SUPPORTING INFORMATION

Cyclodextrin/Caffeic Acid Nanofibers with Enhanced Antioxidant Activity, Fast-Release and Fast-Disintegrating Properties

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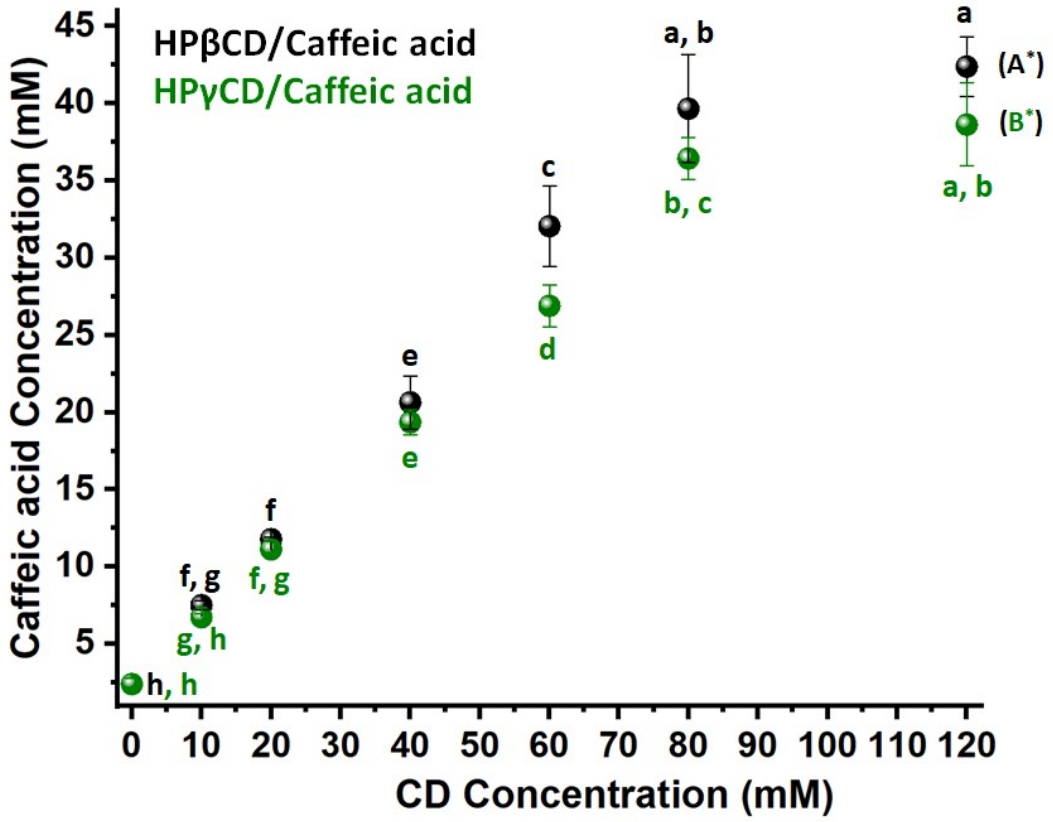

Fig. S1. Phase solubility diagram of HPβCD/caffeic acid and HPγCD/caffeic acid systems. (The comparison lettering for mean caffeic acid concentrations (mM) at each CD concentration (mM) is indicated using lowercase letters, while uppercase letters represent comparisons within each CD type. Means that do not share a common letter are significantly different ($p < 0.05$)).

