IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Cellulose nanofibers recovery from fruits waste**	
Project Number	**IMURA0745**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	

1	*Material Science/Engineering (including Nano, Metallurgy)*	***1***	*Advanced computational engineering, simulation and manufacture*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*	2	*Infrastructure Engineering*
3	*Math, CFD, Modelling, Manufacturing*	3	*Clean Energy*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*	4	*Water*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*	5	*Nanotechnology*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*	6	*Biotechnology and Stem Cell Research*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*	7	*Humanities and social sciences*
8	*HSS, Design, Management*	8	Design

The research problem

The total waste produced by the fruit processing industries is estimated to be around 0.5 billion tonnes worldwide. The utilization of this waste is one of the important and challenging jobs around the world. The discarded fruits as well as the waste can be utilized for further industrial purposes.

Researchers have focussed upon the utilization of pineapple waste for the extraction of bromelain (peptide) and as a low-cost substrate for the production of bio-chemicals such as ethanol, phenolic anti-oxidants, organic acids, biogas, and fiber production. However, there is an opportunity to modify the existing processes in greener and sustainable ways to achieve higher yield of the bio-based chemicals. The pertinent scientific and technological contributions would produce better and more profitable markets for the pineapple waste. A novel bio-refinery approach would aim to produce a wider range of valuable products from pineapple waste.

The major on-farm waste in pineapple crops are pineapple leaves which contain around 65-80% cellulose. Cellulose nanofibers have become the subject of many investigators, due to their application in numerous areas: in the biomedical field, as reinforcement agents in nanocomposites, as electronic papers and as fuel cell membranes. Particularly, the use of nano reinforcements in the polymer matrix improves matrix properties as compared with the neat polymer and micron (sized, filled) composites based on the same fibers. Therefore, there has been growing interest in examining the possibilities of using cellulose-based nanofibers as reinforcing elements.

Usually, the procedure for obtaining CNF involves submitting cellulose pulp to high shear rates, i.e. grinding, micro fluidisation, homogenisation or other similar techniques. These methods usually require large quantities of energy, so extensive research has been targeted at finding methods for pre-treatment, to reduce the required energy hence reducing the costs, as well as

investigating the effect of feedstock composition. There is a strong indication from other research that pineapple leaves, with their high cellulose and hemicellulose content, could be particularly suited as a feedstock.

Project aims

1. Isolation and characterization of cellulose nanofibrils, initially from pineapple leaves, but also targeting other high cellulose content biomass waste, using various pretreatment processes and their characterizations in terms of morphology, crystallinity and thermal stability.
2. Investigate pre-treatments (including enzyme pre-treatments) to extract value-added chemicals prior to processing and the effect of the pre-treatment on the residual cellulose, hemicellulose and nanocellulose production.
3. Evaluating the relationship between cellulosic structure, final nanocellulose dimensions and performance in applications with a particular focus in i) sheet production or ii) nanocomposites.
4. Use the platform established as part of aims 1-3 to investigate other agricultural residues and residues from direct food production eg processed beetroot, potato peels.

Expected outcomes

Highlight the expected outcomes of the project

1. Develop novel value-added applications for waste that is rich in cellulose and hemicellulose currently either left to rot or sent to landfill and that can be applied to both the Indian and Australian agricultural sectors.
2. Develop new appreciation of the relationship between lignocellulosic starting structure and the nanocellulose products.
3. Provide the knowledge and process technology to form the basis of new industries or adjunct industries to those existing, thus creating new employment opportunities
4. Develop personnel trained in adding value to the agricultural residue and industry-ready to enter the relevant fields.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The focus on finding new sustainable uses for the utilisation of cellulose and hemicellulose from food waste and other agricultural biomass sources, addresses the need for finding renewable feedstocks for **new Materials**, applying **Green Chemistry** principles (which includes minimum **Energy** demand processing, use of **Catalysts**) maximising outputs from **Food** crops. Cellulose and hemicellulose also have applications in the **Pharmaceutical** Industry

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

A Masters degree of First Class Honours degree (4 years) or equivalent with a strong background in chemistry, chemical engineering, materials science or biotechnology with strong chemistry. Relevant experience in biomass research, processing and analysis is highly desirable (eg through Masters research or work experience)

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Centre for Sustainable Chemical Technologies – University of Bath, UK
Some Australian industries will be approached – yet to be confirmed

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Waste to Wealth
Green Chemistry and Renewable Energy
Food Innovation
Novel Functional Materials