Junior Science Communications
Faculty of Applied Sciences, UiTM Shah Alam
https://journal.uitm.edu.my/ojs/index.php/JSC

E-ISSN 2637-0689
Vol 63 2026

Colloquium on Applied Sciences 1 2026
19-22 January 2026, Faculty of Applied Sciences, UiTM Shah Alam, Malaysia

Effect of Hydrogen Peroxide Concentration on the Cellulose Extraction and Nanocellulose Preparation Derived from Oil Palm Fronds

Nur Afiqah Hanim Azlan[a], Sabiha Hanim Saleh[ab*]

Structured Abstract

Background: Oil palm fronds (OPF) are an abundant agricultural waste in Malaysia due to the extensive oil palm industry, making them a promising renewable and sustainable raw material for cellulose extraction. This study investigates the extraction of cellulose from OPF through alkaline pre-treatment followed by hydrogen peroxide (H_2O_2) bleaching, with subsequent preparation of nanocellulose via acid hydrolysis.

Methods: Oil palm fronds were chopped to 5–10 mm, washed with distilled water, and oven-dried at 60 °C for 24 hours. Dried OPF were crushed and sieved (70 mesh), then treated with 4% NaOH at 70 °C for 90 minutes under stirring to remove hemicellulose. Bleaching was performed using H_2O_2 (2–11%) for 3 hours. Further delignification was conducted using HNO_3 and acetic acid (1:10 v/v) at 120 °C for 15 minutes. Samples were rinsed to neutral pH and dried. Nanocellulose was produced via 12% H_2SO_4 hydrolysis at 55 °C for 130 minutes, filtered, washed, and freeze-dried to obtain purified nanocellulose suitable for further physicochemical characterization analysis.

Results: This study shows that cellulose yield increased with increasing H_2O_2 concentration from 2% to 8%, rising from 48% to a maximum of 68%, before decreasing at higher concentrations due to cellulose degradation and depolymerization. FTIR analysis confirmed that all observed absorption peaks corresponded to cellulose, indicating effective removal of non-cellulosic components. TGA results showed thermal decomposition between 132 and 325 °C, with maximum weight loss at 276 °C. XRD patterns displayed characteristic cellulose peaks at $2\theta = 16°$ and 23°, with an average crystallinity index of 30%. SEM images revealed progressive morphological changes, where cellulose treated with 8% H_2O_2 exhibited the most uniform structure overall.

Conclusion: Overall, the findings indicate that 8% H_2O_2 is the optimal bleaching concentration for producing high-yield cellulose with desirable structural properties, highlighting the potential of OPF as a sustainable source for cellulose and nanocellulose production and supporting improved biomass waste management.

Keywords: Oil Palm Fronds; Pre-Alkaline Treatment; Alkaline Bleaching Treatment; Acid Hydrolysis

***Correspondence: sabihahanim@uitm.edu.my

[a] School of Chemistry & Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia

[b] Industrial Waste Conversion Technology Research Group, Universiti Teknologi MARA, Shah Alam, Malaysia