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APPENDICES

Appendix A Characterization of CM-Chitin

Table A1 Elemental analysis of CM-chitin

No.	% Carbon	% Nitrogen (N)	C/N ratio
1	40.05	5.89	6.80
2	40.22	5.45	7.38
3	40.16	5.68	7.07
Average	40.14	5.67	7.08

Table A2 Time flow of different concentration of CM-chitin solution in 0.1M NaCl

Concentration of CM-chitin (%w/v), c	Time flow (min), t	$t/t_s, \eta_{rel}$	Average	$(t/t_s)-1, \eta_{sp}$	η_{sp}/c
0 (t_s)	103.98	1.00	1.00		
	104.15	1.00			
	104.27	1.00			
0.05	145.63	1.40	1.41		
	147.33	1.41			
	146.33	1.41			
0.10	198.47	1.91	1.90		
	198.29	1.90			
	196.73	1.89			
0.15	280.10	2.69	2.69		
	280.46	2.69			
	280.52	2.69			
0.20	373.59	3.59	3.59		
	374.70	3.60			
	374.62	3.60			
0.30	682.05	6.55	6.54		
	679.50	6.53			
	680.15	6.53			

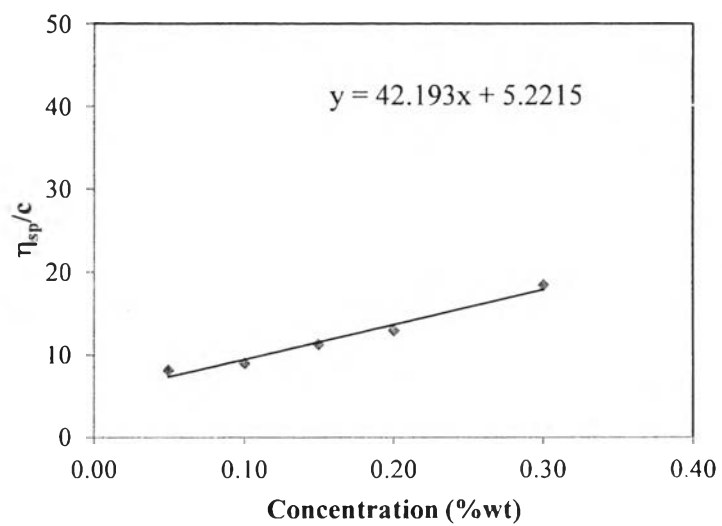


Figure A1 Relationship of reduced viscosity-concentration of CM-chitin solution at 25 °C in 0.1M NaCl

Appendix B Water Absorption Properties

Table B1 Water absorption properties of CM-chitin film at various pH

pH	W _d (g)	W _s (g)	Degree of swelling (%)	Average	SD	W _i (g)	Weight loss (%)	Average	SD
1	0.0897	2.0187	2150.50	2071.57	152.67	0.0573	36.12	39.60	4.64
	0.0954	1.9038	1895.60			0.0526	44.86		
	0.1010	2.2913	2168.61			0.0628	37.82		
2	0.0862	1.9230	2130.86	2236.02	150.03	0.0534	38.05	39.38	4.17
	0.0976	2.2149	2169.36			0.0546	44.06		
	0.0996	2.4978	2407.83			0.0637	36.04		
3	0.0861	2.0390	2268.18	2266.89	106.83	0.0540	37.28	38.79	1.61
	0.0969	2.3964	2373.07			0.0595	38.60		
	0.0993	2.2436	2159.42			0.0591	40.48		
4	0.0772	2.3340	2923.32	2826.57	219.38	0.0502	34.97	31.07	4.06
	0.0934	2.8776	2980.94			0.0683	26.87		
	0.0941	2.5176	2575.45			0.0646	31.35		
5	0.0784	2.3634	2914.54	2812.34	201.81	0.0485	38.14	34.04	5.14
	0.0962	2.9270	2942.62			0.0690	28.27		
	0.0949	2.5432	2579.87			0.0610	35.72		
6	0.0857	3.8772	4424.15	4541.99	110.13	0.0744	13.19	14.35	1.53
	0.0889	4.1423	4559.51			0.0746	16.09		
	0.0879	4.1685	4642.32			0.0758	13.77		
7	0.1046	3.5664	3309.56	3283.04	44.99	0.0798	23.71	26.46	2.39
	0.0997	3.3211	3231.09			0.0721	27.68		
	0.1004	3.4221	3308.47			0.0723	27.99		

