

Fig a. Effect of bacteria (*O. pseudogrignonense* RJ12) on proline activity, a. black gram, b. green pea.

- ❖ Pot and field experiments were conducted on different host plants (black gram, green pea, rice etc.) with the three rhizobacterial strains where significant effects on root/shoot length, leaf area, plant height etc. and higher antioxidant enzyme activities as well as elevation of proline content was recorded. The yield amounts were also significantly improved in treatment compared to the controls.



Fig. A field study of bacterial strains with (a) Green pea and (b) Black gram winter season.

Project Title: S&T interventions to combat malnutrition in women and children

Project No: BSC-125

Funding Agency: CSIR, New Delhi

PI & Members: Dr Siddhartha Proteem Saikia (PI), Mr T H Ahmed

Objective:

- ❖ Assessment of the nutritional status and dissemination of the identified technologies to alleviate malnutrition.
- ❖ Create awareness of the identified technologies amongst the poor villagers of the targeted villages.
- ❖ Build a self-sustainable model in the targeted villages.

Salient Achievements:

- ❖ The beneficiaries trained under the project for mushroom cultivation are ready to showcase

their products. Nutra Readymix from Komal Chaul (Soft Rice) and pigmented rice developed. Few beneficiaries have become successful entrepreneur. In our demonstration of the developed technologies, 150 households have been benefitted under the project. A self-sustainable model has been developed in the target village.



Fig. Ms. Ashima Begum, who is a successful entrepreneur and her value added products developed from mushroom.

Project Title: Biocatalyst for industrial application & green organic synthesis (BIAGOS)

Project No: CSC-106

Funding Agency: CSIR, New Delhi

PI & Members: Dr Sawlang Borsingh Wann (PI)

Salient Achievements:

- ❖ Isolated 150 fungal strains from forest soil samples collected from Gibbon Wildlife Sanctuary, Jorhat.
- ❖ The selected fungal strains were screened for biotransformation of Artemisinin. Detection of transformed product was done through TLC (thin layer chromatography) using ethyl acetate and hexane in the ratio 1:5 (EA/Hexane) as solvent.
- ❖ Out of the 40 strains selected, 4 strains were able to produce metabolite polar than artemisinin while doing TLC.
- ❖ One strain (4RB2) was selected for biotransformation and extraction of compound was done using fungal broth culture containing Artemisinin.
- ❖ The unknown crude product was purified by Column Chromatography and purity checked by TLC in Ethyl acetate: Hexane (8:2).
- ❖ Unknown product was characterized by ¹H NMR, ¹³C NMR, Mass & IR spectroscopy and was identified as Deoxyartemisinin, a derivative of artemisinin.
- ❖ The strain 4RB2 is identified as *Penicillium citrinum* (MTCC12422), a commonly occurring filamentous fungus.

Project Title: Development of sustainable processes for edible oils with health benefits from traditional and new resources

Project No: CSC-112

Funding Agency: CSIR, New Delhi

PI & Members: Dr Siddhartha Proteem Saikia (PI), Dr D Banik, Ms R Kotoky

Salient Achievements:

Seed samples of 90 unexploited tree borne oilseeds of forest origin for edible and non-edible applications were screened out of which 12 has been identified as leads which showed oil yield in the range of 35-50%. The seeds of *Dysoxylum excelsum* Blume (50.31%), *Cinnamomum impressinervium* Meisn. (48.41%), *Litsea cubeba* (Lour.) Pers. (45.02%), *Magnolia champaca* (L.) Baill. ex Pierre (41.41%), *Couroupita guianensis* Aubl., *Chisocheton cumingianus* subsp. *balansae* (C.DC.) Mabb. (40.20%), *Terminalia bellirica* (Gaertn.) Roxb. (38.94%), *Litsea glutinosa* (Lour.) C.B. Rob., *Cinnamomum obtusifolium* (Roxb.) Nees (38.07%), *Garcinia morella* (Gaertn.) Descr. (37.96%), *Sapindus mukorossi* Gaertn. (35.25%), *Chrysophyllum roxburghii* G. Don (35.19%), showed above 35% oil yield.

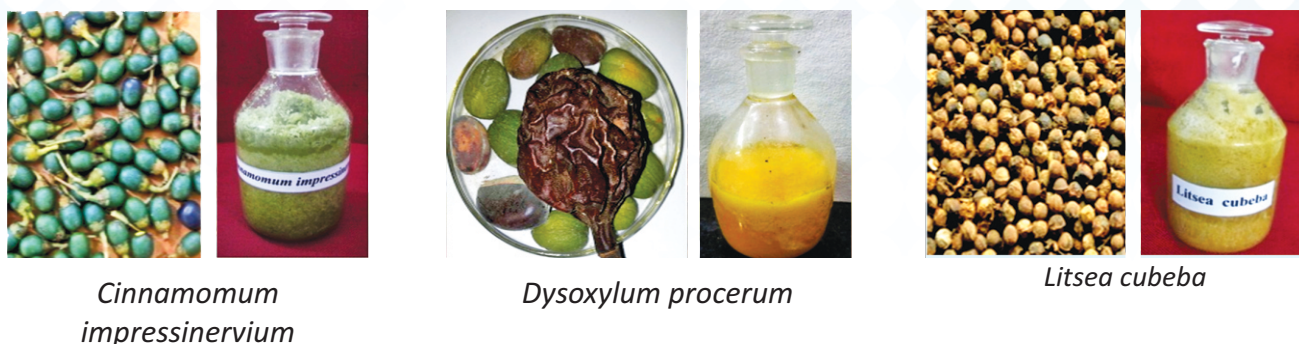


Fig. Most Promising Results

Project Title: BioEn

Work Component at NEIST, Jorhat: Screening of efficient algal species from North East India for biomass culture to be utilized for biofuel/biodiesel production.

Project No: CSC-116

Nodal Lab: IIP, Dehrradun

Funding Agency: CSIR, New Delhi

PI & Members: Dr Hari Prasanna Deka Boruah (Nodal Scientist), Dr A K Singh, Dr P Sengupta

Objectives:

- I. Selection and collection of efficient algal species from North East India for bio fuel production.
- II. Culture of algal species and standardize the parameters for maximum biomass production.
- III. Mass culture production in photo bioreactors and in natural condition.
- IV. Mass culture production for biomass and harvesting of cells for the concern laboratory for bio fuel/ biodiesel production.

Salient Achievements:

- ❖ Screened eight potential strains namely Chlorella S2, Chlorella emersonii S13, Scenedesmus sp. S1., Selenestrum sp. A6, Spirulina sp.S7, Anabeana sp.NEIST1, and Gloeocapsa sp NEIST2, Desmodesmus S10. Growth and process optimization at bench scale 1.0 L were performed. All the strains selected contain lipid 20.1 to approx 49%. Carbon content were 44 to 49% with optimal nitrogen.

❖ **Technology leads identified**

Technology Lead identified	Salient features	Current TRL	Potential for further development
Production of High biomass of <i>Chlorella emersonii</i> S13, <i>Scenedesmus</i> S1 and <i>Desmodesmus</i> S10	<ul style="list-style-type: none"> Contain high lipid, C and large cell size. Doubling time of growth ranges between 4 to 6 days. 	Laboratory scale optimization of process parameters was performed.	The strain screened has the lipid content of 20.1 to 49% which has inferred potential for large scale biomass production.

Project Title: Field demonstration of region specific medicinal & aromatic plants genotypes of CSIR for socio-economic upliftment of masses in J&K region (J&K AROMA AROGYA GRAM-JAAG).

Project No: RSP-4001

Funding Agency: CSIR, New Delhi

PI & Members: Dr Siddhartha Proteem Saikia (PI), Dr M Lal, Mr S K Chanda, Mr H Lekhak

Objectives:

- ❖ Field level demonstration of region specific superior genotypes of CSIR R&D work on Medicinal & Aromatic plants on higher scale in Jammu & Kashmir region.
- ❖ Skill development, technology transfer and employment generation through CSIR technologies.
- ❖ To provide proven business model based on CSIR MAPs technology for adoption by masses.

Salient Achievements:

- ❖ 1,99,800 slips were distributed and planted in Resi, Kathua and Jammu Districts. 61,200 slips were distributed and planted in Pallan and Said areas of Kathua district covering 2.15 Hac., 68,000 slips were distributed in Reasi district covering 2.5 Hac. And 70,000 slips were distributed in Pony Chowk, Jammu covering 2.5 Hac. A total of 7.15 Hectare area were covered by CSIR-NEIST variety Jor-Lab C-2 od citronella at different districts of J&K and number of beneficiary farmers so were ten (10) nos.

Project Title: CSIR knowledge gateway & open source private cloud infrastructure

Project No: ISC 102

Funding Agency: CSIR, New Delhi

PI & Members: Dr Jatin Kalita (PI), Dr P K Barooah, Mr K Buragohain, Mr R Deka, Mr D Bhattacharjee

Objectives:

- ❖ To enhance the capacity and capability of CSIR computing power through CSIR private cloud infrastructure and Open Source Software Technology Solution Cell (OSSTSC)
- ❖ To provide CSIR KRCs an Integrated Library Management Solution using open source Software
- ❖ To share information resources among CSIR laboratories by creating CSIR Distributed Library: catalogue sharing; inter library loans, & referral service for document supply service
- ❖ To analyze CSIR research, technology and related data using multi-dimensional analysis

Salient Achievements:

- ❖ Installation KOHA has been completed
- ❖ Customization of OSS ILMS software have been completed
- ❖ Migration of catalogue data to new ILMS (OPAC development)
- ❖ Data validation & ILMS support
- ❖ Validation of migrated data is in progress
- ❖ Integration for federated search
- ❖ Implementation of Z39.50 protocol completed
- ❖ Catalogue sharing, inter library loans, & referral service for document supply service among all CSIR labs

(ii) In-house, Grant in aid & Consultancy Projects

Project Title: In situ bioremediation technology

Project No: FTT (MLP-1001)

Funding Agency: CSIR, New Delhi

PI & Members: Dr Hari Prasanna Deka Boruah (PI)

Objectives:

- ❖ Microbial remediation of mine and oil affected sites of North-East India for Eco-restoration and Environmental Sustainability

Salient Achievements:

- ❖ Detail evaluation of the microbes for in situ conversion of oil contaminated pit water was performed. Systemic acute oral toxicology test of the bacterial strains were performed for safety of tested bacterial strains.

Project Title: Herbal product for management of pain

Project No: FTT (MLP-1002)

Funding Agency: CSIR, New Delhi

PI & Members: Dr Mantu Bhuyan (PI), Dr P K Baruah, Dr S P Saikia, Dr J C Borah, Mr S K Chanda, Mr H Lekhak, Mr D Ojha, Prof S Bhattacharya (Visva- Bharati, Santiniketan)

Objectives:

- ❖ To develop herbal product for pain management

Salient Achievements:

- ❖ Pharmacological studies have been conducted in pain model with the herbal formulation and observed significant improvement of pain. Various formulations have already been prepared and now are in the process of clinical trial.

Project Title: Bio-profiling and bio-prospecting microbes, plants and insects from North East Gene pool and their application potentials

Project No: MLP-2000

Funding Agency: CSIR, New Delhi

PI & Members: Dr Hari Prasanna Deka Boruah (PI), Dr S B Wann, Dr R Saikia, Dr J Kalita, Dr C Chikkaputtai, Dr A K Singh, Mrs A Yadav, Mrs P Bordoloi, Dr Y S Devi

Objectives:

- ❖ Survey and identification of specific niches/settings, and collection & isolation of microbes and strains. Screening & short-listing strains /metabolites/ species for potential functionalities.
- ❖ Molecular characterizations of species/metabolites following SOP.
- ❖ *in-vitro*, *in-vivo* assay of leads/hits and field scale application of consortia.
- ❖ Optimization of process parameters and developments of process/technology for gainful utilization.

Salient Achievements:

- ❖ More than 1000 bacterial isolates collected from different regions of NE India has been explored for antibacterial activities. Few promising strains will targeted further for antibacterial products.
- ❖ Full genome sequencing of *Micromonospora* sp. HK10 has been done and 7 novel secondary metabolite pathways identified. We have also identified the gene cluster encoding anti-TB drug Isoniazid analogue (2-methyl heptyl isonicotinate).
- ❖ Screening of various synthetic and natural compounds has been done for efflux pump inhibitor. Few compounds have shown good activities which will be taken for further validation.

Project Title: Creation and development bioinformatics infrastructure facility in North East India

Project No: GAP-200

Funding Agency: Department of Biotechnology (DBT), Govt. of India

PI & Members: Dr Ratul Saikia (PI & Coordinator), Dr H P Deak Boruah, Dr Y Silla Devi, Mr Robin Das

Objectives:

- ❖ To serve bioinformatics and computational facility to researchers in relation to wet laboratory experiment.
- ❖ To conduct training and workshop for promoting bioinformatics application in biological research and development.
- ❖ To strengthen the Human Resource Development in the field of Bioinformatics.

Salient Achievements:

- ❖ **Training-cum-Workshop on "Biological Data Analysis Using R":** With the support of Department of Biotechnology (DBT), Govt. of India, 2 days Training-cum-Workshop on "Biological data analysis Using R" was successfully organized at BIF Center, BSTD-Biotechnology, CSIR-NEIST on 5–6 January, 2017.
- ❖ **Monthly Bioinformatics Bulletin:** The centre is continuously publishing its monthly newsletter "Bioinformatics Upto Date" from June 2008 to till this month in NEIST official website.
- ❖ **Human Resource Development.** Under DBT-Traineeship & Studentship program, some

students, Ms Sunayana Bordoloi, Mr. Mintu Sarmah, Ms. Jahnabi Saikia, Ms. Sima Kumari Dutta, Mr. Abinash Hazarika and Ms. Mayuri Baruah had undergone in structural bioinformatics, drug design, MD simulation and other related work.

- ❖ **M. Sc. Dissertation for 6 Months** Ms. Kasmika Borah and Ms. Rasna Paul, M.Sc. 4th Semester in Bioinformatics, Dibrugarh University have completed six month dissertation.
- ❖ **Winter trainees and summer trainees.** Students from different universities/colleges had undergone training as summer trainee as well as winter trainee. (Fig below).



Fig. A view of BIF Centre of NEIST, Jorhat

Project Title: The role of the Arabidopsis DEAD-box RNA helicases, STRS1 and STRS2 in regulating responses to multiple abiotic stresses

Project No: GAP-741

Funding Agency: SERB- Department of Biotechnology (DST), Govt. of India

PI & Members: Dr C Chikkaputtaiah, (PI), Ms Indrani Baruah

Objectives

- ❖ Identification of STRS-interacting proteins (STIPs) and Determination of the protein partners of STRS1 and STRS2.
- ❖ Unravelling the direct RNA targets of STRS1 & STRS2 and elucidation of the molecular mechanism of STRS1 and STRS2 function in regulating the Arabidopsis stress responses.

Salient Achievements:

- ❖ Loss of function (reverse genetics) and over-expression analysis of the Arabidopsis DEAD-Box RNA helicases and STIPs has been completed.
- ❖ In vivo protein-protein interaction of DEAD-Box RNA helicases and STIPs was studied.

