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EXTRACTION OF CELLULOSE FROM *TYPHA ANGUSTIFOLIA L.* AND *PHRAGMITES COMMUNIS TRIN.* BY AN ACID- ALKALINE METHOD AND ITS THERMAL ANALYSIS

Mahmudov Muxammadrasul Sodiqjon oqli¹,
Mamajanov Gulomjon Odiljanovich¹,
Toshmatov Yoldoshali Raxmonovich¹

¹ Namangan State University

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Abstract

This article examines the extraction of cellulose from *Typha angustifolia L.* and *Phragmites communis Trin.* using acid–alkaline chemical methods and investigates its thermal properties. Thermogravimetric analysis (TGA) and differential thermal analysis (DTA) were applied to the cellulose samples to evaluate weight changes and thermal reactions under the influence of temperature. The obtained results made it possible to identify differences in the thermal stability and degradation characteristics of cellulose isolated from the two plant sources.

Keywords: cellulose, thermogravimetry, differential thermal analysis, *Typha angustifolia*, *Phragmites communis*, acid–alkaline extraction, thermal stability

Introduction

Cellulose is a natural polymer widely used in various industrial sectors, including paper production, printing, pharmaceuticals, and the manufacture of composite materials. Traditionally, cellulose is primarily derived from wood; however, due to the limited availability of forest resources and environmental concerns, alternative sources are being explored.

Fast-growing aquatic plants, particularly *Typha angustifolia L.* and *Phragmites communis Trin.*, produce large amounts of bio-

mass and are considered promising raw materials for cellulose production.

The process of cellulose extraction involves various chemical methods, and different analytical techniques are employed to evaluate its quality. Thermal analysis, especially TGA and DTA, plays a crucial role in determining the thermal stability and degradation characteristics of cellulose.

In this study, cellulose was extracted from two plant species using an acid–alkaline method, and a comparative analysis was conducted based on thermal analysis results.

Materials and Methods

Cellulose Extraction

Samples obtained from *Typha angustifolia* L. and *Phragmites communis* Trin. were initially treated in a 7% nitric acid solution. Subsequently, lignin and other components were removed through processing in a 3% alkaline solution. Thereafter, a bleaching process was carried out using a mixture of alkali and hydrogen peroxide (H₂O₂) in a 1:3 ratio, resulting in purified cellulose.

Thermal Analysis

The extracted cellulose samples were subjected to thermogravimetric analysis (TGA) and differential thermal analysis (DTA). The analyses were performed using a Shimadzu thermal analyzer. Samples were heated in an argon atmosphere from 25 °C to 500 °C

at a heating rate of 10 °C/min. TGA recorded weight changes, while DTA identified the exothermic and endothermic nature of thermal events.

