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Data Article

Data on the preparation of chitosan-tripolyphosphate nanoparticles and its entrapment mechanism for egg white derived peptides

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ABSTRACT

The data article refers to the paper "A study on the preparation of chitosan-tripolyphosphate nanoparticles and its entrapment mechanism for egg white derived peptides" [1]. Data presented here include impact factors (chitosan molecular weights, pH values, chitosan-tripolyphosphate mass ratio, and chitosan concentration) on the preparation and colloidal properties of chitosan-tripolyphosphate nanoparticles. Data also refer to the effect of impact factors (chitosan molecular weight, chitosan concentration, peptides-chitosan mass ratio and pH values) on the entrapment efficiency and entrapment capacity of chitosan-tripolyphosphate nanoparticles loading with egg white derived peptides. Data also involve the size and zeta potential change after the egg white derived peptides entrapped in chitosan-tripolyphosphate nanoparticles. Additionally, data exhibit the free amino group and surface hydrophobicity of egg white derived peptides with different molecular weights.

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Specifications Table

Subject area	Chemistry
More specific subject area	Food Chemistry on the entrapment of egg white derived peptides
Type of data	Table, graph
How data was acquired	UV−Vis spectrophotometer, TEM, Zetasizer Nano-ZS, Fluorescence spectrophotometer
Data format	Raw, analyzed
Experimental factors	pH varying from 2 to 6; different chitosan molecular weight (30, 50, 100, 150, 300 kDa)
Experimental features	Room temperature
Data source location	Changchun, Jilin University, China
Data accessibility	https://doi.org/10.17632/74f4cwnszr.1
Related research article	Du Z, Liu J, Zhang T et al. A study on the preparation of chitosan-tripolyphosphate nanoparticles and its entrapment mechanism for egg white derived peptides [J]. Food chemistry, 2019, 286: 530−536.

Value of the Data

- Particle size, PDI, and zeta potential of chitosan-tripolyphosphate nanoparticles can be controllable by adjusting the factors in this data. These data could be useful for the fabrication of nanoparticles based on chitosan and tripolyphosphate;
- Further understanding of egg white derived peptides with different molecular weight by the comparison of their free amino acids and surface hydrophobicity in this data. These data could be meaningful for understanding the interaction mechanism between the peptides with different molecular weights and nanoparticles;
- Particle size, zeta potential, entrapment efficiency and entrapment capacity of chitosan-tripolyphosphate nanoparticles can be controllable after the entrapment of egg white derived peptides by adjusting factors in this data. These data could be meaningful to get pleasant entrapment efficiency and entrapment capacity of bioactive peptides in chitosan-tripolyphosphate nanoparticles.

1. Data

The data presented here describe the influence of chitosan molecular weight, pH values, chitosan-tripolyphosphate mass ratio and chitosan concentration on the preparation of nanoparticles (Tables 1−4). Peptides are divided into different molecular weights and entrapped in the nanoparticles, respectively (Tables 5−8). Tables 9−11 shows the effect on the size and zeta potential of chitosan-tripolyphosphate nanoparticles after trapping peptides with different molecular weights range. Moreover, data also refer to the free amino group and surface hydrophobicity of the peptides with different molecular weights (Tables 12 and 13). Finally, data show the transmission electron microscopy (TEM) images of chitosan-tripolyphosphate nanoparticles loading with or without egg white derived peptides (Fig. 1) [1].

2. Experimental design, materials and methods

2.1. Preparation of egg white derived peptides (EWDP) with different molecular weights (MW)

EWDP was prepared according to previous work with some modifications [2]. Briefly, egg white powder dispersed in ultrapure water as a 0.05 g mL-1 protein slurry was heated 90 °C for 10 min to denature the protein, then cooled to 50 °C for hydrolysis in a 500 mL reactor with the temperature and pH values controlled. The pH was adjusted to 10 with 1 M NaOH before adding the alkaline proteinase (Alcalase Food Grade, 4.0% w/w). The reaction was terminated after 180 min. Then, the mixture was centrifuged (1,2000 g, 10 min, 4 °C) after enzyme inactivation in a boiling water bath for 10 min. The supernatant was passed through an ultrafiltration membrane with MW cut-off (MWCO) of 1 kDa, 3 kDa, 10 kDa (Millipore Minitan System, Millipore, Bedford, MA, USA). In this way, MW of <1 kDa, 1−3 kDa, and 3−10 kDa, EWDP were obtained as fraction 1 (F1), fraction2 (F2), fraction 3 (F3). Furthermore, the peptides before ultrafiltration were collected as fraction 4 (F4). Finally, all of the fractions were lyophilized and then stored at - 20 °C until use.

