Three under-utilised vegetables i.e. Musa species from Arunachal Pradesh, India: Three *Musa* species i.e. *Musa markkui* Gogoi & Borah, *Musa itinerens* Cheesman and *Musa aurantiaca* Baker are used as vegetables by the indigenous people in Arunachal Pradesh, India. We found that the flower bud of Musa species contain high phenolic and flavonoid compounds while *Musa aurantiaca* contents considerable antioxidants vegetable.



Musa markkui Gogoi & Borah



Musa aurantiaca Baker



Musa itinerens Cheesman

Studies on Functional food based on some edible herbs : A number of classical edible herbs of Assam were studied, among which, *Fagopyrum esculentum, Paederia scandens* and *Amaranthus viridis* showed strong antioxidant potential with high phenolic contents.

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

Project No: CSC-134

Funding Agency: CSIR

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

Salient Achievements:

- Fabrication of PCL microspheres: morphology and stability of the microspheres were found to be dependent on the concentration of the PCL as well on the stabilizer.

- Synthesized *in situ* Poly (OMA) (POMA) and poly(OMA-*co*-HEMA) (POHMA) by controlled free radical polymerization such as Atom Transfer Radical Polymerization (ATRP) and Reversible Addition Fragmentation Chain Transfer (RAFT) polymerization at different reaction conditions. POMA and POHMA acted as a true steric stabilizer against coalescence in PCL microsphere formation. Spherical, smooth and stable PCL microspheres in the range of 5-20 µm were obtained with these *in-situ* stabilizers. Stabilizing ability of PCL microspheres increased with the increase segment of HEMA in the poly(OMA-*co*-HEMA) copolymer also the particle size decrease with the increase of MWs of the copolymer.

PCL blended gelatin microspheres prepared in the range of 5-20 µm and modified through different composition of PCL and gelatin. Microspheres were seemed to be smooth with definite shape and fine dispersibility.

Project Title: North East Exploration of Pharmaceuticals (NEEP).

Project No: CSC-207

PI & Members: Dr N C Barua (Co-ordinator), Prof Samir Bhattacharya(Mission Director, Visva Bharati, Santiniketan), Dr M J Bordoloi (Project Director), Dr A M Das, Dr G Baishya

Funding Agency: CSIR, New Delhi

Salient Achievements:

- A novel Artemisinin derived molecule arrests oral cancer cell growth.

- The adaptogenic activity of *Elsholtzia communis* (Collett & Hemsl.) Diels : A study was conducted to evaluate the adaptogenic activity of hydroethanolic extract of *Elsholtzia communis* (Collett & Hemsl.) Diels as part of collaborative project work between College of Veterinary science, Khanapara and Natural Products Chemistry Group, CSIR NEIST Jorhat by estimation of neurobiological and biochemical changes associated with acute and chronic stress. The project was granted to College of Veterinary science, Khanapara and Natural Products Chemistry Group, CSIR NEIST Jorhat and Gauhati University. One of the active principle was isolated by repeated chromatography and identified by ^{1}HNMR, ^{13}CNMR, IR and MS spectra. The leaf of the plant is consumed by the local tribes in Nagaland, Arunachal Pradesh of north east India, easily cultivated by farmers for its immense popularity. Hence, our study as an adpatagen has added one more medicinal property of this food plant, which can be successfully utilised as an adpatagen to combat adverse climatic condition prevailing in those areas.

- Inhibition of *Colletotrichum gloeosporioides: Colletotrichum gloeosporioides* is an anthracnose causing pathogen of fruits, vegetables and human beings. The pathogen produces lesions on leaves, fruit and other parts of plant. Finally these lesions become dark and form concentric ring pattern. More than 800 million people do not have adequate food; 1.3 billion live on less than $1 a day and at least 20% of global food production is affected due to plant disease caused by *C.gloeosporioides*. Plant pathologists cannot ignore the juxtaposition of these figures for food shortage and the damage to food production caused by plant pathogens. Further, immune-compromised patients are also infected by *Colletotrichum* including healthy persons with compromised skin barrier. It can cause keratitis in both healthy and immunocompromised persons and can induce phaeohyphomycosis in patients with hematologic malignancies and iatrogenic immunosuppression. We have found that a fraction of ethanol extract developed from a new edible plant having potent antifungal activity against *C.gloeosporioides* (vide figure 1 below). In laboratory condition, a fraction of ethanol extract of the identified plant showed excellent inhibitory activity against *Colletotrichum gleosporioides* Penz at conc. of 100, 300 and 500 ppm respectively.

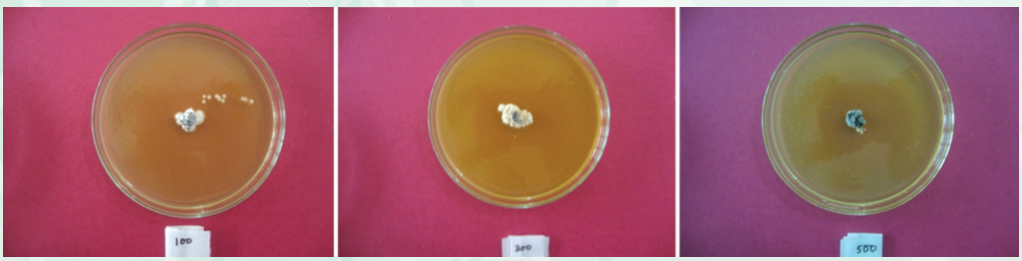
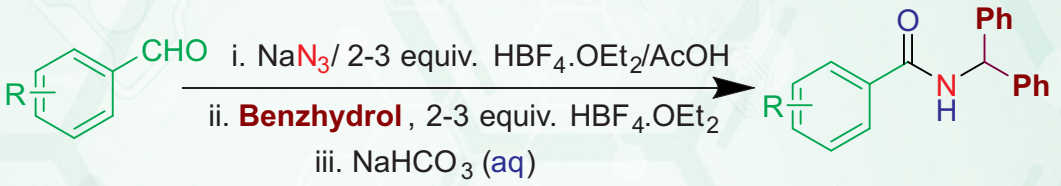
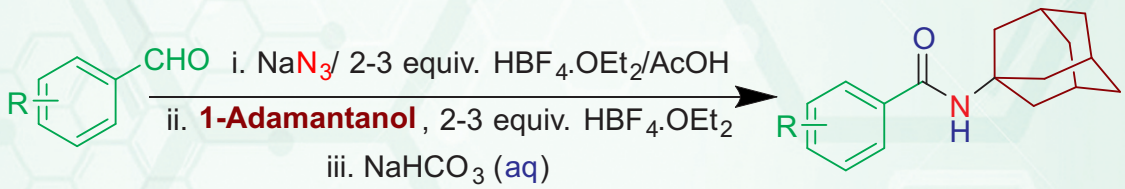


Fig. 1: Antifungal assay of a fraction of ethanol extract against *Colletotrichum gleosporioides* Penz at conc. of 100, 300 and 500 ppm respectively.

❖ A practical synthesis of N-diphenylmethyl and N-adamantyl amides directly from aldehydes via one-pot Schmidt and Ritter reactions sequence: 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. The reagent mixture consisting of NaN3 and HBF4.OEt2 in acetic acid converts aldehydes to their respective nitrile analogues which in situ undergo the Ritter reaction with diphenylmethanol or 1-adamantanol to afford their corresponding N-diphenylmethyl or N-adamantyl amide derivatives in very good yields. The method does not require column chromatography purification for isolation of the products. Simple reaction procedure and easy product purification technique outshines earlier conventional two steps methods.





R = electron-donating and withdrawing groups

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

Project Title: Creation of value–added products from renewable resources: A green approach.

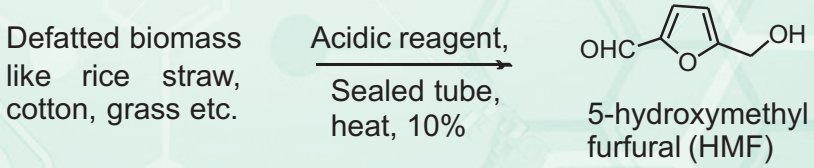
Project No: MLP-3000/03

Funding Agency: CSIR

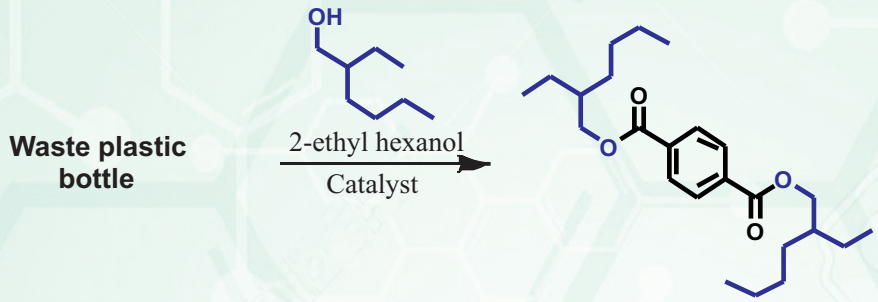
PI & Members: Dr D Konwar (PI), Dr A Goswami (Retd.), Dr P Pahari, Mr R N Das, Mr G K Rastogi, Mr M J Bora

Salient Achievements:

❖ Process for the preparation of hydroxymethyl furfural (HMF) from waste biomass: Work is going on to develop a process for the preparation of hydroxymethyl furfural (HMF) from treated biomass like rice straw, cotton, grass etc. We have succeeded to achieve the conversion using an acidic reagent under sealed tube heating condition. The yield was found to be 8-10% starting from defatted rice straw.

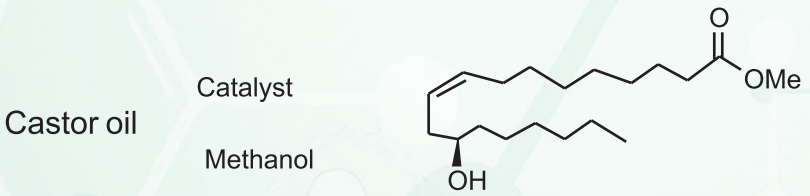


❖ Process for the preparation of dioctyl terephthalate (DOTP) from waste plastic bottle: We are working to develop a process for the preparation of dioctyl terephthalate (DOTP) from waste PET bottles. DOTP is an excellent non-toxic plasticizer widely used in polymer industries. The reaction requires heating at high temperature under sealed tube condition. A heterogeneous catalyst is used in the reaction which can be reused several times without much loss in activity.



Dioctylterephthalate (DOTP)

❖ Process for the preparation of methyl ricinoleate from castor oil: A bench scale process (10 gm) has been developed for the preparation of methyl ricinoleate by the transesterification of castor oil using a cheap heterogeneous catalyst. The product methyl ricinoleate is a highly useful chemical. It is an important ingredient in various cosmetics and toiletries and also used as biodiesel. It has been observed that the catalyst can be recycled 3-4 times without much loss in activity.



Methyl ester of ricinoleic acid

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 M Ahmed (Collaborator)

Funding Agency: Department of Biotechnology, Govt of India

Salient Achievements:

Prepared different Extracts (Ethanol, Hydroethanol and Hydro) of *Homalomenea aromatica* rhizome and *Clerodendrum indicum* (whole plant).

Fractionation of the hydro-ethanol extract of *Clerodendrum indicum*(whole plant)

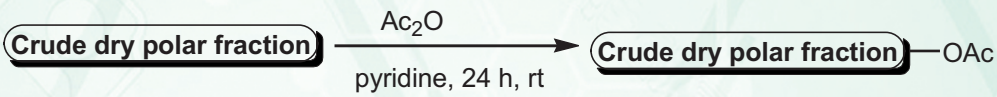
Three fractions were prepared: 1. Hexane fraction 2. Chloroform fraction 3. Remaining solid.

