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APPENDICES

APPENDIX A

Table A1: Pore size of 1%wt shrimp chitosan scaffolds freezing at temperature –10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	43.9	52.7	33.0	37.7	43.9
L_2	51.5	59.5	53.8	39.5	34.8
L_3	62.3	62.3	62.3	39.7	43.6
L_4	52.6	61.0	53.2	41.2	52.9
L_5	49.7	58.0	58.0	38.6	49.7
L_6	52.3	72.7	60.2	45.7	61.7
L_7	36.4	72.7	48.5	48.5	48.5
L_8	48.9	58.6	43.5	43.8	53.0
Average	50.8				
Standard deviation	7.4				

Table A2: Pore size of 1%wt squid chitosan scaffolds freezing at temperature –10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	37.7	37.7	33.0	33.0	52.7
L_2	43.5	43.5	38.9	43.8	49.2
L_3	43.6	54.5	54.5	62.3	62.3
L_4	61.0	52.6	52.3	61.0	61.7
L_5	58.0	69.5	49.7	69.5	58.0
L_6	46.0	73.6	52.6	52.6	61.0
L_7	48.5	54.5	54.5	54.5	54.5
L_8	38.4	43.2	42.9	41.9	59.5
Average	51.5				
Standard deviation	4.4				

Table A3: Pore size of 2%wt shrimp chitosan scaffolds freezing at temperature −10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	43.9	37.7	29.3	33.0	26.4
L_2	30.7	37.8	30.2	33.6	30.2
L_3	36.4	39.7	33.6	31.2	31.2
L_4	33.3	40.9	28.3	33.5	26.6
L_5	31.6	31.6	29.0	31.6	29.0
L_6	33.7	28.5	30.9	33.7	27.3
L_7	43.6	33.6	31.2	36.4	33.6
L_8	30.2	33.6	27.5	37.8	33.3
Average	32.9				
Standard deviation	2.8				

Table A4: Pore size of 2%wt squid chitosan scaffolds freezing at temperature −10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	37.7	43.9	43.9	43.9	52.7
L_2	50.8	52.3	43.5	60.9	75.6
L_3	54.5	62.3	48.5	62.3	72.7
L_4	61.7	73.6	52.9	52.9	52.6
L_5	43.5	69.5	58.0	43.5	69.5
L_6	51.9	61.0	50.0	60.2	61.4
L_7	54.5	62.3	62.3	62.3	62.3
L_8	43.5	59.5	43.8	50.0	60.9
Average	55.7				
Standard deviation	6.1				

Table A5: Pore size of 3%wt shrimp chitosan scaffolds freezing at temperature −10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	33.0	26.4	33.0	26.4	26.4
L_2	38.1	30.5	34.6	25.8	30.7
L_3	39.7	36.4	39.7	31.2	31.2
L_4	37.5	37.5	37.7	33.3	28.5
L_5	34.8	31.6	38.6	34.8	26.7
L_6	33.5	33.1	36.6	30.7	30.1
L_7	33.6	36.4	31.2	33.6	33.6
L_8	27.1	37.5	30.5	28.7	32.8
Average	32.8				
Standard deviation	2.4				

Table A6: Pore size of 3%wt squid chitosan scaffolds freezing at temperature −10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	33.0	29.3	29.3	37.7	33.0
L_2	38.4	34.1	34.6	34.6	34.1
L_3	39.7	39.7	39.7	33.6	39.7
L_4	37.5	41.7	41.4	33.5	37.3
L_5	34.8	34.8	34.8	38.6	38.6
L_6	30.3	40.4	40.9	40.2	36.4
L_7	33.6	33.6	36.4	36.4	36.4
L_8	30.7	38.4	31.1	38.6	30.5
Average	36.0				
Standard deviation	0.8				

Table A7: Pore size of the mole ratio of 2%wt shrimp chitosan to DAZ (1:0.05) at UV irradiation time 40 min freezing at temperature –10°C.