Project Title: Isolation and characterization of antifungal peptides from muga silkworm *antheraea assama* helper

Project No: GPP-290

Funding Agency: Department of Biotechnology (DBT), Govt. of India (Twinning Programme)

Collaborating University/Institute: Central Muga-eri Research & Training Institute, Central Silk Board & Indian Institute of Technology, Kharagpur, West Bengal

PI & Members: Dr Jatin Kalita (PI)

Objectives:

- ❖ Isolation and purification of anti-fungal peptides from the hemolymph of fungal challenged muga silkworm, *Antheraea assamensis* Helfer.
- ❖ Biochemical characterization of isolated anti-fungal peptides.
- ❖ Determination of mode of action anti-fungal peptides against various fungi of *Candida* and *Aspergillus* sp.

Salient Achievements:

- ❖ Antifungal assay of haemolymph of *Antheraea assamensis* (Muga Silkworm) was done by spread plate method using *Candida albicans* showed a clear zone of inhibition that observed around the well containing crude haemolymph extract and fluconazole but not around 0.1% TFA alone indicating presence of antifungal compound in the haemolymph of Muga Silkworm.

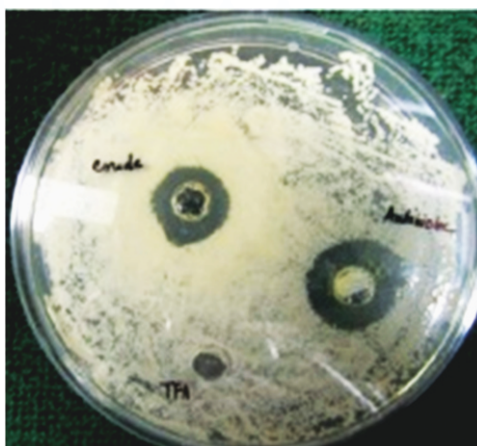


Fig. Antifungal activity of crude haemolymph extract, 20 µg fluconazole use as (+)control and TFA as (-) control

Project Title: DNA-fingerprinting of lignocellulose degrading microbes isolated from protected forest areas of Assam and Mizoram

Project No: GPP-291

Collaborating University/Institute: Mizoram University, CSIR-IMTECH and Tamil Nadu Agricultural University

Funding Agency: Department of Biotechnology (DBT), Govt. of India

PI & Members: Dr Ratul Saikia (PI), Ms P Buragohain, Ms M Kakoti

Objectives:

- ❖ Screening of microbes for lignocelluloses degradation
- ❖ Identification and genetic diversity of lignocellulolytic microbes
- ❖ Evaluation of potential isolates for production of extracellular enzymes

- ❖ Enzyme production and biomass conversion (delignification and cellulolysis) using biomass as a substrate

Salient Achievements:

- ❖ **Isolation and screening of the isolates:** During this year, we have collected 52 nos. of different samples like degrading bark, rhizospheric soil, leaf litters and elephant dung. About 800 isolates were screened against four selected enzymes (viz. cellulase, xylanase, pectinase & Laccase). Out of these isolates screened, few bacterial isolates were positive for cellulase, few isolates were positive for xylanases and some isolates were for pectinase. While in case of fungal isolates, 8 isolates were positive for cellulase and xylanases each, while 7 isolates were positive for laccase. The bacterial strains isolated from elephant dung were screened for xylanase activity. The indication of brick red colour showed the positive reaction against fungal laccase in the presence of Guaiacol (0.1%). Furthermore, hydrolytic capacity of different isolates was also determined by the ratio between the diameter of clear zone and the diameter of the colony.
- ❖ **Enzymatic assay:** We have found 34 Nos. of xylanase positive bacteria after qualitative test and among those 8 Nos. of bacteria showed highest enzymatic activity which was isolated from elephant dung.
- ❖ **Antibiotic sensitivity test:** All the positive bacterial (both xylanase and cellulase) isolates were taken to check the antibiotic sensitivity pattern on Nutrient agar medium against standard antibiotics using octadisc. A single octadisc included eight nos of antibiotic viz. chloremphenicol, erythromycin, fusidic acid, methicillin, novobiocin, penicillin-G, streptomycin and tetracycline. The positive isolates were either considered as sensitive (S), intermediate (I) or resistant (R) to an antibiotic (**Fig below**)



Fig. Antibiotic susceptibility test of few cellulase positive bacterial isolates.

Project Title: Mining the metagenome of bacterial in extreme areas of North East India

Project No: GPP-292

Funding Agency: ICAR, New Delhi

PI & Members: Dr Ratul Saikia (PI), Dr H P Deka Boruah, Mrs A Yadav

Salient Achievements:

- ❖ A natural hot water spring, Borpung of Nambor Wild Life Sanctuary, Golaghat, Assam, India is

- located within Indo-Burma Mega hotspot. DNA was extracted from the collected samples (soil and water) of natural hot water spring. The V3-V4 region of 16S rRNA gene for 30 samples (27 soil and 3 water) was sequenced using Next-Generation Sequencing techniques (Illumina HiSeq).
- ❖ Soil physico-chemical properties of the hot water spring was determined. Water temperature of Borpung was recorded 45-47°C in the month of May whereas it was found 43°C during March and pH was recorded 5 – 6. Micro and Macro-nutrients (Na, NH₄⁺, K, Ca, Mg, SO₄²⁻, Cl⁻, NO₃⁻, Fe, Mn, Zn, Cr, organic carbon, Cu and S) were determined using atomic absorption spectrophotometer (AAS) by standard protocol. The concentration of hydrazine was found to be 0.2 PPM. However, 25–45 PPM recorded in calcium hardness test and fluoride was recorded as 2 PPM. Nitrate ion and nitrite ion was found to be 0–10 PPM and 5-25 PPM respectively. Concentration of heavy metals were estimated (mg/L) in soil and water which was determined as - Na (22-709), K (30-726), Ca (10-295), NH₄⁺ (4-34), SO₄²⁻ (0-201.489), Cl⁻ (5-479) etc. (**Fig. a**).
 - ❖ Pre-processed reads from all samples were pooled and clustered into Operational Taxonomic Units (OTUs) based on their sequence similarity using Uclust program. QIIME program was used for the entire downstream analysis. Representative sequences were identified for each OTU and aligned against Greengenes core set of sequences using PyNAST Program. Then taxonomy classification was performed using RDP classifier and SILVA OTUs database. The top 10 phylum found to be dominant in the hot water spring were Actinobacteria, Bacteroidetes, Proteobacteria, Firmicutes, Chloroflexi, Cyanobacteria, Gemmatimonadetes, etc. and family of Rhodocyclaceae, Hyphomicrobiaceae, Sphingomonadaceae, Caulobacteraceae, Methylobacteriaceae, Chitinophagaceae and Comamonadaceae (**Fig. b**).
 - ❖ The bacterial diversity within the samples (alpha diversity) was analyzed by calculating Shannon, Chao and observed species metrics. It is observed that compared to other samples (out of 30 samples), one of the soil sample (sample no. 8a) showed highest species richness and evenness and the water sample (2c) possessed lowest species richness and evenness. An explicit comparison of bacterial communities between the samples (beta diversity) was performed. The distance matrix was generated using both weighted and unweighted Unifrac approach. A jack knife test was performed to construct a consensus UPGMA (Unweighted Pair Group Method with Arithmetic Mean) tree for all samples.

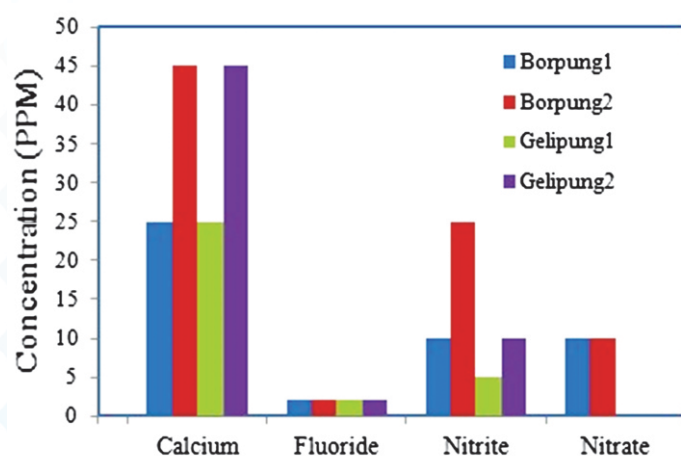


Fig a. Physico-chemical properties of soil in natural hot waterspring (Gelipung and Borpung).

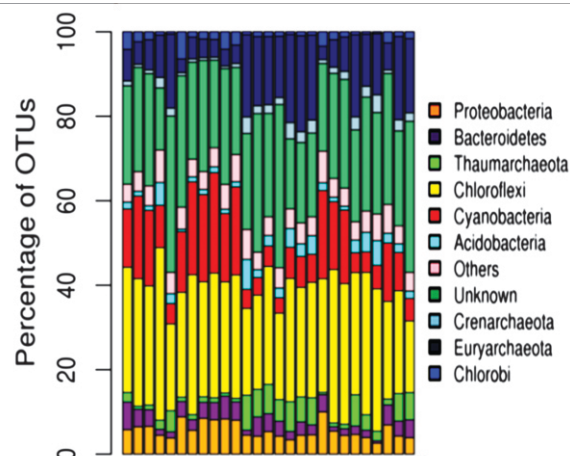


Fig b. Taxonomy classification of OTUs at phylum level for the sample (only top 10 phylum).

Project Title: Raising of clonal microgarden and validation of microclones of 'Assam Teak' (*Phoebe goalparensis* Hutchinson) through multilocal trials in selected areas of North East Region

Project No: GPP-298

Funding Agency: Department of Biotechnology (DBT), Govt. of India

PI & Members: Dr K D Mudoi (PI), Dr S P Saikia (Co-PI)

Objectives:

- ❖ Optimization of nutritional status, culture conditions for in vitro propagation/ multiplication of *Phoebe goalparensis* through different explants sources.
- ❖ Standardization of the reproducible protocol for mass multiplication, rooting, followed by hardening and acclimatization for regeneration of quality propagules.
- ❖ To study genetic fidelity of tissue culture raised propagules for rising of clonal microgarden and to assess validation through multilocal field trials.

Salient Achievements:

- ❖ Collected apical shoot buds of *Phoebe goalparensis* were cultured into MS and WPM medium along with the supplementation of cytokinins.
- ❖ After inoculation, if the colour of the explants remains green then it responds quickly and if the colour of the explants becomes pale green or brownish then it leads to either contamination or dead. Fungal contamination was noticed after 10-15 days of inoculation of the explants.
- ❖ 1-3 nos. of shoot buds were regenerated from the each survived explants. BAP enriched medium promoted shoot multiplication (**Fig. a**). IBA helped in root induction of *P. goalparensis* (**Fig. b**).



Fig a. Shoot multiplication

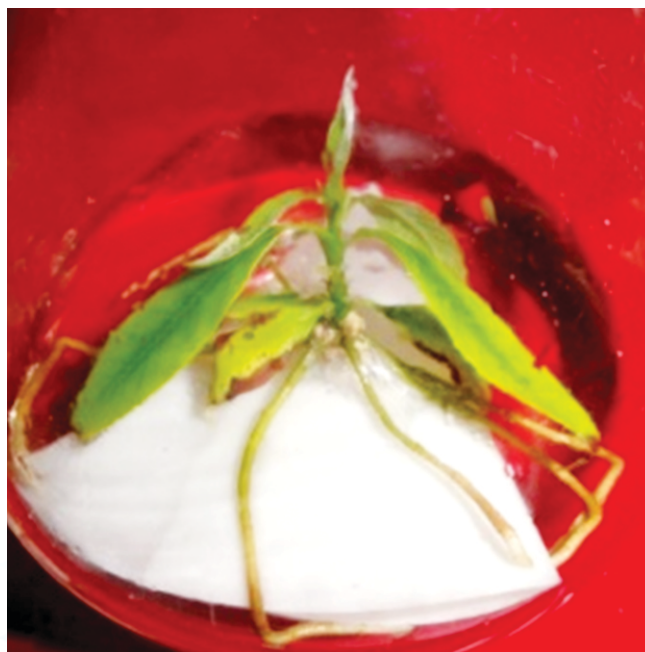


Fig b. rooting (B) of *P. goalparensis*

Project Title: Process development and optimization for production of in-situ generated Vitamin D fortified mushrooms

Project No: GPP-314

Funding Agency: Department of Biotechnology (DBT), Govt. of India

PI & Members: Dr Siddhartha Proteem Saikia (PI)

Objectives:

- ❖ Development and optimization of protocol for enhancement of Vitamin D fortified mushrooms by the UV treatment.
- ❖ Screening of mushroom types for its Vitamin D accumulation potential
- ❖ Demonstration and installation of a pilot production unit for fortified mushrooms
- ❖ Skill training for growing fortified Mushroom as a functional food

Salient Achievements:

- ❖ The project has recently been sanctioned which aims specifically to consider mushrooms as a major source of nutritional supplement. It aims to achieve this by enhancing the nutraceutical properties of mushroom by increasing the Vitamin D content so that it can serve as a functional food. This proposal would also like to carry out a detailed analysis of the accumulation capacity of Vitamin D among the established mushroom types. Moreover the project aims at developing a protocol for drying so that this fortified mushroom have longer shelf life for export and can be used for application in nutraceutical companies for subsequent therapeutic usage.

Project Title: Development of multiple abiotic and biotic stress resistance in tomato (*Solanum lycopersicum* L.) crop model through dual-gene multiplex CRISPR/Cas9 genome editing

Project No: GPP-324

Funding Agency: SERB- Department of Biotechnology (DST), Govt. of India

PI & Members: Dr C Chikkaputtaiah (PI), Ms Banashree Saikia

Objectives:

- ❖ Generating target specific multiplex dual-gene editing of HyPRPs in tomato (cv. Micro-Tom) using CRSIPR/Cas9 genome editing approach
- ❖ Phenotypic and molecular characterization of HyPRPs and CRISPR/Cas9 edited tomato lines in multiple abiotic stress (drought, salinity and cold) responses
- ❖ Molecular evaluation of genetic resistance to bacterial -spec &-spot through proteomic approaches to develop multiple-abiotic & biotic stress resistant tomato lines

Salient Achievements:

- ❖ Work in progress

Project Title: Development of commercial bioformulation of plant growth promoting rhizobacteria (PGPR) using coir pith as carrier

Project No: CLP-286

Funding Agency: Coir Board, Min. of MSME, Govt. of India

PI & Members: Dr Jatin Kalita (PI)

Objectives:

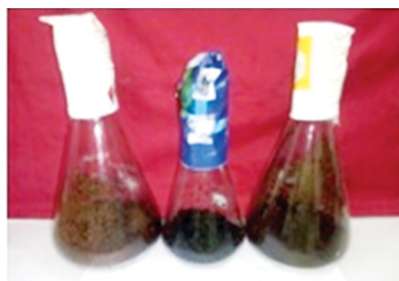
- ❖ Compatibility studies of various PGPRs to Coir pith as substrate/carrier
- ❖ Colony establishment of PGPRs in coir pith
- ❖ Field application of PGPR formulation with coir pith in specific agricultural crops for determining its ability to enhance crop production.
- ❖ Influence of inorganic nutrients (MOP, Urea and Rock Phosphate) on PGPRs with coir pith as substrate.
- ❖ Developing a commercial PGPR formulation using Coir pith as carrier.

