

Supplementary Information

Part B: Improvement of the Optical Properties of Cellulose Nanocrystals Reinforced Thermoplastic Starch Bio-Composite Films by Ex Situ Incorporation of Green Silver Nanoparticles from *Chaetomorpha linum*

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Supplementary Tables

Supplementary Table 1. Assignment of bands found in FTIR spectra of different isolated water extract, silver nanoparticles and bio-nanocomposite

	Main peak (cm ⁻¹) from isolated water extract, silver nanoparticles and bio-nanocomposite							
	CL-W		CL-WE		CL-WE-AgNp		CS-CL-CNC-AgNP 20%	
	Peak (cm ⁻¹)	% T	Peak (cm ⁻¹)	% T	Peak (cm ⁻¹)	% T	Peak (cm ⁻¹)	% T
O-H stretching from water molecules	3338.27	96.45	3313.79	96.14	3350.51	91.05	3321	91.92
	3279.10	96.56	3275.01	97.12	3279.10	90.88	-	-
C-H stretching Lipid – carbohydrate Mainly vas) stretching ₃ (CH ₂) and <i>vs.</i> (CH	2938.33	96.42	2948.8	96.42	-	-	2942	93.30
	2909.76	94.75	2913.00	96.95	2922.00	90.80		
	2842.43	95.70	2862.83	96.86	2870.99	91.69	2709 2532	93.70 94.10
stretching vibrations of the C=N chain of Nitrile compounds [53] (Subrhamanian, Suriyamoorthy, & Rajasekar, 2017)	2297	97.04	-	-	-	-	-	-
	-	-	-	-	-	-	1787	96.88
	-	-	-	-	-	-	1642	98.60
Amide I from proteins Stretching vibration of the (NH) C=O group	1644.7	89.27	1644.60	91.86	1640.61	84.37	1608	96.76
Amide II from proteins	1538.54	88.65	1544.66	93.11	1524.26	85.09	1597	96.38
C=C-C, Aromatic ring stretch, Aromatic compound	-	-	-	-	1467.12	86.06	1434	85.76
O-H bend, Alcoholic group	1412.03	87.04	1414.07	96.14	1416.11	86.42	1348	85.60
Asymmetric stretching vibration of sulfate groups	1224.30	85.43	1220.22	91.58	1218.18	80.61	1218	92.62
Stretching vibrations of the glycosidic C—O bond	-	-	-	-	1132.48	87.04	1154	84.98
	1095	88.91	1079.39	90.08	-	-	-	-

v (C-O-C) stretches from carbohydrates								
Sulfate groups as S = O, C-O-S and v(C-S-C) of sulphated polysaccharides [55] (Trabelsi, M'sakni, Ouada, Bacha, & Roudesli, 2009)	1046.78	86.06	1044.74	89.10	-	-	-	-
δ (C-O-H) deformation, v (C-O-C) stretches of polysaccharides from carbohydrates, ν_s (P=O) symmetric stretches from nucleic acid	1003.93	84.26	1001.93	91.14	991.68	69.28	1018	75.86
P-O-C stretch, Aromatic phosphates	924.35	84.90	-	93.64	-	-	-	-
the bands at 827 cm ⁻¹ and 887 cm ⁻¹ indicated the coexistence of α and β -configurations of the sugar units [51,52] (Harshal & Lalitha, 2014; Tang et al., 2020)	863.13	97.85	865.17	92.75	869.25	77.49	879	84.58
bending band of N-H and C-N from the amide III band	838.6	86.68	832.52	92.75	822.32	78.56	-	-
Vibration of C-O bonds for an epoxy function	706.01	84.45	703.97	90.25	-	-	-	-
C-Cl stretching, Aliphatic Chloro compound	644.8	81.42	-	89.99	-	-	-	-
C-Br stretching, Aliphatic bromo compounds	614.19	80.17	-	87.40	-	-	-	-