Table 1
Particle size, PDI and zeta potential of chitosan-tripolyphosphate nanoparticles with different chitosan molecular weights.

Molecular Weights (kDa)	Size/nm	PDI	Zeta/mV
30	228.8	0.442	42.5
30	233.2	0.418	41.4
30	242.4	0.425	44
50	203.9	0.294	59.1
50	210.3	0.316	59.9
50	204.5	0.309	62.4
100	205.9	0.303	48.9
100	213.7	0.305	49.6
100	220.1	0.31	50.1
150	210.1	0.304	59.7
150	212.9	0.309	62.8
150	213.7	0.323	60.8
300	253	0.322	54.2
300	254.9	0.304	49.6
300	225.6	0.376	51.4

Table 2
Particle size, PDI and zeta potential of chitosan-tripolyphosphate nanoparticles under different pH values.

pH	Size/nm	PdI	Zeta/mV
2–1	184.73	0.32	51.30
2–2	158.43	0.33	49.03
2–3	240.60	0.42	55.77
3–1	205.9	0.303	48.9
3–2	213.7	0.305	49.6
3–3	220.1	0.31	50.1
4–1	219.83	0.38	42.63
4–2	200.37	0.40	43.17
4–3	263.37	0.50	43.23
5–1	228.07	0.25	30.90
5–2	245.30	0.26	29.40
5–3	222.30	0.25	33.57
6–1	418.20	0.39	23.13
6–2	433.80	0.40	19.90
6–3	425.93	0.28	22.73

Table 3
Particle size, PDI and zeta potential of chitosan-tripolyphosphate nanoparticles with different chitosan-tripolyphosphate (CS-TPP) mass ratio.

CS:TPP	Size/nm	PDI	Zeta/mV
6:1	155.5	0.384	57.9
6:1	164.3	0.3	57.8
6:1	162.3	0.321	59.6
5:1	176	0.459	54.2
5:1	171.9	0.451	57.2
5:1	179.6	0.454	53.6
4:1	186.8	0.428	52.1
4:1	193.9	0.451	50.4
4:1	199	0.445	52.6
3:1	205.9	0.303	48.9
3:1	213.7	0.305	43.5
3:1	220.1	0.31	50.1
2:1	250.6	0.447	40.2
2:1	242.6	0.444	36.2
2:1	257.6	0.467	38.5

Table 4
Particle size, PDI and zeta potential of chitosan-tripolyphosphate nanoparticles with different chitosan concentration.

Chitosan	Size/nm	PdI	Zeta/mV
0.25	163.7	0.295	34.4
0.25	165.5	0.291	35
0.25	182.2	0.297	32.1
0.5	205.9	0.303	48.9
0.5	213.7	0.305	43.5
0.5	220.1	0.31	50.1
1	245.4	0.458	52.2
1	234.5	0.451	53.8
1	242.9	0.46	54.3
1.5	234.3	0.412	69.7
1.5	255.7	0.406	66.2
1.5	260.1	0.394	67.5
2	271.2	0.423	74.7
2	280.8	0.413	68.8
2	279.6	0.405	70.2
2.5	282.6	0.325	71.7
2.5	285.8	0.296	77.2
2.5	290.2	0.296	75.7

2.2. Preparation of chitosan-tripolyphosphate nanoparticles (CS-TPP NPs)

CS-TPP NPs were prepared as previously detailed with some modifications [3,4]. Briefly, CS was added to 1% (w/v) acetic acid solution with sonication in an ice bath until the solution was transparent. The formation of CS-TPP NPs started spontaneously via the TPP-initiated ionic gelation mechanism, with the addition of TPP solution (0.8 mg/mL) to a CS solution with stirring at room temperature.