Salient Achievements

- ❖ Developed a bioformulation of Plant Growth Promoting Rhizobacteria (PGPR) using Coir pith as carrier in laboratory scale. The effect of the bioformulation on crop plants such as tomato (*Solanum lycopersicum*), chilli (*Capsicum annuum*), cauliflower (*Brassica oleracea var botrytis*), brinjal (*Solanum melongena*) was found to increase in the shoot height, number of leaves, early fruiting and total biomass after treatment.



Microbial colonies grown on
Nutrient Agar



Colony establishment of
PGPR on coir pith



PGPR Formulation with coir
pith



Field experiment of PGPRs in Green gram

CHEMICAL SCIENCES & TECHNOLOGY DIVISION

Chemical Science & Technology Division (CSTD) is a multi-disciplinary division of CSIR-NEIST, Jorhat, which is dedicated for frontline research at the frontiers of modern chemical research with emphasis effective utilization of the vast resources of the North east India. The division has three groups (i) Analytical Chemistry Group (ii) Applied organic chemistry Group and (iii) Natural products Chemistry Group and all these groups has maintained the highest standards of excellence in research

Applied Organic Chemistry Group (AOCG) under Chemical Science & Technology Division (CSTD) is dedicated for frontline research in applied & application oriented basic organic chemistry. The group is actively engaged, for last several years in the area of bioactive molecules with main emphasis being laid on the development of process route for drugs/drug intermediates and synthesis of new molecular entities (NMEs) based on known drug molecules and on lead molecules from natural sources. A major thrust of the AOCG is directed in the development of process/heterogeneous recyclable catalyst for industrially important specialty chemicals. The group is also involved in the synthesis of stable metal nanoparticles on nanoporous biopolymers/cellulose templates and their application in organic synthesis.

The major emphasis of **Natural Products Chemistry Group (NPCG)**, since its inception, has been on chemical investigation of selected traditionally reputed medicinal plants of the northeastern region of India for drugs, pest management agents and nutraceuticals. This group has investigated a large number of plants and isolated a quite a good number of interesting molecules of different class having novel structures and published ~ 500 research papers in peer reviewed national and international journals. The group has filed a sizeable number of patents and developed several technologies and transferred to private industries, as well. The technology for Arteether, Artemether and Artesunate has been transferred to M/s FDC Ltd. Mumbai for commercial exploitation. In the recent past, this group played a key role in developing two herbal drugs: one for treatment of rheumatoid arthritis and one for fungal infection.

Applied Organic Chemistry Group (AOCG), which is under Chemical Science & Technology Division (CSTD) of CSIR-NEIST, Jorhat is dedicated for frontline research in applied & application oriented basic organic chemistry. The group is actively engaged, for last several years in the area of bioactive molecules with main emphasis being laid on the development of process route for drugs/drug intermediates and synthesis of new molecular entities (NMEs) on lead molecules as well as for lead generation. The main focus on the synthesis of new molecular entities is based on known drug molecules and bioactive molecules identified from natural sources. A major thrust of the AOCG is directed in the development of process/heterogeneous recyclable catalyst for industrially important speciality chemicals. The group is also involved in the synthesis of stable metal nanoparticles on nanoporous biopolymers/cellulose templates and their application in organic synthesis.

HIGHLIGHTS OF IMPORTANT WORK DONE DURING 2016-17

- ❖ Process for the production of environment friendly plasticizer dioctyl terephthalate (DOTP) from waste polyethylene terephthalate (PET)
- ❖ Electrochemical Immunosensor based gold nanoparticles deposited on the surface of graphene layer platform for detection of prostate specific antigen (PSA).

- ❖ Synthesis and Characterization of Poly (*n*-eicosyl methacrylate) and their uses as Stabilizer in the Preparation of Polyester Particles.
- ❖ Biopolyester from Castor Oil: Synthesis, Characterization and its use as Biolubricants.
- ❖ An eco-friendly process for the preparation of vanillin from *ipomea carnea*.
- ❖ Synthesis of stable metal nanoparticles on nanoporous biopolymers/cellulose templates and their application in organic synthesis.
- ❖ Synthesis of new molecular entities is based on known drug molecules and bioactive molecules identified from natural sources
- ❖ Created the facilities of one High Resolution Mass spectrometer and one High Resolution Transmission Electron Microscope (HRTEM), Field Emission Scanning Electron Microscope (FE-SEM) with Energy Dispersive X-ray (EDX) facility & High Resolution Mass spectrometer facility
- ❖ Development of new synthetic methodologies for fine chemicals and pharmaceuticals
- ❖ Design, synthesis and biological evaluation of heterocyclic scaffolds
- ❖ Developed new methodologies for the synthesis of 8-amido isocoumarins, 1-aminoisoquinolines, chromones and 4*H*-benzo[*d*][1,3]oxazin-4-ones using C-H bond activation and functionalization
- ❖ Visible light driven photocascade coupling of α -keto vinyl azides with 1,2,3,4-tetrahydro- β -carbolines and *N,N*-dimethyl anilines

ACHIEVEMENTS OF THE DIVISION DURING 2016-17

- ❖ Dr Ram Awatar Maurya was awarded NASI Young Scientist Platinum Jubilee Award (2016) for his outstanding contributions in the area of synthetic organic chemistry.
- ❖ Certificate of honour was conferred to Dr M J Bordoloi for his phenomenal research contribution made in the field of natural products chemistry by the organizing committee of the International Conference on Global Biodiversity, Climate Change and Sustainable Development (ICBCS-2016) held on 15th to 18th October 2016 at Rajiv Gandhi University, Rono Hills, Doimukh-791112, Itanagar, Arunachal Pradesh
- ❖ Dr Pitambar patel was awarded Prof. R. C. Tripathy Memorial award for his Significant contribution in the field of chemical research by Orissa Chemical Society (OCS) During 30th Annual conference of Orissa Chemical Society held on 24th - 25th December 2016, at KIIT University, Bhubaneswar, Odisha.
- ❖ **Publications with Impact Factor above 6**
 - a. Visible Light Driven Photocascade Catalysis: Ru(bpy)₃(PF₆)₂/TBHP-Mediated Synthesis of Fused β -Carbolines in Batch and Flow Microreactors by D Chandrasekhar, B Satheesh Orra, Jagadeesh Babu Nanubolu, Ram Awatar Maurya, *Organic Letters*, **2016**, 18, 2974-2977 (IF-6.732)
 - b. Coumarin to Isocoumarin: One-Pot Synthesis of 3-Substituted Isocoumarins from 4-Hydroxycoumarins and Benzyne Precursors by Kashmiri Neog, Dhiraj Dutta, Babulal Das, Pranjal Gogoi, *Organic Letters*, **2017**, 19, p-730-733 (IF-6.732)
 - c. Synthesis of oxindole from acetanilide via Ir(III)-catalyzed C-H carbenoid functionalization by Pitambar Patel, Gongutri Borah, *Chemical Communications*, **2017** (IF-6.567)
 - d. Ru(II)-Catalyzed C-H activation and annulation of salicylaldehydes with monosubstituted and disubstituted alkynes Swagata Baruah, Partha Pratim Kaishap, Sanjib Gogoi, *Chemical Communications*, **2016**, 52, 13004-13007 (IF-6.567)
 - e. The amide C-N bond of isatins as the directing group and the internal oxidant in Ru-catalyzed C-

H activation and annulation reactions: Access to 8-amido isocoumarins by P P Kaishap, B Sarma, S Gogoi, *Chemical Communications*, **2016**, 52, 9809-9812 (IF-6.567)

FUTURE PLANS OF THE DIVISION

- ❖ Value addition to natural products through chemical/ microbiological routes.
- ❖ Stereo selective total synthesis of biologically active natural products.
- ❖ Technology development for drugs/drug intermediates.
- ❖ Nutraceuticals & Functional food
- ❖ Plant based pest control agents
- ❖ Phytochemical analysis service to entrepreneurs and medicinal plant farmers
- ❖ Herbal drug development as affordable healthcare agent
- ❖ Different plants parts of selected medicinal plants will be extracted and extracts will be bio evaluated against different diseases and pests and the active extracts will be chemically investigated to look for drug like molecules.

A) National Collaboration

(i) Network Projects

Project Title: Organic reactions in generating innovative and natural scaffolds

Project No: CSC-108

Funding Agency: CSIR, New Delhi

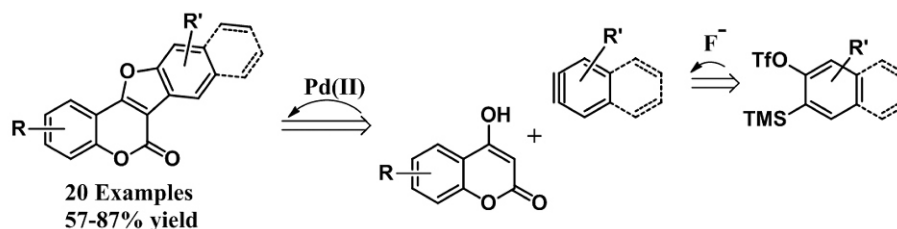
PI & Members: Dr Pranjal Gogoi (PI), Dr PJ Bhuyan, Dr S Gogoi

Objectives:

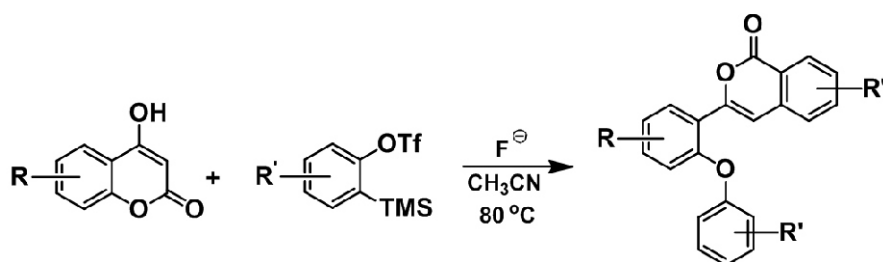
- ❖ Design and synthesis of small molecules as potential therapeutic agents in human health care
- ❖ Development of new methods towards C-C and C-X bond forming reactions and application to scaffold synthesis taking into account the green chemistry principles

Salient Achievements:

- ❖ A palladium catalyzed cascade reaction of 4-hydroxycoumarins and *in situ* generated arynes has been developed for the direct synthesis of coumestans. This cascade strategy proceeds *via* C-H bond activation/C-O and C-C bond formations in a single reaction vessel. This methodology affords moderate to good yields of coumestans and is tolerant of a variety of functional groups including halide. The methodology was applied to the synthesis of natural product flemichapparin C.



- ❖ A novel transition-metal free direct synthesis of 3-substituted isocoumarin from 4-hydroxycoumarin and benzyne precursor is developed. This synthetic strategy proceeds via C-O and C-C bond cleavage as well as C-O and C-C bond formations in a single reaction vessel by simple treatment with CsF in the absence of catalyst. This methodology affords moderate to good yields of 3-substituted isocoumarins and is tolerant of a variety of functional groups including halide.



Project Title: Natural products as affordable healthcare agents (NaPAHA)

Project No: CSC-130

Funding Agency: CSIR, New Delhi

PI & Members: Dr Manab Jyoti Bordoloi (PI), Dr K G Raghu (CSIR-NIIST), Dr H V Thulasiram (CSIR-NCL), Dr Sunil Kumar (CSIR-IIP), Dr Bikram Singh (CSIR-IHBT), Dr K Sureshbabu (CSIR-IICT), Dr Ram A Meena (CSIR-CSMCRI), Dr Shashi Singh (CSIR-CCMB), Dr S S Cameotra (CSIR-IMTech)

Objectives:

- ❖ Identification of unexplored flora and microbes from different regions of India
- ❖ Isolation and identification of new bio-active molecules from plants and microbes using Bio-assay guided approach
- ❖ Characterization of isolated new bio-active molecules by modern techniques of spectroscopic methods, x-ray crystallography and by suitable chemical methods.
- ❖ Rational drug design based chemical modification of lead compounds and analogue synthesis.
- ❖ Lead optimization and SAR studies
- ❖ Development of Integrated Discovery Platform for Natural Products based design of new Biotherapeutics through integration of informatics, simulation and modeling resources
- ❖ Development of Natural Products and their analogues as clinical trial drug candidates

Salient Achievements:

- ❖ **Anti-cancer Natural Compounds:** Cancer is a major health problem for the world with rise of burden to 14 million new cases with 8.2 million deaths every year. This is estimated to be 70% in next 2 decades as reported by WHO. These steady rises in death demand for rapid developments of newer and effective anti-cancer agents. A total of 123 compounds present in essential oils of different plants were analyzed for their drug like attributes which were then allowed to dock with PI3K dependent receptors crucial for development of cancer malignancies. Among them, 21 compounds were filtered possessing high druglikeness with favourable metabolism Volatile compounds, namely, methyl nonanoate, (R)-citronellol, cis-carveol (L-carveol), 3-methyl-Cyclohexanone, 4-carene and thujopsene were finally screened

for PI3K targeted anti-cancer therapies. Among them, 3-methyl-cyclohexanone and thujopsene were found to be most cytotoxic to the lung cancer cells and immunoblot assay further confirmed their efficacy for inhibition of mTOR and AKT. The results of our present work will pave the way for the development of targeted anti-cancer therapy against cancer types where dysregulation of PI3K pathway occurs like lung cancer (includes small cell carcinoma, squamous cell carcinoma, adenocarcinoma, large cell carcinoma, non-small cell lung carcinoma).

