

Pretreatment and fiber content analysis of *Cannabis sativa L.* Part II.

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Abstract:

Cannabis Sativa L., more commonly known as hemp, has become one of the fastest-growing plants whose refined products have immense commercial value. Various products such as: biofuels, biodegradable plastics, textiles, dietary supplements, paper, clothing and more include refined hemp in their composition. Hemp fibers are also used in construction and manufacturing applications as a way to strengthen composite products. The various qualities of hemp make it a high yielding, sustainable, and environmentally friendly crop which has the potential to yield valuable raw materials for a great number of applications. Our research evaluates the pretreatment of hemp as well as the comparative analysis of the fiber content thereof. Our goal is to determine the suitability and the potential use of ionic liquid-based pretreatment (1-Butyl-3-methylimidazolium chloride) for the breakdown of hemp lignocellulosic biomass. The data presented and discussed in the following sections is compiled from procedures done on hemp during the fall of 2020 and compared to the results from spring of 2021.

Introduction :

Hemp, a crop popularly used as a major sustainable fiber for production, is from the Cannabis family and contains 0.3% THC compared to marijuana 17.1%, allowing it to be a safe and compelling raw material. Factors such as its rapid growth cycle, withstand of harsh environmental conditions and fiber makeup positively supports hemp's resurgence in the textile, agricultural, pharmaceutical and fuel industries. *Cannabis Sativa L.*, hemp, is classified as second-generation biomass due to its composition of non-edible plant material such as lignocellulose; which is responsible for the structural stability, high strength and stiffness of hemp's cell walls.

The goals of this study are, 1; to determine how efficient the use of ionic liquid is for the pretreatment of hemp lignocellulosic material and, 2; evaluate the quality of fiber obtained thereof.

Procedure

I. Biomass Preparation

The hemp was donated by SUNYrf. The hemp was chopped into three sizes (Ground ¼", Short ½", and Large 1"), washed in deionized water, and placed in an oven at 70 degrees Celsius for three days to dry. Once dried, the "ground" samples were ground with mortar and pestle to resemble a fine powder. The "Short and Large" samples were cut using scissors to their respective sizes. Then 0.3g of each sample were weighed using an analytical balance and distributed into respective Erlenmeyer flask for pretreatment.

II. Ionic Liquid(IL) Pretreatment

The pretreatment used for the hemp samples was 1-Butyl-3-methylimidazolium chloride. For each flask, 3.0 grams of this ionic liquid was added along with a magnetic stirrer. All sample flasks were heated in mineral oil baths in crystallizing dishes at temperatures between 75-80 degrees Celsius. Each dish was placed on a hotplate for either 3, 6, or 9 hours. Once samples reached their target heating period, they were removed and left to cool.