2.3. Entrapment of egg white derived peptides (EWDP) in CS-TPP NPs

The EWDP with different MW was encapsulated in the CS-TPP NPs. The excess EWDP was separated at 4000 r/min for 10 min with an Amicon Ultra centrifugal filter (10 k MWCO, Millipore Corp.). The unencapsulated EWDP in the filtrate was quantified with an established standard curve at 220 nm ($R^2 \geq 0.999$) recording from a UV−Vis spectrophotometer (UV-2550, Shimadzu, Tokyo, Japan). The EE and EC of the EWDP were calculated according to the following equation:

$$EE(\%) = (\text{Total EWDP-Filtrated EWDP})/(\text{Total EWDP}) \times 100(\%)$$

$$EC(\%) = (\text{Entrapped EWDP})/(\text{Total NPs} + \text{Entrapped EWDP}) \times 100(\%)$$

2.4. Characterization of nanoparticles

The morphological characteristics of NPs were examined by TEM (JEOL H-7650, Hitachi, Japan).

The measurements of particle size, PDI, and zeta potential of NPs were performed on a Zetasizer Nano-ZS (Malvern Instruments) based on dynamic light scattering (DLS) techniques with a DTS1060 capillary cell. Particle size distribution data were presented based on intensity frequency.

2.5. Free amino group determination

The amount of free amino nitrogen present in the EWDP fractions was determined using the O-phthaldehyde method as reported previously [5]. Namely, 0.4 mL of 1 mg/mL peptide sample was mixed with 3 mL of the O-phthaldehyde reagent. The mixture stood for exactly 2 min before it was measured at 340 nm in the spectrophotometer. Serine (1 mg/mL) was used as the standard and the free amino nitrogen was expressed as milliequivalent serine NH_2/g.

Table 5
Entrapment efficiency and entrapment capacity of egg white derived peptides entrapped in chitosan-tripolyphosphate nanoparticles with different chitosan molecular weights.

chitosan molecular weights (kDa)	F1		F2		F3		F4		F1		F2		F3		F4	
	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD
30	28.48445	2.18702	29.80281	3.57206	43.87188	6.37763	30.90667	6.94546	17.60279	1.61379	18.26867	2.60915	24.75767	4.56488	18.81799	4.95118
50	25.27682	4.48917	35.06345	3.30237	34.648	0.74156	25.23522	2.44684	15.93644	3.25721	20.82192	2.41692	20.6261	0.5531	15.91439	1.80206
100	27.78575	0.35983	39.59223	0.64997	44.34032	1.46975	33.19667	9.205	17.24547	0.26915	22.89554	0.48511	24.95605	1.09029	19.93435	6.45791
150	21.70469	0.65611	33.47805	0.94235	33.19159	3.51196	37.3343	2.15614	13.99959	0.48967	20.0694	0.70181	19.93191	2.56637	21.87544	1.59137
300	31.98368	1.86859	27.13645	1.51848	36.02349	0.61087	32.57029	2.99533	19.34688	1.38207	16.91063	1.12603	21.27076	0.45606	19.63205	2.19714

Chitosan concentration = 0.5 mg/mL, peptides-chitosan mass ratio = 1:1, pH 3. F1, F2, F3, F4 = <1k, 1k-3k, 3k-10k and egg white derived peptides.

Table 6
Entrapment efficiency and entrapment capacity of egg white derived peptides entrapped in chitosan-tripolyphosphate nanoparticles with different chitosan concentration.

chitosan concentration (mg/mL)	F1		F2		F3		F4		F1		F2		F3		F4	
	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD
0.1	23.1588	1.11625	38.20997	0.81047	41.64577	1.11856	29.29	6.63546	14.7987	0.83024	22.27424	0.60418	23.80043	0.83194	18.01095	4.74067
0.5	27.78575	0.85983	39.59223	0.64997	44.34032	1.46975	33.19667	9.205	17.24547	0.64074	22.89554	0.48511	24.95605	1.09029	19.93435	6.45791
1	30.11392	0.77603	47.60206	0.88542	47.17554	8.27598	36.24667	1.8609	18.42424	0.57865	26.30887	0.65969	26.13475	5.84423	21.37438	1.37646
1.5	32.93808	1.67608	58.03236	1.65273	48.82523	4.06874	40.86	2.89363	19.80983	1.25548	30.32537	1.23801	26.8037	3.04227	23.4567	2.16552
2	47.06284	2.31373	65.52363	1.96177	51.07034	5.28653	43.93	1.65907	26.0886	1.7057	32.95013	1.45	27.69486	3.81369	24.78234	1.22901