- ❖ **In-silico** screening of anti-viral compounds, peptide designing and network construction for unveiling protein interactions of influenza virus : Virus are non-living materials when outside a living system. This seemingly harmless material can cause devastation when comes in contact with living system. We evaluated one hundred seventy four phytochemicals from *Ocimum sanctum*, *Tinospora cordifolia*, *Cinnamomum camphora*, *Allium sativum*, *Curcuma longa* and *Aloe vera* for their affinity to all viral proteins. After *in silico* analysis of 174 naturally occurring compounds, a flavonoid C-glycoside (Vicenin) from the traditional medicinal plant *Ocimum scantum* was found as highly effective against all proteins of H1N1 virus screened through consensus scoring system of docking analysis and this can devise ways to inhibit H1N1 virus within the stipulated time frame for better management of the infection.
- ❖ **Arsenic-induced instrumental genes of apoptotic signal amplification in death-survival interplay:** Arsenic is a well-known environmental contaminant causing systemic toxicity. Paradoxically, it is also a susceptible carcinogen. This contrasting behavior of arsenic is fairly concentrated and cell-type dependent. Chronic- and low-concentration exposure has been reported to be responsible for carcinogenesis but not apoptosis, whereas high-concentration arsenic is responsible for apoptosis. Arsenic-associated detrimental effects also include generation of reactive oxygen species and lipid per oxidation. In this study we adopted an expression profile-based approach and reported the possible regulatory genes and their interaction leading to progression of apoptosis in the concourse of death and survival in HepG2 cells. It is concluded that intrinsic pathway is the initial process of apoptosis found to be responsive exclusively at low-treatment concentration (1 μ M), which in general remains subdued at no cell death condition. During apoptotic boom, extrinsic pathways are activated. We also designated the genes, which are instrumental in progression of apoptosis. We anticipate that our report will provide a novel outlook in targeting molecules for inducing apoptosis in hepatocellular carcinoma as well as inhibiting apoptosis in normal cell.
- ❖ **Functional food from wild edible herbs :** Twelve classical edible herbs of Assam were studied, among which, *Fagopyrum esculentum*, *Paederia scandens* and *Amaranthus viridis* showed strong antioxidant potential with high phenolic contents. Rutin and gallic acids were the most abundant phenolic compounds. α -Tocopherol was present in all herbs, while ascorbic acid was found only in some. *Leucas aspera* and *Hydrocotyle sibthorpioides* were good sources of both α -tocopherol and ascorbic acid. All twelve herbs were devoid of Pb and Cd. *Pouzolzia indica* was a rich source of Ca, Fe and Zn. Further, the plants were found to be moderately active against mycotoxin producing fungus *Alternaria tenuissima*.
- ❖ **Microbial secondary metabolite:** Infectious diseases are responsible for about one third of all deaths worldwide. The emergence of multidrug resistance organisms makes the scenario worse in current times with high mortality rate and their severity of infection is very high in immunocompromised patients especially who are suffering with some chronic diseases like AIDS. An oily bioactive compound was extracted from *Micromonospora auratinigra*, HK-10

(GenBank accession no. JN381554) and found to have promising antibacterial activity against Infectious *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris*, *Echerichia coli*, *Pseudomonas aeruginosa* and *Mycobacterium abscessus*.

- ❖ **Antimalarial silver and gold nanoparticles :** A rapid, easy and eco-friendly approach for the synthesis of AuNPs and AgNPs using bark and leaf extract of *Syzygium jambos* with antimalarial activity against both chloroquine sensitive (3D7) and resistant (Dd2) strain of *P. falciparum*. The cytotoxic effect the NPs was also examined against human cervical cancer cell line (HeLa) and rat skeletal muscle cell line (L6) using 3-(4,5-dimethylthiazol-2-yl)- 2,5-diphenyltetrazolium bromide (MTT) assay. Thus, the present study suggests that the biosynthesized NPs using *S. jambos* could be tuned for advanced biomedical applications in the treatment of malaria.

Project Title: Molecules to materials to devices (M2D)

Project No: CSC-134

Funding Agency: CSIR, New Delhi

PI & Members: Dr Prakash Jyoti Saikia (PI), Ms A Phukan

Objectives:

- ❖ Development of efficient polymerization method for the preparation of polymeric microspheres of polyesters and their copolymers with easy manipulation and control over their properties for tissue engineering

Salient Achievements:

- ❖ Poly (n-eicosyl methacrylate) (PEMA) and poly(n-eicosyl methacrylate-co-hydroxyethyl methacrylate) (PEHMA) prepared by free radical copolymerization and their characterization. Established PEMA/PEHMA as effective stabilizers in the preparation of polycaprolactone (PCL) and poly(lactic acid) (PLA) particles. Reaction conditions were established with the variation of weight ratio and reaction time. Formation of PCL/PLA particles using the prepared stabilizers PEMA and PHEMA have been established by scanning electron microscopy (SEM) results. Spherical, smooth and stable PCL and PLA nanoparticles were obtained with these stabilizers. Stabilizing ability of PCL particles increases using PEHMA as stabilizer.
- ❖ Polycaprolactone blended gelatin microspheres of larger particle size (30-100 micron) by established solvent evaporation method with the varied composition of PCL and Gelatin. Smooth, spherical microspheres were obtained with good surface morphology.
- ❖ Designed and prepared stable poly (DL Lactide) (PDLLA) blended gelatin microspheres in the range of 10-30 μm and modified through different composition of PDLLA and gelatin. The microspheres were found to be smooth with spherical shape and fine dispersibility with the increase concentration of gelatin to the polymer.

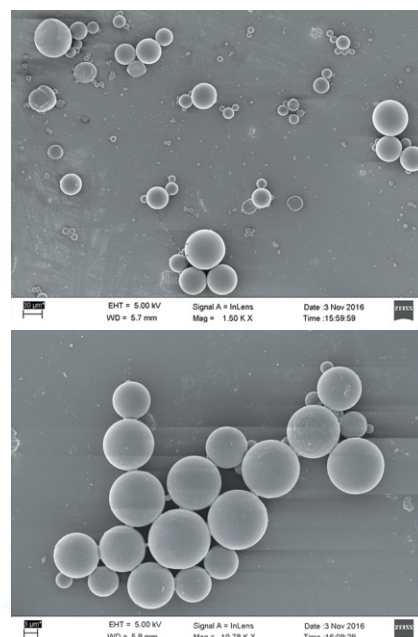


Fig: SEM images of the PDLLA-gelatin blend

- ❖ Designed porous PCL particles using different molecular weights of linear polymer polyethylene glycol as porogen and with prepared stabilizer, poly (octadecyl methacrylate).

Project Title: North east exploration of pharmaceuticals (NEEP)

Project No: CSC-207

PI & Members: Dr D Ramaiah (Co-ordinator), Dr M J Bordoloi (Nodal Officer), Prof Samir Bhattacharya (Mission Director, Visva Bharati, Santiniketan), Dr A M Das, Dr G Baishya, Dr P K Baruah, Dr (Mrs) Dipanwita Banik, Dr Thaneswar Borah

Funding Agency: CSIR, New Delhi

Objectives:

- ❖ To develop affordable herbal medicines from diverse medicinal plants of North East India
- ❖ Maintenance of the bioassay facility created during 11FYP (2010-2012).
- ❖ Creation of animal house facility and its maintenance for in vivo studies and preclinical efficacy studies
- ❖ Cultivation of Rungying (Naga ginseng) by farmers in Nagaland and development of Rungying (Naga ginseng) as immunomodulatory and adoptogenic herbal product

Salient Achievements:

- ❖ **A novel Artemisinin derived molecule arrests oral cancer cell growth:** An in vivo tongue cancer model in mice by 4NQO induced carcinogenesis was prepared. Treatment of these mice with Art1 could effectively reduce the progress of tongue cancer cell growth. This was possible because Art1 markedly suppressed EGFR expression. In addition, Art1 enhanced p16 level, a CDK4/6 inhibitor, in tongue cancer cells that resulted cyclin D1 transport from nucleus to cytosol where it was degraded through proteasomal ubiquitin pathway. These findings demonstrate that Art1 would be a meaningful choice for treating oral cancer. Art 1, artemisinin derived compound was prepared from dehydroartemesinin through a multi-step process. 500 MHz NMR Spectrometer was installed and maintained under NEEP project. This facility is giving service to many projects of the laboratory.
- ❖ Cell culture of cell lines started with 8 cell lines like A549, MCF7, Rat 16 muscle, HepG2 etc obtained from NCCS, Pune. Cells are growing properly and culture is standardized. Preliminary works have been done to do further work on bioactive plant extract using these cell-lines.
- ❖ Activity of Some medicinal plants of Assam against *Mycobacterium smegmatis* was determined. The genus *Mycobacterium sp.* is unique for their cell wall structure due to the presence of mycolic acid which is resistant to many antibiotics. The genus is responsible for skin infections, respiratory diseases (TB) etc. in human being caused by *Mycobacterium leprae* and *Mycobacterium tuberculosis* respectively. Globally about 9.6 million people were infected with tuberculosis whereas in India an estimation of 2.2 million cases are reported (WHO, 2014). Although *Mycobacterium smegmatis* was regarded as non-pathogenic saprophytic bacteria, researchers have identified 22 human isolates of *M. smegmatis* from Australia and the southern United States out of which 19 were from skin or soft-tissue infections. *Mycobacterium smegmatis*, a fast growing less pathogenic bacteria can be used as a model organism for *in-vitro* studies as it possesses the same cell wall structure with other *Mycobacterium* species. Plant based secondary metabolites plays an interesting role in combating the growth of deadly pathogenic bacteria. It indicates that plant based natural

products could be rewarding field in the discovery of new antimycobacterial leads. The present study was done to evaluate *in-vitro* activity of locally available a number of medicinal plants of Assam against *Mycobacterium smegmatis*. Five of these plants showed inhibitory activity against the test pathogen. The best inhibition result was found among these five plants with MIC as low as 0.5mg/ml in Resazurin reduction assay.

- ❖ Worked for cultivation of Rungying at Nagaland by Naga farmers under M/S Loli Geotech, Dimapur, Nagaland under the guidance of NEIST, Jorhat. M/S Loli Geotech has approached us during 11 FYP for chemical profiling and validation of biological activity of Rungying claimed through traditional uses and toxicity studies. Rungying farmers through M/s. LOLI Geotech and Associates, Dimapur, Nagaland were promoted through this project and was cultivated Naga farmers at Chungtore, Longkhim, etc. The average soil temperature is 20.2-38.8 °C and average humidity is 23-86 % at the cultivation area with an altitude of 1400-2500 m above mean sea level. Rungying extracts was chromatographed and several compounds were isolated and spectral data were recorded. Rungying ehanol extract was evaluated and was found to have moderate inhibition against lung cancer cell-lines A549. Isolated compounds were found less active as compared to ethanol extract.
- ❖ The construction of an animal house at NEIST, Jorhat has completed and was inaguarated by Padmashri National Professor Goverdhan Mehta, University of Hyderabad. An institutional Animal Ethics Committee has been formed and sent to CPCSEA, New Delhi for approval, registration and the nomination of member by CPCSEA as required by regulatory requirements, applicable rules, guidelines and laws of CPCSEA.
- ❖ We have isolated five long chain alkane derivatives from plants of North east India for controlling leaf blight disease of *Solanum khasianum* Clarke (Solanaceae) caused by *Alternaria tenuissima* and *Alternaria alternata* during commercial cultivation. Three new and two white powdered compounds were extracted from *Cinnamomum obtusifolium* (Roxb.) Nees (Lauraceae), *Elaeocarpus lanceifolius* (Roxb.) (Elaeocarpaceae) and *Baccaurea sapida* (Roxb.) Mull. Arg. (Euphorbiaceae). New compounds were characterized as Triacontanoic acid (1), octatriacontan-1-ol (2) and dotriacontane (3) isolated from *C. obtusifolium* and *E. lanceofolius* by ¹H, ¹³C NMR and mass spectroscopy respectively. Other two known compounds were palmitic acid (4) and oleic acid (5) and from *B. sapida*. Complete inhibition of pathogenic fungi *A.tenuissima* and *A. alternata* were observed for compound 2 and 3. The antifungal potential of three new isolated compounds from *C. obtusifolium* and *E. lanceifolius* is reported for the first time. The results indicate the possible use of triacontanoic acid, octatriacontan-1-ol and dotriacontane as potential antifungal agents.
- ❖ **Inhibition of *Colletotrichum gloeosporioides*:** *Colletotrichum gloeosporioides* is an anthracnose causing pathogen of fruits, vegetables and human beings. The pathogen produces lesions on leaves, fruit and other parts of plant. Finally these lesions become dark and form concentric ring pattern. More than 800 million people do not have adequate food; 1.3 billion live on less than \$1 a day and at least 20% of global food production is affected due to plant disease caused by *C.gloeosporioides* Ethanol extract of the *Amphineuron opulentum* showed excellent inhibitory activity against *Colletotrichum gleosporioides* Penz at conc. of 100, 300 and 500 ppm respectively.

Project Title: Affordable cancer therapeutics 'ACT'

Project No: CSC-301

PI & Members: Dr Sanjib Gogoi (PI), Dr P J Bhuyan, Dr P Gogoi

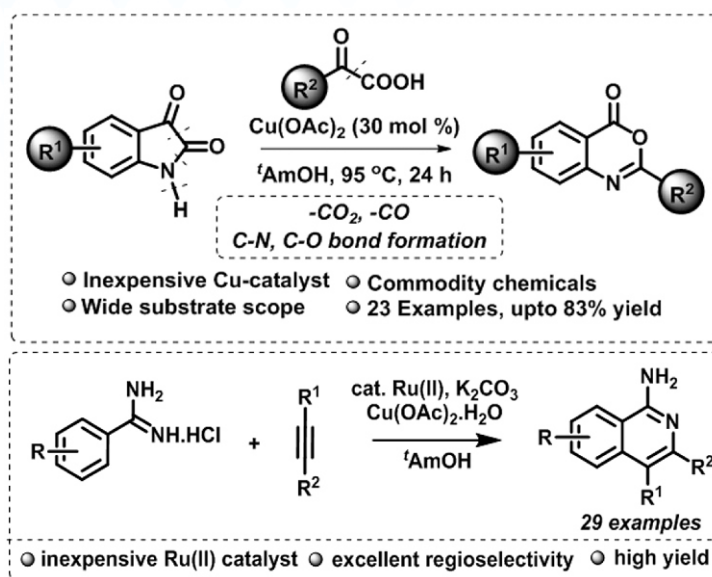
Funding Agency: CSIR, New Delhi

Objectives:

- ❖ To develop new synthetic methods for the efficient construction of potent and diverse small molecule libraries for cancer therapy.
- ❖ Hetero annulation of the plant based intermediates via Semi-synthesis
- ❖ Biological assay for the novel synthetic molecules

Salient Achievements:

- ❖ Few new methods have been developed for the efficient construction of biologically important heterocycles.
- ❖ All these synthesized molecules were screened for their in-vitro cytotoxic activity.



Project Title: CSIR advanced analytical facility for North East, (CAAF-NE)

Project No: CSC-408

PI & Members: Dr Pulakjyoti Bhuyan (PI), Dr L Saikia (Co-PI), Dr R Khan, Dr P J Saikia

Funding Agency: CSIR, New Delhi

Obejctives:

- ❖ Construction of a Laboratory Building
- ❖ Creation of a Field Emission Scanning Electron Microscope (FE-SEM) with Energy Dispersive X-ray (EDX) facility.
- ❖ Creation of High Resolution Mass spectrometer facility.
- ❖ Creation of a High Resolution Transmission Electron Microscope (HRTEM) facility.

Salient Achievements:

- ❖ Created the facilities of one High Resolution Mass spectrometer and one High Resolution Transmission Electron Microscope (HRTEM).



Fig. High Resolution Mass spectrometer (HRMS)



Fig. High Resolution Transmission Electron Microscope (HRTEM)

(ii) Inhouse, Grant in aid & Consultancy Projects

Project Title: Development of sensors for detection of pesticides

Project No: MLP-3000/05

Funding Agency: CSIR, New Delhi

PI & Members: Dr Raju Khan (PI), Dr R K Boruah

Objectives:

- ❖ Development of a cost effective sensor for the determination of pesticides in food samples based on flow injection analysis of pesticides using Screen-Printed Electrodes Containing Multi-Wall Carbon Nanotubes towards performing a pilot study on average pesticides intake.
- ❖ Use of proposed device to perform a correlative study of pesticides intake with human health (cancer occurrence).