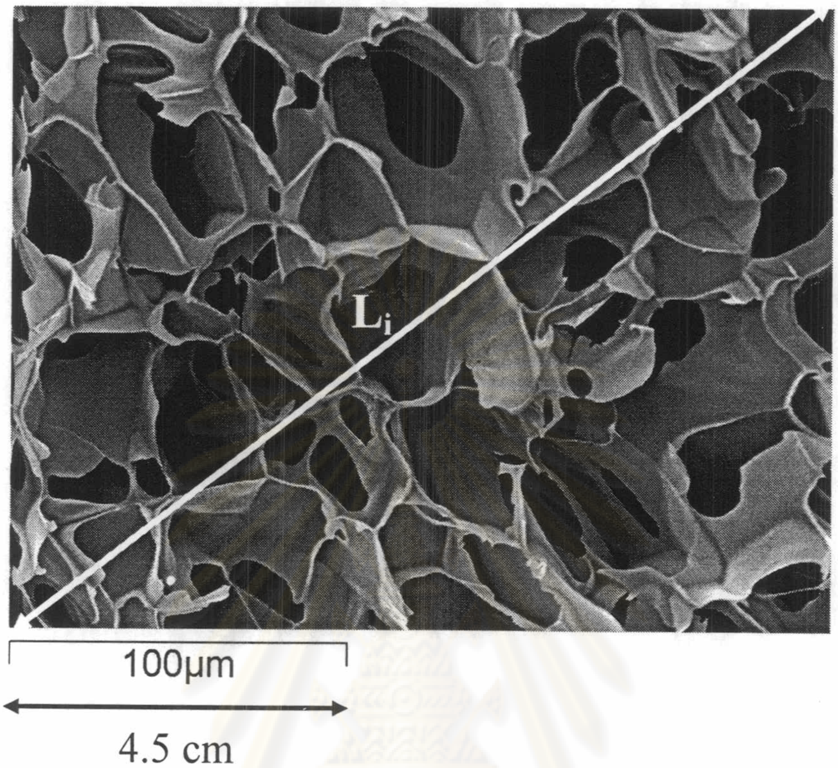
Pore size (μm)	Sample				
	1	2	3	4	5
L_1	49.0	36.8	27.8	33.2	33.7
L_2	37.0	37.0	37.0	37.0	37.0
L_3	32.0	34.0	43.7	42.4	38.5
L_4	33.1	53.8	47.8	47.8	43.1
L_5	45.6	45.6	33.2	36.9	36.5
L_6	34.4	38.2	38.2	49.1	38.2
L_7	36.5	40.3	32.9	51.8	33.2
L_8	33.1	43.1	35.9	43.1	39.1
Average	39.2				
Standard deviation	2.5				

Table A8: Pore size of the mole ratio of 2%wt shrimp chitosan to DAZ (1:0.1) at UV irradiation time 40 min freezing at temperature –10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	42.0	47.9	49.0	47.8	35.6
L_2	43.1	51.8	51.8	51.8	43.1
L_3	47.8	50.6	46.7	32.7	41.7
L_4	47.9	53.8	47.8	47.8	39.1
L_5	52.8	44.7	51.4	45.6	45.6
L_6	47.9	47.9	49.1	49.1	34.4
L_7	40.8	52.8	52.1	44.1	44.1
L_8	47.8	47.8	47.8	39.2	47.8
Average	46.6				
Standard deviation	3.5				

Table A9: Pore size of the mole ratio of 2%wt shrimp chitosan to DAZ (1:0.5) at UV irradiation time 40 min freezing at temperature –10°C.

Pore size (μm)	Sample				
	1	2	3	4	5
L_1	32.4	30.6	45.4	30.4	43.0
L_2	37.0	37.0	43.1	32.4	37.0
L_3	44.4	37.4	37.6	38.2	46.4
L_4	39.1	35.9	35.9	33.1	39.1
L_5	60.4	36.5	52.1	36.2	40.0
L_6	49.1	42.9	49.1	38.2	49.1
L_7	52.4	40.8	53.4	41.0	45.9
L_8	43.1	39.1	43.1	43.1	53.8
Average	42.0				
Standard deviation	3.8				



Calculation of pore size

$$\text{Pore size} = \frac{\sum_{i=1}^{n} (L_i/a) \times 100\ \mu m}{N \times 4.5\ cm}$$

Where L_i = test line length (cm)

a = number of pores within total length of random test lines

N = number of samples

APPENDIX B

Table B1: Compressive modulus of 2%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

Compressive modulus (MPa)	Freezing temperature (°C)					
	Shrimp chitosan			Squid chitosan		
	-10	-80	-196	-10	-80	-196
1	0.68	1.70	2.39	0.97	1.11	1.26
2	0.74	1.33	2.73	1.19	1.23	1.39
3	0.84	1.65	2.02	1.34	1.53	1.11
4	1.03	1.02	1.05	1.19	1.72	1.31
5	1.22	0.47	1.05	1.05	1.69	1.11
6	0.97	1.24	2.11	0.54	1.66	1.80
7	1.18	1.12	1.75	1.00	1.01	0.81
8	1.60	0.70	1.95	0.97	1.57	0.93
9	0.95	1.69	1.91	0.80	0.76	1.20
10	1.13	1.61	1.44	0.82	1.40	1.35
Average	1.03	1.25	1.84	0.99	1.37	1.23
Standard deviation	0.27	0.43	0.54	0.23	0.33	0.27

