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APPENDICES

Appendix A Determination of the Molecular Weight of Chitosan

Table A1 Running time of solvent and chitosan treated 1st solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	98.78	98.70	98.61	98.70
0.0125	112.12	112.05	112.08	112.08
0.0250	126.56	126.59	127.02	126.72
0.0500	159.37	159.18	159.21	159.25
0.0750	194.90	194.72	194.95	194.86
0.1000	236.55	236.37	236.66	236.53

Table A2 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1257	1.14	0.14	10.85
0.0250	1.2613	1.28	0.28	11.36
0.0500	1.5761	1.61	0.61	12.27
0.0750	1.9049	1.97	0.97	12.99
0.1000	2.2793	2.40	1.40	13.97

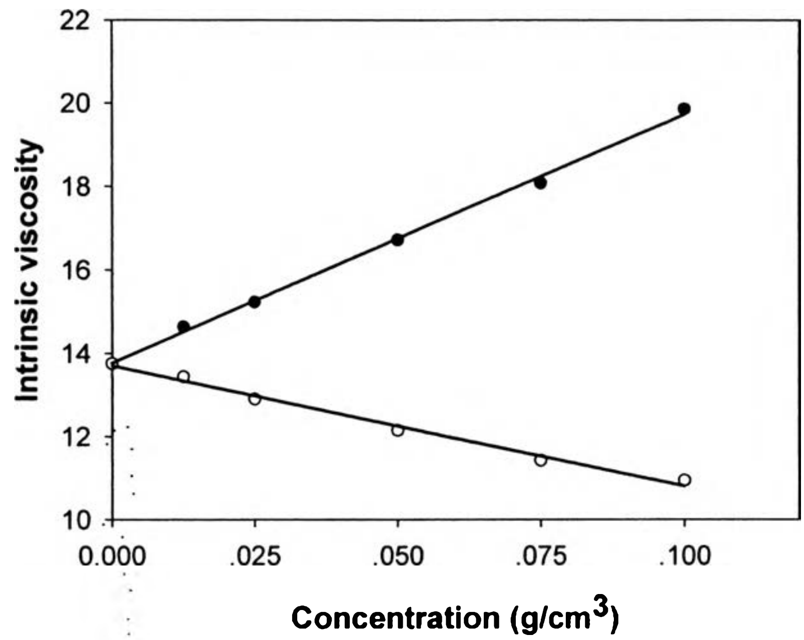

Figure A1 Plot of reduced viscosity (η_{sp}/c) and ln((η_{rel})/c) versus concentration of chitosan solution: ● = (η_{sp}/c) and o = ln((η_{rel})/c).

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})\, M^{0.88}$$

Where $[\eta]$ = intrincsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 13.75$

From calculation;

$$M^{0.88} = (13.75)/6.59 \times 10^{-5} = 2.08 \times 10^{5}$$

$$0.88 \log M = \log[2.08 \times 10^{5}]$$

$$\log M = 6.044$$

$$M = 1.10 \times 10^{6}$$

The viscosity-average molecular weight of chitosan obtained from calculation was 1.10×10^{6} g/mol.

Table A3 Running time of solvent and chitosan treated 2nd solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
109.31	109.72	109.09	109.3733	109.31
123.85	123.56	123.59	123.6667	123.85
138.25	138.12	138.28	138.2167	138.25
171.90	171.75	171.84	171.8300	171.90
206.00	206.22	206.25	206.1567	206.00
245.78	245.90	245.78	245.8200	245.78

Table A4 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1307	0.1307	10.4547	9.8258
0.0250	1.2637	0.2637	10.5486	9.3622
0.0500	1.5710	0.5710	11.4208	9.0348
0.0750	1.8849	0.8849	11.7985	8.4516
0.1000	2.2475	1.2475	12.4753	8.0983

