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Physicochemical Characterization of Cationic Surfactant-Modified Banana Stem as an Adsorbent for Wastewater Treatment

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Structured Abstract

Background: Biomass-modified surfactants provide a viable and environmentally sustainable wastewater treatment option. Because of their superior adsorption qualities, these modified surfactants speed up the remediation process and remove contaminants from water sources. By using more renewable resources and lowering dependency on conventional surfactants derived from petroleum, this strategy encourages sustainability. Utilizing biomass-modified surfactants in wastewater treatment allows for the possibility of an economical and environmentally friendly method of water filtration, while also resolving environmental issues. Research has been done on the use of biomass modified with surfactants in wastewater treatment. For instance, biomass has been used as an adsorption technique for the removal of oil, heavy metals, and decolorization from wastewater. This innovative approach involves utilizing natural materials, such as banana stems, modified with surfactants to enhance their adsorption capabilities. The objective is to investigate the effects of cetyltrimethylammonium bromide (CTAB) surfactant modification on the physical and chemical characteristics of banana stems.

Methods: Various samples, including raw banana stems (RBS), NaOH-treated banana stems (NaOH-BS), and banana stems modified with different concentrations of CTAB surfactant (5mM SMBS and 0.07813mM SMBS), were prepared and analyzed using scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), bulk density measurement, pH zero-point charge (pH_{pzc}) determination, and Boehm titration.

Results: SEM results revealed distinct morphological differences, with RBS exhibiting a hard surface, NaOH-BS displaying an uneven and porous surface, and 5mM SMBS presenting a smoother surface compared to 0.07813mM SMBS. FTIR spectra identified characteristic functional groups vary at the region 2950-2800cm^{-1}, and Bulk density measurements indicated varying densities for each sample. The pH_{pzc} values differed among the samples, highlighting the potential impact of surfactant modification. Boehm titration revealed the surface acidity and basicity, with NaOH-BS exhibiting higher acidity than RBS, and SMBS showing a reduction in surface acidity.

Conclusion: In conclusion, the findings of the study indicated that the modification of banana stems with CTAB surfactant significantly alters their physical and chemical properties. This gives comprehension of the modification affected banana's capability which the changes of the properties on the surface will affect the adsorption activities.

Keywords: Banana stem, surfactant modification, physicochemical characterization, cetyltrimethylammonium bromide (CTAB).

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