Table B2: Compressive modulus of 3%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

Compressive modulus (MPa)	Freezing temperature (°C)					
	Shrimp chitosan			Squid chitosan		
	-10	-80	-196	-10	-80	-196
1	1.31	1.41	5.34	1.53	3.63	2.74
2	1.05	2.47	5.48	1.77	1.84	4.50
3	0.92	1.94	3.50	0.95	5.01	2.29
4	0.69	3.10	4.54	1.34	1.62	3.70
5	1.46	2.89	3.41	0.73	2.55	2.37
6	1.31	2.64	4.91	0.83	2.30	1.57
7	1.38	1.98	4.66	1.67	2.15	3.59
8	1.59	1.51	4.67	1.29	2.35	2.96
9	1.39	2.26	4.22	0.91	3.31	2.19
10	1.11	1.09	2.37	1.54	2.00	3.61
Average	1.22	2.13	4.31	1.26	2.68	2.95
Standard deviation	0.27	0.66	0.96	0.37	1.03	0.89

Table B3: Compressive modulus of mole ratio of 2% shrimp chitosan to DAZ (1:0.05) at various irradiation times freezing at –10°C.

Compressive modulus (MPa)	UV irradiation time (min)		
	0	40	60
1	0.16	1.09	0.88
2	0.82	1.13	0.70
3	1.38	0.94	0.87
4	0.92	1.25	0.66
5	1.35	1.16	0.61
6	0.89	0.94	0.66
7	0.83	1.03	0.59
8	1.12	0.74	0.59
9	0.67	0.54	0.61
10	0.72	0.73	0.54
Average	0.97	0.95	0.67
Standard deviation	0.26	0.22	0.12

Table B4: Compressive modulus of mole ratio of 2% shrimp chitosan to DAZ (1:0.1) at various irradiation times freezing at –10°C.

Compressive modulus (MPa)	UV irradiation time (min)		
	0	40	60
1	0.96	1.07	0.73
2	0.95	1.26	0.68
3	0.74	0.99	0.49
4	0.98	1.13	0.64
5	1.05	1.27	0.72
6	0.51	0.97	0.69
7	0.57	0.92	0.45
8	0.49	1.06	0.86
9	0.49	0.89	0.65
10	0.61	0.80	0.76
Average	0.73	1.04	0.67
Standard deviation	0.23	0.15	0.12

Table B5: Compressive modulus of mole ratio of 2% shrimp chitosan to DAZ (1:0.5) at various irradiation times freezing at –10°C.

Compressive modulus (MPa)	UV irradiation time (min)		
	0	40	60
1	0.65	0.19	0.20
2	0.47	0.16	0.21
3	0.41	0.20	0.15
4	0.42	0.14	0.20
5	0.27	0.12	0.22
6	0.70	0.11	0.18
7	0.29	0.18	0.15
8	0.37	0.25	0.16
9	0.49	0.23	0.18
10	0.33	0.18	0.23
Average	0.44	0.18	0.19
Standard deviation	0.14	0.04	0.03

APPENDIX C

Table C1: Density of 1%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

Density (g/ml)	Freezing temperature (°C)					
	Shrimp chitosan			Squid chitosan		
	-10	-80	-196	-10	-80	-196
1	0.022	0.020	0.021	0.025	0.023	0.022
2	0.024	0.025	0.027	0.026	0.028	0.021
3	0.021	0.023	0.024	0.020	0.029	0.028
Average	0.022	0.023	0.024	0.024	0.027	0.024

Table C2: Density of 2%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

Density (g/ml)	Freezing temperature (°C)					
	Shrimp chitosan			Squid chitosan		
	-10	-80	-196	-10	-80	-196
1	0.032	0.032	0.033	0.034	0.036	0.055
2	0.031	0.031	0.037	0.034	0.037	0.046
3	0.030	0.033	0.034	0.035	0.039	0.043
Average	0.031	0.032	0.035	0.034	0.037	0.048

Table C3: Density of 3%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

Density (g/ml)	Freezing temperature (°C)					
	Shrimp chitosan			Squid chitosan		
	-10	-80	-196	-10	-80	-196
1	0.051	0.048	0.048	0.058	0.055	0.061
2	0.050	0.050	0.048	0.059	0.056	0.061
3	0.050	0.050	0.050	0.058	0.055	0.060
Average	0.050	0.049	0.049	0.058	0.055	0.061

Table C4: Density of 1, 2 and 3%wt chitosan films.