Table B2 Water absorption properties of CM-chitin films cross-linked with different glyoxal concentrations

GOX conc. (mM)	W_d (g)	W_s (g)	Degree of swelling (%)	Average	SD	W_i (g)	Weight loss (%)	Average	SD
0.25	0.0891	3.5090	3838.27	4167.81	323.69	0.0740	16.95	19.19	2.52
	0.0749	3.2056	4179.84			0.0609	18.69		
	0.0552	2.5311	4485.33			0.0431	21.92		
0.50	0.0857	3.8772	4424.15	4406.98	19.52	0.0744	13.19	13.47	0.29
	0.0884	3.9654	4385.75			0.0765	13.46		
	0.0879	3.9652	4411.04			0.0758	13.77		
0.75	0.0970	3.8521	3871.24	3663.43	183.85	0.0853	12.06	11.68	0.47
	0.1057	3.8284	3521.95			0.0939	11.16		
	0.1040	3.8450	3597.12			0.0917	11.83		
1.00	0.1006	3.5693	3448.01	3496.74	113.91	0.0907	9.84	10.34	0.61
	0.0944	3.5182	3626.91			0.0840	11.02		
	0.1033	3.6313	3415.30			0.0928	10.16		
1.25	0.1001	3.4116	3308.19	3172.00	145.42	0.0904	9.69	10.02	0.43
	0.1019	3.1781	3018.84			0.0912	10.50		
	0.1034	3.4008	3188.97			0.0932	9.86		
1.50	0.0971	3.0256	3015.96	2881.54	299.59	0.0873	10.09	9.40	1.05
	0.0977	3.1170	3090.38			0.0880	9.93		
	0.1050	2.7702	2538.29			0.0964	8.19		
1.75	0.0959	2.5510	2560.06	2735.83	156.54	0.0876	8.65	9.33	0.61
	0.0914	2.6389	2787.20			0.0824	9.85		
	0.0991	2.9336	2860.24			0.0897	9.49		
2.00	0.0971	2.3192	2288.47	2221.10	126.61	0.0888	8.55	8.98	0.39
	0.0978	2.1272	2075.05			0.0889	9.10		
	0.0968	2.3230	2299.79			0.0878	9.30		

Table B3 Water absorption properties of CM-chitin/CTW composite films crosslinked with 0.50 mM glyoxal

CM-chitin: CTW	W_d (g)	W_s (g)	Degree of swelling (%)	Average	SD	W_i (g)	Weight loss (%)	Average	SD
90:10	0.0640	1.1112	1636.25	1515.89	116.17	0.0585	8.59	8.71	0.15
	0.0994	1.4954	1404.43			0.0908	8.65		
	0.0957	1.5379	1507.00			0.0872	8.88		
80:20	0.1003	1.1491	1045.66	992.37	51.74	0.0944	5.88	5.77	0.15
	0.1064	1.1588	989.10			0.1002	5.83		
	0.1018	1.0611	942.34			0.0961	5.60		
70:30	0.1050	0.7592	623.05	604.75	17.55	0.1001	4.67	4.61	0.10
	0.1005	0.6915	588.06			0.0958	4.68		
	0.1022	0.7186	603.13			0.0976	4.50		
60:40	0.0913	0.5127	461.56	464.21	2.31	0.0890	2.52	2.51	0.16
	0.1026	0.5801	465.40			0.1002	2.34		
	0.1052	0.5951	465.68			0.1024	2.66		
50:50	0.0943	0.3672	289.40	299.72	15.09	0.0921	2.33	2.35	0.14
	0.1039	0.4333	317.04			0.1013	2.50		
	0.1032	0.4053	292.73			0.1009	2.23		
40:60	0.1015	0.2663	162.36	160.44	4.17	0.0991	2.36	2.49	0.12
	0.1079	0.2841	163.30			0.1051	2.59		
	0.1080	0.2761	155.65			0.1053	2.50		

Table B4 Water absorption properties of CM-chitin/CTW composite films crosslinked with 0.75 mM glyoxal

