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APPENDICES

Appendix A Characterization of Raw Materials

Table A1 Percent yield of chitin

Samples	Dry weight (%)
Dry shrimp shell	100
Decalcication product	54.17
Deproteination product	20.12
Chitin	25.71

Table A2 Percent yield of chitin hydrogel

Samples	Dry weight (%)
Chitin powder	100
Chitin hydrogel	65.8

Table A3 Degree of deacetylation of chitin and chitin hydrogel

Type of chitin	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
Chitin powder	32.51	34.74	36.62	34.62	2.05
Chitin hydrogel	5.42	3.87	36.64	35.31	1.38

Appendix B Preparation of Chitin Hydrogel by Using Solution Plasma

Table B1 Solid content of chitin hydrogel and the ratio of alcohol solution without NaOH system for deacetylation reaction

Ratio of Alcohol $:H_2O$	Chitin hydrogel (ml)	Alcohol (ml)	Water (ml)	Total volume (ml)	Amount of chitin hydrogel (g)
90 : 10	10	90	0	100	1.82
50 : 50	10	50	40	100	1.82
10 : 90	10	10	80	100	1.82

Table B2 Solid content of chitin hydrogel and the ratio of alcohol solution with NaOH system for deacetylation reaction

NaOH concentration (%)	Chitin hydrogel (ml)	50% NaOH w/v (ml)	Alcohol (ml)	Total volume (ml)	Amount of chitin hydrogel (g)
1%	10	1.8	88.2	100	1.82
5%	10	9	81	100	1.82
10%	10	18	72	100	1.82
12%	10	21.6	68.4	100	1.82

Appendix C Deacetylation of Chitin Hydrogel without NaOH Concentration

Table C1 Effect of type of alcohol and alcohol concentration on degree of deacetylation by using solution plasma technique

Ratio of methanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	43.54	44.32	43.43	43.76	0.48521473
50:50	45.44	43.43	46.54	45.14	1.57703308
10:90	54.64	54.43	53.43	54.17	0.64655497
Ratio of ehanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	43.5	46.44	44.58	44.84	1.48714492
50:50	45.65	47.98	48.98	47.53	1.70869346
10:90	55.5	53.44	54.58	54.50	1.03195607
Ratio of propanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	44.5	47.44	48.58	46.84	2.10513658
50:50	47.54	48.67	49.91	48.70	1.18542538
10:90	59.98	56.98	58.98	58.64	1.52752523

Table C2 Effect of type of alcohol and alcohol concentration on degree of deacetylation by using conventional heat treatment

Ratio of methanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	35.64	37.87	35.86	36.46	1.2289155
50:50	36.56	38.45	39.98	38.33	1.713155
10:90	39.43	38.45	40.32	39.40	0.9353609
Ratio of ehanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	35.67	37.89	36.64	36.73	1.1129391
50:50	37.55	39.87	39.9	39.11	1.3481963
10:90	40.87	41.54	40.34	40.92	0.6013596
Ratio of propanol :H_2O	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
90:10	36.47	35.04	38.79	36.77	1.8925204
50:50	39.67	39.43	38.22	39.11	0.7771958
10:90	40.32	40.53	39.32	40.06	0.646555

Table C3 Effect of cycles of plasma treatment time on degree of deacetylation

1 cycle of treatment time					
Type of Alcohol	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
Methanol	42.78	43.07	46.11	43.99	1.844568604
Ethanol	43.5	46.44	44.58	44.84	1.487144916
Propanol	44.5	47.44	48.58	46.84	2.105136575
2 cycles of treatment time					
Type of Alcohol	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
Methanol	48.64	47.86	45.88	47.46	1.422814113
Ethanol	54.76	56.97	54.87	55.53	1.245404887
Propanol	60.54	58.76	57.78	59.03	1.399190242
3 cycles of treatment time					
Type of Alcohol	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
Methanol	49.87	53.78	52.17	51.94	1.965120861
Ethanol	56.67	56.89	57.77	57.11	0.582065288
Propanol	62.87	62.91	58.44	61.41	2.569286542

Appendix D Deacetylation of Chitin Hydrogel with NaOH concentration

Table D1 Effect of no NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using solution plasma technique

No NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	47.28	43.49	44.77	45.18	1.9279782
2	53.096	51.36	54.71	53.06	1.6753702
3	54.87	55.77	54.87	55.17	0.5196152
4	56.71	54.52	59.23	56.82	2.356926
5	57.52	59.54	54.98	57.35	2.2849362

1 Cycle of plasma treatment = 1 Hour

Table D2 Effect of 1% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using solution plasma technique

1% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	54.01	54.54	56.94	55.16	1.5612922
2	57.01	55.54	59.72	57.42	2.1204323
3	57.82	61.57	60.58	59.99	1.9433734
4	62.82	60.73	61.94	61.83	1.0493331
5	62.59	64.34	64.98	63.97	1.2372146

1 Cycle of plasma treatment = 1 Hour

Table D3 Effect of 5% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using solution plasma technique

5% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	55.43	55.97	59.27	56.89	2.0787496
2	65.24	60.05	65.76	63.68	3.1572826
3	67.24	67.05	65.03	66.44	1.2247857
4	69.01	71.22	70.59	70.27	1.1385224
5	72.01	71.25	70.35	71.20	0.8309834

1 Cycle of plasma treatment = 1 Hour

Table D4 Effect of 10% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using solution plasma technique

10% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	55.87	57.87	58.93	57.56	1.5538769
2	69.65	68.87	69.43	69.32	0.4021608
3	70.59	75.75	68.65	71.66	3.6696776
4	70.59	74.86	76.65	74.03	3.1134279
5	74.76	76.89	75.87	75.84	1.0653169

1 Cycle of plasma treatment = 1 Hour

Table D5 Effect of 12% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using solution plasma technique

12% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	56.42	58.82	62.23	59.16	2.9195947
2	72.87	70.56	69.54	70.99	1.706136
3	70.43	75.87	78.76	75.02	4.2295508
4	76.76	78.54	79.98	78.43	1.6129889
5	76.08	78.97	80.32	78.46	2.1661102

1 Cycle of plasma treatment = 1 Hour

Table D6 Effect of 5% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using conventional heat treatment

5% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	37.45	38.87	39.45	38.59	1.0289801
2	39.54	40.65	41.87	40.69	1.1654327
3	45.78	46.56	47.98	46.77	1.1154072
4	50.76	51.97	53.56	52.10	1.404291
5	56.43	49.71	55.34	53.83	3.6065542

1 Cycle of plasma treatment = 1 Hour

Table D7 Effect of 10% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using conventional heat treatment

10% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	38.43	40.54	42.34	40.44	1.9570471
2	41.43	45.34	45.32	44.03	2.2516883
3	50.32	51.98	55.45	52.58	2.6176771
4	55.53	56.84	56.34	56.24	0.661085
5	56.32	59.34	59.43	58.36	1.7701507

1 Cycle of plasma treatment = 1 Hour

Table D8 Effect of 12% w/v of NaOH concentration in methanol solvent on degree of deacetylation for deacetylation chitin hydrogel by using conventional heat treatment

12% (w/v) NaOH concentration					
Cycle of plasma treatment	Degree of deacetylation (%DD)				
	1	2	3	Average	SD
0	35.42	33.87	36.64	35.31	1.3882723
1	38.54	36.32	35.34	36.73	1.6395528
2	43.43	49.65	46.87	46.65	3.1158305
3	50.35	51.54	54.97	52.29	2.3987983
4	55.34	58.23	59.54	57.70	2.148961
5	56.65	58.87	59.97	58.50	1.6911929

1 Cycle of plasma treatment = 1 Hour

Appendix E Solubility of Plasma Treated Chitin Hydrogel

Table E1 Effect of 5% w/v of NaOH concentration in methanol solvent on solubility of plasma treated chitin hydrogel

5% (w/v) NaOH concentration					
Cycle of plasma treatment	% solubility of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	0	0	0	0	0
1	15.72	18.87	22.13	18.90667	3.205157
2	17.82	17.16	19.64	18.20667	1.284419
3	28.3	25.8	28.96	27.68667	1.666893
4	38.76	38.5	39.08	38.78	0.290517
5	49.75	48.75	48.92	49.14	0.53507

1 Cycle of plasma treatment = 1 Hour

Table E2 Effect of 10% w/v of NaOH concentration in methanol solvent on solubility of plasma treated chitin hydrogel

10% (w/v) NaOH concentration					
Cycle of plasma treatment	% solubility of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	0	0	0	0	0
1	24.37	28.92	22.2	25.16333	3.429524
2	36.76	38.59	39.84	38.39667	1.549075
3	49.83	47.07	48.7	48.53333	1.387528
4	70.62	72.59	71.99	71.73333	1.009769
5	79.73	78.97	80.32	79.67333	0.676782

1 Cycle of plasma treatment = 1 Hour

Table E3 Effect of 12% w/v of NaOH concentration in methanol solvent on solubility of plasma treated chitin hydrogel

12% (w/v) NaOH concentration					
Cycle of plasma treatment	% solubility of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	0	0	0	0	0
1	38.44	38.82	35.23	37.49667	1.972165
2	60.28	60.56	59.54	60.12667	0.527004
3	81.35	85.87	81.76	82.99333	2.499687
4	100	100	98	99.33333	1.154701
5	100	100	100	100	0

1 Cycle of plasma treatment = 1 Hour

Appendix F Yield of Plasma Treated Chitin Hydrogel

Table F1 Yield of plasma treated chitin hydrogel with 5% w/v NaOH concentration

5% (w/v) NaOH concentration					
Cycle of plasma treatment	% Yield of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	100	100	100	100	0
1	81.32	83.87	82.13	82.44	1.302958
2	73.82	71.16	69.64	71.54	2.11575
3	58.37	55.87	53.96	56.06667	2.211568
4	48.76	48.5	52.08	49.78	1.996096
5	39.75	38.75	34.92	37.80667	2.549438

