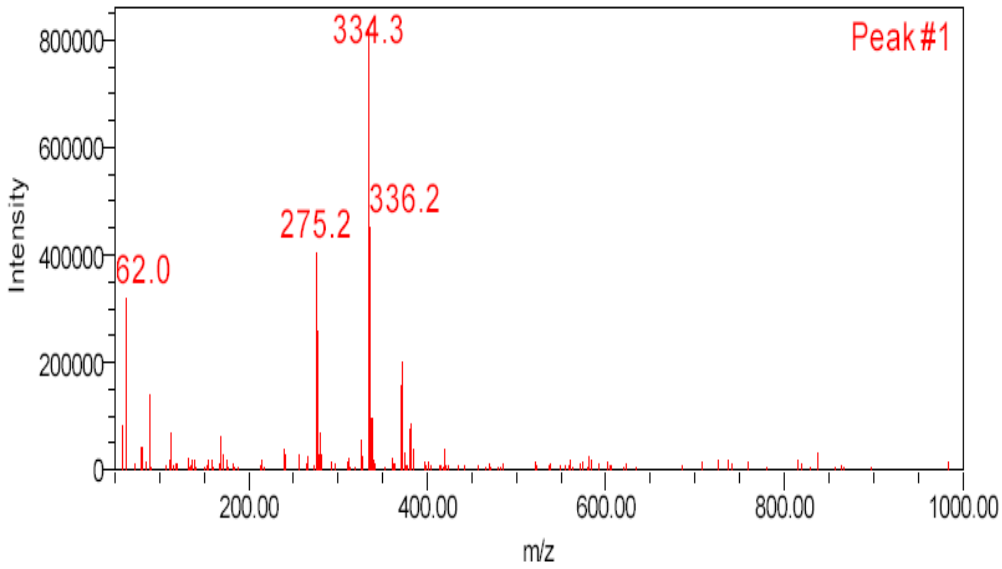
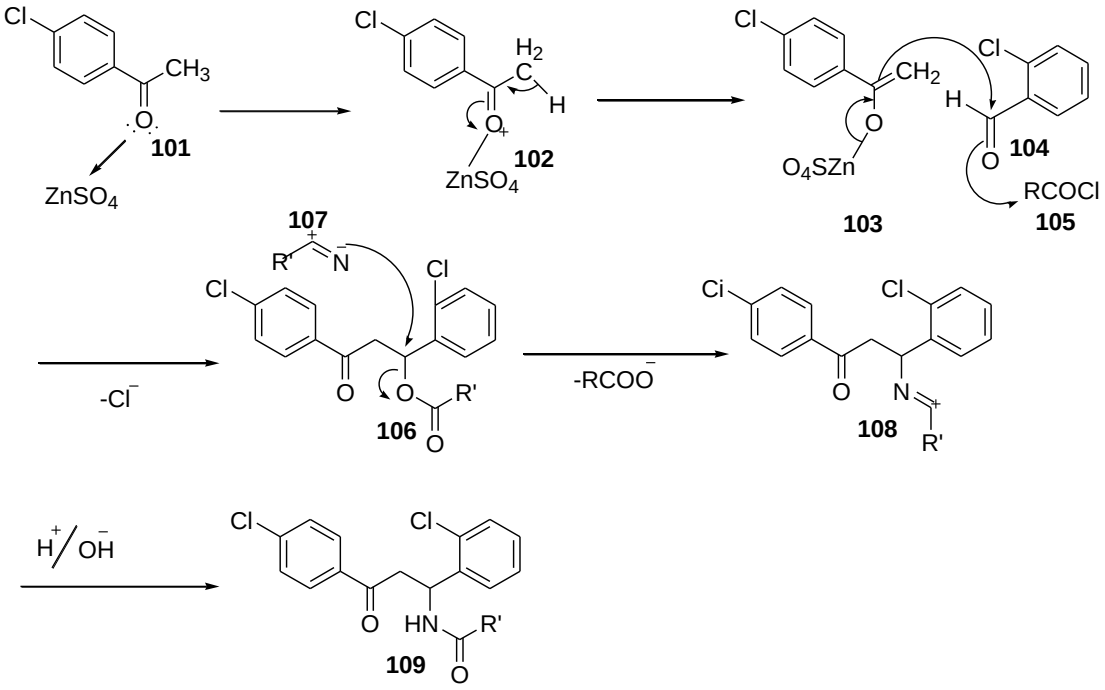


