



Technology Solutions for Soil & Water Remediation

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Center of Excellence

Highlights

Technology Solutions for Soil & Water Remediation (TSSR)

Rapid industrialization, increased productivity demands and environmentally inappropriate human activities continuously challenge natural resources including Soil, Air, & Water. Multiple pollutants generated as refuse/effluent present serious environmental threats. Biotechnology offers economical and safe solutions to restore Soil, & Water quality through application of a choice of plants & microbes. At TSSR, we propose to address issues of soil & water pollution broadly subdivided into three subdivisions namely: MAR - Microbe Assisted Remediation, PAR - Plant Assisted Remediation, EAR – Enzyme Assisted Remediation. In MAR, Bacteria & Fungi with proven bioremediation capabilities would be employed for clean-up processes in soil / water environments. Under PAR, chosen phytoremediator plants will be applied to decontaminate soil/water of organic and inorganic pollutants. EAR focuses on Metabolites & Enzymes derived from Plants or microbes, developing them as formulations (nano/micro) for bioremediation.

Sub-divisions in TSSR:

MAR - Microbe Assisted Remediation: Prof. Krishna Sundari, Prof. Indira P. Sarethy

PAR - Plant Assisted Remediation: Prof. Pammi Gauba, Dr. Ekta Bhatt

EAR - Enzyme Assisted Remediation: Prof. Neeraj Wadhwa, Dr. Garima Mathur

Objectives:

1. Microbe-mediated remediation of polluted water and pesticide residues in soil
2. Phytoremediation of PPCPs and heavy metals
3. Enzyme-mediated remediation of polluted water bodies

Research Focus Areas

- Understanding of emerging pollutants such as Pharmaceuticals and Personal Care Products (PPCPs), antimicrobials and other similar pharmaceutical pollutants, and heavy metals that are discharged into the environment pose a serious threat due to uptake by plants and animals. Their effects and mitigation strategies are being focused on.
- Ability of native plant growth promoting microorganisms (PGPMs) are being evaluated to offer holistic plant growth benefits (providing nutritional benefits along with resistance to soil pathogens, and help reclaim agriculture soils containing residual pesticides). A consortium of PGPM is developed that can be used as bioinoculant (biofertilisers, biopesticides) to improve agriculture productivity. Ability of select PGPM to remediate organic pollutants in agriculture soils is also being explored.
- Isolation and identification of microorganism for the bioremediation of sites contaminated

with poly-aromatic compounds is being studied. Microbial (ex. *Pseudomonas putida*) ability for tertiary treatment of paper mill effluent has been studied by applying sequential treatment composed of two-step chemical precipitation in order to meet discharge limits for various environmental contaminants.

- Biorefining, involving biocatalysts in the form of whole cell microbes or enzymes derived from native sources is being experimented with, to remove nitrogen and sulfur/aromatic content present in fossil fuels. Research comprises isolation of microorganisms capable of expressing genes involved in the degradation of contaminants present in fossil fuels.

Faculty Profile

Prof. Pammi Gauba, Head, Department of Biotechnology

Research focuses on the optimization of various bioremediation and phytoremediation measures to render soil free from heavy metal contamination and use of different strains of yeast, bacteria and fungi as chief sources for bioremediation and potential grass and some weed species for phytoremediation. Increasing human activities have led to an increase in pollution and accumulation of toxic chemicals in air, soil, water etc. Heavy metals have also accumulated in agricultural soils leading to biomagnification, which is a challenge for scientists. This problem has led to an increase in the heavy metal toxicity in raw herbs which are being widely used worldwide as phytopharmaceuticals.

Prof. Neeraj Wadhwa

She works in the field of waste material management by developing processes to convert wastes from food processing industries into valuable products. These waste materials are biodegradable and organic in nature and their improper disposal can create environmental problems. Therefore, these can be reduced by the use of new or modified processing methods and through reuse of other into food ingredients, and valuable bio products. The data obtained from her research shows that feathers from poultry processing plant can be degraded completely by novel keratinase producing bacteria isolated from soil and waste extracts of corm and peel of *Amorphophallus paeoniifolius*, can be used in bioprocessing of cotton fiber. A Wheat -Jimikand composite bread developed was rich in Dietary fiber content is also reported by the research group

