Supplementary Information

Functionalized jute with high-water absorption, low thermal conductivity and efficient radiative cooling for preservation of perishable green vegetables reducing cold storage energy requirements

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Table S1:- Thermogravimetric parameters of NJF, DJF, PJF30, PJF45, PJF60 and PJF75

Sample Name	T_{onset} (10 % degradation)	T_{max} (°C)	T_{max} (% degradation)	Residual weight % (700 °C)
NJF	272 °C	386 °C	65.31%	3.31%
DJF	274 °C	370 °C	63.63%	7.68%
PJF30	149 °C	278 °C	53.09%	32.32%
PJF45	222 °C	296 °C	43.66%	28.46%
PJF60	178 °C	279 °C	46.01%	28.36%
PJF75	166 °C	280 °C	52.04%	30.76%

Table S2*:* Represents the elemental composition of DJF and PJF30 from XPS Analysis

DJF	
Element	**Atomic (%)**
C	69.11
O	30.79
P	-
PJF30	
C	67.59
O	30.49
P	1.92

Table S3: - Crystal structure properties of DJF, PJF30, PJF45, PJF60 and PJF75

Name of sample	2θ	C.I.	Crystallite size (in nm)	d-spacing (in nm)
DJF	16.2	69.51%	0.03	0.545
	22.5		0.046	0.398
PJF30	16.8	68.35%	0.033	0.5334
	22.5		0.046	0.3967
PJF45	16.8	65.62%	0.032	0.53
	22.5		0.044	0.391
PJF60	16.8	63.30%	0.032	0.535
	22.5		0.041	0.395
PJF75	16.8	61.87%	0.036	0.514
	22.5		0.036	0.392

Table S4: Sensitivity analysis of dominant environmental categories for the production of 1 kg of phosphorylated jute by varying key parameters electricity, delignification, phosphorylation

Categories	Electricity		Delignification		Phosphorylation	
	10% increase	8% decrease	10% increase	8% decrease	10% increase	8% decrease
Fossil Depletion	9.68	-7.80	4.30	-3.49	2.96	-2.69
Freshwater consumption	0.35	-0.35	8.45	-6.83	1.39	-1.16
Photochemical Ozone Formation, Ecosystems	9.91	-7.96	4.35	-3.45	3.00	-2.40
Photochemical Ozone Formation, Human Health	9.92	-7.97	4.36	-3.46	3.01	-2.41

Table S5: - Sensitivity analysis of dominant environmental categories for the storage of 600 kg of coriander leaves for 8 days in cold storage and the remaining 2 days in phosphorylated

jute by varying key parameters electricity, delignification, phosphorylation and wholesaler storage.

Categories	Electricity		Delignification		Phosphorylation		Wholesaler Storage	
	10% increase	8% decrease	10% increase	8% decrease	10% increase	8% decrease	10% increase	8% decrease
Fossil depletion	8.94	-7.34	0.23	-0.46	0.23	-0.23	8.03	-6.42
Photochemical Ozone Formation, Ecosystems	9.82	-8.13	0.28	-0.42	0.14	-0.42	8.84	-7.29
Photochemical Ozone Formation, Human Health	9.83	-8.01	0.28	-0.42	0.14	-0.28	8.85	-7.30
Terrestial acidification	9.40	-7.69	0.00	-0.85	0.00	0.00	8.55	-6.84

Table S6: - List of Assumptions (LCA)

LCA Assumptions for phosphorylated jute production
The production of normal jute is considered in LCA
23 % weight loss was considered during delignification and 10 % weight gain during phosphorylation. Liquid waste generated during delignification; phosphorylation is not considered in the environmental impact calculation
Electricity sources were considered from hard coal (*GaBi*)
Sodium chlorite is replaced with sodium hypochlorite;
LCA Assumptions for cold storage of coriander leaves
Assume that 600 kg of coriander leaves are transported from farm to wholesaler, the distance between the farm and the wholesaler is estimated to be 35 km, and for this journey, the truck utilizes diesel as fuel, consuming a total of 4.97 L. The travel time for this route is approximately 1 hour. The truck involved in the transportation has a weight ranging from 12 to 16.2 tonnes, with an axle configuration of 4*2. The fuel consumption rate for this vehicle is 14.2 L per 100 km.
Upon the coriander leaves' arrival at the wholesaler, a Life Cycle Assessment (LCA) is conducted for two scenarios**:** **Case one** involving the storage of 600 kg of coriander leaves in cold storage conditions for a period of 10 days, and **Case two** involving the storage duration of 2 days in 10.6 kg of phosphorylated jute followed by 8 days in cold storage conditions. In case two during LCA, the production of phosphorylated jute is considered.
The cold storage room measures 2.5 meters in length, 2.5 meters in width, and 2.4 meters in height. It has a maximum capacity of 0.6 tons. The temperature within the cold storage is maintained between -4 to 6 degrees Celsius. The average power consumption for this cold storage facility is 0.75 kilowatt-hours.
The wholesaler will distribute coriander leaves to retailers based on the prevailing demand

