Biodegradable cellulose/polycaprolactone/keratin/calcium carbonate mulch films prepared in imidazolium-based ionic liquid

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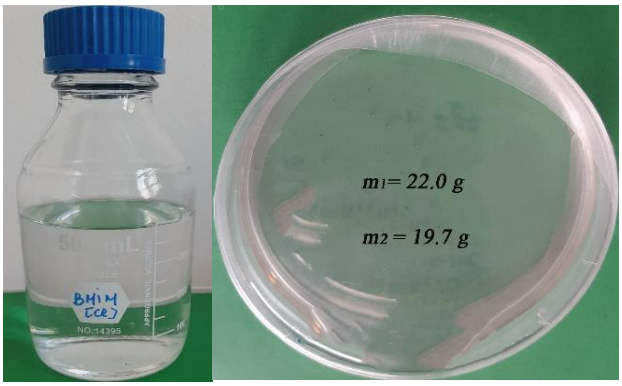


Figure S1. Regeneration of ionic liquid [BMIM][Cl] (1-Butyl-3-methylimidazolium chloride): left - aqueous solution of [BMIM][Cl] obtained after mulch film regeneration and extraction/washing; right - regenerated [BMIM][Cl], m_1-mass of [BMIM][Cl] used in experiment and m_2-mass of regenerated [BMIM][Cl]

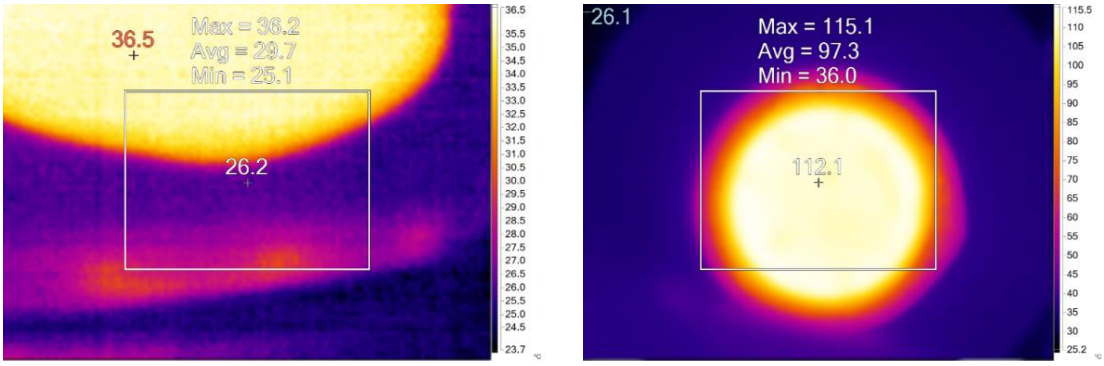


Figure S2. Thermal infrared images ultrasonic dispersion of the GCC in [BMIM][Cl] solution. The temperature of the dispersion increased from 36.5 °C to 112.1 °C after 7 min exposure to ultrasonication.

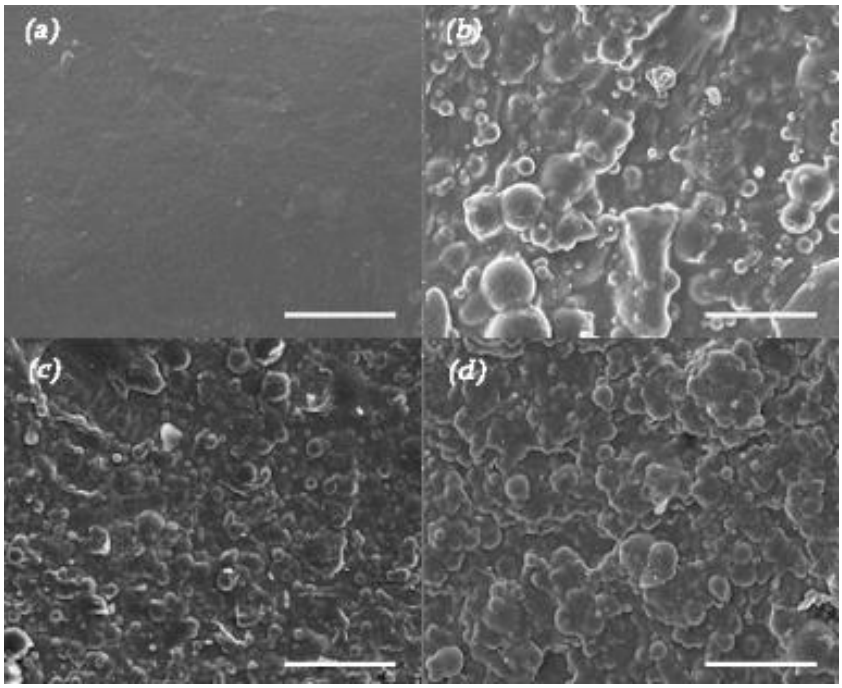
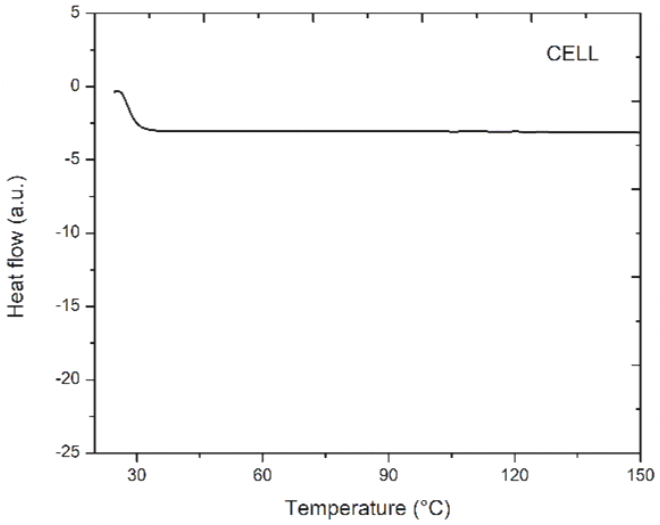
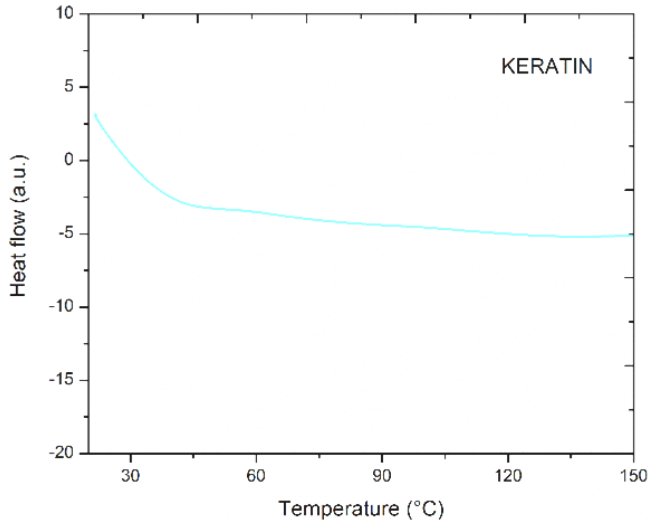