Prof. S. Krishna Sundari

Research interests include plant-microbe interactions, development of bioinoculants for sustainable agriculture, mycorrhizae research, bioactive compounds from fungi, microbial biodiversity profiling and bioremediation of organic pollutants including pesticides applying plant growth promoting microorganism. Prof. Krishna Sundari has so far successfully carried out 4 DBT funded projects with a cumulative value of more than

1.5Crore rupees. The DBT funded project presently progressing focuses on development of microbial consortia that provides dual benefits of rhizoremediation of residual pesticide along with plant growth support, exploring molecular mechanism of pesticide degradation in fungal and bacterial isolates. Her work also focuses on the conversion of agricultural wastes into value added products of which industrially important enzymes like tannases and pharmaceutically important products like gallic acid are researched upon.

Prof. Indira P. Sarethy

Her research is focused on the natural products (for therapeutic and industrial applications) from microbial and plant biodiversity. Based on a culture-dependent approach, microorganisms from niche habitats (desert, forest, limestone rock, monuments and endophytic) are identified and characterized for bioactive compounds. Metagenomics-based approaches focus on eliciting production of natural products from the environmental DNA. The work is targeted towards taxonomically characterizing and studying microbial diversity for products of use in environment waste management and of industrial importance - anti- microbial metabolites, biosurfactants, anti-oxidants and enzymes. The key findings of her research are characterization of new antimicrobial and antioxidant compounds, taxonomical characterization of novel actinobacterial taxa from the Thar Desert, identification of metabolites such as biosurfactants, enzymes and siderophores and cellulase production for environmental waste management.

Dr. Garima Mathur, Assistant Professor (Senior Grade)

The research interest of Dr. Garima Mathur includes production of microbial polymers and composites, their characterization and exploring the therapeutic potential of commercial Indian medicinal plants. She also aims at the production and characterization of two biopolymers: bacterial cellulose (BC) and fungal chitosan (FC) and development of composites/blends with various applications and developing *in vitro* culture systems for *Stevia rebaudiana* and studying the effects of various biotic and abiotic parameters on yield of steviol glycosides.

Dr. Ekta Bhatt, Assistant Professor (Grade-I)

Dr. Ekta Bhatt's research interests are in the area of Environmental and Microbial Biotechnology. Presently she is involved in the phytoremediation of organic pollutants (in reported environmental concentrations) and assessing the environmental impact of these organic pollutants on plants, soil and water. Where she worked on to investigate chemical profiling and secondary metabolites of aromatic and medicinal plants in response to various environmental stresses. She also aims at the Water quality assessment & monitoring, Air quality monitoring and chemical characterization and source receptor modeling of pollutants (VOCs and PAHs) in air, water and soil. Her research interests are also on solid

waste management, impact of air pollutants on medicinal plants, micro plastic pollution and their remediation, contamination hydrology and emerging pollutants.

Publications

International Journals

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Books Published

1. *Advances In Bioresources, Biodiversity And Therapeutics*, (Eds. **Pammi Gauba, Indira P. Sarethy, Ashwani Mathur**), ISBN 978-93-86768-87-2, pp 35-52, June 2020, I.K. International Pvt. Ltd., New Delhi, India
2. **Gauba P., Gabrani R, Mathur G.** *Recent Trends in Biosciences and Biotechnology*, Vidya Kutir Publications, New Delhi, 2021 (ISBN: 978-81-953535-8-3)