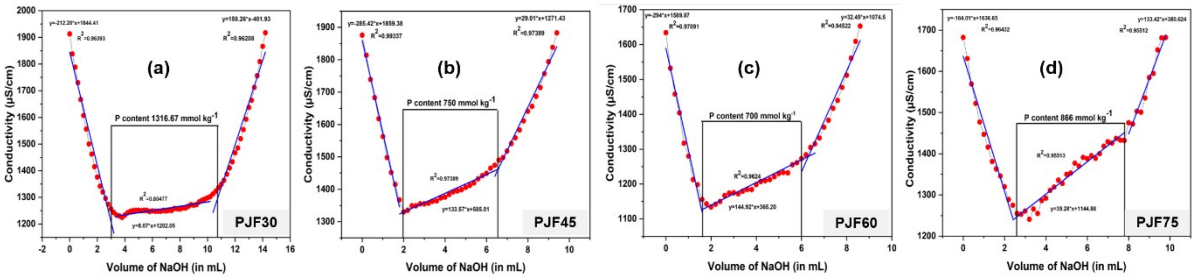

Figure S1 : Represents the charge content of (a)PJF30 (b)PJF45 (c)PJF60 (d)PJF75

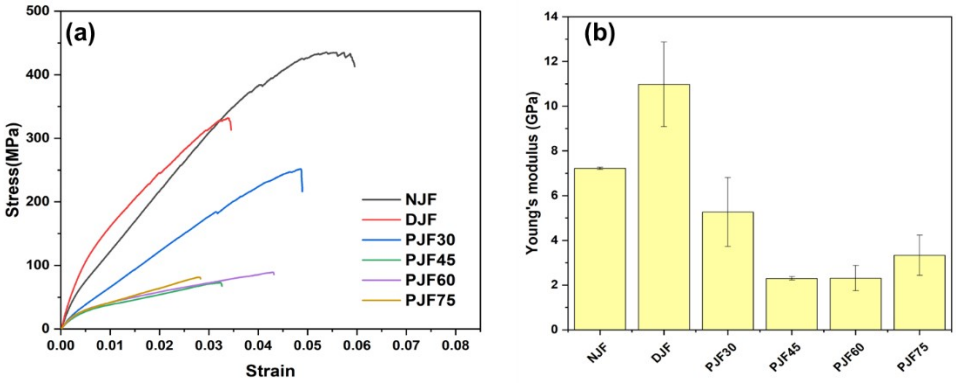

Figure S2: - Represents (a) Tensile strength (b) Young's modulus

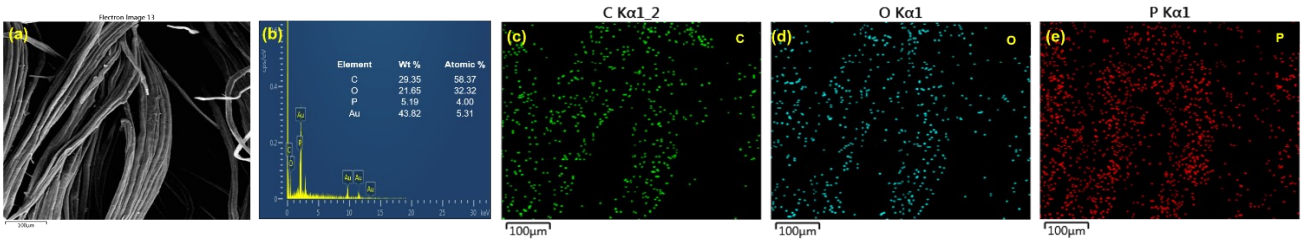

Figure S3: - Represents (a) original SEM image (b) EDX spectra of PJF30 with their elemental composition and elemental mapping of (c) carbon, (d) oxygen and (e) phosphorous

