

## CSIR-NEIST AT A GLANCE 2014-2015

### RESOURCE BASE

<b>Infrastructural</b>	
R&D Department	13
Branch Laboratory	02
Seismic Stations	13

### HUMAN RESOURCES

<b>Total S&amp;T Staff</b>	<b>257</b>
Scientist (Gr IV)	73
Technical (Gr III)	61
Technical (Gr I+Gr II)	123
<b>Total Administrative Staff</b>	<b>89</b>

### FINANCIAL

	<b>(Rs in Lakhs)</b>
Government Allocation	6037.77
From Contract R&D and Consultancy	469.03
Testing/ Analytical Services	18.94
Miscellaneous including Royalty/ Premia	8.17

### BUDGET

	<b>Sanctioned (Rs in Lakhs)</b>
Recurring	4228.705
Capital	1809.065
Network Project (task force)	1788.295
Non-Recurring	871.615
Recurring	916.680

## R&D PERFORMANCE: 2014-2015

### Knowledge Generation

Papers published	114
International peer reviewed Journals	97
National peer reviewed Journals	09
Book Chapters	04
Proceedings	04
<b>Average IF</b>	<b>3.204</b>
<b>Highest IF (Review)</b>	<b>41.298</b>
<b>Highest IF (Research)</b>	<b>6.834</b>

### Technological Output

Process developed	05
Processes released to industry	04

### Extramural & Human Resource Development

PI, DST Woman Scientist Scheme	01
Research Associates	01
Sr Research Fellow	21
Jr Research Fellow	05
CSIR-TWAS Fellow	03
DST Inspire Fellow	08
Young Scientist Scheme	01
Teachers Fellow	01
JNCASR-ROCASA	01
Project Fellow	174

### Patents Filed

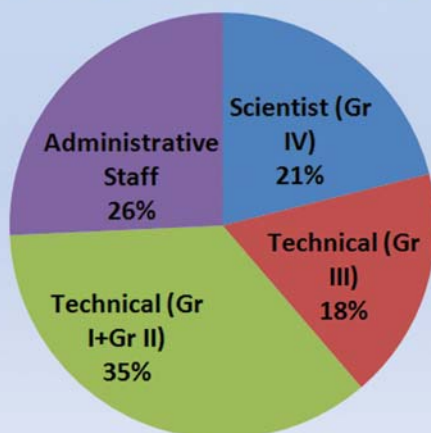
In India	07
Abroad	06

### Patents Granted

In India	02
Abroad	06

## PERFORMANCE INDICATOR

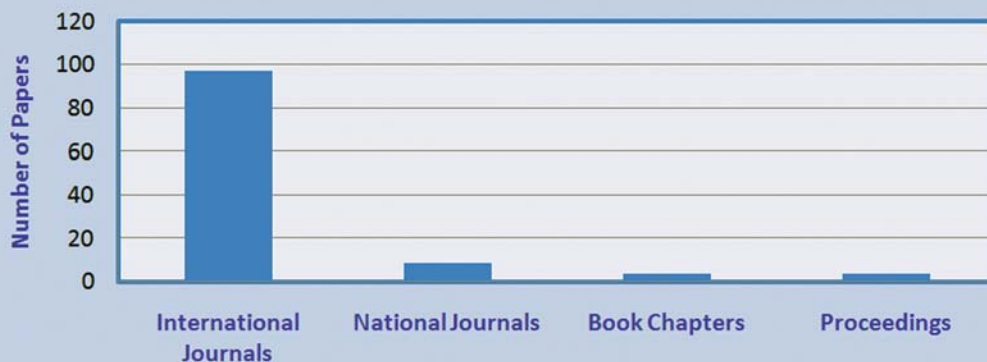
### Human Resource: 2014-2015



Area wise ECF (in Lakh)

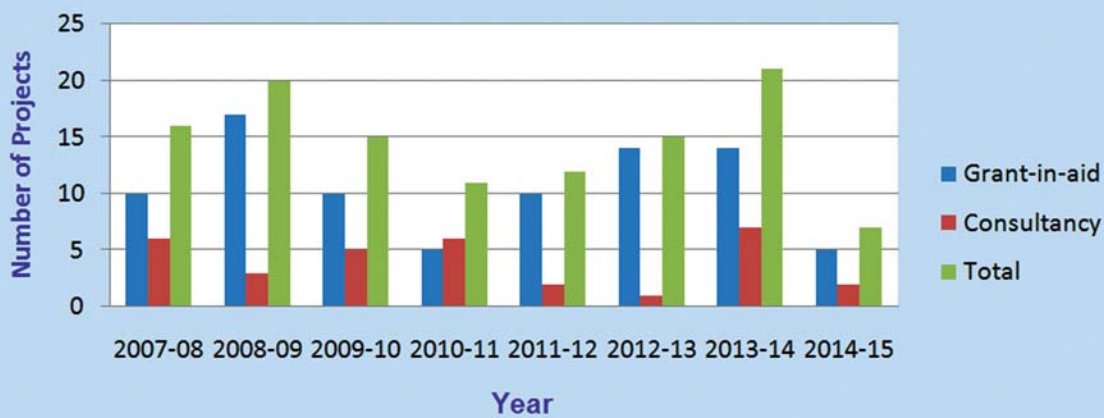


### Paper Published: 2014-2015

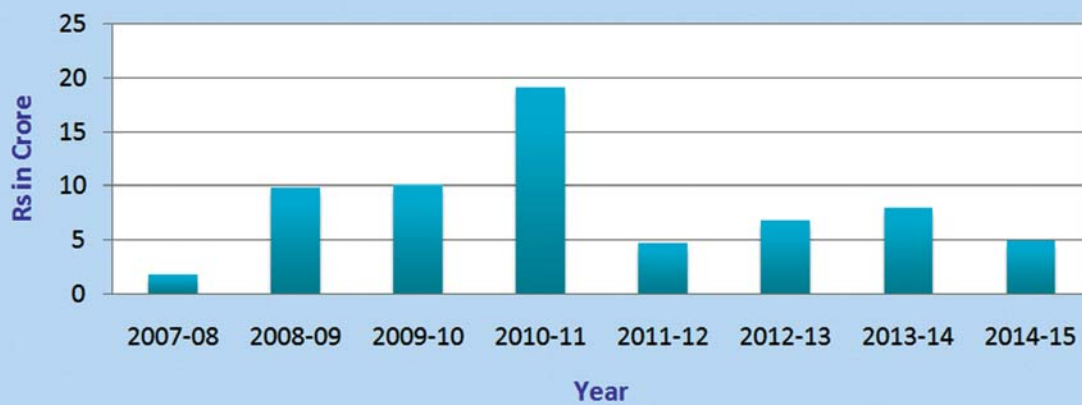




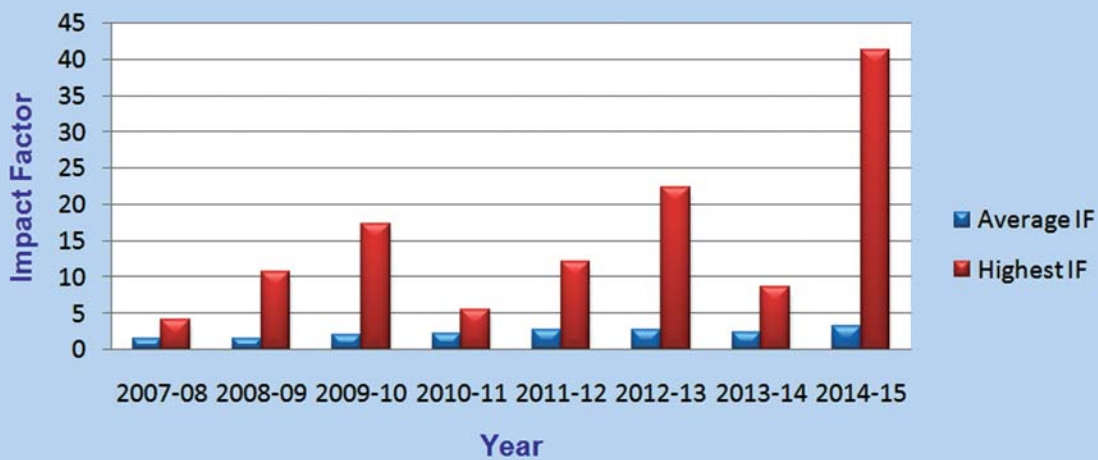
### Funded Projects Completed



### External Cash Flow



### Impact Factor



**MEMBERS OF RESEARCH COUNCIL  
2014-2015**



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Chairman



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External Member



**Prof H R Wason, Emeritus**  
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**Prof Kankan Bhattacharyya,**  
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**Prof Samir Bhattacharyya,**  
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**Prof K S Rangappa,**  
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**Prof BB Dhar,**  
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External Member



**Dr P K Biswas, Former**  
Advisor (S & T), Planning  
Commission  
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**Shri Ashoke Kumar Dutta,**  
North East Council  
Member



**Dr A Ajayghosh, Outstanding**  
Scientist, CSIR –NIIST  
Thiruvananthapuram  
DG's Nominee



**K.C. Gupta, Director, Indian**  
Institute of Toxicology  
Research (IITR), Lucknow  
Sister Laboratory



**Dr. Suresh Das, Director**  
CSIR –NIIST  
Thiruvananthapuram  
Cluster Director



Head or his nominee, PPD,  
CSIR, New Delhi



**Dr D Ramaiah, Director,**  
CSIR-NEIST, Jorhat  
Director



Permanent Invitee



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CSIR-NEIST, Jorhat  
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CSIR-Indian Institute of  
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**Dr Dipak Prajapati,  
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**Dr R L Bezbaruah, Senior  
Principal Scientist,  
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**Dr Tridip Goswami,  
Principal Scientist,  
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**Dr Mantu Bhuyan,  
Scientist, CSIR-NEIST  
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**DR (Mrs) A M Das,  
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**Shri O P Sahu,  
Principal Technical Officer  
CSIR-NEIST  
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**Shri Parag Patar  
Finance and Accounts Officer  
CSIR-NEIST  
Member**

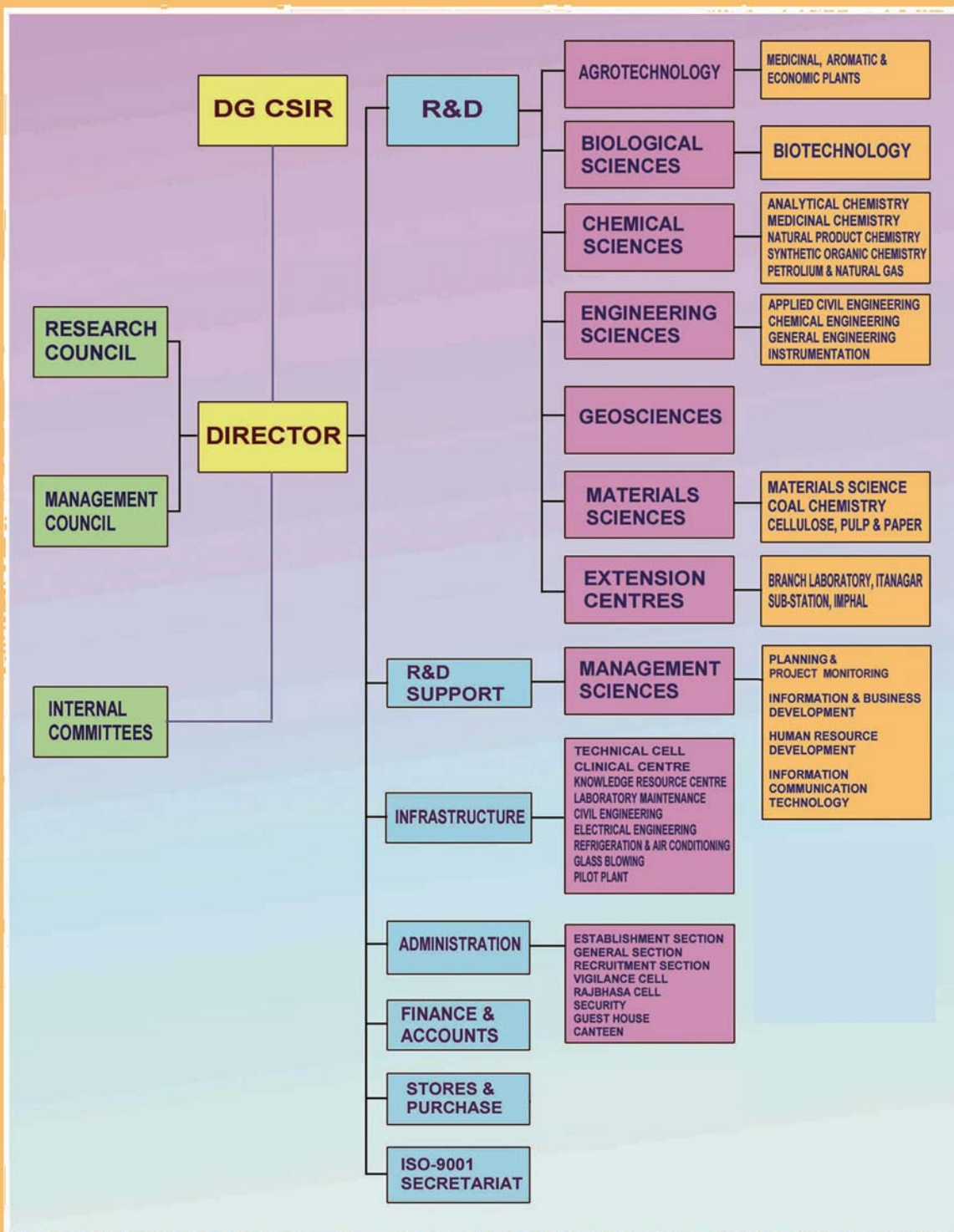


**Dr R C Boruah,  
Outstanding Scientist,  
CSIR-NEIST  
Special Invitee**



**Shri Vikram Singh,  
Administrative Officer  
CSIR-NEIST  
Member - Secretary**

# ORGANIZATION CHART



## R&D ACTIVITIES

### AGRO TECHNOLOGY

As one of the major areas in R&D, Agro-technology division carried out few major projects on exploration of the plant resources, identification of potential medicinal, aromatic and industrial value up to development of process, technology and conservation of plants of NE India. The main objective of the division are development of technology for mass multiplication of commercially viable species and their conservation with value addition of the germplasm through development of different products and dissemination of proven technologies to the people, Govt. Organizations, entrepreneurs for overall economic development.

The division is involved in 4 Network projects (BSC & CSC), 2 Nos. of In-house project, 3 Nos. of GPP, 1 CNP and 1 International project during the year 2014-2015.

#### A) International Collaboration

**Project Title:** Comparative studies on the physiological and biochemical aspects of adaptation and productivity in *Camelina sativa* L. in different biogeographic regions.

**Funding Agency:** CSIR, India / CNR, Italy

**PI & Members:** Dr SP Saikia (PI)

#### Salient Achievements:

Several *Camelina* genotypes were used and three genotypes were compared between temperate and sub-tropical area. Comparison at agronomical, physiological and biochemical levels have been carried out in both Italian and Indian regions. The results have demonstrated that *Camelina* was able to grow and



Fig: *Camelina* plantation at CSIR-NEIST experimental field

produce seeds in both countries; in North-East India only during November to March. The seed yield in India was found lower (0.3 ton/ha) than in Italy (1.0-2.5 ton/ha). The seeds harvested in North-East India showed a lower oil content, about 25% accompanied by minor differences in the oil compositions, in comparison to approximately 35% of oil, for the same genotypes, grown in Italy.

#### B) National Collaboration

##### (i) Network Projects

**Project Title:** Bioprospection of Plant Resources and Other Natural Products.

**Project No:** BSC-106

**Funding Agency:** CSIR

**PI & Members:** DR SC Nath (PI), Dr BS Bhau, Dr Mohan Lal

#### Salient Achievements:

Botanical identities of 53 plant species collected from the study areas (Gibbon Wildlife Sanctuary & Nokrek Biosphere Reserve) have been ascertained. Folklore Medicinal values of 36 plant species have been documented. Information about 30 plant species used in Traditional Systems of Medicines (codified) have been documented, followed by the documentation of biological activities of 20 plant species and bio-active substances of 20 plant species based on the review of literatures. *Chemical profiling pertaining to essential oils of Elsholtzia blanda (whole plant) and Litsea cubeba (fruit) have been completed.* A total of 30 and 17 components representing 96.9-98.3% and 92.6-92.8% of the total oils from the flowers and aerial parts of *E. blanda* have been identified respectively. Linalool was the major component of both inflorescence (77.3-80.2%) and vegetative aerial parts (57.9-62.9%). Likewise, twenty-two components representing 97.3% of the total oil of *L. cubeba* fruit are identified where citronellal alone constitutes 84.7% of the total oil. Other components above 0.5% concentrations are citronellol (7.6%), limonene (1.1), isopulegol (1.0) and myrcene (1.0). DNA Sequencing of *Aquilaria malaccensis*, *Cinnamomum tamala* and *Nepenthus khasiana* has been completed. DNA extraction and PCR amplification of *Clerodendrum indicum*, *Cymbopogon flexuosus* and *Litsea cubeba* have been successfully done using 4 different DNA Barcode primers (ITS, rbcL 1F, rbcL724 and trnH-psba).



**Project Title:** Introduction, domestication, improvement and cultivation of economically important plants (AGTEC).

**Project No:** BSC-110

**Funding Agency:** CSIR

**PI & Members:** Dr P R Bhattacharyya (PI), Dr S C Nath, Dr M Borthakur, Dr B S Bhau, Dr S P Saikia, Dr M Bhuyan, Dr M Lal

**Salient Achievements:**

Development of superior variety of Lemon grass. Eight hybrids of lemon grass have been produced. Selection trials of lemon grass of 50 different chemo types of *Cymbopogon flexuosus* were conducted. A lot of variability in herbage yield, and oil percentage were observed.



Fig: Identified a new variety (Jor Lab C-5) of Java citronella

Jor Lab C-5 of Java citronella, a superior clone from EMS mutant progeny with 30 % better oil yield for commercial cultivation.



Fig: Identified a New Clone (Jor Lab L- 8 ) of Lemon grass

Jor Lab L- 8 of Lemon grass with higher herbage yield 260q/ha accompanying citral content of 78% for commercial cultivation was developed.

**Project Title:** Plant microbes and soil interaction.

**Project No:** BSC-117

**Funding Agency:** CSIR

**PI & Members:** Dr B S Bhau (PI), Dr S B Wann, Dr Mohan Lal

**Objective:** Studies on Nematodes of Patchouli and control by PGPR

**Salient Achievements:**

Isolated and identified 7 bacterial strains from the soil as *Pseudomonas putida*, *Bacillus toyonensis* and *Pseudomonas fluorescence* by using 16s RNA. These strains effectively killed root-knot nematode (*Meloidogyne incognita*) in *in-vitro* conditions. It was observed that there was no gall formation in the roots of Patchouli plants treated with *P. putida* and *P. fluorescence*. *P. putida* can be used as a bio-control measure for nematode infection in Patchouli.

**Project Title:** Development of sustainable processes for edible oils with health benefits from Traditional and new Resources.

**Project No:** CSC-112

**Funding Agency:** CSIR

**PI & Members:** Dr S C Nath (PI), Dr B S. Bhau, Dr S B Wann, Dr Mohan Lal and Mr Bitupon Borah

**Objective:**

Screening of unexploited tree borne oil seeds of forest origin for edible and non-edible applications

**Salient Achievements:**

Collected seed samples of 66 plant species from NE India. Extractions of seed samples of 55 plant species have been carried out; 20 plant species have exhibited oil yield ranging from 10% - 50% while nine plant species of less known category resulted yield ranging from 27% -50%. Physicochemical properties of fatty oils of 47 plant species and mineral contents in the oils of 16 species have been evaluated. Compositions of Fatty acids of 33 plant species have been analyzed. Eleven species of less known category with the oil yield above 10% recovery exhibited encouraging results. Three plant species are found to be rich in C12 fatty acids (56-85%), while two species for C 16:00 fatty acids (36%-44%), four plant species for 18:1 fatty acids (46%-75%) and two plant species for 18:2 fatty acids (31%-49%) have been identified.

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

**Project Title:** Bioprospection and Assessment of Genetic Diversity of Medicinal Aromatic and Economic Plants of North-East Indian for Industrial and Socio economic Development.