Figure 2.4 Mass spectrum of compound **4-1a**

2.4 Mechanism



Scheme 30. Proposed catalytic cycle for the formation of *β*-acetamido ketone derivatives using Zinc sulphate as catalyst

The suggested Mechanism of the reaction is shown in Scheme 30. The reaction is initiated by the co-ordination of the carbonyl oxygen of the ketone moiety**101** with the metal atom of the catalyst. Zinc sulphate acts as a Lewis acid and thus activates the enol **103** formation. The addition of aldehyde moiety **104** followed by acid chloride **105** to this complex resulted in the carbon-carbon bond formation to produce a *β*-acyloxy ketone derivative**106.** The acyloxy group in **106** is then displaced by the more nucleophilic nitrogen of the nitrile **107** to produce a stable cation intermediate **108**. Addition of water leads to the formation of the *β*-acetamido ketone derivative **109.**

2.5 Experimental

General: All solvents and reagents were of reagent grade quality from Aldrich Chemical Company, Fluka, or Merck and used without any further purification. Fourier transform infrared (FT-IR) spectra were recorded on a Jasco FTIR-4100

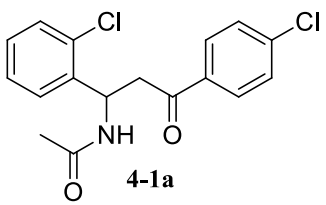
spectrometer. The ^{1}H- and ^{13}C-nuclear magnetic resonance (NMR) spectra operating at the frequencies of 400 and 100 MHz, respectively, were measured with Varian NMR (VNMRS-400) spectrometer in dimethylsulphoxide-d (DMSO-d_6). Chemical shifts are reported in parts per million (ppm) relative to TMS as internal standard (d=0ppm) for ^{1}H NMR. The coupling constants are reported in hertz (Hz). Reactions were monitored by thin-layer chromatography (TLC) using plates prepared with Merck silica gel G by irradiation with UV light and/or treatment with iodine. Column chromatography was performed on Merck silica (100 to 200 mesh) eluting with the indicated solvent system. Stereochemistry of the compounds were assigned by comparing the coupling constant (J value) of the methine proton with reported data.

Typical Experimental Procedure for the Three Component Coupling Reaction of Aldehydes, Ketones and Acetonitrile with zinc sulphate as catalyst.

A 100 mL Rb flask was charged with a solution of the aryl aldehyde (1.25 mmol), aryl ketone (1.25 mmol), acetyl chloride (3 mL) and acetonitrile (5 mL) in the presence of zinc sulphate (20mol%). The resulting mixture was then set to stir continuously for 4 hours at room temperature. After the completion of the reaction as indicated by TLC, the reaction mixture was diluted with distilled water and stirred well. The obtained precipitate was collected by filtration, washed with distilled water (3 x 20 mL) and dried under vacuum. The dried solid was then washed with diethyl ether (3 x 15 mL) and air-dried to yield the pure *β*-acetamido ketone derivatives.