CM-chitin: CTW	W_d (g)	W_s (g)	Degree of swelling (%)	Average	SD	W_i (g)	Weight loss (%)	Average	SD
90:10	0.0909	1.3380	1371.95	1357.65	16.85	0.0880	3.19	3.15	0.04
	0.0929	1.3369	1339.07			0.0900	3.12		
	0.0927	1.3552	1361.92			0.0898	3.13		
80:20	0.0880	0.8785	898.30	851.65	40.97	0.0868	1.36	1.56	0.20
	0.0907	0.8358	821.50			0.0891	1.76		
	0.0959	0.8968	835.14			0.0944	1.56		
70:30	0.0948	0.6427	577.95	591.12	19.39	0.0936	1.27	1.03	0.27
	0.0956	0.6820	613.39			0.0949	0.73		
	0.1012	0.6902	582.02			0.1001	1.09		
60:40	0.0885	0.4320	388.14	410.41	20.86	0.0876	1.02	1.08	0.13
	0.0984	0.5054	413.62			0.0972	1.22		
	0.1011	0.5353	429.48			0.1001	0.99		
50:50	0.0940	0.3636	286.81	285.93	6.12	0.0930	1.06	1.03	0.05
	0.1031	0.4037	291.56			0.1021	0.97		
	0.1045	0.3965	279.43			0.1034	1.05		
40:60	0.1073	0.2695	151.16	158.83	8.47	0.1062	1.03	0.99	0.06
	0.1085	0.2907	167.93			0.1075	0.92		
	0.1080	0.2780	157.41			0.1069	1.02		

Appendix C Standard Calibration Curve of Dye Solution in Various Solvents

Table C1 Standard calibration of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 100:0

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0397	0
10	0.2008	0.1611
20	0.2933	0.2536
30	0.4988	0.4591
40	0.6339	0.5942
50	0.8495	0.8098
60	1.0211	0.9814

Table C2 Standard calibration of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 100:0

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0416	0
10	0.1382	0.0966
20	0.2376	0.1960
30	0.3416	0.3000
40	0.4744	0.4328
50	0.5218	0.4802
60	0.6289	0.5873

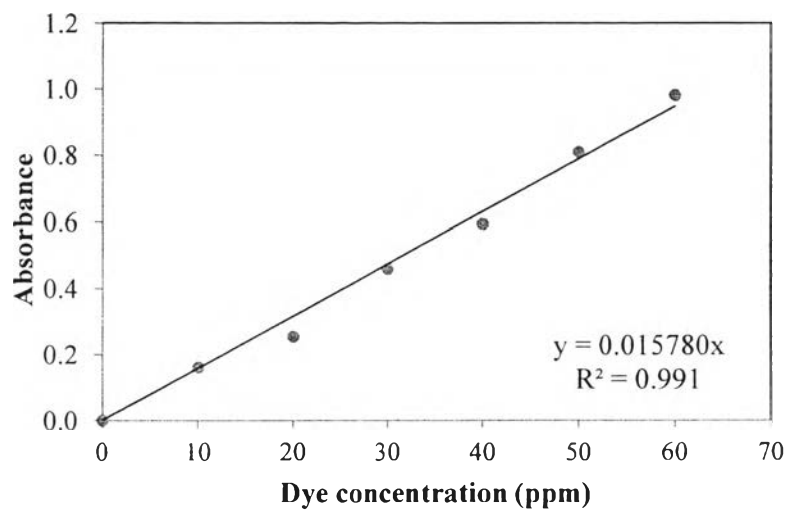


Figure C1 Standard curve of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 100:0.