**Project No:** MLP- 1000

**Funding Agency:** CSIR

**PI & Members:** Dr P R Bhattacharyya (PI), Dr S C Nath (Co-PI), Dr M Borthakur, Dr B S Bhau, Dr S P Saikia, Dr M Bhuyan, Dr MLal

**Salient Achievements:**

After acclimatization, *in-vitro* regenerated rooted plantlets of *Clausena heptaphyla* were transferred to field and survival rate was recorded.

Isolated saponin (9.5%) from non-climbing palm, *Calamus leptospadix* and characterized the saponin. The antimicrobial properties of triterpenoid saponin was tested against bacterial strains of *Escherichia coli* MTCC 739, *Pseudomonas putida* ATCC 17642, *Bacillus toyonensis* BCT 7112, *Staphylococcus aureus* MTCC 6908 and fungal strain *Candida albicans* MTCC3007

Biosynthesis of gold (triangular and spherical shaped) & silver nanoparticles from *Nepenthes khasiana* were done for the first time. It was found that the leaves extract of *N. khasiana* can be used to produce gold and silver nanoparticles with significant amount of antimicrobial activity.

An agro-technology of the species for organized cultivation practices, an experimental agronomic trial has been conducted at a zero technology condition at the Experimental Farm of CSIR-North-East Institute of Science & Technology, Jorhat during 2011-2014. The experiment resulted 18675, 14940 and 11122 numbers of standard brooms (40 nos. of inflorescence per broom) at the row to row & plant to plant spacing of 2.5x 2.0m, 2x2m and 2.5x2.5m. with the economic returns estimated at Rs.4,54,125.00, Rs.3,60,750.00 and Rs.2,65,300.00 per hectare (Rs.25.00/ broom) respectively. Thus the promising potentialities of the plant for its organized cultivation were revealed.

The stem bark of 14 *Cinnamomum* Schaeffer members, used as cinnamon spice in North-East India was investigated for essential oils and aroma chemicals. Yield of essential oils recorded for the members were ranged from 0.1% to 1.7%. Cinnamaldehyde was the major component of the oils from (85.95%) to (60.20-65.6%). It was revealed that cinnamaldehyde is although the main active ingredient responsible for odour and spicy characteristics of cinnamon but 7 taxa viz. *C. sulphuratum* variant IV, *C. asomicum*, *C. bejolghota* variant I, *C. bejolghota* variant II, *C. champokianum*, *C. cassia* variant II and *C. iners* contain aroma component other than cinnamaldehyde as major component in their essential oils.

Identified a new clone (Bharamputra-1) of *Kaempferia galanga*, one stable genotype with higher rhizome yield such as fresh rhizome 10 tons /ha. with dry recovery 25% for commercial cultivation.



**Fig:** Identified a new clone (Bharamputra-1) of *Kaempferia galanga*

**Project Title:** Sustainable Utilization of medicinal, aromatic, aquatic and economic plants:

b) i) Development of agro-technology of selected medicinal, aromatic and edible plant of Arunachal Pradesh.

**Project No:** MLP-8000(B)

**Funding Agency:** CSIR

**PI & Members:** Dr Chandan Tamuly (PI), Dr B C Baruah, Jayanta Bora, M Hazarika

**Objectives:**

- To introduce various medicinal, aromatic and edible plants.
- To develop new/better strain of medicinal/ aromatic plants.
- Development of agro technology for commercial cultivation.

**Salient Achievements:**

A new strain of lemon grass (BLI-ARUN) was developed with 25-35% increase of essential oil content has been achieved having 1.6-1.8% of essential oil.

**Project Title:** b) ii) Chemical investigation of selected medicinal, aromatic and edible plant of Arunachal Pradesh.

**Project No:** MLP-8000(B)

**PI & Members:** Dr Chandan Tamuly (PI), Dr B C Baruah, Jayanta Bora, Moushumi Hazarika

**Funding Agency:** CSIR

**Objectives:**

- Chemical investigation of unexplored medicinal, aromatic and wild edible plant of Arunachal Pradesh.

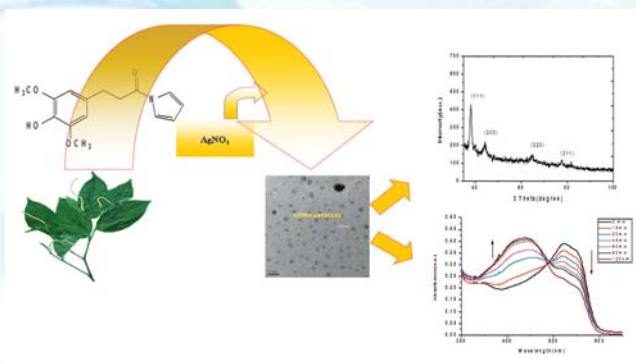
- Evaluation of antioxidant activities, phenolic content, flavonoids content of selected medicinal/edible plant and parts thereof.
- Evaluation of nutraceuticals and mineral content of selective medicinal/edible plant species.

**Salient Achievements:**

**Bio-derived CuO nanocatalyst for oxidation of aldehyde:** A greener approach was done using the peel of *Musa balbisiana*. The synthesized CuO nanoparticles are efficiently utilized in the oxidation of aldehyde to the corresponding carboxylic acid in the presence of 30% H<sub>2</sub>O<sub>2</sub> with high yields. Bio-derived CuO nanoparticles for the photocatalytic treatment of dyes were investigated. Reduction of aromatic nitro compounds catalyzed by biogenic CuO nanoparticles was also investigated.



**Biosynthesis of Ag nanoparticles using pedicellamide and its photocatalytic activity:** An eco-friendly approach was done by using pedicellamide (A), isolated from *Piper pedicellatum* C.DC leaf. Photocatalytic property of the Ag nanoparticles is investigated



**MLP- 8000 (Extension):**

Nearly 150 medicinal, aromatic and economic plants are cultivated inside the herbal garden of BLIM where rare and vulnerable plant species like *Dillenia pentagyna*, *Amoora rohituka*, *Garcinia morella*, *Iris bakeri*, etc. are cultivated. Data on 91 plants species used in the traditional medicine by Chakpa community of Manipur are also collected and identified. Nutritional profile of two herbal spice mixtures is also analyzed.

**Project Title: Biotech Intervention on Selected Medicinal and Aromatic Plants (MAP) of NER for their Effective Utilization.**

**Project No: GPP-256**

**Funding Agency:** DBT

**PI & Members:** Dr P R Bhattacharyya (PI), Dr M Borthakur, Dr BS Bhau

**Salient Achievements:**

Protocol standardization for single step regeneration of *Homalomena aromatica*, a rhizomatous linalool containing source plant having commercial utilization by tissue culture means. Performance of field survivality recorded more than 98%.

Nutritional status for shoot multiplication followed by rooting of *Acorus calamus* from few locations was studied and the optimal hormonal condition was standardized.

**Project Title: Studies on drought resistance strategy in seedlings of Teak (*Tectonagrandis* L.) species and selection of improved genotype for forest management.**

**Project No: GPP-272**

**Funding Agency:** DBT

**PI & Members:** Dr SP Saikia (PI)

**Salient Achievements:**

From the 546 teak germplasms the 5 best transplants were screened based on physiological characteristics as well as chemical constituents under various irrigation treatments.

It was found that transplants viz., GKU-24, CHM-37 and BNU-10 were more tolerant to drought stress compared to the other studied transplants. ASM-124 and LUT-45 were more sensitive to drought stress and the vegetative characteristics of transplant were lower compared to other transplants. GKU-24 recorded the highest tolerance to drought stress followed by CHM-37 and BNU-10.

**Project Title: Exploration & Utilization of wild edible plants consumed by ST people of Arunachal Pradesh for socio economic development of the state.**

**Project No: GPP- 274**

**Funding Agency:** DST, New Delhi

**PI & Members:** Dr Chandan Tamuly (PI), Jayanta Bora (Co-PI), Moushumi Hazarika

**Objectives:**

- Prioritization of wild edible plants having used by Nyishi tribe of Arunachal Pradesh having medicinal and nutritional properties.
- Evaluation of nutraceutical of the selected plants for value addition.
- Prioritization of potential plant species for mass cultivation
- Awareness programme regarding promotion, sustainable utilization and nutritional value of

selected edible plant through mass cultivation particularly on shifting cultivation affected area to conservation of biodiversity and socio-economic development of the tribal people.

- Selection of a few plant species for maximum income generation through market linkage of the tribal people of the state.

#### Salient Achievements:

Prioritization of wild edible plants having medicinal and nutritional properties used by ST of Arunachal Pradesh was done. The nutritional value and mineral contents of ten nos. the selected edibles are evaluated along with the antioxidant activities, phenolic and flavonoid content.

Three nos. of awareness programme organized at Yupia village, Tarajuli village and Pech village, Papum Pare Dist. of Arunachal Pradesh on conservation, cultivation,

sustainable utilization and nutritional value of wild edible plants of Arunachal Pradesh.

**Project Title:** Butterfly Population Studies in NRL Butterfly Valley.

**Project No:** CNP-446

**Funding Agency:** Numaligarh Refinery Ltd, Numaligarh, Golaghat

**PI & Members:** Dr Mantu Bhuyan (PI), Dr PR Bhattacharyya, Dr SC Nath

#### Salient Achievements:

132 species of butterflies are identified in the study area. Several host plants are planted to create congenial atmosphere to attract butterflies. Lifecycle of 15 species of butterflies are studied. 11 species of parasitoids were collected; 2 are egg parasitoids while rests 9 are larval parasitoids.

## BIOLOGICAL SCIENCES

The Division is engaged in bio-prospecting and bio-profiling microbial diversity from North East (NE) Gene pool. More than 2000 microbial strains were isolated, maintained and utilized from specific niches of this biodiversity hot-spot. The group is supplementing novel bacterial genus and species into world microbial taxonomy from NE gene pool in collaboration with IMTECH Chandigarh. The division has developed efficient bacterial consortia as a part of bioremediation package which were extensively applied in ONGC oil fields with success. In the last few years selected PGPR strains have been used in bio-formulation packages and the technology has been released and successfully commissioned. Induction of systemic resistance through root associated bacteria in Patchouli is another interesting ongoing program. Metagenomics on cold adapted microbial strains from Tawang, Arunachal Pradesh and crude oil degrading strains from Oil field area of Digboi have been studied. Whole genome sequencing of certain hydrocarbon degrading and antibiotic producing microbial strains and their analysis has been completed to understand their potentialities in molecular level. Bio control potentialities of certain short-listed strains have been evaluated for their field applications. Screening microbial enzymes having targeted activities such as biotransformation and industrial catalysts are regular activity of the group. Screening anti-infective against *Mycobacterium tuberculosis* and related pathogens is in progress. Isolation, structure elucidation, bioassay and mode of

action of the bioactive molecule isolated from endophytic fungi endowed with anti-prostate cancer activity were completed. Study on the impact of environmental pollution on human health especially COPD have been extensively studied in molecular and genetic level. Extensive study on silk worm biochemistry and productivity has resulted in developing technology packages. DBT-sponsored Bioinformatics facility is catering to the needs of both scientists and students immensely.

#### A) National Collaboration

##### (i) Network Projects

**Project Title:** Studying adaptation biology and understanding/exploiting medicinally important plants for useful bioactives (SIMPLE).

**Project No:** BSC-109

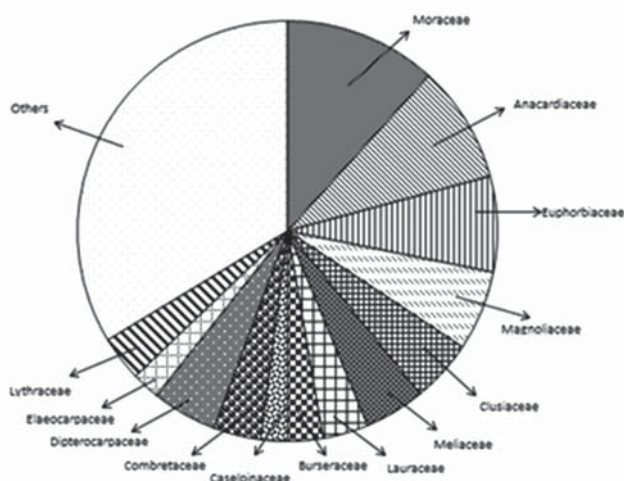
**Funding Agency:** CSIR

**PI & Members:** Dr H P Deka Boruah (Nodal Scientist), Dr R Saikia, Dr Jatin Kalita, Dr Anil Kr Singh, Dr M Khongsai

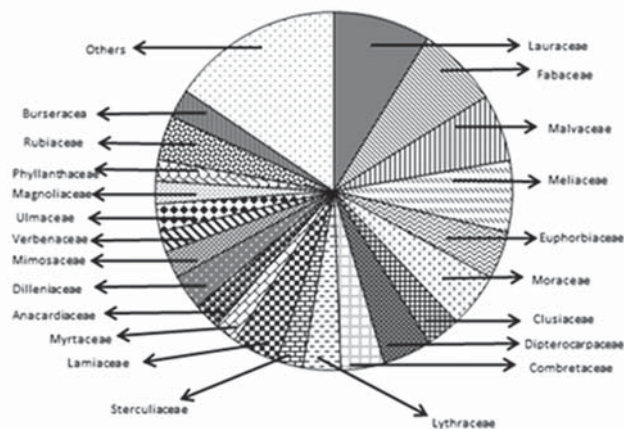
#### Salient Achievements:

Tree composition, diversity, dominance and carbon stocks in the Above Ground Biomass (AGB) and soil of tropical forests viz., the Gibbon wildlife sanctuary (GWS) and the Kholahat reserve forest (KRF) of Assam, were assessed. Soil sampling, tree survey, girth above 1.3 m height of plants >10 cm girth were assessed in 1000 m<sup>2</sup> quadrat. A total of 71 and 108 different tree species belong to 32 and 42 families were found in the GWS and

KRF, respectively. In the GWF, the Shannon diversity index (1.22) and the Simpson index (0.085) were significant, while for the KRF these indices were insignificant. The average soil carbon stock (SOC) in the upper, middle and lower layers was 57.74e78.44 kg m<sup>-2</sup>, 39.22e64.93 kg m<sup>-2</sup> and 30.32e42.86 kg m<sup>-2</sup>, respectively, in the GWS and KRF. However, compared to GWS, a higher AGB and AGBC were found in KRF. This finding reveals that the higher AGB, AGBC and SOC in the KRF were due to old growth matured forest with big and diverse tree species. The forest habitats types in six forest of Assam namely Pobha, Kholahat, Nameri, Dehing Patkai and Upartala while family composition of two studied forest is given below.



**Kholahat reserve forest**



**Gibbon wild life sanctuary**

**Project Title:** Integrated NextGen Approaches in Health, Disease and Environmental Toxicity (INDEPTH).

**Project No:** BSC-111

**Funding Agency:** CSIR

**PI & Members:** Dr Jatin Kalita, PI (WP-I); Dr R Saikia, PI (WP-II); Dr M Bhuyan, PI (WP-III); Dr PR Bhattacharya, Dr TC Bora; Dr HP Deka Boruah; Dr P K Baruah; Dr T Borah; Mr D Ozah

**Salient Achievements:**

Isolation and characterisation of 150 nos. bacteria from crude oil contaminated soil from Digboi oil refinery's areas were made. 10 nos. of bacterial strains were found to be positive in naphthalene, benzo(a)pyrene, phenanthrene degradation. Based on 16S rDNA sequence, few polyaromatic hydrocarbon (PAH) degrading bacterial strains have been identified (NCBI accession no. KP326362, KP326363, KP326364, KP326365). Mass Spectroscopic analysis of metabolite produced in the benzo(a)pyrene containing medium the strain *Bacillus toyonensis* ADG19 degraded benzo(a)pyrene after 48 hrs of incubation.

*In-silico* docking was done to see whether 4-hydroxyphenyl pyruvate was responsible for degradation. It was observed that hydrogen bonds were formed between the protein and the ligand (Fig. 1).

In addition 20 nos. of biosurfactant producing strains were identified based on 16S rDNA sequence. Most of the strains were under *Bacillus* group and 2 strains have ability to degrade crude oil (Fig. 2).

Butterfly diversity and abundance around Gas flaring sites was studied in Rudrasagar, Sibsagar district of Assam and carbon dioxide (CO<sub>2</sub>) was found as major emitted gas. Simulation study was done for host plant *Cassia tora* and the butterfly *Eurema hecabe* in the study area under elevated CO<sub>2</sub> (500ppm). It was found that C/N ratio of *Cassia tora* grown under elevated CO<sub>2</sub> levels increase. Growth and development studies indicated that larval duration of the butterfly *Eurema hecabe* was shorter under elevated CO<sub>2</sub> foliage than in control. Consumption rate of the butterfly larvae is more in OTC then in control (unpolluted).

Characterization of coagulase producing bacteria was done. Screening of bacteria were done having PGPR.

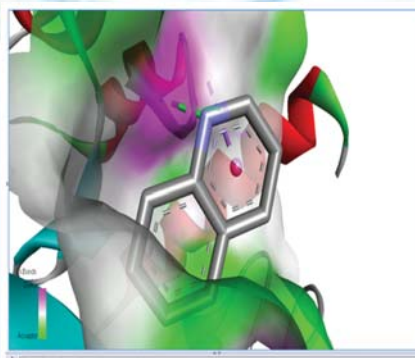


Fig 1: Docking of benzo(a)pyrene with 4-hydroxyphenyl pyruvate



Fig 2: Crude oil degradation by the strains, *Bacillus* sp. N34 (A) and *Bacillus subtilis* N39 (B)

**Project Title:** Therapeutics of Chronic Obstructive Pulmonary Disease (COPD) and related respiratory disorders (COPD-TREAT).

**Work Component at NEIST, Jorhat:** Chronic obstructive pulmonary disease: Study of differential immune responses through gene environment interaction.

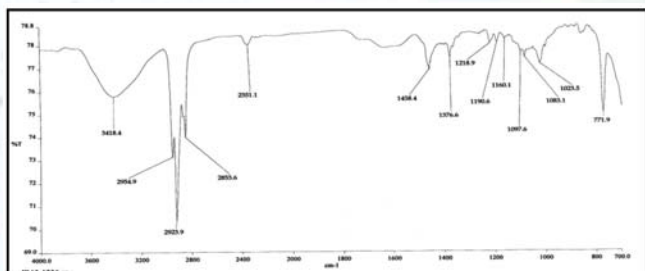
**Project No:** BSC-116

**Funding Agency:** CSIR, New Delhi

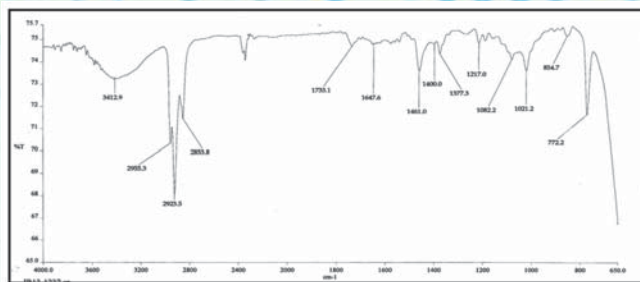
**PI & Members:** Dr Jatini Kalita (PI), Dr H P Dekaboruah (Co-PI), Dr P K Baruah, Dr T Bora, Mr R C Bharali, Mr D Ozah

**Salient Achievements:**

The concentration of Suspended particulate matter, sulphur dioxide and nitrogen dioxide were found to higher in the coal mine area as compared to non-coal mine area. An X-ray diffractometry study reveals the particulate matters are amorphous in nature. FT-IR studies of the environmental dust samples showed higher concentration of C-F compounds and organic silicone present in coal mine area site. Scanning electron microscopy shows the average size of the particulate matters of coal mine site are in nm (Nanometer) range as compared to  $\mu\text{m}$  (Micrometre) range in non-coal mine site. Atomic absorption studies shows higher concentration of Mercury (Hg) and Manganese (Mn) in environmental sample collected from coal mine site. Spirometry tests reveal most of the patients were found to be having FEV1/FVC ratio less than standard (80%). Out of 132 patients, 10 patients were found having absence of GSTT1/GSTM1 gene.