Figure S3. FE-SEM micrographs of the surfaces of (a) CELL, (b) CELL/PCL, (c) CELL/PCL/KER, and (d) CELL/PCL/KER/GCC (scale bar = 200 μm)



(a)



(b)

Figure S4. DSC analysis of (a) neat cellulose (CELL), and (b) keratin (KER).

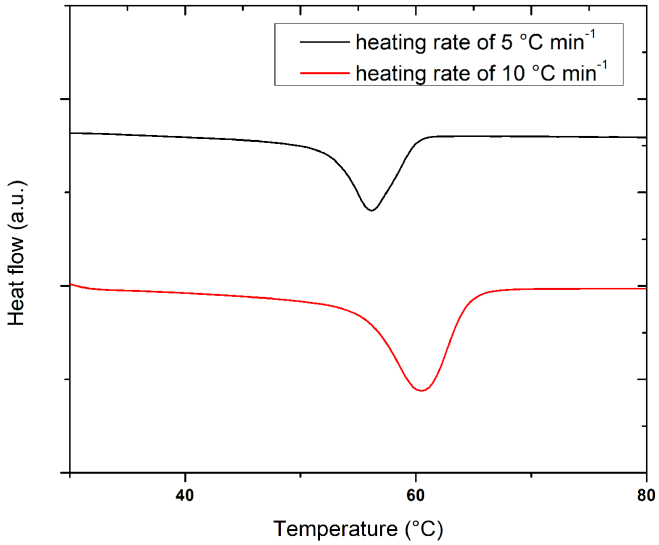


Figure S5. DSC analysis of CELL/PCL/KER/GCC biocomposite films at different heating rates: 5 and 10 °C min^{-1}

Table S1 The weight loss (W_L (%)) of the cellulose and biocomposite films during the biodegradability test

	W_L (%)			
Day	**CELL**	**CELL/PCL**	**CELL/PCL/KER**	**CELL/PCL/KER/GCC**
7	21.22	13.86	16.65	16.16
14	46.96	19.03	25.34	22.18
21	52.03	22.40	45.22	38.32
28	59.12	37.06	52.18	43.62

Table S2 The total content of calcium ions (Ca^{2+}) in the mulch films (mg g^{-1} and % (w/w))

Sample	Total content of Ca^{2+} ions in the mulch films	
	mg g^{-1}	% (w/w)
CELL/PCL/KER/GCC (0 days)	19.889	1.989
CELL/PCL/KER/GCC (28 days)	0.562	0.056

Table S3 ATR-FTIR absorption bands characteristic of biopolymers and biocomposites

Wavenumber, cm^{-1}	Functional group	Components
3000–3700	OH stretching	all
3281	N–H stretching	KER
1722	-C=O stretching	PCL
1100–1710	amide region	KER
1639	C=O stretching (amide I)	KER
1637	-C=O stretching	CELL/PCL
1528	C–N stretching and N–H bending (amide II),	KER
1232	C–O stretching and N–H and O=C–N bending (amide III)	KER
1418	Hydrogen intramolecular bonds	CEL
896	β-glycosidic linkage	CEL
874	C–H out of plane glucose ring	CEL