

A Comparative Analysis of Oil Sorption Efficiency Between Cotton and Vermiculite Clay

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Structured Abstract

Background: Oil spills and petroleum-based pollutants in aquatic environments pose serious threats to ecosystems and human health. Conventional oil sorbents are often costly, synthetic, and non-biodegradable, prompting the need for more sustainable alternatives. This study explores the potential of two natural materials—raw cotton and vermiculite clay—as eco-friendly oil sorbents. While cotton is fibrous and porous with known adsorption properties, vermiculite clay offers a mineral-based alternative with thermal stability and a layered structure. This research aims to evaluate and compare the oil sorption efficiency, retention capacity, hydrophobicity, and selectivity of these materials when exposed to cooking and lubricant oils.

Methods: The raw cotton and vermiculite clay were prepared and characterized using Scanning Electron Microscopy (SEM), Fourier-Transform Infrared Spectroscopy (FTIR), and hydrophobicity testing. Oil sorption and retention capacity were evaluated by immersing 2g of each adsorbent into separate beakers containing either cooking oil or lubricant oil. Selectivity tests in oil–water mixtures were conducted to determine the materials' ability to preferentially absorb oil. Key metrics such as bulk density, pH, and viscosity were also recorded to interpret sorption behaviour.

Results: The results indicate that SEM and FTIR analyses confirmed morphological and chemical differences before and after oil exposure. Cotton showed superior oil sorption capacity (11.19g for cooking oil and 9.92g for lubricant oil) compared to vermiculite clay (1.05g for both). Retention capacities and hydrophobicity were also higher in cotton (98.1%) than in vermiculite clay (81.5%). Cotton displayed significantly better oil-to-water selectivity and removal efficiency, with up to 87.25% efficiency for cooking oil, versus 7.37% for vermiculite clay.

Conclusion: In conclusion, the findings of this study indicated that cotton outperformed vermiculite clay in all evaluated parameters, confirming its potential as an effective, biodegradable, and low-cost sorbent for oil spill remediation. The study supports the use of natural materials like cotton in sustainable environmental management and pollution control strategies.

Keywords: Oil Sorption, Raw Cotton, Raw Vermiculite Clay, Hydrophobicity, Environmental Remediation

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