Chitosan molecular weights = 100 kDa, peptides-chitosan mass ratio = 1:1, pH 3. F1, F2, F3, F4 = <1k, 1k-3k, 3k-10k and egg white derived peptides.

Table 7
Entrapment efficiency and entrapment capacity of egg white derived peptides entrapped in chitosan-tripolyphosphate nanoparticles with the different peptides-chitosan mass ratio.

peptides-chitosan mass ratio	F1		F2		F3		F4		F1		F2		F3		F4	
	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD
4:1	13.6845	0.42977	19.0417	1.12577	22.74534	0.9509	26.63355	3.52004	29.10492	1.27291	36.35644	3.26698	40.55969	2.77359	44.41377	7.55148
3:1	17.62305	0.86192	24.44973	0.82609	26.58681	0.76353	30.79796	3.64312	28.39337	1.90242	35.48882	1.82479	37.42974	1.68893	40.93166	7.57601
2:1	25.98032	0.71099	29.09999	0.71238	30.64434	0.88511	32.10463	3.65814	28.04227	1.05524	30.38635	1.05728	31.49114	1.31027	32.50401	5.20177
1:1	27.78575	0.35983	39.59223	0.64997	44.34032	1.46975	33.19667	9.205	17.24547	0.26915	22.89554	0.48511	24.95605	1.09029	19.93435	6.45791
1:2	37.41014	1.95275	62.96062	0.87917	59.43836	4.06298	40.53328	6.25006	12.30286	0.72696	19.10055	0.32861	18.22675	1.50075	13.19443	2.2901

Chitosan molecular weights = 100 kDa, chitosan concentration = 0.5 mg/mL, pH 3. F1, F2, F3, F4 = <1k, 1k-3k, 3k-10k and egg white derived peptides.

Table 8
Entrapment efficiency and entrapment capacity of egg white derived peptides entrapped in chitosan-tripolyphosphate nanoparticles with different pH values.

pH	F1		F2		F3		F4		F1		F2		F3		F4	
	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment efficiency	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD	entrapment capacity	SD
2	27.46795	1.84362	35.61237	1.03731	29.20033	1.28507	30.44333	0.24987	17.08192	1.36385	21.07918	0.77197	17.96571	0.9546	18.58832	0.18705
3	32.78575	0.35983	39.59223	1.64997	44.34032	1.46975	33.19667	9.205	19.73629	0.26915	22.89554	1.22235	24.95605	1.09029	19.93435	6.45791
4	45.99254	0.604	40.81749	0.97567	45.21795	1.68028	36.11667	0.25423	25.64746	0.45096	23.43801	0.72644	25.32491	1.24453	21.31406	0.19031
5	57.17661	7.04476	49.66033	2.01677	48.90753	1.59767	40.87667	6.77856	30.0124	5.01842	27.13773	1.49004	26.83675	1.18406	23.46402	4.83796
6	59.16813	0.76038	56.89411	1.3714	52.6573	0.76771	58.358	4.95519	30.73646	0.56705	29.90847	1.01808	28.3118	0.57249	30.44373	3.58323

Chitosan molecular weights = 100 kDa, chitosan concentration = 0.5 mg/mL, peptides-chitosan mass ratio = 1:1.

