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Isolation, Characterization of Cellulose From Palm Leaves

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ABSTRACT

This study focuses on cellulose extraction from palm leaves using two different processes with the aim of comparing the studied methods. Isolation was carried out through chemical treatments such as acid hydrolysis and alkaline treatment. The cellulose, lignin, and hemicellulose content were determined through ADF-NDF analysis. The structural characterization of the two obtained celluloses was conducted using Fourier Transform Infrared Spectroscopy (FTIR), thermal properties were analyzed through Thermogravimetric Analysis (TGA/DTG), and morphological study was performed using Scanning Electron Microscopy (SEM).

Keywords: Cellulose, Extraction, isolation, natural polymer.

1. Introduction

Palm leaves are an underutilized waste material in the Saharan region that regenerates annually. In this study, they are employed as raw material for cellulose extraction and modification. Besides the ligno-cellulosic fibers found in palm leaves, they also contain hemicelluloses, fats, essential oils, and proteins. Our work begins with the determination of the composition of Washingtonia Filiferaen palm leaves, specifically cellulose, lignin, and hemicellulose, using the Van Soest and Wine method known as ADF-NDF (acid detergent fiber - neutral detergent fiber) assay. Subsequently, we proceeded with cellulose isolation, employing two extraction methods. Cellulose isolation involves removing lignin and other components such as fats and hemicellulose. This extraction was carried out through successive treatments, including mechanical processes (grinding) and chemical methods like acid hydrolysis or alkaline treatment of ligno-cellulosic fibers. These treatments aim to minimize distortions and preserve the fibrous texture of cellulose. Cellulose and lignin contents in each process were determined using the Van Soest and Wine methods, respectively. The structural characterization of the obtained products was conducted using FTIR, XRD, thermal properties analysis via TGA, and morphological study through scanning electron microscopy (SEM).

2. Experimental

Cellulose was obtained through the chemical treatment of palm leaves using various organic solvents. The purpose of these treatments is to eliminate all other components present in this plant. Initially, palm leaves were washed multiple times with distilled water and dried at 80°C for 12 hours. Subsequently, fats were removed through a Soxhlet extraction using a mixture of ethanol and toluene (1/2, v) at a temperature close to 80°C. After several extraction cycles, the degreased palm leaves were recovered, washed with distilled water, and dried at 80°C for 12 hours. The delignification of our palm leaves was carried out using sodium hydroxide at various concentrations.

3. Results and Discussion

The first observation that can be made about the obtained cellulose samples is their difference in color. Process 1 resulted in a light-colored cellulose, while Process 2 yielded a dark-colored cellulose. This discrepancy in cellulose color suggests that the products obtained have different degrees of purity. Indeed, the product obtained through Process 2 would contain more lignin, thereby explaining its dark color.

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In Figure 1, we have depicted the FTIR spectra of the extracted celluloses from both processes, the FTIR spectrum of raw palm leaves, and the commercial cellulose used as a reference. Thermogravimetric analyses (TGA) were conducted to examine the thermal degradation of the extracted celluloses, palm leaves in their raw, ground state, and commercial cellulose for comparative purposes Figure 2.

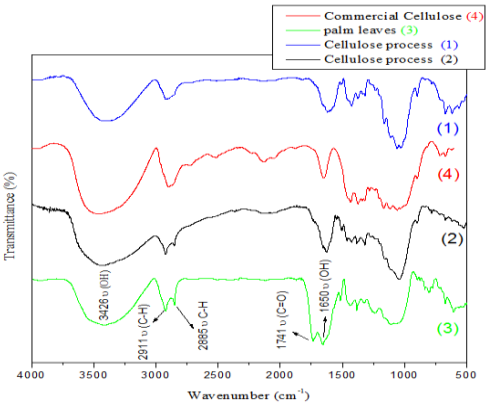

Figure 1: FTIR spectrum of the cellulose extracted using both processes and the raw plant material.

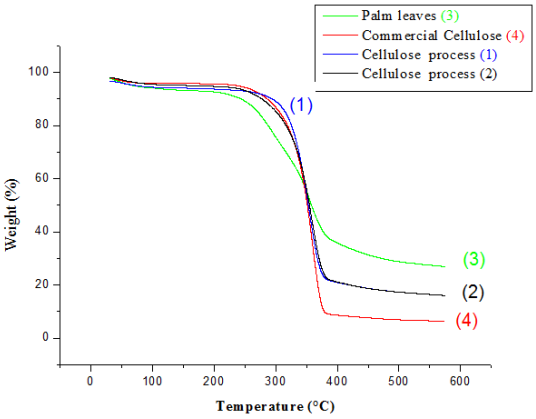

Figure2: TGA analysis of the extracted cellulose as well as the raw plant material.

In our study, cellulose was extracted through two different processes based on the literature (acid hydrolysis and/or alkaline treatment) with the aim of comparing the two extraction methods. The cellulose and lignin content for each obtained product were determined using the ADF-NDF method. The obtained products were characterized using Fourier Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), Scanning Electron Microscopy (SEM), and X-ray Diffraction.

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