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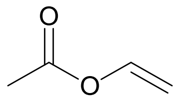
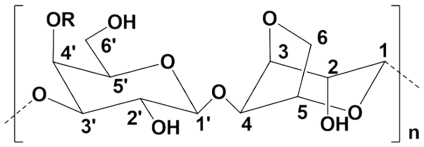
Figure S6b. Biodegradation of thin film prepared from grafted *Gracilaria dura* agar product (Agr*Gd*-*g*-PVAc) in soil conditions.

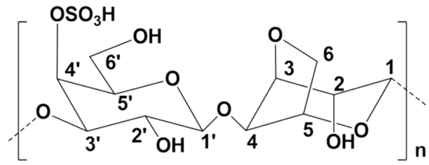


Vinyl acetate



R = H/-OCH_3/-OSO_3

Agar



Kappa-carrageenan

Figure S1. Repeating disaccharide unit of vinyl acetate, agar and *kappa*-carrageenan.

Table S1a. Effect of KPS initiator on the grafting parameters.[a]

Product	Weight ratios (Agr*Gd*: VAc, *w/w*)	KPS (wt%)	Yield* (g, %)	% Grafting efficiency (%E)[b]	% Grafting (%G)[c]
Agr*Gd*-*g*-PVAc	1: 2	0.01	4.1 (68 ± 1)	70 ± 1	70 ± 1
Agr*Gd*-*g*-PVAc	**1: 2**	**0.02**	**5.3 (88 ± 1)**	**82 ± 1**	**165 ± 1**
Agr*Gd*-*g*-PVAc	1: 2	0.03	5.2 (87 ± 1)	80 ± 1	160 ± 1
Agr*Gd*-*g*-PVAc	1: 2	0.04	5.0 (83 ± 1)	75 ± 1	150 ± 1
κC-*g*-PVAc	1: 2	0.01	3.2 (80 ± 1)	60 ± 1	60 ± 1
κC-*g*-PVAc	**1: 2**	**0.02**	**5.2 (87 ± 1)**	**80 ± 1**	**160 ± 1**
κC-*g*-PVAc	1: 2	0.03	5.2 (87 ± 1)	80 ± 1	160 ± 1
κC-*g*-PVAc	1: 2	0.04	5.1 (86 ± 1)	78 ± 1	155 ± 1

* Based on the charged amount of phycocolloid and VAc; [a]glycerol was 0.5 wt%; [b](Wt. of PVAc grafted/ wt. of κC) x 100; [c](Wt. of PVAc grafted/ total wt. of VAc) x 100.[15]

Table S1b. Effect of vinyl acetate (VAc) monomer on the grafting parameters.[a]

Product	Weight ratios (Agr*Gd*: VAc, *w/w*)	KPS (wt%)	Yield* (g, %)	% Grafting efficiency (%E)[b]	% Grafting (%G)[c]
Agr*Gd*-*g*-PVAc	1: 1	0.02	3.3 (82 ± 1)	70 ± 1	70 ± 1
Agr*Gd*-*g*-PVAc	**1: 2**	**0.02**	**5.3 (88 ± 1)**	**82 ± 1**	**165 ± 1**
Agr*Gd*-*g*-PVAc	1: 3	0.02	5.5 (68 ± 1)	58 ± 1	175 ± 1
κC-*g*-PVAc	1: 1	0.02	3.2 (80 ± 1)	60 ± 1	60 ± 1
κC-*g*-PVAc	**1: 2**	**0.02**	**5.2(87± 1)**	**80 ± 1**	**160 ± 1**
κC-*g*-PVAc	1: 3	0.02	5.7 (71 ± 1)	60 ± 1	180 ± 1

*Based on the charged amount of phycocolloid and VAc; [a]glycerol was 0.5 wt%; [b](Wt. of PVAc grafted/ wt. of κC) x 100; [c](Wt. of PVAc grafted/ total wt. of VAc) x 100.[15]

Table S1c. Effect of temperature on the grafting parameters.[a]

Product	Weight ratios (Agr*Gd*: VAc, *w/w*)	KPS (wt%)	Temp. (°C)	Yield* (g, %)	% Grafting efficiency (%E)[b]	% Grafting (%G)[c]
Agr*Gd*-*g*-PVAc	1: 2	0.02	70	4.8 (80 ± 1)	70 ± 1	140 ± 1
Agr*Gd*-*g*-PVAc	**1: 2**	**0.02**	**75**	**5.3 (88 ± 1)**	**82 ± 1**	**164 ± 1**
Agr*Gd*-*g*-PVAc	1: 2	0.02	80	5.4 (90 ± 1)	85 ± 1	170 ± 1
κC-*g*-PVAc	1: 2	0.02	70	4.6 (76 ± 1)	65 ± 1	130 ± 1
κC-*g*-PVAc	**1: 2**	**0.02**	**75**	**5.2(87± 1)**	**80 ± 1**	**162 ± 1**
κC-*g*-PVAc	1: 2	0.02	80	5.3 (88 ± 1)	82 ± 1	165 ± 1