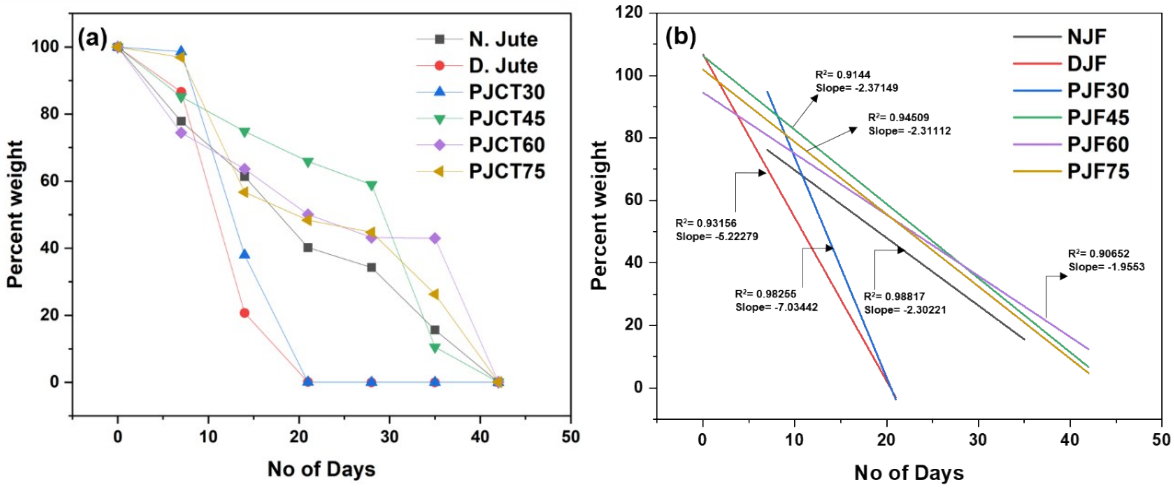

Figure S4 : Represents (a) Percent weight loss (b) rate of degradation of samples

