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To
My Beloved
Aama

DECLARATION

I, MR. PRANESH RAI, Reg. No. Ph. D/Chem. (1278)/R-2020 a research scholar of the Department of Chemistry, University of North Bengal, Darjeeling, West Bengal, hereby declares that the thesis entitled **“BIOLOGICAL AND CATALYTIC ACTIVITIES OF SOME TRANSITION METAL COMPLEXES OF IONIC LIQUID-SUPPORTED LIGAND SYSTEM”** is my work and to the best of my knowledge, it neither contains materials previously published or written by any other person, nor it has been submitted for any other degree/diploma or any other academic award anywhere before. I have used the originality checking service to prevent inappropriate copying.



MR. PRANESH RAI

Research Scholar

Department of Chemistry

University of North Bengal

Darjeeling-734013

West Bengal, India

Date: 29/05/20

DR. BISWAJIT SINHA
Professor
Department of Chemistry
University of North
Bengal
Darjeeling-734 013
West Bengal, INDIA



समानो मन्त्रः समितिः समानी

Phone: +91-353-2776381
Mobile: 99327-38973/
96419-67211
E-mail Id:
biswachem@gmail.com
biswachem@nbu.ac.in

CERTIFICATE

This is to certify that the thesis entitled “**BIOLOGICAL AND CATALYTIC ACTIVITIES OF SOME TRANSITION METAL COMPLEXES OF IONIC LIQUID-SUPPORTED LIGAND SYSTEM**” submitted by Mr. PRANESH RAI to the University of North Bengal, Darjeeling, West Bengal, for the award of the degree of Doctor of Philosophy is authentic documentation of the research conducted by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

Biswajit Sinha
Prof. Biswajit Sinha
Department of Chemistry
University of North Bengal

Dr. Biswajit Sinha
Professor, Department of Chemistry
University of North Bengal
Darjeeling-734013, West Bengal, India

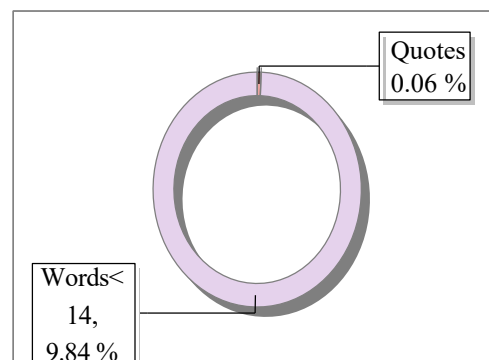
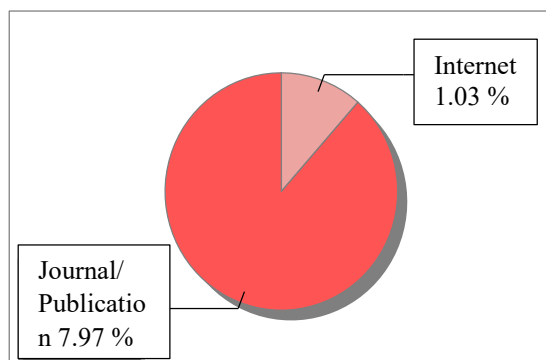
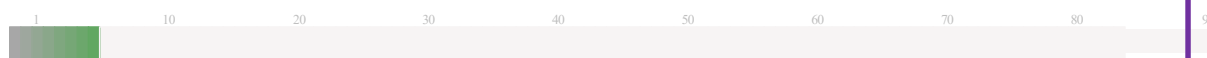


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Pranesh Rai

(Signature of the Scholar)

Bikash Kumar
Prof. Dr. Bikash Kumar
Department of Chemistry
University of North Bengal

(Signature of the Supervisor)

PREFACE

After a long gap of seven years, I decided to pursue research work in Chemistry with full motivation to understand a bit more about the subject thus, seeking growth in it. So, I started my Ph.D. journey in September 2017 by joining the organic synthesis lab. After almost working for two years I happened to change the route of my journey towards the synthesis of transition metal complexes. I thus had to restart my journey which I did in January 2019. And it took me five years and four months to reach this point where I am writing my Ph.D. Thesis. During this wonderful journey, I met many fellow brothers-sisters, faculty, and non-faculty members who helped and taught me many life-long lessons.