Book Chapters Published

1. S Chaturvedi, **I.P. Sarethy**, Major Habitats And Diversity Of Thermophilic Fungi, - Extremophilic Fungi, 2022, In: Extremophilic Fungi: Ecology, Physiology and Applications, Editors: Sanjay Sahay, pp 55-75 April 2022, Springer, Singapore. https://doi.org/10.1007/978-981-16-4907-3_3
2. Razi ur Rahman, **Garima Mathur**. Fungal Chitosan: A Biopolymer. Recent Trends in Biosciences and Biotechnology, ISBN: 978-81-953535-8-3, pp: 253-266, Vidya Kutir Publications, New Delhi, 2022
3. N. Srivastava, **I.P. Sarethy**, Rhizosphere fingerprints: novel biomolecules via meta-omics technology, In: Pudake R.N., Sahu B.B., Kumari M., Sharma A.K. (eds) Omics Science for Rhizosphere Biology. Rhizosphere Biology. Springer, Singapore. https://doi.org/10.1007/978-981-16-0889-6_10, pp 171-188, May 2021
4. Samridh Srivastava, **Garima Mathur**. Bacterial Cellulose: A Versatile Biopolymer. Recent Trends in Biosciences and Biotechnology, ISBN: 978-81-953535-8-3, pp: 76-96, Vidya Kutir Publications, New Delhi, 2021
5. Sukirti Tiwari and **Garima Mathur**. Polymer Based Coating and Its Applications in Food Industry. Recent Trends in Biosciences and Biotechnology, ISBN: 978-81-953535-8-3, pp: 97-112, Vidya Kutir Publications, New Delhi, 2021
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10. S. Tyagi, and **G. Mathur**. *Withania somnifera*: A Review on Ethano-Medicinal Properties and Withanolide Biosynthesis, Advances in Bioresources, Biodiversity and Therapeutics, I.K. International Pvt. Ltd., 2020, pp. 106-118
11. J. Bhasin, A. Vaishali, A. Bhatia, S. Fatima, and **G. Mathur**. Recent Trends in Production of Bacterial Cellulose Composites and Their Applications, Advances in Bioresources, Biodiversity and Therapeutics, I.K. International Pvt. Ltd., 2020, pp. 127-134.
12. S. Tyagi, and **G. Mathur**. Stevia: An Underutilized Sweetener, Advances in Bioresources, Biodiversity and Therapeutics, I.K. International Pvt. Ltd., 2020, pp. 151-160.
13. N. Srivastava, **I.P. Sarethy**, “High Throughput Screening and Drug Discovery”, Chapter 5 in Advances In Bioresources, Biodiversity And Therapeutics, (Eds. Pammi Gauba, Indira P. Sarethy, Ashwani Mathur), ISBN 978-93-86768-87-2, pp 35-52, June 2020, I.K. International Pvt. Ltd., New Delhi, India
14. N. Srivastava, **I.P. Sarethy**, “Bioprospecting: The Screening Steps in the Search for Pharmacologically Important Natural Products”, Chapter 6 in Advances In Bioresources, Biodiversity And Therapeutics, (Eds. Pammi Gauba, Indira P. Sarethy, Ashwani Mathur), ISBN 978-93-86768-87-2, pp 53-78, June 2020, I.K. International Pvt. Ltd., New Delhi, India
15. K. Singh, D. Kaloni, K. Sehgal, S. Pan, **I.P. Sarethy**, “Essential Oils: An Update On Their Biosynthesis And Genetic Strategies To Overcome The Production Challenges”, In Plant- Derived

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 21. **Sundari K.S**¹, Prakash A², Yadav P¹ and Kumari A¹., “PGPM as frontrunners for onsite remediation of organophosphate pesticide residues in agriculture soils”. **Phyto & Rhizoremediation, Springer** (Volume 9), 2019
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 29. **Krishna Sundari Sattiraju**, Pratibha Yadav, Archana Kumari and Anil Prakash. (2018).PGPM as frontrunners for onsite remediation of organophosphate pesticide residues in agriculture soils .

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39. M. Singh, S. Malik, **G. Mathur**. Comparative analysis of Antimicrobial and antioxidant potential of Ginkgo biloba (EGb 761) microemulsions and Ginkgo biloba extract (EGb 761). In —Industrial, medical and environmental applications of microorganisms: current status and trends. Wageningen Academic Publishers, vol. 37, issue 8, pp. 517-520, 2014.
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issue 8, pp.436-440,

42. **S. Krishna Sundari** (2014). Impact of biotic, abiotic stressors: Biotechnologies for alleviating plant stress. In —Use of Microbes for the alleviation of salt stress . M. Miransari (Ed). Springer Science+Business Media New York, DOI: 10.1007/978-1-4939-0721-2_6, Chapter 6.pp.87-120.
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Resource Development