(A)



(B)

Fig: FT-IR spectrum of environmental dust sample; Coal mine area (A), Non-Coal mine area (B)

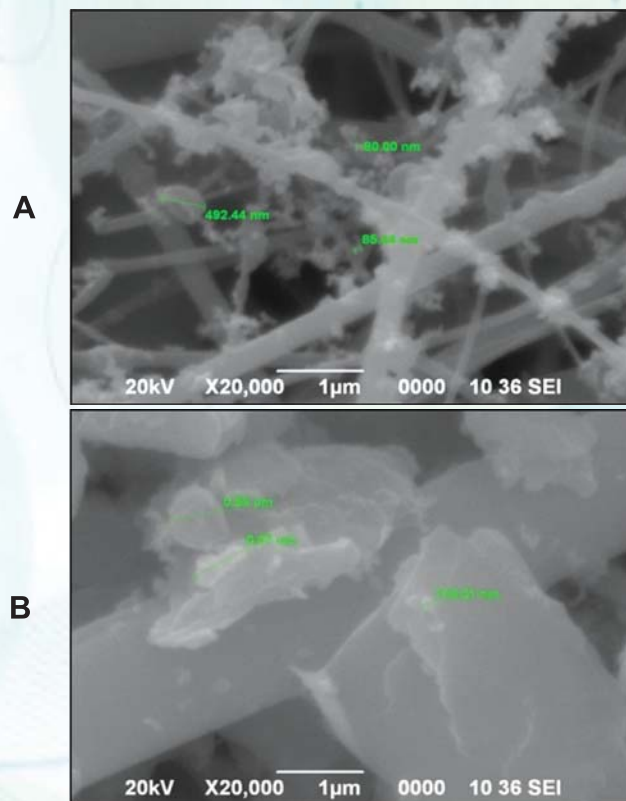


Fig: SEM analysis of air dust sample; Coal mine area (A), Non coal mine area (B)

**Project Title:** Role of ACC-deaminase producing PGPR on alleviation of water stress affect in pulse crops (RAWS, under PMSI).

**Project No:** BSC-117

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr Ratul Saikia (PI), Dr H P Deka Boruah (Co-PI), Dr T C Bora (Co-PI)

**Salient Achievements:**

Isolation and identification of ACC deaminase producing bacterial isolates- A total of 80 numbers of ACC deaminase producing bacteria were isolated from pulse rhizospheric soil in the vicinity of Jorhat, Assam. On the basis of 16S rRNA gene sequence analysis, majority of them were phylogenetically affiliated to the genera *Pseudomonas*, *Burkholderia*, *Bacillus*, *Ochrobactrum*,

*Serratia*, *Comamonas*, *Staphylococcus* and *Klebsiella*. The following GenBank accession nos. were assigned to the respective isolates- KJ784475, KJ784476, KJ784477, KJ801950, KJ784478, KJ801951, KJ801952, KJ801953, KJ784479, KJ784480, KJ818119, KJ831073, KJ831074, KJ831075 etc. and the bacterial isolates were screened for plant growth promoting traits and efficiency in plant growth were investigated. Such as, Effects of bacterial inoculation on plant growth promotion under water deficit condition in black gram and pea plants treated with the isolates individually and in consortium. Study exhibited remarkable improvements in their physiological, biochemical and morphological growth parameters. The effect of drought tolerance was most significant ( $p < 0.05$ ) in the consortium treated host plants after 45 days of treatment (Fig.).

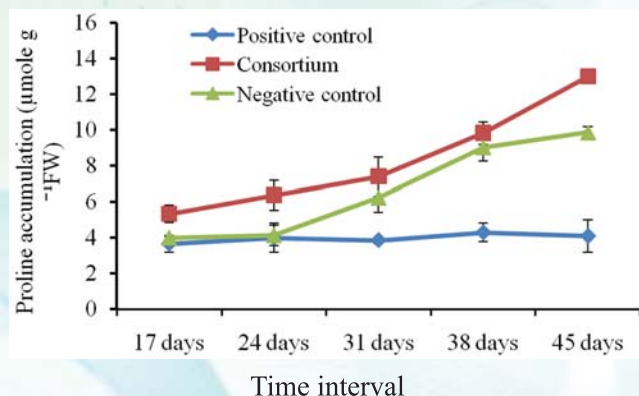


Fig: Quantitative estimation of proline accumulation in consortium treated black gram plants

**Project Title:** Biocatalysts for Industrial Applications & Greener Organic Synthesis (BIAGOS).

**Work Component at NEIST, Jorhat:**

Functionalization, glycosylation and acylation using transferase (AATs) of Artemisinin and related phytochemicals for value addition.

**Project No:** CSC-106

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr TC Bora (Nodal Scientist), Dr NC Barua, Dr RL Bezbaruah, Dr Ratul Saikia, Mr AC Kakoty, Mrs Archana Yadav

**Salient Achievements:**

More than 80 samples from specific niches were collected, 278 fungal strains were isolated from NE gene pool and stock cultures were maintained. Strains were screened for targeted acylation and hydroxylation properties. 20 strains were endowed with acylation and hydroxylation activities; 4 fungal strains showed activity of Artemisinin biotransformation. Potential transformed derivatives have been purified and through spectral analysis complete structure was elucidated.

**Project Title:** Photobiological process to produce bioenergy through carbon sequestration from atmosphere and waste water 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

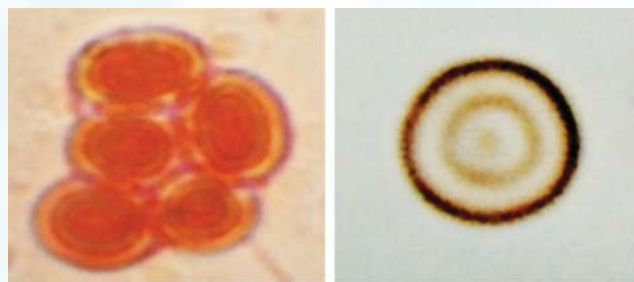
**Funding Agency:** CSIR

**PI & Members:** Dr H P Deka Boruah (Nodal Scientist), Dr TC Borah, Dr R Saikia, Dr Pinaki Sengupta

**Salient Achievements:**

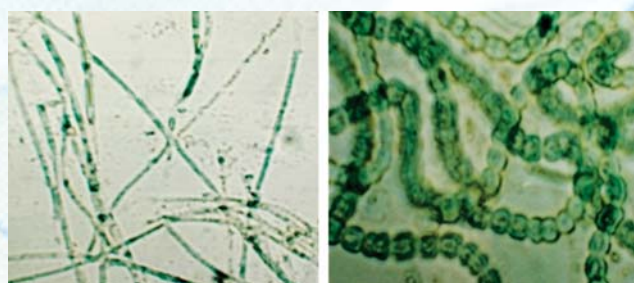
Freshwater microalgae from different districts of Assam were collected and screened. Screened strains were assayed for their subsistence under varied conditions. All the 4 freshwater microalgae viz. *Anabaena*, *Gloeocapsa*, *Spirulina*, *Chlorella* produced biomass in varying amount. Lipid, chlorophyll a, chlorophyll b as well as total chlorophyll were also assayed in *Anabaena*, *Gloeocapsa*, *Spirulina*, and *Chlorella*.

**Fig:** Microscopic View of The Screened Microalgae



*Gloeocapsa*

*Chlorella*



*Spirulina*

*Anabaena*

**Project Title:** Development of new antituberculosis molecules using microbial resources of northeast gene pool.

**Project No:** HCP0001-OSDD

**Funding Agency:** CSIR

**PI & Members:** Dr T C Borah (PI), Dr Anil Kr Singh (Co-PI), Dr H P Deka Boruah (Co-PI)

**Objective:**

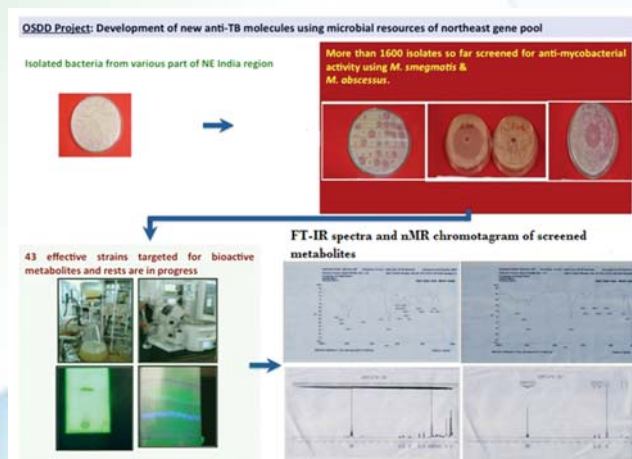
Screening, isolation, and identification of anti-Tb potent microbes and their metabolites.

Further using synthetic organic analogues to optimize the anti-Tb role of metabolites.

Assessment of biosynthetic pathways affected by new metabolites to understand the exact structural-functional mechanisms.

#### Salient Achievements:

1500 bacteria strains were isolated from different ecological niche and screened for the anti TB activities against test organism *Mycobacterium smegmatis* and *Mycobacterium abscessus*. 43 bacterial isolates showed good activity against both the mycobacterial strains. Extraction of Bioactive metabolites and their identification from six effective strains have been done.



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

**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 H P Deka Boruah (PI), Dr S B Wann, Dr Ratul Saikia, Dr M Khongsai, Dr Jatin Kalita, Dr Anil Kr Singh, Mrs Archana Yadav, Mrs Palakshi Bordoloi

#### Salient Achievements:

More than 1000 soil samples from different locations were collected and screened for microbes by following standard protocol. Algae were also collected. Vegetation studies were also performed to predict biodiversity, nature and carbon stocks. Presently more than 1000 important bacterial strains are maintained and being investigated for exploiting different biological activities.

**Project Title:** Bioinformatics Infrastructure Facility.

**Project No:** GAP-200

**Funding Agency:** DBT, New Delhi

**PI & Members:** Dr Rajib Lochan Bezbaruah (Co-ordinator & PI), Dr Ratul Saikia (Co-coordinator)

#### Objectives:

- To serve bioinformatics and computational facility to researcher in relation to wet laboratory experiment.
- To conduct training and workshop for promoting bioinformatics application in biological research and development.
- To provide basic and core Bioinformatics knowledge for PG and UG student coming from different academic Institutions in India and abroad.
- To strengthen the Human Resource Development in the field of Bioinformatics.

#### Salient Achievements:

Basic Introduction to Bioinformatics to the students of Kokrajhar College and Bajali College, Assam. 1 month summer training to Tezpur University PG student of Int. M.Sc in Bioscience and Bioinformatics. Hands on training to B.Sc Student of N.N.Saikia College, Titabar on Bioinformatics applications. Summer training student from Amity University, Noida worked on *E. Coli* and *Lactobacillus* bacteria.

**Project Title:** Development of formulations of microbial bioinoculants with plant growth promoting and biocontrol activities for application in rice cultivation in Manipur and Assam.

**Project No:** GAP-240

**Funding Agency:** DBT

**PI & Members:** Dr H P Deka Boruah (PI), Dr N Saikia, Dr M Khongsai

#### Objectives:

- Revalidation of PGP-BCA strains available with the investigators.
- Optimization of fermentation/mass production for selected BCA/PGP strains.
- Development of formulation of microbial consortia of selected strains and assessment of their efficacy under pot and field trials.
- Optimization of formulation and delivery methods; registration and patenting, if feasible.

#### Salient Achievements:

Strains were screened having the PGPR potential in this programme. A technology with a reactor capacity of 1.0 tonne per day was developed. A strain showing biodegradative potential and other beneficial activities, namely *Pseudomonas aeruginosa* Strain N002 was put to whole genome sequencing. The details of genes and traits were analyzed. The two component system for degradation and adaptation in degradation was established.



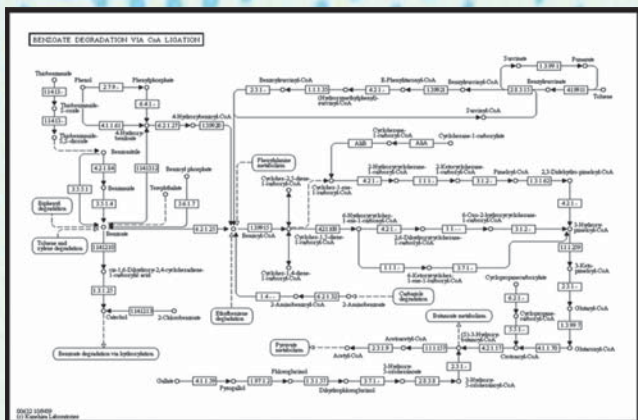


Fig: Benzoate Degradation mechanism in *Pseudomonas aeruginosa* N002

**Project Title:** Application of carbon sequestration of forest ecosystem of Assam for long term sustainability.

**Project No:** GAP-251

**Funding Agency:** DST

**PI & Members:** Dr HP Deka Boruah (PI)

**Salient Achievements:**

The biomass carbon in six forest areas of Assam was assessed. The allometric equations suitable for single species forest types and mixed tropical forest carbon assessment were standardized.

**Project Title:** Genetic Diversity of Antimicrobial Agents Producing *Streptomyces* Isolated from Protected Forest Area of Assam and Arunachal Pradesh.

**Project No:** GAP-255

**Funding Agency:** DBT, New Delhi

**PI & Members:** Dr Ratul Saikia (PI), Dr Tarun C Bora (Co-PI), Dr Manab J Bordoloi (Co-PI), Mrs Archana Yadav

**Salient Achievements:**

Phylogenetic analysis of the antimicrobial *Streptomyces* isolated from Tawang, Arunachal Pradesh was made. The 16S rRNA gene sequence analysis was carried out to elucidate the within species variation among the *Streptomyces* strains. Sequences (1,148–1,466 bp) for each of the 33 nos. of antimicrobial strains were compared with each other. Results showed that 26 of the strains had a 99 % similarity with various *Streptomyces* spp., while the remaining seven had a 98 % similarity to different species of *Streptomyces*. Ten distinct phyletic clusters were formed from the analysis corresponding to different bootstrap values using *Micromonospora aurantiaca* as an out-group. A phylogenetic tree based on 16S rDNA sequences was constructed by distance as well as sequence based methods both of which were concordant. Family 18 chitinase diversity among the

antifungal *Streptomyces* was investigated. The chitinases in the study showed significant variation within the catalytic domain as observed by the phylogram (Fig.). De Novo Whole Genome Sequencing and analysis of broad spectrum antimicrobial agent producing *Streptomyces* strain (RSD27) was isolated from Tawang. De Novo whole genome sequencing was done by Illumina MiSeq. Genome size is 7.9 Mbp approx., Gene 6363, total nucleotide 2355, protein sequences 7447 etc. The genome was submitted to the NCBI GenBank (NCBI Accession No.: JWZS00000000; BioProject: PRJNA267035; BioSample: SAMN03177439).

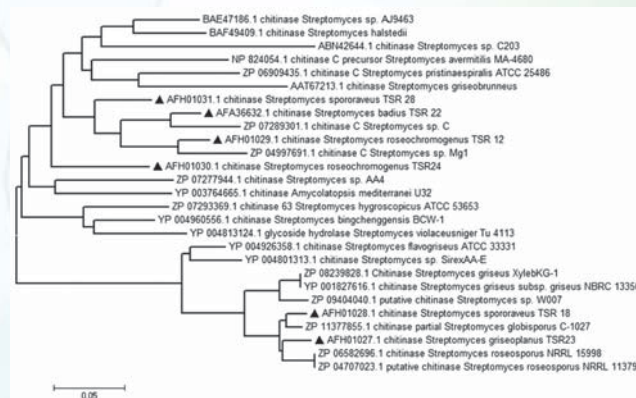


Fig: Neighbour-joining tree showing phylogenetic relationships between glycosyl hydrolase family 18, group I chitinase amino acid sequences (catalytic domain) from the antifungal strains against the GenBank matched entries related to the family

**Project Title:** A study on Taxonomy and Ethnobotany with an emphasis to biochemical parameters of the family *Myristicaceae* R. Br. In North East India.

**Project No:** GPP-262

**Funding Agency:** Science and Engineering Research Board, (SERB), DST, Govt. of India

**PI & Members:** Dr Dipanwita Banik (PI)

**Salient Achievement:**

Confirmed the distribution of 9 species under 3 genera of the family *Myristicaceae* in North East India. The extended distribution was recorded for the 3 species. The ethnobotanical data on the family is collected and compiled for the 5 states viz., Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Tripura. The study confirmed that there is variation in phytochemical constituents along with their taxonomic characters among different species.

**Project Title:** DNA Fingerprinting of Endophytic Actinomycetes Isolated from Protected Forest Areas of Assam and Mizoram.

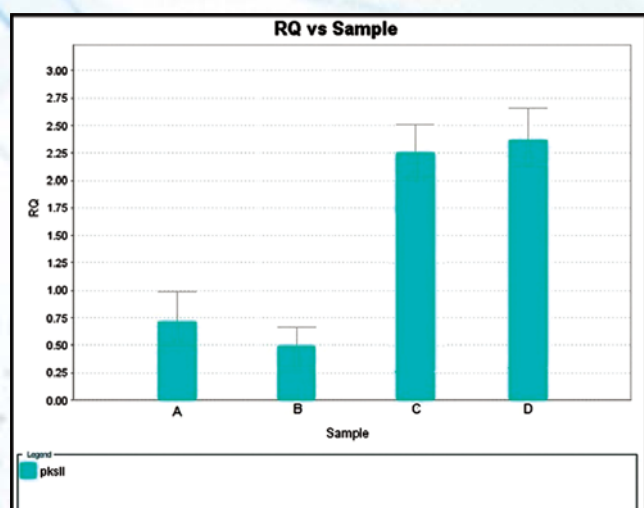
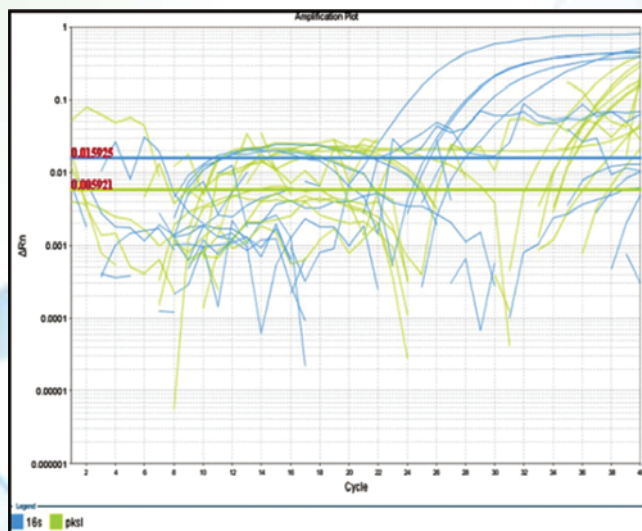
**Project No:** GPP-265 (DBT-Twinning)

**Funding Agency:** Department of Biotechnology (DBT), New Delhi

**PI & Members:** Dr Ratul Saikia (PI), Dr Tarun C Bora (Co-PI), Mrs Archana Yadav

**Salient Achievement:**

**Isolation and identification of 120 nos. of endophytic actinomycetes** of different medicinally important plant samples were collected from Gibbon Wild Life Sanctuaries, Jorhat and Kaziranga National Park (Fig. 1). Taxonomic position has been determined based on 16S rDNA sequence and submitted to NCBI GenBank. Selection of efficient antimicrobial strain and detection of biosynthetic genes viz. PKS I, PKS II and NRPS. These strains showed prevalence of polyketide synthase type II (PKS II, 80%) followed by polyketide synthase type I (PKS I, 3%) and NRPS gene. The study revealed that the bioactive strains were highly expressed as compared to inactive strains (Fig.).



**Fig:** Amplification plot for comparative real time q-PCR analysis for PKSII genes from four potential actinomycetes strains

**Project Title:** Detoxification of mustard seed based product through fermentation process based on North East traditional practice and their value addition.

**Project No:** GPP- 271

**Funding Agency:** DBT, Govt. of India

**PI & Members:** M Khongsai (PI)

**Objective:**

- Survey and collection of fermented mustard seed products from various parts of north east.
- Isolation of glucosinolate-degrading microorganisms using sinigrin as model.
- Detoxification of fermented mustard seed meal
- Biological detoxification of fermented mustard seed meal will be done by the method of Starton, 1970.
- Estimation of reducing sugar by dinitrosalicylic acid method- Miller, G.L., 1959.
- Estimation of total glucosinolate levels by glucose release method of Heaney *et al.*, 1988.

**Salient Achievements:**

**Collection of samples:** Survey and collection of 45 samples of fermented mustard seed products Kahudi, Kharali and Panitenga were carried out extensively from various parts of North East. The samples are traditionally prepared using mustard seed fermented products by Assamese community. The mustard seed fermented products are used as the source for microbial isolation.

**Isolation of microbial strains:** Isolation, screening and production of glucosinolate degrading microbial strains were carried out using sinigrin and traditionally prepared fermented mustard seed recipes (Kahudi and Kharali). A total of 300 bacterial strains have been isolated from the traditionally prepared fermented mustard seed recipes using Nutrient agar media and Sauton's agar media by serial dilution techniques. The pure cultures are maintained at Nutrient agar/Potato Dextrose agar media.