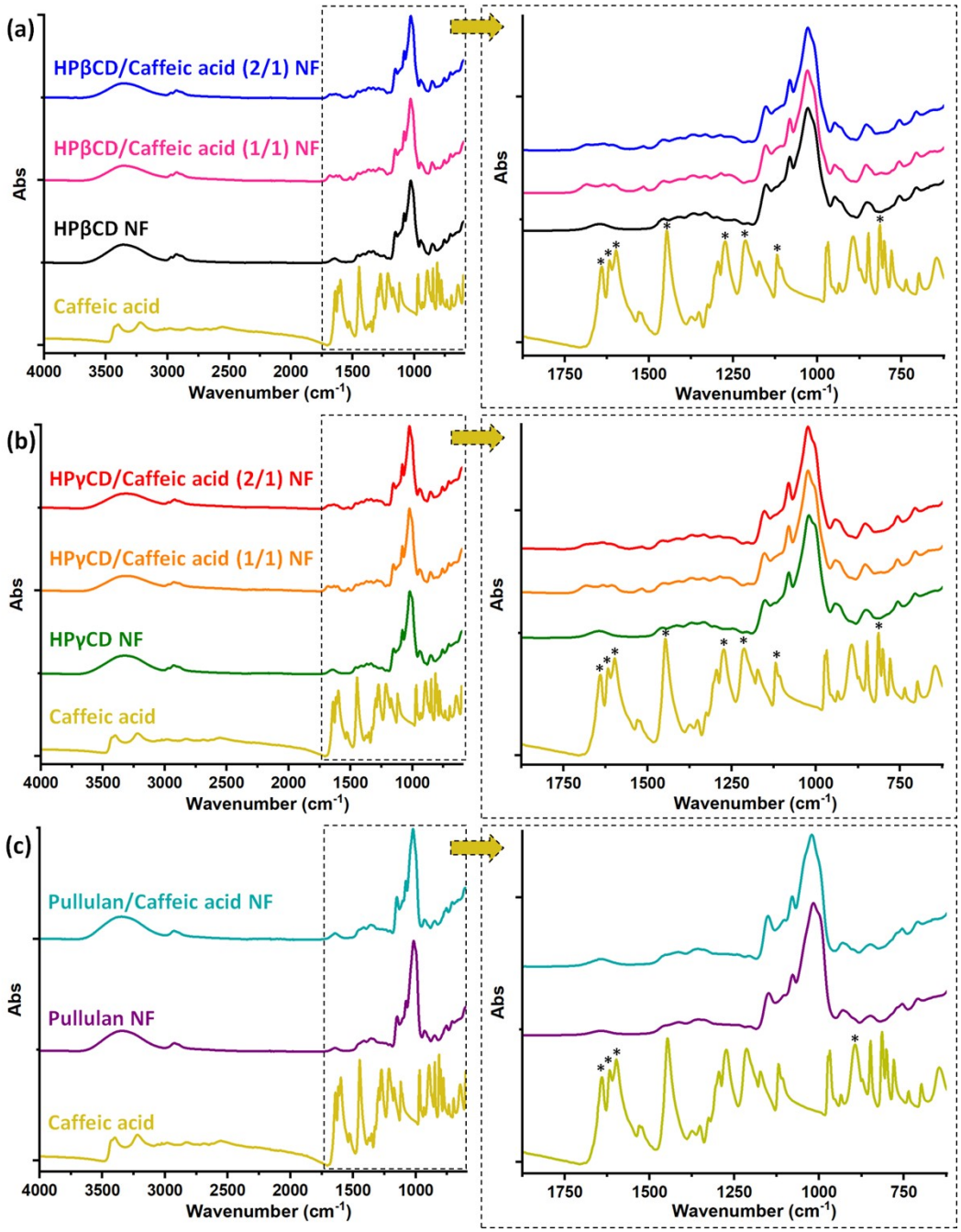

Fig. S2. The full and expanded range FTIR spectra of Caffeic acid powder, (a) HPβCD NF, HPβCD/Caffeic acid (1/1) NF, HPβCD/Caffeic acid (2/1) NF, (b) HPγCD NF, HPγCD/Caffeic acid (1/1) NF, HPγCD/Caffeic acid (2/1) NF and (c) Pullulan NF, Pullulan/Caffeic acid NF (NF: nanofibers).

Table S1. List of absorption band assignments of caffeic acid for FTIR spectra of caffeic acid and CD/caffeic acid nanofibers (NF).