*Based on the charged amount of phycocolloid and VAc; [a]glycerol was 0.5 wt%; [b](Wt. of PVAc grafted/ wt. of κC) x 100; [c](Wt. of PVAc grafted/ total wt. of VAc) x 100.[15]

Table S1d. Effect of reaction time on the grafting parameters.[a]

Product	Weight ratios (Agr*Gd*: VAc, *w/w*)	KPS (wt%)	Time (h)	Yield* (g, %)	% Grafting efficiency (%E)[b]	% Grafting (%G)[c]
Agr*Gd*-*g*-PVAc	1: 2	0.02	4	4.5 (80 ± 1)	60 ± 1	120 ± 1
Agr*Gd*-*g*-PVAc	**1: 2**	**0.02**	**5**	**5.3 (88 ± 1)**	**82 ± 1**	**166 ± 1**
Agr*Gd*-*g*-PVAc	1: 2	0.02	6	5.3 (90 ± 1)	82 ± 1	165 ± 1
κC-*g*-PVAc	1: 2	0.02	4	4.3 (76 ± 1)	57 ± 1	115 ± 1
κC-*g*-PVAc	**1: 2**	**0.02**	**5**	**5.2(87± 1)**	**80 ± 1**	**159 ± 1**
κC-*g*-PVAc	1: 2	0.02	6	5.1 (88 ± 1)	77 ± 1	155 ± 1

*Based on the charged amount of phycocolloid and VAc; [a]glycerol was 0.5 wt%; [b](Wt. of PVAc grafted/ wt. of κC) x 100; [c](Wt. of PVAc grafted/ total wt. of VAc) x 100.[15]

Table S2. Effect of phycocolloids keeping constant vinyl acetate as monomer.*

Phycocolloid	Remarks/Observations
Agar from *G. acerosa* (Agr*Ga*)	Agr*Ga*-*g*-PVAc is flexible, water non-sensitive with good mechanical strength, and can be used for multiple applications including seaweed cultivation.
Agar from *G. dura* (Agr*Gd*)	**Agr*Gd*-*g*-PVAc is flexible, water non-sensitive with greatest tensile (ca. 45 MPa) strength, and might be used for multi applications including seaweed cultivation.**
Kappa-carrageenan	κC-*g*-PVAc is soften in water and having lower tensile (ca. 20 MPa) strength, might be used for multi applications excluding seaweed cultivation.

*Grafting was carried out under optimised reaction conditions [Phycocolloid concentration = 4 wt%; KPS concentration = 0.02 wt%; Reaction temperature = 75 ^{o}C; Reaction time = 5 h]

Table S3. Effect of monomers keeping constant *G. dura* agar (Agr*Gd*) as phycocolloid.*

Phycocolloid	Monomer used (wt%)	Observations
Agr*Gd*	Acrylamide (AAm) (8 wt%)	Stability of Agr*Gd*-*g*-PAAm was checked by swelling and solubility in water, it was highly hydrophilic (soluble in water) and water sensitive (swelled in water) thus not suitable to be used for aqueous applications such as seaweed cultivation.
Agr*Gd*	Acrylonitrile (ACN) (8 wt%)	Stability of Agr*Gd*-*g*-PACN was checked by swelling and solubility in water, it was highly hydrophilic (soluble in water) and water sensitive (swelled in water) thus not suitable to be used for aqueous applications such as seaweed cultivation.

*Grafting was carried out under optimised reaction conditions [Phycocolloid concentration = 4 wt%; KPS concentration = 0.02 wt%; Reaction temperature = 75 ^{o}C; Reaction time = 5 h]

Figure S2. Swelling behavior of the control Agr*Gd*, κC, and polymeric material made of Agr*Gd*-g-PVAc. [a]dispersion was started after 12 h in the control Agr*Gd* and κC, [b]no weight loss was observed in Agr*Gd*-*g*-PVAc up to 10 day; [c]dispersion was started after 24 h in the kC-g-PVAc.