**Screening of microbes for production targeted enzymes and developing consortia (myrosinase enzyme):** Detoxification of mustard seed food supplements was done by supplementing the consortia for production of myrosinase enzyme. The isolated bacteria were used as principle supplement for the degradation of the glucosinolate compound present in the finished products. The available glucosinolate compound sinigrin (allyl glucosinolate) is used as the available substrate to compare with the mustard seed cake.

**Project Title:** Induction of systemic resistance through root associated bacteria in Patchouli (*Pogostemon cablin* Benth.) and management of nematode.

**Project No: GPP-285**

**Funding Agency:** DST, New Delhi

**PI & Members:** Dr S B Wann (PI)

**Salient Achievements:**

A total of 120 morphologically different bacterial colonies were isolated from soil samples and maintained in Nutrient agar, Potato Dextrose agar, Kings' B and Yeast Malt agar (YM agar) media. The selected bacterial isolates were characterized by Gram's reaction, and biochemical test using biochemical kit (HiMedia) for Catalase activity, Oxidase test, Amylase activity, Nitrate reduction test, Indole production test, Urease production test, Carbohydrate fermentation, H<sub>2</sub>S production, and Citrate Utilization Test as per the standard methods. The bacteria were isolated and *in vitro* screening was done for different plant growth promotion activities i.e. tested for antagonism against phytopathogenic fungi and for their abilities to solubilize phosphate, production of IAA, production of Siderophore (Iron Sequestration), HCN production, catalase activity and Fluorescent pigments. The bacteria isolated showing maximum plant growth promotion activities were further identified on the basis of colony morphology, Gram staining and biochemical tests. The selected bacterial isolates showing different plant growth promotion activities were then assessed *in vitro* for effectiveness against nematodes infection in Patchouli in pot experiments in green house condition. The bacterial strains showing positive results were identified by 16S rDNA.

**Project Title: Isolation and characterization of Antifungal peptides from Mug Silkworm *Antheraea assama* Helfer.**

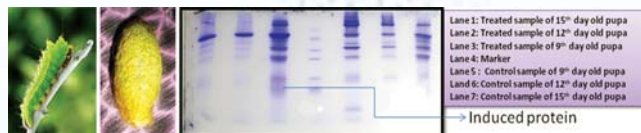
**Project No: GPP-290**

**Funding Agency:** DBT's Twinning Programme for the NE region in collaboration with Central Muga-eri Research & Training Institute, Central Silk Board & Indian Institute of Technology, Kharagpur, West Bengal

**PI & Members:** Dr Jatin Kalita (PI)

**Salient Achievements:**

5<sup>th</sup> instar larva were immunized with the fungal solution (62000 cfu/ml). Equivalent larva were reared as control. Collected hemolymph from larva & subsequently from pupa (treated & control) for analyzing the additional synthesized protein. The SDS PAGE along with medium range marker confirmed that 9<sup>th</sup> day old pupa has produced the induced protein.



**Fig:** Induced protein/peptide by the 9<sup>th</sup> day pupae of silkworm, *A. assamensis*

**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

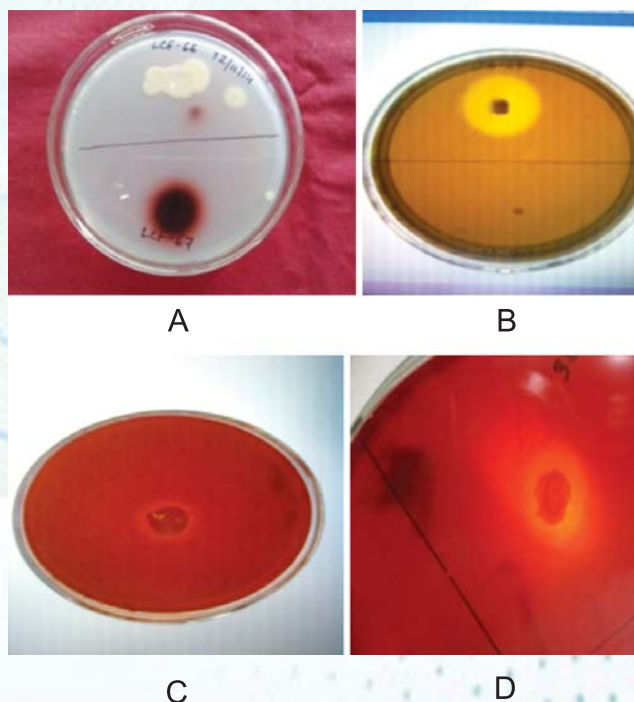
**Funding Agency:** DBT, New Delhi

**PI & Members:** Dr Ratul Saikia (PI), Dr Tarun C Bora (Co-PI), Dr Prakash J Saikia (Co-PI), Mrs Archana Yadav (Co-PI)

**Salient Achievements:**

Isolation of nearly 600 nos of Microbes (bacteria and fungi) was collected from bark, rhizospheric soil sample and leaf litters from protected forest areas of Assam like Gibbon and Nambor wildlife sanctuary.

Then we have isolated 600 nos. of microbes (bacteria and fungi) from those collected sample. Screenings for enzyme activity about 550 isolates were done against four selected enzymes (*viz.* cellulase, xylanase, pectinase and laccase). 40 bacterial isolates were positive for cellulase, 15 isolates were positive for xylanases and 20 isolates were for pectinase. 10 nos of fungal isolates were positive for cellulase and xylanases each, while 12 isolates were positive for laccase and 15 for pectinase (Fig.). The bacterial isolates LCB-13 showed highest xylan hydrolysis capacity followed by LCB-23.



**Fig:** Enzyme assay, A. the brick red zone around the colony indicates laccase activity of a fungal strain; B. the clear zone indicates pectinase activity; C and D indicates cellulase and xylanase activity respectively

Based on 16S rDNA sequence analysis a total 15 nos. of bacterial isolates were identified and observed that most of the strains belonged to *Bacillus* group.

**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 Tarun C Bora, Dr H P Deka Boruah, Mrs Archana Yadav

**Objectives:**

- Construction of metagenomic library
- Bacterial community profiling

**Salient Achievements:**

Microbial diversity studies from traditional culture based polyphasic approach of Taxa identification were started and Illumina Miseq based metagenomics studies were currently employed. This locus of microbes was targeted to pinpoint the identity of assemblage. It can be done by generating census data either by cloning the amplified any of the variable region ( V3 to V9 ) and segregating the target from the mixture by transforming into a bacterial host and identify individual entities by traditional Sanger sequencing or directly deep sequence reads by generated single and or paired end library. The generated libraries are then multiplexed with barcodes for increasing throughput and parallelization.

*Rhododendron arboreum* is an endemic species which is vastly spread in the entire Arunachal Pradesh. In this study, Illumina MiSeq (2X150 bp) PE Library sequencing of 16S-V3 amplicon from some soil samples associated with *Rhododendron arboretum* of Tawang has been done. The sequences were analyzed through UPARSE and QIIME pipelines to generate of operational taxonomic unit (OTU) table and taxonomic assignment was evaluated against RDP database (Fig.). The study showed that elevational gradient influenced rhizospheric bacterial community of *Rhododendron arboreum*.

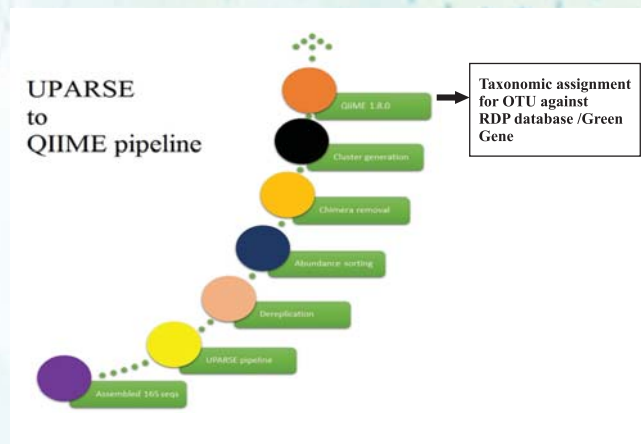


Fig: Flow chart of stepwise generation of OTU table and taxonomic assignment

## CHEMICAL SCIENCES

In Chemical Sciences Area, the thrust of the research has been focused on green approaches for development and value addition of bioactive and biopolymers. This Area consists of five divisions- Natural Products Chemistry, Medicinal Chemistry, Synthetic Organic Chemistry, Petroleum and Natural Gas and Analytical Chemistry with five work packages respectively.

**A) International Collaboration**

**Project Title:** Screen Printed Electrodes (SPEs) Functionalized with Organic- Inorganic Hybrid Nano-Composites for Bio-sensing Applications.

**Project No:** GPP-289

**Funding Agency:** DST, Govt. of India, Indo-Russian Bilateral

**PI & Members:** Dr R Khan (PI), Dr BS Bhau (Co-PI)

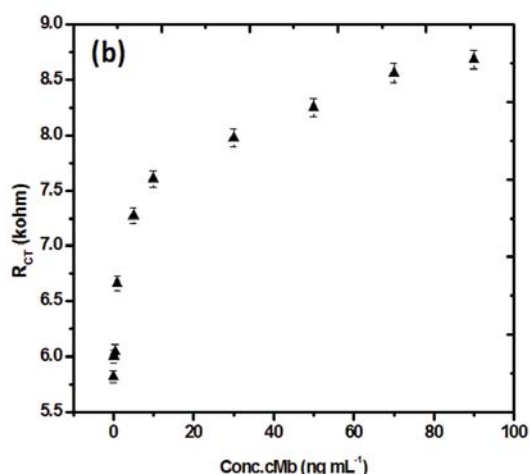
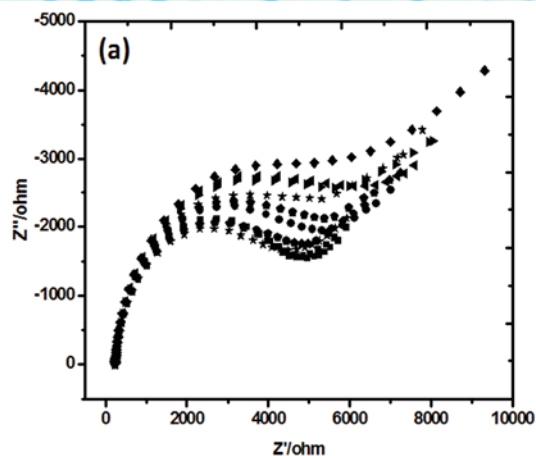
**Objective:**

- Synthesis and characterization of metal oxide nanoparticles.

- Fabrication of organic-inorganic nanocomposites materials on to the Screen Printed Electrodes (SPEs) and its characterization using CV, EIS, SEM, X-ray diffraction, DPV.
- Biofunctionalization of organic-inorganic nanocomposites modified SPEs by surface Modification's using immobilization of hemoproteins.
- Application of electro catalytic activity of hemoproteins (cytochrome c and myoglobin).

**Salient Achievements:**

Myoglobin plays an important role in disease diagnosis because it is a sensitive marker for muscle injury and a potential code for heart attack in patients with chest pain. A simple, immune-sensor signal amplification method was demonstrated to detect cardiac myoglobin using screen-printed electrode containing multiwalled carbon nanotubes. Electrochemical impedance spectroscopy measurements showed a low detection limit of  $\sim 0.08$  ngmL<sup>-1</sup>, with linearity and high sensitivity.



**Fig:** (a) Nyquist plots of SPEs-MWCNTs-anti-IgGs-cMb-BSA Immunosensor with bare electrode and different concentrations of cardiac myoglobin from 0.1 to 90 ng mL<sup>-1</sup>.

**Fig:** (b) Calibration plots showing RCT for different concentrations of cardiac myoglobin from 0.1 to 90 ng mL<sup>-1</sup>

## B) National Collaboration

### (I) Network Projects

**Project Title:** Organic reactions in generating innovative and natural scaffolds, ORIGIN.

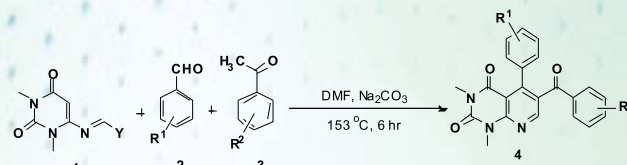
**Project No:** CSC-108

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr Dipak Prajapati (PI), Dr Romesh Ch Boruah, Dr P J Bhuyan, Dr Pranjal Gogoi, Dr Sanjeev Gogoi

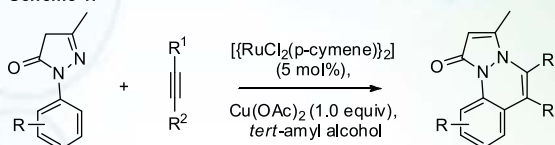
### Salient Achievements:

**Exploration of uracils:** An efficient Pot and step economic protocol for production of pyridine core containing templates by multicomponent aza-Diels-Alder reaction of uracil analogues, aromatic aldehydes and acetophenones in presence of Na<sub>2</sub>CO<sub>3</sub> in DMF was developed. The key step of the reaction is *in situ* generation of the reactive dienophile from aldehyde and acetophenone and their subsequent reaction with diene to give the desired product.

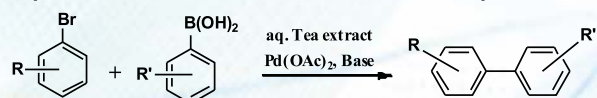


**Ruthenium(II)-catalyzed C-H activation for the synthesis of 1*H*-pyrazolo[1,2-*a*]cinnolin-1-ones:** An intermolecular annulation reaction of 1-phenyl-1*H*-pyrazol-5(4*H*)-ones with internal alkynes for the efficient synthesis of 1*H*-pyrazolo[1,2-*a*]cinnolin-1-ones using ruthenium(II)-catalyst and Cu(OAc)<sub>2</sub>·H<sub>2</sub>O as the oxidant (Scheme 1) was developed.

**Scheme 1:**

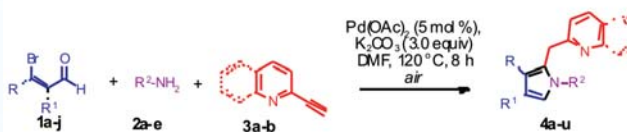


**Phosphine-free Suzuki cross-coupling reaction:** A mild and selective method for the carbon-carbon bond formation has been developed for the palladium-catalyzed phosphine-free Suzuki cross-coupling reaction of aryl bromides with arylboronic acids in aqueous tea extract at room temperature. The aqueous tea extract plays an important role in the reaction, and various functional groups are tolerated under the optimized conditions. The reactions proceeded with very good chemo selectivity in favor of the bromo instead of chloro group even at higher temperature. This protocol could be applied to the cross-coupling of 4-bromoindole without protecting the base sensitive amine group with arylboronic acids in moderate to excellent yields.



23 Examples with excellent yields

**Pd(OAc)<sub>2</sub> catalyzed three component reaction for the synthesis of 2-methylpyridine substituted pyrroles:** In the synthesis of novel azaheterocycles, employing β-bromovinyl/aryl aldehydes as versatile synthons and in order to meet the growing demand for developing new routes for the synthesis of pyrrole moiety, a Pd(OAc)<sub>2</sub> catalyzed three component reaction of β-halovinyl aldehydes, aliphatic amines and 2-ethynylpyridine under ligand free condition was developed for the synthesis of 2-methylpyridine substituted pyrroles (Scheme 1).



**Scheme 1.** Synthesis of substituted pyrroles

**Pd-catalyzed Synthesis of pyrido[2,3-*d*]pyrimidine derivatives:** Synthesis of pyrido[2,3-*d*]pyrimidine heterocycles of biological significance such as anti-inflammatory, analgesic, antihypertensive, antiviral, antimicrobial, antiasthmatic and anticancer activities. An efficient Pd catalyzed synthesis of pyrido[2,3-*d*]pyrimidines using  $\beta$ -halovinyl/aryl aldehydes and 6-amino-1,3-dialkyluracils as the starting materials in solvent-free conditions under microwave irradiation (Scheme 2) was developed.



Scheme 2. Synthesis of pyrido [2,3-*d*] pyrimidine derivatives

**Project Title:** New Generation Lubricants and Additives (Genlube).

**Project No:** CSC-118

**Funding Agency:** CSIR

**PI & Members:** Dr SD Baruah (PI), Dr A Borthakur (Co-PI), Mr A Gautam (Co-PI), Mr NC Laskar, Mr RC Bohra, Mr L Phukan

**Salient Achievements:**

Lubricating oil based on commercial castor oil was prepared from castor oil by epoxidation and followed by epoxide ring opening reaction with fatty acids. One synthesized product meets the characteristics of commercial lubricants and the rheological parameters of developed lubricants is comparable with commercial lubricants.

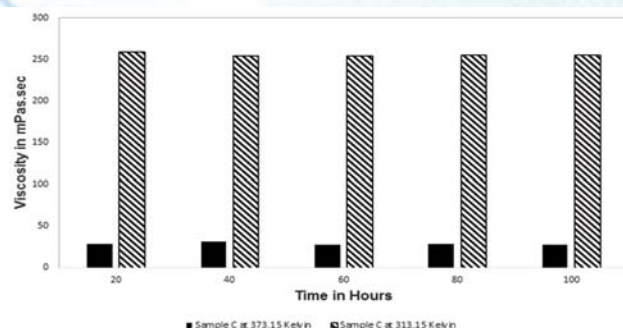


Fig: Thermal stability of castor oil based lubricants

**Project Title:** Natural Products as Affordable Healthcare Agents (NaPAHA).

**Project No:** CSC-130

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr M J Bordoloi (PI), Dr G Baishya, Dr P K Chowdhury, Dr DK Dutta, Dr AM Das

**Salient Achievements:**

Under this project, the work has been carried out on extraction of potent biologically active compounds from plant sources [the medicinal plants (part and whole

plants)] of North East India using different solvents and the chemical investigation and bioevaluation has been taken-up for the products on their innovativeness activity in different diseases.

**Project Title:** Studies on the lignin components obtained by microbial degradation of bamboo chips.

**Project No:** CSC-131

**Funding Agency:** CSIR

**PI & Members:** Dr A Goswami (PI), Dr P Pahari

**Salient Achievements:**

Black liquor received after treatment of lignocellulosic material bamboo with *Penicillium meleagrium* strain (from the soil of bamboo stacking area of Jagiroad paper mill) for 45 days and 60 days was extracted in methanol and observed that major lignin derived products (4-5 components) came out in methanol in 60 days treatment. Preliminary investigation revealed syringyl and feruloyl moiety containing components. Similar results were observed in case of *Inonotus pachyphlous* (another strain from Jagiroad paper mill) treated bamboo.

**Project Title:** Molecules to Materials to Devices (M2D).

**Project No:** CSC-134

**Funding Agency:** CSIR

**PI & Members:** Dr SD Baruah (PI), Dr PJ Saikia (Co-PI)

**Salient Achievements:**

Poly( $\epsilon$ -caprolactone) (PCL) microspheres were prepared by modified solvent evaporation technique using poly(vinylpyrrolidone) (PVP) of different molecular weights as stabilizers with the variation of the different reaction parameters. The size, morphology and stability of the polymer microparticles were tailored by varying the nature and concentration of the stabilizer to the polymer, time and agitation speed of the reaction.

Poly(*n*-octadecyl methacrylate) and poly(*n*-octadecyl methacrylate-co-2-hydroxyethyl methacrylate) block copolymers were also synthesized for use as *in situ* stabilizer in the preparation of PCL microspheres at 80 °C. The changes in the morphology and size of the PCL microspheres at different reaction conditions were evaluated by SEM images.

