Ecofriendly Design and Fabrication of a Microalgae-Based Sponge to Efficiently Remove Oil From Water for Environmental Remediation

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Oil spills continue to affect millions of families yearly. Significant research has gone into the development of both organic and inorganic solvents. However, the issue with these sorbents is that they lack buoyancy, have low oil separation, and are also quite costly. This study investigates alginate-based materials modified with hydrophobic compounds, which have shown promising results with oil absorption and super-hydrophobic properties. However, most modifications for hydrophobicity are not eco-friendly. This research looked at modifying the surface of alginate-based sponges with cinnamic and myristic acid – naturally found in the spice cinnamon and nutmeg, respectively– and maximizing oil uptake while minimizing water uptake through its hydrophobic properties. Hydrophobicity was classified as sponges achieving water sponge contact angles of approximately 90° or above. The sponges were made by freeze-drying alginate and then coating them with cinnamic/myristic acid via a Fischer esterification reaction to the hydroxyl groups on the alginate. Upon testing these sponges, contact angles ranged between 93° and 114°, indicating the sponges were hydrophobic. These sponges absorbed oil within seconds of exposure, with a relative mass change of 11-fold. Further, the sponges maintained their hydrophobicity under environmental stressor conditions, with an average difference of 1° - 3° in the water contact angle. While showing both hydrophobicity and oleophilicity, the sponges could separate oil from an oil/water mixture. The findings of this research provide a highly eco-friendly and cost-effective approach to removing oil contaminants from our waterways, and if implemented, would provide a cutting-edge material for oil spill cleanups.