SRI VENKATESWARA INTERNSHIP PROGRAM
FOR RESEARCH IN ACADEMICS
(SRI-VIPRA)

SRI-VIPRA

Project Report of 2023:

SVP-2320

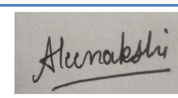
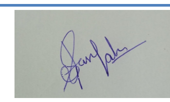
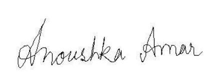
"Green Nanobiopolymers for Environmental Remediation: A Step towards Sustainable Future"

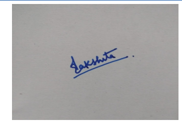
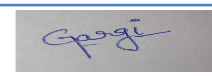
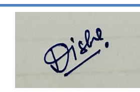
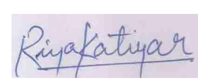
IQAC
Sri Venkateswara College
University of Delhi
Benito Juarez Road, Dhaula Kuan, New Delhi
New Delhi -110021
SRIVIPRA PROJECT 2023

Title: "Green Nanobiopolymers for Environmental Remediation: A Step towards Sustainable Future"

Name of Mentor: Dr. Shikha Gulati
Name of Department: Chemistry
Designation: Assistant Professor

List of students under the SRIVIPRA Project

S.No	Photo	Name of the student	Roll number	Course	Signature
1		Meenakshi	1521045	B.Sc. (H) Chemistry	
2		Tanu Sahu	1521097	B.Sc. (H) Chemistry	
3		Anoushka Amar	1521010	B.Sc. (H) Chemistry	

4		Lakshita Chhabra	1521039	B.Sc. (H) Chemistry	
5		Yamini Moriya	1121038	B.Sc. Life Sciences	
6		Gargi Sajwan	1321023	B.Sc. (H) Biological Sciences	
7		Disha Prasad	1521024	B.Sc. (H) Chemistry	
8		Riya Katiyar	1521065	B.Sc. (H) Chemistry	

9		Kumud Joshi	1121145	B.Sc. Life Sciences	
10		Nabeela Ansari	1221026	B.Sc. (H.) Biochemistry	

Signature of Mentor

Certificate of Originality

This is to certify that the aforementioned students from Sri Venkateswara College have participated in the summer project SVP-2320 titled "**Green Nanobiopolymers for Environmental Remediation: A Step towards Sustainable Future**". The participants have carried out the research project work under my guidance and supervision from 15^{th} June 2023 to 15^{th} September 2023. The work carried out is original and carried out in hybrid mode.

Signature of Mentor

TABLE OF CONTENTS

1. Objectives

The objectives of this project are as follows:

(i) Investigate Green Nanobiopolymers: Explore the field of green nanobiopolymers, focusing on their potential applications in environmental remediation.

(ii) Develop Sustainable Synthesis Methods: Develop environmentally friendly methods for synthesizing green nanobiopolymers that minimize energy consumption and waste generation.

(iii) Characterize Nanobiopolymers: Utilize advanced characterization techniques to analyze the structural and functional properties of green nanobiopolymers.

(iv) Evaluate Environmental Applications: Assess the effectiveness of green nanobiopolymers in remediating environmental pollutants, such as heavy metals, organic contaminants, and emerging pollutants.

(v) Examine Ecological Impact: Investigate the ecological impact and sustainability of using green nanobiopolymers in environmental remediation, including their biodegradability and eco-toxicological effects.

(vi) Provide Future Outlook: Summarize findings, draw conclusions, and offer insights into the potential future developments and applications of green nanobiopolymers in achieving a more sustainable and eco-friendly environment.

2. Abstract

This project report explores the promising realm of Green Nanobiopolymers and their pivotal role in environmental remediation toward achieving a sustainable future. It encompasses the objectives, methodologies, and findings that underpin the project's significance and potential impact.

3. Introduction to Green Nanobiopolymers

Green Nanobiopolymers represent an innovative class of materials that merge the advantages of nanotechnology with the sustainability of biopolymers. These biodegradable and environmentally friendly nanomaterials exhibit unique properties, making them promising candidates for addressing environmental challenges. This section introduces the concept of Green Nanobiopolymers, their composition, and their potential role in revolutionizing environmental remediation practices.

4. Methods of Synthesis of Green Nanobiopolymers

Efficient and sustainable synthesis methods are imperative for the successful development of Green Nanobiopolymers. This section delves into various eco-conscious synthesis techniques, including green synthesis routes, biogenic approaches, and the utilization of renewable feedstocks. The emphasis is on minimizing environmental impact while ensuring high-quality nanobiopolymer production.

5. Characterization Techniques

Comprehensive characterization of Green Nanobiopolymers is crucial for understanding their structural and functional attributes. Advanced characterization techniques, such as spectroscopy, microscopy, and surface analysis, are employed to gain insights into these nanomaterials. This section provides an overview of the methods used to elucidate the physicochemical properties of Green Nanobiopolymers.

Characterization techniques play a critical role in understanding the properties and behavior of nanobiopolymers, which are nanoscale materials derived from biological sources. These techniques allow researchers to assess the structure, morphology, composition, and various other properties of nanobiopolymers. Here are some key characterization techniques commonly used for nanobiopolymer analysis:

Spectroscopy:

(i) UV-Visible Spectroscopy: This technique helps determine the absorbance and transmission of light by nanobiopolymers. It is useful for assessing the presence of functional groups, conjugation, or the absorption of specific wavelengths.

(ii) FTIR (Fourier-Transform Infrared) Spectroscopy: FTIR spectroscopy identifies functional groups in nanobiopolymers by measuring their vibrational modes. It is essential for determining the chemical composition and identifying specific bonds in the material.

