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APPENDICES

Appendix A The composition of materials

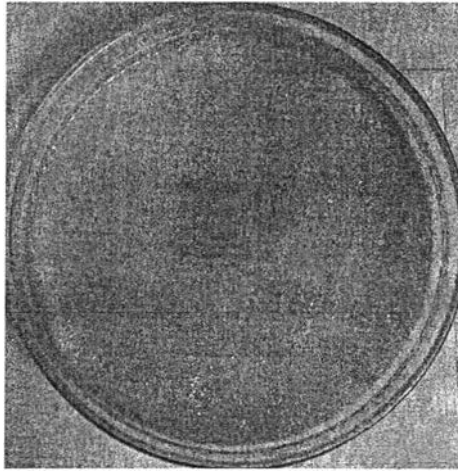


Figure A1 Natural rubber is more than 21 grams.

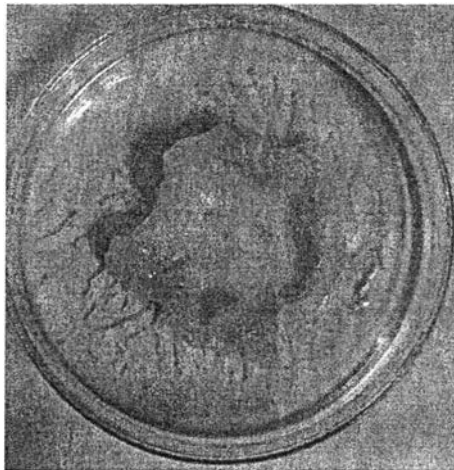


Figure A2 Emulsion content is more than natural rubber content



Figure A3 Natural rubber and emulsion (Don't have chitin whisker content).

Appendix B The bionanocomposite films

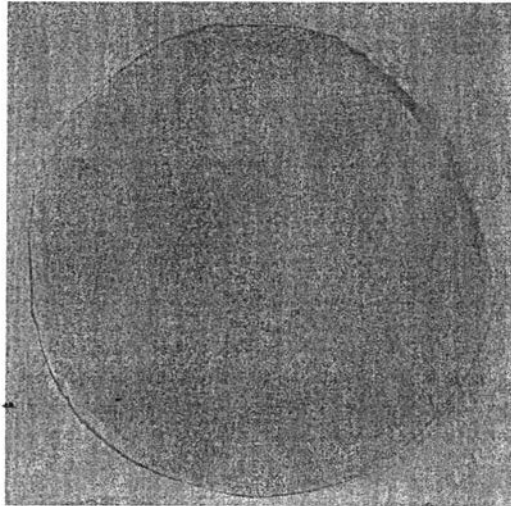
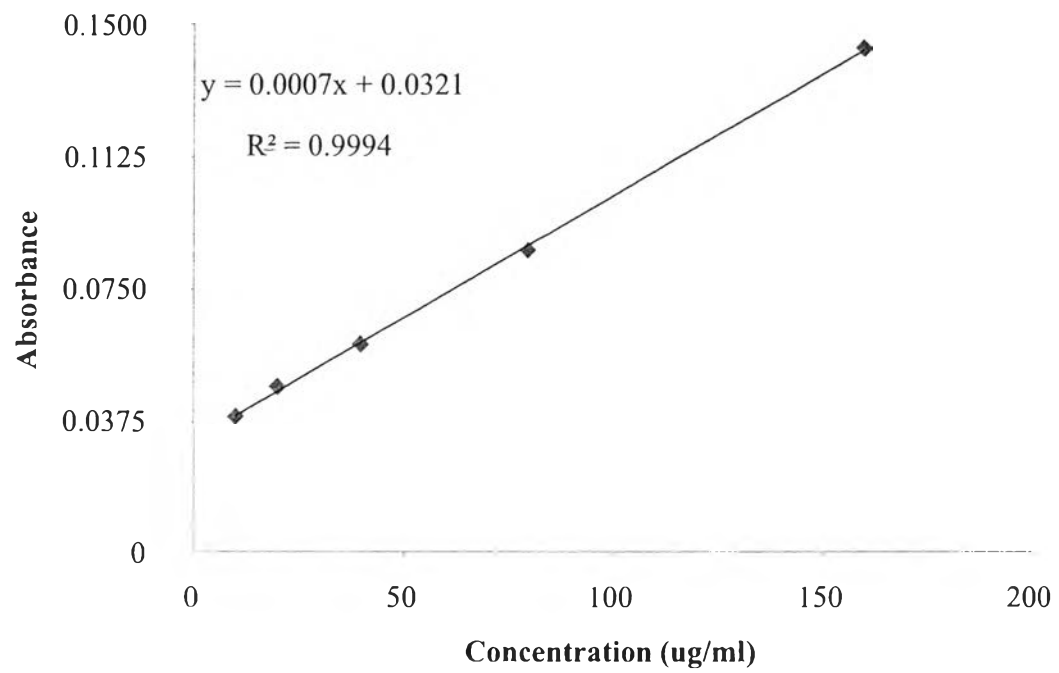


