Dedicated to all My Dear ones...

DECLARATION

I proclaim that the thesis entitled "**SYNTHESIS AND CHARACTERIZATION OF ORGANIC FUNCTIONAL MATERIALS AND STUDIES ON THEIR APPLICATIONS**" has been made and organized by me under the guidance of Prof. Pranab Ghosh, Department of chemistry, University of North Bengal. No portion of this thesis has manufactured the basis in favor of the award of any degree or fellowship formerly.

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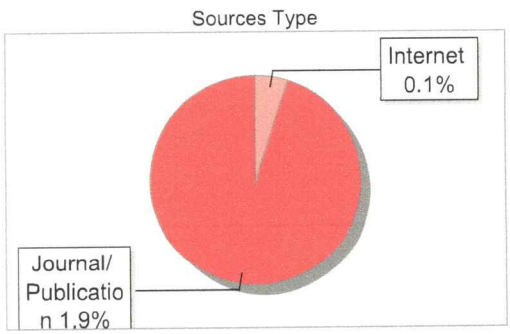
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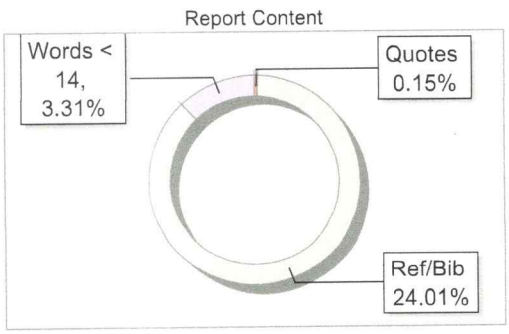
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Ultimately, even with my greatest endeavors and earnestness, I may have made a few accidental blunders and errors in my thesis. Appreciated input and critiques from knowledgeable instructors will be thankfully considered.

With Thanks,

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23/ 12/ 2024

PREFACE

Numerous pharmacologically relevant drugs have been designed using heterocyclic substances. These compounds have a significant impact on the agrochemical sectors as well. In addition, they are thought to be strong building blocks for the synthesis of naturally discovered substances with biological convenience, such as, heterocyclic materials, glycosides, and amino acids.

Reduced friction and wear in between two movable exteriors, heat elimination, pollutant suspension, and other fundamental operations are the main objectives of lubricants. There are further uses for automobiles and industries in addition to these. Essentially, lubricant is a mixture of as much as a 30% additive packaging and lubricating oil. Additives may bring novel features to lubricating oil or improve the ones that already present. They are made up of a vast range of compounds, contingent upon the particular qualities they add. The need for multipurpose additives has grown significantly in recent years. The author of this compilation has synthesized a few multimodal lubricant additives and assessed how well they operate as additions in various base oils. Moreover, the methods for creating a wide variety of biologically relevant heterocyclic compounds are described in this documentation.

In **Chapter I**, after detailed introductory discussion about **Biologically multi - dynamic Organic Molecules as Functional Materials: Their Synthesis and Characterization,** followed by background and entire literature survey, **Section A** has represented, A Rarely Explored, Robust, Green Catalyst, named Humic Acid mediated Solvent-Free, One - pot Synthesis of 4*H*-Benzo[4,5]thiazolo[3,2-*a*]pyrimidine-3-carboxylate from benzaldehyde, 2-aminobenzothiazole and ethylacetoacetate; and the synthesis of Benzo[*d*]thiazole from benzaldehyde and 2-aminothiophenol. After that, **Section B** has depicted, A supramolecular, ecological and robust catalyst, named Beta – Cyclodextrin (β-Cyclodextrin) mediated Solvent–Free Synthesis of 3,3'–(phenylmethylene)bis(2-hydroxynaphthalene-1,4-dione) from a number of aldehydes and 2-hydroxy-1,4-naphthoquinone (Lawson Reagent) via simple Nucleophilic Addition Reaction and the synthesis of 4,4'-(phenylmethylene)bis(3-methyl-1-phenyl-1H-pyrazol-5-ol) from a number of aldehydes and 3-methyl-1-phenyl-1H-pyrazol-5-ol via simple nucleophilic addition (Knoevenagel Michael addition) Reaction.

In **Chapter II**, general introductory explanation about **Wide-ranging analysis of polymeric exploration, synthesis and evaluation,** followed by the detailed discussion of the background of the present study, **Section A**, has depicted the analysis of Synthesis and

Performance Evaluation of Castor oil – Styrene Co-polymer in the form of an Outstanding Multipurpose Directional Lubricant Additive along with thorough characterizations. Next in **Section B**, in details study of Evaluation and Synthesis of Environmentally Benign Multifunctional behenyl acrylate and citral based polymer Additives for Lube Oil along with characterization has incorporated. After that, **Section C**, has represented elaborately, Synthesis, efficacy, followed by entire Characterization of Octadecyl acrylate and citral based polymers and this is a comparative study on their performances as Biodegradable Multifunctional Lube Oil Additives.

Overall, the current study has conveyed a little but some honest contribution on to the unbounded spectrum of Sustainable Developmental aspiration.

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List of Research Publications

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Poster & Oral Presentations

APPENDIX A

List of Research Publications:

- **Manishita Nandi**, Bijeta Mitra, and Pranab Ghosh, "Humic acid: a rarely explored, robust, green catalyst for solvent-free synthesis of 4H-benzo [4, 5] thiazolo [3, 2-*a*] pyrimidine-3-carboxylate and benzo [*d*] thiazole." ***Research on Chemical Intermediates***, 2024, **50,** 4, 1757-1775.

