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RESEARCH ARTICLE

Internally-crosslinked alginate dialdehyde/alginate/gelatin-based hydrogels as bioinks for prospective cardiac tissue engineering applications

Supplementary File

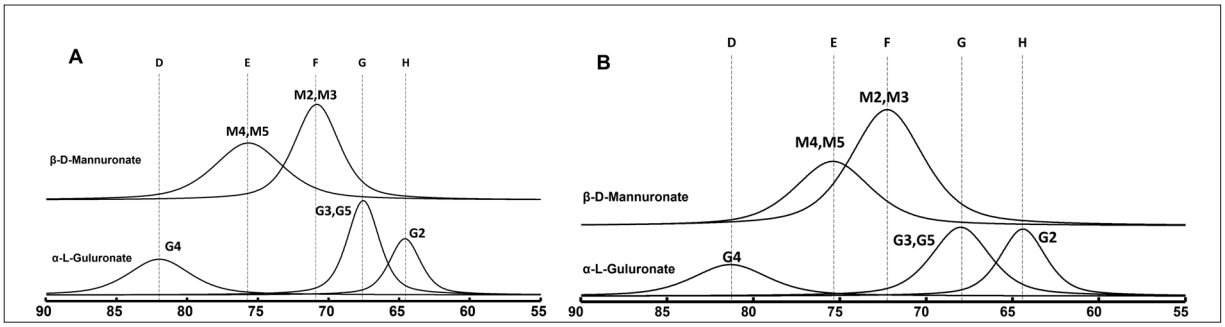

Figure S1. Deconvoluted ^{13}C cross-polarization under magic angle spinning (CP-MAS) nuclear magnetic resonance (NMR) spectra of (A) alginate (Alg) and (B) lyophilized alginate dialdehyde (ADA). In the figure, E and F are the integrated intensities of signals at 76.4 and 71.6 ppm, respectively, to estimate the mannuronate content; and D, G, and H are the integrated intensities of signals at 82.8, 68.4, and 65.5 ppm, respectively, to estimate the guluronate content.