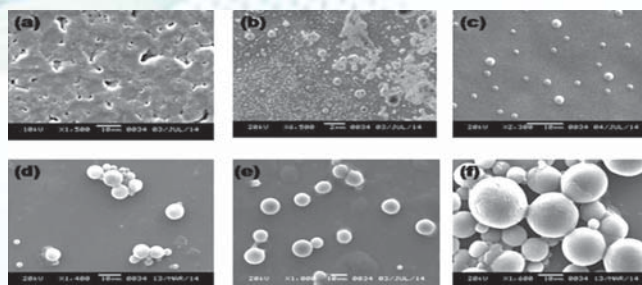
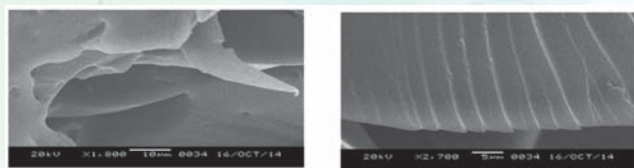


Fig: SEM photographs of PCL microspheres prepared at different molar ratio of OMA: HEMA without (a) and with (b – e) of poly(OMA-co- HEMA)

**Project Title: Advanced Polyolefins.**
**Project No: CSC-206**
**Funding Agency: CSIR**
**PI & Members:** Dr SD Baruah (PI), Mr A Gautam (Co-PI), Mr NC Laskar, Mr RC Bohra, Mr L Phukan

**Salient Achievements:**

Polyolefins with polar functionalities is a focus area of polymer research with increasing demand of olefinic materials for its broad range of commercial applicability. Poly (ethylene-co-butylmethacrylate) copolymer with desired architecture was synthesized. The synthesized poly (ethylene-co-butylmethacrylate) exhibited two stages of decomposition with the main decomposition stage ranging from 275-450 °C. The activation energy ( $E_a$ ) of the reaction was determined and the kinetic model that fits for the autocatalytic decomposition reaction model.



SEM images of poly(ethylene-co-BMA).

Fig: SEM images of ethylene butyl methacrylate copolymer

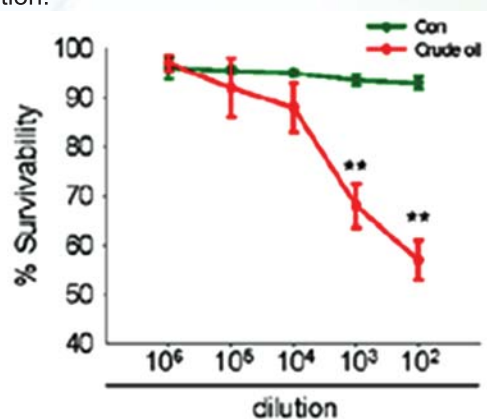
**Project Title: North East Exploration of Pharmaceuticals (NEEP).**
**Project No: CSC-207**
**PI & Members:** Dr NC Barua (Co-ordinator), Prof Samir Bhattacharya (Mission Director, Visva Bharati, Santiniketan), Dr M J Bordoloi (Project Director), Dr AM Das, Dr G Baishya

**Funding Agency:** CSIR, New Delhi

**Salient Achievements:**
**Products**
**Progress made on “Lungcan” Technology:**

Non-small cell lung carcinoma (NSCLC) is a major killer in cancer related human death. Surgical therapy and radiation therapy are not available for lung cancer. Even in the case of chemotherapy, which is the only choice, therapeutic intervention requires superior efficient molecule(s) as it often becomes resistant to present chemotherapy options. In this perspective, as an effective alternative, it is observed that vapor of volatile oil compounds obtained from *L. cubeba* seeds killed human NSCLC cells, A549, through the induction of apoptosis and cell cycle arrest. Vapor generated from the combined oils (VCO) deactivated Akt, a key player in cancer cell survival and proliferation. Interestingly VCO dephosphorylated Akt at both Ser473 and Thr308; through the suppression of mTOR and pPDK1 respectively. As a consequence of this, diminished phosphorylation of Bad occurred along with the

decreased Bcl-xL expression. This subsequently enhanced Bax levels permitting the release of mitochondrial cytochrome c into the cytosol which concomitantly activated caspase 9 and caspase 3 resulting apoptotic cell deaths. Impairment of Akt activation by VCO also deactivated Mdm2 that effected overexpression of p53 which in turn upregulated p21 expression. This causes enhanced p21 binding to cyclin D1 that halted G1 to S phase progression. Taken together, VCO produces two prong effects on lung cancer cells, it induces apoptosis and blocked cancer cell proliferation, both occurred due to the deactivation of Akt. In addition, it has another crucial advantage: VCO could be directly delivered to lung cancer tissue through inhalation.



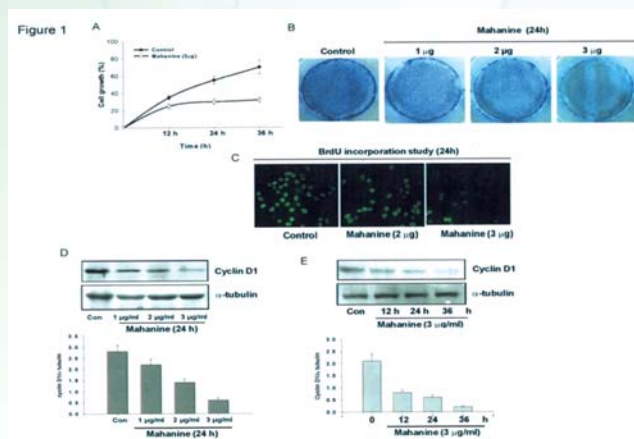
Cell viability of A549 lung cancer cells were measured when exposed to vapors of different dilutions (10<sup>6</sup> to 10<sup>2</sup>) of crude oil for 72 h by using MTT assay and the data was expressed as % of cell survivability relative to control.

To carry forward this interesting finding towards developing an herbal drug for lung cancer, the Institute signed an agreement with M/s Zydus Cadila for detailed animal study, toxicity and clinical trials. For funding this work, M/s Zydus Cadila has submitted a proposal under NMITLI scheme to CSIR, New Delhi in collaboration with CSIR-NEIST and Visva Bharati Santiniketan.

**Progress made on “Mahanine” isolated from *M. koenigii* leaves – as an anti lung cancer natural product:**

In a recent study, it is also observed that mahanine, a carbazole alkaloid from *M. koenigii* leaves, can impose two pronged effects on lung cancer cells A549. Mahanine on one hand blocks cell cycle progression by destroying cyclin D1, a key regulator of G1-S phase progression, therefore significantly retards proliferation and growth of cancer cells; and in another it effectively induces mortality by switching on apoptotic signals in lung cancer cells resulting their death. These two vital effects of mahanine are produced by the regulation of mTORC1 and mTORC2 complexes in cancer cells. In addition to the above mahanine has

another great advantage i.e. its bioavailability, in mice and rat its delivery through oral route could be soon detected in the blood within an hour and it remains at high level till 3 hours then declines due to the distribution to other tissues. Such an excellent uptake of drug is also very rare. Hence, mahanine is expected to be a highly promising and meaningful chemotherapy for treating metastatic lung cancer patients. Therefore, it is planning to develop a combination therapy for lung cancer combining both these herbal products.



A549 cancer cell line, a representative of human non small cell lung adenocarcinoma exhibited more than 70% growth reduction at 36h by 3µg/ml mahanine treatment (Fig 1A). Arrest of cancer cell growth was further examined by clonogenic assay (Fig 1B) and by BrdU uptake assay (Fig 1C) at 24h. It could be seen from Fig 1D and Fig 1E that mahanine markedly inhibited cyclinD1 expression, about 10 fold at 36h as compared to control cells. Such a massive suppression of cyclin D1 drew our attention towards its regulatory pathway as mahanine effect could be mediated through the signaling molecule(s) involved in this pathway.

**Project Title:** Affordable Cancer Therapeutics, ACT.

**Project No:** CSC-301

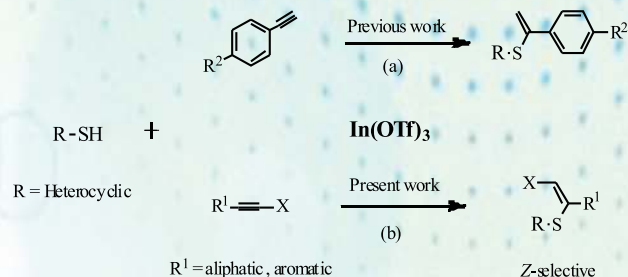
**PI & Members:** Dr Dipak Prajapati (PI), Dr Romesh Ch Boruah, Dr P J Bhuyan, Dr Pranjal Gogoi, Dr Sanjeev Gogoi

**Funding Agency:** CSIR, New Delhi

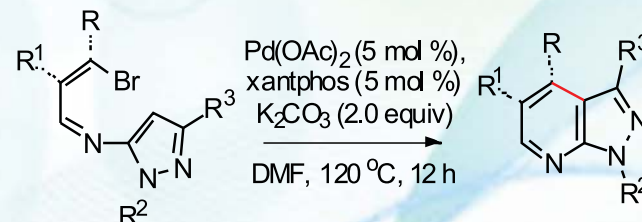
**Salient Achievements:**

**Indium (III) catalysed regio- and stereoselective hydrothiolation of haloalkynes:** Indium (III) trifluoromethanesulfonate was reported as the first catalyst which can catalyse the addition of thiols to haloalkynes with absolute selectivity to generate (Z)-β-halo vinyl sulfides in good yields. The hydrothiolation of haloalkynes under metal catalysed conditions with absolute regio- and stereoselectivity was demonstrated. In(OTf)<sub>3</sub> has shown the remarkable ability to catalyse

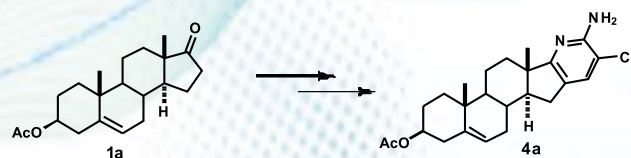
the addition of thiols to haloalkynes successfully and fulfil the primary challenge i.e. selectivity control in hydrothiolation reaction. Attractive features like short reaction time, good yield, high degree of selectivity, variety in substrate scope, no requirement of inert atmosphere and additional additives and absence of any side products makes it a useful protocol.



**Palladium mediated regioselective intramolecular Heck reaction:** One efficient method for the synthesis of 1,3,4-trisubstituted pyrazolo[3,4-*b*]pyridines, 3*H*-pyrazolo[3,4-*c*]isoquinolines and 3*H*-pyrazolo[4,3-*f*][1,7]naphthyridines using palladium acetate as the catalyst via intramolecular Heck reactions of imine derivatives of β-halovinyl/aryl aldehydes and 5-aminopyrazoles under thermal condition was developed (Scheme 2).



**Bold Microwave-assisted synthesis of 2-aminopyridines from β-bromo-α,β-unsaturated aldehydes:** The β-bromo-α,β-unsaturated aldehydes are synthesized from their corresponding ketones using Vilsmeier formylation reaction. The synthetic protocol is used to synthesize some novel steroidal and non-steroidal 2-aminopyridine derivatives.



**Project Title:** Synthesis of spiro-1,3-oxazine derivatives (OSDD-HCP 0001).

**Project No:** HCP - 0001

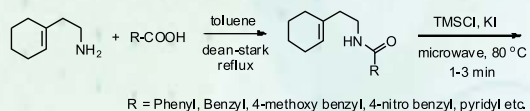
**Funding Agency:** CSIR

**PI & Members:** Dr P Pahari (PI), Dr D Konwar, Dr A Goswami



### Salient Achievements:

A methodology has been developed for the synthesis of spiro-1,3-oxazine derivatives by the microwave assisted cyclization of N-2-(1'-cyclohexenyl)ethyl-acetamides/benzamides. The reaction was catalyzed by the *in situ* generated trimethylsilyl iodide and featured by its very short reaction time. The starting material was easily obtained by the condensation of substituted acetic/benzoic acids with 2-(1'-cyclohexenyl)ethyl amine. Using the methodology a number of different spiroxazines have been synthesized to study their potential antibacterial activity.



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

**Project Title:** Development of Analogues of novel bioactive molecules.

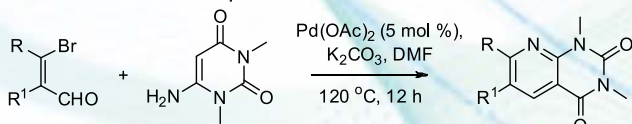
**Project No:** MLP-3000/1

**PI & Members:** Dr Dipak Prajapati (PI), Dr Romesh Ch Boruah, Dr P J Bhuyan, Dr H N Borah, Mr K C Lekhok, Mr K C Lekhok, Dr Pranjal Gogoi, Dr Sanjeev Gogoi

**Funding Agency:** CSIR, New Delhi

### Salient Achievements:

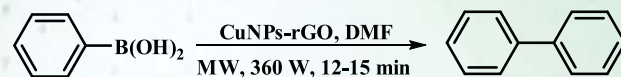
**Synthesis of pyrido[2,3-*d*]pyrimidines via cascade Imination/Buchwald-Hartwig cross coupling reaction/cycloaddition:** One efficient palladium catalyzed method for the synthesis of wide range of pyrido[2,3-*d*]pyrimidines, using readily available  $\beta$ -bromovinyl/aryl aldehydes and 6-amino-1,3-dimethylpyrimidine-2,4(1*H*,3*H*)-dione as the starting material was developed.



**Synthesis of symmetrical biaryls from arylboronic acids under base-free condition:** A green synthesis approach using highly stable Cu(0) nanoparticle onto reduced graphene oxide nanosheets was developed.

The synthesized Cu(0) nanoparticle-rGO composites exhibit excellent catalytic activity for the synthesis of symmetrical biaryls from arylboronic acids under microwave irradiation. The reaction proceeds smoothly under base-free condition with easy recovery and reuse of the catalyst. The methodology is compatible with various functional groups and provides an attractive protocol for the synthesis of symmetrical biaryls with very good yields. The Cu(0) nanoparticles are stable in

the rGO nanosheets and the particle size distribution and oxidation state of the Cu(0) nanoparticle remains same after performing the chemical reaction.

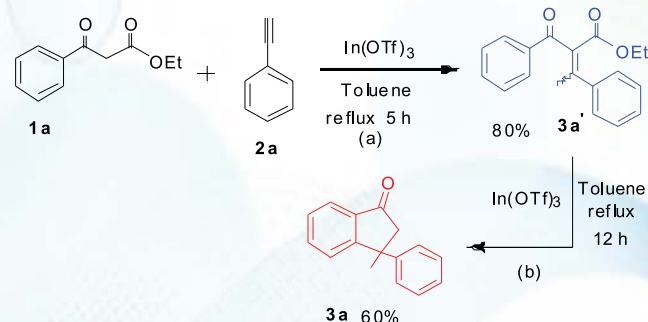


**Arylboronic acid**

**Biaryla**

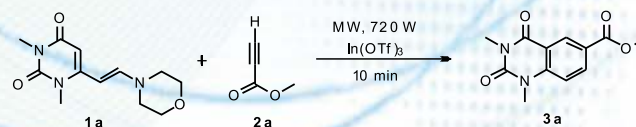
13 Exapmles

Bold Indium-catalyzed novel route to  $\beta,\beta$ -disubstituted indanones *via* tandem Nakamura addition /hydroarylation /decarboxylation sequence : Indium(III) triflate has shown remarkable ability to catalyze three fundamentally different chemical reactions under one-pot conditions in absence of any additives or co-catalysts to generate indanones derivatives in low to good yields. Exploration of Nakamura addition product for further synthetic elaboration was successfully demonstrated and sequential studies were carried out with the isolated isomerized addition intermediate.



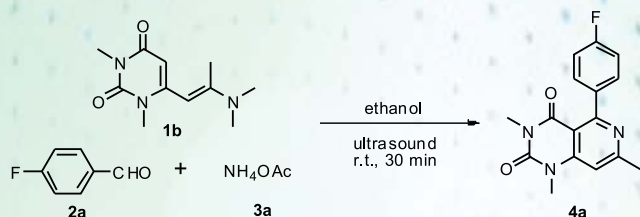
**In-catalyzed synthesis of pyrimidine derivatives:**

Microwave-accelerated carbon-carbon bond formation process towards 'dry-media' synthesis of pyrimidine derivatives explained by pot and time economic Diels-Alder reaction is developed. The method is associated with some attractive characteristics such as short reaction time, high yield of products and recyclability of recovered catalyst from the reaction mixture.

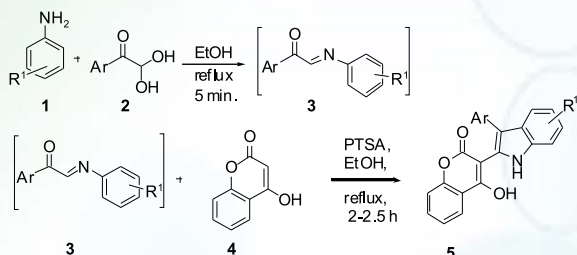


**Catalyst-free ultrasound promoted synthesis of pyrido[4,3-*d*]pyrimidines:**

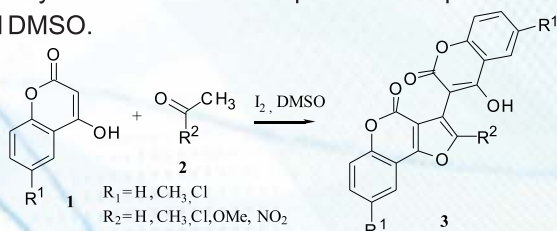
Ultrasound-mediated one-pot synthesis of 7-methyl substituted pyrido[4,3-*d*]pyrimidine scaffolds by catalyst-free MADAR protocol from ethanolic solution of 6-[2-(dimethylamino)prop-1-enyl]-1,3-dimethyluracil, aromatic aldehyde and ammonium acetate is developed under both ultrasound and thermal conditions. The ultrasound methodology is clean and desired cycloadducts are obtained with good yields in short time.



**One-pot three-component synthesis of 5-indolyl-4-hydroxy coumarins:** Some novel 5-indolyl-4-hydroxy coumarin derivatives via three-component reaction were synthesized from one-pot reaction of aniline, phenyl glyoxalmonohydrate and 4-hydroxy coumarin catalyzed by *p*-toluene sulphonic acid in refluxing ethanol. Formation of the product was ascertained from stepwise reaction.



**Synthesis of highly functionalized furo[3,4-c]coumarins and related furyl coumarin derivatives:** Considering the biological importance 3-(4-hydroxy-2-oxo-2H-chromen-3-yl)-5H-furo[3,2-c]isochromen-5-one, a new method is developed. The desired compounds were obtained from the reaction of substituted 4-hydroxycoumarins and acetophenones in presence of  $I_2$  and DMSO.



**Project Title:** Development of a unique portfolio of plant and soil microbe derived bioactive extracts and pure compounds and their value addition involving partial & total synthesis.

**Project No:** MLP-3000/2

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr N C Barua (PI), Dr P K Chowdhury, Dr M J Bordoloi, Dr D K Dutta, Dr A M Das, Dr G Baishya, Ms Preetismita Borah, Ms Rumi Borah

**Salient Achievements:**

**Technology:**

**A Natural Organic extract for management of Red Spider Mite prevalent in tea plantations.**

We have developed a process for the production and application of a highly active plant extract against the pest Red Spider Mite (RSM) affecting tea plants. The alcoholic extract of an indigenous plant *M. laxiflora* Robyns; synonym *Vangueria spinosa* Hook is found experimentally as well as in field study to be a useful herbal pest control agent.



Tea leaf under attack of RSM



Red Spider Mite

Institute has entered into an agreement with M/s Tata Tea & Beverages Ltd. for developing a herbal formulation for this product. Presently we have made a water based formulation with support from CSIR-Tech. and planning for field study within a week in collaboration with M/s Tata Tea & Beverages Ltd. at their tea garden at Teok, Assam.



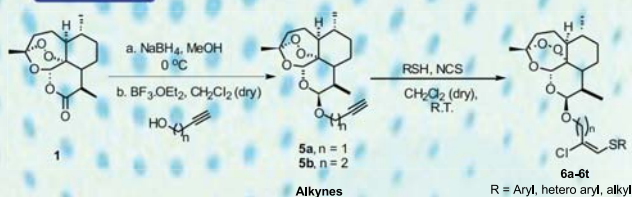
Pilot scale extraction of the plant



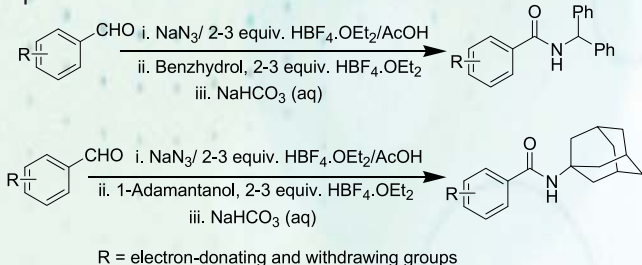
Dry extract

**New Chemistry:**

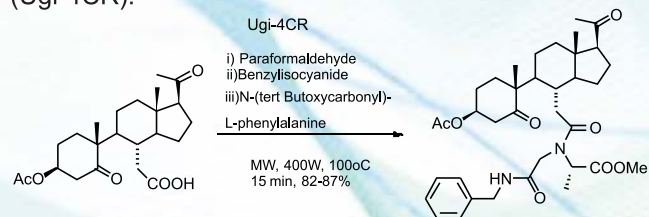
(1) A mild and efficient strategy is explored on the highly sensitive artemisinin derived C-10 oxa terminal alkynes. Several novel artemisinin derived (E)-2-chloroalkenyl sulphides (20) have been synthesized by using this protocol to study their anticancer activities.