List of Ongoing Doctoral Students

S.No	Year of Reg.	Name	Title	Supervisor
1	2012	Sonam Shaheen	Mass Production of PGPR for making microbial consortium and testing their ability to remediate organophosphate pesticides	Prof. Krishna Sundari
2	2014	Pratibha Yadav	Remediation of organophosphate pesticides using PGPM	Prof. Krishna Sundari
3	2016	Ekta Bhatt	Remediation of Organic Pollutants	Prof. Pammi Gauba
4	2017	Shashank Awasthi	Isolation and Characterization of Bioactive Compounds from developing Plant Embryos	Prof. Neeraj Wadhwa
5	2017	Sonia Sharma	Phytoconstituent screening, characterization and application of endophytes from <i>Amorphophallus paeoniifolius</i>	Prof. Neeraj Wadhwa
6	2017	Shalini Tyagi	Therapeutic potential of commercial Indian medicinal plants	Dr. Garima Mathur
7	2017	Archana Kumari	Employing competent microbes for remediation of toxic organic substances	Prof. Krishna Sundari
8	2017	Preeti Thakur	Remediation of inorganic pollutant nitrate by using microbes	Prof. Pammi Gauba
9	2018	Astha	Bioconversion of tannic acid through microbe assisted fermentation to produce pharmaceutically important gallic Acid and its derivatives	Prof. Krishna Sundari
10	2018	Bhumika Gupta	Bioprospecting for carbohydrases from cultivable bacteria and soil metagenome	Prof. Indira P. Sarethy
11	2018	Neetu Saharan	Tuber metabolites and their biodegradation in natural environments	Prof. Neeraj Wadhwa

12	2018	Radhika Bansal	Metal Toxicity in Herbs	Pammi Gauba
13	2019	Chitra Sharma	Bioremediation of environmental pollutants	Prof. Indira P. Sarethy
14	2019	Swapnil Chaturvedi	Characterization of bioactive compounds from natural habitats	Prof. Indira P. Sarethy
15	2019	Priyansh Srivastava	Evaluation of antimicrobial and anticancerous properties of lichens.	Prof. Indira P. Sarethy
16	2019	Arushi Saxena	Remediation of Medical waste	Prof. Pammi Gauba
17	2019	Pooja Upadhyay	Development of enzymatic sensor for detection of Paraben	Dr. Ashwani Mathur & Prof. Pammi Gauba
18	2019	Priyanka Kakkar	Development of food products from Aroids	Prof. Neeraj Wadhwa
19	2019	Gemini Patel	Medicinal plants for disease control against metabolism and microbial diseases	Prof. Neeraj Wadhwa
20	2019	Samriddh Srivastava	Production and characterization of Bacterial Cellulose	Dr. Garima Mathur
21	2020	Razi Rahman	Extraction of Fungal Chitosan and its characterization	Dr. Garima Mathur
22	2020	Saloni Sachdeva	Microbial characterization of polluted sites	Prof. Indira P. Sarethy
23	2022	Apeksha Rathi	Interaction studies on mushroom by using network pharmacology	Prof. Neeraj Wadhwa
24	2022	Rakhi Pandey	Chitosan blends: preparation and characterization	Dr. Garima Mathur
25	2022	Garima Singh	Screening and isolation of bacterial cellulose producing strain	Dr. Garima Mathur

Completed

S.No	Name	Title	Supervisor	Year
1	Nidhi Srivastava	Bioprospection of Microorganisms from Selected Niche Habitat(s) (Soil/ Rocks) for antimicrobial agents	Prof. Indira P Sarethy	2010
2	Sarita Agrahari	Production of enzymes and Degradation of feathers by soil microbes	Neeraj Wadhwa	2011
3	N. Kumara Swamy	Paper mill effluent: Decolorisation and detoxification studies using chemical and microbial methods	Indira P Sarethy	2012
4	Anuradha Singh	Phytoconstituent characterization and application of <i>Amorphophallus paeoniifolius</i> in development of food products"	Neeraj Wadhwa	2015
5	Nivedita Mishra	Developing microbial consortia with and remediation of residual pesticides	Krishna Sunadri	2016
6	A. Ibeyaima	Bioprospection of Actinomycetes from Indian desert and antimicrobial activity of selected isolates	Indira P Sarethy Prof. S. Sharma Prof. R. Lal	2018
7	Swarna Shikha	Screening Heavy Metal Tolerant Plants and Determining Their Phytoremediation Potential	Prof. Pammi Gauba	2019
8	Samiya Khan	Development of a biocatalyst for refining diesel	Prof. Pammi Gauba	2019