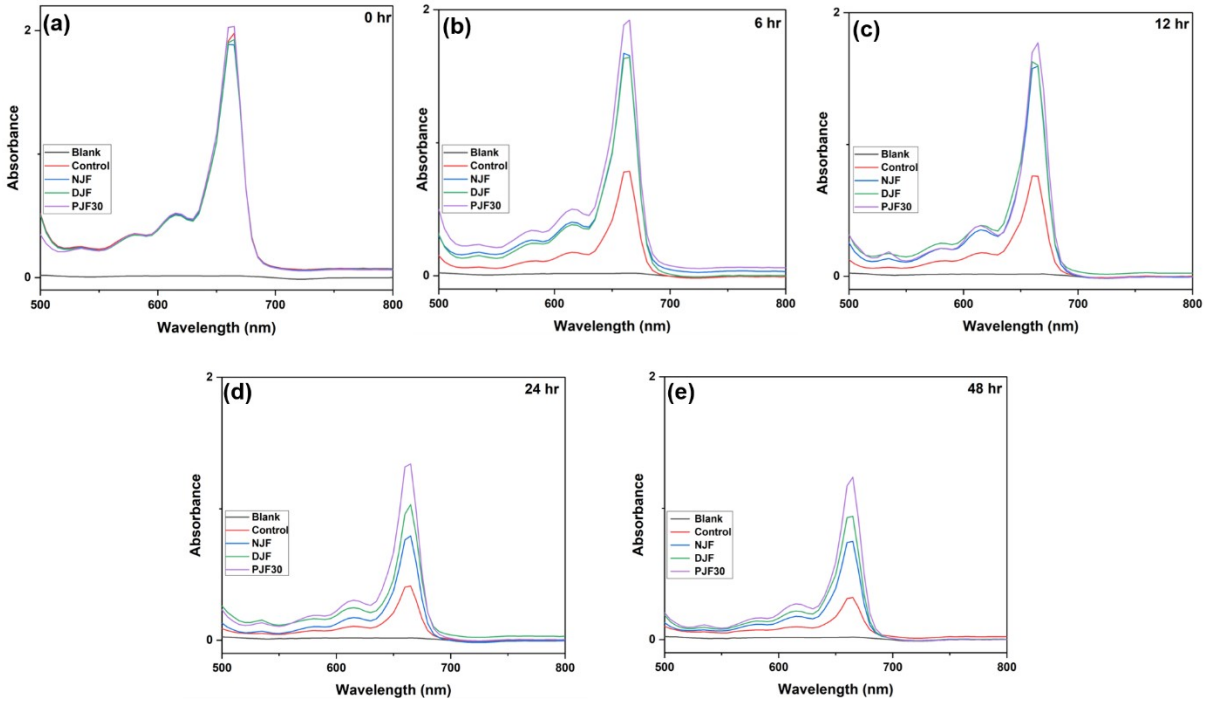

Figure S5:- Represents the full scan spectra from 500-800 nm of (a) 0 hr (b)6 hr (c)12 hr (d)24 hr (e)48 hr for the determination of chlorophyll 'a' content

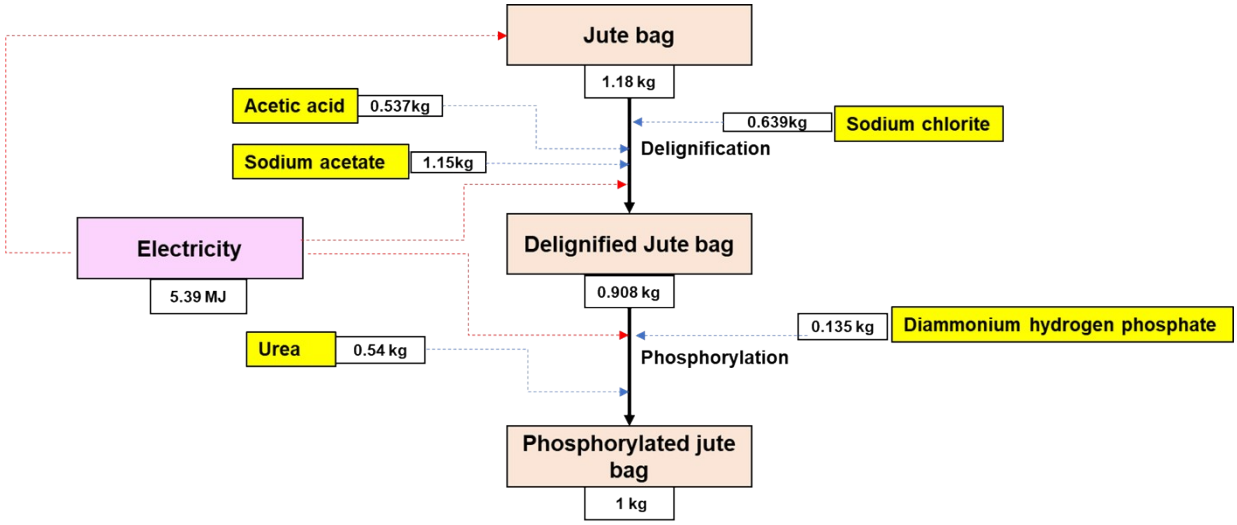

Figure S6 :- Schematic for the production of phosphorylated jute and inputs of chemicals, energy involved

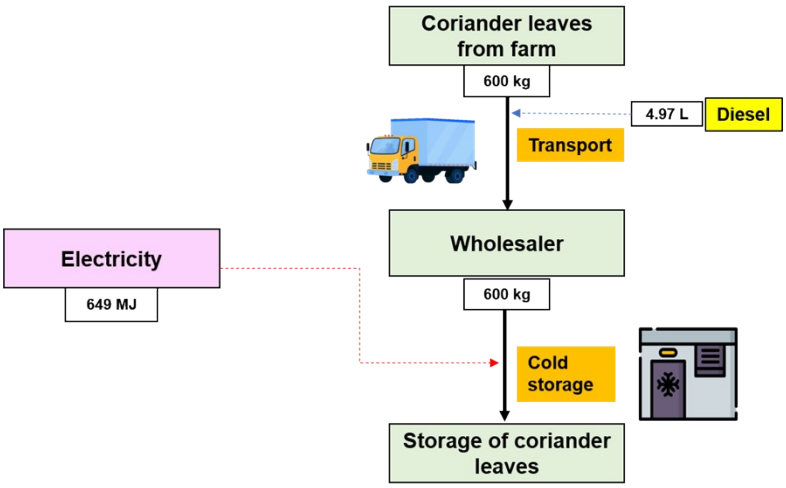

Figure S7 :- Schematic for the storage of 600 kg of corainder leaves for a period of 10 days in cold storage and the inputs of energy, chemicals used

