Supporting information

Core-Shell Biopolymer Nanoparticles for Co-Delivery of Curcumin and Piperine: Sequential Electrostatic Deposition of Hyaluronic Acid and Chitosan Shells on the Zein Core

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Table S1. Light degradation kinetics parameters of curcumin and piperine in the core-shell biopolymer nanoparticles

Bioactive compound	Sample	k (min^{-1})	$t_{1/2}$ (min)	R^2
Curcumin	Cur	0.0256	27.1	0.9752
	Cur-zein	0.0138	50.2	0.9948
	Cur-zein-HA	0.0087	79.7	0.9730
	Cur-zein-HA-Pip	0.0072	96.3	0.9761
	Cur-zein-HA-Pip-LCH	0.0058	119.5	0.9649
	Cur-zein-HA-Pip-MCH	0.0063	110.0	0.9746
	Cur-zein-HA-Pip-HCH	0.0065	106.6	0.9754
	Cur-Pip-zein-HA-LCH	0.0064	108.3	0.9762
Piperine	Piperine	0.0048	144.4	0.9673
	Cur-zein-HA-Pip	0.0037	187.4	0.9646
	Cur-zein-HA-Pip-LCH	0.0026	266.6	0.9494
	Cur-zein-HA-Pip-MCH	0.0028	247.6	0.9439
	Cur-zein-HA-Pip-HCH	0.0029	239.0	0.9314
	Cur-Pip-zein-HA-LCH	0.0021	330.1	0.9369

Table S2. Particle size and zeta-potential of fresh samples and stored samples (2 months)

Sample	Particle size (nm)		Zeta-potential (mV)	
	Fresh	Stored	Fresh	Stored
Cur-zein	105.5 ± 3.6 ^{b}	120.2 ± 2.9 ^{a}	+24.6 ± 1.0 ^{a}	+18.9 ± 0.4 ^{b}
Cur-zein-HA	153.0 ± 5.8 ^{b}	324.5 ± 11.4 ^{a}	-40.6 ± 3.2 ^{b}	-36.3 ± 2.3 ^{a}
Cur-zein-HA-Pip	186.0 ± 8.6 ^{b}	393.8 ± 5.4 ^{a}	-28.8 ± 2.2 ^{b}	-24.5 ± 0.6 ^{a}
Cur-zein-HA-Pip-LCH	598.6 ± 24.9 ^{b}	676.9 ± 33.6 ^{a}	+38.1 ± 3.5 ^{a}	+34.3 ± 2.1 ^{b}
Cur-zein-HA-Pip-MCH	712.0 ± 23.6 ^{b}	811.0 ± 14.3 ^{a}	+38.7 ± 2.3 ^{a}	+33.4 ± 1.9 ^{b}
Cur-zein-HA-Pip-HCH	807.0 ± 18.6 ^{b}	948.5 ± 27.0 ^{a}	+39.8 ± 2.6 ^{a}	+35.9 ± 2.1 ^{b}
Cur-Pip-zein-HA-LCH	613.7 ± 22.9 ^{b}	824.2 ± 18.5 ^{a}	+34.4 ± 1.8 ^{a}	+30.1 ± 1.3 ^{b}

Different superscript letters (a, b…) in the same row indicate significant differences ($p < 0.05$)