Isolation of pure compounds from the hydro-ethanol extract of *Clerodendrum indicum*(whole plant) .

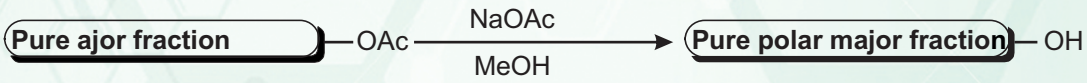
The hydro-ethanol extract was found to be anti-

arthritic against an arthritic mice model. Therefore, the polar part of this extract is subjected to column chromatography 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 chromtoagaphed by water to give semi pure polar fraction. After removal of water under reduced pressure in rotary evaporator and lypholizer, 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, ^{1}H and ^{13}C NMR technique. This clearly proves the introduction of acetate moieties into the polar organic compound. But the exact structure has yet to been determined.

Scheme 1:

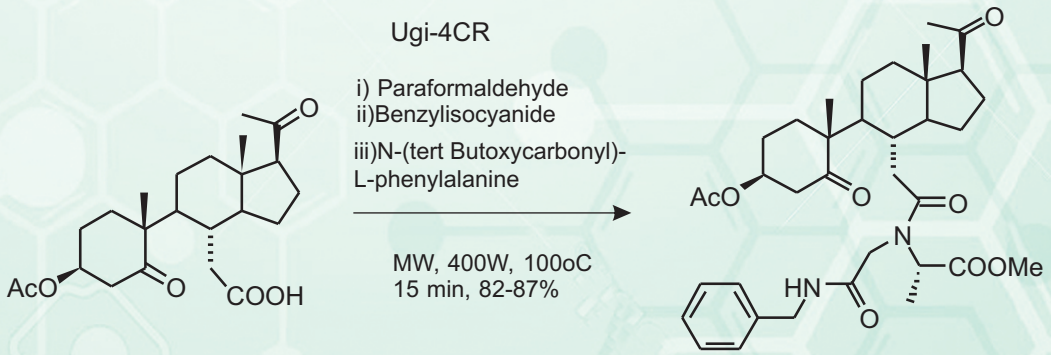


The pure acetate fraction was then subjected to deacetylation method using sodium acetate in methanol. But, the ^{1}HNMR spectrum of the compound has been recorded in CD_3OD. The determination of the correct structure is going on.



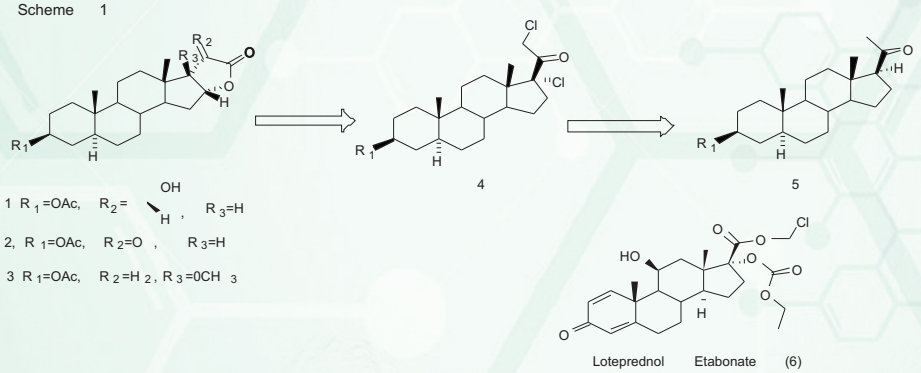
A new compound was isolated from the leaf and petiole oil of in vitro raised plants of Homalomena aromatica (Schott.), and characterized by MS, IR, 1H & 13C NMR spectra The Compound was found to have antimicrobial activity against bacterial strains viz. Bacillus subtilis, Staphylococcus aureus and Escherichia coli and three fungal strains viz. Candida albicans, Fusarium oxysporum and Aspergillus niger.

Microwave (MW) irradiated Ugi four-component reaction (Ugi-4CR): Expedited synthesis of steroid–amino acid conjugates – A novel class of hybrid compounds: Microwave (MW) assisted chemical reactions are currently gaining considerable importance in organic synthesis to contribute in green technology. Considering the importance of peptidomimetic steroid amino acid conjugates – a novel class of hybrid compounds having diverse biological properties, we 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).



Construction of D-Ring fused 16α-Steroidal-γ-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 $\triangle^1$ –testololactone was the first lactone of this kind to show antitumor activity. The steroidal lactones have been found to inhibit the *5α-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. We earlier reported an efficient metal mediated halogenations technique for steroidal olefins & ketones which paved the way for synthesis of corticosteroid side chain and also for the synthesis of side chain Loteprednol Etabonate (6) - an ocular soft-corticosteroid. Here we would like report another application of the same technique to synthesize an important class of steroidal molecules, viz., D-Ring fused 16α-Steroidal-γ-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 (Scheme 1):

Scheme 1



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

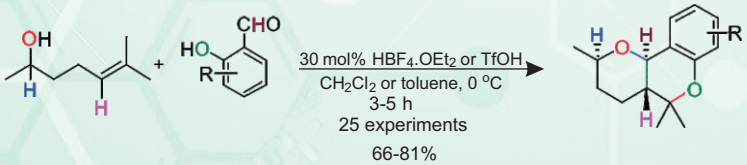
Project No: GAP -258 (DST)

PI & Members: Dr Gakul Baishya (PI)

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

Salient Achievements:

Diastereoselective synthesis of angularly fused pyranochromenes: *o*-Quinonemethides generated from the condensation of 6-methylhept-5-en-2-ol and different salicylaldehydes in the presence 30 mol% HBF4.OEt2 or TfOH undergo [4+2]- cycloaddition reaction to afford angularly fused pyranochromene derivatives in very good yields and excellent diastereoselectivities.



G. Baishya and group. *Synlett* **2014**, *25*, 2151-2155.

Project Title: Synthetic Studies towards Spirocyclic Natural Products.

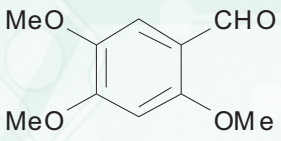
Project No: GPP-299

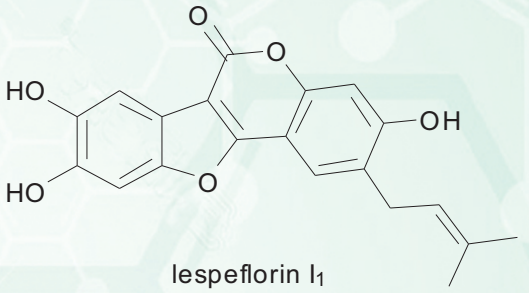
Funding Agency: SERB, New Delhi

PI & Members: Dr P Pahari (PI)

Salient Achievements:

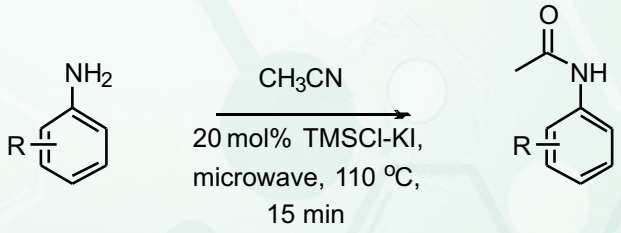
Synthetic studies towards prenylated coumestanes: We have developed a synthetic route for the preparation lespeflorine I_1, a prenylated coumestane natural product. We have also successfully prepared a few different derivatives of the natural product. Further work is going on to study their anticancer activity.





lespeflorin I_1

Acetylation of aromatic amines using acetonitrile as acylating agent: A method for N-acetylation of amines has been developed using acetonitrile as acylating agent and in situ generated trimethylsilyl iodide as the catalyst under microwave heating condition. The reaction is selective towards aromatic amines while aliphatic amines remain intact. The process eliminates the requirement of toxic acylating reagents like acetic anhydride and acetyl chloride. Application of the process for the synthesis of spirocyclic skeleton is going on.



ENGINEERING SCIENCES & TECHNOLOGY DIVISION

The Engineering Sciences & Technology Division has four groups and provides engineering inputs and services to different R&D projects of the Institute. The Applied Civil Engineering Group has expertise in geo-technical and transportation engineering. Chemical Engineering Group provides engineering inputs to different R & D areas and projects of the Institute. General Engineering Group 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 Group is engaged in activities for support to institutional infrastructure like maintenance of equipments and total internal telephone network.

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 & WP-II

Mr Tobiul Hussain Ahmed (PI), Mr Somiron Borthakur, Dr Swapnali Hazarika, Mr Bipul Das, Dr RL Goswamee, Dr PK Baruah, Dr T Bora, Dr PJ Saikia , Mrs Polakshi Bordoloi

Salient Achievements:

- Shelf life study was carried out for the komal chaul (Soft Rice) prepared by a modified method at our laboratory to increase the acceptability of the products amongst the users. Samples were kept in packaged form at different conditions of temperature (viz. ambient, 4°C & 40±2°C) and tested for their microbial contamination and nutritional properties like protein, carbohydrate and free fatty acid contents. The analysis were carried out at an interval of 30 days for a total period of 90 days.
- Steps were taken to popularizing this useful product through NGO amongst the malnourished population at the CSIR identified TECHVIL site.
- Nutra Readymix was prepared at large scale for distribution among Malnourished woman and Children. These are tested in laboratory for both chemical and microbial contamination and distributed among 100 targeted malnourished populations at the CSIR-800 Techvil in Sonitpur, Assam



Fig.: Soft Rice and Nutra Readymix product

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

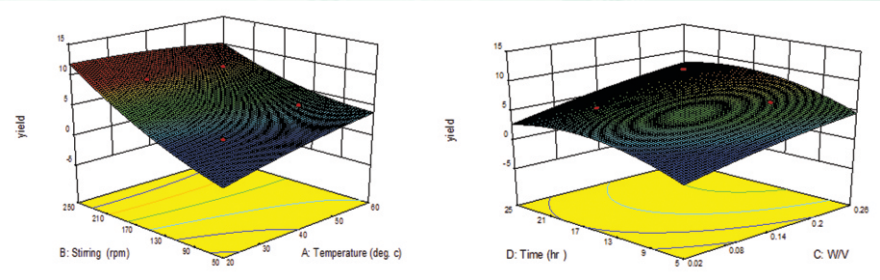
Project No: CSC-104

Funding Agency: CSIR, New Delhi

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

Salient Achievements:

Extraction Study: Studied the extraction kinetics for extraction of important biomolecules such as Resveratrol, natural dye and Amino acids from different *plants available in North East India* considering diffusional effect. The optimum conditions were established for extraction of biomolecules in a cost effective way. Computer aided design of experiments were performed by four-factor central composite design using Response Surface Methodology.