(2) A non-oxidative and non-coupling reaction condition has been developed for the synthesis of *N*-diphenylmethyl and *N*-adamantyl amide derivatives directly from aldehydes employing the concept of Schmidt and Ritter reactions sequence in a one-pot operation.

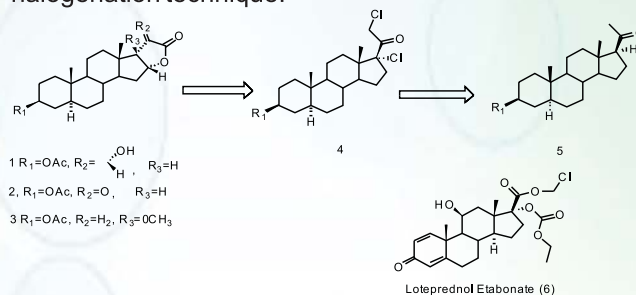


(3) Microwave (MW) irradiated Ugi four-component reaction (Ugi-4CR): Expedited synthesis of steroid–amino acid conjugates – A novel class of hybrid compounds. Considering the importance of peptidomimetic steroid amino acid conjugates – a novel class of hybrid compounds having diverse biological properties, and report here synthesis of these compounds of alanine and valine methyl esters with seco-steroids (A, B and D ring cleavage) in expedited way by MW promoted Ugi-four-component reaction (Ugi-4CR).



(4) Construction of *D*-Ring fused 16 $\alpha$ -Steroidal- $\gamma$ -butyrolactones through metal mediated halogenation of 20-Oxopregnanes: Fusion of a lactone ring on to steroidal nucleus in order to alter the biological activity of the parent compound has been a very productive attempt for medicinal chemists as many of these molecules exhibit antitumor activity. The steroidal lactone testololactone was the first lactone of this kind to show antitumor activity. The steroidal lactones have been found to inhibit the 5 $\alpha$ -reductase, a target enzyme for prostate cancer in men and the *aromatase*, another cytochrome P450 enzyme which converts androgens into estrogens contributing for the promotion of breast

cancer in women. Here would like to report synthesis of an important class of steroidal molecules, viz., *D*-Ring fused 16 $\alpha$ -Steroidal- $\gamma$ -butyrolactone (1-3) starting from the immediate precursor 17a, 21-dichloro-20-oxopregnane (4) which in turn could be obtained in very high yield (80%) from the readily available 20-oxopregnane(5) utilizing the above mentioned halogenation technique.



(5) Modification of biodegradable protein fibre - *Anthearea assama* silk (SH) has been carried out by graft copolymerization using methylmethacrylate (MMA) with ceric ammonium sulphate. The kinetic parameters have been studied using Broido method with FORTRAN 77 computer programming and calculated the activation energy. In comparison with the conventional SH, the resulted methylmethacrylate grafted *Anthearea assama* silk (SHMMA) have improved thermostability properties. The strategy described here a potential alternative to the new technique for thermostable grafted products.

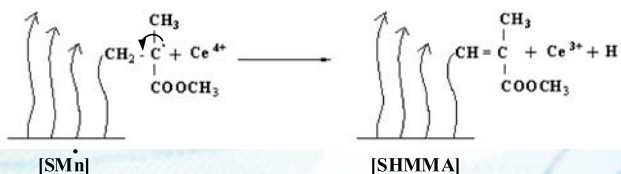
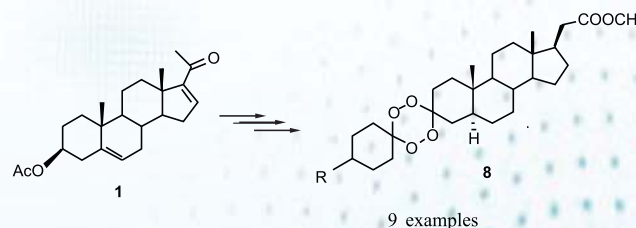


Fig: Diagrammatic representation of grafted silk molecule

(6) A facile synthesis through A-ring manipulation of a C-20 methyl carboxylate steroid derivative with unsymmetrical dispiro 1,2,4,5 tetraoxanes 8 via acid catalyzed cyclocondensation of bis-epidioxo ketone has been achieved starting from 3 $\beta$ - Acetoxy – pregn-5(6), 16(17) – diene -20 –one (16-dehydropregnenolone acetate, ie. 16-DPA) 1 via metal-mediated halogenation as a key reaction.



**Project Title:** Preparation of 5-Hydroxymethyl-2-furfural (HMF) from agrowastes.

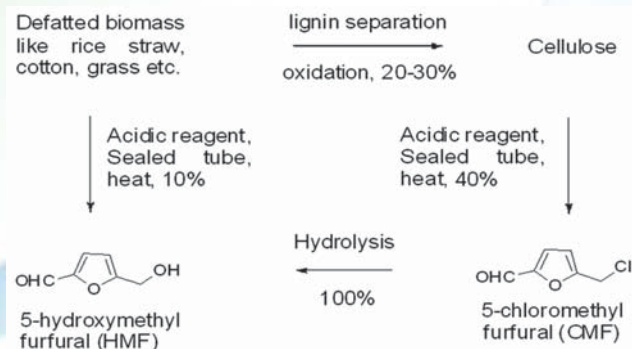
**Project No:** MLP-3000/03

**Funding Agency:** CSIR

**PI & Members:** Dr D Konwar (PI), Dr A Goswami, Dr P Pahari

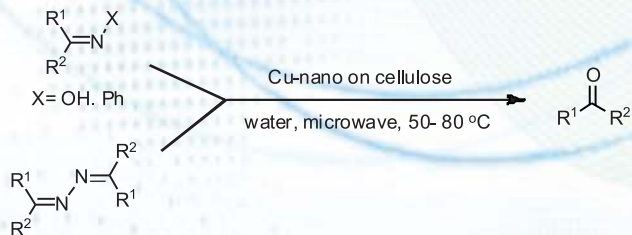
**Salient Achievements:**

A process has been developed to prepare 5-hydroxymethyl-2-furfural (HMF) from treated biomass like rice straw, cotton, grass etc. using environment friendly Lewis acid catalyst which can detect almost 1 gm of HMF from 10 gm of treated rice straw. Use of chloride sources like NaCl, LiCl etc. in the same reaction led to isolation of 5-chloromethyl-2-furfural (CMF) as major product with the yield of 30-40%. The product CMF so formed could be converted to HMF. Both HMF and CMF are very important intermediate for the production different industrially important compounds.

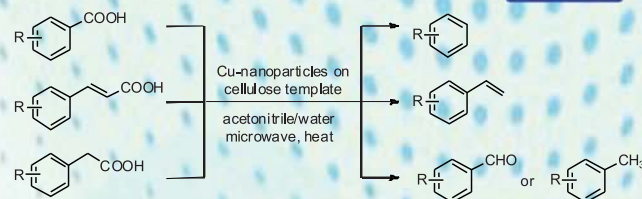


**Synthesis and study of the reactivity of cellulose supported Cu-nano particles:**

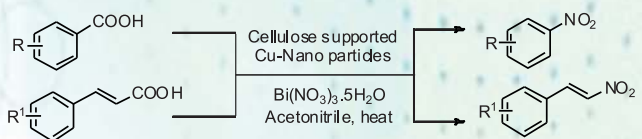
A process has been developed to prepare Cu-nano particles on cellulose template by the reduction of Cu(II) in the cellulose surface. The prepared nano particles were able to carry out the deprotection of oximes, imines, and azines to the corresponding carbonyls and amines under microwave irradiation in water at neutral condition.



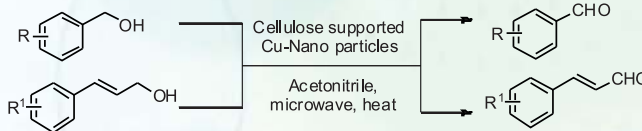
The nano particles were also able to carry out the protodecarboxylation of aromatic and vinylic carboxylic acids producing corresponding arenes and alkenes under base and ligand free condition. In case of phenylacetic acids the oxidative decarboxylation took place to produce substituted benzaldehydes. Protodecarboxylation of phenylacetic acids were also observed under inert atmosphere.



In presence of a nitrating agent like bismuth nitrate, the nano particles can induce a decarboxylative nitration reaction of aromatic carboxylic acids and cinnamic acids. The products are (E)-nitro styrenes and nitro arenes.



The nano particles can also be used as recyclable heterogeneous catalytic system for selective oxidation of benzylic, heteroaryl, and cinnamyl alcohols under ligand and additive free condition.



**Project Title:** Green approaches towards development and value addition of Bioactives & Biopolymers.

**Work Package IV: Natural polymer based nanocomposites and biodegradable polymers.**

**Project No:** MLP-3000/04

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr SD Baruah (PI), Dr A Borthakur (Co-PI), Mr A Gautam (Co-PI), Mr NC Laskar, Mr A Sarmah, Mr RC Bohra, MT L Phukan, Mr RK Baruah

**Salient Achievements:**

**Natural polymer based nanocomposites and biodegradable polymers**

Performance characteristics of alkyd resins based on *Ricinodendron heudelotii* oil -

Alkyd resin based on *R. heudelotii* oil with variation of phthalic anhydride and maleic anhydride was used to synthesize hybrid alkyd-acrylic waterborne binder suitable for coating application. The triple conjugated unsaturated double bond of the  $\alpha$ -eleostearic from *R. heudelotii* oil fatty acid chain could enhance the drying time and crosslinking density and overall properties by the grafting of the alkyd into the acrylate through the double bonds of

the maleic anhydride (MAH). Increased proportion of MAH increased monomer conversion as well as total solid content. The prepared latexes exhibited bimodal particle size distribution and showed improved drying time at room temperature with the increased content in MAH. The increase in MAH content in the alkyd moiety has a significant effect on the improved performance properties of hybrid latexes films. The results suggested that *R. heudelotii* oil based alkyd resins latexes have improved properties for manufacture of waterborne coatings and is usable in place of normal petroleum-based coatings systems.

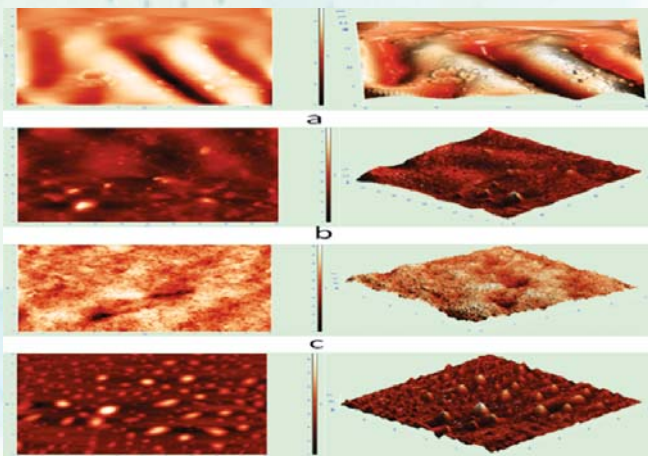


Fig: TEM images of hybrid alkyd-acrylate latex films

**Project Title:** Development of Sensors for Detection of Pesticides.

**Project No:** MLP- 3000/05

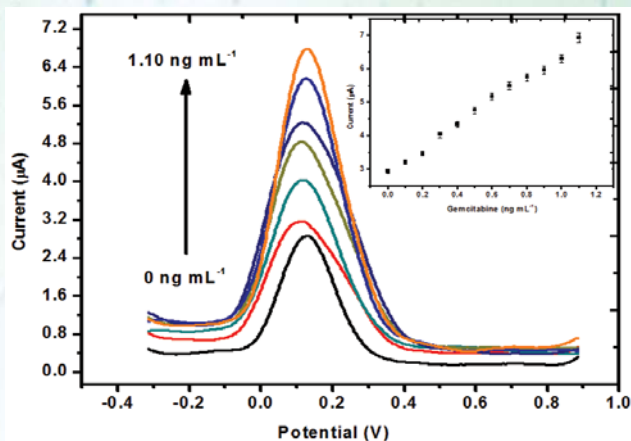
**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr R Khan (PI), Dr P Kotoky (Co-PI)

**Salient Achievements:**

**Biosensor for detection of selective anticancer drug gemcitabine based on polyaniline-gold Nanocomposite.**

An amperometric biosensor was developed based on polyaniline-gold nanocomposite film modified horseradish peroxidase for anticancer drug gemcitabine in bulk and in parenteral formulation. The developed method with detection limit of  $0.031 \text{ ng mL}^{-1}$ , biosensor sensitivity of  $2.934 \mu\text{A ng mL}^{-1}$  has distinct advantages over other existing methods. Biosensors response with increases in concentration of gemcitabine and inset calibration curve shows linearity for gemcitabine as 0.1 to  $1.10 \text{ ng mL}^{-1}$ .



**Project Title:** Utilization of Plant and Waste Materials of North-East India to a Value Added Product: Environment Friendly Technology.

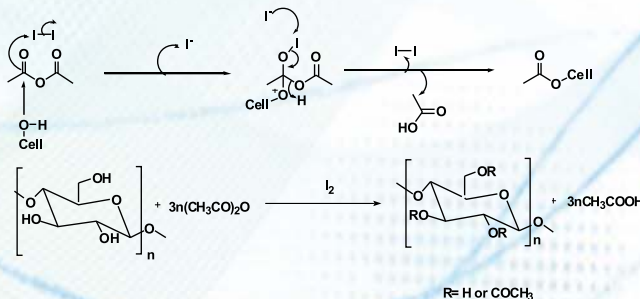
**Project No:** GAP-247

**PI & Members:** Dr AM Das (PI), Dr Dilip Knowar, Dr N C Barua, Dr T C Bora

**Funding Agency:** NEC, Shillong, INDIA

**Salient Achievements:**

Cellulose acetate was synthesized from rice husk by using a simple, efficient, cost-effective and solvent-free method. Cellulose was isolated from rice husk (RH) using standard pretreatment method with dilute alkaline and acid solutions and bleaching with 2%  $\text{H}_2\text{O}_2$ . Cellulose acetate (CA) was synthesized successfully with the yield of 66% in presence of acetic anhydride and iodine as a catalyst in eco-friendly solvent-free conditions.



**Project Title:** Biotech Intervention on Selected Medicinal and Aromatic Plants of NER for their Effective Utilization.

**Project No:** GAP-256

**PI & Members:** Dr P R Bhattacharya (PI), Dr S C Nath (Co-PI), Dr M Barthakur (Co-PI), Dr B S Bhau (Co-PI), Dr Gakul Baishya (Co-PI), Dr Chandana Barua (Collaborator), Dr Iswar Chandra Barua (Collaborator), Dr MAhmed (Collaborator)

**Funding Agency:** Department of Biotechnology, Govt of India

**Objectives:**

- To work out the taxonomy of the germplasm of the four medicinal and aromatic plants.
- To investigate bioactive phytochemical ingredients of selected species for an effective utilization of these unique resources.
- To evaluate pharmacological activity of the plant extracts and their various fractions.
- To assess the drug isolated for potential adverse effects on metabolic system.
- To develop technology of good agricultural practices, mass multiplication and post-harvest management.

**Salient Achievements:**

**(i) Preparation of Hydro-Ethanol Extract of *Clerodendrum Indicum* (whole plant):** 1.5 Kg roughly grinded whole of *Clerodendrum Indicum* was kept dipped in 1:1 mixture of ethanol and water for 10 days and then filtered out the solid residue to get the filtrate. The whole filtrate was evaporated carefully under reduced pressure and then dried under lypholyzer to afford the hydro-ethanol extract (7 gm).

**(ii) Fractionation of the Hydro-Ethanol Extract of *Clerodendrum Indicum* (whole Plant):** Three fractions of the hydro-ethanol extract of *Clerodendrum Indicum* (whole Plant) were prepared using the procedure mentioned above for the ethanol extract.

1. Hexane fraction (1.0 gm),
2. Chloroform fraction (0.52 gm) and
3. Remaining solid (4.5 gm).

These three fractions were submitted to College of Veterinary Science, Khanapara for further bio-evaluation.

**(iii) Column purification of the ethanol extract:** The mixture of three compounds isolated by column chromatography from chloroform fraction of the ethanol extract of *Clerodendrum Indicum* (whole Plant) we have isolated a pure compound (5 mg). structural identification of the compound is in progress

**(iv) Isolation of pure compounds from the hydro-ethanol extract of *Clerodendrum Indicum***

**(Whole plant):** The hydro-ethanol extract was found to be anti-arthritis against an arthritic mice model. Therefore, the polar part of this extract has been subjected to chromatographic purification. Before, the column chromatography, the non-polar part was separated from the polar fraction by extracting the hydro-ethanol extract with hexane followed by chloroform. Then, the residue was column chromatographed by water to give semi pure polar fraction. After removal of water under reduced pressure in rotary evaporator and lypholyzer, the crude dry material was treated with acetic

anhydride in the presence of pyridine (Scheme 1). After usual work-up process, the TLC of the crude acetylated product showed one major spot along with one minor. The major spot was purified by column chromatography on silica gel (100-200 mesh) and analyzed by IR, <sup>1</sup>H and <sup>13</sup>C NMR technique. This clearly proves the introduction of acetate moieties into the polar organic compound. But the exact structure is yet to be determined.

**Project Title: Domino Prins Cyclization Reactions: Syntheses of novel highly functionalized tetrahydropyran and piperidine derivatives.**

**Project No: GAP -258 (DST)**

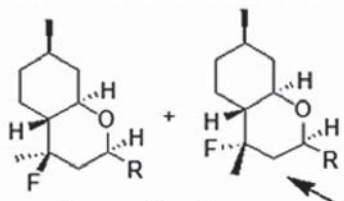
**PI & Members:** Dr Gakul Baishya (PI)

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

**Salient Achievements:**

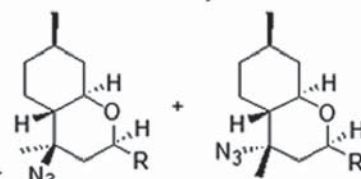
**Use of HBF<sub>4</sub>.OEt<sub>2</sub> in Prins and domino Prins cyclization reactions of (-)-isopulegol:** Recently, Bronsted acid HBF<sub>4</sub>.OEt<sub>2</sub> has been used as both catalyst as well as fluorinating reagent in different organic reactions. It has been established in the literature that an equivalent amount of HBF<sub>4</sub>.OEt<sub>2</sub> smoothly promoted the Ritter reaction of olefins with nitriles under mild reaction conditions. There are many reports where researchers extensively explored the use of HBF<sub>4</sub>.OEt<sub>2</sub> as a catalyst cum fluorinating reagent in the synthesis of various fluorinated tetrahydropyran and piperidine derivatives via domino Hosomi-Sakurai-Prins and aza-Prins cyclization reactions. Recently we have also disclosed an efficient direct method for the synthesis of *t*-butyl amide derivatives from aldehydes via the novel one-pot Schmidt and Ritter reactions sequence. In this method it has been clearly demonstrated that the Schmidt reaction of arylaldehydes with NaN<sub>3</sub>/HBF<sub>4</sub>.OEt<sub>2</sub> in acetic acid efficiently produces the corresponding nitrile derivatives, which in situ undergo the Ritter reaction with *t*-butyl acetate to afford their respective *N*-*tert*-butyl amide derivatives. Hence, we tried to explore different applications of this important reagent in development of various Prins and domino Prins cyclization reactions of (-)-isopulegol with different aldehydes using various external nucleophiles under suitable reaction conditions. Thus we successfully completed the synthesis of various libraries of 4-fluorooctahydro-2*H*-chromenes, 4-fluorooctahydro-2*H*-chromenes, 4-acetamidooctahydro-2*H*-chromenes and 4-thia-*N*-phenyltetrazolooctahydro-2*H*-chromenes etc. via different domino Prins cyclization reactions.