1 Cycle of plasma treatment = 1 Hour

Table F2 Yield of plasma treated chitin hydrogel with 10% w/v NaOH concentration

10% (w/v) NaOH concentration					
Cycle of plasma treatment	% Yield of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	100	100	100	100	0
1	84.37	88.92	87.24	86.84333	2.30079
2	70.76	68.55	67.89	69.06667	1.503141
3	60.13	55.67	58.71	58.17	2.278508
4	45.62	48.55	41.93	45.36667	3.317263
5	39.73	38.96	34.38	37.69	2.892283

1 Cycle of plasma treatment = 1 Hour

Table F3 Yield of plasma treated chitin hydrogel with 12% w/v NaOH concentration

12% (w/v) NaOH concentration					
Cycle of plasma treatment	% Yield of plasma treated chitin hydrogel				
	1	2	3	Average	SD
0	100	100	100	100	0
1	80.44	82.82	75.27	79.51	3.859961
2	60.28	60.56	65.54	62.12667	2.959347
3	51.35	55.57	56.75	54.55667	2.839037
4	41.78	40.43	44.58	42.26333	2.116798
5	30.76	25.79	28.87	28.47333	2.508632

1 Cycle of plasma treatment = 1 Hour

Appendix G Determination of Molecular Weight by GPC

Figure G1 Calibration curve for GPC measurement using pullulan standard

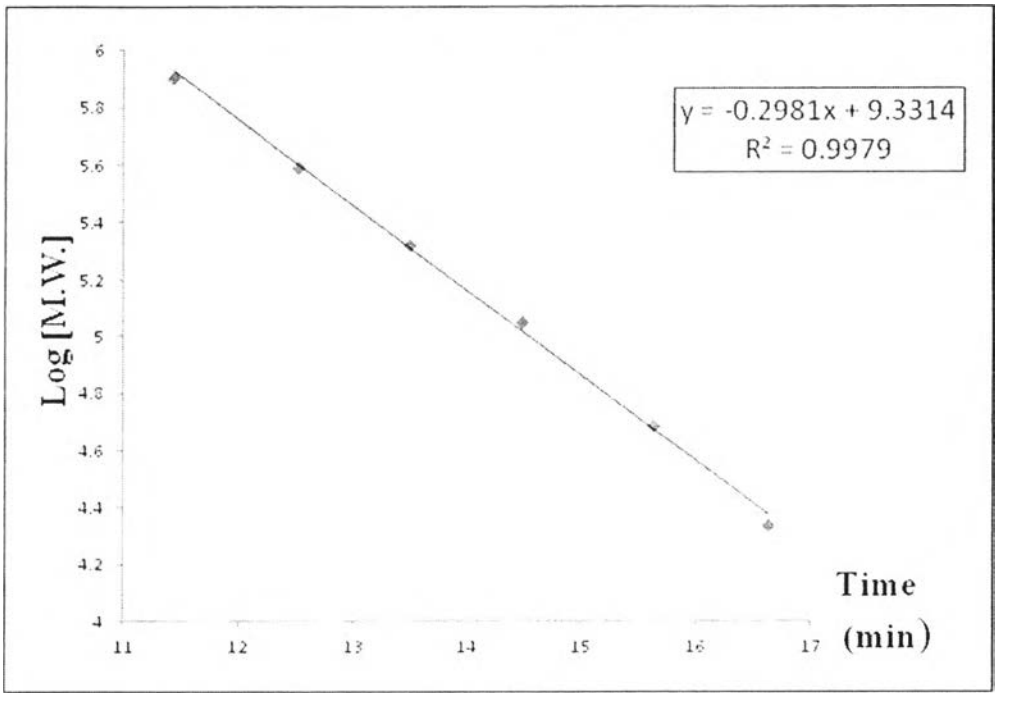

Table G1 The molecular weight of Treated chitin hydrogel in 12% NaOH concentration with different times by using solution Plasma

Condition	Treated chitin hydrogel 3 hours	Treated chitin hydrogel 4 hours	Treated chitin hydrogel 5 hours
M_n	91,141	88,942	87,689
M_w	245,880	230,840	220,149
M_z	627,817	540,912	466,782
PDI	2.69781	2.59541	2.51059

M is molecular weight and PDI is polydispersity index.

Table G2 The molecular weight of plasma-treated chitin hydrogel obtained by varying NaOH concentrations at 5 hours of plasma treatment time

Condition	Plasma-treated chitin hydrogel 5% NaOH	Plasma-treated chitin hydrogel 10% NaOH	Plasma-treated chitin hydrogel 12% NaOH
M_n	103,134	105,596	87,689
M_w	228,674	222,543	220,149
M_z	349,047	324,807	466,782
PDI	2.21726	2.10749	2.51059

M is molecular weight and PDI is polydispersity index.

Appendix H Antibacterial Activity of Plasma Treated Chitin Hydrogel

Table H1 Antibacterial activity of the obtained chitosan from plasma solution treatment against E.coli

Cycles of treatment time.	Bacterial Reduction Rate (%)
4	90.9 ± 6.4
5	96.96 ± 7.3

Table H2 Antibacterial activity of the obtained chitosan from plasma solution treatment against S.aureus

Cycles of treatment time.	Bacterial Reduction Rate (%)
4	89.79 ± 5.4
5	95.91 ± 5.1

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