Salient Achievements:

- ❖ Fabrication a biosensor based on natural polymer polyhydroxyalkanoate-gold nanoparticles composite on indium-tin oxide glass plate for the analysis of artemisinin.
- ❖ Amperometric Immuno-Sensor for Detection of Toxin Aflatoxin B1 based on Polyaniline Probe Modified with Mc-IgGs-a-AFB1 Antibodies. The proposed amperometric immuno-sensor reveals excellent electro-analytical properties relative to Aflatoxin B1 in a linear range from 0.20 to 1.30 ngmL⁻¹ with a relatively low detection limit of 0.049 ngmL⁻¹.
- ❖ High Sensitivity Electrochemical Immunosensor based on Plasma Modified Chitosan/TiO₂ for Ochratoxin-A. Electrochemically quantitative detection of Ochratoxin-A (OTA) concentrations varying from 0.1 to 10 ng mL⁻¹ in buffer solution was carried out on IgGs immobilized plasma treated and untreated CS/TiO₂/ITO electrodes. Plasma modified electrodes showed very good sensitivity at very low OTA concentrations (< 1 ng mL⁻¹) with a linear response upto 2 ng mL⁻¹ whereas the untreated electrodes sensitivity was deprived.

Project Title: Sustainable chemistry in the synthesis of some novel functionalized coumarins and assay for their potential biological activity

Project No: GAP-279

PI & Members: Dr Pulak Jyoti Bhuyan (PI), Dr H P Deka Boruah (Co-PI)

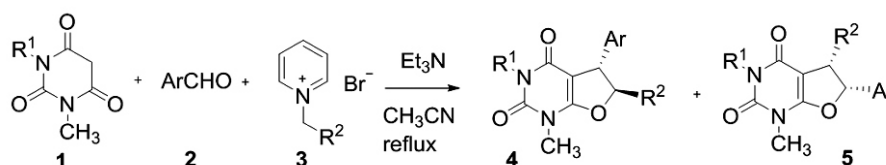
Funding Agency: Department of Science & Technology (DST), Govt. of India

Objectives:

- ❖ To synthesize some novel functionalized functionalized tri-, tetra-, and pentacyclic coumarin derivatives and assay for potential biological activity of the new compounds.

Salient Achievements

- ❖ Synthesized some novel regioisomers of furo[2,3-*d*]pyrimidines in a diastereoselective manner *via* one-pot three-component reaction of barbituric acids, aryl aldehydes and pyridinium bromides in the presence of triethylamine as base. Both the isomers were obtained in comparable ratio with excellent overall yield.



Project Title: Synthetic studies towards spirocyclic natural products

Project No: GAP-299 (DST)

PI & Members: Dr Pallab Pahari (PI)

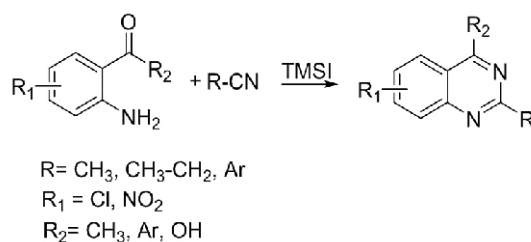
Funding Agency: Department of Science & Technology (DST), Govt. of India

Objectives:

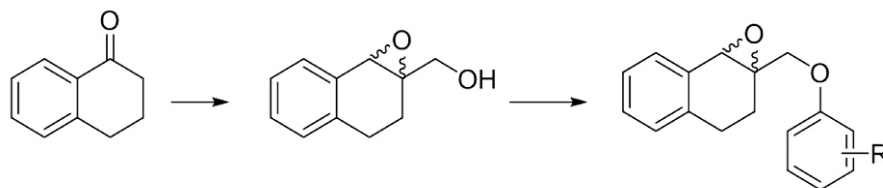
- ❖ Development of novel methodologies for the construction of N- and O- containing spirocyclic compounds

Salient Achievements

- ❖ Developed a mild and rapid method for the synthesis of substituted quinazolines starting from substituted 2-amino benzophenone/acetophenone and nitriles. An imidine is expected as intermediate of the reaction which undergoes cyclization in presence of Lewis acid. This strategy provides a very convenient route to quinazoline without using any oxidant and offers significant advantage such as commercially available reagents and catalysts. It was observed that the reaction was equally applicable to both aliphatic and aromatic nitriles.



- ❖ Synthesis of tetrahydronaphthooxyrine derivatives: A number of tetrahydronaphthooxyrine derivatives were synthesized starting from 1-tetralone. The compounds were prepared via an epoxy cinnamyl alcohol intermediate. Attempts were made to prepare oxaspirocyclic system from this starting material.



Project Title: Synthesis of *n*-heterocyclic compounds via carbenoid functionalization

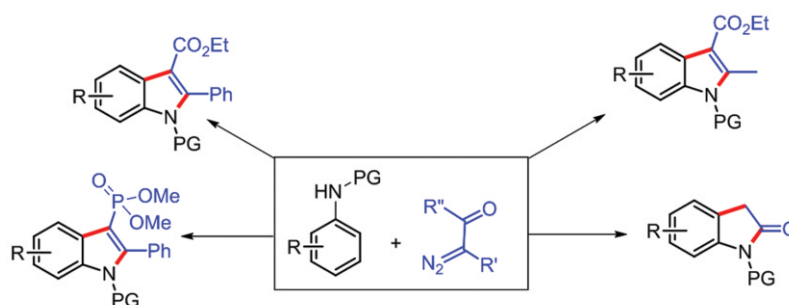
Project No: GAP-738

PI & Members: Dr Pitambar Patel (PI)

Funding Agency: Department of Science & Technology (DST), Govt. of India

Salient Achievements:

- ❖ Nitrogen-containing heterocycles represents a key structural component that occurs ubiquitously in many biologically active natural and unnatural compounds as well as in optoelectronic functional materials. Consequently, practical and atom economical synthesis of various *N*-heterocyclic compounds from simple starting materials is critical to the pharmaceutical and fine chemical industries. Given the low cost and wide variety of commercially available chemicals as starting materials for *N*-heterocyclic compounds synthesis is highly attractive. In this context, we have successfully synthesized a diverse array of nitrogen containing heterocyclic compounds from the reaction of readily available starting materials with α -diazocarbonyl compounds in presence of metal catalyst. Using this concept we have successfully synthesized 2-oxyindole and indole derivative from anilines (Scheme 1). Notably, the reaction generates easily separable nitrogen gas and water/carbon dioxide as by-products.



Scheme 1. Synthesis of various *N*-heterocyclic compounds

Project Title: Multidisciplinary research in medicinal and organic chemistry

Project No: GAP-744 (DST)

PI & Members: Dr Ram Awatar Maurya (PI)

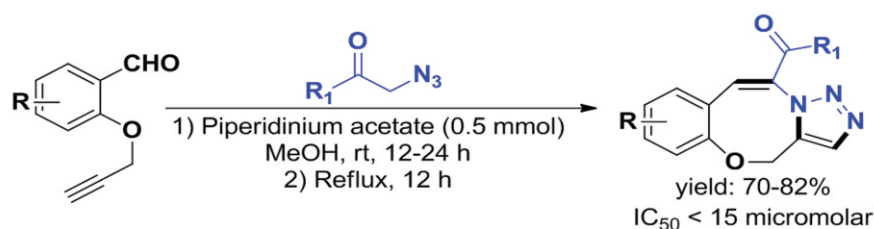
Funding Agency: Department of Science & Technology (DST), Govt. of India

Objectives:

- ❖ Development of new synthetic methodologies for fine chemicals and pharmaceuticals
- ❖ Design, synthesis and biological evaluation of heterocyclic scaffolds

Salient Achievements:

- ❖ Several novel applications of α -azido ketones towards the synthesis of biologically important heterocyclic scaffolds were explored. A cascade reaction involving Knoevenagel condensation and azide-alkyne cycloaddition of substituted salicyl aldehydes and phenacyl azides was developed. The synthesized molecular library was found to possess promising anticancer activity on several human cancer cell lines. Cell cycle and apoptosis assay indicate that they inhibit the cell cycle at the G2/M phase and induce apoptosis. Through the RED100 assay, it is evident that they have potential to inhibit pBR 322 plasmid DNA cleavage by BamH1. UV-visible, fluorescence titration and viscosity studies suggested that these compounds possess DNA binding affinity.



Project Title: Sustainable and biodegradable hybrid nano-composites as bio-integrated materials for advanced functional applications

Project No: GPP-286

Funding Agency: SERB-Department of Science & Technology (DST), Govt. of India

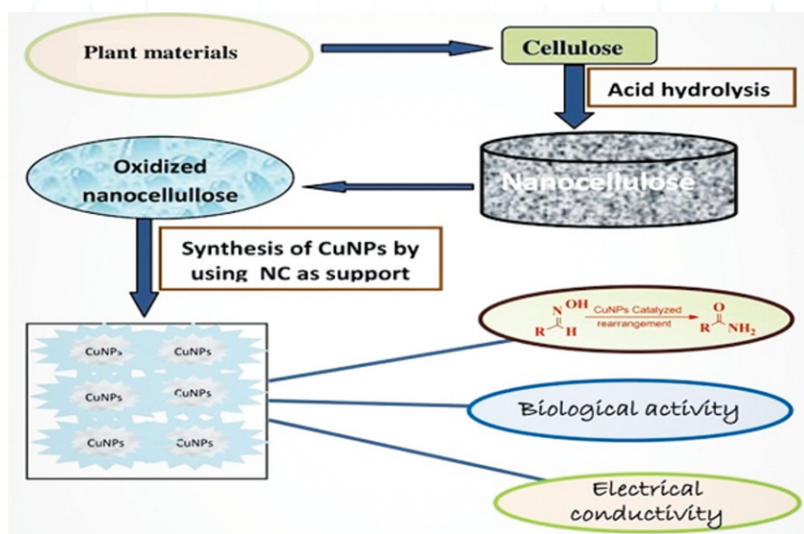
PI & Members: Dr Archana Moni Das (PI)

Objectives:

- ❖ Fibers will be extracted from selected fiber bearing plants and insects of North East India using different methods for preparation of starting materials.
- ❖ Develop nano composite scaffolds and crosslink biodegradable polymers using natural polymer

Salient Achievements:

- ❖ Heresythesis of copper nanoparticles (CuNPs) by using TEMPO oxidized nanocellulose (NC) of fiber bearingplant material by a new method for application in catalytic rearrangement of oximes to amides and also *in-vitro* antibacterial activities against *Escherichia coli* and *Staphylococcus aureus*. Electrical conductivity of CuNPs was studied which shows that conductivity increases with the increase in the concentration of CuNPs upto 8 wt%. Synthesized CuNPs was characterized with the help of XRD, XPS, UV-Visible spectra, TEM, SAED and TG analysis. The NC supported CuNPs effectively catalyzed the rearrangement of oximes into primary amides under microwave irradiation and acid free conditions in a very short time with excellent yield and the catalyst can be recovered easily without loss of its efficiency.



Project Title: Tandem suzuki cross-coupling reactions: synthesis of fused heterocycles and carbocycles

Project No: GPP-293

Funding Agency: Department of Science & Technology (DST), Govt. of India

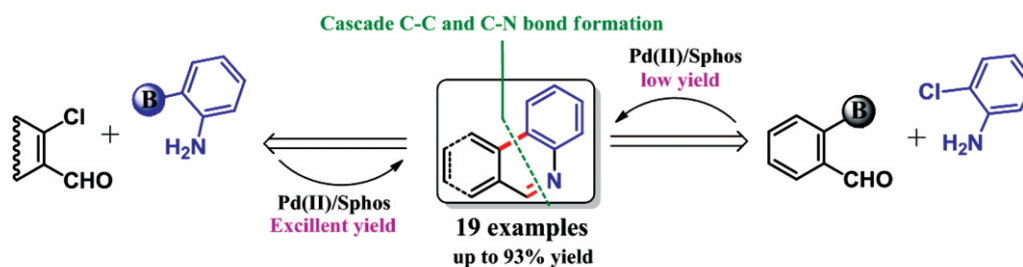
PI & Members: Dr Pranjal Gogoi (PI)

Objectives:

- ❖ Design and synthesis of small molecules as potential therapeutic agents in human health care
- ❖ Development of new methods towards C-C and C-X bond forming reactions and application to scaffold synthesis taking into account the green chemistry principles

Salient Achievements:

- ❖ A Pd-catalyzed cascade process has been developed for the synthesis of quinoline and phenanthridine derivatives. The reaction proceeds through a Pd-catalyzed cascade carbon-carbon and carbon-nitrogen bond formation in a single reaction vessel. The use of the ligand Sphos with Pd (OAc)₂ is crucial for the successful implementation of the present cascade process. This synthetic protocol is also applied for the synthesis of trispheridine alkaloid in gram scale.



Project Title: Transition metal catalyzed C-H bond activation and functionalization for the synthesis of N, O, P and S containing heterocycles

Project No: GPP-303 (DST)

PI & Members: Dr Sanjib Gogoi (PI)

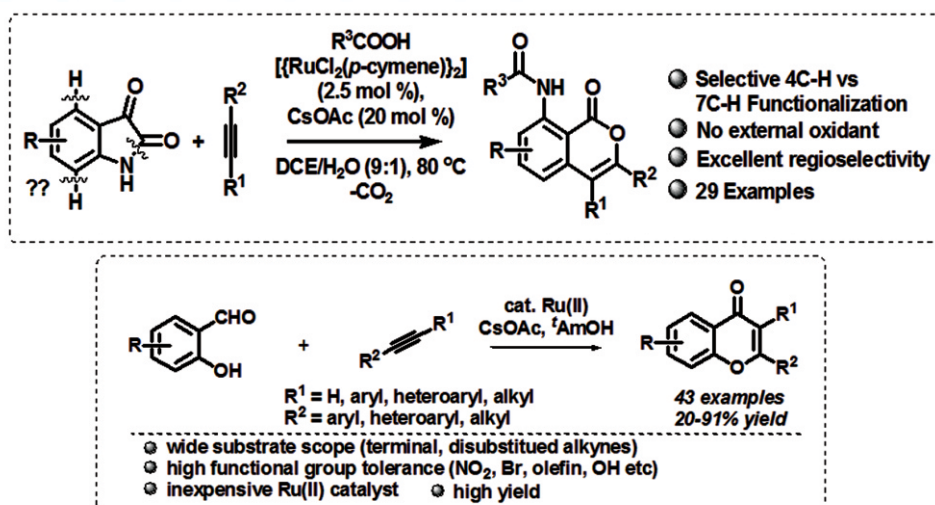
Funding Agency: Department of Science & Technology, Govt. of India

Objectives:

- ❖ To develop new C-H activation and functionalization reactions for efficient synthesis of biologically important heterocycles

Salient Achievements:

- ❖ Developed new methodologies for the synthesis of 8-amido isocoumarins, 1-aminoisoquinolines, chromones and 4*H*-benzo[*d*] [1,3] oxazin-4-ones using C-H bond activation and functionalization



Project Title: Design of a photoresponsive chitosan nanogel to regulate CXCR4 signalling through slow release of SDF-1 α in the infarcted myocardium

