DISHA MISHRA

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D2/594, Sector-F, Jankipuram, Lucknow, 226021

Precis

To achieve good position in reputed organization where I can utilize my knowledge and expertise to the fullest for excelling the growth of organization as well as the nation

Academic Credentials

- Ph.D. (Environmental Science) in CSIR- Central Institute of Medicinal and Aromatic Plants, (JNU-CIMAP PROGRAMME), Lucknow (March-2019)
- M.Phil. in Environment Science & Technology from Central University of Punjab securing CGPA 4.94/5.0 (2013)
- M.Sc. in Environmental Science from Banaras Hindu University securing CGPA 9.24/10.0 (2011)
- B.Sc. from C.S.J.M. University Kanpur, U.P. securing 65% marks (2008)
- Intermediate from U.P. Board securing 77% marks (2005)
- High school from U.P. Board securing 75% marks (2003)

Thesis Title

Synthesis of bio-nanocomposites from plant cellulose: For controlled release of therapeutic molecules

Area of interest

- Solid Waste Management and Production of value added products
- Nanomaterial/nanocomposites fabrication and Application
- Environmental Microbiology and heavy metal /POPs pollution control
- Soil chemistry and bioremediation
- Medicinal analytical chemistry

Academic Achievements

- UGC-NET-JRF (2012)

- UGC-SRF (2015)
- Best Oral Presentation (1)
- Best Poster Presentation (1)
- Best Research Paper (1)

Research Experience (8 years)

- Completed Ph.D. Work entitled "Synthesis of Bio-nanocomposites from Plant cellulose: For controlled release of therapeutic molecules" at CSIR-CIMAP, Lucknow, India under JNU-Ph.D. Programme **(March 2013-June 2018)**

- Completed M.phil Dissertation work **(2013)** entitled "Evaluation of Monocrotophos residues in soils of Bathinda, Punjab and its biodegradation through microbial isolates of contaminated soil" at Central University of Punjab, Bathinda, Punjab, India

- Completed M.Sc. Dissertation Work **(2011)** entitled "Catalytic Incineration Of VOCs (Toluene) Over Supported Copper Manganese Catalysts" at Indian Institute of Technology-Banaras Hindu University, Varanasi, India

Publications

Google Scholar citation- 29

RG Score- 13.7

SCI IF- 36

- **D. Mishra**, V. Yadav, Puja Khare, Jyotshna, M.R. Das, Abha Meena, K. Shanker, Development of Crystalline Cellulosic Fibres for Sustained Release of Drug, Current Topics In Medicinal Chemistry, 16: 18, (2016), 2026-2035. **(IF:3.4)**
- **D. Mishra**, P. Khare , K. Shanker , D. K. Singh , S. Luqman, Controlled delivery systems of cellulose matrix for oxytetracycline: *In vitro* dissolution, New Horizons in Translational Medicine 3(2016), 66–72.
- **D. Mishra**, P. Khare, D. K. Singh, S. Luqman, Y. Deshmukh, P. V A. Kumar, A. Yadav, B. K. Saikia, Retention of antibacterial and antioxidant properties of lemongrass oil loaded cellulose nanofibre-poly ethylene glycol composite, Industrial crops and products , 114 (2018), 68-80. **(IF:4.1)**
- **D. Mishra** , Jyotshna , A. Singh , D. Chanda c , K. Shanker , P. Khare, Potential of di-aldehyde cellulose for sustained release of oxytetracycline: A pharmacokinetic study, International Journal of Biological Macromolecules 136 (2019), 97-105 (**IF: 4.7**)
- **D. Mishra**, P. Khare, M.R. Das, S. Mohanty, D.U. Bawankule, P.V. Ajaya Kumar, Characterization of crystalline cellulose extracted from distilled waste of *Cymbopogan winterianus*, Cellulose chemistry and technology , 52 (2018), 9-17. **(IF: 0.8)**

