DEVELOPMENT OF NANO ADSORBENTS FROM AGRICULTURAL WASTES AND THEIR APPLICATION IN MITIGATION OF ORGANIC, INORGANIC POLLUTANTS FROM INDUSTRIAL EFFLUENTS

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Water pollution, agricultural waste, nano adsorbents, wastewater treatment, agricultural sustainability, renewable resources, environment conservation

Introduction:

Water is the essence of life, fundamental to ecosystems, human health, and economic prosperity. However, water pollution threatens this critical resource, compromising its quality and availability. Therefore, there is an urgent need for new technologies to remove the contaminants from water and wastewater. Hence, many ways and techniques have been developed for water and wastewater remediation. Among all the methods of water and wastewater remediation techniques, the adsorption process has gained tremendous importance as a suitable water and wastewater remediation. Globally, abundant agricultural wastes are being generated each day to fulfil the increasing demands of the fast-growing population. In India, the rice bran waste production is about 10.8 million tons and arecanut waste production is about 5 million tons per year. The limited and/or improper management of the same has created an urgent need to devise strategies for their timely utilization and valorisation, for agricultural sustainability.

The application of nano adsorbent materials is a growing solution to solving this environmental problem. Utilizing agricultural waste to prepare nano adsorbents offers a sustainable solution to address environmental challenges while adding value to underutilized resources. By harnessing the abundant and renewable resources of agricultural waste, such as rice husks or sugarcane bagasse, we can transform them into efficient nano adsorbents by using innovative methods. Through controlled synthesis techniques, such as pyrolysis or chemical modification, agricultural waste can be engineered into nanostructures with enhanced surface area and adsorption capacities. The resulting nano adsorbents exhibit promising potential for various applications, contributing to both environmental conservation and agricultural sustainability.

Objectives:

1. Development of nano adsorbents from agricultural wastes such as arecanut wastes and rice bran wastes.
2. Estimation of adsorption capacity of the nano material in mitigation of organic, inorganic pollutants from wastewater.
3. Regeneration of nano adsorbent by desorption and development of a novel eco-friendly technology.

Methodology:

1. Collection of industrial effluents: The industrial effluents were collected from industry in JP Nagar area, Bangalore, Karnataka.
2. Collection of agricultural waste: The arecanut is collected from Shivamogga, Karnataka and Rice bran waste is collected from Kollegal, Karnataka.
3. Selection and processing of biodegradable materials:
   - Biodegradable polymers that can be used as the base material for the nano adsorbents were identified.
   - Testing of the compatibility of these materials with various nano particle additives that can enhance pollutant removal was done.

The material obtained was cleaned thoroughly before subjecting to the process of development. A simple yet thorough wash was provided with water. The biodegradable material then underwent a process of drying which is carried out either by shed drying or sun drying. This will not only dry off the water particles followed by cleaning but also aid the smooth navigation of the next process.

One of the prerequisites of obtaining nano particles is a well powdered and finely grinded material. Hence, in the next step the biodegradable materials were grinded to a fine powder in order to proceed with the development.

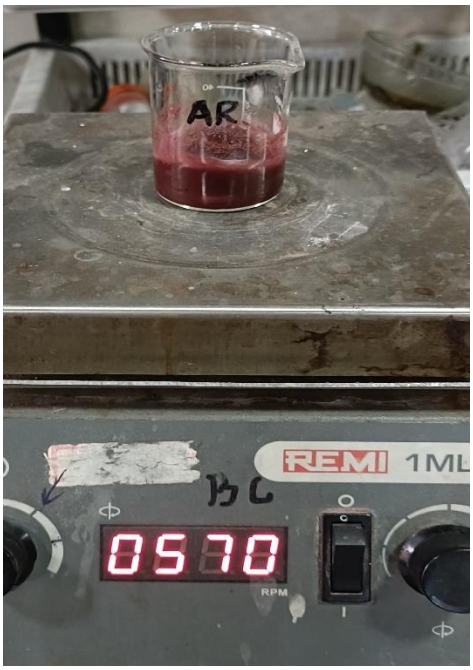
Fine powdered arecanut waste

Fine powder of rice bran

- This fine powder is further utilized for checking the standard parameters such as adsorption, PH, temperature and conductivity.