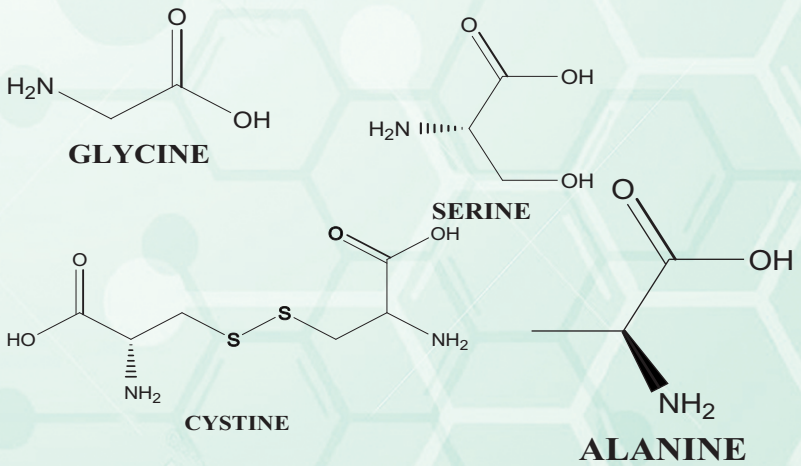


Surface plot for extraction of biomolecule using ANOVA

Membrane Separation Process for Amino Acids and Natural Dye: Developed specific membrane (Microfiltration, ultrafiltration and nanoiltration) for separation and purification of extracted biomolecules such as Resveratrol, natural dye, Amino acids. Scaling up work for separation of and purification of natural dye and resveratrol were completed. Recovery percentage of biomolecules were in the range of 90%-95%.



Fruit of *Spondias Pinnata*



Amino acids separated from plant extract



Purified Natural dye

Developed a membrane device which was made from special proprietary chiral polymeric (CP) material and was used for a process for resolution of drugs. Our membrane technology (MT) was examined in resolution of racemic cardiovascular drugs and anti-inflammatory drugs with high purity (ee>98%). This is an operation with lower energy intensive, recycling, cost effective, independent of functional groups as compared to available technology of HPLC, chromatographic separation using chiral stationary phase. The process can provide faster separation, lower energy consumption and zero waste. The mini units are simple in construction and can be operated continuously to derive benefit of lower operational cost.

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 Swapnali Hazarika (Co-PI), Dr Pranjal Gogoi (Co-PI), Dr Pallab Pahari (Co-PI), Dr Sanjeev Gogoi (Co-PI)

Salient Achievements:

Thermal screening of di-tert-butyl peroxide in Toluene and Benzene

Organic peroxides are widely used in polymer industries for the manufacture of polymers and polyesters. The thermal instability of the peroxides involved in various chemical reactions can cause safety related issues which are of serious concern. The decomposition reactions of peroxides are highly exothermic with extreme self heating rates. Such self-accelerating decompositions are usually accompanied by the formation of hot gaseous decomposition products that can lead to thermal runaway. To prevent such thermal decomposition reactions during transportation, handling and storage extensive safety precautions are necessary. In the present work, decomposition *of di-tert* butyl peroxide (DTBP) in toluene and benzene were studied. The composition of DTBP in Benzene and Toluene in varying percentage of 5 to 20, was used to determine various thermal parameters in the reaction of an uniform screening rate in a Rapid Screening Device (RSD). The onset temperature (T_{onset}), maximum temperature (T_{max}), adiabatic temperature rise (ΔT_{ad}), total heat of reaction (Q_{Total}), self heat rate (dT/dt), pressure rise rate (dP/dt), maximum pressure (P_{max}) were evaluated for both the reaction. Result indicated that with increasing concentration of DTBP in toluene and benzene, the total heat of reaction increased from 53.25 J/gm to 241.38 J/gm, 62.29 J/gm to 198.24 J/gm respectively. It was also observed that with increase in DTBP, the onset temperature and time of exothermicity initiation decreases. It was also observed from the experimental data that toluene is more reactive with DTBP than benzene.

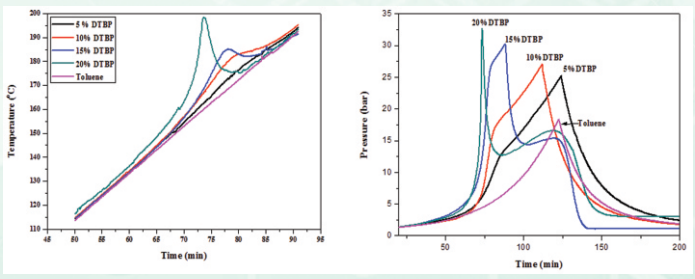


Figure 1: Temperature and pressure profiles of DTBP in toluene

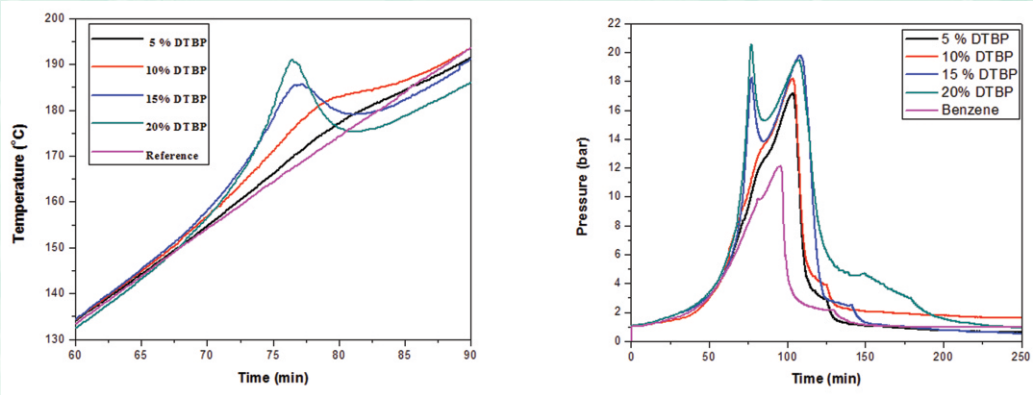


Figure 2: Temperature and pressure profiles of DTBP in benzene

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

Project No: CSC-113

Funding Agency: CSIR, Govt of India

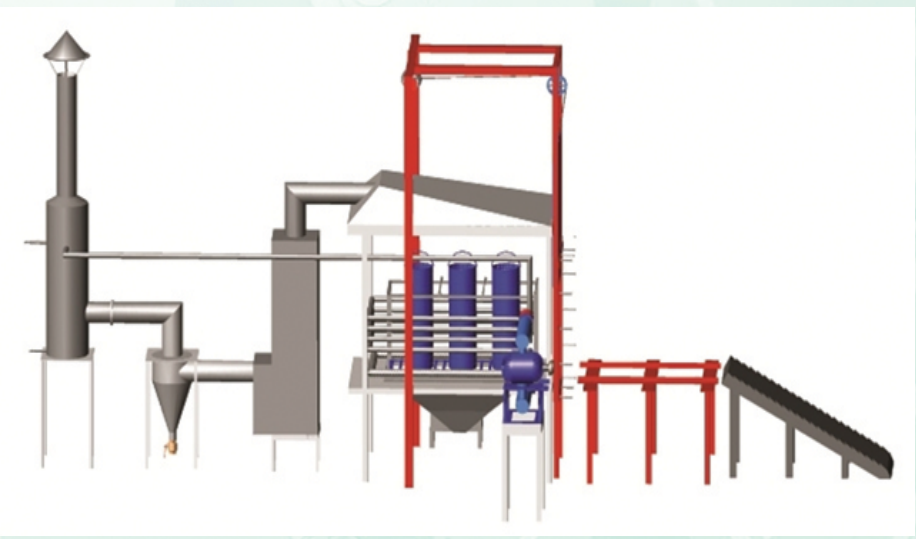
PI & Members: Mr SC Kalita (PI), Mr Jayanta Jyoti Bora (Co-PI), Mr Dipankar Neog (Co-PI), Mr Binoy Kumar Saikia

Salient Achievements:

- A process of removal of wax from the strainers has been developed.
- An experimental prototype has been designed and successfully field trialed.
- The design has been modified according to the result obtained in field trial.
- The modified design has been finalized on the basis of the successful field experimentation.
- An industry level marketable scaled up wax removal and recovery device has been designed.
- The fabrication of the industry level marketable scaled up wax removal and recovery device is in progress.
- The discussion with Oil India Limited (Pipeline Division) regarding the transfer of technology is on progress.



The Experimental Prototype



The Designed Scale-Up Model

Project Title: Engineering of Disaster Mitigation and Health Monitoring for safe and smart built Environment.

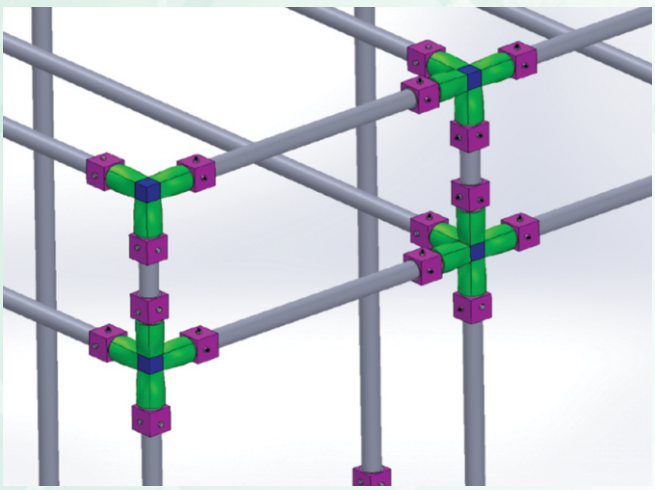
Project No: ESC-102

Funding Agency: CSIR

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

Salient Achievements:

- Designing of connector for fixing bamboos in the construction of Transitory house has been completed in a 3D modeling software, SOLIDWORKS.
- Load analysis, stress analysis of connector has been completed in a Finite Element Analysis software, MSC Nastran.
- Designing of Transitory House has been completed in SOLIDWORKS.
- Load analysis of Transitory House has been completed in MSC Nastran.





(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.

Work Package I: Studies on process intensification, integration, miniaturization and life cycle assessment for industrial bioproducts from natural feedstock and environmental control.

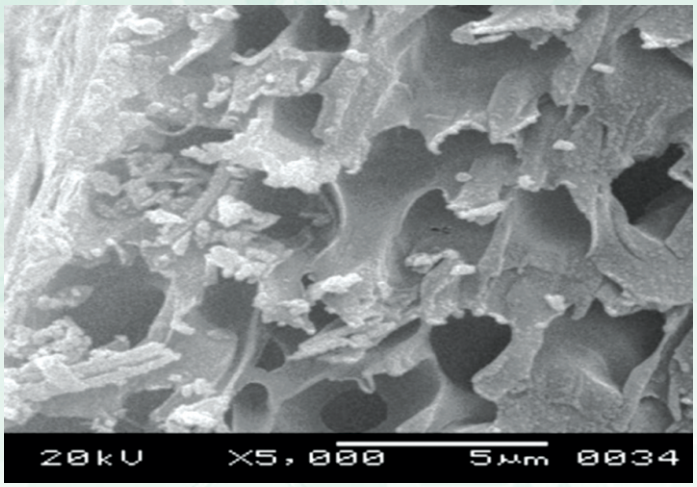
Project No: MLP-4000/01

Funding Agency: CSIR, New Delhi

PI & Members: Dr P Barkakati (PI), Dr M M Bora, Mr S Borthakur, Dr Swapnali Hazarika, Mr Bipul Das, Mr. Ashutosh Namdeo, Mr Tobiul Hussain Ahmed

Salient Achievements:

- Micro-encapsulation method for preparation of Smart polymeric hydrogel from N-isopropyl-acrylamide (NIPAM) has been developed for control release application. Swelling and deswelling kinetics of the hydrogel was studied at different temperature and pH.



