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ISOLATION AND CHARACTERIZATION OF NANOCELLULOSE FROM SUGARCANE BAGGASE AND ITS SWELLING STUDY

Biochemistry

Suman Kumari* Institute of Biochemistry, Magadh University, Bodh Gaya. *Corresponding Author
Pawan kumar Institute of Biochemistry,Magadh University,Bodh Gaya.
RPS Chauhan Department of Chemistry, Magadh University, Bodh Gaya.
Abhilasha Mishra Department of Chemistry,Graphic Era University(Deemed to be), Dehradun.

ABSTRACT
Cellulose in the nanometer range called nanocellulose. In this study, nanocellulose is prepared by Acid hydrolysis method by sugarcane bagasse.To prepare nanocellulose composite, chitosan was addedwith povidone-Iodine (PVP-I) and cross-linker N, N'Methylenebisacrylamide(MBA).XRD processing was used to determine the morphological form of the prepared nanocellulose. The crystalline structure of the prepared nanocellulose is characterized by XRD analysis. The characterization of FTIR to find the chemical composition of extracted nanocellulose. The swelling of the composite in sodium chloride and evaluated D- glucose solution, and the composite was found to be intact in solution with no disintegration. The composite shows maximum swelling capacity in D-Glucose then sodium chloride due to O-H linkage.

KEYWORDS
Swelling capacity,Nanocellulose,N,N'-Methylenebiscarylamide(MBA),Crystalline nature.

INTRODUCTION
Cellulose is isolated from rice straw, banana fiber, Wood, and sugarcane bagasse. Sugarcane bagasse is a byproduct of sugar produced in large quantities of alcohol and sugar industries sugarcane bagasse is used as a raw material in some industries for biomedical application, operated electric generation, fermented products, and biomass development [1]. Sugarcane bagasse contains 40-50% cellulose, with the crystalline structure accounting for most of it. Hemicellulose, which makes up 25-35% of sugarcane bagasse, is an amorphous polymer made up primarily of xylose, arabinose, galactose, and mannose. The rest is mostly lignin, which accounts for 18-24% [2]. Cellulose is a polysaccharide molecule made up of D-glucopyranose joined together by a 1, 4-glycoside bond. In cellulose, the secondary hydroxyl group present the C-2 and C-3 positions and the primary hydroxyl group at the C-6 position. Due to hydroxyl groups, cellulose plays an important role in the compactness of the crystalline morphology and physical property like low thermal property [3, 4]. At the plant fiber, cellulose exists in an amorphous phase that is linked to the crystalline phase by an intermolecular and intramolecular hydrogen bonds. This prevents cellulose from melting at the thermal degradation temperature [5, 6]. Cellulose is biodegradable, has good mechanical properties, and low in density.

Because of high molecular weight and its long-chain shows a hydrophobic property.Nanocellulose has a higher surface area than cellulose. It can be used as an alternate method to make cellulose more readily modified and dissolved in water [7]. Acid hydrolysis, ultrasonic process, and enzymatic hydrolysis, Tempo-oxidation method can produce nanocellulose [8, 9]. Acid hydrolysis is the commonly used methods. This method makes it simple and fast to create nanocellulose with improved properties. According to certain tests, the crystallinity index of nanocellulose generated by acid hydrolysis was higher than that of nanocellulose produced by other processes. The acid hydrolysis nanocellulose has a smaller scale. The acid hydrolysis process was chosen to extract nanocellulose for these purposes. To dissolve the glycoside bonds in cellulose, strong acids like H_2SO_4 and HCl are widely used. Acid hydrolysis is divided into several steps (1) heavy acid hydrolysis of cellulose under regulated conditions such as concentrated acid, time,temperature, and acid to cellulose ratio (2) dilution with some water to avoid the hydrolysis process and repeated centrifugation (3) dialysis to completely extract free acid molecules (4) sonication to form a stable suspension[10] Nanocellulose has a number of distinguishing characteristics, including low density, biodegradability, and strong mechanical properties Also simple to modify, with a large surface area and distinct morphology. Due to its small particle size and high crystallinity nature commonly used in biomedical application such as wound healing, drug delivery and act as nanofiller in polymer materials [11].

2. Experimental
Sugarcane bagasse was collected from Delhi (India). Other reagents used were toluene, ethanol, sodium chloride, sodium hypochlorite, potassium hydroxide, 10%Sulfuric acid.

2.1 METHODS
2.1.1. Isolation of cellulose
Sugarcane bagasse was dried in sunlight, then taken inner side (pith) and discarded outer side (rind) and then inner side was being cut into small pieces. The cut pieces were passes into the grinder to become powder. The powder of bagasse was steeped in sodium hypochlorite, acetic acid solution (2:1) for 10 hours for bleaching. The residue was washed with distilled water twice until neutral P^H. That gives alkali treatment with 1 % NaCl to remove the lignin successively added. Further 5% KOH solution was added to remove hemicelluloses. The residue is washed with distilled water until reaching neutral PH. The neutral residue was added with cellulase enzyme and kept in the water bath for 12 hours to 36 hours at 40^0C. Then dried at room temperature for 1-3 days.