Figure B1 The product of this research.



Figure B2 The transparency film.

Appendix C Protein Content Analysis of Natural Rubber Latex**Figure C1** Calibration curve of protein content.

Appendix D The Mechanical Testing of the nanocomposite films

Table D1 Tensile strength of nanocomposite films

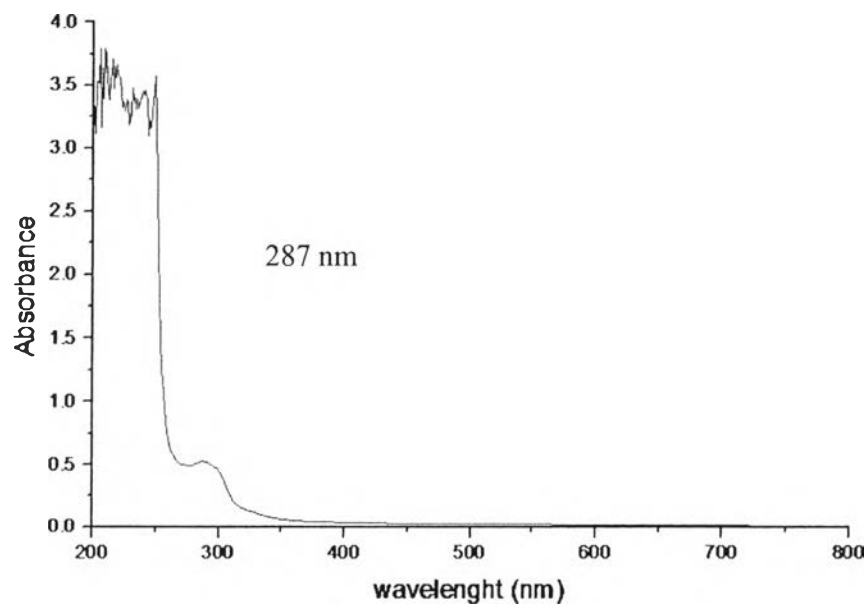
Samples	Tensile strength (MPa)	Average (MPa)	SD
A3	0.3176		
A3	0.3109		
A3	0.3008		
A3	0.2914	0.3052	0.0115
A2	0.2362		
A2	0.2097		
A2	0.2238		
A2	0.2091	0.2197	0.0129
A1	0.1872		
A1	0.1926		
A1	0.1893		
A1	0.1804	0.1874	0.0051
B3	0.3853		
B3	0.3782		
B3	0.3900		
B3	0.3921		
B3	0.3824	0.3856	0.0056
B2	0.2644		
B2	0.2744		

Samples	Tensile strength (MPa)	Average (MPa)	SD
B2	0.2969		
B2	0.2734		
B2	0.2941	0.2806	0.0141
B1	0.2319		
B1	0.2360		
B1	0.2216		
B1	0.1722	0.2154	0.0295
C3	0.4789		
C3	0.4453		
C3	0.4419		
C3	0.4803		
C3	0.4905	0.4674	0.0222
C2	0.3678		
C2	0.3532		
C2	0.3831		
C2	0.3433		
C2	0.3563	0.3607	0.0152
C1	0.2303		
C1	0.2560		
C1	0.2720		
C1	0.2399		
C1	0.2341	0.2465	0.0173

Table D2 Elongation at break of nanocomposite films

Samples	Elongation at break (%)	Average (%)	SD
A3	245.51		
A3	241.46		
A3	244.84		
A3	250.43	245.56	3.70
A2	265.89		
A2	266.32		
A2	269.06		
A2	264.16	266.36	2.03
A1	285.43		
A1	288.00		
A1	275.98		
A1	289.24	284.66	6.00
B3	220.06		
B3	227.38		
B3	229.66		
B3	224.77		
B3	232.98	226.97	4.90
B2	241.38		
B2	244.85		
B2	248.29		