- S. Jain**, D. Mishra**, P. Khare, V. Yadav, Y. Deshmukh, A. Meena , Impact of biochar amendment on enzymatic resilience properties of mine spoils, Science of The Total Environment, 544,(2016),410–421. **(IF:5.5)**
- S. Jain, P. Khare, **D. Mishra,** K. Shanker, P. Singh, R.P. Singh, P. Das, R. Yadav, B.K. Saikia, B.P. Baruah, Biochar aided aromatic grass [*Cymbopogon martinii* (Roxb.) Wats.] vegetation: A sustainable method for stabilization of highly acidic mine waste, Journal of Hazardous Materials (2019), DOI: https://doi.org/10.1016/j.jhazmat.2019.121799 **(IF:7.6)**
- S. Jain, A. Singh, P. Khare, D. Chanda, **D. Mishra**, K. Shanker, T. Karak, Toxicity assessment of *Bacopa monnieri* L. grown in biochar amended extremely acidic coal mine spoils, Ecological Engineering, 108, (2017), 211-219. **(IF:3.4)**
- N. Nigam, P. Khare, V. Yadav, **D. Mishra**, S. Jain, T. Karak, S. Panja, S. Tandon, Biochar-mediated sequestration of Pb and Cd leads to enhanced productivity in *Mentha arvensis*, Ecotoxicology and Environment Safety, 172 (2019), 411-422.**(IF:4.5)**
- N. Nigam, V. Yadav, **D. Mishra**, T. Karak, P. Khare, Biochar amendment alters the relation between the Pb distribution and biological activities in soil, International Journal of Environmental Science and Technology**,** (2019), DOI no-https://doi.org/10.1007/s13762-019-02257-y. **(IF:2.0)**
- **D. Mishra,** K. Shanker, P. Khare, Recent Advancement in Green Sustainable Nanocellulosic Fiber: An Overview, *Green technologies and Environmental sustainability*, Springer International (2017), 289-308 (Book Chapter)
- **D. Mishra,** P. Khare (2019), Antimicrobial Nanocomposites for Improving Indoor Air Quality, Microbial Nanobionics, Springer Cham, pp.253-267 (Book Chapter)
- **D. Mishra**, K. Shanker, P. Khare, Nanocellulose-mediated fabrication of sustainable future materials, In "Sustainable Nanocellulose and Nanohydrogels from Natural Sources **,** Elsevier, UK (Submitted)
- **D. Mishra,** L. Verma, P. Khare, (2018), Phytochemistry and Pharmacological Properties of *Bacopa monnieri, Metabolic Disorders Hypertension*, 48, 60-68 (Book chapter)
- R. Bhadouria, D. Mishra, VK Singh, P. Singh, P. Srivastav, S. Tripathi, R. Singh, (2019), Nanocatalyst types and their potential impacts in agroecosystems: An overview, Elsevier, U.K., 323-344

Technical skills

- Basic Computer Knowledge and familiar with Internet application
- Familiar with Basic Statistics (ANOVA, t-Test, Post-hoc tests, Correlation and Regression Analysis, PCA)
- Knowledge of Response Surface methodology, chemical and enzyme kinetics and thermodynamic related application
- Knowledge of Data analysis on Sigma Plot, Graph Pad Prism, Origin, Design Expert , Chem-Draw
- Handling of instruments like HPLC, GC, FT-IR, DLS, ICP-OES, UV-Vis Spectrophotometer, Flame photometer
- Interpretation skills of the data generated from HPLC, GC, UV-VIS, FT-IR, XRD, SEM, TEM, DLS, DSC, EDS, TGA
- Scientific data retrieval from Scifinder, Scopus, Pubmed, Google Scholar
- Familiar with Reference management tools like ENDNOTE, Mendley