(iii) NMR (Nuclear Magnetic Resonance) Spectroscopy: NMR provides information about the atomic and molecular structure of nanobiopolymers. It is particularly useful for characterizing complex structures, such as proteins and nucleic acids.

Microscopy:

(i) Transmission Electron Microscopy (TEM): TEM offers high-resolution images of nanobiopolymers, allowing researchers to visualize their size, shape, and internal structure at the nanoscale.
(ii) Scanning Electron Microscopy (SEM): SEM provides surface morphology information and enables researchers to examine the external structure of nanobiopolymers.
(iii) Atomic Force Microscopy (AFM): AFM is used to investigate surface properties, topography, and mechanical properties of nanobiopolymers. It can provide three-dimensional images of these materials.

X-ray Techniques:

(i) X-ray Diffraction (XRD): XRD is used to determine the crystallographic structure of nanobiopolymers. It provides information about their crystallinity and atomic arrangement.
(ii) Small-Angle X-ray Scattering (SAXS): SAXS is employed to investigate the nanoscale structure and spatial arrangement of nanobiopolymers in solution.

Thermal Analysis:

(i) Differential Scanning Calorimetry (DSC): DSC measures changes in heat flow associated with phase transitions, providing information about the thermal behavior, stability, and transition temperatures of nanobiopolymers.

Raman Spectroscopy:

Raman spectroscopy is used to study molecular vibrations, providing insights into the chemical composition and structure of nanobiopolymers. It is particularly valuable for non-destructive analysis.

Dynamic Light Scattering (DLS): DLS measures the hydrodynamic size of nanobiopolymers in solution, offering insights into their size distribution and aggregation behavior.

(ii) Zeta Potential Measurement: This technique assesses the surface charge of nanobiopolymers in suspension, which is crucial for understanding their stability and interactions with other molecules or particles.

Gel Electrophoresis: Gel electrophoresis is often used to separate and analyze nanobiopolymers based on their size and charge. It is especially valuable for nucleic acid and protein analysis.

Mass Spectrometry: Mass spectrometry is employed to determine the molecular weight and sequence of nanobiopolymers, particularly relevant for proteins and nucleic acids.

Dynamic Mechanical Analysis (DMA): DMA evaluates the mechanical properties of nanobiopolymers, including elasticity, stiffness, and viscoelastic behavior.

6. Application of Green Nanobiopolymers in Environmental Remediation

Green Nanobiopolymers find diverse applications in environmental remediation, ranging from water purification to air quality enhancement and soil remediation. The potential for these nanomaterials to revolutionize the field of environmental remediation is discussed.

(i) Water Purification:

- Heavy Metal Removal: Green Nanobiopolymers can be functionalized to selectively bind and remove heavy metals like lead, cadmium, and mercury from water sources. Their high surface area and tailored binding properties make them efficient adsorbents for metal ions.
- Organic Contaminant Degradation: Nanobiopolymers can host enzymes and catalytic nanoparticles that degrade organic pollutants, such as pesticides and dyes, through enzymatic reactions or advanced oxidation processes.
- Nanofiltration and Desalination: Nanobiopolymer-based membranes can be used in nanofiltration and desalination processes to remove salts, ions, and impurities from saline water sources, thus producing fresh water.

(ii) Air Quality Improvement:

- Air Pollutant Adsorption: Nanobiopolymers can be designed to adsorb and trap air pollutants like volatile organic compounds (VOCs), nitrogen oxides (NOx), and particulate matter, contributing to improved air quality.
- Gas Sensing: Functionalized nanobiopolymers can be used in gas sensors to detect and monitor the concentration of specific gases in the atmosphere, aiding in pollution monitoring and control.

(iii) Soil Remediation:

- Heavy Metal Immobilization: Nanobiopolymers can immobilize heavy metals in contaminated soils, reducing their mobility and bioavailability. This prevents further contamination and reduces the risk to ecosystems and human health.
- Bioremediation Enhancement: Green Nanobiopolymers can serve as carriers for beneficial microorganisms that facilitate bioremediation processes by degrading organic pollutants or enhancing nutrient availability in soil.

(iv) Waste Management:

- Waste Reduction: Nanobiopolymers can be employed to develop biodegradable and eco-friendly packaging materials, reducing plastic waste and environmental pollution.
- Wastewater Treatment: In wastewater treatment plants, nanobiopolymers can aid in sludge dewatering, increasing the efficiency of solid-liquid separation processes and reducing the volume of waste sludge generated.

(v) Biodegradable Nanoparticles for Delivery:

Contaminant-Targeted Delivery: Green Nanobiopolymers can be engineered to encapsulate and deliver remediation agents (e.g., enzymes, bacteria, or nanoparticles) precisely to the contaminated sites, minimizing environmental impact.

(vi) Phytoremediation Enhancement:

Plant-Nanobiopolymer Interactions: Green Nanobiopolymers can improve the efficiency of phytoremediation by enhancing nutrient uptake, water retention, and contaminant sequestration in plant roots, facilitating the removal of pollutants from the soil.

(vii) Oil Spill Cleanup:

Oil Sorption: Nanobiopolymer-based sorbents can effectively absorb and remove oil and hydrophobic contaminants from water surfaces, making them valuable tools in oil spill cleanup efforts.

7. Conclusion & Future Outlook

In conclusion, Green Nanobiopolymers offer a sustainable and eco-friendly approach to combat environmental challenges. This project report underscores their potential to achieve a cleaner and more sustainable future. As we look ahead, there is a promising future for Green Nanobiopolymers, with opportunities for further research, development, and application in diverse environmental remediation contexts. This report invites readers to consider these innovative materials as a pivotal step towards a greener and more sustainable world.

****