Samples	Elongation at break (%)	Average (%)	SD
B2	256.77		
B2	249.08	248.07	5.74
B1	263.17		
B1	267.31		
B1	268.82		
B1	270.06	267.34	3.00
C3	216.03		
C3	212.97		
C3	219.85		
C3	217.32		
C3	213.22	215.88	2.89
C2	240.03		
C2	240.10		
C2	238.10		
C2	241.85		
C2	238.50	239.72	1.49
C1	248.33		
C1	247.31		
C1	245.13		
C1	250.56		
C1	250.15	248.30	2.21

Appendix E Characteristic of coconut oil**Figure E1** The UV-VIS spectrophotometer at the wavelength of 287 nm.

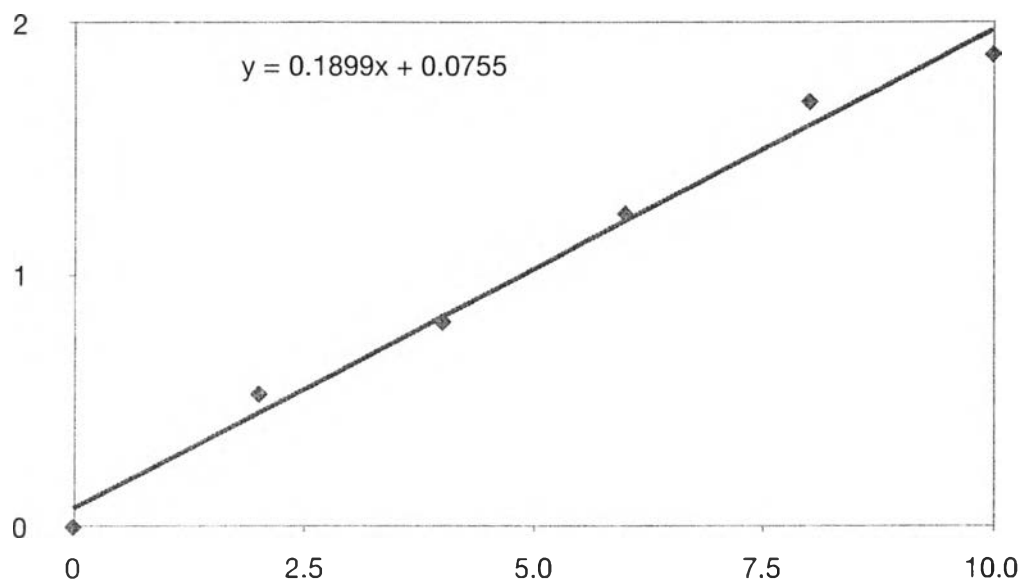


Figure E2 Calibration curve of coconut oil

Appendix F Oil releasing behavior

Table F1 % oil release of A1

A1					
Time (min.)	% oil release			Average	SD
15	8.62	8.68	8.65	8.65	0.030
30	11.43	11.38	11.42	11.41	0.026
45	14.24	14.29	14.28	14.27	0.026
60	18.84	18.78	18.81	18.81	0.030
120	22.35	22.35	22.37	22.36	0.012
180	24.85	24.86	24.8	24.84	0.032
240	28.29	28.29	28.27	28.28	0.012
300	32.45	32.41	32.43	32.43	0.020
360	36.09	36.06	36.07	36.07	0.015
420	38.95	38.97	38.95	38.96	0.012
480	42.76	42.79	42.80	42.78	0.021
540	46.35	46.36	46.36	46.36	0.006
600	50.49	50.49	50.47	50.48	0.012
720	54.42	54.43	54.39	54.41	0.021
840	58.74	58.74	58.76	58.75	0.012

A1					
Time (min.)	% oil release			Average	SD
960	63.32	63.30	63.35	63.32	0.025
1080	67.18	67.20	67.16	67.18	0.020
1200	71.53	71.54	71.53	71.53	0.006
1320	75.63	75.60	75.62	75.62	0.015
1440	79.60	79.63	79.56	79.60	0.035
1560	83.90	83.90	83.83	83.88	0.040
1680	88.36	88.34	88.35	88.35	0.010
1800	88.36	88.34	88.35	88.35	0.010
1920	88.36	88.34	88.35	88.35	0.010
2040	88.36	88.34	88.35	88.35	0.010
2160	88.36	88.34	88.35	88.35	0.010
2280	88.36	88.34	88.35	88.35	0.010
2400	88.36	88.34	88.35	88.35	0.010
2520	88.36	88.34	88.35	88.35	0.010
2640	88.36	88.34	88.35	88.35	0.010
2760	88.36	88.34	88.35	88.35	0.010
2880	88.36	88.34	88.35	88.35	0.010

