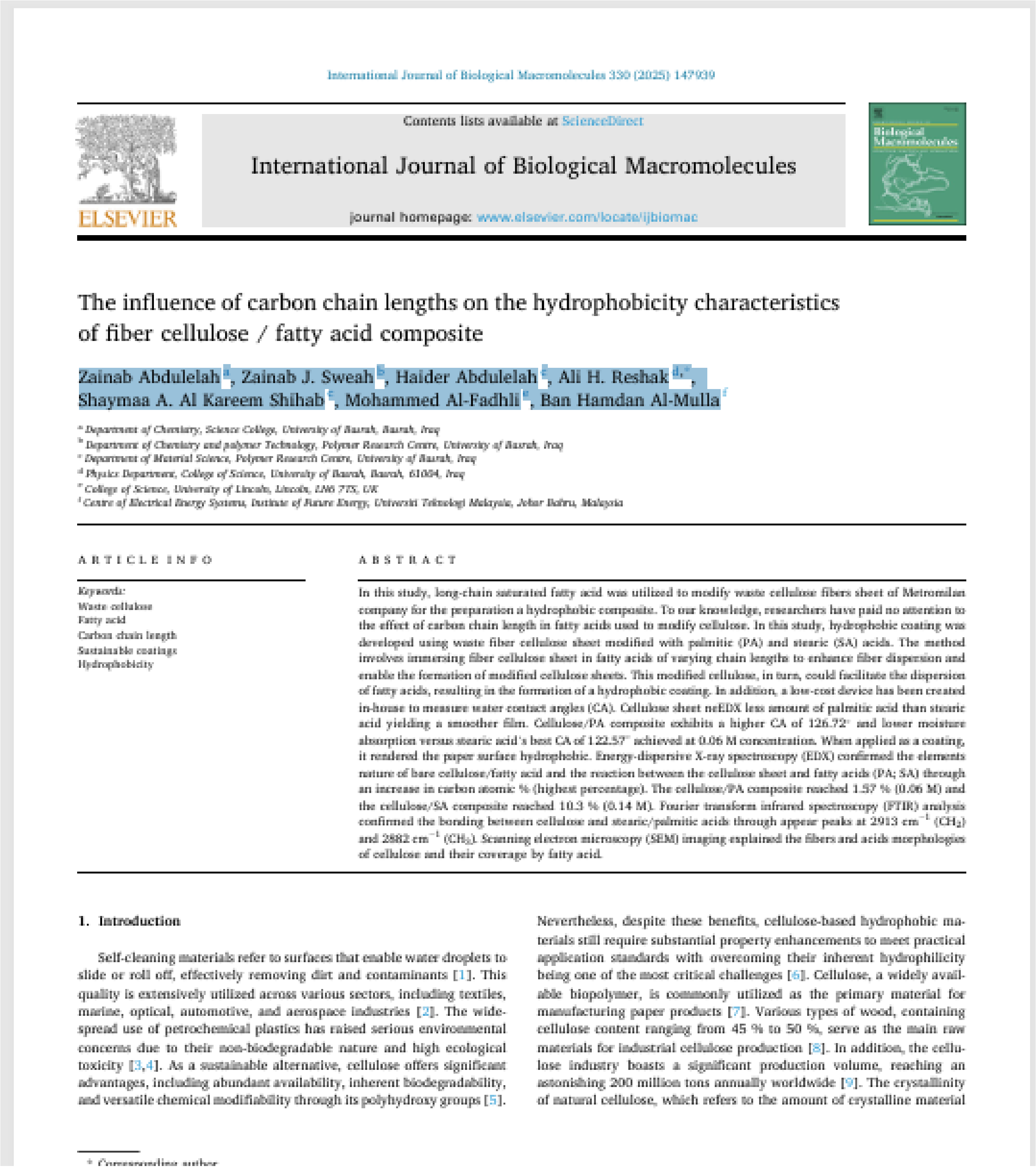

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The influence of carbon chain lengths on the hydrophobicity characteristics of fiber cellulose / fatty acid composite

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ABSTRACT

In this study, long-chain saturated fatty acid was utilized to modify waste cellulose fibers sheet of Metromilan company for the preparation a hydrophobic composite. To our knowledge, researchers have paid no attention to the effect of carbon chain length in fatty acids used to modify cellulose. In this study, hydrophobic coating was developed using waste fiber cellulose sheet modified with palmitic (PA) and stearic (SA) acids. The method involves immersing fiber cellulose sheet in fatty acids of varying chain lengths to enhance fiber dispersion and enable the formation of modified cellulose sheets. This modified cellulose, in turn, could facilitate the dispersion of fatty acids, resulting in the formation of a hydrophobic coating. In addition, a low-cost device has been created in-house to measure water contact angles (CA). Cellulose sheet neEDX less amount of palmitic acid than stearic acid yielding a smoother film. Cellulose/PA composite exhibits a higher CA of 126.72° and lower moisture absorption versus stearic acid's best CA of 122.57° achieved at 0.06 M concentration. When applied as a coating, it rendered the paper surface hydrophobic. Energy-dispersive X-ray spectroscopy (EDX) confirmed the elements nature of bare cellulose/fatty acid and the reaction between the cellulose sheet and fatty acids (PA; SA) through an increase in carbon atomic % (highest percentage). The cellulose/PA composite reached 1.57 % (0.06 M) and the cellulose/SA composite reached 10.3 % (0.14 M). Fourier transform infrared spectroscopy (FTIR) analysis confirmed the bonding between cellulose and stearic/palmitic acids through appear peaks at 2913 cm^{-1} (CH$_2$) and 2882 cm^{-1} (CH$_3$). Scanning electron microscopy (SEM) imaging explained the fibers and acids morphologies of cellulose and their coverage by fatty acid.

1. Introduction

Self-cleaning materials refer to surfaces that enable water droplets to slide or roll off, effectively removing dirt and contaminants [1]. This quality is extensively utilized across various sectors, including textiles, marine, optical, automotive, and aerospace industries [2]. The widespread use of petrochemical plastics has raised serious environmental concerns due to their non-biodegradable nature and high ecological toxicity [3,4]. As a sustainable alternative, cellulose offers significant advantages, including abundant availability, inherent biodegradability, and versatile chemical modifiability through its polyhydroxy groups [5]. Nevertheless, despite these benefits, cellulose-based hydrophobic materials still require substantial property enhancements to meet practical application standards with overcoming their inherent hydrophilicity being one of the most critical challenges [6]. Cellulose, a widely available biopolymer, is commonly utilized as the primary material for manufacturing paper products [7]. Various types of wood, containing cellulose content ranging from 45 % to 50 %, serve as the main raw materials for industrial cellulose production [8]. In addition, the cellulose industry boasts a significant production volume, reaching an astonishing 200 million tons annually worldwide [9]. The crystallinity of natural cellulose, which refers to the amount of crystalline material

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