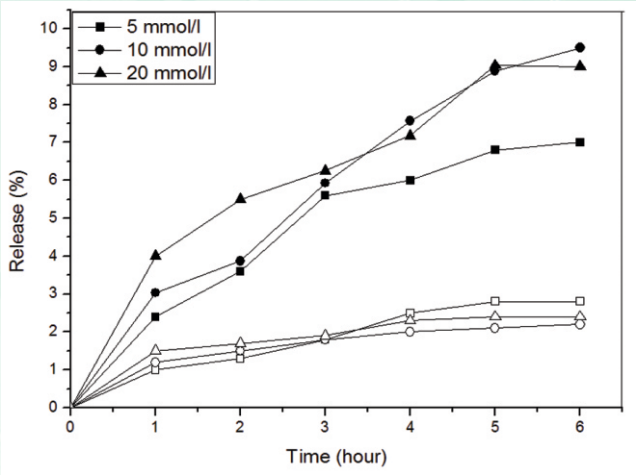


Figure: SEM image of the hydrogel and Controlled Release graph of Vitamin B through the hydrogel Closed symbol: using NaCl, Open symbol: using H_2O

❖ Studied the drying characteristic of *Capsicum Chinese* using hot air, microwave and in microwave convective drying method. The quality parameters of the fresh and dried product were carried out.

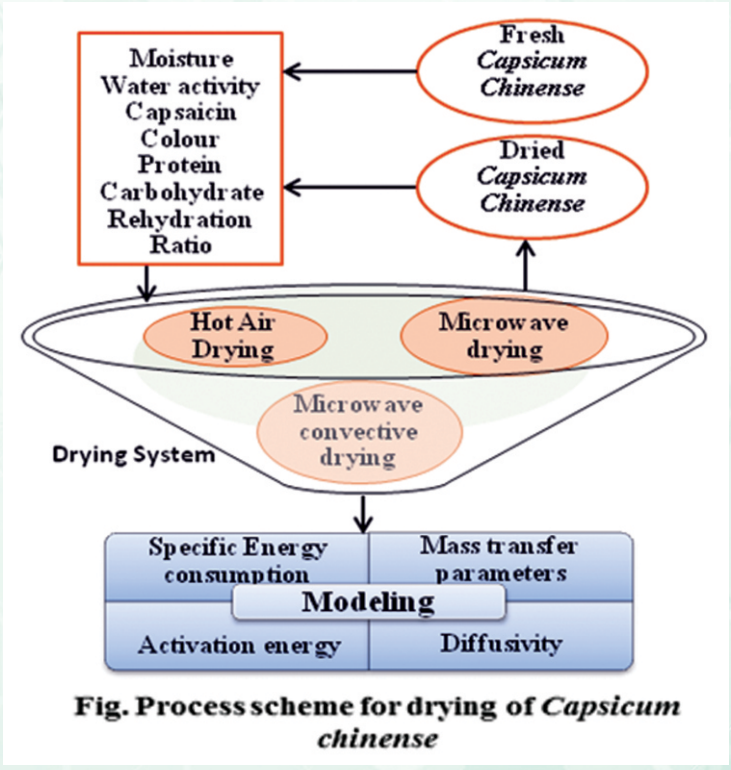


Fig. Process scheme for drying of *Capsicum chinense*

❖ A porous microfiltration ceramic membrane was prepared and characterized. The average pore size of the membrane was in the range of 1.59 µm to 2.56 µm and porosity of the membrane supports was decreases from 18.88% to 5.59% when sintering temperature increases from 850°C to 950°C.

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

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

Project No: GAP-214

Funding Agency: DSIR, Govt of India

PI & Members: Mr Dipankar Neog (PI)

Salient Achievements:

One innovator has successfully completed the project namely 'Development and commercial extraction of Bio-product from Biomass'. The innovator has tested his product/ process in a pilot scale and also has started production for commercial scale. The developed process/ product under this project are listed below:

- Design and development of a sodium bicarbonate manufacturing unit that can burn banana fiber and produce sodium bicarbonate.
- Development of a processing technology to extract sodium bicarbonate from banana fiber both in solid or liquid form.
- Development of an 'Organic Potash' extraction technology from banana plant. During laboratory testing of percentage of potash it was found 23.59%.
- Development a anti bacterial ash base detergent bar
- Marketing of the products has already been started.

Project Title: Development of Molecular gate Membrane for CO_2 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:

Dendrimer based gas separation membrane was developed for separation of CO_2 from gaseous mixture. Absorption of CO_2 from CO_2/N_2 mixtures was studied in dendrimer based hollow fibre membranes.

Introduction of feed gas in the tube side or shell side of the HF module effected the permeation flux of CO_2. Introduction of pure gas in the shell side at identical dendrimer concentration decreases the flux of CO_2. The CO_2 permeation rates were controlled by diffusion in the liquid at moderate flow rate. At high flow rate of liquid, fast chemical reaction in the liquid phase accelerates the CO_2 mass transfer in the liquid. Thus CO_2 permeated at finite and appreciable rate depend on operating conditions. Under suitable conditions the dendrimer based hollow fibre membrane can be an attractive alternate to packed columns for absorption of CO_2 from CO_2/N_2 gas mixture of industrial relevance.

Project Title: Common Facility Centre (CFC) On Weaving And Textile Product Manufacturing.

Project No: GPP - 283

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

PI & Members: Mr Dipankar Neog (PI), I.Ilika Zhimo (Co-PI)

Salient Achievements:

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

Project Title: Performance Evaluation of River Brahmaputra Bed Materials for use in construction of 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 Brahmaputra River Bed at different locations.
- Characterized river bed samples in laboratory.
- 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.
- Experimental testing is set-up for evaluation of field performance of the stabilized materials.

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

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.
- Developed the technology of Modular Bricks from Brahmaputra River bed materials.
- Evaluation of Modular bricks and the technology is under progress.

Project Title: Soil Investigation Work for LPG Mounded Bullets at NRL.

Project No: CNP-470

Funding Agency: Numaligarh Refinery Limited, *Golaghat.*

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

Objective:

- To determine safe bearing capacity of foundation soil.

Salient Achievements:

- Various Field Tests such as Standard Penetration Tests (SPT), Static Cone Penetration Tests (SCPT), Electrical Resistivity Tests (ERT), Block Vibration Test, Plate Load Test were carried out.
- Laboratory Tests such as Atterberg Limit Tests, Consolidation Tests, Unconfined Compression Tests, Triaxial Tests, CBR Tests etc. were carried out.
- Submitted the Final Report to M/s NRL, Golaghat with advice and recommendation on safe bearing capacities of foundation soil.

Project Title: Rural Entrepreneurship And Skill Development Through Demonstration And Training Of Appropriate Technologies Of CSIR-NEIST.

Project No: RSP-4007 (CSIR-800)

Objective:

- Creating a rural technology demonstration set-up for live demonstration of appropriate rural technologies of CSIR-NEIST.
- To demonstrate nine different rural technologies to the entrepreneural youths with lab to market approach.
- To impart skill development training programme for rural youth in fourteen different categories.
- Awareness programe for financial linkage, trade build-up and market linkages for the trained entrepreneurs.

Salient Achievements:

- The design of the technology demonstration centre has been completed and its construction is going on.
- Skill development trainings are going on in three different places and subjects.
  - Training on *Handloom Weaving using Jacquard Loom and Product Designing* at Chipahikhola

Development Block and Chenijan Gaon of Jorhat.

- Training on *Basic Footwear and Allied Products Designing* at Tezpur Footwear Training cum Production Centre.
- Training on *Basic Welding, Fitting and Plumbing Practices* at the workshop of General Engineering of CSIR-NEIST.





GEO SCIENCES & TECHNOLOGY DIVISION

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. 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.

A) National Collaboration

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

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

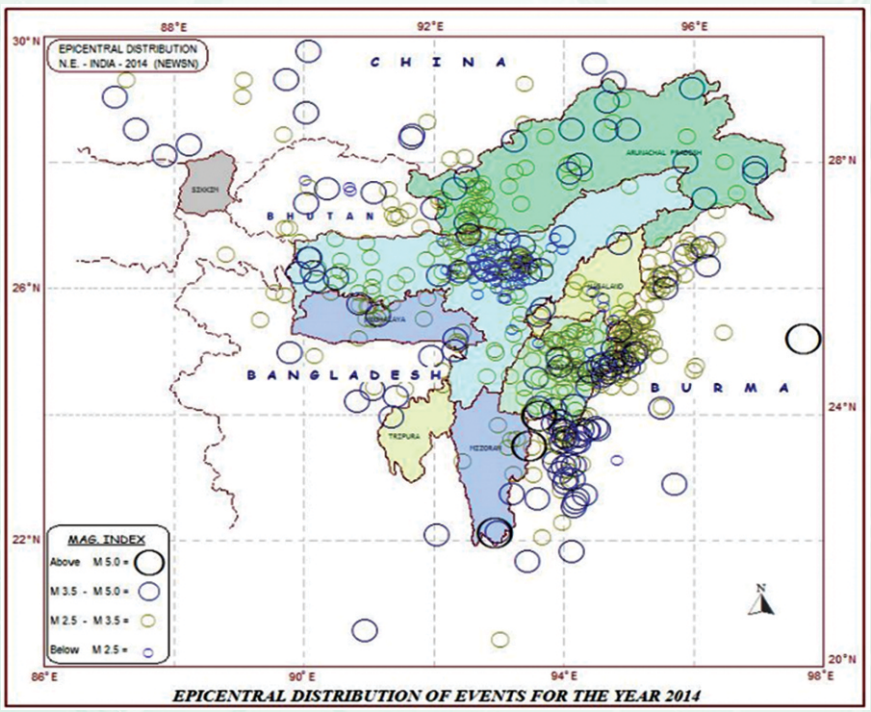
Project No: GAP-142

Funding Agency: North Eastern Council, Shillong

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

Salient Achievements:

Preparation of Annual Seismological Bulletin of NE India and adjoining region for the year 2014



EPICENTRAL DISTRIBUTION OF EVENTS FOR THE YEAR 2014

Gross seismicity map prepared with 545 events located for the period in NE India and adjoining region within the magnitude range of 1.5 - 5.7 having depth range between 5km – 165km. Intense seismic activity is observed in Mikir Hills and Indo-Myanmar.

Project Title: Active Tectonics & Palaeoseismic studies using geographical parameters along the frontal part of the eastern syntaxial bend, lower Dibang valley and Lohit Dist, Arunachal Himalaya.

Project No: GAP-259

Funding Agency: Department of Science and Technology, New Delhi

PI & Members: Dr Mrinalinee Devi (PI)

Salient Achievements:

The frontal Mishmi Thrust region in the Eastern Syntaxial Belt of the Arunachal Himalaya was found to be dislocated dextrally at many places due to Active and Neotectonic activity, associated with the progression of Indian-Asian plate collision. At Latitude 27^0 52.747/ N and Longitude $96^0$21.467/ E, in Parsuramkund, an active NE-SW trending left lateral strike-slip movement displaces the T_3 terrace of the Lohit river and places bedrock midway of the river channel. Prominent joint planes dipping 80^0, 88^0, 65^0 towards NW; 43^0 towards SW; 40^0 towards S; were observed on the steeply tilted bedrocks. Continuation of the NE-SW trending fault trend extending towards Parsuramkund temple bedrocks was also observed.

Study of paleoseismological evidences also revealed that, in addition to the great 1950 Assam earthquake, the Eastern Syntaxial region of Arunachal Himalaya was found to be frequented by large earthquake events, during the recent Geological Holocene time, which had generated liquefaction of sand and silt particles during the time spans of <10 ± 2 ka, 3±0.1ka & very recent <1ka geological ages.

Climatic studies of Frontal Eastern Syntaxis of Arunachal Himalaya.