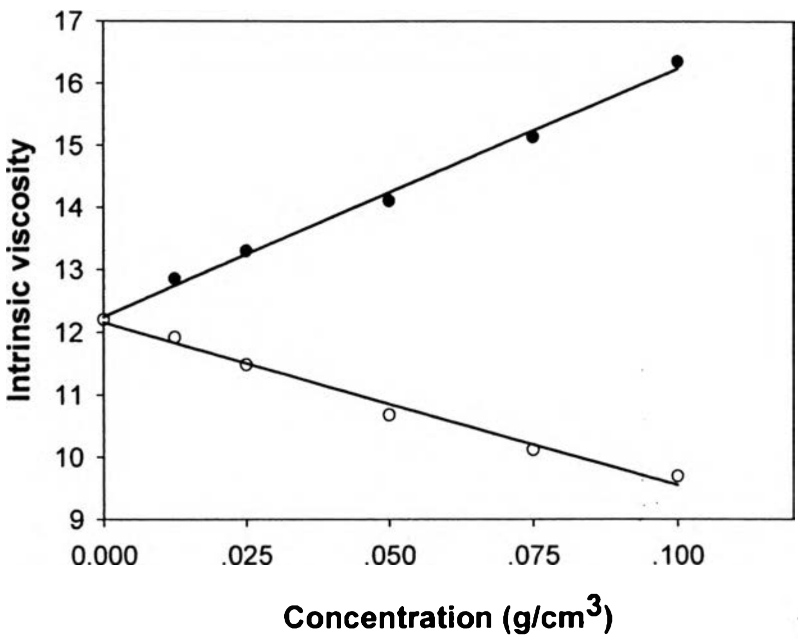

Figure A2 Plot of reduced viscosity (η_{sp}/c) and $\ln((\eta_{rel})/c)$ versus concentration of chitosan solution: ● = (η_{sp}/c) and o = $\ln((\eta_{rel})/c)$.

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})\, M^{0.88}$$

Where $[\eta]$ = intrincsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta] = 12.20$

From calculation;

$$M^{0.88} = (12.20)/6.59 \times 10^{-5} = 1.85 \times 10^{5}$$

$$0.88 \log M = \log[1.52 \times 10^{5}]$$

$$\log M = 5.98$$

$$M = 9.98 \times 10^{5}$$

The viscosity-average molecular weight of chitosan obtained from calculation was 9.68×10^{5} g/mol.

Table A5 Running time of solvent and chitosan treated 3rd solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	121.28	121.16	121.18	121.2067
0.0250	133.66	133.47	133.82	133.6500
0.0500	160.81	161.06	161.19	161.0200
0.0750	191.24	191.15	191.16	191.1833
0.1000	225.25	225.75	225.53	225.5100

Table A6 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.1082	0.1082	8.6650	8.2184
0.0250	1.2220	0.2220	8.8785	8.0183
0.0500	1.4722	0.4722	9.4441	7.7352
0.0750	1.7480	0.7480	9.9721	7.4462
0.1000	2.0618	1.0618	10.6184	7.2360

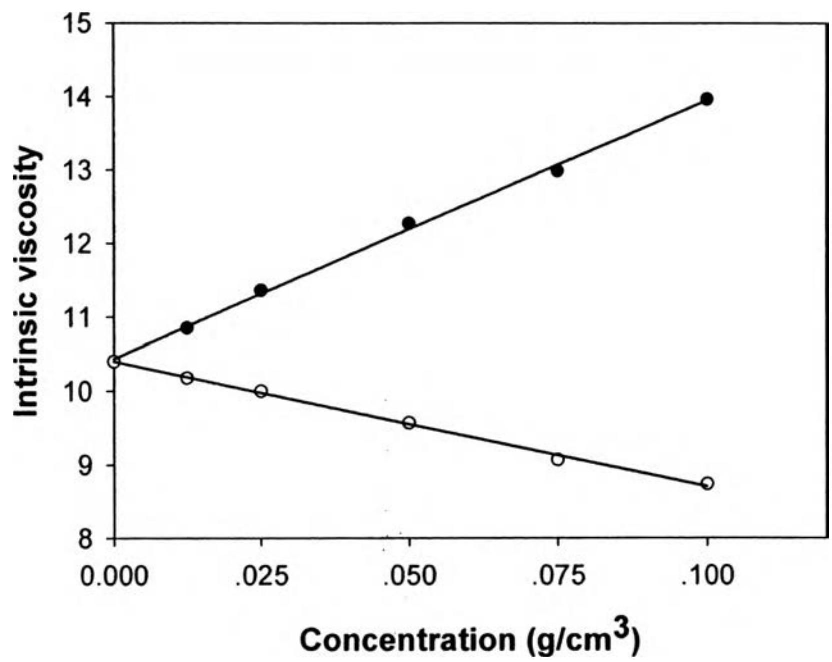

Figure A3 Plot of reduced viscosity (η_{sp}/c) and ln((η_{rel})/c) versus concentration of chitosan solution: ● = (η_{sp}/c) and o = ln((η_{rel})/c).