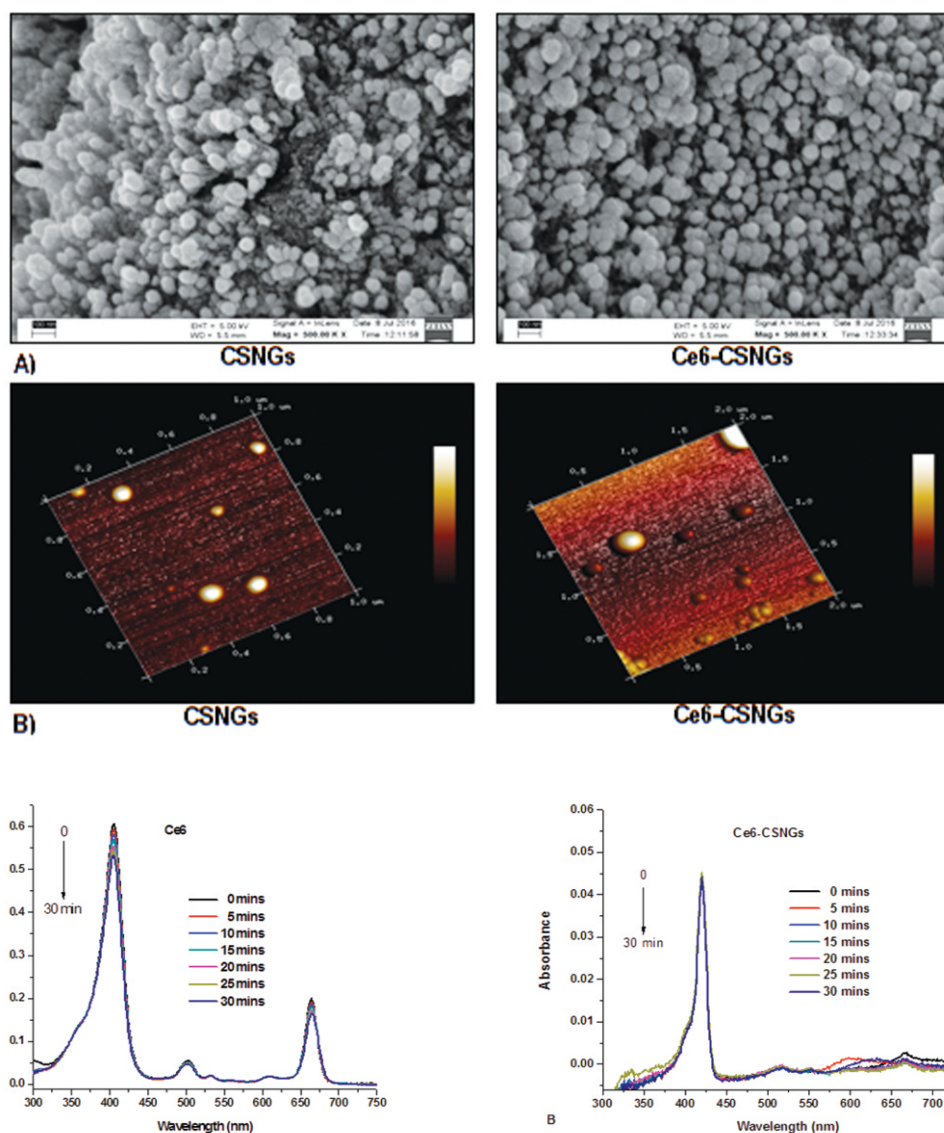
Project No: GPP-307

PI & Members: Dr Krishnamoorthy Ganesan (PI)

Funding Agency: SERB-Department of Science & Technology (DST), Govt. of India

Salient Achievements:

- ❖ With an objective to improve the photosensitizer efficacy, we have synthesized a chlorin e6 (Ce6) decorated chitosan nanogel through ionic gelation technique and have investigated its photophysical and morphological properties under different conditions. The chlorin based sensitizer, Ce6 was encapsulated onto the chitosan nanogel, which in turn was prepared through the self-assembly of low molecular weight chitosan (CS) in the presence of sodium tripolyphosphate (TPP) under aqueous conditions.



- ❖ The scanning electron microscopic (SEM) images of CSNGs and Ce6-CSNGs. SEM image of Ce6-CSNGs was spherical particles with homogenous distribution and smooth surfaces when compared to native CSNGs. B) The atomic force microscopic (AFM) images of CSNGs and Ce6-CSNGs. AFM image of Ce6-CSNGs exhibited smooth spherical shape particles compared to native CSNGs. Photostability experiment was made using a halogen lamp (Optel) with 630 nm long-pass filter, while the light was delivered to the sample through a fiber optic cable. Free Ce6 and Ce6-CSNGs were irradiated. A) Absorption spectra of photoirradiated free Ce6 (10 μ g in 1 ml) and B) Ce6-CSNGs (1 μ g in 1 ml) in DMSO/water with various time interval. The Ce6-CSNGs have higher photostability when compared to free Ce6. Our results demonstrate that the nano-encapsulation involving hydrophobic interactions significantly enhances the photophysical properties and bioefficacy of the photosensitizer thereby the potential of the nanogel as an effective vehicle for drug molecules and various sensitizers in Photodynamic therapy (PDT) applications. Further work, the cell viability assay of these nanogels with various cell culture experiments and SDF-1 encapsulation and release studies are under progress now.

Project Title: Green, sustainable and flash chemistry using flow microreactors

Project No: GPP-313

PI & Members: Dr Ram Awatar Maurya (PI)

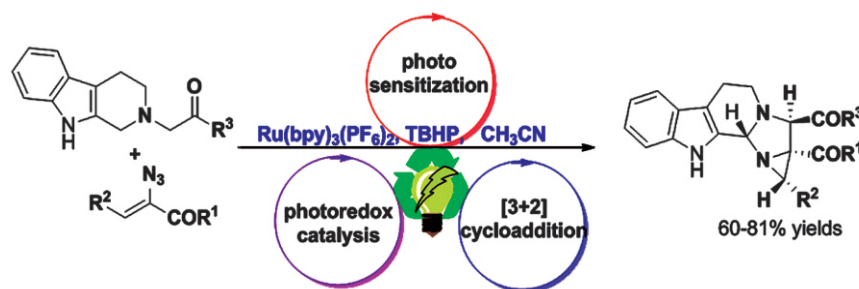
Funding Agency: Department of Science & Technology (DST), Govt. of India

Objectives:

- ❖ Flash generation and reaction of *o*-bromo(heteroaryl)lithium without (hetero)aryne formation using a flow microreactor
- ❖ Investigation of enantioselective synthesis using pack-bed flow microreactors
- ❖ Investigation of new photochemical reactions in flow microreactors

Salient Achievements:

- ❖ Visible light driven photocascade coupling of α -keto vinyl azides with 1,2,3,4-tetrahydro- β -carbolines and *N,N*-dimethyl anilines were developed. The reactions were demonstrated in both the batch and flow microreactors, and several mechanistic experiments were conducted. These reactions provided structurally diverse fused *N*-heterocycles containing highly strained aziridines.



Project Title: Nanoparticles supported self assembled conducting polymer monolayer based platform for rapid detection of monosodium glutamate in food products

Project No: GPP-318

Funding Agency: Department of Biotechnology (DBT), Govt. of India

PI & Members: Dr Raju Khan (PI), Dr B S Bhau

Objectives:

- ❖ Synthesis and optimizations condition of the conducting polyaniline with combination of nanostructure metal/ metal oxide (TiO₂, Au, ZnO, CdS).
- ❖ Immobilization of glutamate oxidase on the surface of the biocompatible nanostructure metal/metal oxide (TiO₂, Au, ZnO, CdS) and to establish protocol for better coordination of metal oxides with polyaniline films during Langmuir-process.
- ❖ Validation of the electrochemical biosensor for detection of MSG in food products.

Salient Achievements:

- ❖ Optimization of the condition for synthesis of polyaniline conducting polyaniline on the surface of the ITO substrate.

ENGINEERING SCIENCES & TECHNOLOGY DIVISION

Engineering Sciences & Technology Division has four groups and provides engineering inputs and services to different R&D projects of the Institute. The Applied Civil Engineering Group, Chemical Engineering Group, General Engineering Group and The Electronics & Instrumentation Group.

Chemical Engineering Group provides a broad spectrum of engineering inputs to the other research and development groups at CSIR-NEIST. The group has expertise in coupled research of Applied and Basic research for generation of knowledge base, knowhow and knowwhy. The group is involved in industry oriented research in the area of Separation and Purification Technology, Reaction Calorimetry, Food & Nutraceuticals and Reaction Engineering & Catalysis. Membrane Technology is one of the priority research area of the group. Transport phenomena in solid/liquid membrane based separation, catalytic membrane reactors, controlled transport in microcapsule membrane of stimuli responsive smart polymeric micro gel, facilitated transport in gas and liquid phases through host-guest chemistry are the basic/applied R&D work of the group. Membrane based Technology for separation of Biomolecules from natural feedstock, Racemic Resolution, Gas separation etc. are the priority research work for Translational research from the group. Engineering analysis of chemical reaction systems i.e. reaction-diffusion phenomena in heterogeneous catalysed reactions, Design and Scale up studies of bioprocesses, Reaction calorimetry, development of process for food & nutraceuticals etc. are also the current activities of the group

General Engineering Group has the expertise in the field of product and process equipment design and fabrication, CAD, CFD simulation, CNC programming & simulation, destructive testing of engineering materials and TEFR preparation. The group is involved in multidisciplinary research and innovative technology development apart from support services for R&D and infrastructural in the form design & development, fabrication, repair & maintenance through workshop, pilot plant and also to look after maintenance of office vehicles and air-conditioning units.

Applied Civil Engineering Group is committed to research & development, technical consultancy, testing and evaluation of building and road materials. The main areas of research include geotechnical and transportation engineering and have expertise in geo-technical and transportation engineering. This group is presently involved in R&D work for stabilization of Brahmaputra river bed materials for use in road construction and modular brick for building structures. The group also renders technical consultancy services for soil investigation and evaluation of roads, and testing and evaluation services for road & building materials including soil, cement, concrete, aggregates, brick and other construction materials. The department had contributed towards R&D activities in development of ferro-cement products, low cost housing techniques, light roofing sheets, water filter candles from paddy husk and also in the sector of structural engineering.

Electronics & Instrumentation Group is engaged in activities for support to institutional infrastructure like maintenance of equipments and total internal telephone network.

HIGHLIGHTS OF IMPORTANT WORK DONE DURING 2016-17

- ❖ Development of Membrane based Process Technology for Extraction and Separation of Oxyresveratrol and Natural dyes, Membrane for removal of Acetic acid ($\leq 3\%$) from Process Effluent., membrane for racemic resolution of Amino acids, drugs and pharmaceuticals,

- ❖ membrane for CO₂ separation and Ceramic membrane for waste water treatment
- ❖ Modular Bricks from Brahmaputra River Bed Sand: Complete plant design with layout, costing and estimation.
- ❖ Membrane Based Process Technology for Commercial Production of Bio molecules: Engineering scale up work with fabrication and pilot study, costing and estimation.
- ❖ The full scale designed prototype of the wax removal cum recovery device useful in crude pipeline strainer application with capacity of three strainers in a batch has been completed.
- ❖ A bamboo based transitory house for disaster application is designed and developed.
- ❖ Weaving cluster development activities under DST project CSTR Centre of CSIR-NEIST.
- ❖ Entrepreneurship development works has been carried out under DST sponsored project on Promoting innovations in individuals, start-ups MSMEs (PRISM).
- ❖ Different industrial trade training for the trades on welding, fitting, plumbing, weaving and footwear manufacturing were provided under CSIR 800 programme.
- ❖ Design & development of transitory houses for disaster vulnerable rural sectors in the NE region.
- ❖ Performance evaluation of River Brahmaputra bed materials for use in construction of road embankment, subgrade & sub-base.

ACHIEVEMENTS OF THE DIVISION DURING 2016-17

- ❖ The technology on Extraction and Separation of oxyresveratrol has been developed
- ❖ CSIR-NEIST has developed membrane for removal of acetic acid from the process stream containing $\leq 3\%$ acetic acid with highest recovery (95%) of acetic acid from process effluent. Material Transfer Agreement has been signed with M/s DAK America, USA for transfer of material for testing in their laboratory.
- ❖ CSIR NEIST has developed membrane for racemic resolution of Amino Acids, drugs and pharmaceuticals.
- ❖ Developed membrane for racemic resolution of drugs and pharmaceuticals and APIs.
- ❖ Developed Technology for production of Modular Bricks from Brahmaputra River Bed Sand.
- ❖ Modular Bricks from Brahmaputra River Bed Sand: Complete plant design with layout, costing and estimation.
- ❖ 532 nos have been trained for skill development and 209 nos of entrepreneurs have been provided entrepreneurship development training under the project "Enhancement of Rural Employment / Entrepreneurship through MSME Technologies and Industrial Trades Training.
- ❖ The project "CSTR and Common Facility Centre on Weaving and Textile product Manufacturing" has achieved the level of full commercial production in business mode. More than 150 weavers are producing weaving products have captured the local markets.
- ❖ Soil Investigation for LPG Mounded Bullet at Numaligarh Refinery Ltd.(NRL), Golaghat sponsored by NRL, Golaghat.
- ❖ A large numbers of technical reports for soil investigation, road evaluation and testing and evaluation reports for building and road materials furnished to various clients like NRL, Golaghat; IOCL, AOD, Digboi; Oil India Ltd., Duliajan; ONGCL; BRPL, Bongaigaon; NF Railway, Power Grid Corporation of India Ltd; etc.

FUTURE PLANS OF THE DIVISION

- ❖ To develop the membrane based technology for separation and purification of natural dyes.

- ❖ To develop membrane (Flat sheet/Hollow Fibre) and membrane based technology for Racemic resolution of Amino acids, drugs and pharmaceuticals.
- ❖ To developed New/improved membrane (Flat sheet/Hollow Fibre) for gas separation.
- ❖ Development of cosmetic products from natural dyes.
- ❖ Reaction engineering and catalytic studies on bio-oil up-gradation.
- ❖ A new Mission Mode Project “Engineering towards Value Added Building Materials and Products Using Construction and Demolition Wastes”
- ❖ A new Mission Mode Project “Study, evaluation and documentation of some of the selected heritage structures of Assam and providing possible restoration techniques”.