Functional group	**Absorption peak of caffeic acid (cm^{-1})**	**Absorption peak of caffeic acid HPβCD NF (cm^{-1})**	**Absorption peak of caffeic acid HPγCD NF (cm^{-1})**
v(C=O)	1641	1685	1683
v(C=C)	1617	1634	1634
v(C=C)	1599	1606	1603
v(C=C)	1446	1516	1517
v(C-OH)	1273	1287	1286
$\beta(OH) + \beta(CH)_{C=C}$	1214	1250	1251
β(CH)	1118	1116	1114
β(C=O)	813	809	809

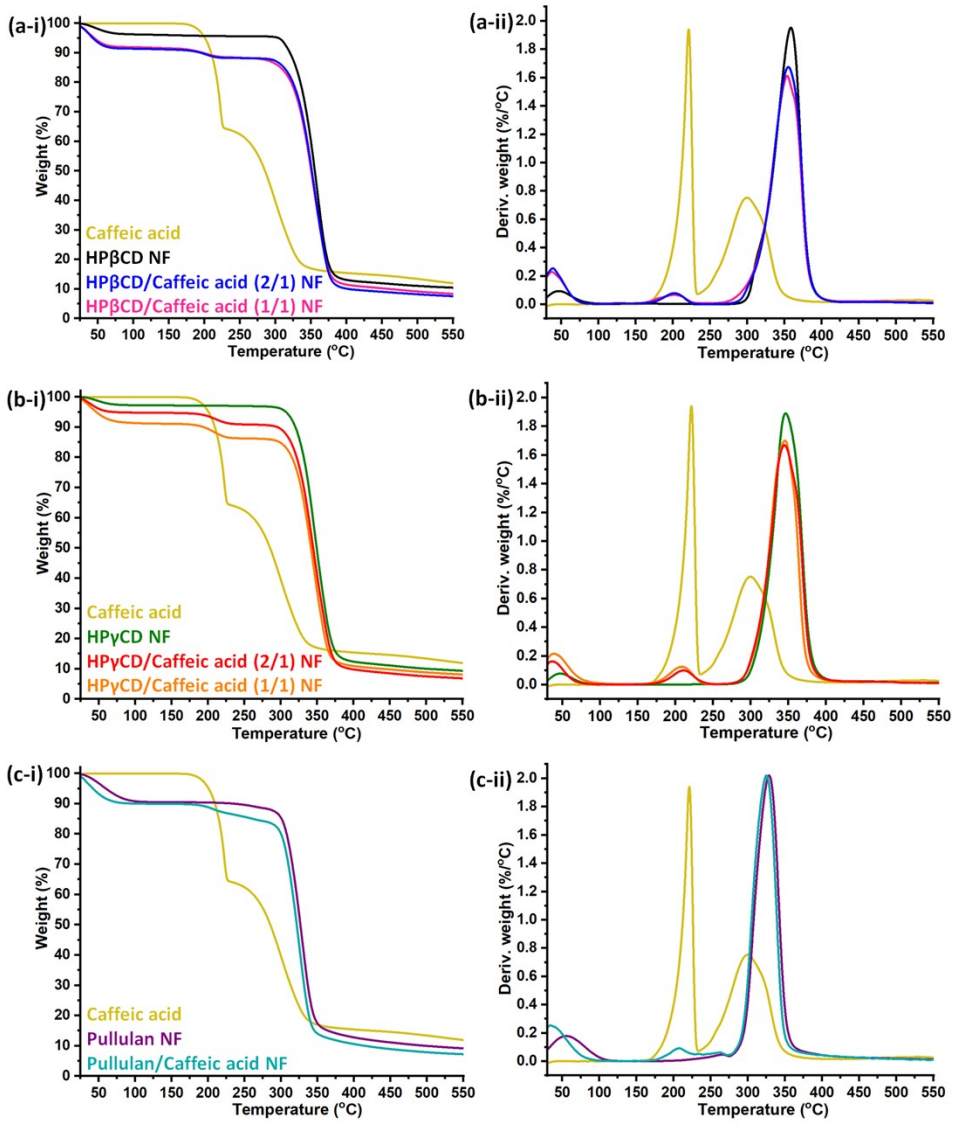

Fig. S3. (i) TGA thermograms and (i) derivative graphs (DTG) of Caffeic acid powder, (a) HPβCD NF, HPβCD/Caffeic acid (1/1) NF, HPβCD/Caffeic acid (2/1) NF, (b) HPγCD NF, HPγCD/Caffeic acid (1/1) NF, HPγCD/Caffeic acid (2/1) NF and (c) Pullulan NF, Pullulan/Caffeic acid NF (NF: nanofibers).