Table F2 % oil release of A2

A2					
Time (min.)	% oil release			Average	SD
15	7.65	7.66	7.64	7.65	0.010
30	10.4	10.36	10.39	10.38	0.021
45	13.69	13.71	13.71	13.70	0.012
60	16.75	16.79	16.78	16.77	0.021
120	20.51	20.47	20.49	20.49	0.020
180	23.72	23.7	23.69	23.70	0.015
240	26.58	26.59	26.56	26.58	0.015
300	29.83	29.8	29.81	29.81	0.015
360	33.4	33.37	33.37	33.38	0.017
420	36.79	36.78	36.76	36.78	0.015
480	39.87	39.93	39.9	39.90	0.030
540	44.15	44.12	44.13	44.13	0.015
600	47.62	47.63	47.6	47.62	0.015
720	50.46	50.44	50.46	50.45	0.012
840	54.3	54.27	54.28	54.28	0.015
960	58.94	58.97	58.97	58.96	0.017

A2					
Time (min.)	% oil release			Average	SD
1080	63.15	63.11	63.14	63.13	0.021
1200	67.31	67.33	67.33	67.32	0.012
1320	71.64	71.68	71.65	71.66	0.021
1440	75.79	75.75	75.77	75.77	0.020
1560	79.84	79.85	79.86	79.85	0.010
1680	84	84.04	84.03	84.02	0.021
1800	84	84.04	84.03	84.02	0.021
1920	84	84.04	84.03	84.02	0.021
2040	84	84.04	84.03	84.02	0.021
2160	84	84.04	84.03	84.02	0.021
2280	84	84.04	84.03	84.02	0.021
2400	84	84.04	84.03	84.02	0.021
2520	84	84.04	84.03	84.02	0.021
2640	84	84.04	84.03	84.02	0.021
2760	84	84.04	84.03	84.02	0.021
2880	84	84.04	84.03	84.02	0.021

Table F3 % oil release of A3

A3					
Time (min.)	% oil release			Average	SD
15	6.8	6.79	6.81	6.8	0.010
30	8.59	8.55	8.56	8.57	0.021
45	12.19	12.2	12.18	12.19	0.010
60	14.24	14.27	14.26	14.26	0.015
120	17.56	17.6	17.59	17.58	0.021
180	20.01	19.97	19.99	19.99	0.020
240	22.95	22.92	22.92	22.93	0.017
300	25.87	25.84	25.85	25.85	0.015
360	29.28	29.25	29.28	29.27	0.017
420	32.14	32.16	32.16	32.15	0.012
480	36.86	36.84	36.85	36.85	0.010
540	40.43	40.44	40.43	40.43	0.006
600	44.07	44.05	44.06	44.06	0.010
720	47.89	47.89	47.87	47.88	0.012
840	52.15	52.18	52.16	52.16	0.015
960	56.79	56.78	56.78	56.78	0.006

A3					
Time (min.)	% oil release			Average	SD
1080	61.53	61.51	61.52	61.52	0.010
1200	65.49	65.46	65.48	65.48	0.015
1320	69.74	69.7	69.71	69.72	0.021
1440	74.45	74.42	74.43	74.43	0.015
1560	77.89	77.85	77.86	77.87	0.021
1680	81.32	81.33	81.35	81.33	0.015
1800	81.32	81.33	81.35	81.33	0.015
1920	81.32	81.33	81.35	81.33	0.015
2040	81.32	81.33	81.35	81.33	0.015
2160	81.32	81.33	81.35	81.33	0.015
2280	81.32	81.33	81.35	81.33	0.015
2400	81.32	81.33	81.35	81.33	0.015
2520	81.32	81.33	81.35	81.33	0.015
2640	81.32	81.33	81.35	81.33	0.015
2760	81.32	81.33	81.35	81.33	0.015
2880	81.32	81.33	81.35	81.33	0.015