2.6 Spectral Data

N-(1-(2-chlorophenyl)-3-(4-chlorophenyl)-3-oxopropyl) acetamide 4-1a



4-1a

^{1}H NMR (400 MHz, DMSO - d_6): δ 8.39-8.37 (d, J= 7.2 Hz, 1H), 8.00-7.98 (d, J = 8Hz, 2H), 7.60-7.28 (m, 6H), 5.68 (s, 1H), 3.49-3.25 (dd, J = 20 and 21 Hz, 2H), 1.74 (s, 3H); FT-IR (KBr) γ_{max}: 3287.07, 3063.97, 2973.01, 1682.59, 1647.88, 1597.73, 1550.49, 1446.35, 1405.85, 1369.43, 1272.79, 1203.03, 900.21, 799.35, 778.14 cm^{-1}; MS m/z: 334.3 (M^+) , 336.2 (M+2), 62, 275.2.

Conclusion

Multicomponent reactions are the most versatile method for the synthesis of complicated molecules in a one pot, fast, efficient and time saving manner. With their advantages of atom-efficient transformations, readily available materials, and various products, multicomponent reactions (MCRs) have received significant research interest from chemical and medicinal communities. With respect to their productivity, yield, convergence and facile execution, MCRs occupy an outstanding position among all other reactions- making them especially interesting for synthetic chemists. One of the mostly studied MCRs is the Mannich reaction, discovered in 1912. This is an amino alkylation reaction of aldehyde and is a very useful method for the preparation of *β*-amino compounds.

β-acetamido ketone derivatives are versatile synthetic building blocks, which can easily be converted into a range of useful and valuable derivatives. These scaffolds have many attractive applications, for example in plant protection, in paint manufacturing and in polymer chemistry. However, the most important application by far is in the area of pharmaceutical products since their skeletons exist in a number of biologically active and pharmacologically important compounds examples being for the preparation of 1,3 amino alcohols, *β* amino acids, γ lactams, antibiotic Nikkomycin or neopolyoximes. Therefore the synthesis of amino carbonyl compounds continues to be a challenging endeavor.

Not only the synthesis, but also the way by which they are synthesized is of importance. So improvement of synthetic efficiency in terms of increasing yields and decreasing the number of reaction steps for interesting scaffolds is became central to current research on synthetic chemistry. Even though various research groups have reported many catalysts, more and more methods have to be still introduced to get a

greener look. If this is our goal, the idea of green chemistry should reflect on various aspects of the reaction. Even though many methods have been reported, some of them suffer draw backs such as longer reaction times, tedious work up, higher temperatures, expensive catalysts, lower yields and feasible only under an inert atmosphere. Therefore, the introduction of new and efficient methods is still necessary for this reaction.

Here we have reported the efficiency of zinc sulphate catalysts for the synthesis of *β*-acetamido ketone derivatives via MCR Chemistry. The study reveals that the catalyst is more efficient in catalyzing the reaction. The method offers several advantages such as high yields, short reaction times, mild reaction conditions, simple experimental procedures, cost effectiveness and tolerance to a wide variety of reactants. The catalysts used are environmentally friendly, inexpensive and highly efficient. Since catalysts are commercially available, the study can be extended to explore their possibility also. That is, in addition to this MCR Chemistry reported here, the work can be extended to many other name reactions.

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MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES

Dissertation submitted to the Christ College (Autonomous) in partial fulfilment of the requirement for the Degree of

BACHELOR OF CHEMISTRY

IN

CHEMISTRY

Submitted by

MOHAMMED SIYAD BM

Reg. No: CCAVSCH018

2021-2024

P.G AND RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

DECLARATION

I,MOHAMMED SIYAD BM (Reg.No.CCAVSCH018) do hereby declare that, this dissertation work entitled **"MULTI COMPONENT SYNTHESIS OF BETA-ACETAMIDO KETONE DERIVATIVES"** submitted to the University of Calicut in Partial Fulfilment of the requirement for the award of degree of Bachelor of Science was carried under the guidance of Dr.Arun S, Assistant professor, Department of Chemistry, Christ College, Irinjalakuda and it is a record of original project work carried out by me and it has not previously formed the basis for the award of, any degree, Diploma fellowship or other similar title of recognition by any other university or institutions.