Conferences /Workshops/Training Presented /Participated

- D. Mishra and P. Khare, *Fabrication of CNF/PEG nanocomposites for sustained release of aroma molecules of lemongrass oil*- 4th Annual Symposium-INSA-JIGYASA, Oral presentation-March, 2018
- D. Mishra, S. Jain, P. Khare, *Effect of pH on In-Vitro Release of Oxytetracyclin by Nano Bio-polymer*- First Indo-Russian Meet and Second International Conference on "Biotechnological Advancements in Free Radical Biology and Medicine" (ICBAFM – 2017), Oral presentation-January, 2017
- S. Jain, A. Singh, D. Mishra, P. Khare , *Reduction in bioavailability of Pb in Bacopa monnieri by Biochar amendments*- International Conference on Medicinal Plants: Resource for Affordable New Generation Healthcare (ICOMP), Poster presentation, March, 2015
- D. Mishra and P. Khare, *Production of nanocellulose for sustainable future: A comparative study*- 5th Asia-Oceania conference on Green and Sustainable Chemistry (Oral Presentation)-January, 2015
- D. Mishra, Dhananjaya, V. Yadav, S. Luqman, P. Khare, *Isolation and characterization of nanocellulose from plant waste biomass and its antimicrobial properties against P. aerugionosa*- International conference on Environmental Technology and sustainable development: Challenges and Remedies-February, 2014
- D. Mishra and P. Khare, *Conversion of Plant waste into polymeric material*- National Seminar on Climate change, Environment and sustainable development (Oral presentation)-December, 2013
- D. Mishra and Dhanya M.S,. *Biofertilizers: As Bioprotecting Agents*- Agriculture, Foods Sciences Environmental Technology for Sustainable Global Development (AFSET) (Oral presentation)- October, 2012
- D. Mishra and Dhanya M.S., *Biofertilizers: A Viable Option For Sustainable Agriculture*, National Seminar On "Environment Concerns And Sustainable Development: Issues And Challenges For India- (Oral presentation), February, 2012
- Attended National Seminar on Environment and Health, organized by Central University of Punjab, Bathinda (2011)
- Participated in International seminar on the topic Technology, Energy And Sustainable Rural Environment (2010)
- 1 week workshop by the Board of Research in Nuclear Sciences (BRNS)/ 10th school on Analytical Chemistry (SAC-10) organized by Bhabha Atomic Research Centre-AEACI, BARC, Mumbai, India, (2016)
- Attended workshop on e-Resource management by INFLIBNET Govt. of INDIA, organized by Central University of Punjab, Bathinda, India, (2012)
- 45 days Training certificate on the topic Entrepreneurship Skill Development

Programme On Biotechnology conducted by Ministry of Micro, Small & Medium Enterprises of Indian Government, at Department of Chemical Engineering, IIT - BHU, Varanasi, India, (2011)

- 2 months Industrial training on Waste water Treatment in Hindalco Industries Ltd., Renusagar, U.P. India, (2010)

Co-curricular activities

- Consolation Prize at Hindi Divas for the Topic Nanofertilizers (2014)
- Participated as Volunteers in SSBBT organized by CSIR (2016)
- Lifetime member of Association of Environmental Analytical Chemistry of India (AEACI), BARC, Trombay, Mumbai (Membership No. LM 344, (2015)

Personal Profile

Spouse Name:	Mr. Vivek Shukla
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Mother's Name:	Mrs. Maya Mishra
DOB:	12/01/1989
Nationality:	Indian
Language Known:	Hindi, English

Declaration

I, hereby declare that the above-mentioned information is correct up to my knowledge and I be responsibility for the correctness of the above-mentioned particulars.

Place: Lucknow

(DISHA MISHRA)
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Journal of Hazardous Materials

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Biochar aided aromatic grass [*Cymbopogon martini* (Roxb.) Wats.] vegetation: A sustainable method for stabilization of highly acidic mine waste

Shilpi Jain [a], Puja Khare [a,*], Disha Mishra [a], Karuna Shanker [b], Priyambada Singh [a], Raghavendra Pratap Singh [a], Paurabi Das [a], Ranu Yadav [a], Binoy K. Saikia [c], B.P. Baruah [c]

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Keywords:
Mine waste
Biochar
Phytostabilization
Acid neutralization
Risk assessment code

ABSTRACT

Dumping of acidic mine waste poses severe threats to the ecosystem due to high acidity, nutrient deficiency and mobility of toxic metals. The present study has been undertaken on phytoremediation by amending the acidic soil/mine waste with biochar (BC) and plantation of palmarosa (*Cymbopogon martini* (Roxb.) Wats. A greenhouse experiment in different combinations of biochar and acidic mine waste was conducted to assess the phytoremediation efficiency of palmarosa by BC amendments. Results indicate that the palmarosa tolerates multiple stresses effectively with a 54 % metal tolerance index (MTI) and capable of reducing acid production from the acidic mine waste alone. BC incorporation in the mine waste and soil treatments significantly enhanced the palmarosa biomass (1.11–3.3 times) and oil content by liming the acid, immobilization of metals and improving the soil quality. BC addition in highly acidic mine waste amplified the phytoremediation efficiency and mitigates abiotic oxidative stress on plants (MTI 84 % to >100 %). BC aided palmarosa plantation shifted the soil from high-risk assessment code (RAC) to low RAC for vegetation. Biochar amendments along with palmarosa plantation offer a sustainable technology for phytostabilization of highly acidic mine waste along with the production of industrially important essential oil.

