



Technology Solutions for Soil & Water Remediation

Index

| S.No. | Item & Detail | Page Number |
|--------------|---|--------------------|
| 1 | Centre Highlights | 3 |
| 2 | Research Focus Areas | 3 |
| 3 | Faculty Profile | 4 |
| 4 | Ongoing Projects & Publications in Journals | 6 |
| 5 | Books | 16 |
| 6 | Chapters | 17 |
| 7 | Resource Development | 20 |

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 area is Environmental and Microbial Biotechnology. Presently she involved in Phytoremediation of organic pollutants by using aromatic plants and impact of organic pollutants on soil and water. She also aims at to investigate chemical profiling and secondary metabolites of aromatic and medicinal plants in response of various environmental stresses. Her research interest are also on solid waste management, impact of air pollutants on medicinal plants, micro plastic pollution and their remediation, contamination hydrology and emerging pollutants.

Ongoing Projects

| S.No. | Title of Project | Source of Funds | Amount | Duration |
|-------|---|---|------------|-----------|
| 1. | Biotechnology Solutions for Soil and Water Remediation | JIIT Noida | 15 Lakhs | 2022-2025 |
| 2. | Development of Natural Product Laboratory for Advance Research | DST-FIST | 66 Lakhs | 2022-2027 |
| 3. | Evaluation of the production strategies, nutritional value and therapeutic properties of probiotic Seabuckthorn juice | DST, GoI under India-Egypt Bilateral Research Grant | 12.6 Lakhs | 2021-2023 |
| 4. | Exploring efficacy of plants and microbes for remediation of e-waste contaminated soil | MoEF | 47.9298/- | 2019-2023 |

Publications

International Journals

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Resource Development

List of Ongoing PhD

| 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 | 2017 | Shashank Awasthi | Isolation and Characterization of Bioactive Compounds from developing Plant Embryos | Prof. Neeraj Wadhwa |
| 3 | 2017 | Sonia Sharma | Phytoconstituent screening, characterization and application of endophytes from <i>Amorphophallus paeoniifolius</i> | Prof. Neeraj Wadhwa |
| 4 | 2017 | Archana Kumari | Employing competent microbes for remediation of | Prof. Krishna Sundari |

| | | | | |
|----|------|---------------------|--|--|
| | | | toxic organic substances | |
| 5 | 2018 | Neetu Saharan | Tuber metabolites and their biodegradation in natural environments | Prof. Neeraj Wadhwa |
| 6 | 2019 | Swapnil Chaturvedi | Characterization of bioactive compounds from natural habitats | Prof. Indira P. Sarethy |
| 7 | 2019 | Priyansh Srivastava | Evaluation of antimicrobial and anticancerous properties of lichens. | Prof. Indira P. Sarethy |
| 8 | 2019 | Arushi Saxena | Remediation of Medical waste | Prof. Pammi Gauba |
| 9 | 2019 | Pooja Upadhyay | Development of enzymatic sensor for detection of Paraben | Dr. Ashwani Mathur & Prof. Pammi Gauba |
| 10 | 2019 | Priyanka Kakkar | Development of food products from Aroids | Prof. Neeraj Wadhwa |
| 11 | 2019 | Gemini Patel | Medicinal plants for disease control against metabolism and microbial diseases | Prof. Neeraj Wadhwa |
| 12 | 2019 | Samridh Srivastava | Production and characterization of Bacterial Cellulose | Dr. Garima Mathur |
| 13 | 2020 | Razi Rahman | Extraction of Fungal Chitosan and its characterization | Dr. Garima Mathur |
| 14 | 2020 | Saloni Sachdeva | Microbial characterization of polluted sites | Prof. Indira P. Sarethy |
| 15 | 2021 | Abhiruchi Varshney | Applications of bacteriophages | Prof. Indira P. Sarethy |
| 16 | 2021 | Mahima | Microbial profiling of selected traditional Indian fermented foods | Prof. Indira P. Sarethy |
| 17 | 2022 | Apeksha Rathi | Interaction studies on mushroom by using network pharmacology | Prof. Neeraj Wadhwa |
| 18 | 2022 | Rakhi Pandey | Chitosan blends: preparation and characterization | Dr. Garima Mathur |
| 19 | 2022 | Garima Singh | Screening and isolation of bacterial cellulose producing strain | Dr. Garima Mathur |

Completed

| S.No | Name | Title | Supervisor | Year |
|------|----------------|--|-------------------|------|
| 1 | Radhika Bansal | Metal Toxicity in Herbs | Pammi Gauba | 2024 |
| 2 | Preeti Thakur | Remediation of inorganic pollutant nitrate by using microbes | Prof. Pammi Gauba | 2024 |

| | | | | |
|----|-----------------|---|---|------|
| 3 | Pratibha Yadav | Remediation of organophosphate pesticides using PGPM | Krishna Sunadri | 2022 |
| 4 | Ekta Bhatt | Remediation of Organic Pollutants | Prof. Pammi Gauba | 2022 |
| 5 | Sarita Agrahari | Production of enzymes and Degradation of feathers by soil microbes | Neeraj Wadhwa | 2011 |
| 6 | N. Kumara Swamy | Paper mill effluent: Decolorisation and detoxification studies using chemical and microbial methods | Indira P Sarethy | 2012 |
| 7 | Anuradha Singh | Phytoconstituent characterization and application of <i>Amorphophallus paeoniifolius</i> in development of food products" | Neeraj Wadhwa | 2015 |
| 8 | Nivedita Mishra | Developing microbial consortia with and remediation of residual pesticides | Krishna Sunadri | 2016 |
| 9 | A. Ibeyaima | Bioprospection of Actinomycetes from Indian desert and antimicrobial activity of selected isolates | Indira P Sarethy Prof. S. Sharma Prof. R. Lal | 2018 |
| 10 | Swarna Shikha | Screening Heavy Metal Tolerant Plants and Determining Their Phytoremediation Potential | Prof. Pammi Gauba | 2019 |
| 11 | Samiya Khan | Development of a biocatalyst for refining diesel | Prof. Pammi Gauba | 2019 |