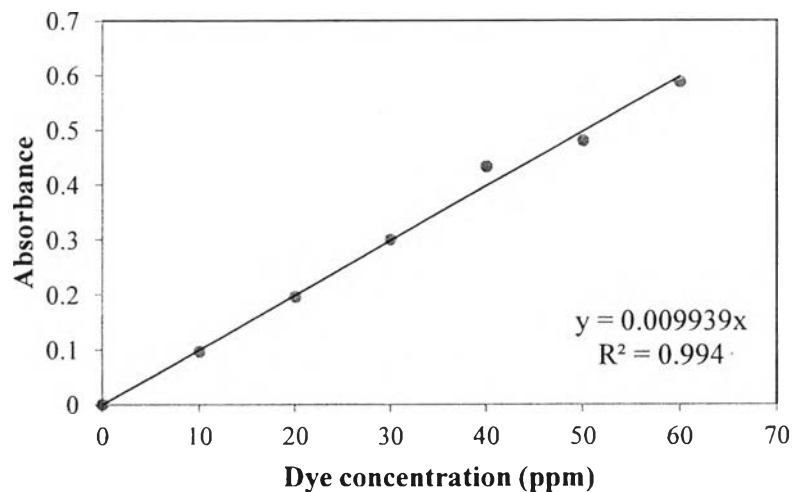


Figure C2 Standard curve of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 100:0.

Table C3 Standard calibration of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 80:20

Dye Concentration	Absorbance at 670 nm	Absolute Absorbance
0	0.0528	0
10	0.2582	0.2054
20	0.4492	0.3964
30	0.6427	0.5899
40	0.8057	0.7529
50	1.0959	1.0432
60	1.3617	1.3089

Table C4 Standard calibration of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 80:20

Dye Concentration	Absorbance at 468 nm	Absolute Absorbance
0	0.0471	0
10	0.1509	0.1038
20	0.2599	0.2128
30	0.3677	0.3206
40	0.4554	0.4083
50	0.5786	0.5315
60	0.6638	0.6167

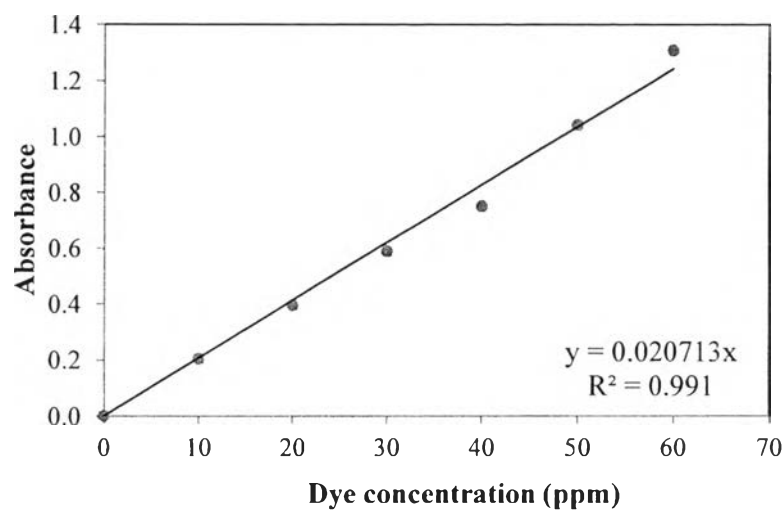


Figure C3 Standard curve of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 80:20.

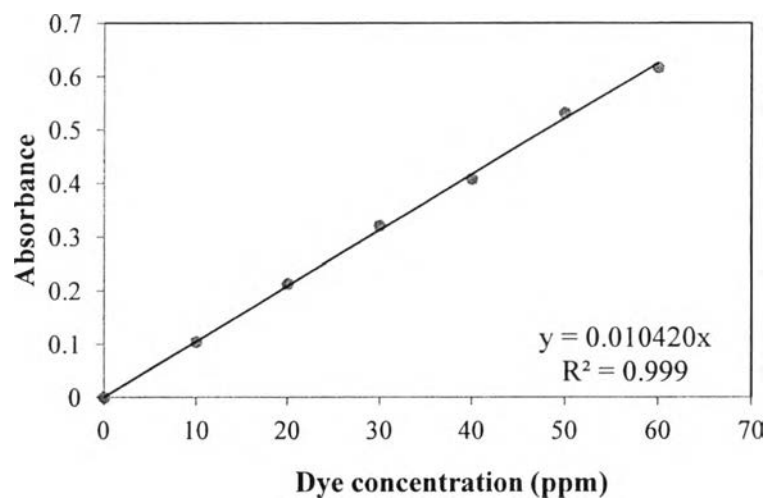


Figure C4 Standard curve of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 80:20.

