DEVELOPMENT OF ACTIVATED CARBON COATED NANOPARTICLE COMPOSITE FOR REMOVAL OF HEAVY METALS

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Introduction:

Heavy metal contamination in water is a major concern that can have harmful effects on aquatic ecosystem as well as human being. Heavy metals such as chromium, cadmium, lead, mercury and arsenic can contaminate water sources through various means like industrial discharges, mining activities and the leaching of contaminated soils. These metals can gradually accumulate in aquatic organisms, absorbed by plants and bioaccumulate in the food chain, posing risks to human populations. Exposure to heavy metals leads to various health hazards like neurological disorders, kidney damage, cancer and many more.

The Moringa seed powdered was found to be effective and influenced by different pH in removing impurities from water. On the other hand, activated carbon is a commonly used as adsorbent material for the removal of contaminants from water. Activated carbon can be made from wide range of natural material containing carbon. The activated carbon proved to be inexpensive and potential adsorbent with strong physical adsorption forces.

In the present investigation, we will prepare activated carbon from coconut shells, which will provide larger surface area for adsorption. The activated carbon from naturally available material will provide several advantages like cost effective, higher adsorption efficiency, safe, renewable easy to use.

Owing to the several advantages of nanoparticle like larger surface area, which increase the adsorption capacity, small in size, faster reaction rate, lower energy consumption, we will synthesize nanoparticle from moringa seed powder. The nanoparticle will be synthesized by using green synthesis approach, which is nontoxic and environmentally friendly. The synthesized nanoparticle will be coated on to the activated carbon. The combination of nanoparticle-coated activated carbon will have higher potential in removing heavy metals from water and increase overall

performance in water treatment process. Our research will provide a sustainable option for the removal of heavy metals and other impurities from water and contribute to the development of green and low-cost water treatment technology.

Objectives:

The objective of our research is to remove heavy metal from water and to develop a more efficient and sustainable water treatment technology that can remove heavy metals and impurities from water.

Nanoparticles synthesized from natural resource, Moringa seed will offer several advantages over traditional adsorbents like high surface area, small size, faster reaction rates, lower energy consumption, reduced sludge production, and improved water quality.

- To ensure the composite maintains its structural integrity and adsorption performance over multiple cycles of use.
- To develop a synthesis process that is simple, cost-effective, and scalable for large-scale production.
- To ensure the composite is safe for the environment and human health during production, use, and disposal.
- To develop a composite that can be easily regenerated and reused multiple times without significant loss of performance.

Methodology:

Materials:

Coconut shell, CaCl2, metal oxide, ethanol, saturated solution, Moringa seeds

Methods:

Preparation of activated carbon from coconut shell

Coconut shell is collected and after cleaning it is burnt. Charcoal is extracted and the extracted charcoal is crushed, sieved and its impurities are separated using calcium chloride. The crystalline form of activated carbon will be collected.

Preparation of nanoparticles from Moringa olifera seeds

The preparation of Moringa nanoparticles for the removal of heavy metals typically done by a green synthesis approach, making use of the naturally occurring compounds present in Moringa oleifera that possess chelating and adsorption properties.

Formation of Moringa nanoparticles

Mixing the Moringa extract with a metal salt solution under controlled conditions can lead to the formation of nanoparticles through precipitation. The bioactive compounds in the extract act as reducing and stabilizing agent. Adding a metal salt solution to

the Moringa extract followed by the addition of a reducing agent such as sodium borohydride or hydrogen peroxide can facilitate the formation of nanoparticles.

Characterization and removal of heavy metals

To test the synthesized Moringa nanoparticles or their heavy metal removal efficiency, the nanoparticles were exposed to solutions containing heavy metal ions (e.g., lead, cadmium, arsenic) and measuring the concentration of metals before and after treatment using techniques such as atomic absorption spectroscopy (AAS) or inductively coupled plasma mass spectrometry (ICP-MS).

Methodology of coating of nanoparticle into activated carbon

Preparation of Nanoparticle Suspension: the nanoparticles were dispersed the nanoparticles in a suitable solvent or dispersant to form a stable suspension. Sonication or agitation method will be used to ensure uniform dispersion.

Immersion or Impregnation: The activated carbon in the nanoparticle were immersed by soaking or spraying. This allows the nanoparticles to adhere to the surface of the activated carbon for about 10 hours.

Drying: The solvent from the activated carbon will be removed by drying it under controlled conditions in oven at 95 degree Celsius. This step is crucial to ensure the nanoparticles remain attached to the surface.

Characterization: The coated material will be analyzed using techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD) to confirm the presence and distribution of nanoparticles on the activated carbon.

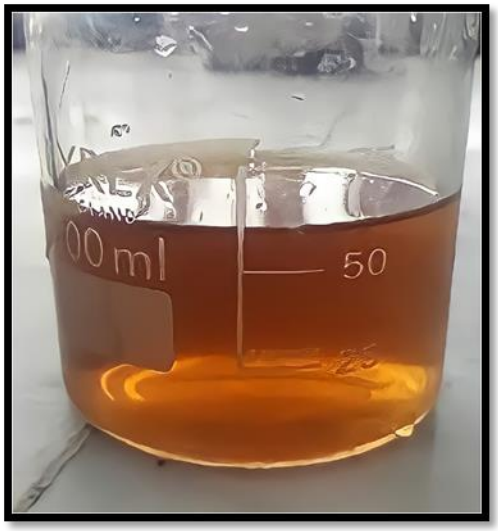
Details of work carried out

1. Preparation of activated carbon using coconut shell:

- Coconut shell was collected and washed thoroughly to remove soil and other debris and kept under sunlight to remove moisture.
- It was burnt inside a furnace at 300 degree Celsius for 2 to 3 hours which formed charcoal.
- The charcoal is separated from impurities using calcium chloride.

2. Preparation of moringa seed extract:

- Collection of moringa seeds and sun dry the seeds.
- Clear it from impurities and grind it by grinder to make fine powder.
- Measure the desired amount of moringa powder and add distilled water about 100 ml per 10 grams of moringa seeds.
- Stir the mixture well to ensure the seeds are evenly distributed in water and soak for 24 hours. This allows soluble compounds to dissolve in the water.
- After soaking filter the mixture through cheesecloth to remove solid seed particles and collect the filtrate in a container. This liquid is moringa seed extract.



Conclusion:

- Activated charcoal from coconut shell prepared and extract of moringa seeds extracted successfully.
- Removal of toxic heavy metal contamination from water [chromium (VI), cadmium (II)]
- Use of activated carbon coated nanoparticle for high efficiency removal of heavy metals
- Environmentally friendly process
- Cost effective, safe and easy to use water treatment technology
- Lowered use of chemicals and energy consumption in the process
- Overall, the development of activated carbon coated with nanoparticles holds more effective and sustainable solution to mitigate heavy metal contamination in environment.