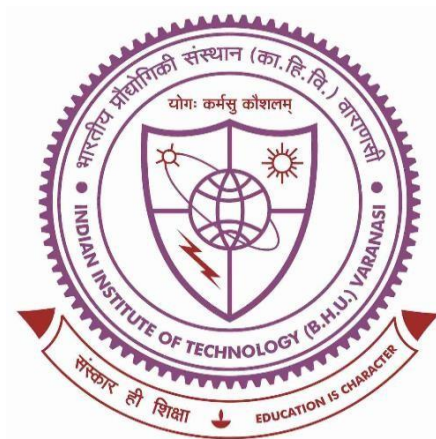


# Green and Benign Strategies for Efficient Synthesis of Heterocyclic Compounds



Thesis submitted in partial fulfillment  
for the Award of Degree

**Doctor of Philosophy**

By

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**Year: 2024**



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to  
My Family***

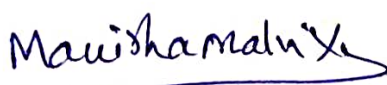
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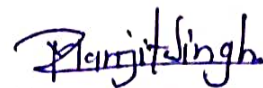
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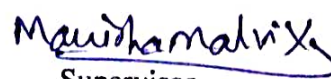
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## List of Notation, Symbols and Abbreviations

Notation	Abbreviation
<i>et al.</i>	et alia, Latin for “and others
<i>i.e.</i>	That is
e.g.	Example
etc.	Et cetera, Latin for "and other similar things"
Fig.	Figure
mL	Milliliter
mg	Milligram
g	Gram
cm	Centimeter
Hz	Hertz
min	Minute
h	Hour
aq.	Aqueous
s <sup>-1</sup>	Per Second
m.p.	Melting point
viz.	Namely
IR	Infrared
NMR	Nuclear magnetic resonance
TMS	Tetramethylsilane
R <sub>f</sub>	Retardation Factor
HRMS	High resolution mass spectroscopy
MHz	Megahertz
rt	Room temperature
ppm	Parts per million
brs	Broad
Calc.	Calculated

Obser.	Observed
o	ortho
<i>p</i>	para
dil.	Diluted
approx.	Approximate
Equiv.	Equivalent
tert.	Tertiary
d	Doublet
m	Multiplet
q	Quartets
s	Singlet
t	Triplet
MW	Micro wave
m.f.	Molecular formula
V	Volume
vs.	Versus
sec	Second
CH <sub>3</sub> CN	Acetonitrile
EtOAc	Ethyl acetate
OH	Hydroxy
I <sub>2</sub>	Molecular iodine
TBN	<i>tert</i> - butyl nitrite
TEMPO	(2,2,6,6-tetramethylpiperidin-1-yl)oxyl
DMAP	4-Dimethylaminopyridine
Na <sub>2</sub> SO <sub>4</sub>	Sodium sulfate
TLC	Thin layer chromatography
D <sub>2</sub> O	Deuterium oxide
CDCl <sub>3</sub>	Deuterated chloroform
CHCl <sub>3</sub>	Chloroform
MeOH	Methanol

DCE	Dichloroethane
DMF	N, N-Dimethyl formamide
DMSO	Dimethyl sulfoxide
THF	Tetrahydrofuran
PhMe	Toluene
Py	Pyridine
AgOTf	Silver trifluoro methane sulfonate
PPh <sub>3</sub>	Triphenylphosphine
CuCl	Copper(I) chloride
MgFe <sub>2</sub> O <sub>4</sub>	Magnesium Ferrite
PTSA	<i>p</i> -Toluenesulfonic acid
NH <sub>4</sub> Cl	Ammonium chloride
SiO <sub>2</sub>	Silicon dioxide
FeCl <sub>3</sub>	Iron (III) chloride
H <sub>2</sub> SO <sub>4</sub>	Sulphuric acid
ZrCl <sub>4</sub>	Zirconium tetrachloride
SOCl <sub>2</sub>	Thionyl chloride
NaNCS	Sodium thiocyanate
Fe <sub>3</sub> O <sub>4</sub>	Iron (II, III) oxide
VOCs	Volatile organic solvent
MCRs	Multi component reaction
MgO	Magnesium oxide
InCl <sub>3</sub>	Indium (III) chloride
PHI(OAC) <sub>2</sub>	(Diacetoxyiodo) benzene
AcOH	Acetic acid
NBS	N-Bromo succinimide