A) National Collaboration

(i) Network Projects

Project Title: Membrane and adsorbent technology platform for effective separation of gases and liquids

Work Component at CSIR-NEIST, Jorhat:

Activity I: Membrane Separation Processes for Liquids and Gases

Activity II: Nano Oxidic Membrane Reactors by Green Chemical Approach

Project No: CSC-104

Funding Agency: CSIR, New Delhi

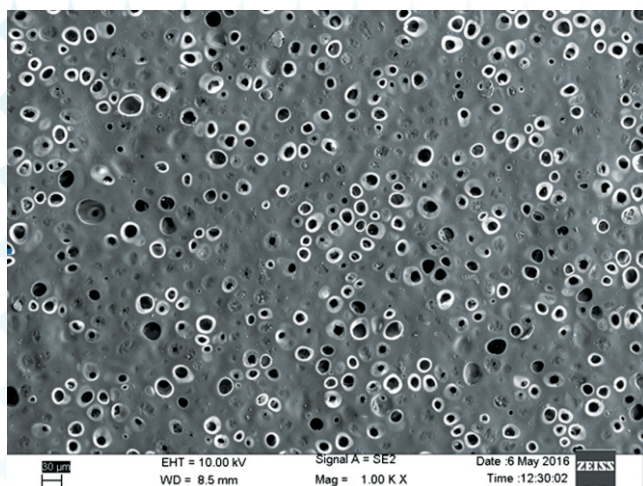
PI & Members: Dr Swapnali Hazarika (Nodal Scientist), Dr P Barkakati, Dr M M Bora, Mr S Borthakur

Objectives:

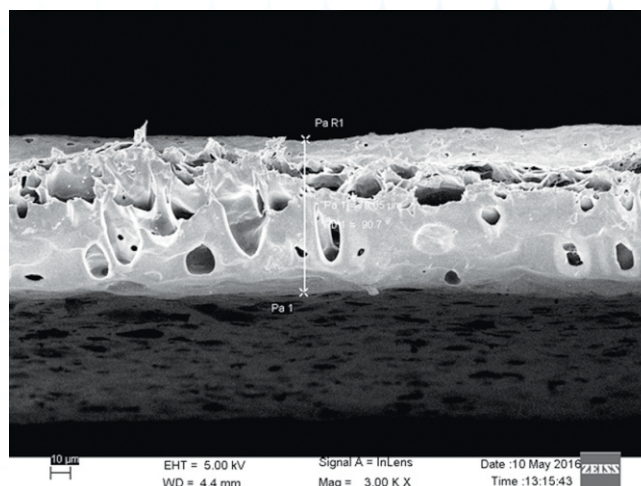
- ❖ **Activity I:**
- ❖ Development of Nanofiltration/enantioselective membrane for Extraction and separation of value added products from Natural feeDepartment of Science & Technology (DST), Govt. of Indiaock of North East region and racemic resolution.
- ❖ Enzymatic conversion in Membrane reactor for naturally occurring substrates in Bioresource based chemical platform.
- ❖ Molecular Gate' membrane technology for gas separation e.g. CO₂, CH₄ for such application as biogas up gradation.

Salient Achievements:

- ❖ **Activity I:** Designed and developed membrane and membrane based process for resolution of racemic compounds. The membrane can be used in modular form like spiral wound and Hollow Fibre module for effective separation of racemic mixtures. The process is lower energy intensive, recycling, cost effective as compared to available technology of HPLC, chromatographic separation using chiral stationary phase. Resolution performance of the membrane is independent of functional groups, provide faster separation, lower energy consumption and zero waste. The mini units are simple in construction and can be operated continuously to derive benefit of lower operational cost.



(a) Front view



(b) Cross section

Fig: SEM photograph of Membrane

Project Title: Inherently safer practices for industrial risk reduction (INSPIRE)

Project No: CSC-107

Funding Agency: CSIR, New Delhi

PI & Members: Mr Bipul Das (PI), Mr T H Ahmed (Co-PI), Dr S Hazarika (Co-PI), Dr P Gogoi (Co-PI), Dr P Pahari (Co-PI), Dr S Gogoi (Co-PI)

Objectives:

- ❖ Setting up of thermo chemical laboratory facility at CSIR- NEIST, Jorhat.
- ❖ Studies on reactive hazard evaluation Determination of heat of reaction, adiabatic temperature rise, reactivity and exothermicity data etc. for select runaway reaction systems.(NEIST)
- ❖ Selection of systems for studies on solvent affects in reactions, towards identification of non hazardous solvents for solvent replacement.(NEIST)

Salient Achievements:

- ❖ **Esterification of acetic acids with ethanol in the presence of sulphuric acid catalyst:** Esterification is one of the important unit processes in chemical engineering. Various important products are produced from esterification reaction and they have a wide array of application. Esterification reactions are exothermic in nature where in every reaction; heat will be released to the surrounding. In this work the esterification reaction was carried out in similar reaction calorimeter between acetic acid with ethanol solution in presence of varying concentration of sulfuric acid (3M – 5 M) catalyst. From the experiment it has been seen that the total heat of reaction increases with increasing the concentration of sulfuric acid amount. From the experimental result it has been observed that the total heat of reaction were 5.38 KJ, 7.14 KJ and 8.76 KJ in 3M, 4M and 5M of sulfuric acid concentration respectively.

furic acid

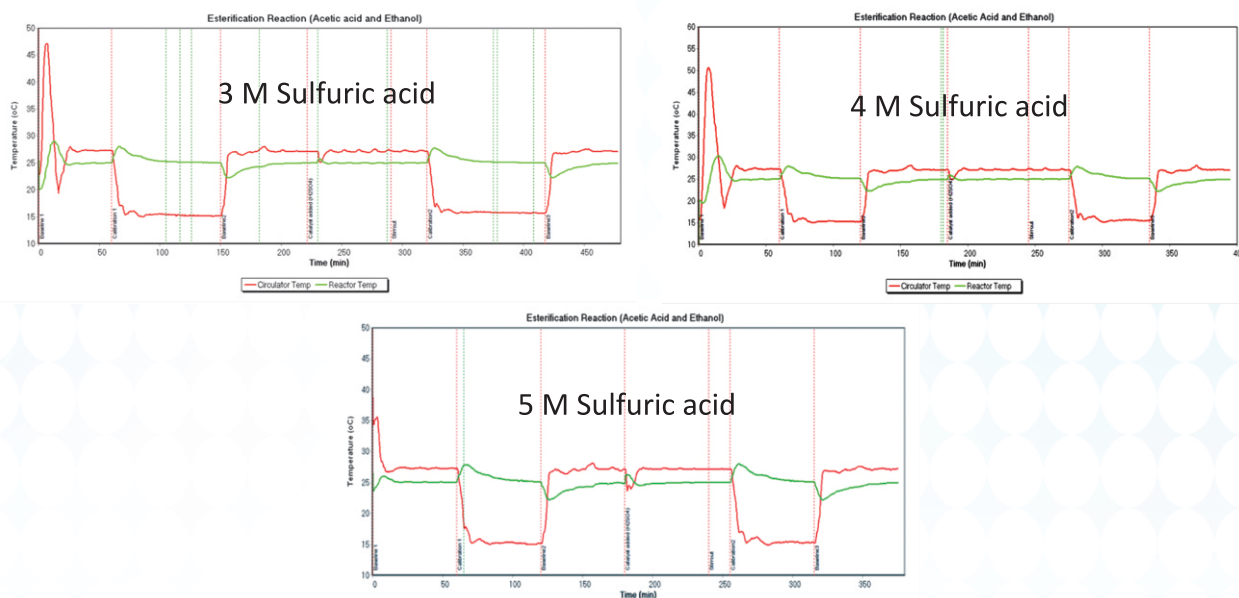


Fig. Graphical representation of esterification reaction of acetic acid with ethanol in presence of various concentration of H_2SO_4

Project Title: Development of sustainable waste management technologies for chemical and allied industries (SETCA)

Project No: CSC-113

Funding Agency: CSIR, Govt of India

PI & Members: Mr Subodh Chandra Kalita (PI), Mr J J Bora (Co-PI), Mr D Neog (Co-PI), Mr B K Saikia

Objectives:

- ❖ Determination of physical and chemical properties of deposited solids of high API gravity crude oil obtained from strainers and other sources of crude oil pumping station.
- ❖ Development of process for cleaning of strainers / removal of solid deposits.
- ❖ Design and Development of suitable device for recovery of different constituents of solid deposits for commercial exploitation.

Salient Achievements:

- ❖ The full scale design prototype of the wax removal cum recovery device useful in crude pipeline strainer application with capacity of three strainers in a batch has been completed in all respect.
- ❖ Discussion with OIL is going on for the technology transfer of the developed wax removal and recovery device.

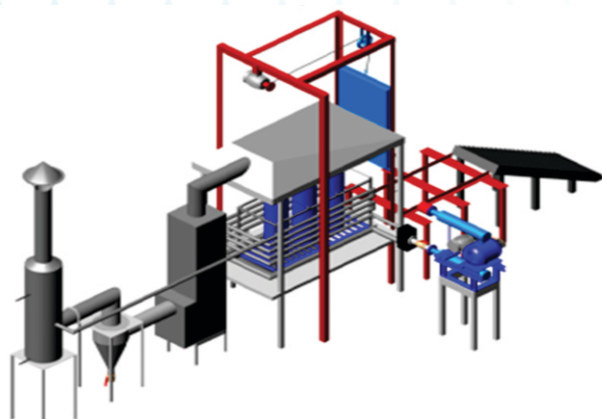


Fig. CAD Model of the developed wax removal Device



Fig. The Fabricated prototype the wax removal device

Project Title: Engineering of disaster mitigation and health monitoring for safe and smart built environment

Project No: ESC-102

Funding Agency: CSIR

PI & Members: Mr Dipankar Neog (PI), Mr D Basumatari (Co-PI), Mr JJ Borah, Dr D Kalita

Objectives:

- ❖ Design of assembled mass housing units, using locally available construction materials and metals, polymers for their sustainability during post disaster mitigation for natural calamities like flood, earthquake, cyclone etc

Salient Achievements:

- ❖ A bamboo based transitory house for disaster application is designed and developed. The project is in TRL5

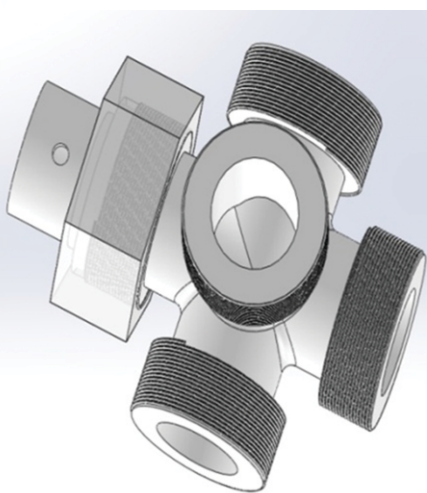


Fig. CAD Model of the Designed connector



Fig. Fabricated prototype structure (Unit) of the tramitory house

(ii) **In-house, Grant in aid & Consultancy Projects**

Project Title: Modular bricks from river Brahmaputra bed sand

Project No: FTTP (MLP-1004)

Funding Agency: CSIR, New Delhi

PI & Members: Mr Sanjay Deori (PI), Mr D Basumatari, Mr D Neog

Objectives:

- ❖ Collection of materials from Brahmaputra river bed at different selected location.
- ❖ Characterization of collected materials from Brahmaputra river bed.
- ❖ Chemical and Micro-structural analysis of collected river bed materials.
- ❖ Development of methodology for composition of collected river bed materials with cement, lime and chemical additives for mix design of modular bricks.
- ❖ Development of Methodology for manufacturing modular bricks for different sizes and shapes and interlocking block.
- ❖ Field trials of modular bricks using in construction of building structures, boundary wall and foundation.
- ❖ Preparation of specification and design guidelines for use of Brahmaputra river bed materials in manufacturing modular bricks.

Salient Achievements:

- ❖ Collection of Brahmaputra river bed materials from Nimatighat, Kokilamukh & Spur No.8.
- ❖ Characterization of collected materials from Brahmaputra river bed.
- ❖ Preparation of design mix for collected river bed materials with cement for manufacturing modular bricks.
- ❖ Partial field trials of modular bricks using in construction of building structures, boundary wall and foundation completed.

Project Title: Membrane based process for commercial production of biomolecules

Project No: FTTP (MLP 1003)

Funding Agency: CSIR, New Delhi

PI & Members: Dr Swapnali Hazarika (PI), Mr S Borthakur (Co-PI), Dr M M Bora (Co-PI), Mr J J Bora, Mr D Das

Objectives:

- ❖ Development of membrane based technology for commercial production of oxyresveratrol and natural dyes from plant species.

Salient Achievements:

- ❖ Designed and fabricated the scale up model with full instrumentation and control measures. Successfully run the scaled up model for production of oxyresveratrol. Designed and fabricated the extraction unit having temperature controller (upto 100oC) and stirring speed (upto 3000 rpm) in NEIST workshop. 4000 sq m membrane has been prepared for the process and fabricated the membrane module. Optimized the scaled up process for 3 kg input in terms of operating conditions for obtaining the pure product. After membrane treatment 98.9% pure

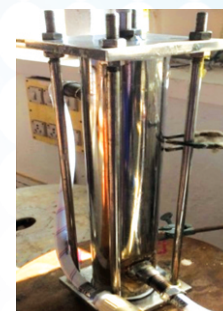
product has been obtained. The product has been analyzed by NMR, GCMS, LCMS and HPLC. It was found that purity of the product is >98%.



Extraction unit



Membrane



Membrane module

Project Title: Design and development of an integrated technology for drying of different agricultural product including heat sensitive one having export potential from high humid area like North Eastern states of India using biomass as fuel

Project No: MLP-4000

Funding Agency: CSIR, New Delhi

PI & Members: Mr Subodh Chandra Kalita (PI), Mr JJ Bora (Co-PI), Mr D Neog, Mr D Das

Objectives:

- ❖ Pre Drying Operations (Standardization of different pre-drying operations).
- ❖ Development of Dryer (Design and development of multipurpose drier comprising controlled operating parameters for drying of different products suitable for high humid region like NE India.)
- ❖ Development of Biomass Combustion Chamber

Salient Achievements

- ❖ Basic design of integrated dryer specifically for use of spice drying is completed.
- ❖ Analysis of fluid flow and heat transfer, energy balance, moisture removal rate is completed for different spices and paddies with reference to North-Eastern Region.
- ❖ Fabrication of the Dryer is completed.



Fig. Fabricated prototype of the Biomass drier

Project Title: Studies on process intensification & integration process for bioproducts, chemicals & fuels from bio sources & development of soil stabilization technique

Project No: MLP-4000

Funding Agency: CSIR, New Delhi

PI & Members: Dr Pranab Barkakaty (PI), Dr S Hazarika, Mr B Das, Mr A Namdeo, Dr M M Bora, Mr S Borthakur, Mr T H Ahmed

Objectives:

- ❖ Studies on Downstream and upstream Processing Techniques: Membrane and adsorptive separation process, Miscellar Enhanced ultrafiltration for Recovery of Biomolecules, industrial solvents from process stream, hydrocarbon contaminated waste water treatment, Resolution of racemic compound by membrane and enzyme membrane reactor.
- ❖ Esterification and transesterification of enantioselective synthesis of therapeutic intermediates from biomass based substrate.
- ❖ Process design for nutraceuticals, functional foods, pharmaceuticals and fine chemicals.
- ❖ To develop Insitu microcapsulation method utilizing “SMART” materials of polymer for control release of drug and nutraceuticals

Salient Achievements

- ❖ Under the project, a Process Intensification device (Jet reactor) for extraction of valuable compound from natural feedstock was developed. A bench scale process for extraction and separation of lignin from NE biomass has been developed. Hybrid separation process has been used to separate the value added product in the process. Established the biotransformation reaction from lignin to vanillin with process optimization. Developed a micro-encapsulation method for preparation of smart polymeric hydrogel from N-isopropyl-acrylamide (NIPAM) for control release applications. Developed membrane for waste water treatment. Developed ceramic membrane for waste water treatment. Performed scale up studies for the production of anti RSM extract from Meyna Laxiflora leaves and optimization of the extraction process parameters

Project Title: Study and development of soil modification or stabilization techniques for various types of soil used in construction activities in and around Jorhat and in some selected areas of Assam

Project No: MLP-4000/03

Funding Agency: CSIR, New Delhi

PI & Members: Mr Sanjay Deori (PI), Mr D Basumatari (Co-PI), Mr T Das, Mrs ABharali, Mr N P Borah, Mr R Das

Objectives:

- ❖ To develop soil improvement techniques used in road sub-grade/sub-base, airfield, embankment etc.
- ❖ To modify and improve engineering properties of soil with admixtures such as lime, cement, bitumen, flyash or blends of any materials and with use of reinforcements like geogrids, geotextiles, and waste materials etc.