- **Manishita Nandi** and Pranab Ghosh, "Evaluation and Synthesis of Environmentally Benign Multifunctional Additives for Lube Oil." ***Asian Journal of Chemical Sciences,*** 2024, **14,** 1, 42-49.

- **Manishita Nandi,** Passang Tshering Lepcha and Pranab Ghosh, "Synthesis and Performance Evaluation of Castor Oil – Styrene Co – Polymer: An Outstanding Multipurpose Directional Lubricant Additive", ***Asian Journal of Green Chemistry****,* 2023, **7,** 269-282.

- **Manishita Nandi,** Sultana Yeasmin and Pranab Ghosh, " Synthesis of behenyl acrylate and citral based polymers: A comparative study on their performances as biodegradable multifunctional lube oil additives", ***Journal of Emerging Technologies and Innovative Research,*** 2024, **11,** 3, b218-b224

Under the process of Communication:

- A Review Article, on the topic, "Expository Analysis regarding Flow Enhancers for Reliable Crude Oil Transportation in Midstream Pipelines", **Manishita Nandi**, Pranab Ghosh.

- Beta – Cyclodextrin (β-Cyclodextrin) mediated Solvent–Free Synthesis of 3,3'–(phenylmethylene)bis(2-hydroxynaphthalene-1,4-dione) and 4,4'-(phenylmethylene)bis(3-methyl-1-phenyl-1H-pyrazol-5-ol), **Manishita Nandi**, Bijeta Mitra, Pranab Ghosh

APPENDIX B

Poster Presentation

- Poster representation in the INTERNATIONAL SEMINAR **(2020)** OF FRONTIERS IN CHEMISTRY, ON THE TOPIC, **"Olean12(13), 15(16)-diene,Olean-12(13), 15(16)-dien-3β-olandolean-15(16)-en-11*α*-ol: Isolation, characterization and evaluation of their biocidal activity"**.

Oral Presentation

- Oral Presentation in the INTERNATIONAL SEMINAR **(2023)** OF FRONTIERS IN CHEMISTRY AND PROF. C. N. R. RAO ENDOWMENT LECTURE; ON THE TOPIC, **"Solvent-Free Synthesis of 4*H*-Benzo[4,5]thiazolo[3,2-*a*]pyrimidine-3-carboxylate, using Humic Acid: A Rarely Explored, Robust, Green Catalyst"**

ABBREVIATIONS

Abbreviation	Full Form
AA	Alternaria alternata
AFM	Atomic Force Microscopy
AIBN	Azobisisobutyronitrile
AO	Antioxidant
ASTM	American Society for Testing and Materials
ASTMD	ASTM Standard D
AW	Anti-Wear
AV	Acid Value
BBO	Broad band Observe
BO	Base Oil
BPL-400B	Butane Propane Lubricant - 400B
BZP	Benzoyl Peroxide
CB	Alkyl Cyanobiphenyl
CBP	Cetyl Pyridinium Bromide
CC	Colletotrichumcamelliae
CD	Cyclodextrin
CE	Curvulariaeragrostidis
CG	Colletotrichum gloeosporioides
CPC	Alkylcyanophenyl Cyclohexane
DD	Disc Diffusion
DDQ	2,3-Dichloro-5,6-dicyano-1,4-benzoquinone
DMF	Dimethylformamide
ECB	Alkoxycyanobiphenyl
EVA	Ethylene Vinyl Acetate
FA	Fatty Acid
FBWT	Four Ball Wear Test
FE	Field Emission
FI	Flow Improvers
GC	Gas Chromatography

GPC	Gel Permeation Chromatography
HPLC	High-Performance Liquid Chromatography
IOCL	Indian Oil Corporation Limited
ISO	International Organization for Standardization
LOA	Loss on Aging
MCM-41	Mesoporous Silica Material
MLC	Multilayer Coating
MMT	Montmorillonite
MUFA	Monounsaturated Fatty Acid
MW	Microwave
MWD	Molecular Weight Distribution
NPC	Nano Particles
OEM	Original Equipment Manufacturer
OCP	Olefin Copolymer
PBR	Polybutadiene Rubber
PDI	Polydispersity Index
PE	Polyester
PEB	Poly(ethylene-butene)
PIB	Polyisobutylene
PMAA	Poly(methyl acrylic acid)
PMA	Poly(methyl acrylate)
ppm	Parts Per Million
PPt	Pour point
PUFA	Polyunsaturated Fatty Acid
PVC	Polyvinyl Chloride
PWL	percentage weight loss
RT	Room Temperature
SBD	Sequential Biodegradation
SAE	Society of Automotive Engineers
SBC	Styrene-Butadiene Copolymer
SBA	Santa Barbara Amorphous
SBA-15@ELA	Santa Barbara Amorphous-15 Functionalized with Elaidic Acid
SBT	Soil Burial Test

SIP	Hydrogenated Styrene Isoprene Copolymer
SST5R	Small Molecular Somatostatic Receptor Subtype 5 Antagonist
TBAHS	Tetrabutylammonium Hydrogen Sulfate
TEBFs	Tetrahydro Epoxyetheno Benzo-Furan Propellanes
TFA	Trifluoroacetic Acid
TGA	Thermo Gravimetric Analysis
THF	Tetrahydrofuran
TMSCl	trimethylchlorosilane
TLC	Thin Layer Chromatography
VM	Viscosity Modifier
WIL-471	Lubricant Grade 471
WSD	Wear Scar Diameter