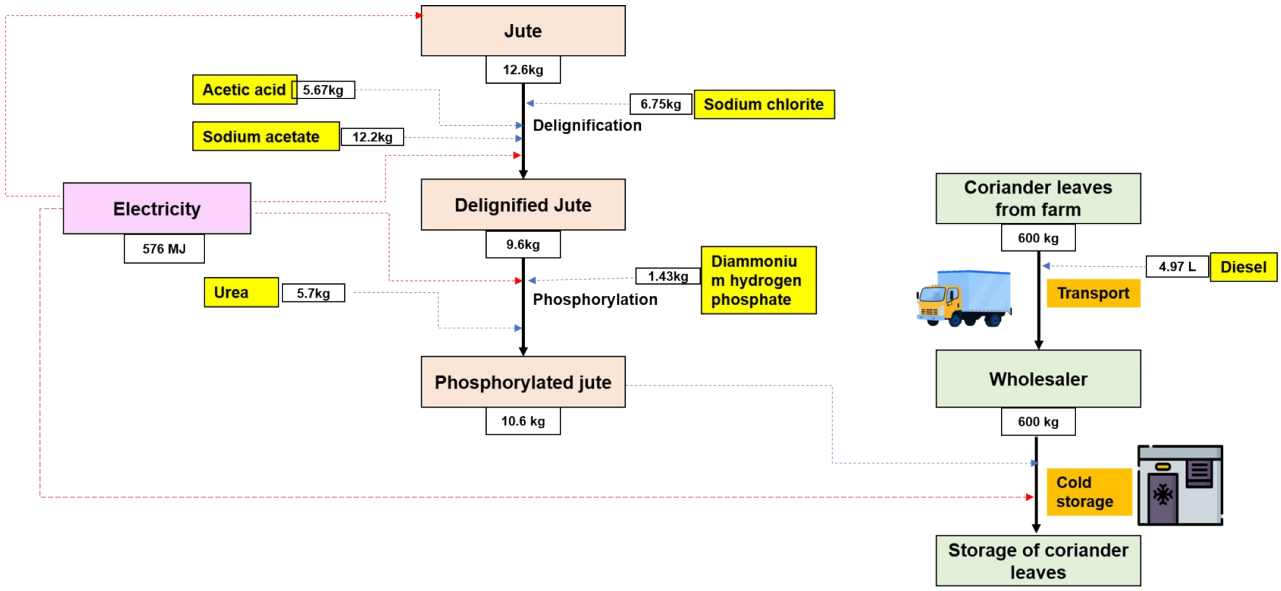

Figure S8 :- Schematic for the storage of 600 kg of corainder leaves for 8 days in cold storage and for the remaining 2 days in phosphorylated jute and the inputs of the energy, chemicals used.

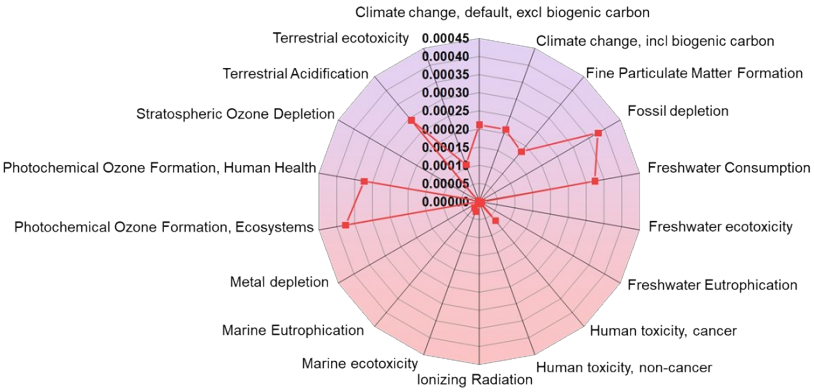

Figure S9 : Radar plot of normalized results of production of 1 kg of phosphorylated jute bag