1. Introduction

Acidic mine wastes are considered as the largest and continuously increasing hazardous waste which jeopardizes the nearby environmental conditions worldwide (Migaszewski et al., 2019). Many of these mine wastes enriched in sulfide-bearing minerals (e.g. pyrites), which on oxidation generate the acid leading to an increase in mobility of the toxic metals. The acidification and proliferation in heavy metal content deteriorate the physicochemical properties of nearby soils and aquatic ecosystems (Havlickova et al., 2019).

Phytostabilization of acid-generating wastes in the mine site is considered as a promising option for inhibition of aqueous run-off and spreading of the acidic generating minerals (such as pyrites) and toxic metals. The natural plant growth is not favorable in these areas due to several abiotic stresses such as extreme pH, soil nutrient and organic matter deficiency, low water retention capacity and presence of toxic metals (Asensio et al., 2013; Wong and Ho, 1993, 1994). The organic and/or inorganic amendments were widely used for optimal plant growth for soil amelioration on mine tailings. Biochar (BC) has been considered as an emerging panacea for rehabilitating mine waste affected soils and can enhance the process of phytostabilization (Ippolito et al., 2019; Jain et al., 2016; Novak et al., 2019). The additional benefits of BC are an increase of soil organic matter levels, sequestration of heavy metal; neutralization of the soil acidity; improvements in microbial activities and nutrient cycling (Nigam et al., 2019a; Yadav et al., 2019a). It acts as a source of macro and micro-nutrients with longer soil residence times (Ippolito et al., 2019; Jain et al., 2017; Yadav et al., 2019b).

The aromatic grasses considered as an excellent candidate for phytoextraction and phytostabilization and have more potential than shrubs or trees due to better adaptability to stress environment and higher biomass production (Malik et al., 2010). In addition, the essential oil extracted from these grasses has commercial importance. The palmarosa [*Cymbopogon martini* (Roxb.) Wats.], a perennial aromatic grass from the family- Poaceae is reported as a candidate for phytosta-

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Retention of antibacterial and antioxidant properties of lemongrass oil loaded on cellulose nanofibre-poly ethylene glycol composite

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ARTICLE INFO

Keywords:
Cellulose nanofibres
Lemongrass essential oil
Antioxidant capacity
Antibacterial activity

ABSTRACT

The lemongrass oil (LgEo) exhibits excellent antioxidant and antibacterial properties. However, low aqueous solubility and instability of its major constituents reduced the retention of these properties for the longer time. Hence, LgEo loaded composites of cellulose nanofibres (CNFs)- polyethylene glycol (PEG) were fabricated through melt and mixing process and sustainability of their antioxidant and antibacterial properties was assessed. The interaction of essential oil with composite systems was evaluated using Fourier-transform infrared spectroscopy (FT-IR), scanning electron microscope (SEM), Transmission electron microscopy (TEM), and X-ray powder diffraction (XRD) and quantification of released major compounds up to 120 days was done by Solid phase micro extraction/Gas chromatography–mass spectroscopy (SPME/GC–MS) methods. Results suggested that composite systems were able to sustained major compounds of lemongrass essential oil (geranial, neral and geranyl acetate) up to 120 days and followed Pseudo Fickian diffusion of aroma molecules. *In vitro* study of total antioxidant capacity, total phenolic, free radical scavenging efficiency and antibacterial properties (against *S. aureus* and *E. coli*) of the composites were suggested that composite system retained the properties of the pure lemongrass oil. These results indicate that fabricated scented composites can be used further in various industrial applications such as indoor air quality improvement materials and food storage.

