Supporting Information

Ammonium “catch and release” from wastewater using TEMPO-oxidized cellulose nanofiber beads

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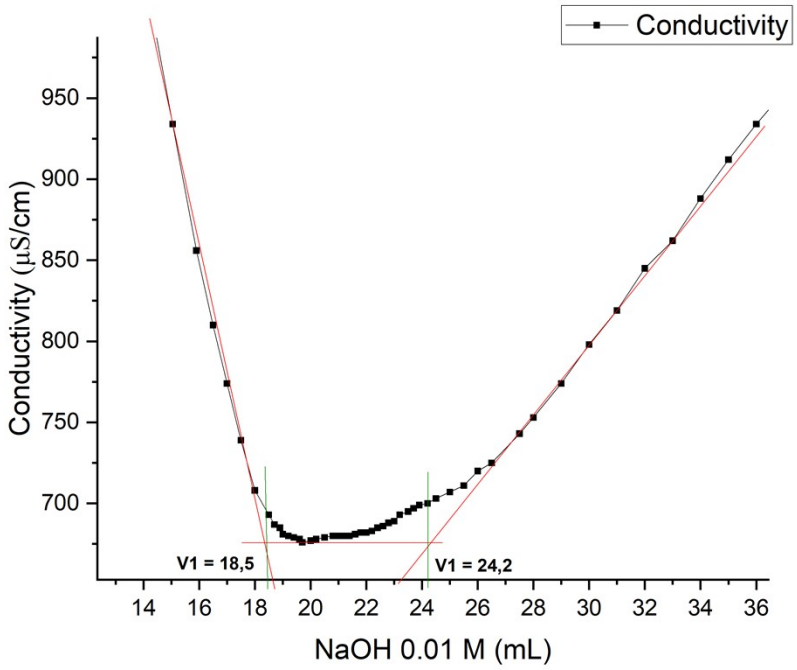

Fig. S1 Conductimetric titration graph of TOCN.

$$OD = \frac{162 * C_{NaOH} * (V_2 - V_1)}{m - 36 * C * (V_2 - V_1)} \qquad Eq.S1$$

$$\sigma = \frac{C_{NaOH} * (V_2 - V_1) * 1000}{m} \qquad Eq.S2$$

Table S1. Oxidation degree and carboxylate content of TOCN.

	[1]	[2]	[3]	Average	STD
OD	0.188	0.201	0.212	0.20	0.01
σ	1.217	1.298	1.378	1.29	0.08

Where C_{NaOH} corresponds to the molar concentration of NaOH, $V_1$and V_2 represent the volume (L) of NaOH in which a region of the graph remains stable for a long time, m is the weight of the sample in grams, 36 in the equation is the difference between the molecular weight of an anhydroglucose unit (162 g/mol) and the sodium salt residue of glucuronic acid (198 g/mol).