Geochemistry and Palaeo-weathering analyses were performed specifically for eleven samples collected from selected sites of Palaeoseismicity and active tectonic evidences, to understand the geological and structural disposition of the provenance of the sand samples of the frontal part of the Eastern Syntaxial Bend in Lower Dibang Valley and Lohit districts of Arunachal Himalaya Indicates extensive conversion of feldspar to clay i.e. high chemical index of alteration (CIA) value, as well as intense plagioclase index of alteration (PIA) and high chemical index of weathering (CIW) values. The alteration and weathering values for the sand particles are found to be varying from 81.41 to 90.78; 82.05 to 93.38; 82.24 to 93.77 respectively for the above indexes, indicating intense weathering condition of the source rock related to humid climate, supporting the above evidences. Sand samples of the study area, is in the process of intense weathering condition, which may be related to humid climate as well as, due to active tectonic activities, giving rise to crushing and weakening of the source rocks, on the Arunachal Higher Himalayan regions.

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

Project No: GAP-273

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 that 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.

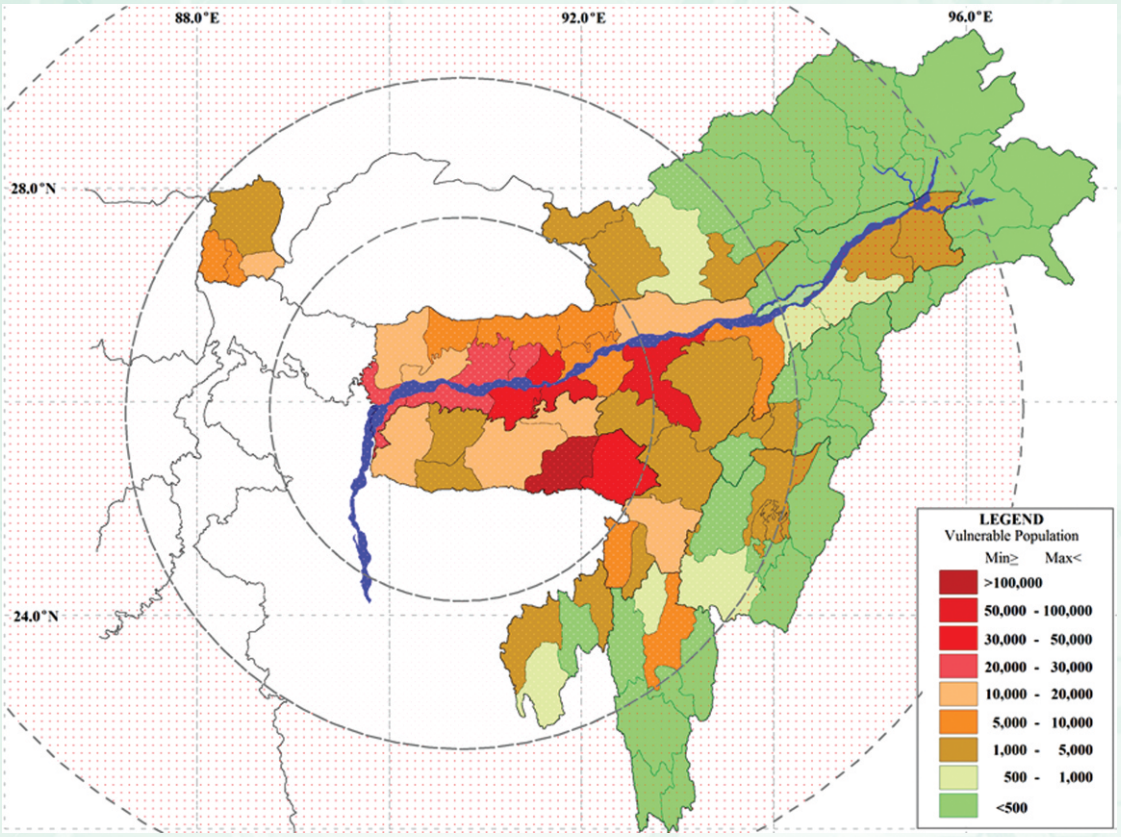


Figure: Isoseismal map of North East India region.

- 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), Ms Sangeeta Sharma (Co-PI), Dr Santanu Baruah (Co-PI), Mr Sanjay Deori (Co-PI)

Salient Achievements:

- Estimated the probable Peak Ground Acceleration at the centre of the most populated ward of Shillong City (Ward 21) for respective localized faults/lineaments ascertained within a span of 20x20 sq. km. area around Shillong. The existing faults/lineaments are considered as source and the surface wave magnitude (Ms) of the maximum credible earthquake associated to those faults were estimated.

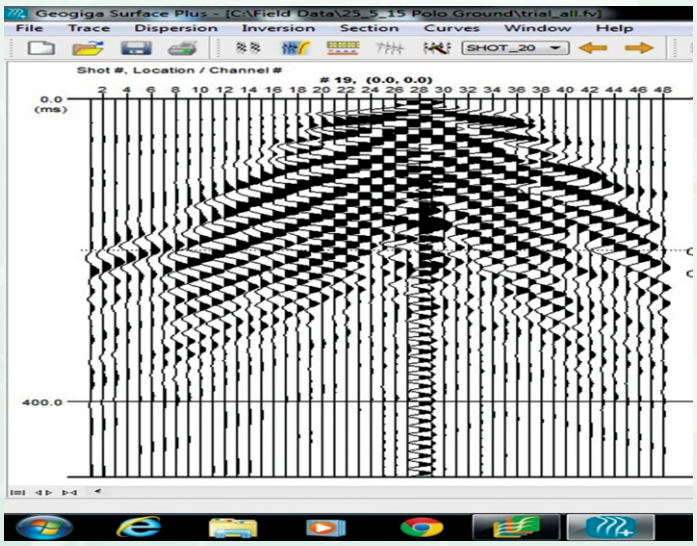
- Site amplification parameters in Shillong City supplemented by the distribution pattern of PGA and PGV due to three major causative faults (Kopili fault, Dauki fault and Dhubri fault) in and around Shillong city are estimated based on varying Geomorphological units of Shillong city.
- Altogether, 31 nos. of suitable sites have been selected across Shillong City for conducting active and passive MASW survey. These sites are mainly of plain topography having at least 90m extension for laying out a survey line of 47m.





Figure : (Left) Members of field trip for MASW study along with the Professors & students of Physics Department of St. Edmunds College at the St. Edmunds College Play Ground. (Right) The layout of the instruments for multichannel seismograph system at Golf Link, Shillong.

- Preliminary site classification for Shillong city has been performed based on NEHRP, USGS and FEMA regulations placing the city in E(Vs^{30} : <180m/s ~soft clay soil), D1 (Vs^{30} : 180-240 m/s ~ stiff soil), D2 (Vs^{30} : 240-300m/s ~ stiff soil), C(Vs^{30} : 360-760m/s ~ very dense soil and soft rocks) classes.



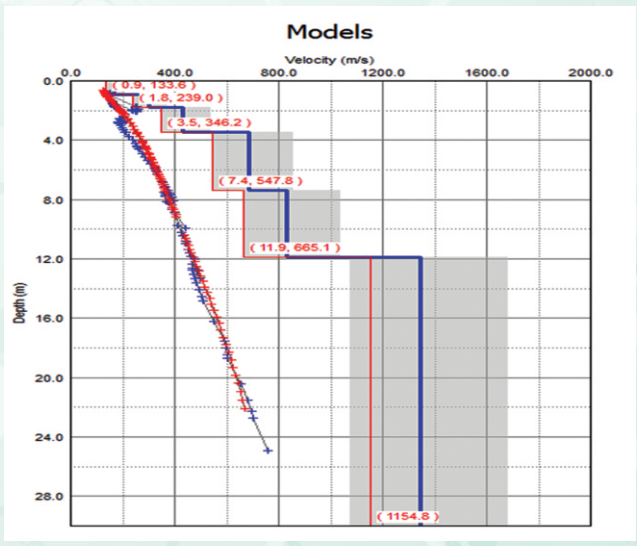


Figure : (Left) Raw Multichannel data acquired; (Right) Velocity Model Estimated

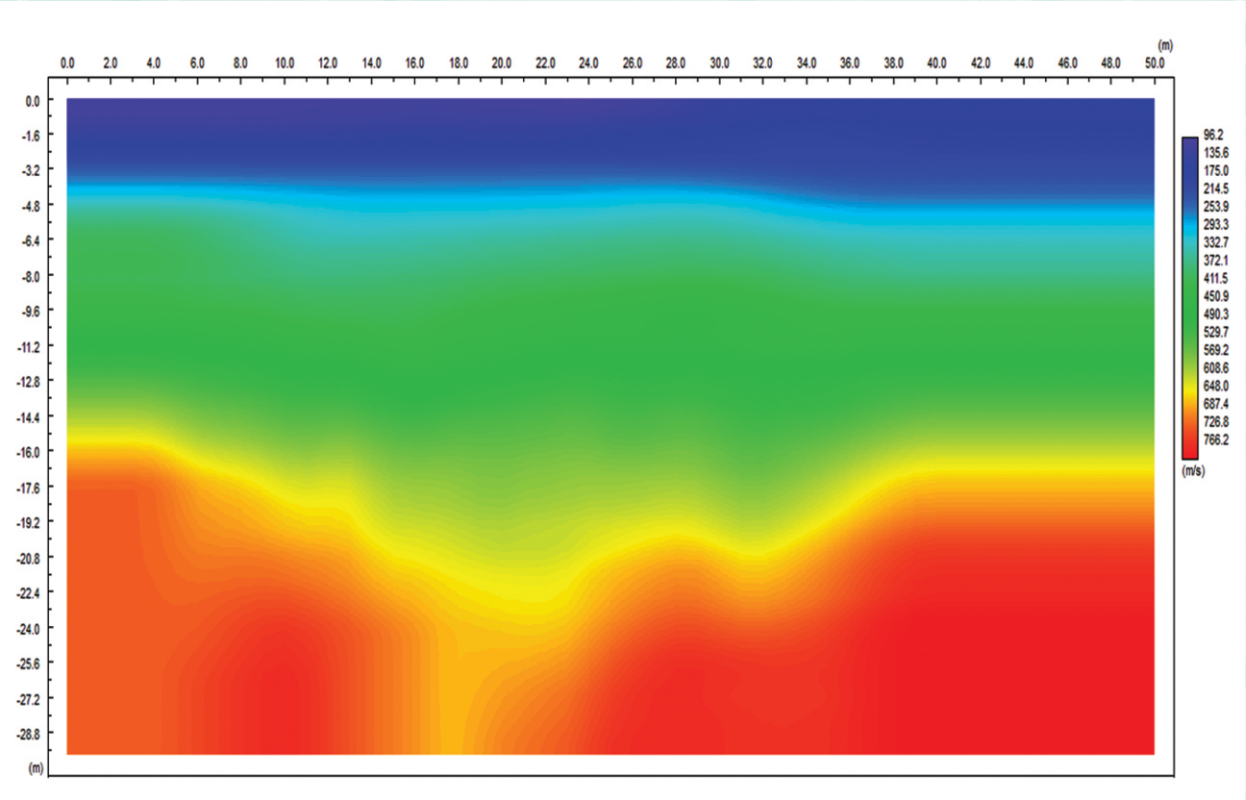


Figure : 2D Velocity section acquired through roll on MASW survey

- Modeling of active Kopili Fault in Mikir Hills plateau based on slip rate, moment and seismic activity, towards the estimation of recurrence intervals is carried out. The return periods for the recurrence magnitude Mw 4.5 is 5years for the 80Km long Kopili Fault while the return period for the recurrence magnitude Mw 3.5 is around half a year.
- Altogether 26 wards out of 27wards are surveyed under GIS platforms with almost around 33 parameters. Altogether more 11,000 houses belong to 14wards are digitized considering various parameters. RVS for Hospitals and Educational buildings are completed while RVS for residential buildings are being continued.
- The urban landscape of Shillong city is heterogeneous in terms of distribution of building patterns, site geology and geomorphology, assessment of vulnerability function for the densest part of the city was made based on several prime parameters estimated through field visits, which ensures the mapping of characteristics of each of the buildings built on the site.
- The study evolved a new methodology for estimation of seismic vulnerability of a part of Shillong City taking into account as the built in information, prevalent construction practices, material of construction, quality/workmanship of construction, types of buildings, ambience, and geological/geotechnical parameters and is based on ground realities. The developed procedure can be readily applied to any urban region of our country in order to assess the necessity of more detailed investigation for earthquake damage scenario prediction.