Salient Achievements:

- ❖ Soil samples were collected from different locations which are being used for construction activities.
- ❖ Determined the different properties of collected soil samples in the laboratory.
- ❖ RBI Grade-81 and Cement have been used as admixture for stabilization of collected soil samples.
- ❖ Soil samples with RBI Grade-81 and Cement admixtures in different proportions have been prepared and determined the MDD - OMC relationship.
- ❖ Evaluated the Strength characteristics (CBR test in un-soaked / 4-days soaked condition) of the stabilized soil samples in the laboratory.

Project Title: CSTRI and Common facility centre on weaving and textile product manufacturing

Project No: GAP-232 & GAP-283

Funding Agency: Department of Science & Technology (DST), Govt. of India

PI & Members: Mr Dipankar Neog (PI), Ms I I Zhimo (Co-PI), Mr J J Bora, Mr S C Kalita

Objectives:

- ❖ To set up a Center for Council of Science and Technology for Rural India (CSTRI) which will act as an intermediate to solve the identified scientifically solvable problems of rural areas of North East Region (NER) of India through the inputs of funding, expertise domain experts, proved technologies, business scale up and overall monitoring of implementations of the projects.
- ❖ To develop the action plan of the center and form a core team to realize and implement the plan.
- ❖ To develop a format to evaluate the “Rural Resources and Need Appraisal” in the context of rural areas of the North East India.
- ❖ The center will identify the thrust areas in the rural NER such as- rural decentralized energy generation and distribution (e.g. bio-energy, solar energy, micro-hydral etc.); rural health including water, sanitation etc.; technology for bamboo based products & their value addition; appropriate technology for small tea growers; technology bases services during natural calamities like flood, earthquake etc.; technologies for food processing & preserving; technologies for mechanized cultivation; specific technologies for rural group having traditional expertise etc.

Salient Achievements:

- ❖ Setting up of a Common Facility Center (CFC) on weaving and textile product manufacturing under the CSTRI Centre of CSIR-NEIST including procurement, installation, and commissioning of all the plant and machineries are completed.
- ❖ Basic training on natural dyeing, textile design, operating the different equipments including jacquard looms are imparted to 160 nos. of weavers in 8 batches at the CFC, Mariani has been completed.
- ❖ Invitation to take part in different Exhibition and Trainings.

Project Title: Promoting innovations in individuals, start-ups MSMEs (PRISM)

Project No: GAP-2014

Funding Agency: Department of Science & Technology, Govt. of India

PI & Members: Mr Dipankar Neog (PI), Ms I I Zhimo, Mr. J J Bora, Mr S C Kalita

Objectives

- ❖ Regular advertisement for scouting for project proposal.
- ❖ Counseling with the innovators across the table for the innovative idea thrown by the individual innovators for funding and helping the innovators for preparing the project proposal.
- ❖ Reviewing the proposals through the empanelled list of subject experts, providing all necessary supports to the innovators towards implementing their project proposals. These supports include technical guidance for design, mathematical calculations, fabrications of models and prototypes, report preparation, IPR protection etc.
- ❖ Continuous monitoring of the project implementation and timely review.

Salient Achievements:

- ❖ Under the project “Promoting Innovations In Individuals, Start-ups MSMEs (PRISM)”, two projects are successfully completed. 10 nos of projects are different stages of evaluation under TOCIC-NEIST Jorhat. One project on development of digital paper facility has recently been approved by DSIR.

Project Title: Development of molecular gate membrane for CO₂ separation and green emission control

Project No: GPP-276

Funding Agency: Department of Science & Technology (DST), Govt. Of India

PI & Members: Dr Swapnali Hazarika (PI), Dr D Konwar (Co-PI), Mr S Borthakur (Co-PI), Dr M M Bora

Objectives:

- ❖ Preparation and characterization of dendrimer and dendrimer derivatives and their characterization to make a comprehensive QSAR study in respect of molecular structure of dendrimer and its derivatives.
- ❖ Preparation and characterization of Molecular Gate membrane from dendrimer and dendrimer derivatives and optimize the preparation procedure followed by the studies on microvoid formation mechanism with respect to membrane preparation parameter.
- ❖ To study the equilibrium and kinetics of adsorption and desorption of CO₂ and associated gas on dendrimer, develop appropriate model and estimate the model parameters. Also to make a molecular modeling study in order to understand the adsorptive interaction for deducing implication of molecular design of specific dendrimer.
- ❖ Extensive experimental study to understand permeation behavior of CO₂ using simulated biogas and develop appropriate flux model incorporating solute diffusion, mass transfer, adsorption effects and optimize the process for Spiral wound membrane module.

Salient Achievements:

- ❖ Membranes for CO₂ separation has been prepared and characterized by IR, XRD, TGA-DSC, and SEM analysis. The permeability of the membranes for CO₂ has been studied using the membranes. The transportation of CO₂ through the membrane follows the facilitated transport mechanism while using dendrimer of generation G-0 to G-7 as the membrane material. The effect of feed gas pressure on the permeabilities and selectivities of the membranes have also been observed. It is observed that permeability and selectivity of the membrane increased with increase in the amine groups present in the dendrimer molecule due to the formation of CO₂ molecular gates.

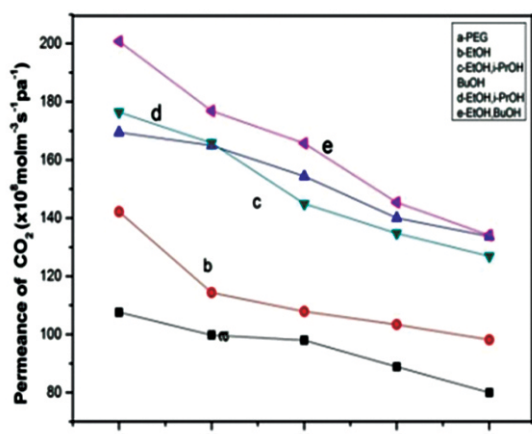


Fig. Effect of feed gas pressure on permeabilities of membranes using CO₂/N₂ gaseous mixture

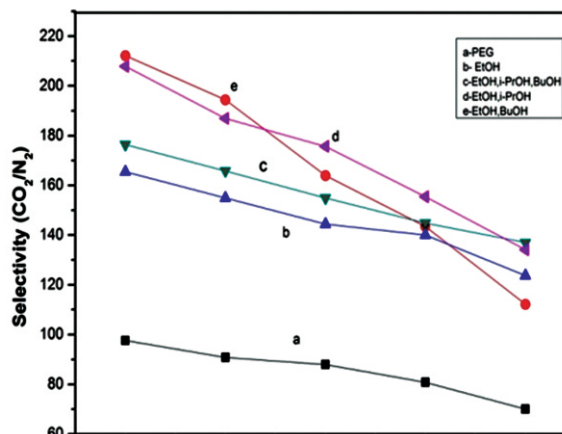


Fig. Effect of feed gas pressure on CO₂/N₂ selectivities

Project Title: Performance evaluation of river Brahmaputra bed materials for use in construction of embankment, subgrade and subbase

Project No: GPP- 284

Funding Agency: Department of Science & Technology (DST), Govt. of India

PI & Members: Mr Sanjay Deori (PI), Mr D Basumatari, Mrs A Bharali, Mr N P Borah, Mr M Agarwal, Mr R Das, Mr S C Kalita

Objectives:

- ❖ To evaluate the performance of stabilized river bed materials conforming to available Indian Specification for materials used in construction of road embankment, subgrade and sub-base.
- ❖ Performance evaluation of stabilized river bed materials through laboratory model studies.
- ❖ Preparation of specification/guidelines for use of stabilized Brahmaputra river bed materials in construction of road embankment, subgrade and subbase.

Salient Achievements:

- ❖ Procurement of equipments such as Concrete Mixer, Digital Concrete Test Hammer, Lab

Permeability Test Apparatus etc. under process.

- ❖ Collection of Brahmaputra river bed materials from Nimatighat, Kokilamukh & Spur No.8.

Project Title: Development of methodology for manufacturing modular bricks from river Brahmaputra bed material

Project No: GPP-295

Funding Agency: Department of Science & Technology (DST), Govt. of India

PI & Members: Mr Sanjay Deori (PI), Mr M Agarwal (Co-PI), Mr D Basumatari, Mrs A Bharali, Mr N P Borah, Mr R Das

Objectives:

- ❖ Preliminary identification of different locations for collection of materials from Brahmaputra river bed during its course from Eastern to Western stream in the state of Assam.
- ❖ Collection of materials from Brahmaputra river bed at different selected location.
- ❖ Characterization of collected materials from Brahmaputra river bed.
- ❖ Chemical and Micro-structural analysis of collected river bed materials.
- ❖ Development of methodology for composition of collected river bed materials with cement, lime and chemical additives for mix design of modular bricks.
- ❖ Development of Methodology for manufacturing modular bricks for different sizes and shapes and interlocking block.
- ❖ Field trials of modular bricks using in construction of building structures, boundary wall and foundation.
- ❖ Preparation of specification and design guidelines for use of Brahmaputra river bed materials in manufacturing modular bricks.

Salient Achievements:

- ❖ Collection of Brahmaputra river bed materials from Nimatighat, Kokilamukh & Spur No.8.
- ❖ Characterization of collected materials from Brahmaputra river bed.
- ❖ Preparation of design mix for collected river bed materials with cement for manufacturing modular bricks.

Project Title: Development of appropriate product by studying the possible use of coir dust in oil industry with reference to North-East India for absorption of oil spill

Project No: CLP-285

Funding Agency: CCRI, Govt. of India

PI & Members: Mr Jayanta Jyoti Bora (PI), Mr D Neog (Co-PI), Dr R L Goswami, Dr D Kalita, Mr D Das, Mr SC Kalita

Objective:

- ❖ Study of different properties of coir pith as an absorbent to be used for prevention of oil spillage effect with reference to NE oil industries.
- ❖ Design and development of coir pith captor in the shape of membrane/ blanket/ block/

- ❖ granules to deal with oil spillage.
- ❖ Study on possibilities of re-use & disposal of coir pith captor.

Salient Achievements:

- ❖ **Carried out Proximate chemical analysis of coir dust for :-**
 - i) Ash content, ii) Calorific value, iii) Cellulose content, iv) Lignin content, v) Hot water solubility, vi) Cold water solubility, vii) Solubility in dil. Alkali
- ❖ **Carried out Physical properties of coir dust for**
 - i) Bulk density, ii) Total porosity, iii) Aeration porosity, iii) Water holding capacity
- ❖ **Physicochemical treatments of coir dust**
 - i) Heat treatment, ii) Acetylation, iii) Acid treatment, iv) Alkali treatment
- ❖ **Water and Crude Oil absorption capacity of coir dust**
 - i) For different particle sizes raw coir dust, ii) heat treated coir dust, iii) Acetylated coir dust, iv) Acid treated coir dust, v) Alkali treated (digested coir) coir dust
- ❖ Preparation of Coir dust as blocks (bricks type), pouches and related tests are going on.

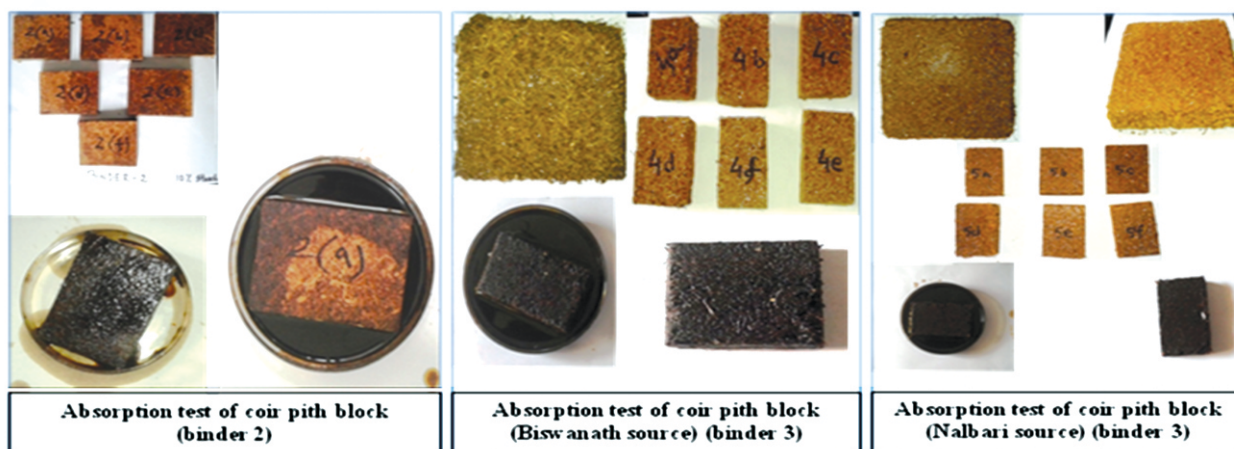
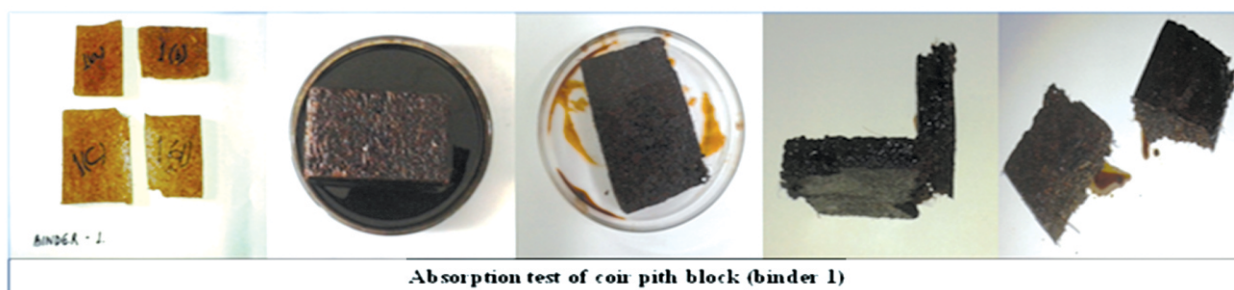


Fig.Experimental Photo