1. Introduction

Nowadays, the development of biodegradable polymer is gaining importance over the synthetic materials particularly encapsulation and/or coating of natural molecule. They can improve the quality and the shelf life of natural product (Bashir et al., 2017; Esfanjani and Jafari, 2016). They can also act as vehicles for different naturally occurring compounds for instance antioxidants or antimicrobial compounds, vitamins, flavor compounds, and colorants, (Aytac et al., 2016; Castro-Rosas et al., 2017; Cerqueira et al., 2016; Fidelis et al., 2015). The composite system of the biodegradable polymers and herbal products such as plant extracts and essential oils provides a better durability of desired properties such as increase its functionality, improve their appearance, and extended the shelf life through controlling the release (Echeverría et al., 2016; Oliveira et al., 2017; Sultanbawa, 2011). Cellulose, being most naturally abundant polymer has attracted attention for such type application. Cellulose nano-fibers (CNFs) obtained from the native cellulose persist remarkable excellent properties such as biocompatibility, nontoxicity, and biodegradability. The unique properties of CNFs widen the possible applications of this biopolymer such as in pharmaceutical, biomedical, electronic and textile, as well as in food packaging industries (Chauve and Bras, 2014; Lee et al., 2017). Recently, cellulosic fibers used for reinforcement due to its biodegradability, lower weigh, renewability, and molecular strength. These fibers are used to produced nano compounds with phenolic resin, styrene butyl acrylate, poly urethane, starch (Borah and Kim, 2017; Rojo et al., 2015). Similar to CNF, poly ethylene glycol (PEG) is also a biocompatible and nontoxic polymer composed of repeating ethylene glycol units. It is commonly used in designing of various successfully commercialized biomaterial in various applications, such as nonionic surfactants, lubricants, solvents, adhesives, cosmetics, and pharmaceutical formulations (Lou et al., 2017; Lu et al., 2017; Ravikumar et al., 2017; Wang et al., 2017; Zhang et al., 2017). It is reported that Polyethylene glycol (PEG) has excellent compatibility and affinity with CNF

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Potential of di-aldehyde cellulose for sustained release of oxytetracycline: A pharmacokinetic study

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ABSTRACT

This study focused on the *in-vivo* sustained release of oxytetracycline (OTC) loaded on di-aldehyde cellulose (DAC). The periodate oxidation method was used for the synthesis of DAC. The prepared DAC-OTC material was characterized by different techniques such as Scanning electron microscopy (SEM), Fourier transforms infrared spectroscopy (FT-IR), X-ray diffraction (XRD), Transmission electron microscopy (TEM) and particle size analyzer. The pharmacokinetic studies were performed on DAC-OTC composite system and commercial tablet (COTA). The results of pharmacokinetic studies demonstrated that DAC-OTC exhibited higher area under the curve (AUC) (482.8 $\mu ghmL^{-1}$) as compared to COTA (90.72 $\mu ghmL^{-1}$). DAC-OTC composite system has double compartment pattern with improvement in mean residing time (MRT) and area under moment curve ($AUMC_{0-\infty}$) than the commercial tablet (2.8 and 15.13 folds higher, respectively). Swelling index of DAC-OTC at different pH and pKa of OTC release imply that controlled *in-vivo* release in DAC-OTC composite system could be due to the simultaneous occurrence of the covalent and hydrogen bond between OTC and di-aldehyde cellulose. These results indicate that di-aldehyde cellulose may improve the *in-vivo* bioavailability of OTC.

1. Introduction

The sustained release drug delivery system (SRDDs) has gained extensive consideration in the pharma and nutraceutical industry due to the extended release of the encapsulated drug and nutraceutical molecules. Many drugs highly required the SRDDs due to their initial burst release causing heavy dose, the poor and toxic effect to the patient [1]. As compared to immediate release formulation, the rate of release of drug through SRDDs can be achieved through diffusion and dissolution controlled, pH-triggered, ion exchange resin based complexes or osmotic-pressure controlled -systems. They had frequently been adopted for the formulation of various kinds of drugs [2]. But, certain prerequisites should be considered for the selection of drug for oral SRDDs like molecular weight, solubility, absorption, partitioning, bioavailability, elimination and including half-life of the drug [3]. Hence, the major goal for designing SRDDs is the effective delivery of the drug with improved performance. In this regards, nanofibers have attracted attention for the sustained drug delivery system due to their research literature because the resultant nanofibers have many valuables characteristics such as high surface areas, porosity and a continuous 3-D web structure [4,5]. Various new techniques, excipients, and modifications in the existing excipients were tried for production of tailored drug delivery system.

