sustainability

Supporting Information

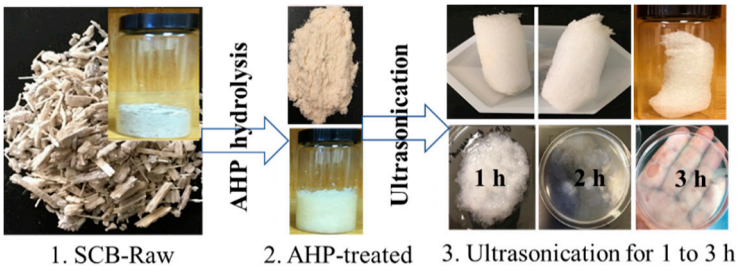

Figure S1. The transformation process of sugarcane bagasse to cellulose nanofiber: 1. Sugarcane bagasse- raw with a pulverized fine powder, 2. AHP hydrolyzed pulp cellulose (Below) and dried powder (Above) and 3. Ultrasonication gel-like CNF at 1 to 3 h (Below) and Freeze-dried fibers (Above).

Table S1. Composition analysis of sugarcane bagasse, cellulose and ultrasonicated fibers at 1 h, 2 h, and 3 h

Sample	Concentration (%)					
	Cellulose	Hemicellulose				Lignin
	Glu	Xyl	Gal	Ara	Man	AS+AIL
SCB-Raw	38.7	11.4	4.5	1.3	4.3	33.4
Cellulose	67.2	0.1	3.0	1.3	3.4	13.4
CNF-US1	86.1	-	2.0	1.3	2.0	3.5
CNF-US2	92.5	-	2.0	1.2	2.1	1.5
CNF-US3	92.7	-	1.2	1.2	2.2	1.4

Table S2. Crystallinity property of raw (SCB-Raw), AHP treated (cellulose), ultrasonication at 1 h, 2 h, and 3 h (CNF-US1, CNF-US2 and CNF-US3) and commercial cellulose (CNC and CNF).

Sample	Angle (2θ)	d(nm)	Height	Height%	Area	Area%	FWHM	CI(%)
SCB-Raw	16.0	0.6	11.7	0.2	5.0	0.5	0.368°	35.1
	20.8	0.4	66.2	1.0	9.5	1.0	0.122°	
	22.2	0.4	54.7	0.8	7.7	0.8	0.119°	
	22.5	0.4	51.3	0.8	5.7	0.6	0.094°	
	35.0	0.3	9.9	0.1	4.3	0.5	0.380°	
Cellulose	16.3	0.5	146.6	0.5	302.2	0.5	1.753°	45.4
	18.4	0.5	92.0	0.3	29.4	0.1	0.271°	
	20.8	0.4	205.6	0.8	469.3	0.8	1.940°	
	22.6	0.4	261.3	1.0	553.9	0.9	1.802°	
CNF-US1	15.7	0.6	56.7	0.2	45.3	0.1	0.679°	52.7
	21.0	0.4	131.2	0.5	312.1	0.5	2.023°	
	22.0	0.4	246.6	1.0	672.7	1.0	2.319°	
	22.5	0.4	257.4	1.0	660.3	1.0	2.181°	
CNF-US2	16.4	0.5	118.3	0.3	114.9	0.1	0.827°	57.7
	20.9	0.4	226.3	0.6	424.1	0.4	1.594°	
	21.7	0.4	407.9	1.0	986.8	1.0	2.057°	
	22.3	0.4	406.6	1.0	1003.1	1.0	2.098°	

	34.4	0.3	32.4	0.1	11.0	0.0	0.290°	
CNF-US3	16.6	0.5	149.1	0.4	342.2	0.4	1.951°	61.6
	21.4	0.4	277.3	0.7	534.3	0.6	1.638°	
	22.1	0.4	404.7	1.0	890.6	1.0	1.871°	
	22.2	0.4	408.4	1.0	890.0	1.0	1.853°	
	35.4	0.3	39.4	0.1	26.2	0.0	0.565°	
CNC	16.4	0.5	62.9	0.1	55.5	0.1	0.751°	67.7
	19.8	0.4	278.6	0.6	346.0	0.4	1.056°	
	22.0	0.4	463.1	0.5	249.0	0.3	1.017°	
	22.4	0.4	460.6	1.0	770.9	1.0	1.423°	
	34.5	0.3	80.2	0.2	57.2	0.1	0.607°	
CNF	15.7	0.6	141.4	0.3	381.5	0.4	2.294°	55.9
	22.5	0.4	425.7	1.0	865.2	1.0	1.728°	
	34.5	0.3	68.7	0.2	49.9	0.1	0.617°	