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})\ M^{0.88}$$

Where $[\eta]$ = intrincsic viscosity

M = viscosity-average molecular weight

Interception: $[\eta]$ = 10.40

From calculation;

$$M^{0.88} = (10.40)/6.59 \times 10^{-5} = 1.57 \times 10^{5}$$

$$0.88 \log M = \log[1.26 \times 10^{5}]$$

$$\log M = 5.90$$

$$M = 8.07 \times 10^{5}$$

The viscosity-average molecular weight of chitosan obtained from calculation was 8.07×10^{5} g/mol.

Table A7 Running time of solvent and chitosan treated 4th solution

Concentration (g/100ml)	Time (second)			
	1	2	3	Average
0.0000	109.31	109.72	109.09	109.3733
0.0125	118.93	118.92	118.98	118.9433
0.0250	129.15	128.84	129.03	129.0067
0.0500	151.47	151.64	151.38	151.4967
0.0750	176.78	176.65	176.85	176.7600
0.1000	204.99	204.89	204.98	204.9533

Table A8 Data of relative viscosity (η_{rel}), specific viscosity (η_{sp}), and reduced viscosity (η_{red}) of chitosan solution with various concentrations

Concentration (g/100 ml)	η_{rel}	η_{sp}	η_{red}	$\ln[\eta_{rel}]/c$
0.0000	1.0000	0	-	-
0.0125	1.0875	0.0875	6.9999	6.7104
0.0250	1.1795	0.1795	7.1803	6.6039
0.0500	1.3851	0.3851	7.7027	6.5159
0.0750	1.6161	0.6161	8.2149	6.4003
0.1000	1.8739	0.8739	8.7389	6.2802

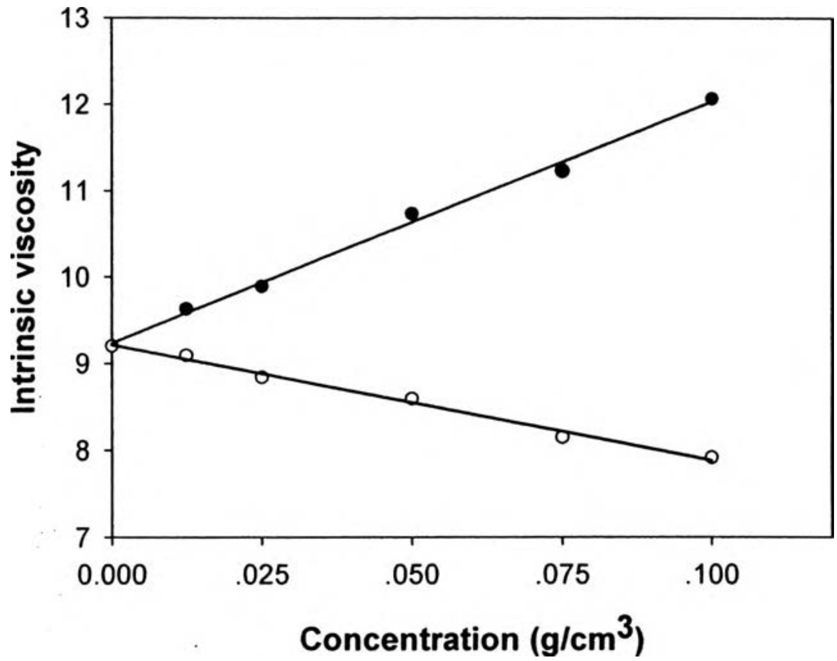

Figure A4 Plot of reduced viscosity (η_{sp}/c) and ln((η_{rel})/c) versus concentration of chitosan solution: • = (η_{sp}/c) and o = ln((η_{rel})/c).

The viscosity-average molecular weight of chitosan was determined base on Mark-Houwink equation. The K and values were according to Wang *et al.* (1997).

$$[\eta] = (6.59 \times 10^{-5})\ M^{0.88}$$

where [η] = intrincsic viscosity

M = viscosity-average molecular weight

Interception: [η] = 9.2

From calculation;

$$M^{0.88} = (9.2)/6.59 \times 10^{-5} = 1.39 \times 10^{5}$$

$$0.88 \log M = \log [1.39 \times 10^{5}]$$

$$\log M = 5.85$$

$$M = 7.02 \times 10^{5}$$

The viscosity-average molecular weight of chitosan obtained from calculation was 7.02×10^{5} g/mol.