The solid dispersion of poorly soluble drugs has immense potential to improve oral bioavailability [6]. The various techniques were used for the development of such a system, for example, a new triaxial electrospinning process for fabrication of ferulic acid-gliadin fibers [7] and drug-protein nanocomposites synthesis [8], coaxial electrospinning system for the sustained release of berberine hydrochloride [1], side-by-side electrospinning process for ketoprofen-loaded Janus fibers [9], hot melt extrusion for the preparation of hydrogenated soybean phosphatidylcholine [10]. Apart from these qualities, appropriate excipients are also another important factor to be considered in SRDDs. Biopolymeric macromolecules and their derivatives are very recently explored as a carrier of therapeutic molecules for improving their bioavailability, dissolution, and release rate [11]. For example, the use of lignin as a carrier for aspirin demonstrated higher release rate, improved dissolution, and bioavailability [12]. Likewise, hydrophilic nanocomposites were developed through coating with Shellac resin of biological origin as a drug carrier [13]. A similar type of core/shell structures was also fabricated using Shellac as coating material through the electrospinning process for the immediate release of helicid, [14]. In addition to these macromolecules, a newer kind of pharmaceutical carrier was developed using zein protein through electrohydrodynamic atomization process for encapsulation of tamoxifen citrate [15]. In a recent review,

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Biochar-mediated sequestration of Pb and Cd leads to enhanced productivity in *Mentha arvensis*

Nidhi Nigam[a], Puja Khare[a,*], Vineet Yadav[a], Disha Mishra[a], Shilpi Jain[a], Tanmoy Karak[b,c], Saumik Panja[c], S. Tandon[d]

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ARTICLE INFO

Keywords:
Biochar
Cadmium
Herbs
Lead
M. arvensis
Phyto-availability
Phytopharmaceuticals
M. arvensis

ABSTRACT

Immobilization of cadmium (Cd) and lead (Pb) along with the alleviation of their phytotoxicity in *Mentha arvensis* by biochar was examined in this investigation. A greenhouse experiment was executed to evaluate the effect of biochar (BC) amended Cd and Pb spiked soil on their immobilization and uptake, plant growth, photosynthetic attributes (total chlorophyll, photosynthetic rate, transpiration rate, and stomatal activity) and oxidative enzymes (guaiacol peroxidase: POD; catalase: CAT and superoxide dismutase: SOD). In the present study, the photosynthetic attributes showed that BC significantly improved the total chlorophyll, photosynthetic, transpiration rates, and stomatal activity in the plants. The incorporation of BC in soil increase the Pb and Cd tolerance in *M. arvensis* vis-à-vis improved the biomass yield and nutrient intake. In addition, biochar has also reduced the POD, CAT, and SOD in the plant as well as improved the soil pH and enzymatic activities. Overall, BC immobilized the Cd and Pb in soil by providing the binding site to the metals and reduced the phytotoxicity in *M. arvensis*. However, large-scale field trials of BC are required for safe cultivation of *M. arvensis* which is known for its phytopharmaceuticals importance.

1. Introduction

Heavy metals (HMs) are ubiquitously present in all the spheres of the environment. Soil acts as a funnel through which these HMs disperse into different environmental compartments like plants and living organism through the food chain. The HM contamination in agricultural soil possesses serious problem for plants, microflora of soil, and human health. Among HMs, lead (Pb) and cadmium (Cd) are the most potentially hazardous metallic pollutants to human health due to their non-biodegradability and readily transferred through the food chain (Murtaza et al., 2015; Rizwan et al., 2012). The major sources of Pb and Cd in the soil are anthropogenic activities such as transportation, mining, smelting, gasoline, and paint industries. The phyto-availability of point and non-point sources of Pb and Cd in soil is a major concern for edible crops in connection with food safety and health (Ashraf et al., 2017; López-Orenes et al., 2018). The consumption of the Pb and Cd contaminated plants could have chronic health effects. Cd and Pb exposure can result in neurological and gastrointestinal distress, pulmonary disease, and kidney damage (Rehman et al., 2016; Tang et al., 2018). In the plant, the HMs enhance the oxidative stress by increasing the production of reactive oxygen species (ROS) in different parts of the plant (Karak et al., 2013). This overproduction of ROS may damage the biological macromolecules and negatively affects the antioxidant system in plants (Ali et al., 2017; Huang and Wang, 2010; Redovniković et al., 2017). Leaf chlorosis, retardation in plant growth, disturbance of plant physiological activities and nutrient metabolism are the major toxic effects of the HMs stress.

