



## PhD Project

### Project Details

Project Title	Development of a sustainable and green route for production of food waste derived 2,3 butanediol and its catalytic conversion to methyl ethyl ketone and 2-butanol
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Project Summary	<p>Around one-third of the food produced in the world is wasted (~1.3 billion tonnes) or lost through the food chain every year and cost the world economy about \$750 billion. As per the UN report, in India, 40% of the food produced is either lost or wasted annually resulting in losses of Rs 1 lakh crore (~£10 billion). In addition to being a significant loss of valuable materials, these enormous quantities result in serious management problems, both economically and environmentally. Emission calculations indicate losses of two tonnes CO<sub>2</sub> per tonne of waste. Presently most of this highly perishable food waste (FW) forms a significant part of municipal solid waste which stinks, creates air pollution, contaminates ground water and serve as breeding ground for pathogenic microbes. To a lesser extent conventional methods like composting, anaerobic digestion or landfills are also used. A more profitable way of channelizing FW could be the efficient transformation of this renewable organic carbon source to spectrum of industrially important chemicals and fuels via greener route. FW is attractive in terms of its nutrient content, i.e. 30–60% starch/sugars, 5–10% proteins and 10–40% lipids. Notably, the sugar content is high in value for microbial fermentation in comparison to other bulk, crude, or renewable sources such as recalcitrant lignocellulose wastes. The valorization of FW is extremely important for achieving a circular carbon economy. The high quantity of FW has the potential feedstock for global bioproduction of large quantities of chemicals with high market value and indeed, the conversion of FW to building block chemicals can be more profitable than conventional processing methods without affecting food market. The current work will be undertaken to valorize FW rich in fermentable sugars into 2,3 butanediol (2,3 BDO) via microbial route. 2,3 BDO is a C<sub>4</sub> metabolite and the presence of two hydroxyl groups makes BDO a versatile molecule for the synthesis of numerous chemicals with huge market potential such as methyl ethyl ketone, diacetyl, polyurethane, 1,3-butadiene etc. Downstream products of 2,3-BDO have an estimated global market potential of around 32 million tons per annum, valued at \$43 billion.</p> <p>This proposal aims to use FW as feedstock for sustainable manufacturing of platform chemical 2,3 BDO and its catalytic downstream products - methyl ethyl ketone and 2-butanol which all have huge market value. The identified FW will be subjected compositional analysis followed by saccharification for extraction of fermentable sugars and their microbial mediated conversion to 2,3 BDO. Process optimization and intensification for production of 2,3 BDO at high yields and titers from the FW will then be performed. Parallely, conversion of 2,3 BDO to methyl ethyl ketone and 2-butanol by catalysis will be performed. This will be done by developing catalysts with desired reaction specificities. Finally, sustainability assessment will be conducted for life cycle and techno-economic analysis. Overall, this will lead to the generation of a green technology for production of chemical building blocks with high commercial potential from FW as feedstock and also contribute towards solid waste (FW) management.</p>
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### PhD Supervisors

Role	Faculty	Academic Unit in IITD	Email ID
Supervisor 1	Dr. M. Ali Haider	Chemical Engineering	<a href="mailto:haider@iitd.ac.in">haider@iitd.ac.in</a>

Supervisor 2	Dr. Ashish Misra	DBEB	<a href="mailto:ashishmisra@iitd.ac.in">ashishmisra@iitd.ac.in</a>
Supervisor 3	Dr. Vinod Kumar	Cranfield University	<a href="mailto:Vinod.Kumar@cranfield.ac.uk">Vinod.Kumar@cranfield.ac.uk</a>

### Project requirements (Student qualifications, experience required, etc)

- B. Tech or M. Tech in Chemical or Biochemical Engineering with experience in fermentation technology/Bio/Process Engineering AND/OR organic chemistry

### Source of funding (IRD/FITT Project details, if any)

Sponsored (JRF/SRF, Industry) or Part-time candidate (no full-time funding available with the PI's)

### Role of Faculty Members involved:

The supervisors have expertise in the following areas relevant for the project.

- Supervisor 1: Catalytic technologies for the production of renewable chemicals and energy
- Supervisor 2: Metabolic engineering for conversion of sugars to value added products
- Supervisor 3: Sustainable bioprocesses for valorization of waste; microbial fermentations

Supervisor 1 will guide the selection of catalytic techniques for conversion of 2,3 BDO to methyl ethyl ketone and 2-butanol along with life cycle and techno-economic analysis. Supervisor 2 and 3 will guide the selection of microorganisms for conversion of food waste to 2,3 BDO and process intensification for its production. The complementary expertise of the supervisors is critical for the project.