Table C5 Standard calibration of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 50:50

Dye Concentration	Absorbance at 664 nm	Absolute Absorbance
0	0.0494	0
10	0.3585	0.3090
20	0.6330	0.5836
30	0.8832	0.8337
40	1.1126	1.0632
50	1.3804	1.3310
60	1.6794	1.6300

Table C6 Standard calibration of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 50:50

Dye Concentration	Absorbance at 448 nm	Absolute Absorbance
0	0.0459	0
10	0.1465	0.1006
20	0.2430	0.1971
30	0.3468	0.3009
40	0.4405	0.3946
50	0.5389	0.4930
60	0.6290	0.5831

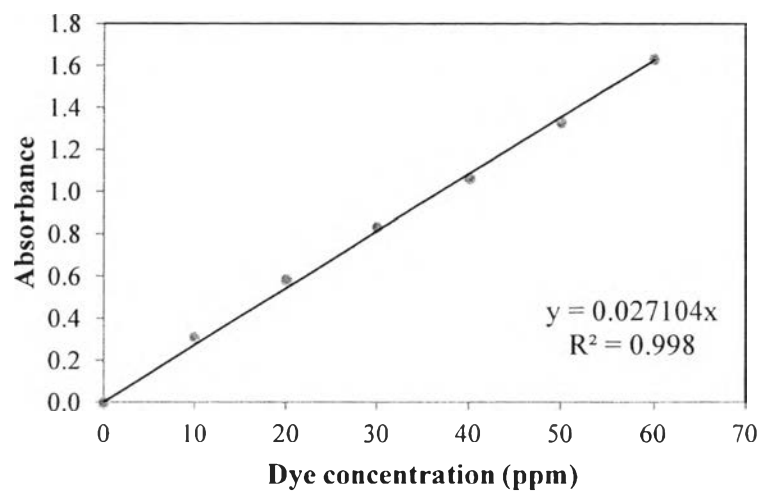


Figure C5 Standard curve of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 50:50.

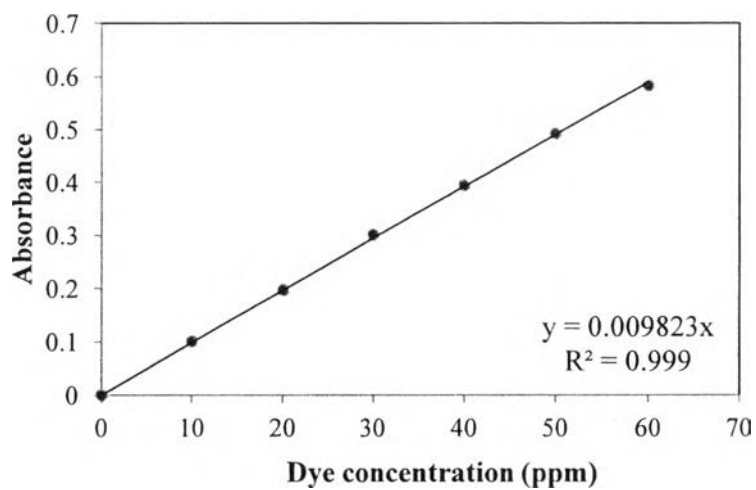


Figure C6 Standard curve of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 50:50.

Table C7 Standard calibration of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 20:80

Dye Concentration (ppm)	Absorbance at 662 nm	Absolute Absorbance
0	0.0462	0
10	0.2969	0.2507
20	0.5521	0.5059
30	0.8302	0.7840
40	1.0383	0.9921
50	1.3343	1.2881
60	1.5967	1.5505

Table C8 Standard calibration of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 20:80

Dye Concentration	Absorbance at 430 nm	Absolute Absorbance
0	0.0520	0
10	0.1573	0.1053
20	0.2604	0.2084
30	0.3737	0.3217
40	0.4562	0.4042
50	0.5737	0.5217
60	0.6841	0.6321