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), 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 are being established for earthquake precursory research related to the earthquake of Kopili fault and its vicinity.

Project Title: **Estimation of ground motion parameters in Shillong Mikir hills plateau from acceleration time history of earthquake events originated in North East India.**

Project No: GPP-300

Funding Agency: Ministry of Earth Sciences, New Delhi

PI & Members: Ms Sangeeta Sharma (PI), Dr Saurabh Baruah (Co-PI)

Objective:

- Estimation of peak ground acceleration due to maximal credible earthquake and the attenuation relation.
- Computation of the three dimensional Q structure of the region.

Salient Achievements:

The acceleration time histories obtained from accelerograph stations existed in Northeastern India are analyzed for the estimation of the ground parameters eg. (i) Fourier amplitude vs. frequency (ii) Power amplitude vs. frequency (iii) Response acceleration vs. frequency and (iv) Response acceleration vs. period. These site specific ground motion parameters along with the design response from maximum credible earthquake helps immensely towards the design of new structure and also assessing the performance of the existing old structures.

Project Title: Crustal anisotropy studies for Shillong-Mikir plateau and subsequent determination of velocity structure of NE India.

Project No: GPP-302

Funding Agency: Department Of Science and Technology(SERB), New Delhi

PI & Members: Dr Santanu Baruah (PI)

Objective:

- Seismic anisotropy in Shillong Mikir plateau
- Seismic velocity structure of NE India

Salient Achievements:

State of Tectonic Stress in Shillong Plateau of Northeast India

Tectonic stress regime in the Shillong plateau, northeast region of India, is examined by stress tensor inversion. Some 97 reliable fault plane solutions are used for stress inversion by the Michael and Gauss methods. Although an overall NNW-SSE compressional stress is observed in the area, the stress regime varies from western part to eastern part of the plateau. The eastern part of the plateau is dominated by NNE-SSW compression and the western part by NNW-SSE compression.

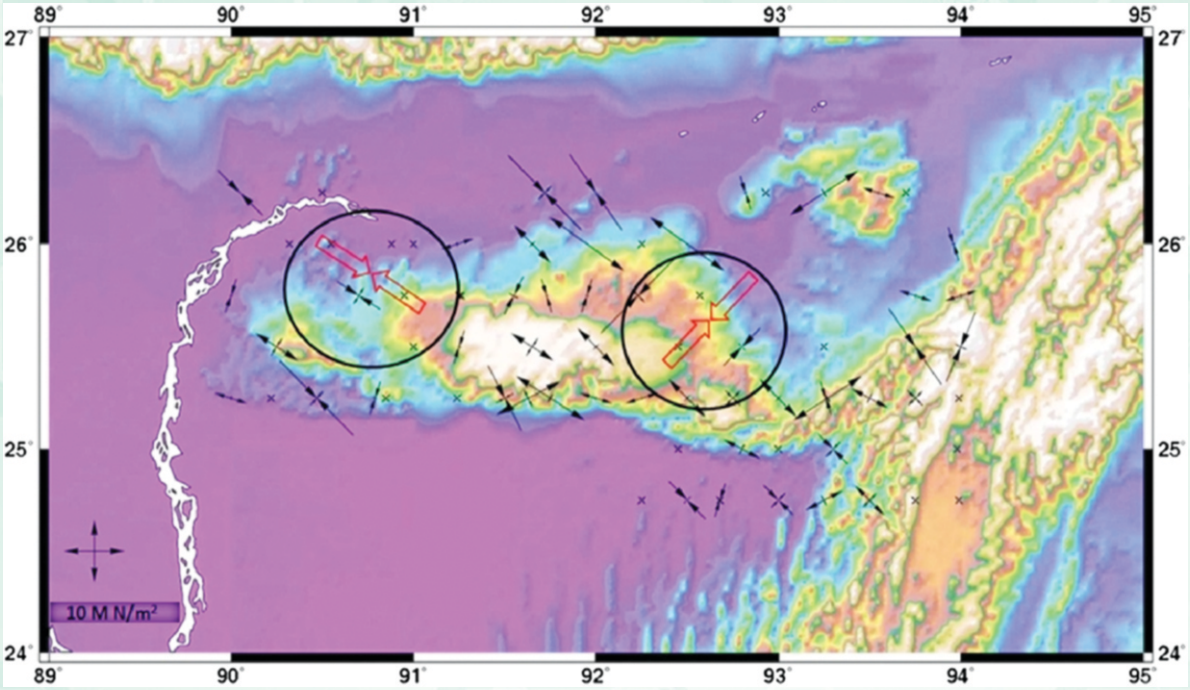


Figure : The GPE derived deviatoric stress in the Shillong plateau region. The red arrows in the circles represent the stress pattern corresponding to the clusters "a" and "b". The direction of compressive stress in the eastern edge of the plateau is approximately in NE direction while in western edge in NW direction

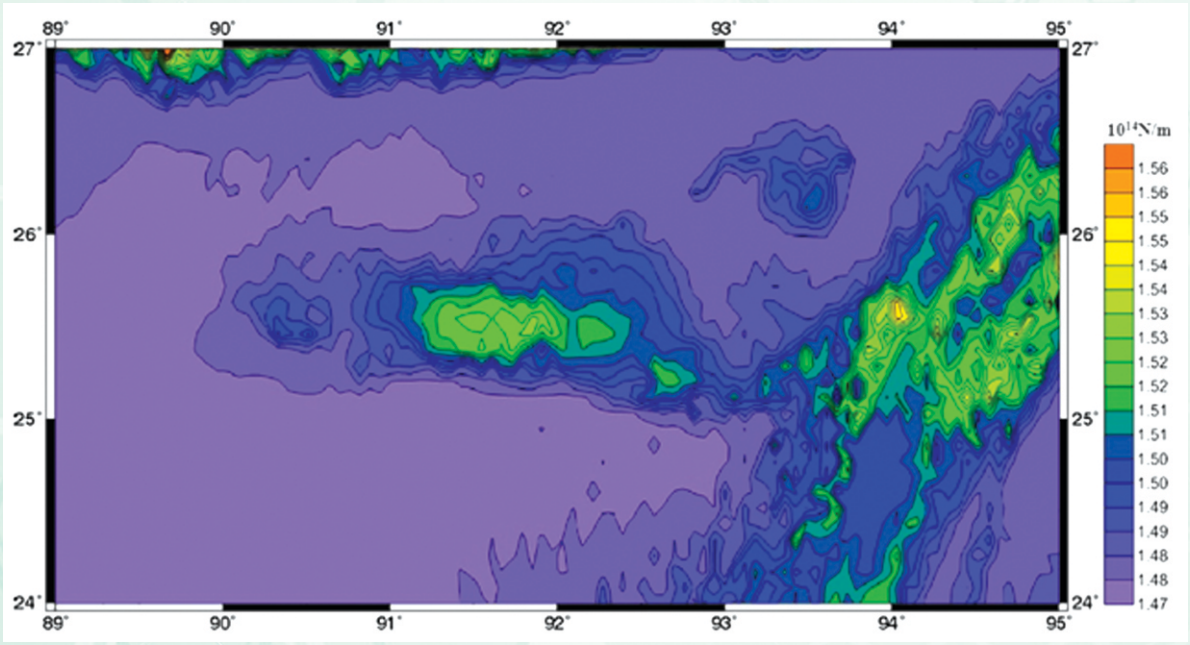


Figure : GPE estimated from SRTM 30 and Crust 2.0 model for the Shillong plateau region. The contour interval are at 0.01 _ 1014 Nm (ref.; Physics and Chemistry of the earth (2015), http://dx.doi.org/ 10.1016/ j.pce.2015.11.009)

The NNW-SSE compression in the western part may be due to the tectonic loading induced by the Himalayan orogeny in the north, and the NNE-SSW compression in the eastern part may be attributed to

the influence of oblique convergence of the Indian plate beneath the Indo-Burma ranges. Further, Gravitational Potential Energy (GPE) derived stress also indicates a variation from west to east.

Project Title: Vulnerability assessment in Shillong city.

Project No: GPP-308

Funding Agency: Meghalaya State Disaster Mangement Authority, Shillong

PI & Members: Dr Manoj Kumar Phukan (PI)

Objective:

- Seismic Site Amplification Study of Shillong

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), Dr Santanu Baruah (Co-PI), Prof Paul Tapponnier (PI, Singaporian Project Leader)

Arunachal Pradesh, triggering large landslides and debris flows all around the eastern Himalayan Syntaxis and eastern Assam plain (Poddar, 1950; Tandon, 1950; Tillotson, 1951; Kingdon-Ward, 1953). No surface rupture, however, was ever documented, whether at the time of the event, or in the 6 decades since.

We present here the first evidence for a primary rupture of that event, along both the Main Himalayan Frontal Thrust (MFT) and the Mishmi Thrust. Geomorphic features indicative of tectonic surface uplift and recent active faulting were first identified in field reconnaissance surveys guided by satellite image interpretation. Topographic profiles across fault scarps crossing at high angle fluvial terrace risers were then leveled with a Total Station, to quantify the vertical offsets of uplifted, perched Quaternary alluvial terraces. Such offsets range from $\approx$ 2.6 to $\approx$ 29 m. At a few sites, the analysis of the profile shapes and slopes enables a preliminary assessment of the co-seismic throws of the 1950 earthquake and its predecessors. At Pasighat and Wakro, for instance, the minimum heights of the steepest scarps along the MFT and Mishmi Thrust are 2.6 ± 0.1 and 7.3 ± 0.1 m, respectively. We interpret them to represent the vertical co-seismic offsets of the 1950 earthquake. On the Mishmi Thrust near Wakro, our topographic profiles also show evidence for about 14 m of cumulative vertical offset - the sum of two identical 7 m throw amounts - suggestive of locally characteristic slip in the 1950 and penultimate earthquake. The differences in co-seismic throw on the MFT and Mishmi Thrust may result from large changes in dip around the eastern Syntaxis, which would be consistent with large-scale changes in the topography of the corresponding mountain ranges.

Material Sciences & Technology Division

Materials Sciences & Technology Division comprises three areas, viz., Advanced Materials, Cellulose Paper & Pulp and Polymer Petroleum & Coal Chemistry group. In these groups, R & D works are being continued in the areas of (i) nanoparticles, coordination complexes, layered materials, nano material coated membranes etc. for separation and catalysis of organic reactions, (ii) construction materials, (iii) bio-pulping and bio-bleaching for paper, (iv) value added products from lignocellulosic wastes, (v) composite materials, (vi) resource quality assessment of North Eastern coal, (vii) clean coal initiatives (viii) petroleum and polymers etc., which have resulted in technologies, publications, patents, PhDs and also testing, analytical & consultancy services.

A) International Collaboration

Project Title: Synthesis and Reactivity of Nanoporous Metal–Silica Composites – Novel Heterogeneous Catalysts for Selective Oxidation Reactions.