Synthesis of 4-fluoro-octahydro-2H-chromene

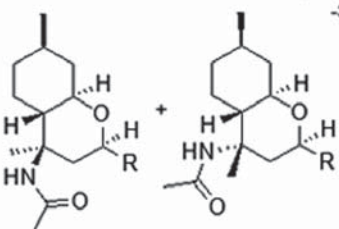


Inseparable mixture  
1 equiv. HBF<sub>4</sub>.OEt<sub>2</sub>  
CH<sub>2</sub>Cl<sub>2</sub>, -30 °C-rt

Synthesis of 4-azido-octahydro-2H-chromene



20 mol% HBF<sub>4</sub>.OEt<sub>2</sub>  
CH<sub>2</sub>Cl<sub>2</sub>, 0 °C-rt



major minor

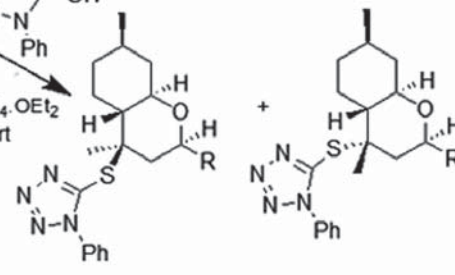
Synthesis of 4-acetamido-octahydro-2H-chromene

Prins-Ritter reaction

20 mol% HBF<sub>4</sub>.OEt<sub>2</sub>  
CH<sub>2</sub>Cl<sub>2</sub>, 0 °C-rt

Prins-thiolation reaction

20 mol% HBF<sub>4</sub>.OEt<sub>2</sub>  
CH<sub>2</sub>Cl<sub>2</sub>, 0 °C-rt



major minor

Synthesis of 4-thio-N-phenylterazolo-Octahydro-2H-chromene

**Project Title:** Sustainable and Biodegradable Hybrid Nano-Composites as Bio-integrated Materials for Advanced Functional Applications.

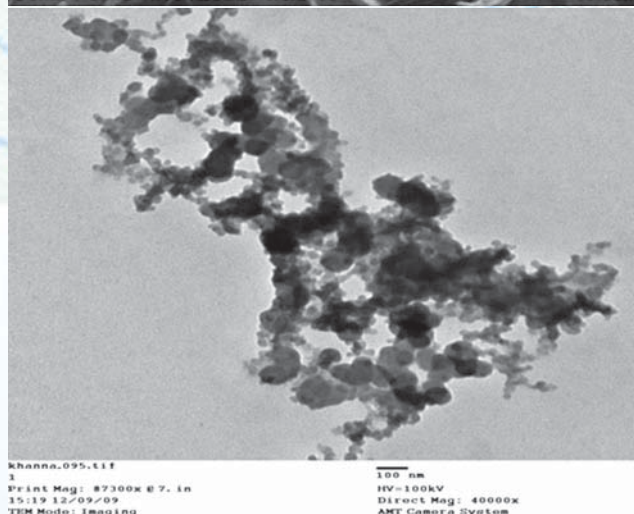
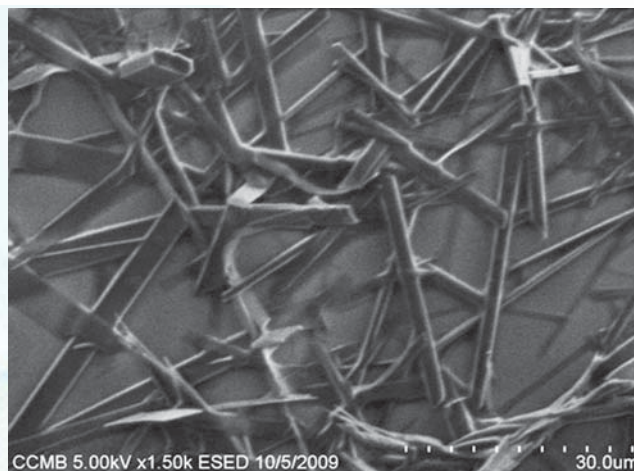
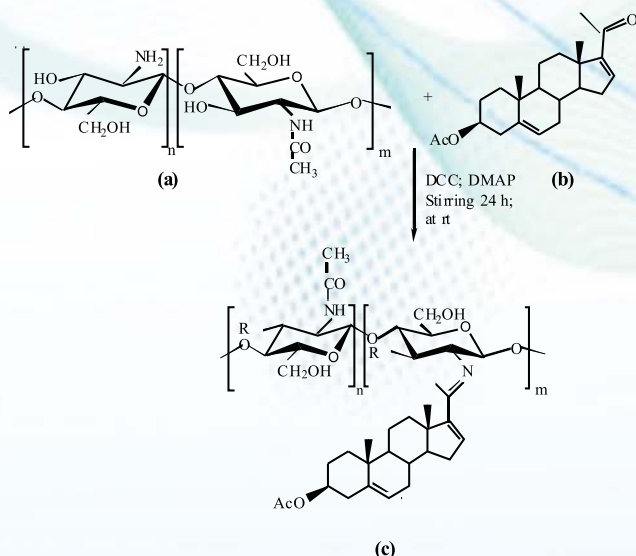
**Project No:** GAP-286

**PI & Members:** Dr AM Das (PI)

**Funding Agency:** Ministry of Science & Technology

**Salient Achievements:**

One-Pot Synthesis of Chitosan- Dehydropregnanolone Acetate Ketimine Nanoparticles and Antifungal Bioevaluation.



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

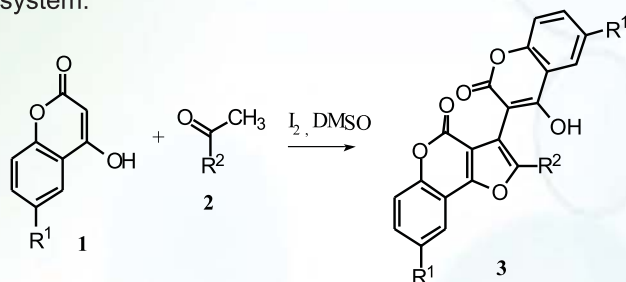
**Project No:** GPP-279

**PI & Members:** Dr Pulak J Bhuyan (PI), Dr H P Dekaboruah (Co-PI)

**Funding Agency:** DST, New Delhi

**Salient Achievements:**

**Novel synthesis of furo[3,4-c]coumarins :** Considering the biological importance 3-(4-hydroxy-2-oxo-2H-chromen-3-yl)-5H-furo[3,2-c]isochromen-5-one, a new method is developed for the synthesis of highly functionalized furo[3,4-c]coumarins which involves sp<sup>3</sup> C-H activation by iodine and DMSO system.



**Project Title:** CSIR Advanced Analytical Facility for North East (CAAF-NE).

**Project No:** FAC-408

**PI & Members:** Dr Pulak J Bhuyan (PI), Dr Lakshi Saikia (Co-PI), Dr Prabhat Katoky, Dr Raju Khan, Dr P J Saikia

**Funding Agency:** CSIR, New Delhi

**Objectives:**

Synthesis of some novel functionalized coumarins.

**Salient Achievements:**

Cycloaddition reaction and synthesis of some novel annelated coumarins and related heterocyclic compounds were done.

## ENGINEERING SCIENCES

The engineering science area has four divisions and provides engineering inputs and services to different R&D projects of the Institute. The Applied Civil Engineering Division has expertise in geo-technical and transportation engineering. Chemical Engineering Division provides engineering inputs to different areas and projects of the Institute. General Engineering Division is committed towards R&D in the field of mechanical design and product development, environmental studies, disaster mitigation, technopreneurship development and technological intervention for socio economic uplifting in rural areas. The Electronics & Instrumentation division is engaged in activities for support to institutional infrastructure like maintenance of equipments and total internal telephone network. The department also has R&D activities for development of electronic sensor based devices for pre-disaster management, gas monitoring and early warning systems for coal mines.

**A) National Collaboration**

**(i) Network Projects**

**Project Title:** S & T intervention to combat malnutrition in women & children.

**(WP-I & WP-II)**

**Project No:** BSC-125

**Funding Agency:** CSIR, New Delhi

**PI & Members:**

**WP-I**

Dr (Mrs) Aradhana Goswami (PI), Mr Tobiul Hussain Ahmed (Co-PI), Dr PK Chaudhury, Dr RL Goswamee, Mrs Polakshi Bordoloi, Mr Bipul Das, Mr Somiron Borthakur, Dr PK Baruah, Dr T Bora

**WP-II**

Dr (Mrs) Aradhana Goswami(PI), Dr PK Chaudhury, Dr (Mrs) Swapnali Hazarika, Dr PJ Saikia, Mr Bipul Das, Mr Tobiul Hussain Ahmed, Mrs Polakshi Bordoloi, Dr PK Baruah, Dr T Bora

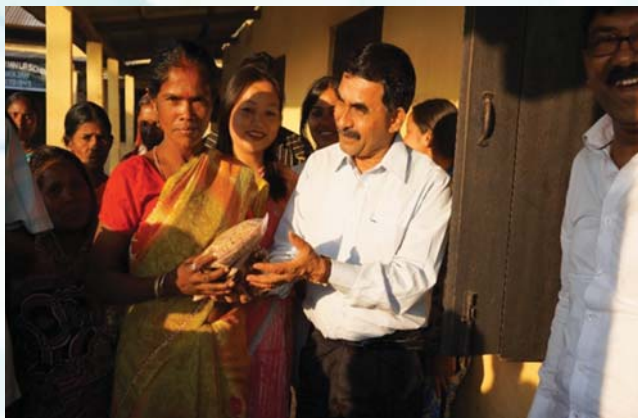


**Objective:**

- **WP-I:** Development of technology for preparation of soft rice from traditional varieties of rice of NE region.
- **WP-II:** Development of Nutraceuticals and functional food from pigmented rice of North Eastern Region Of India

**Salient Achievements:**

Proximate analysis and nutritional properties of the soft rice and Nutra Readymix was done using standard analysis method. Micro nutrients content of the developed product was done by FAAS method. Safety and microbial toxicity test of the different products were done at ICMR Dibrugarh. It was found that no pathogens grew in the product during 3 months of time. Clinical examinations and biochemical testing of around 200 volunteers in two batches were done by an allopathic doctor and paramedics following consent from the patients at the CSIR identified TECHVIL, Tezpur. Komal Chaul (Soft Rice) has been made with intact bran and thus is rich in dietary fiber, essential fatty acids and also contains significant quantities of starch, protein, vitamins, and minerals. Dissemination of the product was done through NGO amongst the malnourished population at the CSIR identified TECHVIL site.



**Fig:** Product preparation and distribution amongst the malnourished population

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

**Work Component at 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 MM Bora, Mr S Borthakur

**Salient Achievements:**

The extraction of some value added products from plant samples such as such as *Dillenia indica L*, *Vitex Negundo*, *Artocarpus lakoocha* Roxb. using green solvent., have been done. The extraction kinetics of Resveratrol from *Artocarpus lakoocha* Roxb. have been established. The optimum conditions for extraction of Resveratrol have been established using Response Surface Analysis (RSM) using ANNOVA. The extracted compounds have been separated and purified by using indigenously developed nanofiltration membrane and the purity of compound has found to be >98%.



a) Flat sheet membrane



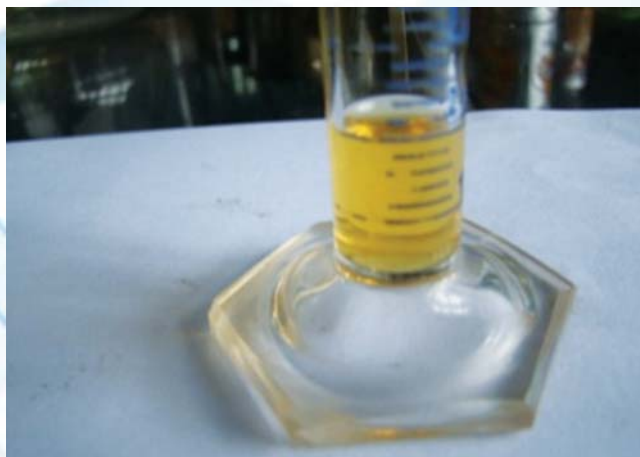
b) Hollow Fibre membrane module

Scaling up for extraction and separation of oxyresveratrol from *Artocarpus lakoocha* Roxb. was done and obtained the product with 99.9% purity. In a single batch 2 kg pure product was obtained. (Patent App No. 2853/DEL/2014).

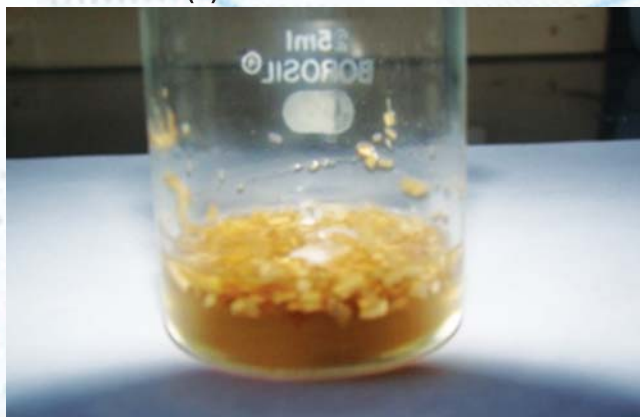
Ionic liquid (IL) assisted extraction of Lignin from Rice straw was studied for recycling and reused of ionic liquid. The extracted lignin was separated by using indigenous nanofiltration membrane and was converted to vanillin by enzyme catalysed hydrolysis.



(a) Rice straw



(b) IL before treatment



(c) IL after treatment

**Project Title:** Inherently Safer Practices for Industrial Risk Reduction (INSPIRE).

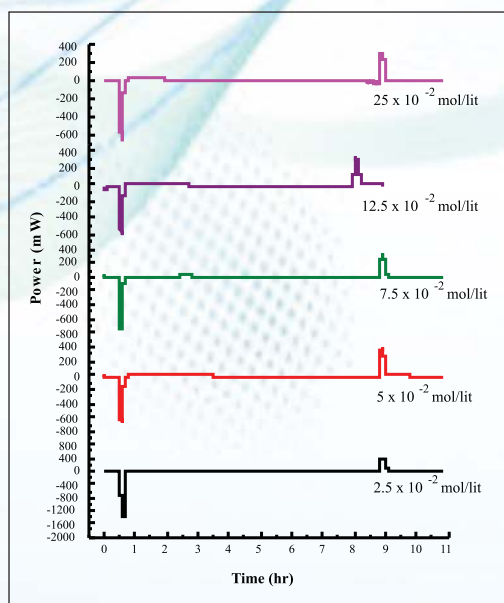
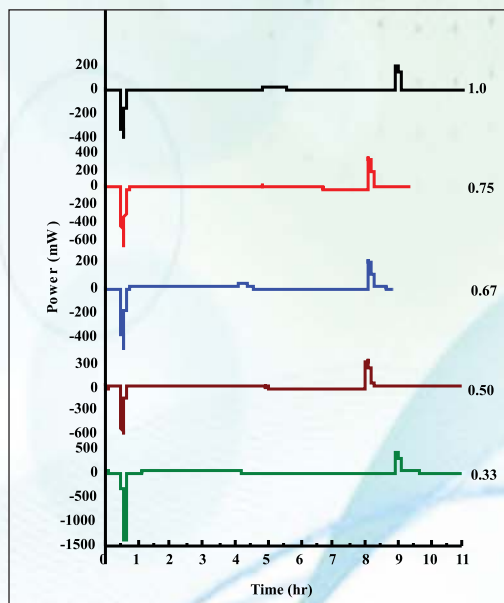
**Project No:** CSC-107

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Mr Bipul Das (PI), Mr Tobiul Hussain Ahmed (Co-PI), Dr (Mrs) Aradhana Goswami, Dr Swapnali Hazarika, Dr Pranjal Gogoi, Dr Pallab Pahari, Dr Sanjeev Gogoi

**Salient Achievements:**

Suspension polymerization studies were made by varying different operating parameters using micro reaction calorimeters and the thermodynamic parameters were evaluated to determine the safe and risk free environment.



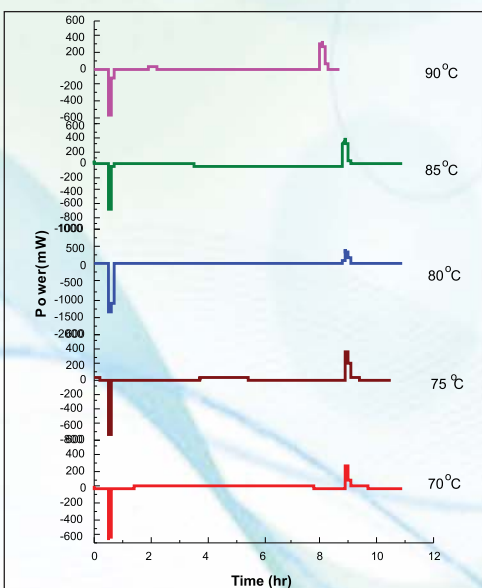
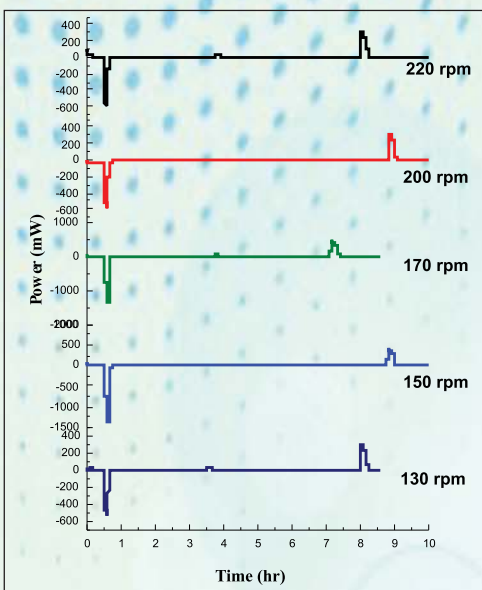


Fig: Calorimetric studies of exothermic styrene polymerization reaction at various reaction conditions

**Project Title:** Development of Sustainable Waste Management Technologies for Chemical and Allied Industries (SETCA).

**Project No:** CSC-113

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Mr SC Kalita (PI), Mr Jayanta Jyoti Bora (Co-PI), Mr Dipankar Neog, Mr Binay Kumar Saikia

**Salient Achievements:**

A prototype is designed and fabricated for removal of solid deposits from the strainer (used in crude oil pumping station) having pollution control measures. The whole experimental set up was installed in Oil India Ltd. (OIL) pumping station 3 (PS 3) for field trials.



Fig: Prototype for removal of solid deposits from strainer installed at OIL PS-3

Fabrication of Experimental setup to study the solid deposition mechanism at varying parameters is completed and dry test was carried out.

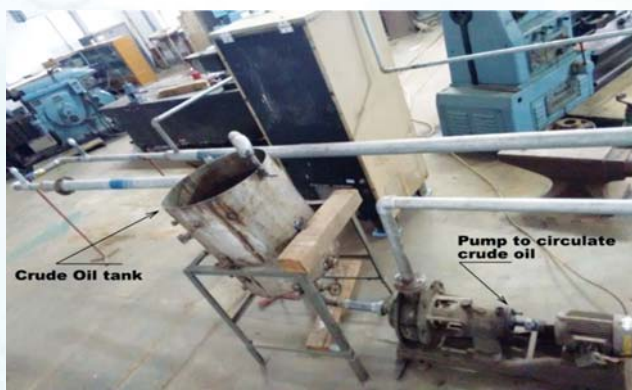


Fig: Redesigned Experimental Set-up

**Project Title:** Post disaster Management- Design and development of Transitory houses for Disaster Vulnerable rural sectors in the North East Region.

**Project No:** ESC-102

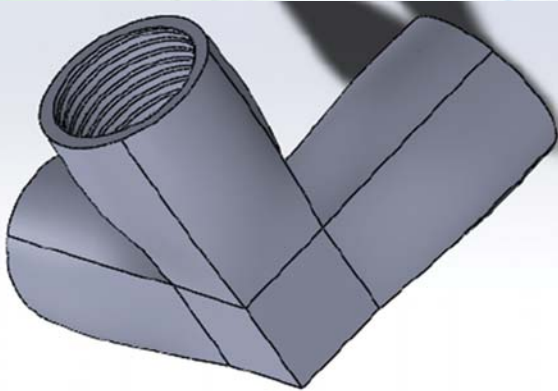
**Funding Agency:** CSIR

**PI & Members:** Mr Dipankar Neog (PI), Mr Dipak Basumatari (Co-PI), Dr Pranab Barkakati, Mr SC Kalita, Mr JJ Borah, Dr Dipul Kalita, Dr Tridip Goswami, Mr Sanjay Deori

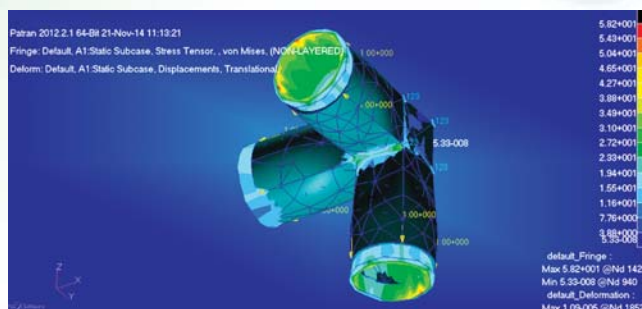
**Salient Achievements:**

Initial selection of bamboo species, determination of some basic mechanical properties, chemical treatment of bamboo species and selection of most suitable bamboo species for the proposed transitory house. Design of the connector/connectors for the transitory House.