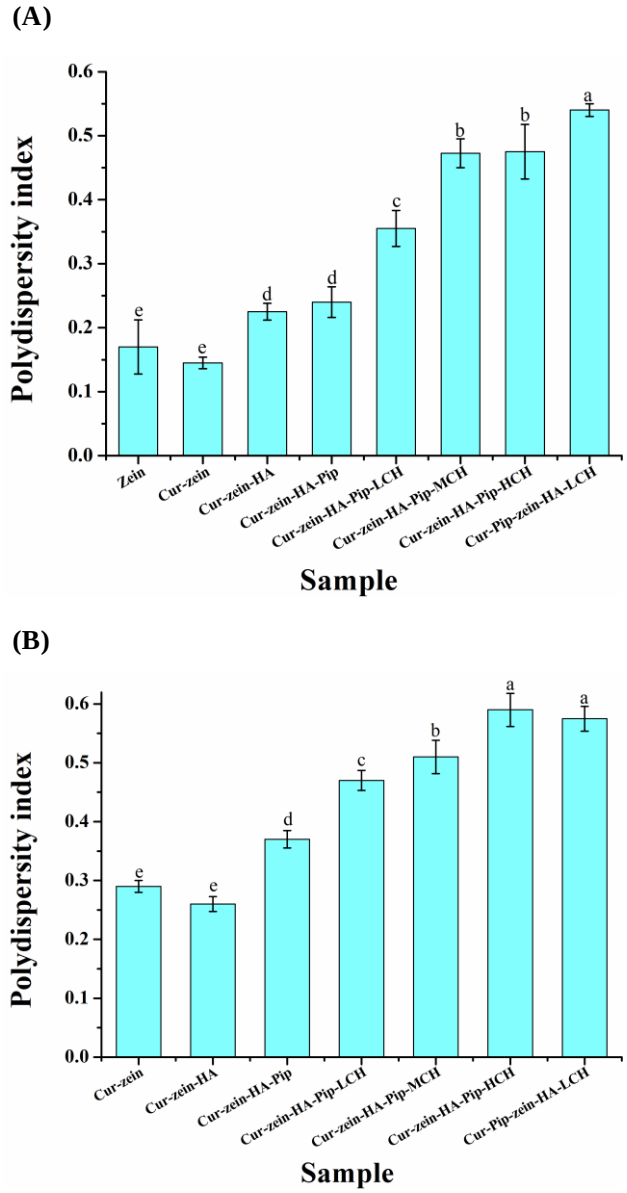

Figure S1. The polydispersity index (PDI) of freshly prepared nanoparticle dispersions **(A)** and stored (2 months) nanoparticle dispersions **(B)**. Different superscript letters (a, b, c…) in the Figure indicate significant differences ($p < 0.05$)

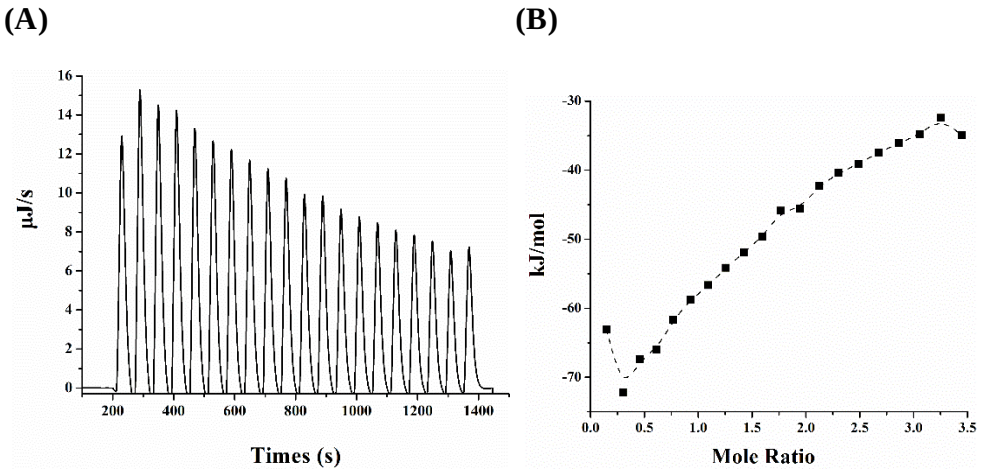

Figure S2 A-B. Isothermal calorimetry titration thermogram **(A)** binding isotherm **(B)** of piperine-hyaluronic acid. (1.8 mM piperine (50 µL) was placed in the syringe and 0.18 mM hyaluronic acid (170 µL) was placed in reaction cell, 20 successive 2.5 µL injections of piperine solution were titrated into hyaluronic acid solutions at time intervals of 60 seconds). The ΔH, TΔS, and ΔG were calculated as −91.2 KJ/mol, −71.0 KJ/mol, and −20.2 KJ/mol. The interaction between piperine and hyaluronic acid was exothermic and enthalpy driven, and hydrogen bonding was involved in the molecular interaction between piperine and hyaluronic acid.