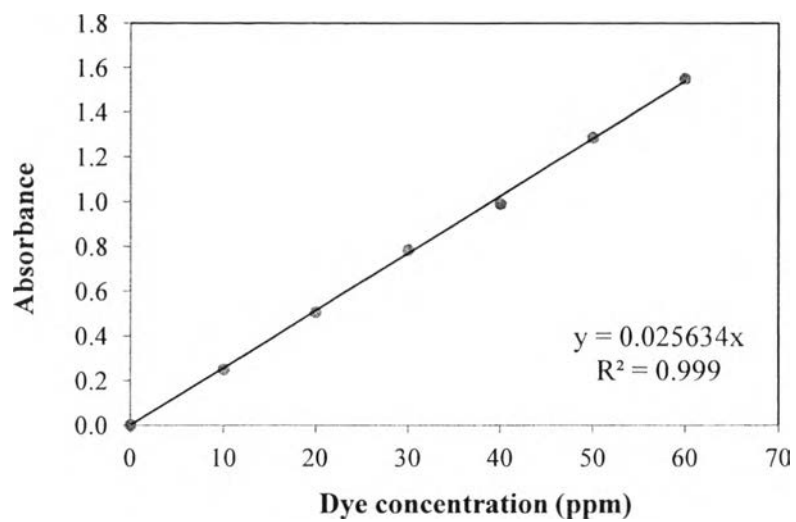


Figure C7 Standard curve of methylene blue solution in the mixture of distilled water and ethanol having volume ratio as 20:80.

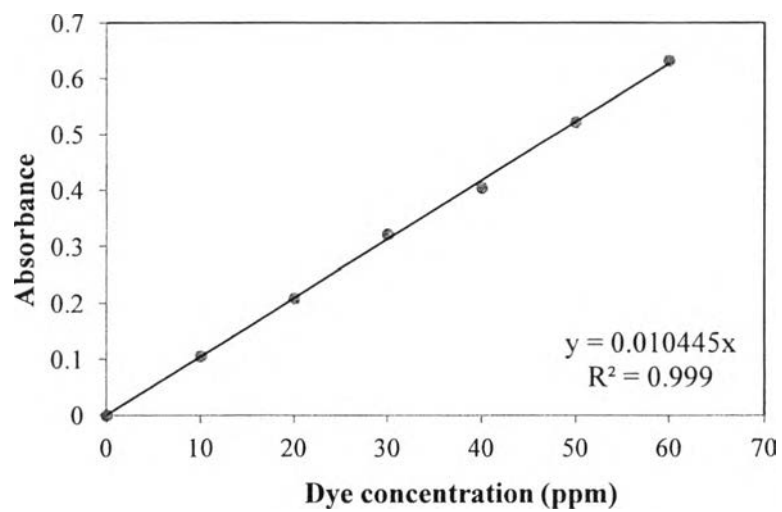


Figure C8 Standard curve of methyl orange solution in the mixture of distilled water and ethanol having volume ratio as 20:80.

Appendix D Dye Adsorption Characteristics in Various Solvents

Table D1 Methylene blue adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 100:0

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.4160	26.3625	0.0000	0.0000	0.0000
	0.4224	26.7681	0.0000		
	0.4190	26.5526	0.0000		
10	0.4062	25.7414	2.3558	2.7030	0.3278
	0.4108	26.0330	2.7462		
	0.4064	25.7541	3.0072		
20	0.4021	25.4816	3.3413	2.8968	0.3963
	0.4115	26.0773	2.5805		
	0.4074	25.8175	2.7685		
30	0.3992	25.2978	4.0385	3.6279	0.3602
	0.4077	25.8365	3.4801		
	0.4049	25.6591	3.3652		
45	0.3927	24.8859	5.6010	6.1830	0.9404
	0.3917	24.8226	7.2680		
	0.3952	25.0444	5.6802		
60	0.3637	23.0482	12.5721	12.0903	0.4175
	0.3724	23.5995	11.8371		
	0.3693	23.4030	11.8616		
90	0.3307	20.9569	20.5048	20.5321	0.8087
	0.3322	21.0520	21.3542		
	0.3363	21.3118	19.7375		
120	0.3028	19.1888	27.2115	27.1730	0.8536
	0.3041	19.2712	28.0066		
	0.3088	19.5691	26.3007		
180	0.2703	17.1293	35.0240	33.8322	1.7963
	0.2758	17.4778	34.7064		
	0.2859	18.1179	31.7661		
240	0.2557	16.2041	38.5337	38.0921	1.4866
	0.2685	17.0152	36.4347		
	0.2543	16.1153	39.3079		
360	0.2133	13.5171	48.7260	49.2620	1.4304
	0.2189	13.8720	48.1771		
	0.2058	13.0418	50.8831		