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Date: 25thMarch 2024

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I extend my sincere and heartfelt gratitude to my project guide Dr.Arun S, Department of chemistry, Christ College, Irinjalakuda for his valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to him for the completion of this work in the specified period.

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CONTENTS

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IN

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Submitted by

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CONTENTS

POROUS CARBON BASED ALKALINE SUPERCAPACITORS

Project submitted to the University of Calicut

in partial fulfilment of the Requirements for the Award of the Degree of

BACHELOR OF SCIENCE IN CHEMISTRY

By

SETHULAKSHMI N S

CCAVSCH021

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CERTIFICATE

This is to certify that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS,** submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a record of research work carried out by **Mr. SETHULAKSHMI N S CCAVSCH021** , during the academic year 2021- 2024 under my supervision.

Dr. V . T . Joy

Head, Dept. of Chemistry

Christ College (Autonomous)

Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

Dr. Dijo Damien

Supervisor

Assistant Professor

Dept of Chemistry

Christ College(Autonomous)

Irinjalakuda

Dr. Bijy P Mathew
Vimala College, TCR

DECLARATION

I , **SETHULAKSHMI N S** , hereby declare that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS** , submitted to the University of Calicut, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a research work done by me under the supervision and guidance of **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

SETHULAKSHMI N S

Department of Chemistry

Christ College (Autonomous)

Irinjalakuda-680125

ACKNOWLEDGEMENT

I express my gratitude to God Almighty for the endless blessings and intervention in helping me to complete my project without any hassles. I extend my gratitude to **Christ College (Autonomous),** Irinjalakuda, for giving me this opportunity to widen the horizons of my knowledge through this project. I am eternally grateful to **Rev Dr Jolly Andrews CMI**, the Principal, Christ College (Autonomous), Irinjalakuda, for the congenial research atmosphere he has always tried to foster during the course of my studies.

I thank **Dr V T Joy**, Head, Department of Chemistry, for his timely help and generous encouragement that enabled me to successfully complete this project work.

I am indebted to my supervisor, **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for extending his expertise and guidance in enhancing my research skills and knowledge.

I extend my gratitude to **Mrs. Krishnapriya K.M ,** Assistant Professor and all other faculty members of the Department of Chemistry for their enduring support and help during the course of my study.

I express my heartfelt gratitude to my parents, teachers, friends and all those who have helped me directly or indirectly, in the successful completion of the project work.

SETHULAKSHMI N S

CCAVSCH021

ABSTRACT

As high-performance energy storage devices that can support the rapid expansion of low-power electronics (such as wearable, portable electronics) and high-power military applications (such as guided missile techniques and highly sensitive naval warheads), supercapacitors (SCs) are attracting a lot of research interest. The electrochemical characteristics of the mixture of the electrode and electrolyte components can be used to evaluate the performance of SCs. Similarly, the choice of these materials can have a big impact on the charge storage capacities of SCs (e.g., via surface redox processes). So, tremendous efforts have been made to increase their competitiveness with currently available energy storage technologies, including rechargeable batteries. This article examines the most recent developments in SC technology with regard to electrode materials, electrolytes (such as 3D porous structures that resemble paper or fibre), and charge storage techniques. There is also discussion of the benefits and difficulties that come with commercializing SCs.

CONTENTS

POROUS CARBON BASED ALKALINE SUPERCAPACITORS

Project submitted to the University of Calicut

in partial fulfilment of the Requirements for the Award of the Degree of

BACHELOR OF SCIENCE IN CHEMISTRY

By

SIVANANDANA

CCAVSCH022

March 2024

PG & RESEARCH DEPARTMENT OF CHEMISTRY

Christ College (Autonomous), Irinjalakuda

Kerala - 680125

CERTIFICATE

This is to certify that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS,** submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a record of research work carried out by **Mr. SIVANANDANA CCAVSCH022 ,** during the academic year 2021- 2024 under my supervision.