Several amendments were used to immobilize the Pb and Cd in soil and restrict their translocation in edible parts of the plant (ur Rehman et al., 2018). Among these techniques, biochar (BC) is recently considered as a metal immobilizing agent in the soil contaminated with organic (pesticides, dyes, and polyaromatic hydrocarbons) and inorganic (e.g. HMs) pollutants (Kumar et al., 2018; Lu et al., 2017; Park et al., 2011). Biochar, a carbon-rich material is produced from carbonization of biomass in a limited oxygen environment at a high temperature (350–700 °C) (Wang et al., 2018). The micro and nanopore

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Impact of biochar amendment on enzymatic resilience properties of mine spoils

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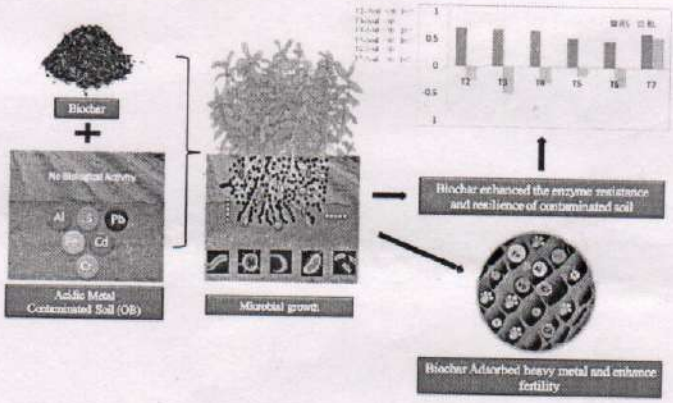
HIGHLIGHTS

- We evaluated the effect of overburden & biochar amendment on the resistance & resilience of soil.
- Phyto-remediated OB-contaminated soil has its own resilience power.
- Biochar addition enhanced the enzyme resistance and resilience of OB contaminated soil.
- In silico study indicates that biochar–Fe complex play a significant role in controlling the enzymatic activities of soil.

GRAPHICAL ABSTRACT



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ABSTRACT

Soil enzymes are crucial for soil nutrient cycling function. Understanding of the factors that control their response to major disturbances such as dumping of environmentally toxic acidic waste remains limited. We evaluated the effect of dumping of overburden (OB) and their amendments using biochar, on the resistance and resilience of soil enzyme activities involved in phosphorus, nitrogen, sulphur and carbon cycling (acid & alkaline phosphatase, urease, arylsulphatase, dehydrogenase, phenol oxidases, cellulase and β-glucosidase). For investigation the soils treated with OB and with the mixture of OB and biochar were used for the cultivation of bacopa were used. We assessed 0 day, 45 day and 90 days activities of the target soil enzymes, available phosphorus, nitrogen, sulphur, soil organic carbon and microbial identification. The resilience and resistance index of all the treatments were calculated. We found that phyto-remediated OB-contaminated soil has its own resilience power. However, biochar addition enhanced the enzyme resistance and resilience of OB contaminated soil. In silico study indicates that biochar–Fe complex play a significant role in enzymatic activities. Overall, the results indicate a significant influence of phytoremediation and biochar addition on soil enzymatic activity that is extremely resistant to OB. This study provides insight on how biochar addition modulates soil biochemical and microbiological response to OB affected soils.

Self Attested
Disha

1. Introduction

The over burden or mine spoils generated near the coal mine could be considered responsible for the disturbance in the nearby soils. Though, these disturbances may be positive or negative for the soil

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