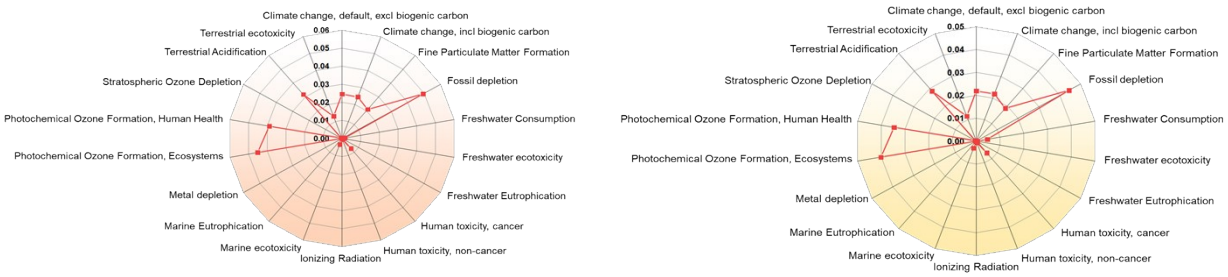

Figure S10 : Radar plot of normalized results of (a) Case 1 (b) Case 2

Figure S11:-

Photographs of NJF and DJF bags

Figure S12:-

Representative image of large scale storage of corainder leaves in phosphorylated jute bags

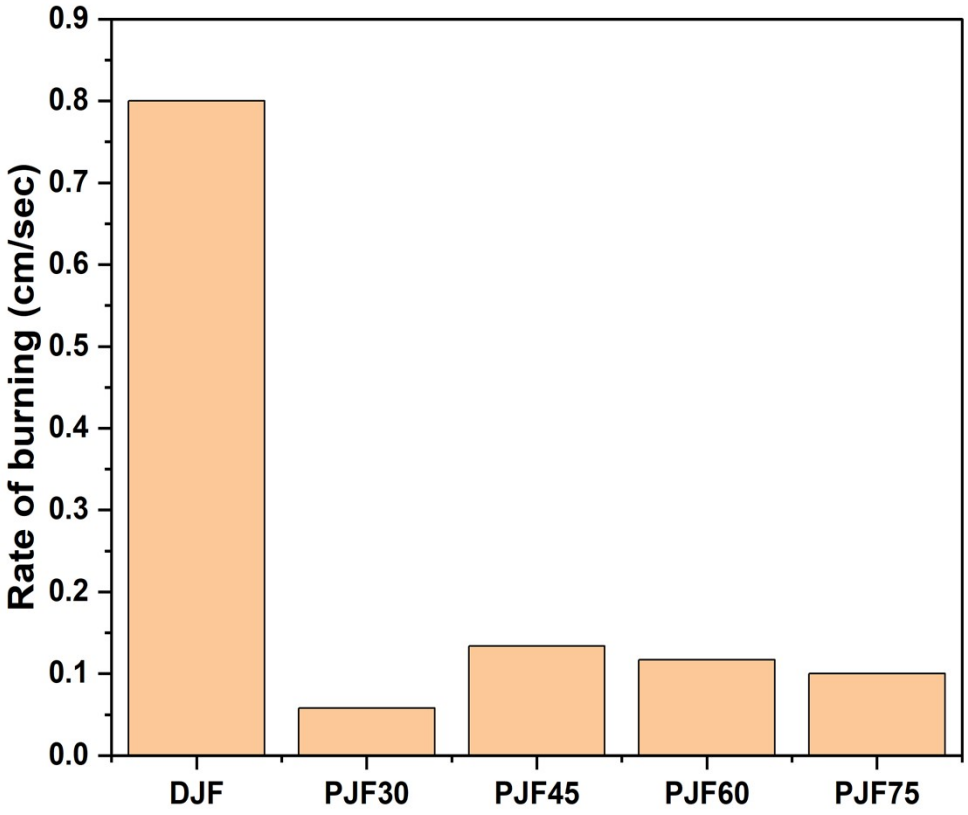

Figure S13:- The rate of burning of samples PJF30-75