The connector is designed in SOLIDWORKS software and is found to be most suitable for the proposed transitory house.



Finite Element Analysis of the final Designed Connector with the assumptions considered viz.,



Compatibility with bamboo material, very easy for assembling & disassembling, design simplicity for the purpose of easy moulding with polymeric materials like poly propylene, capable of withstanding the different possible loads in operation, the design and selection of material for repeated use in the structure and entire structure to be connected by using minimum varieties of connectors.

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

**Project Title:** Studies on Process Intensification and Integration Process for Bioproducts, Chemicals and Fuel from Bio-resources and development of Soil stabilization technique.

**Project No:** MLP-4000/01

**Funding Agency:** CSIR, New Delhi

**PI & Members:** Dr P Barkakati (PI), Dr Aradhana Goswami, Dr M M Bora, Mr S Borthakur, Dr Swapnali Hazarika, Mr Bipul Das, Mr Tobiul Hussain Ahmed

**Salient Achievements:**

Process design for nutraceuticals, functional foods based on rice and rice bran were developed. The analysis of the value added products and the microbial toxicity tests indicated that the products to be of good nutritional value as functional food.

Benzo-18-crown-6-acrylamide was synthesized from acryloyl chloride and was characterized. Smart polymeric hydrogel from N-isopropyl-acrylamide

(NIPAM) and Benzo-18-crown-6-acrylamide was synthesized and characterized. The smart polymeric hydrogel was applied for studying the control release of Vitamin B and the optimum conditions were established.

Process intensification studies were undertaken at pilot plant for extraction of anti Red Spider Mite (RSM), a herbal product. The process parameters were optimized for maximum yield and the following process scheme was developed.

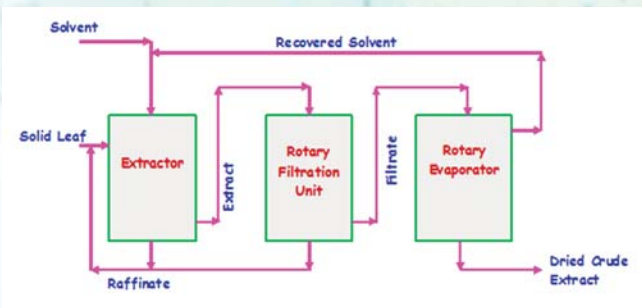


Fig: Scheme for extraction of Anti RSM

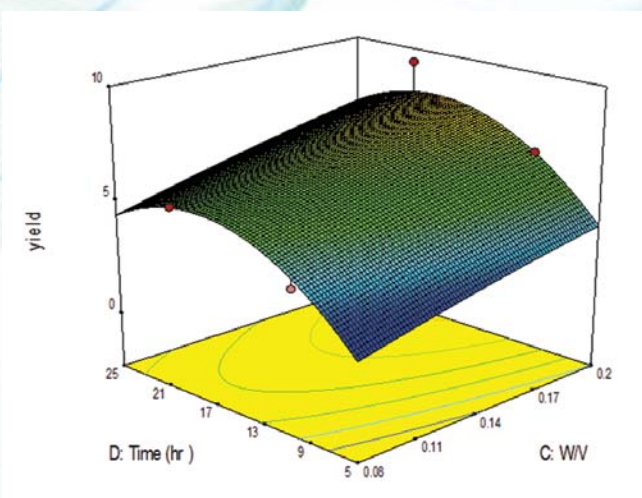
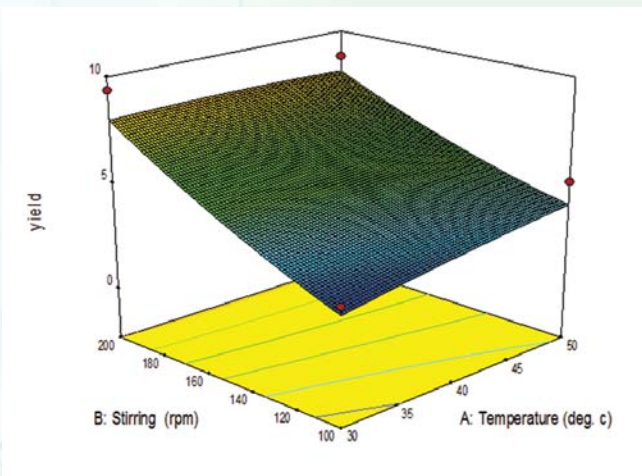


Fig: Yield optimization studies for extraction anti RSM product

**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-4000/2

**Funding Agency:** CSIR

**PI & Members:** Mr SC Kalita (PI), Mr Jayanta Jyoti Bora (Co-PI), Mr Dipankar Neog, Mr Basanta Kumar Sarmah, Mr Ajoy Barkataky, Mr Ashok Kalita

**Objective:**

- Standardization of pre-drying/pre-processing parameters for different commodities.
- Optimization of commodity wise drying parameters.
- Prototype of integrated drier unit with different controlling mechanism for multipurpose use.

**Salient Achievements:**

The basic design for the integrated dryer is completed.

**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 Dipak Basumatari (Co-PI), Mr Tapas Das, Mrs Anjumoni Bharali, Mr Nibir Pran Borah, Mr Rajib Das

**Salient Achievements:**

Soil samples were collected for laboratory test which is 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. Samples with RBI Grade-81 and Cement admixtures in different proportions have been prepared and the MDD-OMC relationship was determined. Evaluated the Strength characteristics (CBR test in un-soaked/4-days soaked condition) of the stabilized soil samples.

**Project Title:** Promoting Innovations In Individuals, Start-ups and MSMEs (PRISM).

**Project No:** GAP-214

**Funding Agency:** DSIR, Ministry of Science and Technology

**PI & Members:** Mr Dipankar Neog (PI), Dr Pranab Barkakati (Advisor), Mr Ajay Borkatoki, Ms Ilika Zhimo, Dr Dipanwita Banik as TUC members

**Objective:**

- To tap the vast innovative potential of citizens of India
- To develop technology solutions aimed at helping MSME units in clusters.

- To promote individual innovators to become technology based entrepreneurs
- To develop technology solutions.

**Salient Achievements:**

Five nos. of projects completed successfully, three nos. of projects are being commercialized. 1<sup>st</sup> Phase funding for three nos. of projects. Various nos. of projects are ongoing under PRISM. A Programme namely TECHNODEA is organized every year among the students of various School, where innovation/idea of the students is rewarded.

**Project Title:** Development of Molecular gate Membrane for CO<sub>2</sub> Separation and Green Emission Control.

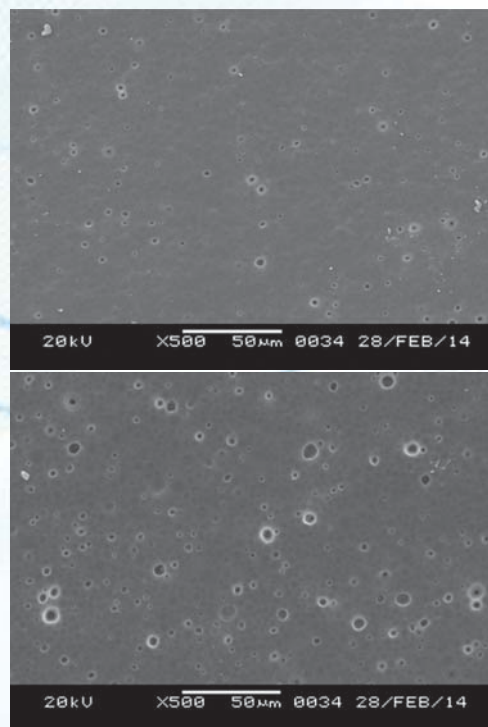
**Project No:** GPP-276

**Funding Agency:** DST, New Delhi

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

**Salient Achievements:**

Zero and First generation dendrimer were prepared and characterized. QSAR study has also been made for dendrimer molecules using Density Functional Theory. The synthesized dendrimers were used for preparation of molecular gate membrane and characterized for Surface Morphology study. The membranes were tested for separation of CO<sub>2</sub> from CO<sub>2</sub>/N<sub>2</sub> gas mixture. It was found that more than 97% CO<sub>2</sub> gas can be separated from CO<sub>2</sub>/N<sub>2</sub> gas mixture. The gas transport mechanism for permeation of CO<sub>2</sub> through the membrane was established.



**Fig:** SEM photograph of Gas separation membrane

**Project Title:** Setting up of A Common Facility Centre (CFC) on Weaving and Textile Product Manufacturing.

**Project No:** GPP - 283

**Funding Agency:** DST

**PI & Members:** Mr Dipankar Neog (PI), I.Ilika Zhimo (Co-PI), Dr Pranab Borkakoti (Advisor), Mr SC Kalita (Advisor), Mr JJ Bora, Ajay Borkatoki, Mr Dipak Basumatari

**Objective:**

- Concept to Erection of a Common Facility Centre (CFC) on weaving and textile products at the identified area of New Sonowal near Assam Nagaland Border.
- Selection of the plant and machineries suitable for the proposed CFC and also creation of the yarn bank to initiate the production activities.
- Tie-up with a local NGO for arrangement of the indigenous weavers and other local assistance for the proposed CFC.
- Man-Material-Machine linkup with the approximately 300 weavers of the identified rural area.
- Design intervention for product diversification and increased productivity with the help of textile technologist and fashion technologist.
- Measure of quality control of the products
- Design and implementation of the best suitable business model with the target of 50% growth in per capita income.
- Running the centre in a self sustainable business mode.
- Implementing different marketing strategies like own showroom at commercial complex, buyers sellers meet, development of a website, skill and entrepreneurship development training programmes etc.
- Fixing up of the modularity of operation of the CFC and also identifying authority and responsibility of the associated NGO.
- Study of the post project impact in terms of growth of per capita income.

**Salient Achievements:**

Completed design, erected the shed of Common Facility Centre (CFC). Installed the machineries for the CFC and individual weavers. Arranged trainings and workshops on namely,

- Natural Dyeing
- Design Innovation for Textile Products and Complete Product Development With Demonstration for Marketing.
- Organized the Ethnic Fashion Show at the International Trade Fair, Jorhat
- Arrange a trainings programme for 30 days and production is initiated.

**Project Title:** Performance Evaluation of River Brahmaputra Bed Materials for use in construction of Road, Embankment, Subgrade and Subbase.

**Project No:** GPP-284

**Funding Agency:** DST, New Delhi

**PI & Members:** Mr Sanjay Deori (PI), Mr Dipak Basumatari, Mrs Anjumoni Bharali, Mr Nibir Pran Borah, Mr Mukesh Agarwal, Mr Rajib Das

**Salient Achievements:**

Collected samples from different locations of Brahmaputra River Bed and characterized the samples. Developed methodology of stabilization process for river bed materials using chemical additives for construction of road embankment, subgrade and subbase. Evaluated the strength characteristics of stabilized samples.

**Project Title:** Development of Methodology for Manufacturing Modular Bricks From River Brahmaputra Bed Material.

**Project No:** GPP-295

**Funding Agency:** DST, New Delhi

**PI & Members:** Mr Sanjay Deori (PI), Mr Mukesh Agarwal (Co-PI), Mr Dipak Basumatari, Mrs Anjumoni Bharali, Mr Nibir Pran Borah, Mr Rajib Das

**Objective:**

- 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:

Collected Brahmaputra river bed materials from different

locations. Characterized the collected materials samples in laboratory. Designed various mix compositions for modular bricks. Developed methodology for manufacturing modular bricks using Brahmaputra river bed sand with different constituent materials in the laboratory. Evaluated the strength characteristics of modular bricks.

## GEO SCIENCES

The North East India has a complex structural framework with changing behaviours of Seismic activity in different tectonic domains controlled by ancient Plate margin. It occupies a distinct position in the World Seismicity with two great earthquakes of  $M \geq 8.7$  and 1950, and the entire region lies in the severe Seismic Zone -V. The division is fully focussed on real-time monitoring of active faults along plate margin to assess the seismic hazard potential, dissemination of scientific knowledge in public decision making and to create mass awareness to mitigate the adverse effects of earthquakes by reducing the vulnerability are the main agenda today.

#### A) National Collaboration

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

**Project Title:** Online/Real-time seismic network for disaster mitigation in NE India.

**Project No:** GAP-142

**Funding Agency:** North Eastern Council, Shillong

**PI & Members:** Dr R Duarah (PI), Dr Manoj Kumar Phukan (Co-PI)

#### Salient Achievements:

An attempt was made to estimate the velocity of P & S waves along 6 defined paths considering seismic station alignment. In this regard 120 well located local shallow events were considered to estimate the average velocity of the crustal layer. The well known Wadati method and Riznichenko diagram, which is based on the linear relationship between the square of travel time ( $T^2$ ) and the square of the epicentral distance ( $\Delta^2$ ):  $T^2 = (\Delta^2 + h^2)/V^2$  was used for estimation of the velocity. The method was found useful for near source shallow earthquakes.

**Project Title:** Literature Survey of available Earthquake Hazard Assessment Studies related to North Eastern Region.

**Project No:** GAP-273

**Funding Agency:** Assam State Disaster Management Authority, Guwahati

**PI & Members:** Dr Saurabh Baruah (PI), Dr Pabon Kumar Bora (Co-PI)

#### Salient Achievements:

Almost all the subjects of Earth Sciences are consulted and compiled for ready reference. Nearly thousands of literature are compiled and reviewed. Based on information from original scientific research by the Indian and Foreign research communities, **eleven** important parameters/topics have been proposed which needed further extensive research viz.,

- SEVEN** (T1, T2, T3, T4, T5, T6, T8) pertaining to **Hazard** assessment
- THREE** (T7, T10, T11) related to **Risk** and
- ONE** (T9) related to earthquake **precursory** phenomena.

T1 : Earthquake catalogue since historical till present

T2 : Earthquake database comprising phase data and waveforms

T3 : Active fault mapping and source characterization

T4 : Modelling of Geodetic strain rate

T5 : Application of remote sensing and GIS towards mitigating hazard

T6 : Prediction of ground motion parameters

T7 : Seismic microzonation and site characteristics

T8 : Re-evaluation of Intensity Scale of great earthquakes of 1897(M~8.7) & 1950(M~8.5) and recurrence period.

T9 : Multiparametric geophysical studies towards earthquake precursory research

T10 : Seismic vulnerability studies

T11 : Impact of earthquake shaking on lifeline structures including industrial com- PLEXES

**Project Title:** M 8.7 Shillong 1897 Earthquake Scenario: NE Multi – State Preparedness Campaign.

**Project No:** GAP-288

**Funding Agency:** National Disaster Management Authority, New Delhi

**PI & Members:** Dr R Duarah (PI), Dr Manoj Kumar Phukan (Co-PI)

#### Salient Achievements:

Estimated the vulnerable population in Isoseismal

Zones I-III:

For preliminary (1st Order) analysis the houses built using mud, burnt brick, stone without mortar & concrete which are vulnerable to earthquakes are accounted to assess the population at risk in States/districts lying in the Intensity Zones I – III respectively based on the severity of ground shaking (acceleration) and building types. The factors which may lead to local increments in the intensity level have been considered for refinement of data/results.

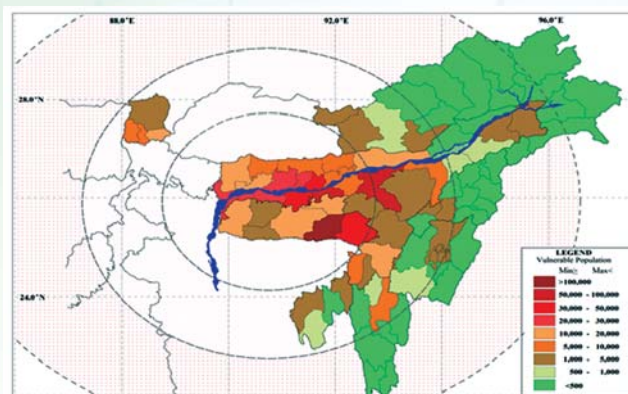


Fig: Isoseismal map of North East India region

The population & household data were obtained from Census India Report -2011 at district level for all the 8 NE India states. The intensity levels (Isoseists) of M8.7 1897 Earthquake as described by Oldham were converted to MSK scales for assessment of loss and damage in the present day context. It has been observed that the Isoseists I – III, equivalent to MSK XII- VIII covers almost the entire NE India. The estimation of vulnerable population dwelling in different households and intensity zones (Zone –I, II & III) are attempted at district to State levels. The initial estimates of vulnerable population & household showing both Urban & Rural population of different age group for different intensities are presented in thematic map layers.

**Project Title:** Seismic Vulnerability Assessment of Major cities in North-Eastern India.

**Project No:** GPP-275

**Funding Agency:** North Eastern Council, Shillong

**PI & Members:** Dr Saurabh Baruah (PI), Dr Pabon Kumar Bora (Co-PI), Dr Ranju Duarah (Co-PI), Ms Sangeeta Sharma (Co-PI), Dr Santanu Baruah (Co-PI), Er Sanjay Deori (Co-PI), Mr Dipak Basumatari (Co-PI)

**Salient Achievements:**

Site characteristics of Shillong city has been estimated. Ground motion parameters in Shillong was estimated based on Geomorphology and attenuation relation The physical dimension of vulnerability for the complex urban system of capital city Shillong, India was investigated. Emphasis were given to geomorphology, geology,

besides seismotectonic features. An urban land cover classification based on high resolution satellite data established the basis to analyse the spatial distribution of different types of buildings, the carrying capacity of the street network or the identification of open spaces. A DEM (Digital Elevation Model) is the basis to calculate slope map that enables localization of potential landslide areas. A methodology to combine these attributes related to the physical dimension of vulnerability was developed. In this process an n-dimensional coordinate system plotted the variables describing vulnerability against each other. This enables identification of the degree of vulnerability and the vulnerability-determining factors with subject to a specific location. This assessment of vulnerability provides a broad spatial information basis for decision-makers to develop mitigation strategies.

**Project Title:** Setting up of Multiparametric Geophysical observatory in Mikir Hills, North Eastern India for earthquake precursory research.

**Project No:** GPP-294

**Funding Agency:** Ministry of Earth Sciences, New Delhi

**PI & Members:** Dr Saurabh Baruah (PI), Dr Ranju Duarah (Co-PI), Dr Pabon Kumar Bora (Co-PI), Ms Sangeeta Sharma (Co-PI), Dr Manoj Kumar Phukon (Co-PI), Dr Santanu Baruah (Co-PI)

**Salient Achievements:**

A Multi-parametric Geophysical Observatory (MPGO) with a number of Geophysical/Seismological Instruments to study the anomaly pertaining to seismicity pattern, gravity, magnetic, resistivity, radon and helium emanation, ultra low frequency and very low frequency, GPS is being established for earthquake precursory research related to the earthquake of Kopili fault and its vicinity.

**Under Indo-Singapore collaborative project:**

**Project Title:** Indo-Asia Plate Collision Tectonics.

**Funding Agency:** Earth Observatory of Singapore, Singapore

**PI & Members:** Dr Saurabh Baruah (PI, Indian Project Leader), Ms Sangeeta Sharma (Co PI) Prof Paul Tapponnier (PI, Singaporean Project Leader)

**Geological Field Work :** Dr. Santanu Baruah, Scientist, visited Arunachal Pradesh during 06<sup>th</sup> November 2014 to 26<sup>th</sup> November, 2014 for a geological Field Work in connection with a Joint International Project Between CSIR-NEIST-Jorhat and Earth Observatory of Singapore (EOS), Singapore. The other team members were Prof. Paul Tapponnier, EOS; Prof. V. W. Jerome, University of Strasburg, France; Dr. Elise Kali, University of Strasburg, France; Dr. A. C. Curveur (EOS); Dr. Cagil Karakas (EOS). The project aims towards Geomorphological studies in the Arunachal Himalaya in order to understand