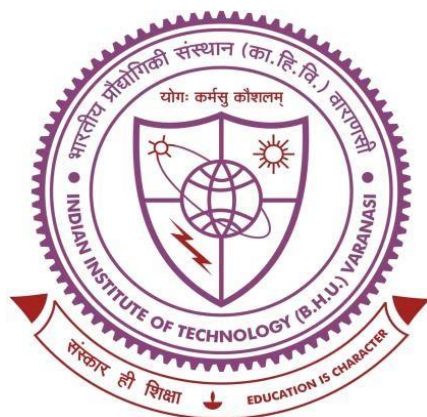


Green Approaches for the Synthesis of Some Biologically Relevant Nitrogen-Containing Organic Compounds



Thesis submitted in partial fulfilment for the
Award of Degree

Doctor of philosophy

By

Vishal Singh

DEPARTMENT OF CHEMISTRY
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Year 2024

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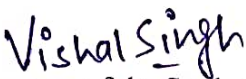
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Vishal Singh
Vishal Singh

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List of Notations, Symbols and Abbreviations

Notations	Abbreviations
et al.	:et alia, Latin for “and others”
β	:Beta
<i>o</i>	:Ortho
<i>m</i>	:Meta
<i>p</i>	:Para
Boc	:Di- <i>tert</i> -butyl dicarbonate
[bmim][BF ₄]	:1-butyl-3-methyl-imidazolium tetrafluoroborate
Bu ^t OK	:Potassium tert-butoxide
CHCl ₃	:Chloroform
CH ₃ CN	:Acetonitrile
CMCSO ₃ H	:sulfonated carboxymethylcellulose (SCMC)
chitosan@Fe ₃ O ₄	: Chitosan supported Fe ₃ O ₄
Cs ₂ CO ₃	:Caesium carbonate
DCE	:Dichloroethane
DMSO	:Dimethylsulfoxide
DDQ	:2,3-Dichloro-5,6-dicyano-1,4-benzoquinone
EDAX	:Energy dispersive X-ray
Fe ₃ O ₄ @Cu- β -CD	:Fe ₃ O ₄ particles modified by β -cyclodextrin
<i>s</i> -Fe ₃ O ₄	:starch functionalized magnetite nanoparticles
EtOAc	:Ethyl acetate
Et ₃ N	:Triethyl amine
Er(OTf) ₃	:Erbium(III) triflate
FeCl ₃	:Iron(III) chloride
FePO ₄	:Iron(III) phosphate
H ₅ BW ₁₂ O ₄₀	:Tungstoboric acid
H ₂ O ₂	:Hydrogen peroxide
h	:Hour(s)
I ₂	:Iodine
IR	:Infrared radiation
In ₂ O ₃	:Indium(III) oxide
KI	:Potassium iodide
K ₂ S ₂ O ₈	:Potassium persulfate
K ₂ CO ₃	:Potassium carbonate
LnCl ₃	:Lanthanum chloride
MgO	:Magnesium oxide
MPMS	:Mission Planning and Monitoring System
mg	:Milligram

NH ₂ NH ₂	:Hydrazine hydrate
NaOH	:Sodium hydroxide
NH ₄ OAc	:Ammonium acetate
NH ₄ Fe(SO ₄) ₂	:Ammonium iron(III) sulfate
NiCl ₂	:Nickel(II) chloride
NH ₂ OH. HCl	:Hydroxyl amine hydrochloride
O ₂	:Oxygen
P ₂ O ₅	:Phosphorus pentoxide
P-TSA	: <i>p</i> -Toluenesulfonic acid
PEG-400	:Polyethylene glycol
P ₂ O ₅ /SiO ₂	:P ₂ O ₅ supported on SiO ₂
PhI(OAc) ₂	:2-Iodoxybenzoic acid
[PVPH]ClO ₄	:poly(vinylpyrrolidonium) perchlorate
PCl ₅	:Phosphorus pentachloride
RT	:Room temperature
SEM	:Scanning electron microscopy (SEM)
TBHP	: <i>tert</i> -Butyl hydroperoxide
TLC	:Thin-layer chromatography
TsOH	: <i>p</i> -Toluenesulfonic acid
TEM	:Transmission electron microscopy
TBHP	: <i>tert</i> -Butylhydroperoxide
THF	:Tetrahydrofuran
TAP-Cu	:Triazole-Phosphine-Copper
UHP	:Urea hydrogen peroxide
XRD	:X-ray diffraction (XRD) pattern
ZnO	:Zinc oxide
ZnClO ₄	:Zinc perchlorate

Instrumentation and Materials

Melting points were measured using the Buchi apparatus in open capillary tubes and were uncorrected. **IR spectra** were recorded on the Perkin Elmer FT-IR Spectrophotometer. (ν_{\max} expressed in cm^{-1}). **The ^1H and ^{13}C -NMR spectra** were recorded on a Bruker-500 Avance Spectrometer in DMSO-d_6 and CDCl_3 . Chemical shifts are given in δ ppm, using tetramethyl silane (TMS) as an internal standard. **X-ray diffraction (XRD)** patterns of dried powder samples were recorded on Rigaku Mini-X 600 (Japan) from 2θ value 10° – 90° (scan rate of 1° per min) with step size 0.02. **SEM analysis** was done by EVO - Scanning Electron Microscope MA15 / 18. **TEM analysis** was carried out by using a FEI-Tecnai-G2 Transmission electron microscope. **EDAX analysis** was analyzed by EDX (Oxford instrument; USA). **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. Merck silica gel (100-200 mesh) was used for column chromatography (approximately 15-20 g per 1 g of the crude product).

All the chemicals and solvents were procured from Aldrich, USA and E. Merck, Germany and were used as received. The preparation and particulars of the substrates employed for the work undertaken are given in their respective chapters.

Preface

Nitrogen is a naturally occurring element that is essential for the growth and development of both plants and animals. It is found in proteins, nucleic acids and in several other organic and inorganic compounds. A vast number of nitrogen-containing heterocyclic compounds have found applications in pharmaceutical research, agriculture science and drug discovery. Nitrogen is a part of several functional groups such as amines, imines, amides, oximes etc. and biologically relevant heterocyclic compounds like pyrrole, pyridine, pyrimidine, indole, benzimidazole, and benzoxazoles. In this context, the thesis entitled “**Green Approaches for the Synthesis of Some Biologically Relevant Nitrogen-Containing Organic Compounds**” will introduce various aspects of the synthesis of nitrogen-containing organic compounds.

Chapter 1 will provide a general introduction and literature review of the synthesis and applications of some main class of nitrogen-containing organic compounds. Chapter 2 will describe transamidation of secondary carboxamides and the amidation of esters facilitated by magnetic Co@NC nanoparticles, under neat conditions. Chapter 3 will describe microwave-assisted Chemoselective transamidation of secondary amides by selective N-C(O) bond cleavage under catalyst, additive and solvent-free conditions. Chapter 4 will highlight A green approach for the synthesis of 2-Oxo-1,2,3,4-tetrahydropyrimidines through oxidative functionalization of methyl arenes/benzyl derivatives via *in situ* generated urea. Chapter 5 will describe montmorillonite K-10 catalyzed synthesis of Hantzsch dihydropyridine derivatives from methyl arenes via *in situ* generated ammonia under microwave irradiation in neat conditions.