

# Separation Process of Nisin Using Aqueous Two-Phase Systems: A New Approach Featuring Nanoparticles

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## Supporting information

Content:

- **S1.** Experimental mass fraction composition and partition coefficients of nisin in PEG (1) + K<sub>2</sub>HPO<sub>4</sub> (2) + KH<sub>2</sub>PO<sub>4</sub> (3) + Nisin (4) + H<sub>2</sub>O (5) + nanoparticle (6) + citric acid ( $\approx$  5.7%) at 101 kPa and T= 298 K.

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**S1.** Experimental mass fraction composition and partition coefficients of nisin in PEG (1) + K<sub>2</sub>HPO<sub>4</sub> (2) + KH<sub>2</sub>PO<sub>4</sub> (3) + Nisin (4) + H<sub>2</sub>O (5) + nanoparticle (6) + citric acid ( $\approx$  5.7%) at 101 kPa and T= 298 K.

Nanoparticle	mass fraction composition / wt %								K	K (average) $\pm \sigma^a$		
	feed						(w <sub>4</sub> ) <sub>top</sub>	(w <sub>4</sub> ) <sub>bottom</sub>				
	w <sub>1</sub>	w <sub>2</sub>	w <sub>3</sub>	w <sub>4</sub>	w <sub>5</sub>	w <sub>6</sub>						
Mw (PEG)= 4000												
without nano	9.08	7.95	5.70	0.11	71.39	0.00	1.49	1.42	1.05	$1.02 \pm 0.04$		
	9.23	8.04	5.75	0.11	71.40	0.00	1.50	1.51	1.00			
n-Gr	8.97	7.86	5.63	0.12	71.76	0.01	0.93	0.38	2.44	$2.47 \pm 0.04$		
	8.75	7.65	5.45	0.12	72.47	0.01	0.90	0.36	2.50			
n-Fe <sub>2</sub> O <sub>3</sub>	8.97	7.86	5.63	0.12	71.76	0.01	0.61	4.07	0.15	$0.15 \pm 0.00$		
	8.97	7.86	5.63	0.12	71.76	0.01	0.65	4.01	0.16			
n-ZnO	9.21	8.08	5.74	0.11	71.07	0.01	1.54	1.38	1.11	$1.08 \pm 0.04$		
	9.19	8.03	5.75	0.11	71.16	0.01	0.88	0.84	1.05			
n-Ag	9.21	8.08	5.74	0.11	71.07	0.01	1.46	1.29	1.13	$1.14 \pm 0.02$		
	9.19	8.03	5.75	0.11	71.16	0.01	1.18	1.02	1.16			
Funct.n-Gr	8.97	7.86	5.63	0.12	71.76	0.01	5.14	1.47	3.49	$3.78 \pm 0.42$		
	8.75	7.69	5.45	0.12	72.47	0.01	5.81	1.42	4.09			
Mw (PEG)= 6000												
without nano	9.17	8.04	5.77	0.12	71.10	0.00	0.69	0.67	1.03	$1.04 \pm 0.00$		
	9.17	8.07	5.78	0.12	71.07	0.00	0.67	0.65	1.04			
n-Gr	8.97	7.86	5.63	0.12	71.76	0.01	1.01	0.32	3.20	$3.04 \pm 0.22$		
	8.75	7.65	5.45	0.12	72.47	0.01	1.11	0.39	2.88			
n-Fe <sub>2</sub> O <sub>3</sub>	8.97	7.86	5.63	0.12	71.76	0.01	1.23	2.83	0.44	$0.51 \pm 0.09$		
	8.97	7.86	5.63	0.12	71.76	0.01	1.30	2.25	0.58			
n-ZnO	9.21	8.08	5.74	0.11	71.07	0.01	1.37	1.33	1.03	$1.01 \pm 0.03$		
	9.19	8.03	5.75	0.11	71.16	0.01	1.36	1.37	0.99			
n-Ag	9.21	8.08	5.74	0.11	71.07	0.01	0.08	0.07	1.17	$1.22 \pm 0.06$		
	9.19	8.03	5.75	0.11	71.16	0.01	0.09	0.07	1.27			
Funct.n-Gr	9.19	8.02	5.78	0.12	71.11	0.01	6.31	1.41	4.48	$4.34 \pm 0.19$		
	9.17	8.04	5.76	0.13	71.13	0.01	5.91	1.41	4.20			
Mw (PEG)= 10000												
without nano	9.21	8.06	5.77	0.12	71.03	0.00	0.74	0.67	1.10	$1.16 \pm 0.08$		
	9.08	7.94	5.67	0.11	71.47	0.00	0.73	0.60	1.22			
n-Gr	8.97	7.86	5.63	0.12	71.76	0.01	1.59	0.34	4.64	$4.14 \pm 0.69$		
	8.75	7.65	5.45	0.12	72.47	0.01	1.55	0.42	3.65			
n-Fe <sub>2</sub> O <sub>3</sub>	8.97	7.86	5.63	0.12	71.76	0.01	2.79	1.69	1.65	$1.21 \pm 0.61$		
	8.97	7.86	5.63	0.12	71.76	0.01	1.07	1.37	0.78			
n-ZnO	9.21	8.08	5.74	0.11	71.07	0.01	1.72	1.43	1.20	$1.16 \pm 0.05$		
	9.19	8.03	5.75	0.11	71.16	0.01	1.53	1.36	1.13			
n-Ag	9.21	8.08	5.74	0.11	71.07	0.01	0.25	0.17	1.49	$1.53 \pm 0.06$		
	9.19	8.03	5.75	0.11	71.16	0.01	0.27	0.17	1.57			
Funct.n-Gr	9.21	8.08	5.74	0.11	71.07	0.01	5.04	0.67	7.53	$8.17 \pm 0.92$		
	9.19	8.03	5.75	0.11	71.16	0.01	5.82	0.66	8.83			

<sup>a</sup> Standard deviation. Standard uncertainties: u(T)= 0.5 K; u(P)= 10 kPa.