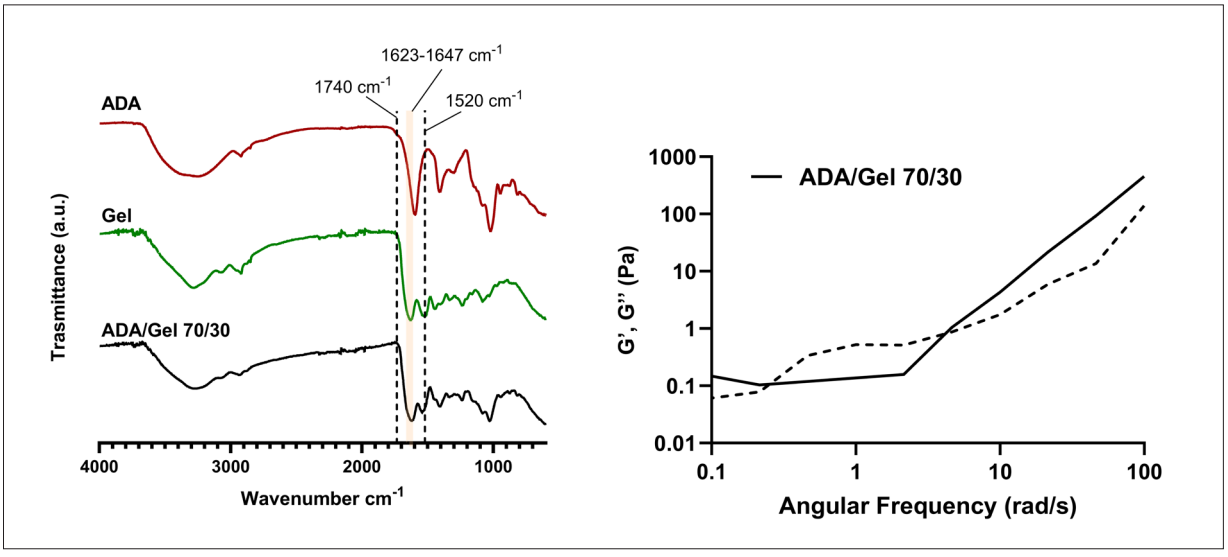

Figure S2. Characterization of ADA/Gel hydrogels. (A) Attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectra of lyophilized ADA (alginate dialdehyde; red), Gel (gelatin; blue), and ADA/Gel 70/30 hydrogels (total polymer concentration 6% w/v; ADA:Gel weight ratio 70/30; black). (B) Storage modulus (G′; continuous line) and loss modulus (G″; dotted line) of ADA/Gel 70/30 hydrogels (total polymer concentration 6% w/v; ADA:Gel weight ratio 70/30) as a function of angular frequency (1–100 rad/s) at 37°C (n = 3).

Table S1. Gelation point obtained by time-sweep analysis of alginate dialdehyde (ADA)-alginate (Alg) samples with varying D-(+)-glucono-1,5-lactone (GDL) concentrations (n = 2).

Code	Final concentrations		GDL (%w/v)	Average gel point (s)
	ADA (% w/v)	Alg (% w/v)		
ADA/Alg_50/50_GDL5	3	3	5	N.D.
ADA/Alg_50/50_GDL2.5	3	3	2.5	N.D.
ADA/Alg_50/50_GDL2	3	3	2	62
ADA/Alg_50/50_GDL1.5	3	3	1.5	135
ADA/Alg_50/50_GDL1	3	3	1	82

Note: N.D. (not detected).

Table S2. Elastic modulus (E) and storage modulus (G′) of ADA/Alg_66/33_C1.5, ADA/Alg_66/33_C3, ADA/Alg_66/33_C6, ADA/Alg_50/50_C3, ADA/Alg_50/50_C6 at 1 rad/s (n = 3).

Code	Storage modulus, G′ (Pa)	Elastic modulus, E (Pa)
ADA/Alg_66/33_C1.5	180 ± 100	540 ± 300
ADA/Alg_66/33_C3	205 ± 65	615 ± 195
ADA/Alg_66/33_C6	330 ± 90	990 ± 270
ADA/Alg_50/50_C3	655 ± 30	1965 ± 100
ADA/Alg_50/50_C6	2265 ± 65	6795 ± 195

Note: E was calculated from rheological data following **Equation III**; data is presented as the mean ± standard deviation. Abbreviations: ADA: Alginate dialdehyde; Alg: Alginate.

Table S3. Elastic modulus (E) and storage modulus (G′) of ADA/Alg samples with varying D-(+)-glucono-1,5-lactone (GDL) concentrations at 1 rad/s (n = 3).

Code	Storage modulus, G′ (Pa)	Elastic modulus, E (Pa)
ADA/Alg_50/50_GDL5	2680 ± 680	8040 ± 2040
ADA/Alg_50/50_GDL2.5	2340 ± 380	7020 ± 1140
ADA/Alg_50/50_GDL2	1965 ± 265	5895 ± 795
ADA/Alg_50/50_GDL1.5	1490 ± 180	4470 ± 540
ADA/Alg_50/50_GDL1	710 ± 100	2130 ± 300

Note: E was calculated from rheological data following **Equation III**; data is presented as the mean ± standard deviation. Abbreviations: ADA: Alginate dialdehyde; Alg: Alginate.

Table S4. Elastic modulus (E) and storage modulus (G′) at 1 rad/s of ADA/Alg/Gel samples (n = 3).

Code	Storage modulus, G′ (Pa)	Elastic modulus, E (Pa)
ADA/Alg/Gel_50/50/0	1350 ± 65	4050 ± 195
ADA/Alg/Gel_50/47.5/2.5	1300 ± 190	3900 ± 570
ADA/Alg/Gel_50/45/5	1170 ± 115	3510 ± 345
ADA/Alg/Gel_50/40/10	850 ± 115	2550 ± 345
ADA/Alg/Gel_50/35/15	870 ± 55	2610 ± 165
ADA/Alg/Gel_50/30/20	720 ± 265	2160 ± 795
ADA/Alg/Gel_50/25/25	650 ± 55	1950 ± 165

Note: E was calculated from rheological data following **Equation III**; data is presented as the mean ± standard deviation. Abbreviations: ADA: Alginate dialdehyde; Alg: Alginate; Gel: Gelatin.