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TRANSFORMING FERMENTATION RESIDUES FROM DATE FRUIT POMACE FOR THE SYNTHESIS OF BIOADSORBENT MATERIAL IN AN INTEGRATED BIOREFINERY FRAMEWORK

by

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Abstract

In the pursuit of enhanced waste management solutions, this comprehensive research delves into the untapped potential of date fruit pomace (DFP), an abundant byproduct from the date syrup industry that is currently underutilized, leading to environmental concerns. The study emphasizes the need for proper waste management and valorization strategies to mitigate the environmental impact of DFP and promote sustainability within the date processing industry. The initial phase involves characterizing DFP from Emirati varieties, highlighting its compositional and functional properties. The analysis reveals that DFP is rich in total dietary fiber (45.5%), residual sugars (35.3%), protein (10.6%), ash (4.1%), and fat (1.3%). Recognizing the global shift towards a circular, sustainable bioeconomy, the research explores the potential of fermented DFP as a bioadsorbent for sulfate removal from high salinity rejected brine, a critical issue in desalination plants. The bioadsorbent prepared from the fermented DFP in the form of activated carbon exhibited a 90.9% sulfate removal when 500 mg/L brine was treated with 20 g/L of activated carbon at 25°C for 2 h with a BET surface area of 166.48 m2/g. The mechanism of the sulfate adsorption fits the Langmuir model with a maximum adsorption capacity of 415.2 mg/g. The adsorption isotherms and kinetic model indicate that the adsorption is exothermic in nature in close alignment with both pseudo-first- and pseudo-second-order kinetics, indicating that sulfate adsorption is both physical and chemical in nature. A biorefinery based on DFP is proposed and the economic viability is assessed through a techno-economic analysis (TEA) using the software SuperPro Designer. The TEA of the project exhibits a payback period of 3.6 years, highlighting its economic sustainability. The proposed biorefinery project not only aligns with environmental goals but also demonstrates economic viability, making a significant contribution to the sustainable development of the date processing industry in the UAE. In summary, this research provides a holistic exploration of the multifaceted applications of DFP, transforming what was once overlooked waste into a catalyst for sustainable innovation.

Keywords: Date fruit pomace, fermentation residue, bioadsorbent, activated carbon, sulfate removal, Langmuir, biorefinery, techno-economical assessment, SuperPro Designer.