Table F4 % oil release of B1

B1					
Time (min.)	% oil release			Average	SD
15	7.65	7.68	7.65	7.66	0.017
30	10.92	10.87	10.89	10.89	0.025
45	13.42	13.45	13.41	11.43	0.021
60	15.49	15.54	15.51	15.51	0.025
120	19.43	19.42	19.4	19.42	0.015
180	22.19	22.23	22.17	22.20	0.031
240	25.43	25.39	25.41	25.41	0.020
300	28.45	28.43	28.42	28.43	0.015
360	32.37	32.34	32.33	32.35	0.021
420	36.54	36.57	36.55	36.55	0.015
480	39.65	39.67	39.63	39.65	0.020
540	43.86	43.85	43.84	43.85	0.010
600	48.6	48.65	48.62	48.62	0.025
720	51.75	51.74	51.72	51.74	0.015
840	55.84	55.79	55.82	55.82	0.025
960	59.14	59.14	59.12	59.13	0.012

B1					
Time (min.)	% oil release			Average	SD
1080	62.84	62.83	62.85	62.84	0.010
1200	66.37	66.36	66.35	66.36	0.010
1320	69.84	69.83	69.81	69.83	0.015
1440	73.56	73.56	73.54	73.55	0.012
1560	77.69	77.7	77.68	77.69	0.010
1680	81.57	81.54	81.55	81.55	0.015
1800	85.11	85.08	85.09	85.09	0.015
1920	85.11	85.08	85.09	85.09	0.015
2040	85.11	85.08	85.09	85.09	0.015
2160	85.11	85.08	85.09	85.09	0.015
2280	85.11	85.08	85.09	85.09	0.015
2400	85.11	85.08	85.09	85.09	0.015
2520	85.11	85.08	85.09	85.09	0.015
2640	85.11	85.08	85.09	85.09	0.015
2760	85.11	85.08	85.09	85.09	0.015
2880	85.11	85.08	85.09	85.09	0.015

Table F5 % oil release of B2

B2					
Time (min.)	% oil release			Average	SD
15	6.58	6.57	6.56	6.57	0.010
30	9.58	9.61	9.6	9.60	0.015
45	11.89	11.91	11.87	11.89	0.020
60	14.21	14.15	14.18	14.18	0.030
120	18.05	18.03	18.01	18.03	0.020
180	20.95	20.92	20.92	20.93	0.017
240	23.87	23.89	23.86	23.87	0.015
300	26.82	26.8	26.79	26.80	0.015
360	30.1	30.12	30.11	30.11	0.010
420	34.34	34.36	34.34	34.35	0.012
480	37.78	37.75	37.76	37.76	0.015
540	41.93	41.95	41.92	41.93	0.015
600	46.25	46.2	46.23	46.23	0.025
720	49.88	49.9	49.88	49.89	0.012
840	53.5	53.45	53.48	53.48	0.025
960	56.82	56.87	56.82	56.84	0.029

B2					
Time (min.)	% oil release			Average	SD
1080	60.13	60.12	60.1	60.12	0.015
1200	63.4	63.34	63.37	63.37	0.030
1320	66.45	66.46	66.44	66.45	0.010
1440	70.24	70.2	70.23	70.22	0.021
1560	73.3	73.34	73.29	73.31	0.026
1680	76.93	76.89	76.91	76.91	0.020
1800	80.34	80.27	80.32	80.31	0.036
1920	80.34	80.27	80.32	80.31	0.036
2040	80.34	80.27	80.32	80.31	0.036
2160	80.34	80.27	80.32	80.31	0.036
2280	80.34	80.27	80.32	80.31	0.036
2400	80.34	80.27	80.32	80.31	0.036
2520	80.34	80.27	80.32	80.31	0.036
2640	80.34	80.27	80.32	80.31	0.036
2760	80.34	80.27	80.32	80.31	0.036
2880	80.34	80.27	80.32	80.31	0.036

Table F6 % oil release of B3

B3					
Time (min.)	% oil release			Average	SD
15	6.23	6.25	6.26	6.25	0.015
30	9.15	9.13	9.13	9.14	0.012
45	11.23	11.26	11.25	11.25	0.015
60	13.45	13.5	13.48	13.48	0.025
120	17.28	17.24	17.27	17.26	0.021
180	19.56	19.57	19.59	19.57	0.015
240	22.26	22.24	22.24	22.25	0.012
300	26.21	26.24	26.19	26.21	0.025
360	29.69	29.74	29.68	29.70	0.032
420	33.89	33.89	33.86	33.88	0.017
480	37.49	37.49	37.48	37.49	0.006
540	41.65	41.65	41.63	41.64	0.012
600	45.26	45.27	45.24	45.26	0.015
720	49.53	49.54	49.51	49.53	0.015
840	53.39	53.42	53.38	53.40	0.021
960	56.62	56.59	56.61	56.61	0.015