## Symboles used

Symboles	Used
$\alpha$	Alfa
$\beta$	Beta
$\gamma$	Gamma
$^{\circ}\text{C}$	Degree Celsius
K	Kelvin
$\sigma$	Sigma
$\mu$	Micro
$\Delta$	Delta uppercase
©	Copyright
$\delta$	Delta
>	Greater than
<	Less than
%	Percentage
Å	Angstrom
$\lambda$	Lambda
&	And
$\pi$	Pi
$\pm$	Either plus or minus

## General Experimental Considerations

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All solvents and chemicals were purchased from commercial sources (Sigma Aldrich, Alfa Aesar, and Avra) and used without further purifications, unless otherwise stated. **Thin-layer Chromatography (TLC)** was performed on glass plates (7.5 × 2.5 and 7.5 × 5.0 cm) coated with Merck silica gel GF 254 using various combinations of ethyl acetate and *n*-hexane as an eluent. Visualization of spots was accomplished either in **iodine chamber or by exposure to UV light**. The **column chromatography** was performed on silica-gel (60-120 mesh) using various combination of ethyl acetate and *n*-hexane eluents. **Melting points** of the products were measured through staurt SMP10 melting point apparatus (range 0 °C-300 °C) using an open capillary tube. **IR spectra** were recorded on Perkin-Elmer Spectrum 100 FT-IR spectrophotometer. **<sup>1</sup>H** and **<sup>13</sup>C NMR** spectra were recorded on Bruker Avance 500 MHz spectrometer in CDCl<sub>3</sub> and DMSO-*d*<sub>6</sub> as solvent and Tetramethylsilane (TMS) as an internal standard at 298 K, chemical shifts are given in ppm. **High resolution mass spectra (HRMS)** for all the compounds were measured on water's Quattro Micro V 4.1. **Ultrasonic irradiation** was performed using Sonics Vibra Cell Ultrasonic Processor Model VCX750 (Sonics & Materials, Inc.) with a fix power of 750 W and 20% amplitude and a tapered micro tip was used as ultrasonic probe operating at a frequency of 20 kHz. **Elemental analysis** was done by Eurovector EA3000 elemental analyzer.

## Preface

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Heterocyclic compounds are abundant in nature and they have important role in human life as they are present in vitamins, hormones, antibiotics and pigments. A vast number of nitrogen, oxygen and Sulphur containing heterocyclic compounds show biological activities and are used as key building blocks to develop compounds of biological or medicinal interest to organic chemists. Heterocyclic compounds are present in many biologically important moieties out of them some of the main scaffolds are thiadiazols, coumarin, imidazo[1,2-a] pyridines and 4-*H* pyran. In this context, the thesis entitled “**Green and Benign Strategies for Efficient Synthesis of Heterocyclic Compounds,**” will introduce various approaches for the synthesis of these heterocyclic compounds. **Chapter 1** will provide a general introduction and literature review of synthesis and applications of some main class of heterocyclic compounds. **Chapter 2** In this chapter, we have discussed a new synthetic method for the preparation of coumarin derivatives from *o*-cresols and active methylene compounds under metal and catalyst-free condition using beta-cyclodextrin as a green catalyst with the equimolar ratio of ethanol: water (**1:1**) reaction medium. **Chapter 3** is concerned with the development of novel, facile, efficient and scalable route for the synthesis of imidazo[1,2-a] pyridines. **Chapter 4** In this chapter, we have developed a facile, efficient and scalable protocol to successfully achieve the 6,7-dihydrobenzofuran-4(5H)-ones. **Chapter 5** Describes a completely eco-friendly and straightforward protocol for the biologically important synthesis of trisubstituted thiazole derivatives by the reaction of easily available starting materials barbituric acid, acetophenone and aryl thioamides in the presence FeCl<sub>3</sub>.6H<sub>2</sub>O and O<sub>2</sub>(Air) in DMF solvent.