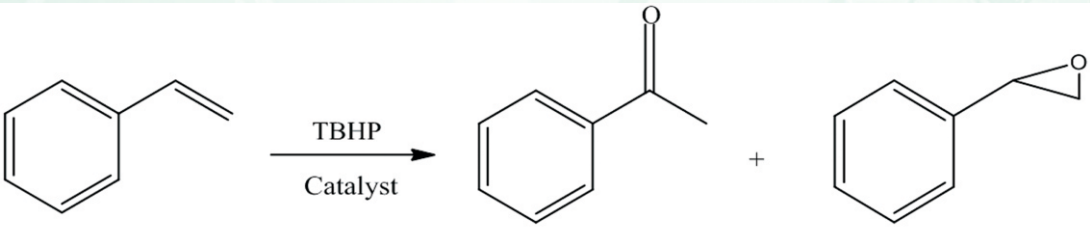
Project No: GPP-287

Funding Agency: DST, New Delhi and Russian Foundation for Basic Research (RFBR)

PI & Members: Dr Lakshi Saikia (Indian-PI), Dr Oxana A Kholdeeva (Russian-PI): Boreskov Institute of Catalysis, Novosibirsk; Russia, Dr Dipak Kumar Dutta

Salient Achievements:

Au-Ag bimetallic nanoparticles in a core shell type arrangement were synthesized on SBA-15 and it's characterization by techniques like FESEM, TEM, XRD, surface area analyzer etc. are carried out. The catalytic evaluation for oxidation of styerene has been performed and conversion upto 65 % is being achieved so far with both aldehyde and epoxide as product.



Catalyst-Ag@Au-Ag-ap/SBA 15

Scheme - Schematic representation of oxidation of styrene with TBHP

Project Title: Metal nanoparticles on graphene, h-BN and low dimensional (2D) transition metal chalcogenides.

Project No: GPP-301

Funding Agency: DST, New Delhi and Russian Foundation for Basic Research (RFBR)

PI & Members: Dr Manash R Das (Indian PI), Prof Vladimir E. Fedorov, Nikolaev Institute of Inorganic Chemistry, Novosibirsk, Russia, Dr PinakiSengupta

Salient Achievements:

Decoration of reduced graphene Oxide sheet with CuS

nanoparticles and utilization in photodegradation of Congo Red dye molecules: The CuS-reduced Graphene oxide (CuS-rGO) nanocomposite was synthesized by simple and very cost effective microwave irradiation technique. $CuSO_4.5H_2O$ was used as a salt and thiourea was used as a sulfur source as well as reducing agent. The synthesized CuS-rGOnanocomposite was characterized by various analytical techniques such as XRD, XPS, TGA and TEM. Figure 3 shows the XRD and TEM analysis of the CuS-rGO nanocomposite. The synthesized CuS-rGO nanocomposite was utilized as a very efficient catalyst for the photocatalytic degradation of carcinogenic Congo Red dye molecule .The catalyst is reusable upto five times without loss of its significant activity.

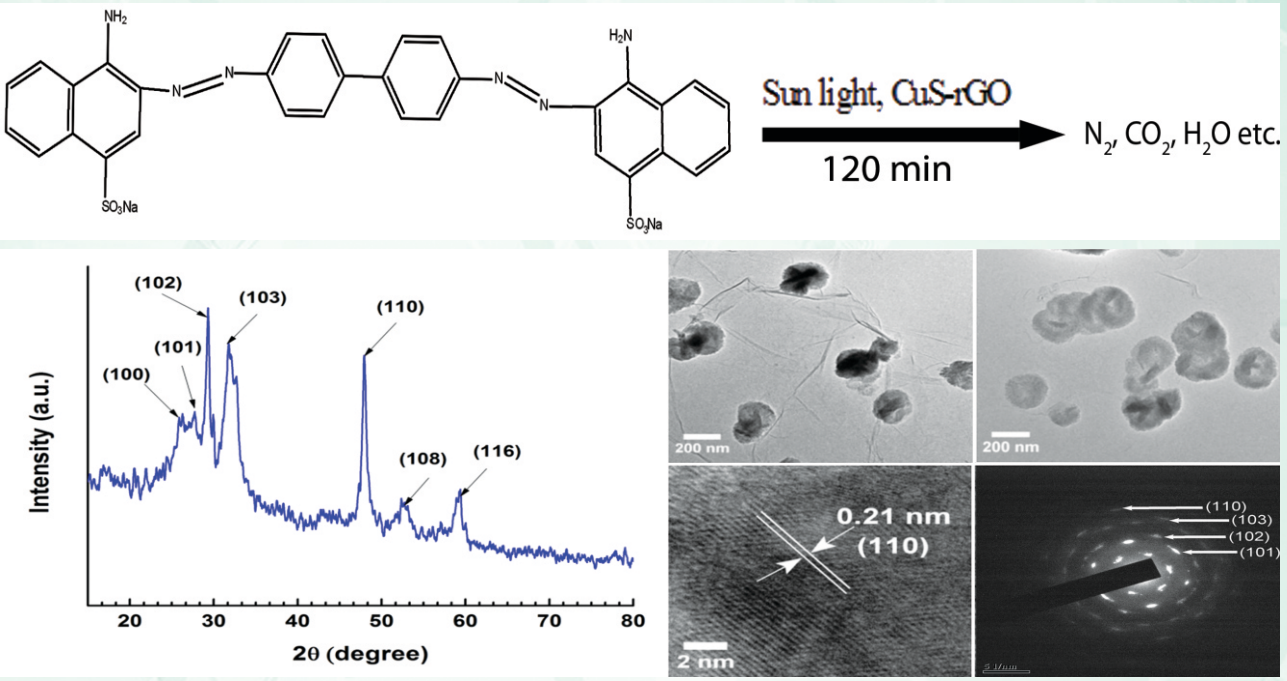


Figure : XRD pattern and HRTEM images of CuS-rGO nanocomposite

B) National Collaboration

(i) Network Projects

Project Title: Nanomaterials: Applications and Impact on Safety, Health and Environment (NanoSHE).

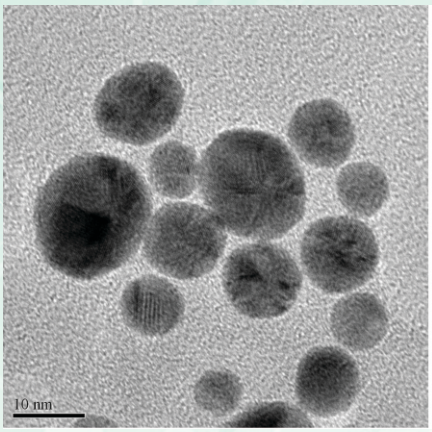
Project No: BSC-112

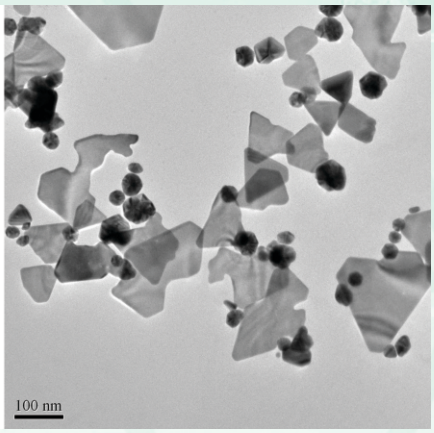
Funding Agency: CSIR

PI & Members: Dr Dipak Kumar Dutta (PI, Nodal Scientist, Activity-I), Dr Lakshi Saikia, Dr Pinaki Sengupta, Dr Ratul Saikia, Dr Montu Bhuyan (PI, Activity-II), Dr P R Bhattacharyya

Salient Achievements:

Inhibition of *Candida albicans* in presence of AuNPs (prepared with *Tulsi* leaf extract): In further investigation, the colony count method was adopted. *Candida albicans* was spread over Potato Dextrose Agar followed by the synthesized AuNPs and kept at 28 ± 2 °C for 24 h. In the study, 67.5% inhibition was observed in presence of spherical shaped ~11 nm (TG150) AuNPs, while the inhibition was 62.5% in presence of triangular pyramidal shaped ~60 nm (GR27) AuNPs.





Project Title: Zero Emission Research Initiative for solid waste (ZERIS).

Work Component at NEIST, Jorhat: New composite materials for apparel and goods from leather waste of EI shaving, buffing dust and dyed trimmings. (WP 22)

Project No: CSC-103

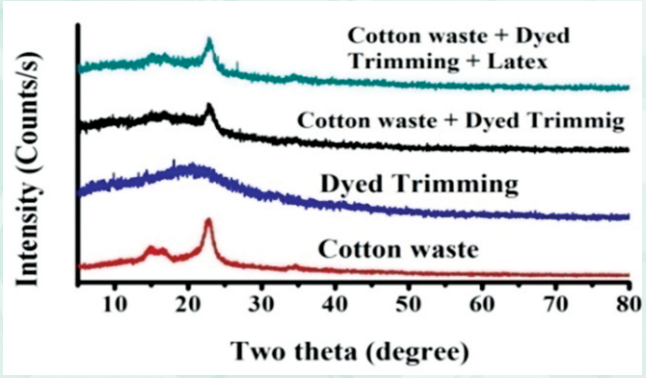
Funding Agency: CSIR, New Delhi

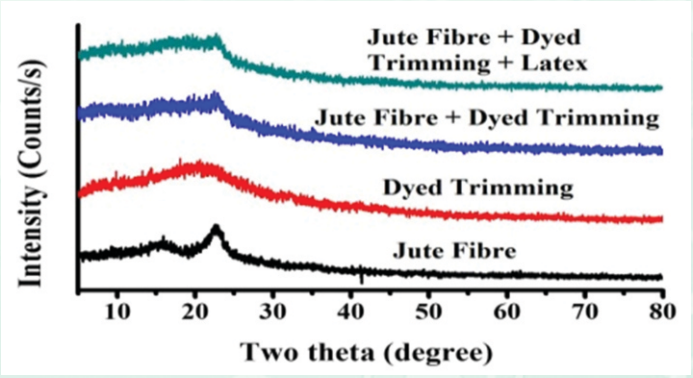
PI & Members: Dr T Goswami (PI), Dr D Kalita, Dr D Dutta, Ms Puspa K Das

Salient Achievements:

- Evaluation of mechano-chemical properties of flexible board made from the blends of dyed trimmings, EI saving and jute with or without latex and additives.
- Development of insole material, gasket board and flexible leather sheets from the mixture of leather wastes and natural fibre and testing of the products as per standard methods.
- Development of sole and heel material from the mixer of leather waste, natural fibre and polymeric waste using dry process under hydraulic hot press conditions. Process optimization is in progress.
- Study on scanning electron micrograph of the cotton, jute and dyed trimmings along with the structural properties of flexible board made from these fibres.
- XRD analysis of dyed trimmings and also with the mixer form with cotton waste and jute fibre.