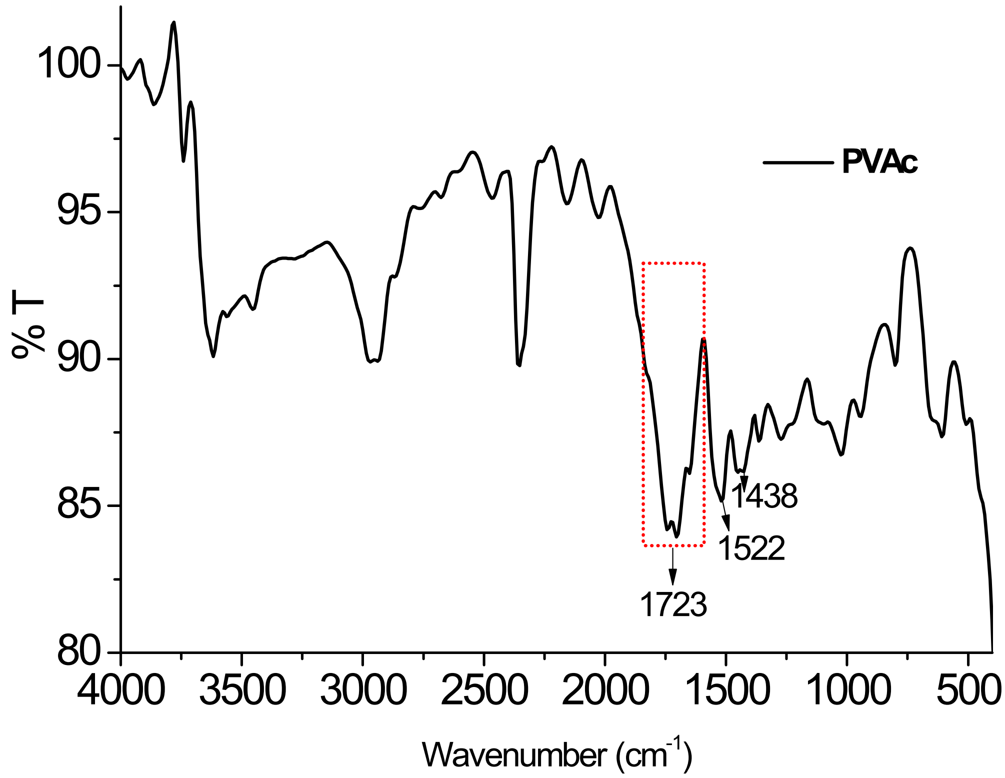


Figure S3. FTIR spectra of poly(vinyl acetate) (PVAc).

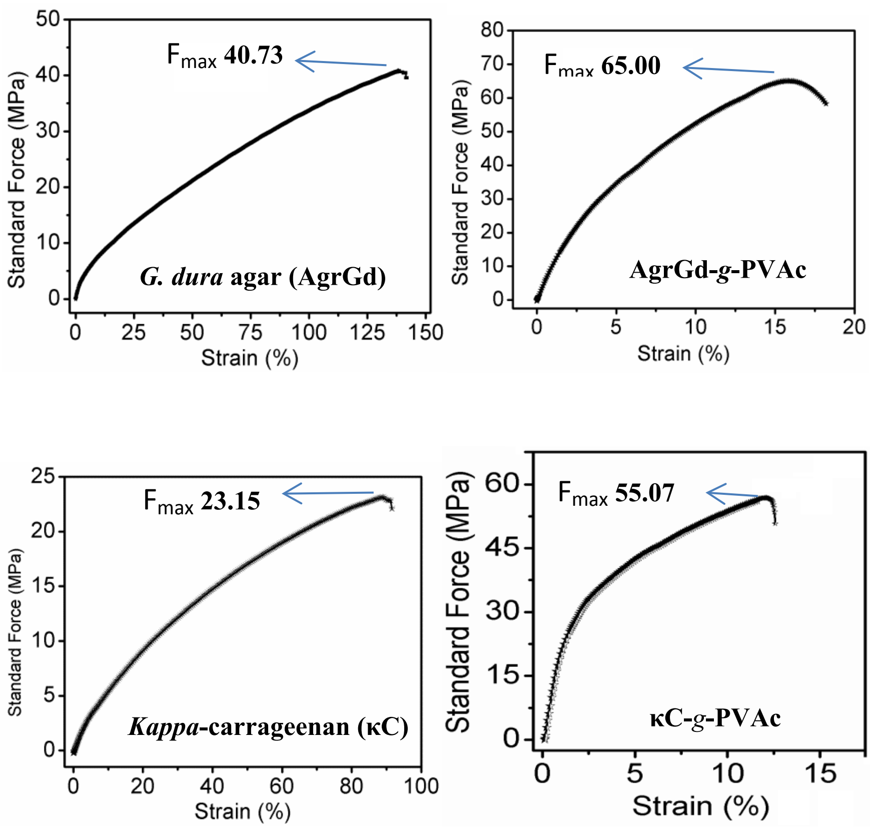


Figure S4. Tensile strength of (a) control agar, (b) AgrGd-g-PVAc, (c) control κC, and (d) κC-g-PVAc.