Table S2. The disintegration profile analysis of electrospun nanofibers.

Video	Sample Type	t_0 (s:ms)	t_e (s:ms)	Total Duration (s:ms)
Video S1	HPβCD/caffeic acid (1/1) NF	01:23	07:15	05:92
Video S2	HPγCD/caffeic acid (1/1) NF	01:10	06:05	04:95
Video S3	HPβCD/caffeic acid (2/1) NF	01:05	06:20	05:15
Video S4	HPγCD/caffeic acid (2/1) NF	01:25	07:35	06:10
Video S5	Pullulan/caffeic acid NF	01:15	09:10	07:95*

*at the end of duration, sample remained as a thin transparent layer without complete disintegration.

Table S3. Mean interactions obtained from the Tukey post hoc comparison test. Mean release values at each time point and for each sample type are presented; values that do not share a common letter are significantly different ($p < 0.05$).

Sample Type	Time (min)	Mean	Groups					
HPβCD/caffeic acid (2/1) NF	6	102.6*	A					
HPβCD/caffeic acid (2/1) NF	4	102.0*	A					
HPβCD/caffeic acid (2/1) NF	2	101.9*	A					
HPβCD/caffeic acid (2/1) NF	10	101.7*	A					
HPβCD/caffeic acid (2/1) NF	1	101.5*	A					
HPβCD/caffeic acid (2/1) NF	8	101.5*	A					
HPγCD/caffeic acid (2/1) NF	4	99.2	A					
HPγCD/caffeic acid (2/1) NF	6	99.0	A					
HPγCD/caffeic acid (2/1) NF	2	98.6	A					
HPβCD/caffeic acid (1/1) NF	6	98.5	A					
HPβCD/caffeic acid (1/1) NF	10	98.0	A					
HPβCD/caffeic acid (1/1) NF	8	97.5	A					
HPγCD/caffeic acid (2/1) NF	10	97.4	A					
HPβCD/caffeic acid (1/1) NF	4	97.2	A					
HPβCD/caffeic acid (1/1) NF	2	97.1	A					
HPγCD/caffeic acid (2/1) NF	8	97.0	A					
HPγCD/caffeic acid (2/1) NF	1	96.5	A					
HPγCD/caffeic acid (1/1) NF	2	96.2	A					
HPβCD/caffeic acid (2/1) NF	0.5	95.5	A					
HPγCD/caffeic acid (1/1) NF	6	95.2	A					
HPβCD/caffeic acid (1/1) NF	1	94.8	A					
HPγCD/caffeic acid (1/1) NF	8	94.3	A	B				
HPγCD/caffeic acid (1/1) NF	10	94.2	A	B				
HPγCD/caffeic acid (1/1) NF	4	94.1	A	B				
HPγCD/caffeic acid (1/1) NF	1	93.8	A	B				
HPγCD/caffeic acid (1/1) NF	0.5	91.8	A	B				
HPβCD/caffeic acid (1/1) NF	0.5	89.8	A	B	C			
HPγCD/caffeic acid (1/1) NF	0.5	88.6	A	B	C			
Pullulan/caffeic acid NF	10	78.1	A	B	C			
Pullulan/caffeic acid NF	8	75.7	A	B	C			
Pullulan/caffeic acid NF	6	66.0		B	C	D		
Pullulan/caffeic acid NF	4	62.9			C	D		
Pullulan/caffeic acid NF	2	38.7				D	E	
Pullulan/caffeic acid NF	1	32.3					E	
Pullulan/caffeic acid NF	0.5	21.5					E	F
HPγCD/caffeic acid (2/1) NF	0	0						F
Pullulan/caffeic acid NF	0	0						F
HPγCD/caffeic acid (1/1) NF	0	0						F
HPβCD/caffeic acid (2/1) NF	0	0						F
HPβCD/caffeic acid (1/1) NF	0	0						F

*Values slightly exceeding 100% are attributed to experimental and analytical variability and were considered to be within the acceptable margin of error.