Dr. V . T . Joy

Head, Dept. of Chemistry

Christ College (Autonomous)

Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
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Dr. Dijo Damien

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Dr. Bijoy P Mathew
Vimala College, TCR

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SIVANANDANA

CCAVSCH022

DECLARATION

I , **SIVANANDANA ,** hereby declare that the project entitled **POROUS CARBON BASED ALKALINE SUPERCAPACITORS ,** submitted to the University of Calicut, in partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry , is a research work done by me under the supervision and guidance of **Dr. Dijo Damien**, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

SIVANANDANA

Department of Chemistry

Christ College (Autonomous)

Irinjalakuda-680125

ABSTRACT

As high-performance energy storage devices that can support the rapid expansion of low-power electronics (such as wearable, portable electronics) and high-power military applications (such as guided missile techniques and highly sensitive naval warheads), supercapacitors (SCs) are attracting a lot of research interest. The electrochemical characteristics of the mixture of the electrode and electrolyte components can be used to evaluate the performance of SCs. Similarly, the choice of these materials can have a big impact on the charge storage capacities of SCs (e.g., via surface redox processes). So, tremendous efforts have been made to increase their competitiveness with currently available energy storage technologies, including rechargeable batteries. This article examines the most recent developments in SC technology with regard to electrode materials, electrolytes (such as 3D porous structures that resemble paper or fibre), and charge storage techniques. There is also discussion of the benefits and difficulties that come with commercializing SCs.

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

BY

AASHIKA CJ

CCCAVSCH024

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

V.T JOY

ASSOCIATE PROFESSOR

HEAD ,DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

BY

AASHIKA CJ

CCCAVSCH024

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

V.T JOY

ASSOCIATE PROFESSOR

HEAD ,DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is an authentic record of study carried out by AASHIKA CJ(Reg. No. CCAVSCH024) as a part of BSC Project during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 11-04-2024

Dr. V.T JOY

Associate Professor

Head ,Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijay P Mathew
Vimala College, TCR

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

DECLARATION

I hereby declare that the dissertation entitled, "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is a genuine record of project work done by me under the guidance of Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date : 11-04-2024

AASHIKA CJ

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to all other teaching and non teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

AASHIKA CJ

CONTENTS

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

BY

ADHELIA JESSIL

CCAVSCH025

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

V.T JOY

ASSOCIATE PROFESSOR

HEAD ,DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is an authentic record of study carried out by ADHELIA JESSIL (Reg. No. CCAVSCH025) as a part of BSC Project during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 11-04-2024

Dr. V.T JOY

Associate Professor

Head ,Department of Chemistry

Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

DECLARATION

I hereby declare that the dissertation entitled, "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is a genuine record of project work done by me under the guidance of Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date : 11-04-2024

ADHELIA JESSIL

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to all other teaching and non teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

ADHELIA JESSIL

CONTENTS

ABSTRACT

Hydrogen production by membrane water splitting teachnologies is a sustainable method to synthesis hydrogen and provides an alternative to hydrogen production instead of conventional process of synthesizing hydrogen from steam methane reforming.Currently Nafion is mainly used as membrane for water splitting.However,the high cost of purchasing Nafion membrane and inability to execute electrolysis operational above 90^0C has sparked interest in developing membrane with good thermal stability.In this project a new graphene proton conducting polymer memebrane was developed and tested for water splitting in acid electrolyzer.

HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the Requirements for the Award of Degree of Bachelor of Science in Chemistry 2021-2024

BY

AEINJANA DIXON

CCAVSCH026

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

V.T JOY

ASSOCIATE PROFESSOR

HEAD ,DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CHRIST COLLEGE, IRINJALAKUDA

(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled "**HYDROGEN PRODUCTION BY ELECTROCHEMICAL WATER SPLITTING USING REDUCED GRAPHENE OXIDE MEMBRANE AS A SEPARATOR**" is an authentic record of study carried out by AEINJANA DIXON (Reg. No. CCAVSCH026) as a part of BSC Project during the year 2021-2024 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date: 11-04-2024

Dr. V.T JOY

Associate Professor

Head ,Department of Chemistry

Christ College, Irinjalakuda

Dr. Joy V.T.
Associate Professor & Head,
Department of Chemistry,
Christ College, Irinjalakuda - 680125

Dr. Bijoy P Mathew
Vimala College, TCR

DECLARATION

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I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda

Date : 11-04-2024

AEINJANA DIXON

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr.V.T Joy, Associate Professor, Head,Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to all other teaching and non teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

AEINJANA DIXON

CONTENTS

ABSTRACT

Hydrogen production by membrane water splitting teachnologies is a sustainable method to synthesis hydrogen and provides an alternative to hydrogen production instead of conventional process of synthesizing hydrogen from steam methane reforming.Currently Nafion is mainly used as membrane for water splitting.However,the high cost of purchasing Nafion membrane and inability to execute electrolysis operational above 90^0C has sparked interest in developing membrane with good thermal stability.In this project a new graphene proton conducting polymer memebrane was developed and tested for water splitting in acid electrolyzer.

GREEN SYNTHESIS OF SILVER NANOPARTICLE USING *Dipteracanthus prostrata.*

Project work

Submitted to Christ College (Autonomous), Irinjalakuda (University of Calicut) in partial fulfilment of the requirements for the award of Degree of

BACHELOR OF SCIENCE IN

CHEMISTRY

Submitted by

ANLEE BENNY

Reg No: CCAVSCH027

2021-2024

P.G RESEARCH DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

THRISSUR-680125

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

(Nationally accredited at A++ level by NAAC & affiliated to university of Calicut)

CERTIFICATE

Certified that the project report entities "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide record of work at our laboratory (Christ college Irinjalakuda) by Miss. ANLEE BENNY, CCAVSCH027 - final semester B.Sc. Chemistry student of this institution under my supervision in partial fulfilment of the requirements for the degree of Bachelor of Science in Chemistry of Christ College (Autonomous), Irinjalakuda (University of Calicut).

IRINJALAKUDA

APRIL 2024

Dr. RANI VARGHESE
Department of chemistry
Christ College, Irinjalakuda

Dr. Bijoy P Mathew
Vimala College, TCR

Dr.RANI VARGHESE
ASSISTANT PROFESSOR
PG & RESEARCH DEPT. OF CHEMISTRY
CHRIST COLLEGE, IRINJALAKUDA

DECLARATION

I hereby declare that this project report titled "**GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Dipteracanthus prostrata***" is a bonafide work done by me and this work has not previously formed basis for the award of any other academic qualification, fellowship or other similar title of any other University or board.

Place : Irinjalakuda
Date 08-04-2024

ANLEE BENNY

ACKNOWLEDGEMENT

I extend my sincere and heartfelt gratitude to my project guide Dr. Rani Varghese, Assistant Professor, Department of chemistry, Christ College (Autonomous), Irinjalakuda for her valuable and inspiring guidance, critical assessment and constant encouragement at all stages of this project. I am greatly indebted to her for the completion of this work in the specified period.

I express my sincere thanks to Dr. V T Joy, Head, PG and Research Department of Chemistry, for granting permission to carry out my project. I would like to express my gratitude to all the faculty members in the Department of Chemistry for their inspiration and guidance to complete this work.

I wish to acknowledge my gratitude to Rev. Dr. Jolly Andrews, C.M.I, Principal of Christ College (Autonomous), Irinjalakuda and Library staff of the Christ College for providing the timely help and necessary facilities.

I cheerfully express my profound thanks to all my classmates for their support and co-operation. Above all I humbly thank God Almighty, whose sustaining grace has been sufficient for me to complete this endeavor.

ANLEE BENNY

CONTENTS