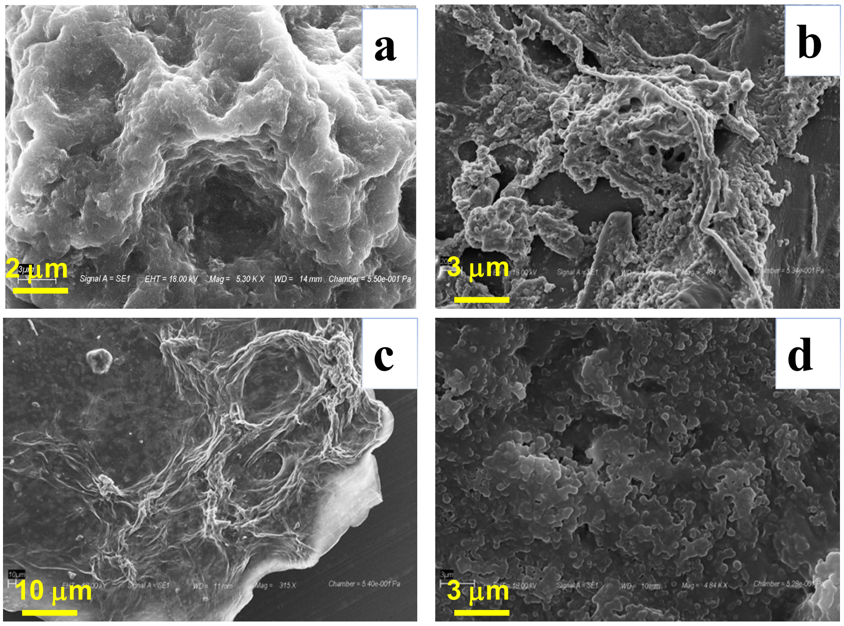


Figure S5. SEM images of (a) *G. dura* agar, (b) Agr*Gd*-*g*-PVAc, (c) κC and (d) κC-*g*-PVAc.

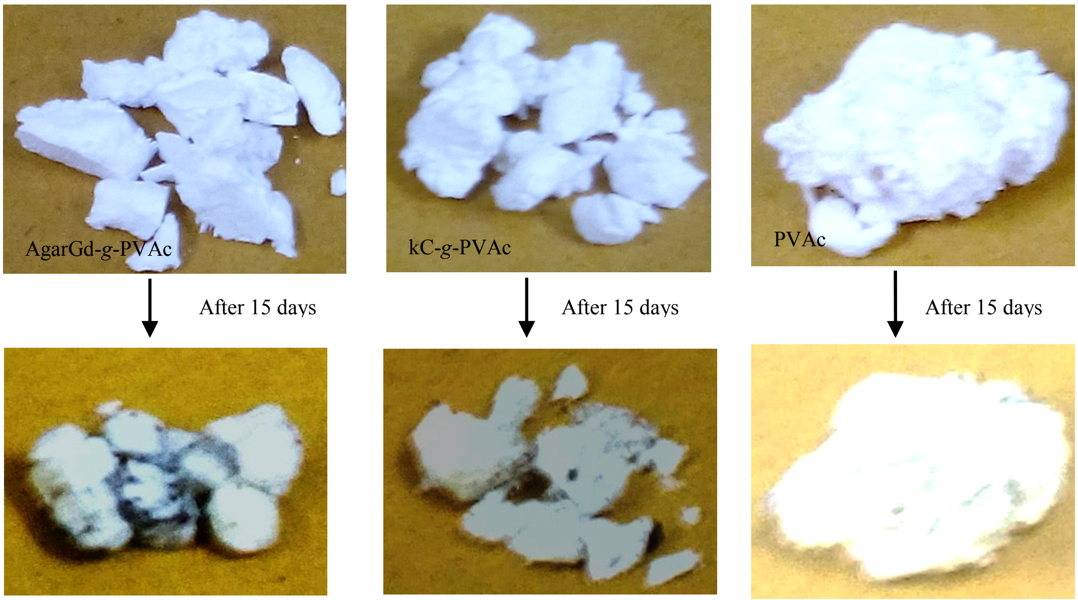


Figure S6a. Biodegradation of the control polyvinyl acetate (PVAc), grafted *Gracilaria dura* agar product (Agr*Gd*-*g*-PVAc), and grafted carrageenan product (kC-*g*-PVAc) in soil conditions.

Figure S6b. Biodegradation of thin film prepared from grafted *Gracilaria dura* agar product (Agr*Gd*-*g*-PVAc) in soil conditions.