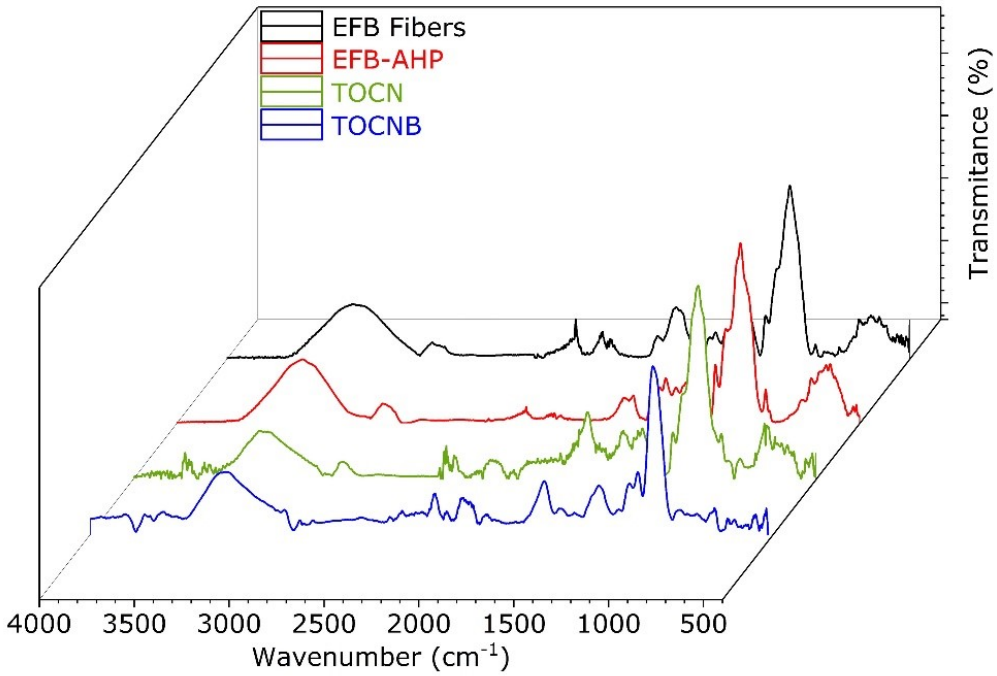

Fig. S2 IR-ATR spectra of nanocellulose specimens obtained from empty fruit bunches (EFB, EFB-AHP, TOCN and TOCNB).

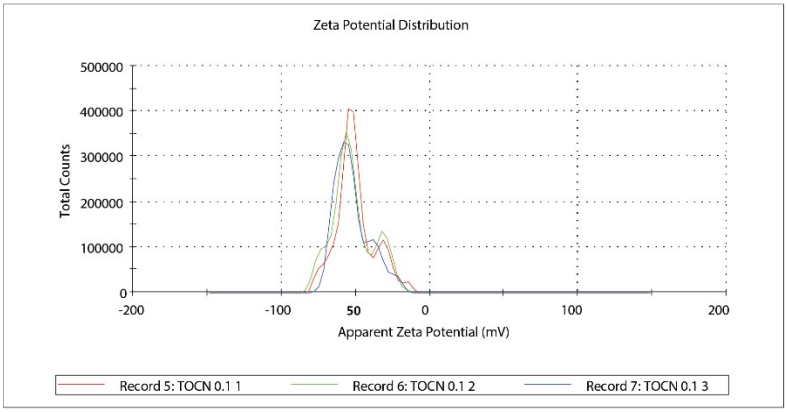

Fig. S3 zeta potential (ζ) of TOCN (0.1% w/v)

Table S2. Mass of TOCNB.

dry-bead weight [mg]	dry-bead weight [mg]	dry-bead weight [mg]
56.82	2.23	28.69
53.84	2.13	28.63
53.09	2.48	24.63
48.78	2.14	26.85
52.27	2.19	31.55
52.1	2.37	26.94
52.7	2.06	26.69
51.5	2.1	29.54
52.78	2.2	31.57
51.83	2.13	23.83
49.99	2.03	33.23
54.83	2.15	30.69
54.82	2.13	32.43
56.64	2.25	32.27
52.99	1.97	28.56
51.99	2.09	26.98
51.68	2.32	26.42
49.47	2.41	27.56
55.04	1.99	33.42
50.45	2.25	29.94
50.27	2.05	31.46
52.43	2.07	29.32
56.15	2.07	31.55
53.4	2.12	27.79

50.62	2.3	30.72
51.31	2.26	32.98
54.26	2.18	28.12
52.53	2.13	28.16
51.19	2.18	29.86
52.37	2.16	25.21
54.52	2.27	29.11
57.23	2.1	30.22
50.14	2.17	28.74
51.5	2.16	25.95
51.11	2.17	24.91
47.55	2.21	30.33
50.84	2.2	27.55
50.62	2.34	24.66
55.35	2.16	27.26
52.59	2.37	29.84
49.3	2.14	28.84
54.3	2.12	23.9
52.09	2.19	28.86
49.04	2.22	29.89
51.57	2.21	28.15
51.58	2.34	28.06
50.95	2.32	26.46
52.94	2.24	24.2
47.93	2.13	27.32
52.29	2.16	30.86
55.11	2.35	25.7
54.76	2.2	28.61
55.32	2.01	30.78
55.34	2.09	25.21
56.16	2.1	28.96
50.42	2.32	28.45
54.74	2.16	26.13
48.78	2.46	25.29
51.55	2.26	30.42
48.66	2.19	29.79
55.19	2.12	23.56
55.82	2.3	28.98
52.44	2.15	27.7
56.79	2.07	24.47
51.39	2.25	25.75
53.21	2.18	28.41