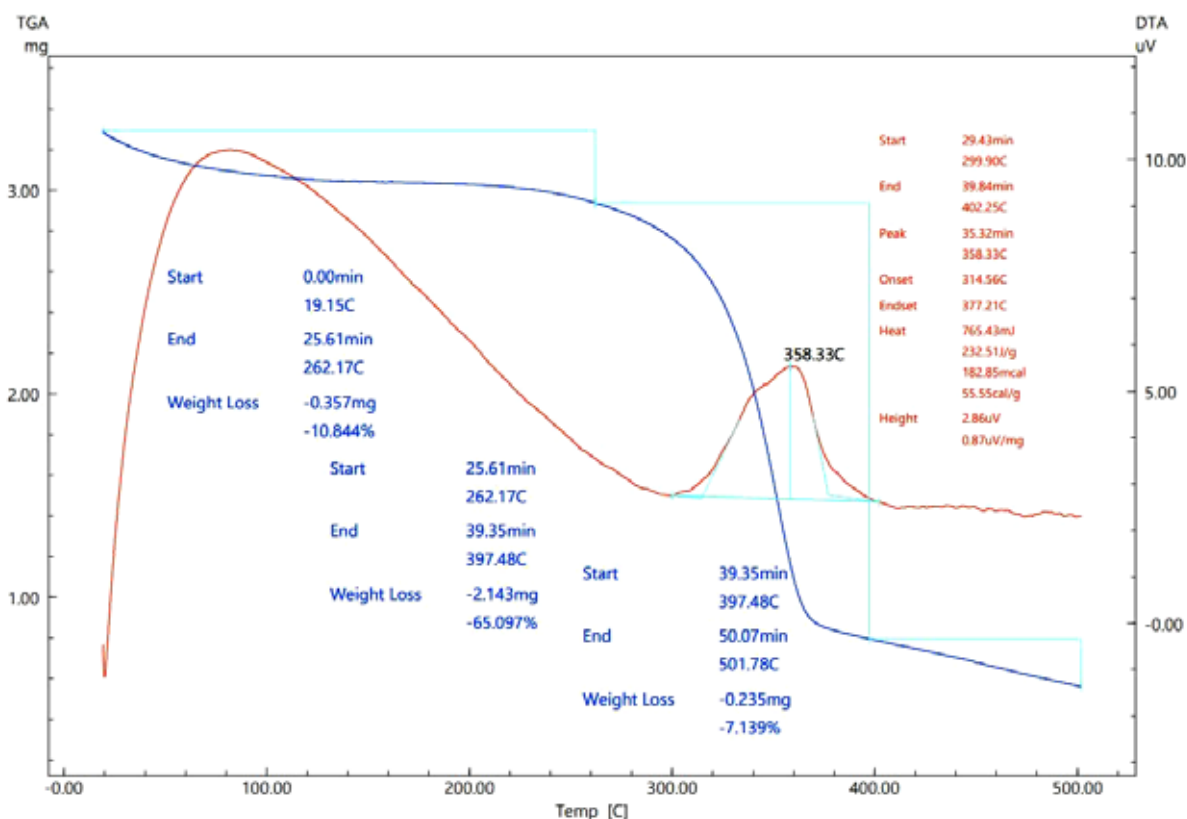
Results

Cellulose from *Typha angustifolia* L.

TGA results indicated that the initial weight loss in the sample reached approximately 10.8% within the temperature range of 19.15 °C to 262.17 °C. The second main degradation stage occurred between 262.17 °C and 397.48 °C, with a weight loss of 65.1%. At 50.07 minutes, the total weight loss was 7.14%.

The DTA curve showed a pronounced exothermic peak at 358.33 °C, corresponding to the most active stage of degradation (Figure 1).

Figure 1. TGA and DTA curves of cellulose obtained from *Typha angustifolia* L.



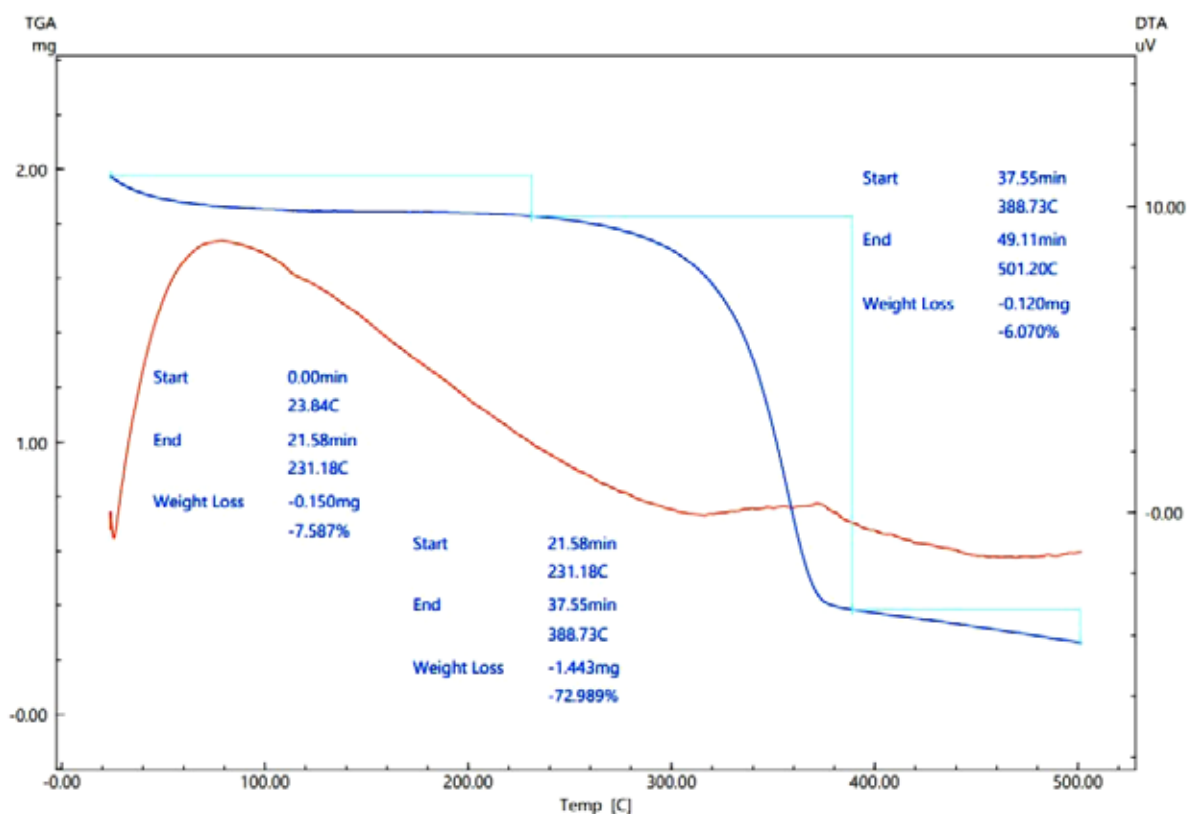
Cellulose from *Phragmites communis* Trin