XRD Study of Leather wastes &blends with natural fibre

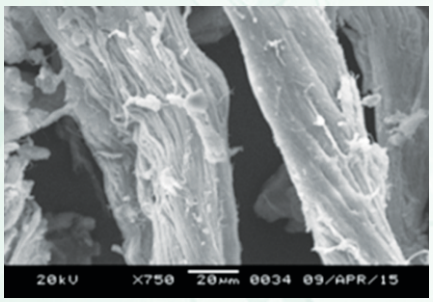




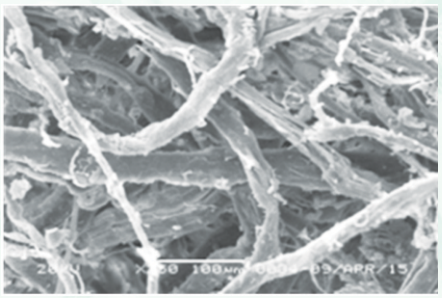
Physical properties of leather composites

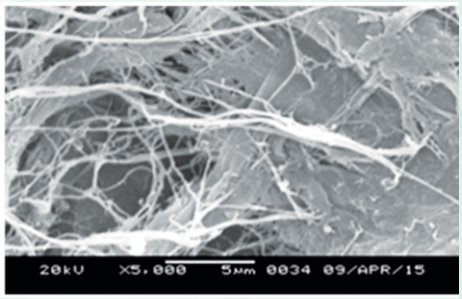
Sample	Thickness (mm)	Density (g/cm^3)	Absorption (%)		UTS (MPa)	Folding endurance
			Water	Oil		
			After 24 h	After 24 h		
CW+ DT	1.05	0.410	36.10	14.55	72.35	7500+
JF+ DT	1.20	0.598	42.86	13.73	68.45	6000+
CW+ES	1.15	0.535	23.06	2.68	70.85	6500+
JF+ ES	1.30	0.585	35.45	8.46	62.25	5500+

DT=Dyed trimmings, CW=Cotton waste , JF=Jute fibre , ES=EI shavings

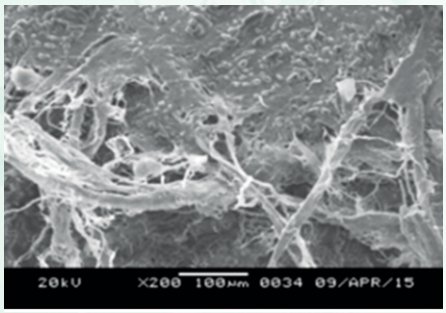


Dyed trimming

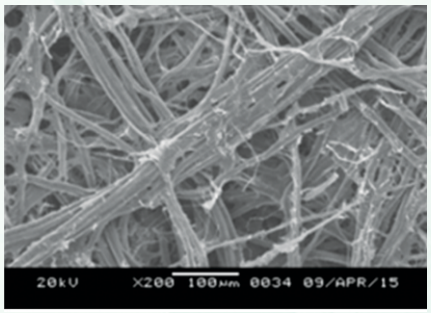




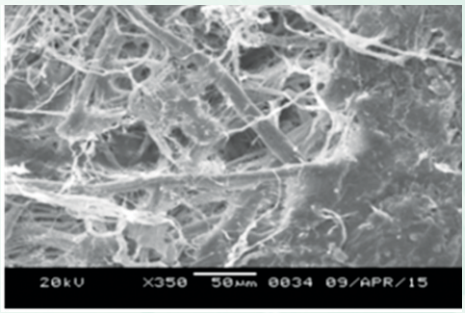
Cotton waste fibre



Dyed trimmings +cotton waste



Jute fibre



Dyed trimmings + Jute fibre

SEM of natural and leather waste composite



Products made from leather waste material

Project Title: Membrane and Adsorbent Technology Platform for Effective Separation of Gases and Liquids (MATES).

Work Component at NEIST, Jorhat: Nano oxidic Membrane Reactors by Green Chemical Approach

Project No: CSC-104

Funding Agency: CSIR

PI & Members: Dr Rajib L Goswamee (PI)

Salient Achievements:

- Synthesised silica-Layered Double Hydroxide (LDH) core shells of different binary and ternary LDHs in non-aqueous solvent at various SiO_2:LDH and fabricated core-shell coated monolithic nano catalytic reactor for decomposition of toxic gases in automobile exhaust conditions
- Synthesis from LDH precursors sublimable mixed metal di-keto complexes for MOCVD thin film formation and nano porous thin sheets for prospective catalytic membrane reactors.
- Synthesis of polyacrylamide/polylactide-LDH hybrid gel loaded with antibiotic molecule amoxicillin, ampicillin and norfloxacin and their performance evaluation as controlled release vehicle in bacterial culture medium.
- Evaluation of effect of particle size of LDH on the flow behavior of aqueous gels of swelling clays determination of flow model, storage modulus, elastic modulus. Fabrication of honey comb monolthic reactors with such wash coated gels and studied N_2O decomposition in presence of CO, CO_2 and CH_4 gas.

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

Project No: CSC-118

Funding Agency: CSIR

PI & Members: Mr A Gautam (PI), Mr NC Laskar, Mr RC Bohra, Mr L Phukan

Salient Achievements:

Castor oil based bio-lubricant: An efficient route for synthesis of bio-based lubricant with reusable *Candida Rugosa* lipase immobilized on Immobead lipase catalyst in conjunction with economically viable nickel nano catalyst was made. The catalyst system takes relatively less time than conventionally used Prilezhaev method for the synthesis of epoxides based lubricants. The method is advantageous because of the efficient 'green' technique, which allows the production of Castor-oil based bio-lubricants with less material purification process and the process is cost effective.

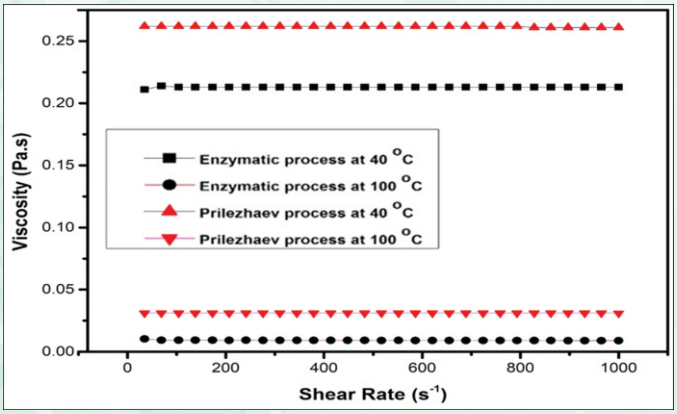


Figure: Comparison of rheological behaviour of bio-lubricants

Project Title: Catalysts for Specialty Chemicals (CSC).

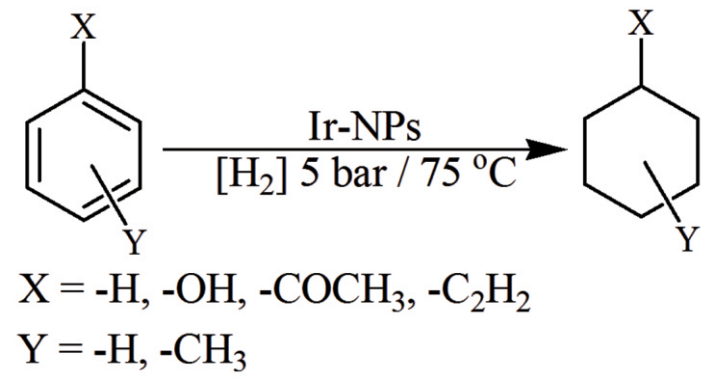
Project No: CSC-125

Funding Agency: CSIR

PI & Members: Dr Dipak Kumar Dutta (PI, Nodal Scientist), Dr Dilip Konwar, Dr Lakshi Saikia, Dr Pinaki Sengupta

Salient Achievements:

Aromatic ring hydrogenation catalysed by efficient Ir(0)-nanoparticles supported nanoporous montmorillonite composite under solvent free condition.



Project Title: Environmental Research Initiative for Paper and Process Industry (ERIPP).

Work Component at NEIST, Jorhat: Clean technology for pulp processing (WP).

Project No: CSC-131

Funding Agency: CSIR, New Delhi

PI & Members: Dr T Goswami (PI), Dr D Kalita, Dr D Dutta, Ms Puspa K Das, Dr Amrit Goswami, Dr Pallab Pahari

Salient Achievements:

- Optimized the xylanase enzyme production from *Aspergillus* sp. under shake flask condition and the enzyme assay was carried out.
- A process for production of a microbial consortium from fungal strains *Curvularia, Microporus* and *Rigidoporus* and also from *Inonotus pachyphloeus* and *Penicillium sumatrense* useful for degradation of bamboo lignin has been optimized in lab scale. The bioreactor optimization of enzyme production is in progress.
- The microbial consortium prepared from two fungal strais *I.pachyphloeus* and *P. sumatrense* was applied to bamboo under open environmental condition. Maximum degradation of lignin have been observed after 60 days of treatment. As the microbes don't have cellulytic activity, the degradation of cellulose has been found very less (1- 1.5%).
- Effect of microbial pretreatment on energy consumption in bamboo chipping have been carried out in lab scale. 30-40% less energy consumption during bamboo chipping have been recorded after microbial treatment.

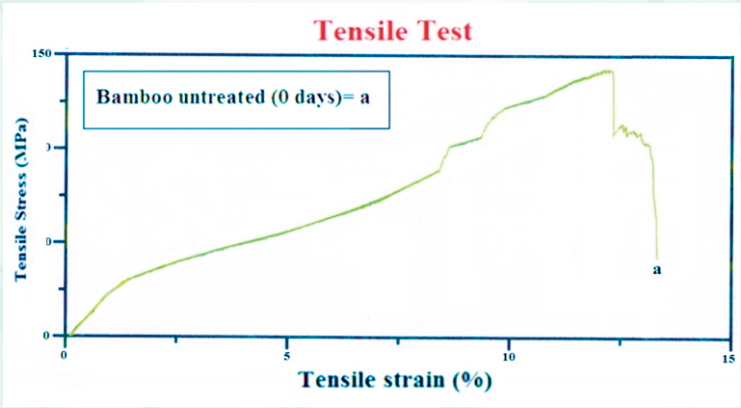
Effect of microbial pretreatment on constituents of bamboo & energy saving during chipping

Sl No	Fungal Strains	Wt. of Bamboo (kg)	Power consumed (kW)	Lignin (%)	Cellulose (%)	Pentosan (%)
1	Blank	25	0.9	27.5	57.6	22.15
2	2c	25	0.5	20.3	53.8	17.26
3	6s	25	0.6	19.2	55.8	16.84
4	p1	25	0.6	21.3	54.67	16.53
5	Consortium 2c+4s+6s+p1	25	0.45	22.6	53.70	17.48

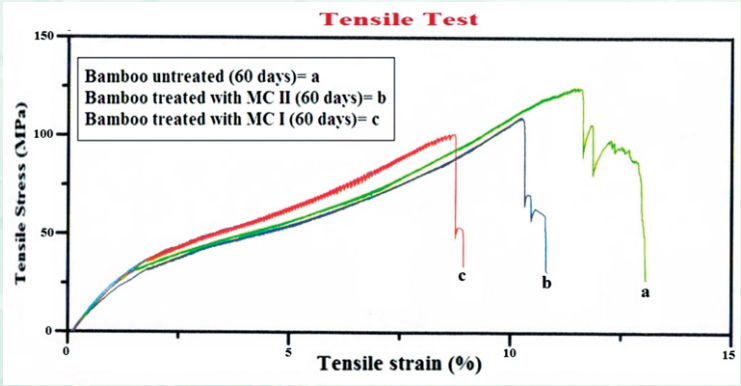


- An eco-friendly pulping of bamboo with Poly hydroxy alcohol from carbohydrate pool was carried out by varying cooking time, temperature and solvent concentration. The Pulp yield was recorded higher (> 50%) than kraft process.
- Large scale microbial treatment on bamboo was carried out with individual strain as well as in consortium form. The microbial treatment reduces 30-40% energy consumption during chipping. Also, it reduces lignin content without affecting the cellulose.

Mechanical strength properties of treated & untreated bamboo



Tensile strength of untreated bamboo (0 day)



Tensile strength of treated bamboo (60 days)