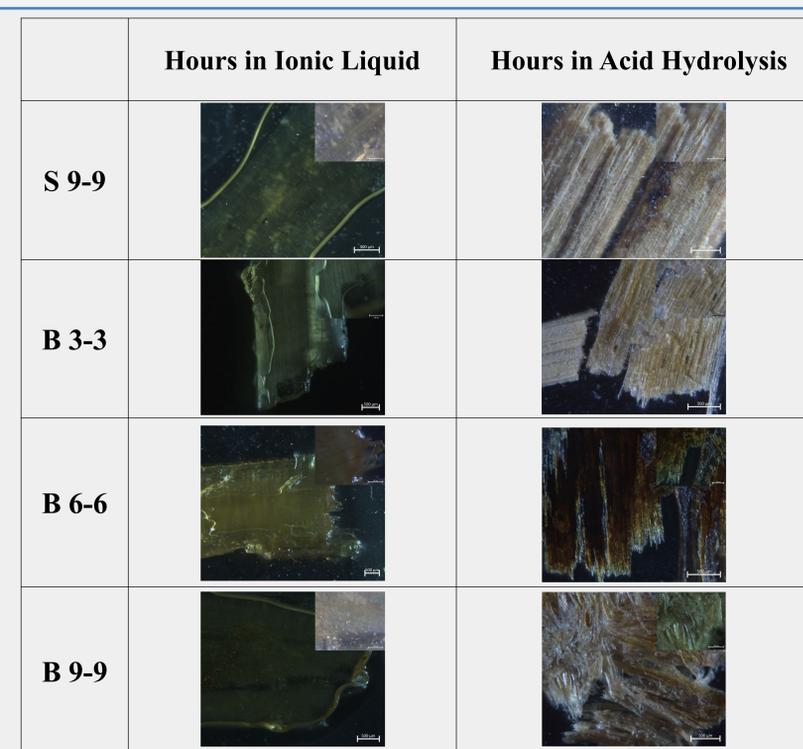
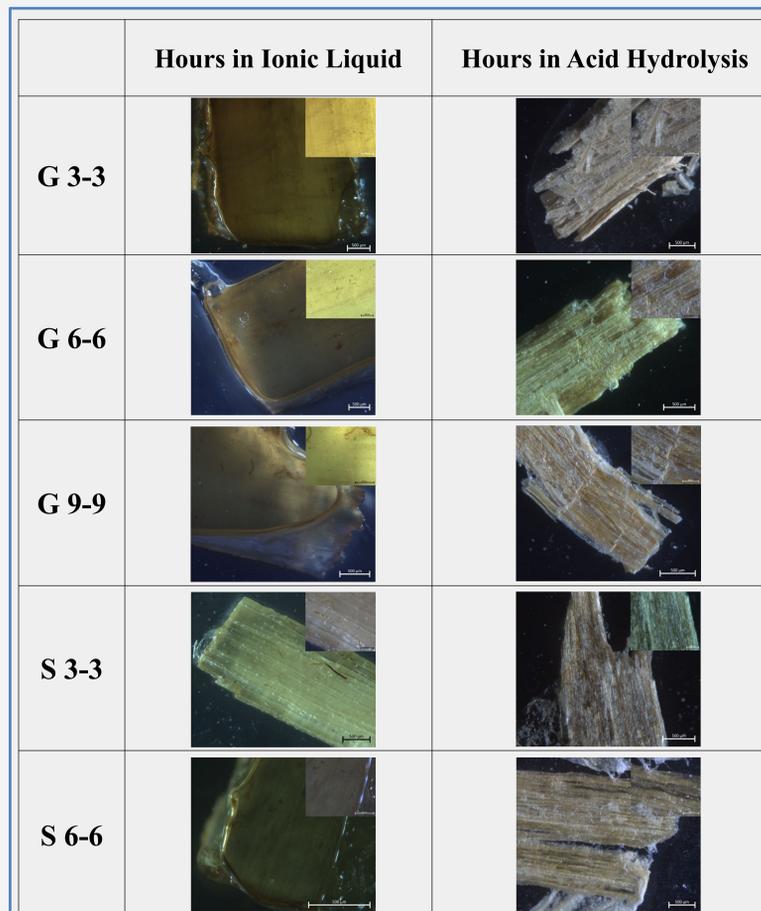


Table 1 and 2.

Stereomicroscope images of hemp from ionic liquid and acid hydrolysis stages. The abbreviation "G" corresponds with Ground Hemp, "S" for Short Hemp and "B" for Big Hemp.

Procedure continued...

III. Acid Hydrolysis

After the ionic liquid pretreatment, the samples containing ionic liquid and hemp, were filled with 10.0 mL of 0.5 Hydrochloric acid. The samples were heated in mineral oil baths in crystallizing dishes for either 3, 6, or 9 hours at 80 degrees Celsius. Once heated, samples were removed and left to cool for 30 minutes. After cooling, 10.0 mL of 0.5 M sodium hydroxide solution was added to each acidic sample as a neutralizer.

IV. Slide Preparation

From each step: raw, ionic liquid, and acid hydrolysis, hemp samples were collected for fiber examination. Hemp fragments were removed from each flask, rinsed with deionized water, and placed on glass slides to be examined using a stereomicroscope. Slides were labeled A for acid hydrolysis, IL for Ionic liquid, and RAW for raw samples.

V. Stereomicroscope

The microscope used for the data collection was ZEISS SteREO Discovery.V20. The objective lens applied for all images was the Achromat S 1.5x FWD 28mm. For optimal imagery, a z-stack was conducted based on the topography of each hemp fiber. Additionally, images underwent further processing methods such as "Extended View of Focus" to sharpen resolution, or "White Balance" to adjust light reflection. Images displayed show two fields of vision of each hemp sample, a half and zoomed view. Additional samples under acid hydrolysis are shown to allow an updated comparison to previous images of samples under the ionic liquid treatment.

Results and Future directions:

The pretreatment of the hemp fiber resulted in more fibrous material in each treatment stage. These results suggest that the ionic liquid 1-Butyl-3-methylimidazolium chloride may serve as a good pretreatment candidate for further studies on hemp.

Future directions will include imaging the remainder of the samples to gain a better understanding of the differences in fiber breakdown after ionic liquid and acid hydrolysis treatment. Further data of the hemp fiber decomposition can be obtained using Thermal Gravimetric Analysis. This analysis would measure the mass of the sample over time as the temperature changes to provide information about the thermal decomposition/stability of hemp.

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