According to TGA data, the *Phragmites communis* sample exhibited a weight loss of 7.6% in the initial stage (23.84 °C–231.18 °C). In the second stage (231.18 °C–388.73 °C),

a weight loss of 72.99% was observed. In the final stage (388.73 °C–501.20 °C), an additional 6.07% weight loss occurred.

DTA analysis revealed a thermal peak at 362.24 °C, corresponding to the main thermal degradation phase of cellulose (Figure 2).

Figure 2. TGA and DTA curves of cellulose obtained from *Phragmites communis Trin*



Comparison of the Two Samples

The thermal degradation behavior of cellulose extracted from both plants appears similar in terms of temperature ranges and percentage weight losses. However, the cellulose from *Typha angustifolia* undergoes degradation at slightly lower temperatures in the second stage (262.17 °C–397.48 °C), whereas *Phragmites communis* degrades

within a slightly higher temperature range (231.18 °C–388.73 °C).

In terms of weight loss, *Phragmites communis* shows a higher value (72.99%) in the second stage, indicating greater susceptibility to thermal degradation. The DTA peaks for both samples lie within the range of 350–360 °C, representing the primary thermal reaction of cellulose.

Table 1. Comparative analysis of the two samples

Parameter	<i>Typha angustifolia L.</i>	<i>Phragmites communis Trin.</i>
Initial degradation temperature range (°C)	19.15–262.17	23.84–231.18
Mass loss in initial stage (%)	10.8	7.6
Main degradation temperature range (°C)	262.17–397.48	231.18–388.73
Mass loss in main stage (%)	65.1	72.99
Final degradation temperature range (°C)	—	388.73–501.20
Mass loss in final stage (%)	—	6.07
Peak degradation temperature (DTA, °C)	358.33	362.24
Thermal stability assessment	Relatively higher	Relatively lower
Degradation intensity	Moderate	Higher

Discussion

The results of the study demonstrate that cellulose extracted from *Typha angustifolia* L. and *Phragmites communis* Trin. using acid–alkaline chemical methods exhibits comparable thermal stability and degradation characteristics. Thermal analysis results, particularly the DTA peaks, indicate that the primary thermal degradation of cellulose occurs within the range of 350–360 °C, which is consistent with previously reported findings (Zhao et al., 2020; Kumar et al., 2018).

Cellulose obtained from both plant sources exhibits sufficient thermal stabil-

ity, making it suitable for application in industrial processes, including composite material production and biopolymer technologies. The higher weight loss observed in *Phragmites communis* during the second stage suggests a greater tendency toward thermal degradation, which may be attributed to differences in chemical composition.

Thermal analysis methods serve as effective tools for evaluating cellulose quality and are essential for determining the influence of plant sources and extraction methods on the thermal properties of cellulose.

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Contact: muxammadrasulmahmudov98@gmail.com