Density (g/ml)	Concentration of chitosan films (%wt)					
	Shrimp chitosan			Squid chitosan		
	1	2	3	1	2	3
1	1.30	1.24	1.33	1.31	1.32	1.38
2	1.30	1.29	1.31	1.35	1.24	1.38
3	1.25	1.27	1.34	1.28	1.30	1.37
Average	1.28	1.27	1.33	1.31	1.29	1.38

Table C5: %Porosity of 1, 2 and 3%wt chitosan scaffolds freezed at temperature –10, -80 and –196°C.

%Porosity	Concentration of chitosan scaffolds (%wt)					
	Shrimp chitosan			Squid chitosan		
	1	2	3	1	2	3
-10	98.3	97.6	96.2	98.2	97.3	95.8
-80	98.2	97.5	96.3	97.9	97.1	96.0
-196	98.2	97.3	96.3	98.3	96.3	95.6

APPENDIX D

Table D1: Degree of crosslinking of mole ratio of 2% shrimp chitosan to DAZ (1:0.1) at various irradiation times.

UV irradiation time (min)	Degree of crosslinking (%)		Average	Standard deviation
	X1	X2		
40	12.1	5.7	8.9	4.5
100	43.4	35.4	39.4	5.7
150	69.6	73.4	71.5	2.7
200	69.3	72.4	70.9	2.2

Table D2: Degree of crosslinking of mole ratio of 2% shrimp chitosan to DAZ (1:0.5) at various irradiation times.

UV irradiation time (min)	Degree of crosslinking (%)		Average	Standard deviation
	X1	X2		
40	57.6	62.8	60.20	3.68
100	67.5	65.6	66.55	1.34
150	68.9	70.4	69.65	1.06
200	84.1	82.6	83.35	1.06

Table D3: Degree of crosslinking of mole ratio of 2% shrimp chitosan to DAZ (1:1) at various irradiation times.

UV irradiation time (min)	Degree of crosslinking (%)		Average	Standard deviation
	X1	X2		
40	56.9	57.9	57.4	0.71
60	73.5	78.2	75.9	3.32
150	77	77.6	77.3	0.42
200	79.7	80.4	80.1	0.49

APPENDIX E

Table E1: Dimension increasing of mole ratio of 2% shrimp chitosan to DAZ (1:0.1) at various irradiation times (pH5)

UV irradiation time (min)	Dimension increasing (%)			Average	Standard deviation
	X1	X2	X3		
20	397.3	327.1	424.9	383.1	50.5
40	198.5	213.5	201.3	204.4	8.0
100	119.5	118.4	110.3	116.1	5.0
150	83.9	120.8	116.5	107.1	20.2

Table E2: Dimension increasing of mole ratio of 2% shrimp chitosan to DAZ (1:0.5) at various irradiation times (pH5)

UV irradiation time (min)	Dimension increasing (%)			Average	Standard deviation
	X1	X2	X3		
20	75.7	87.4	79.6	80.9	5.9
40	45.6	52.5	50.7	49.6	3.6
100	32.0	36.8	35.6	34.8	2.5
150	30.5	26.2	30.0	28.9	2.4

Table E3: Dimension increasing of mole ratio of 2% shrimp chitosan to DAZ (1:1) at various irradiation times (pH5)

UV irradiation time (min)	Dimension increasing (%)			Average	Standard deviation
	X1	X2	X3		
20	45.5	36.4	46.2	42.69	5.46
40	42.3	48.6	37.9	42.94	5.38
100	18.8	25.6	26.8	23.71	4.33
150	22.4	15.9	25.7	21.33	5.00

Table E4: Dimension increasing of mole ratio of 2% shrimp chitosan to DAZ (1:0.1) at various irradiation times (pH7)

UV irradiation time (min)	Dimension increasing (%)			Average	Standard deviation
	X_1	X_2	X_3		
20	13.6	16.9	15.8	15.4	1.7
40	11.0	13.7	14.0	12.9	1.7
100	19.6	21.0	11.5	17.4	5.2
150	13.4	14.2	11.2	12.9	1.5

Table E5: Dimension increasing of mole ratio of 2% shrimp chitosan to DAZ (1:1) at various irradiation times (pH7)

UV irradiation time (min)	Dimension increasing (%)			Average	Standard deviation
	X1	X2	X3		
20	10.1	12.7	9.5	10.7	1.7
40	8.4	10.1	12.0	10.2	1.8
100	15.5	13.7	18.5	15.9	2.5
150	14.1	13.5	14.3	13.9	0.4

VITAE

Miss. Temsiri Wangtaveesab was born in Bangkok, Thailand, on May 28th, 1977. She recieved Bachelor Degree of Science in 1998 from Department of Chemistry, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang. She started as a Master Degree student in Petrochemistry and Polymer Science, Chulalongkorn University in 2002 and completed the program in 2005.