	53.22	2.32	29.11
	50.54	2.17	28.57
	53.84	1.82	27.83
	57.15	2.27	29.35
	50.62	1.94	29.65
	54.86	2.37	30.74
	52.54	2.4	27.86
	56.78	2.12	28.46
	53.94	2.03	31.35
	54.37	2	30.56
	54.3	2.28	25.93
	53.43	2.15	30.62
	49.81	2.1	28.84
	55.94	2.14	30.12
	49.86	2.43	28.5
	53.4	2.22	30.72
	54.23	2.27	26.61
	51.03	2.27	23.85
	53.2	2.3	29.42
Average	52.71	2.19	28.26
STD	2.32	0.12	2,47

Table S3. Effect of pH on the NH_4^+ adsorption capacity of TOCNB.

pH	$q_{e\,[1]}$ [mg/g NH_4^+]	$q_{e\,[2]}$ [mg/g NH_4^+]	$q_{e\,[3]}$ [mg/g NH_4^+]	Average	STD
5	13.8923	14.6162	9.2052	12.5713	2.9374
6	24.8300	22.6581	22.6590	23.3824	1.2537
7	36.1025	30.0522	33.1894	33.1147	3.0258
8	40.1680	40.2854	40.3241	40.2592	0.0813

Table S4. Effect of ionic strength on the NH_4^+ adsorption capacity of TOCNB

Ion	$q_{e\,[1]}$ [mg/g NH_4^+]	$q_{e\,[2]}$ [mg/g NH_4^+]	$q_{e\,[3]}$ [mg/g NH_4^+]	Average	STD
K^+	23.6414	23.1548	23.4739	23.4234	0.2472
Ca^{2+}	30.3040	30.1209	30.8375	30.4208	0.3723
SO_4^{2-}	35.0090	20.2872	26.6480	27.3147	7.3835

Table S5. Experimental adsorption kinetics of NH_4^+ onto TOCNB

Time [min]	$q_{e\,[1]}$ [mg/g NH_4^+]	$q_{e\,[2]}$ [mg/g NH_4^+]	$q_{e\,[3]}$ [mg/g NH_4^+]	Average	STD
10	14.7361	9.8660	8.2042	10.9354	3.3947
20	26.7637	25.5453	24.9072	25.7387	0.9432
30	33.6372	29.4198	28.4281	30.4950	2.7660
40	27.4435	27.4429	27.5424	27.4763	0.0573
50	29.3417	29.2884	29.4386	29.3562	0.0761
60	35.3310	31.4768	30.2775	32.3618	2.6404

Table S6. Experimental adsorption isotherm of NH_4^+ onto TOCNB

C_e [mg L^{-1}]	$q_{e\,[1]}$ [mg/g NH_4^+]	$q_{e\,[2]}$ [mg/g NH_4^+]	$q_{e\,[3]}$ [mg/g NH_4^+]	Average	STD
9.56	1.5703	1.5438	1.5532	1.5558	0.0134
18.55	5.2591	5.1743	5.2141	5.2158	0.0424
36.42	12.9129	12.8347	12.8990	12.8822	0.0417
56.31	15.7537	13.0759	15.3604	14.7300	1.4459
71.26	26.6571	26.5736	26.5993	26.6100	0.0428
91.51	28.2213	32.5611	30.7776	30.5200	2.1813
151.32	36.4633	27.5082	29.6585	31.2100	4.6748

Table S7. Germination and growth performance of *Phaseolus vulgaris* L. seeds under three soil treatments over two weeks on Stem length.

Stem length [cm]

	Day 7	Day 15
S1	15.58	34.33
S2	23.36	43.16
S3	19.42	48.66

Table S8. Germination and growth performance of *Phaseolus vulgaris* L. seeds under three soil treatments over two weeks on dry weight

	Dry weight (mg)
S1	268.35
S2	309.56
S3	291.20

Table S9. Germination and growth performance of *Phaseolus vulgaris* L. seeds under three soil treatments over two weeks on number of trifoliate leaves

	Number of trifoliate leaves	
	Day 7	Day 15
S1	0	2
S2	2	5
S3	1.6	5

Table S10. Germination and growth performance of *Phaseolus vulgaris* L. seeds under three soil treatments over two weeks on leaves length

	Leaves length (cm)
S1	0
S2	2.65
S3	3.07