Table 9
Effect of chitosan concentration on the particle size and zeta potential of peptide fractions with different molecular weights entrapped in chitosan-tripolyphosphate nanoparticles.

peptides	<1k		1k-3k		3k-10k		Egg white derived peptides	
Chitosan concentration	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential
0.1	95.23 ± 5.47^{cBC}	51.93 ± 1.39^{aA}	100.57 ± 7.61^{cB}	54.67 ± 3.62^{abA}	148.80 ± 7.47^{dA}	50.77 ± 2.55^{bA}	85.04 ± 6.94^{dC}	51.27 ± 1.59^{bA}
0.5	165.27 ± 5.34^{dA}	53.07 ± 2.90^{aA}	180.17 ± 7.77^{bA}	54.87 ± 3.27^{abA}	178.20 ± 1.01^{cA}	53.87 ± 1.79^{abA}	135.83 ± 3.93^{cB}	56.37 ± 3.37^{aA}
1.0	179.30 ± 2.02^{bBC}	51.20 ± 2.82^{aA}	189.37 ± 6.93^{bAB}	49.77 ± 1.87^{bA}	177.03 ± 7.54^{cC}	51.73 ± 4.01^{bA}	196.83 ± 6.61^{aA}	53.70 ± 2.20^{abA}
1.5	201.20 ± 5.70^{aC}	50.73 ± 0.32^{aB}	227.77 ± 8.45^{aA}	55.27 ± 2.58^{aA}	213.40 ± 3.97^{bB}	55.07 ± 1.59^{abA}	183.27 ± 5.95^{bD}	53.57 ± 1.40^{abAB}
2.0	205.03 ± 3.18^{aB}	51.17 ± 1.00^{aA}	223.23 ± 5.59^{aA}	54.60 ± 3.08^{abA}	226.07 ± 3.57^{aA}	56.40 ± 2.15^{aA}	185.13 ± 5.52^{bC}	53.77 ± 4.14^{abA}

Table 10
Effect of peptides-chitosan mass ratio on the particle size and zeta potential of peptide fractions with different molecular weights entrapped in chitosan-tripolyphosphate nanoparticles.

peptides	<1k		1k-3k		3k-10k		Egg white derived peptides	
Peptides-chitosan mass ratio	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential
4:1	172.37 ± 5.29^{abB}	47.30 ± 0.72^{bA}	187.63 ± 7.50^{abA}	47.30 ± 1.40^{bA}	173.87 ± 3.98^{cB}	44.70 ± 2.15^{dAB}	105.03 ± 2.27^{dC}	41.90 ± 2.52^{bB}
3:1	158.13 ± 1.07^{cB}	49.07 ± 2.42^{bA}	189.30 ± 6.62^{abA}	48.57 ± 1.22^{bAB}	182.67 ± 3.11^{bA}	48.23 ± 1.63^{cAB}	107.70 ± 1.55^{dC}	44.67 ± 3.20^{bB}
2:1	172.63 ± 7.20^{abB}	53.03 ± 1.24^{aA}	188.73 ± 4.43^{abA}	50.07 ± 0.84^{bAB}	176.00 ± 2.85^{cB}	49.80 ± 2.04^{cAB}	176.70 ± 4.83^{bB}	46.73 ± 3.43^{bB}
1:1	165.27 ± 5.34^{bcB}	54.67 ± 2.96^{aA}	180.17 ± 7.77^{bA}	53.87 ± 1.58^{aA}	178.20 ± 1.01^{bcA}	53.77 ± 1.79^{bA}	135.83 ± 3.93^{cC}	56.37 ± 3.37^{aA}
1:2	178.33 ± 3.25^{aC}	55.30 ± 1.37^{aAB}	198.87 ± 7.36^{aB}	55.60 ± 2.71^{aAB}	194.83 ± 1.72^{aB}	58.77 ± 0.51^{aA}	230.27 ± 8.16^{aA}	52.80 ± 2.63^{aB}

Table 11
Effect of pH values on the change of particle size and zeta potential of peptide fractions with different molecular weights entrapped in chitosan-tripolyphosphate nanoparticles.