Appendix B Contact Angle Measurement

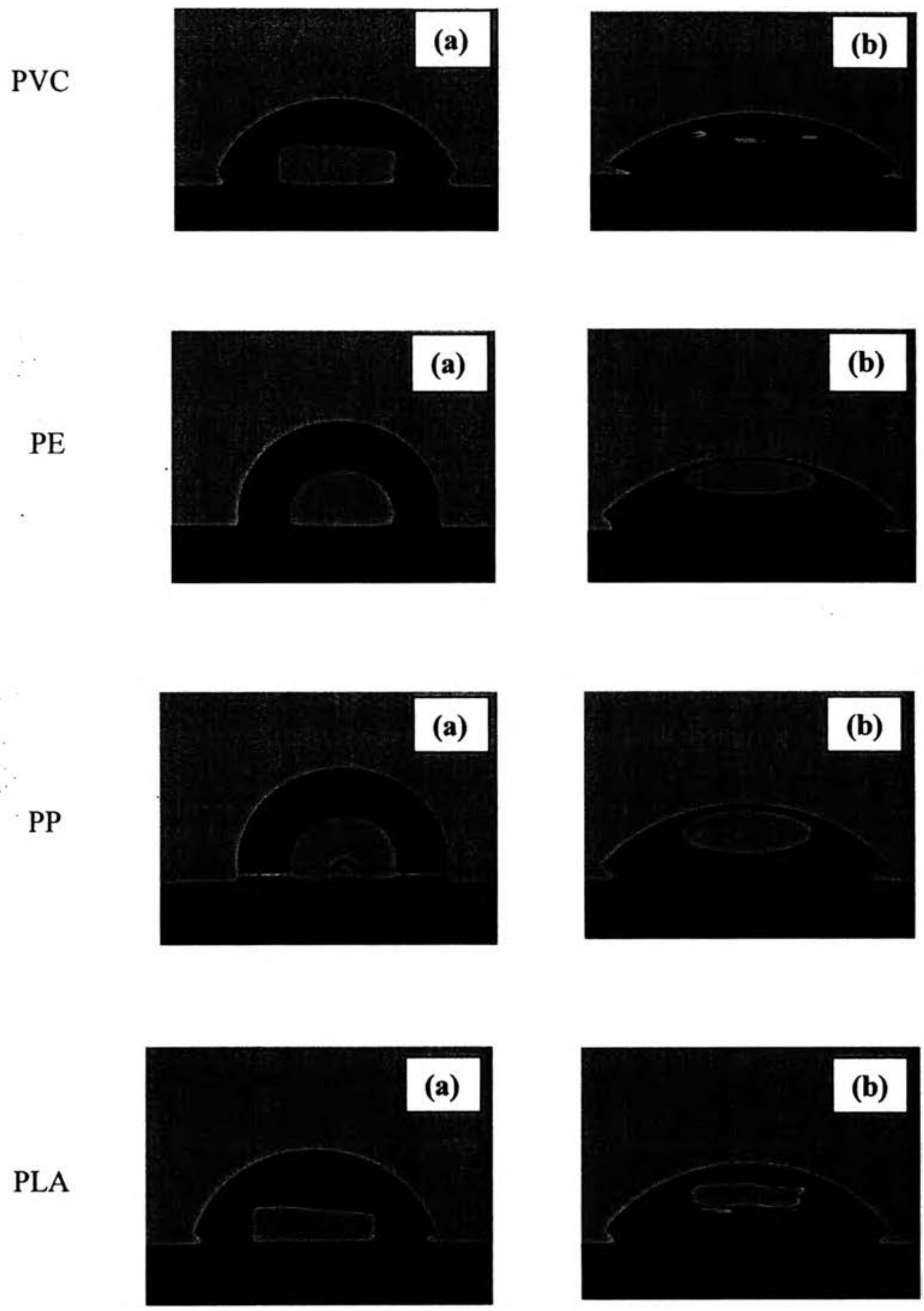

Figure B1 Water contact angle images of the four polymeric films (a) before and (b) after DBD plasma treatment for 10 s.