B3					
Time (min.)	% oil release			Average	SD
1080	60.13	60.12	60.1	60.12	0.015
1200	63.4	63.34	63.37	63.37	0.030
1320	66.45	66.46	66.44	66.45	0.010
1440	70.24	70.2	70.23	70.22	0.021
1560	73.3	73.34	73.29	73.31	0.026
1680	76.93	76.89	76.91	76.91	0.020
1800	80.34	80.27	80.32	80.31	0.036
1920	80.34	80.27	80.32	80.31	0.036
2040	80.34	80.27	80.32	80.31	0.036
2160	80.34	80.27	80.32	80.31	0.036
2280	80.34	80.27	80.32	80.31	0.036
2400	80.34	80.27	80.32	80.31	0.036
2520	80.34	80.27	80.32	80.31	0.036
2640	80.34	80.27	80.32	80.31	0.036
2760	80.34	80.27	80.32	80.31	0.036
2880	80.34	80.27	80.32	80.31	0.036

Table F7 % oil release of C1

C1					
Time (min.)	% oil release			Average	SD
15	12	12.01	12.03	12.01	0.015
30	16.97	16.98	16.95	16.97	0.015
45	19.63	19.65	19.61	19.63	0.020
60	22.55	22.56	22.53	22.55	0.015
120	27.57	27.59	27.56	27.57	0.015
180	32.59	32.58	32.57	32.58	0.010
240	37.61	37.6	37.6	37.60	0.006
300	42.2	42.21	42.23	42.21	0.015
360	46.33	46.35	46.33	46.34	0.012
420	50.9	50.83	50.86	50.86	0.035
480	54.74	54.72	54.71	54.72	0.015
540	58.55	58.59	58.53	58.56	0.031
600	63.33	63.28	63.29	63.30	0.026
720	68.78	68.79	68.76	68.78	0.015
840	73.12	73.1	73.11	73.11	0.010
960	78.56	78.55	78.54	78.55	0.010

C1					
Time (min.)	% oil release			Average	SD
1080	60.13	60.12	60.1	60.12	0.015
1200	63.4	63.34	63.37	63.37	0.030
1320	66.45	66.46	66.44	66.45	0.010
1440	70.24	70.2	70.23	70.22	0.021
1560	73.3	73.34	73.29	73.31	0.026
1680	76.93	76.89	76.91	76.91	0.020
1800	80.34	80.27	80.32	80.31	0.036
1920	80.34	80.27	80.32	80.31	0.036
2040	80.34	80.27	80.32	80.31	0.036
2160	80.34	80.27	80.32	80.31	0.036
2280	80.34	80.27	80.32	80.31	0.036
2400	80.34	80.27	80.32	80.31	0.036
2520	80.34	80.27	80.32	80.31	0.036
2640	80.34	80.27	80.32	80.31	0.036
2760	80.34	80.27	80.32	80.31	0.036
2880	80.34	80.27	80.32	80.31	0.036

Table F8 % oil release of C2

C2					
Time (min.)	% oil release			Average	SD
15	10.57	10.6	10.55	10.57	0.025
30	15.52	15.54	15.55	15.54	0.015
45	18.75	18.79	18.73	18.76	0.031
60	21.5	21.48	21.46	21.48	0.020
120	25.21	25.16	25.19	25.19	0.025
180	29.63	29.62	29.6	29.62	0.015
240	33.46	33.45	33.43	33.45	0.015
300	37.89	37.9	37.91	37.90	0.010
360	42.37	42.31	42.35	42.34	0.031
420	47.15	47.19	47.14	47.16	0.026
480	51.9	51.87	51.89	51.89	0.015
540	55.65	55.65	55.63	55.64	0.012
600	59.3	59.32	59.29	59.30	0.015
720	63.7	63.7	63.67	63.69	0.017
840	68.15	68.1	68.12	68.12	0.025
960	73.15	73.15	73.1	73.13	0.029