peptides	<1k		1k-3k		3k-10k		Egg white derived peptides	
pH	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential	Size	Zeta potential
2.0	186.00 ± 5.82^{cdA}	55.90 ± 2.46^{aB}	182.63 ± 5.47^{cA}	57.57 ± 2.44^{aB}	184.70 ± 3.41^{cA}	63.63 ± 2.25^{aA}	157.60 ± 5.71^{dB}	54.20 ± 2.98^{aB}
3.0	165.27 ± 5.34^{dA}	54.67 ± 2.96^{aA}	180.17 ± 7.77^{cA}	54.33 ± 2.70^{aA}	178.20 ± 1.01^{cA}	53.87 ± 1.79^{bA}	135.83 ± 3.93^{eB}	56.37 ± 3.37^{aA}
4.0	199.53 ± 2.51^{cA}	47.57 ± 2.34^{bA}	187.13 ± 7.44^{cB}	45.20 ± 1.90^{aA}	194.60 ± 4.05^{cAB}	44.97 ± 4.35^{cA}	197.00 ± 2.65^{cA}	43.33 ± 2.23^{bA}
5.0	536.37 ± 3.16^{bB}	31.67 ± 1.65^{cA}	330.83 ± 8.17^{bC}	32.00 ± 1.35^{cA}	509.47 ± 45.31^{bB}	31.20 ± 1.90^{dA}	711.10 ± 6.07^{bA}	30.90 ± 0.75^{cA}
6.0	1112.33 ± 32.39^{aA}	24.37 ± 0.59^{dA}	729.13 ± 51.90^{aC}	24.80 ± 0.10^{dA}	983.00 ± 111.27^{aB}	23.53 ± 1.06^{eA}	978.00 ± 15.25^{aB}	24.47 ± 1.21^{dA}

Values reported are the mean ± standard deviation of three measurements from three replicates. Values within columns/rows with different lowercase superscript and letters are significantly different ($p < 0.05$).

Table 12
Free amino group of egg white derived peptides with different molecular weights.

peptides fractions	Free amino group (milliequivalent Serine NH_2/g)	SD
F1	187.87798	2.96273
F2	187.66867	5.67274
F3	165.65544	3.99821
F4	147.63015	3.51435

Table 13
Surface hydrophobicity of egg white derived peptides with different molecular weights.

peptides fractions	Surface hydrophobicity	SD
F1	51.374	1.08946
F2	48.87567	3.53789
F3	51.32867	4.00748
F4	108.86333	4.30006

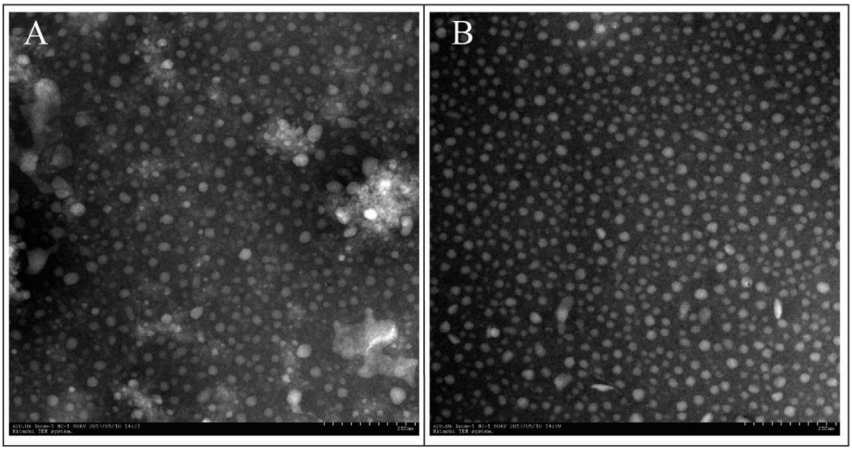

Fig. 1. Transmission electron microscopy of chitosan-tripolyphosphate nanoparticles entrapping without (A) or with (B) egg white derived peptides.

2.6. Surface hydrophobicity determination

Surface hydrophobicity of the peptides was determined by hydrophobic fluorescence probe, 8-anilino-1-naphthalenesulfonic acid reported previously [6]. Aqueous solutions of the samples containing 0.0009–0.015% peptides with 8 mM ANS (in 0.01 M phosphate buffer, pH 7), were measured at an excitation and emission wavelengths of 390 and 470nm, respectively. The slope of the fluorescence versus concentration was taken as the surface hydrophobicity of the peptides.

2.7. Statistical analysis

Results were given as mean ± standard deviation (SD) (n = 3). Variance (ANOVA) or unpaired Student's t-tests were used to detect the differences between two means. Statistical significance was set at $p < 0.05$, and extreme significance was set at $p < 0.01$.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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