Table B1 Effect of DBD plasma treatment time on water contact angle values of four polymeric films

Time of plasma treatment (s)	Types of polymeric films			
	PVC	PE	PP	PLA
0	71.5 θ ± 0.94	95.2 θ ± 1.37	94.9 θ ± 0.74	72.4 θ ± 1.11
5	52.5 θ ± 1.31	47.7 θ ± 0.67	54.1 θ ± 0.76	55.0 θ ± 1.09
10	46.4 θ ± 2.02	45.7 θ ± 0.35	50.3 θ ± 0.92	53.8 θ ± 0.82
20	46.9 θ ± 4.14	46.0 θ ± 1.35	50.8 θ ± 0.80	53.8 θ ± 0.90
30	47.9 θ ± 4.09	46.3 θ ± 0.70	50.6 θ ± 1.73	54.8 θ ± 1.14
40	48.7 θ ± 2.48	46.2 θ ± 0.67	51.8 θ ± 0.77	55.7 θ ± 0.84
50	43.0 θ ± 4.50	45.8 θ ± 0.43	51.9 θ ± 0.71	54.7 θ ± 1.96
60	42.3 θ ± 2.81	45.7 θ ± 0.85	51.7 θ ± 0.43	52.6 θ ± 1.42
90	43.6 θ ± 4.03	44.2 θ ± 1.23	51.7 θ ± 1.98	53.4 θ ± 1.53
120	47.8 θ ± 5.12	44.3 θ ± 1.63	52.0 θ ± 1.94	49.9 θ ± 1.80

θ = water contact angle values

Appendix C Effect of Plasma Treatment Time on The Mechanical Properties

Table C1 Effect of plasma treatment time on tensile strength of four polymeric films

Type of polymeric films	Tensile strength (MPa)			
	untreated	5 s	10 s	30 s
PVC	7.67±0.83	6.59±1.52	6.20±2.87	3.06±0.21
PE	2.57±0.28	1.93±0.35	1.92±0.28	1.66±0.28
PP	5.64±1.04	5.31±1.83	5.29±1.34	5.33±0.82
PLA	7.93±1.90	7.75±1.93	7.20±1.75	7.18±1.16

Table C2 Effect of plasma treatment time on elongation at break of four polymeric film

Type of polymeric films	Elongation at break (%)			
	untreated	5 s	10 s	30 s
PVC	173.44±30.20	144.62±48.72	141.69±21.05	126.31±8.83
PE	647.20±50.77	519.87±243.07	519.11±168.43	488.52±175.54
PP	610.21±97.98	604.18±194.57	602.44±38.31	580.44±150.12
PLA	5.90±2.72	5.05±1.66	4.16±0.66	3.68±1.27

Appendix D Kjeldahl Method

Table D1 Effect of the number of washing cycle on the amount of deposited chitosan on polymeric films (polymeric films coating with 2% chitosan concentration)

Type of polymeric films	Amount of deposited chitosan* ($\mu g/cm^2$)			
	1 cycle	2 cycles	3 cycles	4 cycles
PVC	64.18±16.92	38.07±1.54	31.56±4.02	25.02±1.54
PE	245.82±3.08	194.16±2.31	115.77±3.29	115.30±3.08
PP	246.91±1.54	194.70±1.54	123.55±9.33	122.91±13.84
PLA	197.96±3.08	97.35±10.00	91.21±3.09	81.58±1.54

*(n=3)

Table D2 Amount of deposited chitosan on polymeric films with different concentrations of chitosan

Chitosan concentration (g/100ml)	Amount of deposited chitosan* (μg/cm^2)			
	PVC films	PE films	PP films	PLA films
0.125	0±0.00	3.57±0.00	3.61±1.53	1.64±0.00
0.25	1.45±0.31	5.04±0.64	6.42±0.00	6.55±0.77
0.50	6.07±0.98	8.35±0.64	13.59±0.78	7.87±0.76
0.75	8.95±0.23	17.53±1.28	21.47±1.69	14.75±0.00
1.0	22.28±2.02	32.34±1.15	34.35±6.64	24.11±2.01
2.0	31.56±4.01	115.77±1.64	123.55±9.33	91.21±3.08

*(n=3)

CURRICULUM VITAE

Name: Ms. Siriporn Theapsak

Date of Birth: November 15, 1985

Nationality: Thai

University Education:

2004-2007 Bachelor Degree of Industrial Chemistry, Faculty of Science, Chiangmai University, Thailand

Proceeding:

1. Theapsak, S.; Tokura, S.; and Rujiravanit, R. (2010, April 22) Chitosan-Coated Food Preserving Film Surface Modified by Using DBD Plasma Technique for Antimicrobial Property Improvement. Proceedings of the 1^{st} National Research Symposium on Petroleum, Petrochemicals, and Advanced Materials and The 16^{th} PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentation:

1. Theapsak, S.; Tokura, S.; and Rujiravanit, R. (2009, August 23 -25) Preparation of Chitosan-Coated on Polymeric films by DBD Plasma Technique. Paper presented at Proceedings of the 4^{th}International Symposium in Science and Technology at Kansai University 2009, Osaka, Japan.