- The parameter check is done by taking minimal amount of waste and mixing it in industrial effluent by using magnetic stirrer carefully and observing under standard time and temperature.

Rice bran mixed with industrial waste

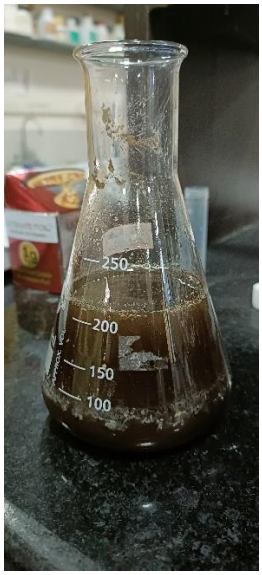


Arecanut mixed with industrial waste

- Preparation of silver nano particles was done by taking 3.4 g of silver nitrate crystals in 200 ml distilled water along with 4 g of rice bran powder.

This was thoroughly mixed in a magnetic stirrer for 2 hours. Care should be given to cover the conical flask of silver nitrate solution with aluminium foil as silver nitrate is light sensitive.

Before stirring



After stirring

Conclusion:

The development of nano adsorbents from agricultural wastes presents a promising solution for mitigating organic and inorganic pollutants from industrial effluents. Through this project, we have successfully demonstrated the feasibility of repurposing agricultural by-products into effective adsorbents, contributing to both environmental sustainability and waste valorisation. The utilization of nanotechnology has significantly enhanced the adsorption capacity and efficiency of these materials, thereby improving their effectiveness in treating industrial wastewater. Overall, the results indicate that nano adsorbents derived from agricultural wastes have the potential to be cost-efficient, eco-friendly, and highly efficient alternatives for water treatment applications. Furthermore, the successful removal of pollutants underscores the practical utility of these materials in addressing water pollution challenges.

Material	Temperature	Adsorption	PH	Conductivity
Rice bran (RB)	At 50^0 boiling water bath	The adsorbent adsorbed the materials present in the effluent and turned darker than its initial colour.	7.2	6.0
Arecanut (AR)	At 50^0 boiling water bath.	The adsorbent adsorbed the materials present in the effluent and turned darker than its initial colour.	8.6	5.4
Mixture - M1 70:30 (RB:AR)	96 hours incubation at room temperature ($35^0 – 36^0$)	The adsorbent adsorbed the materials present in the effluent and turned darker than its initial colour.	8.5	8.1
- M2 50:50 (RB:AR)	72 hours incubation at room temperature ($35^0 – 36^0$)	The adsorbent adsorbed the materials present in the effluent and turned darker than its initial colour.	8.4	7.9

In conclusion, this project not only highlights the innovation in utilizing agricultural wastes for adsorbent production but also underscores the importance of interdisciplinary approaches, combining nanotechnology, environmental engineering, and waste management. Moving forward, further research and development efforts are warranted to optimize the production process, explore multifunctional adsorbents, and validate the effectiveness of these materials in real-world scenarios.

Scope for future work:

The future scope of this project includes further optimization of the nano adsorbent production process to enhance efficiency and scalability for industrial applications. Additionally, research could explore the potential for multifunctional adsorbents capable of removing a broader range of contaminants. Moreover, investigating novel methods for the regeneration and reuse of the adsorbents to improve sustainability and reduce operational costs would be valuable. Furthermore, conducting field trials and pilot studies to validate the effectiveness of these nano adsorbents in real-world industrial settings would be crucial for widespread adoption and commercialization. Lastly, exploring potential collaborations with industries and policymakers to integrate these innovative solutions into water treatment practices and regulatory frameworks would be essential for long-term impact.

Reference:

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