Now regarding my work, I worked on the synthesis of ionic liquid-supported Schiff base ligand systems and some of their transition metal complexes, followed by determining their biological and catalytic activities. During this, what I have found is that designing the ligand system is the most fundamental step in the synthesis of transition metal complexes because it controls the overall properties of the metal complex to a greater extent compared to that of metal ions present in it. Also, drawing a scheme for synthesizing a ligand is much easier than actually producing it. Further, the characterization of the synthesized compounds is a tedious job. Thus, the knowledge of important tools that are necessary and sufficient to well characterize the compounds is crucial. In my case, I mainly rely upon Magnetic Susceptibility Balance, UV-visible spectrometer, FTIR Spectrometer, NMR Spectrometer, HRMS, MALDI spectrometer, and PXRD tools. Once the synthesized compounds are well characterized then they are ready to test their applicability in biological science and catalysis. For instance, the Pd(II) complex successfully catalyzes the Suzuki reaction at room temperature under aerobic conditions within a reaction time frame of 1 hour. Similarly, Cu(II), Zn(II), and Cd(II) complexes are found to be potent against the ACHN cell line thus exhibiting their Cytotoxicity activity. The less IC_{50} values for the metal complexes compared to the free ligand system indicate a synergistic effect between the ligand system and the metal ion. This confirms that metal complexes are more potent than the free ligand system against the ACHN cell line. However, their mode of action toward the ACHN cell line has not been studied. So, a detailed study of the mechanistic pathways of their mode of action towards the ACHN cell line needs to be done. This thus may attract a good number of future researchers for the same.

In one of the projects, DFT calculations of some electronic parameters were performed. The results obtained were in good agreement with the experimentally obtained data.

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First and foremost, praises and thanks to God, the Almighty, for His showers of blessings throughout my research work and for allowing me to complete it successfully.

I would like to express my sincere gratitude to my supervisor Prof. Biswajit Sinha, Department of Chemistry, University of North Bengal, Darjeeling for his continuous support throughout my research work. For allowing me to do research under his supervision and providing invaluable guidance throughout this research work. I am extremely grateful for what he has offered me. Besides my supervisor, I extend my sincere thanks and gratitude to all other faculty members, the Department of Chemistry, University of North Bengal, Darjeeling. Also, I would like to thank all the non-teaching staff for their cooperation and support during my research work. I sincerely thank all of my dear Research Scholar brothers and sisters. I am grateful to Prof. Sajal Das, Department of Chemistry, University of North Bengal, Darjeeling for enlightening me at the first glance of research. My sincere thanks to Prof. Pranab Ghosh for his support and help during this research work. I extend my sincere thanks to Dr. Pramod Rai, IISER, Kol., for his constant support and help during my research work. Last but not least my sincere thanks and gratitude to my beloved Aama Smt. Asha Rai for sacrificing so many things just to support and encourage me. And my papa late Krishna Rai for his spiritual guidance and support.

Mr. Pranesh Rai

Research scholar

Department of Chemistry

University of North Bengal

Darjeeling-734013

West Bengal, India

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ABBREVIATIONS

IL	Ionic Liquid
ILs	Ionic Liquids
FILs	Functionalized Ionic Liquids
TSILs	Task-specific Ionic Liquids
M. P.	Melting Point
r. t.	Room temperature
h	Hour
min	Minute
mL	Mili Litre
° C	Degree in Celsius
° A	Degree in Angstrom
IC ₅₀	Minimum Inhibition Concentration
ppm	Parts per million
AAS	Atomic Absorption Spectroscopy
MeOH	Methanol
EtOH	Ethanol
DMSO	Dimethylsulfoxide
DMSO-d ₆	Deuterated Dimethylsulfoxide
EtOAc	Ethyl acetate
mmol	Milli moles
FTIR	Fourier Transform Infrared
HRMS	High Resolution Mass Spectroscopy
¹ H NMR	Proton Nuclear Magnetic Resonance
¹³ C NMR	Carbon-13 Nuclear Magnetic Resonance
s	Singlet
d	Doublet
t	Triplet
m	Multiplet
Mol.wt.	Molecular weight

KBr	Potassium bromide
M ⁿ⁺	Metal ion
PXRD	Powder X-ray Diffraction
MALDI	Matrix assisted laser desorption/ionization
M(OAc) ₂	Metal acetate
TLC	Thin Layer Chromatography
LMCT	Ligand to Metal ion Charge Transfer
MTT	3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide
ROS	Reactive Oxygen Species
ACHN	Human renal adenocarcinoma
H ₂ DCFDA	2,7-dichlorofluorescein
PBS	Phosphate Buffer Solution
O.V.	Ortho Vanillin
DFT	Density Functional Theory
HOMO	Highest Occupied Molecular Orbital
LUMO	Lowest Unoccupied Molecular Orbital
RDG	Reduced Density Gradient