C2					
Time (min.)	% oil release			Average	SD
1080	60.13	60.12	60.1	60.12	0.015
1200	63.4	63.34	63.37	63.37	0.030
1320	66.45	66.46	66.44	66.45	0.010
1440	70.24	70.2	70.23	70.22	0.021
1560	73.3	73.34	73.29	73.31	0.026
1680	76.93	76.89	76.91	76.91	0.020
1800	80.34	80.27	80.32	80.31	0.036
1920	80.34	80.27	80.32	80.31	0.036
2040	80.34	80.27	80.32	80.31	0.036
2160	80.34	80.27	80.32	80.31	0.036
2280	80.34	80.27	80.32	80.31	0.036
2400	80.34	80.27	80.32	80.31	0.036
2520	80.34	80.27	80.32	80.31	0.036
2640	80.34	80.27	80.32	80.31	0.036
2760	80.34	80.27	80.32	80.31	0.036
2880	80.34	80.27	80.32	80.31	0.036

Table F9 % oil release of C3

C3					
Time (min.)	% oil release			Average	SD
15	9.4	9.35	9.38	9.38	0.025
30	14.88	14.9	14.85	14.88	0.025
45	17.9	17.84	17.88	17.87	0.031
60	20.93	20.98	20.96	20.96	0.025
120	23.88	23.85	23.85	23.86	0.017
180	27.32	27.34	27.35	27.34	0.015
240	31.85	31.81	31.84	31.83	0.021
300	35.9	35.86	35.91	35.89	0.026
360	39.84	39.9	39.87	39.87	0.030
420	44.46	44.5	44.47	44.48	0.021
480	48.9	48.93	48.91	48.91	0.015
540	52.75	52.75	52.74	52.75	0.006
600	56.65	56.62	56.65	56.64	0.017
720	60.93	60.86	60.9	60.90	0.035
840	65.01	64.97	64.98	64.99	0.021
960	68.73	68.76	68.77	68.75	0.021

C3					
Time (min.)	% oil release			Average	SD
1080	72.25	72.25	72.24	72.25	0.006
1200	75.96	75.98	75.95	75.96	0.015
1320	79.58	79.59	79.56	79.58	0.015
1440	83.1	83.09	83.07	83.09	0.015
1560	86.45	86.47	86.43	86.45	0.020
1680	86.45	86.47	86.43	86.45	0.020
1800	86.45	86.47	86.43	86.45	0.020
1920	86.45	86.47	86.43	86.45	0.020
2040	86.45	86.47	86.43	86.45	0.020
2160	86.45	86.47	86.43	86.45	0.020
2280	86.45	86.47	86.43	86.45	0.020
2400	86.45	86.47	86.43	86.45	0.020
2520	86.45	86.47	86.43	86.45	0.020
2640	86.45	86.47	86.43	86.45	0.020
2760	86.45	86.47	86.43	86.45	0.020
2880	86.45	86.47	86.43	86.45	0.020

Appendix G The degree of swelling and the percentage of weight loss**Table G1** The degree of swelling for 6,12 and 24 h

Samples	6	12	24
A1	3.86	6.84	12.30
A2	3.59	6.41	11.82
A3	3.16	6.28	11.20
B1	2.91	6.14	10.90
B2	2.82	5.84	10.41
B3	2.44	5.38	10
C1	4.40	7.30	13.67
C2	4.29	7	13.23
C3	4	6.92	12.85

Table G1 The percentage of weight loss for 6,12 and 24 h

Samples	6	12	24
A1	0.96	2.87	2.96
A2	0.92	2.60	2.79
A3	0.86	2.17	2.41
B1	0.77	1.92	2.02
B2	0.64	1.57	1.97
B3	0.30	1.34	1.87
C1	1.25	3.37	3.57
C2	1.22	3.12	3.38
C3	1.12	3.07	3.14

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Proceedings:

1. Hansapaiboon, S.; Vanichvattanadecha, C.; Ohya, Y.; and Rujiravanit, R. (2013) Preparation of Coconut Oil-incorporated Natural Rubber/Pluronic/Chitin Whisker Nanocomposite Film for Wound Treatment. Proceedings of the 4th Research Symposium on Petrochemical, and Material Technology and The 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentations:

1. Hansapaiboon, S.; Vanichvattanadecha, C.; Ohya, Y.; and Rujiravanit, R. (2013) Preparation of Coconut Oil-incorporated Natural Rubber/Pluronic/Chitin Whisker Nanocomposite Film for Wound Treatment. Proceedings of the 4th Research Symposium on Petrochemical, and Material Technology and The 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.