FTIR analysis

FTIR spectroscopy was used to investigate changes on the surface of the cellulose fibers throughout the pretreatment to find the changes in lignocellulosic composition. The spectrum of SCB-Raw was compared to the spectra for ultrasonic treated and commercial CNF samples. FTIR spectra of SCB-Raw, cellulose, and ultrasonication at different times are shown in Figure 2a, b. The dominant peaks around 3340 to 3350 cm-1 in the spectra of all the fibers samples corresponded to the O-H and C-H stretching of the OH- and CH- group, respectively [1]. A sharp band at 2900 cm-1 represents C-H stretching of methyl and methylene group; a similar peak was reported [2]. Another sharp peak at 1730 cm-1 on spectra of SCB-Raw represents the vibration of acetyl and uronic ester groups of hemicelluloses [3], and this peak was not observed in ultrasonicated samples. Similarly, peaks at 1604 and 1505 cm-1 on spectra of SCB-Raw represent aromatic C=C vibration in lignin [4,5], and these peaks were also not observed in ultrasonicated samples. This indicated that hemicellulose and lignin were completely removed during ultrasonication. The peak observed in all samples at 1031 cm-1 is due to the C-O-C pyranose ring stretching vibration and absorption band at 902 cm-1 associated with the β-glycosidic linkages between glucose units in cellulose [6].

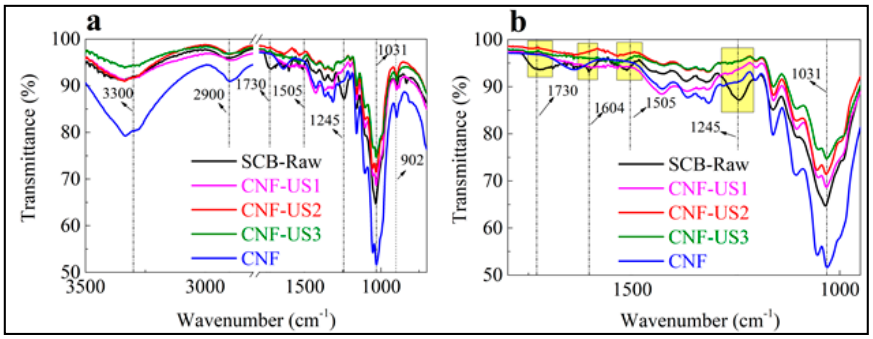

Figure S2. FTIR spectrum: a. A comparative spectrum of SCB-Raw, CNF obtained at 1 h, 2 h and 3 h sonic (CNF-US1, CNF-US2, and CNF-US3), and commercial cellulose (CNF), b Magnified spectrum of all the samples and highlighted (light yellow) box indicates lignin or hemicellulose region, SCB-Raw (black spectra) have prominent peaks.

Table S3. Percentage residue (% weight loss) at different temperatures for raw (SCB-Raw), AHP treated (cellulose), ultrasonication at 1 h, 2 h, and 3 h (CNF-US1, CNF-US2, and CNF-US3) and commercial cellulose (CNF).

Temperature (°C)	Weight loss (%)					
	SCB-Raw	Cellulose	CNF-US1	CNF-US2	CNF-US3	CNF
200	5.70	10.10	17.41	15.64	10.23	5.23
250	11.92	16.97	45.42	26.8	27.85	7.23
300	38.08	66.3	67.27	72.82	72.46	55.78
350	75.6	75.45	70.68	76.48	76.44	65.06
550	86.18	85.64	80.12	83.14	81.2	77.36

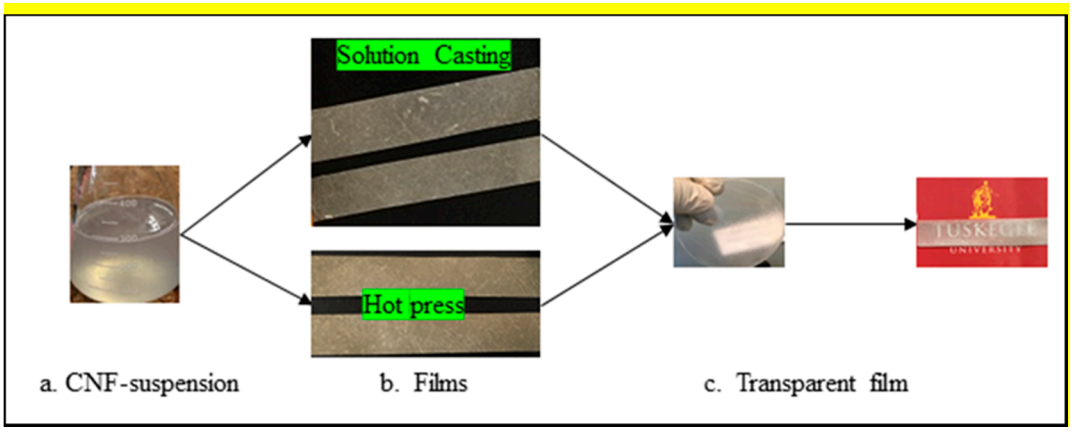

Figure S3. CNF-film fabrication process: a. CNF-suspension from ultrasonication, b. film developed by hot press and solution casting and c. CNFs- films from 1 h, 2 h and 3 h ultrasonication.

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