Table S4. The lettering obtained from the Tukey post hoc comparison test shows the comparison of mean release values for each sample type; values that do not share a common letter are significantly different ($p < 0.05$).

Sample Type	Mean	Groups
HPβCD/caffeic acid (2/1) NF	88.4	A
HPγCD/caffeic acid (2/1) NF	84.9	A
HPβCD/caffeic acid (1/1) NF	84.1	A
HPγCD/caffeic acid (1/1) NF	82.0	A
Pullulan/caffeic acid NF	46.9	B

Application of release data on mathematical models:

Zero order model: The release of drug can be represented by the equation:

$C_0-C_t = K_0t$

$C_t=C_0+K_0t$

C_t is the amount of drug released at time t, C_0 is the initial concentration of drug at time t=0, K_0 is the zero-order rate constant. Here, the slope of the cumulative drug release *vs.* time plot gives the correlation coefficient (R^2) value.

First order model: The release of drug can be represented by the equation:

$DC/dt=-K_1C$

K_1 is the first order rate constant, expressed in $time^{-1}$ or per hour

After rearranging and integrating the equation,

$Log\ C=log\ C_0-K_1t/2.303$

C_0 is the initial concentration of the drug, C is the percent of drug remaining at time t. Here, the slope of the log % of drug remaining *vs.* time gives the R^2 value.

Higuchi model: Higuchi release model is represented as:

$M_t/M_\infty = K_ht^{1/2}$

where M_t/M_∞ is the fraction of drug released at each time point (t), Mt is the amount of drug released in time t, M∞ is the amount of drug released after time ∞, and K_h represents the Higuchi release kinetic constant. Here, the plot is obtained by cumulative percentage drug release *vs.* square root of time and the slope gives R^2 value.

Korsmeyer-peppas model: Korsmeyer-peppas model is represented as:

$M_t/M_\infty=K_{kp}t^n$

$Log\ (M_t/M_\infty) =log\ K_{kp} + nlog\ t$

M_t/M_∞ is a fraction of drug released at time t, M_t is the amount of drug released in time t, M_∞ is the amount of drug released after time ∞, n is the diffusional exponent or drug release exponent, K_{kp} is the Korsmeyer release rate constant. Here, the graph is plotted between log cumulative % drug release *vs.* log time and the slope gives R^2 value.

Table S5. The correlation coefficient (R^2) values of samples calculated by using different kinetic models.

Kinetic model	**HPβCD/ Caffeic acid (1/1) NF**	**HPγCD/ Caffeic acid (1/1) NF**	**HPβCD/ Caffeic acid (2/1) NF**	**HPγCD/ Caffeic acid (2/1) NF**	**Pullulan/ Caffeic acid NF**
Zero-order	0.2272	0.2021	0.2056	0.2041	0.8500
First-order	0.4681	0.2389	0.2969	0.2391	0.9520
Higuchi	0.4480	0.4175	0.4212	0.4215	0.9768
Korsmeyer-Peppas	0.7698	0.7643	0.7646	0.7652	0.9598
Diffusion exponent (*n* value) *	0.6733	0.6672	0.6782	0.6272	0.6751

*calculated by the linear regression of Korsmeyer-Peppas equation of $\log(M_t/M_\infty)$ versus log *t.*

Table S6. The lettering obtained from the Tukey post hoc comparison test shows the comparison of mean antioxidant performance (%) for each sample type; values that do not share a common letter are significantly different ($p < 0.05$).

Sample Type	Mean	Groups		
HPβCD/caffeic acid (1/1) NF	64.4	A		
HPγCD/caffeic acid (1/1) NF	63.9	A		
HPβCD/caffeic acid (2/1) NF	50.8		B	
HPγCD/caffeic acid (2/1) NF	48.0		B	
Pullulan/caffeic acid NF	30.5			C