2.1.2 Preparation of Nanocellulose by acid hydrolysis method
Isolated cellulose from sugarcane bagasse was hydrolyzed with 10% sulfuric acid. The ratio is cellulose, and sulfuric acid was taken 1:25 and held for hydrolysis till overnight. The hydrolysis of cellulose was controlled by concentrated sulfuric acid, temperatures, and time periods.The hydrolysis was halted by adding purified water in a 10-fold excess to the reaction mixture. To create colloidal suspension sample centrifuge at 6500rpm for 30 minutes. The water was then dialysis for 5 days to extract and neutralize the sulphate ions to homogenize and then Sonicated the sample for 15 min.

2.3. Characterization
To examine the chemical changes during the cellulose extraction process from sugarcane bagasse, FTIR spectra were reported in the spectral area between 4000 and 400 cm^{-1} (Thermo Scientific Nicolet 6700). X-ray diffraction was used to study the crystalline structure of cellulose and helps in phase recognition of cellulose composites (Rigaku, Smartlab). Swelling Measurement is a traditional gravimetric technique was used to assess the degree of the swelling. A dried nanocellulose composite with a known weight (W_d) was soaked in a known amount of sodium chloride and D-Glucose medium respectively, at room temperature before equilibrium swelling was achieved. The swollen composite was carefully squeezed between two filter papers to drain excess water and then adequately weighted (Ws). The following equation is used to measure the amount of sodium chloride and D-Glucose taken in.

Swelling ratio=Ws/W_d

3. RESULT AND DISCUSSION
3.1. Infrared Spectroscopy analysis (FTIR)

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Figure 1 shows FTIR spectra on extraction of cellulose process, delignification of cellulose by chemical treated Sample .FTIR spectra show absorbance regions in the ranges of 600–4000cm-[1].

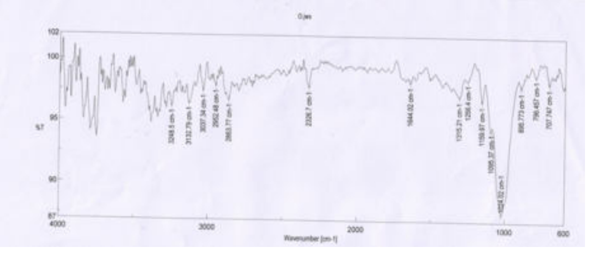

Figure.1 FTIR Spectra of chemical treated Nanocellulose

In the above graph, the C-O stretching in-plane aromatic or aromatic C-H deformation vibration of cellulose and lignin is connected to the highest peak at 1024 cm-[1].

3.2. X-ray Diffraction Analysis

X-RD was used to validate the crystalline activity of acid hydrolyzed cellulose nanocrystals. Figure 2 depicts the XRD graph. The lignin content of cellulose makes it amorphous in nature. And the cellulose content itself resembles the crystalline component. To achieve the crystalline form of cellulose, raw cellulose was hydrolyzed with 2% acid solution during chemical treatment. The degree of crystallite is influenced by the acid concentration and hydrolysis time. The presence of a sharp point in the XRD graph confirms the nanocellulose highly crystalline composition.

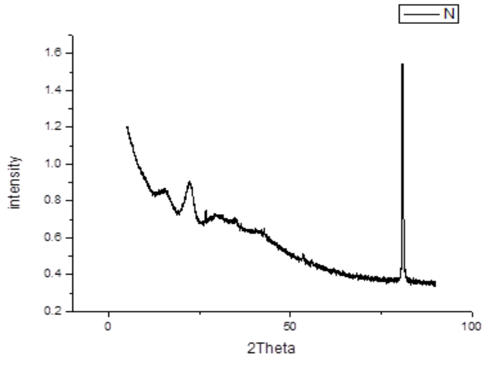

Figure.2 XRD study of Acid hydrolysis nanocellulose

3.3 Swelling ratio

The swelling ratio provides information about the sample's ability to retain water. The cellulose nanocomposite with different nanocellulose concentrations was studied. Figure 3 shows saturation periods of 24 hours and maximum swelling ratios of 0.5 in NaCl and 0.8 in glucose, respectively. The results revealed that when cellulose nanocrystals was added to the composite membrane, povidone-iodine(PVP-I) drug and crosslinker N,N'-Methylenebisacrylamide (MBA) was joined as an unstructured part between the chitosan polymer chains, and ultimately making the nanocellulose composite.

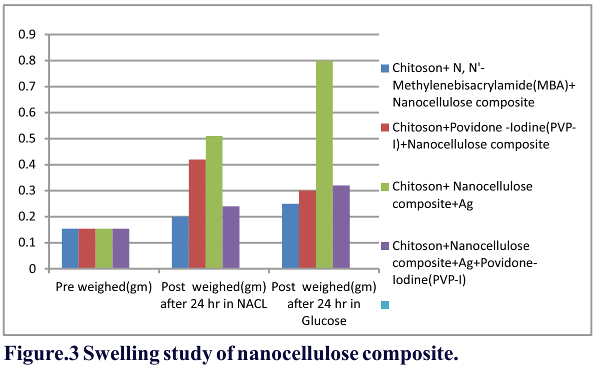

Figure.3 Swelling study of nanocellulose composite.

CONCLUSION

In this study, the acid hydrolysis method was used to remove the cellulose from sugarcane bagasse. The bleaching was used to remove hemicellulose and lignin from the sugarcane bagasse shown in FTIR spectra. The treated nanocellulose had crystalline nature according to XRD data. The nanocellulose composite is prepared by different ratio of chitosan, Povidone-iodide drug and MBA. The swelling ratio of nanocellulose composite is maximum in D-glucose than sodium chloride.

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