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
540	0.1996	12.6489	52.0192	52.5844	0.8259
	0.2019	12.7947	52.2017		
	0.1947	12.3384	53.5322		
780	0.1967	12.4651	52.7163	53.0835	0.4425
	0.1961	12.4271	53.5748		
	0.1971	12.4905	52.9594		
1020	0.1893	11.9962	54.4952	54.4226	0.2058
	0.1935	12.2624	54.1903		
	0.1903	12.0596	54.5823		
1260	0.1853	11.7427	55.4567	55.8342	0.7517
	0.1829	11.5906	56.6998		
	0.1871	11.8568	55.3461		
1500	0.1820	11.5336	56.2500	55.9441	0.8388
	0.1901	12.0469	54.9953		
	0.1819	11.5272	56.5871		

Table D2 Methylene blue adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 80:20

Time (min)	Absorbance at 670 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.4544	21.9363	0.0000	0.0000	0.0000
	0.4475	21.6032	0.0000		
	0.4393	21.2073	0.0000		
10	0.4365	21.0721	3.9395	2.6227	1.5221
	0.4342	20.9611	2.9723		
	0.4351	21.0045	0.9561		
20	0.4253	20.5314	6.4045	5.3740	1.6781
	0.4194	20.2465	6.2798		
	0.4242	20.4783	3.4375		
30	0.4202	20.2852	7.5270	5.3314	2.0359
	0.4253	20.5314	4.9613		
	0.4239	20.4638	3.5058		
45	0.4113	19.8555	9.4857	6.3656	2.9070
	0.4212	20.3334	5.8775		
	0.4229	20.4155	3.7335		
60	0.3963	19.1313	12.7870	11.5960	1.2273
	0.3953	19.0830	11.6657		
	0.3939	19.0154	10.3354		
90	0.3823	18.4554	15.8682	14.8210	0.9411
	0.3824	18.4602	14.5486		
	0.3776	18.2285	14.0461		
120	0.3766	18.1802	17.1227	16.3198	0.9020
	0.3737	18.0402	16.4928		
	0.3719	17.9533	15.3438		
180	0.3547	17.1229	21.9426	19.3486	2.7536
	0.3596	17.3595	19.6439		
	0.3670	17.7167	16.4593		
240	0.3227	15.5780	28.9854	29.2940	0.9177
	0.3118	15.0517	30.3263		
	0.3138	15.1483	28.5703		
360	0.3154	15.2255	30.5920	28.3473	2.2179
	0.3209	15.4911	28.2926		
	0.3244	15.6601	26.1572		
540	0.2968	14.3276	34.6856	34.6543	0.5825
	0.2899	13.9944	35.2205		
	0.2897	13.9848	34.0568		

Time (min)	Absorbance at 670 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2883	13.9172	36.5564	36.3163	1.6743
	0.2781	13.4247	37.8576		
	0.2876	13.8834	34.5348		
1020	0.2809	13.5599	38.1850	37.1694	0.8882
	0.2829	13.6565	36.7849		
	0.2788	13.4585	36.5382		
1260	0.2586	12.4833	43.0930	42.8142	0.2824
	0.2572	12.4157	42.5283		
	0.2512	12.1260	42.8214		
1500	0.2523	12.1791	44.4795	43.5483	1.1907
	0.2508	12.1067	43.9586		
	0.2539	12.2564	42.2067		

Table D3 Methylene blue adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 50:50

Time (min)	Absorbance at 664 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.6572	24.2461	0.0000	0.0000	0.0000
	0.6585	24.2941	0.0000		
	0.6536	24.1133	0.0000		
10	0.6356	23.4492	3.2868	2.6024	1.1020
	0.6375	23.5193	3.1892		
	0.6449	23.7923	1.3312		
20	0.6250	23.0581	4.8998	4.6328	0.6822
	0.6331	23.3569	3.8575		
	0.6200	22.8736	5.1410		
30	0.6214	22.9253	5.4476	5.5820	0.3968
	0.6238	23.0138	5.2698		
	0.6142	22.6596	6.0285		
45	0.6103	22.5157	7.1367	6.7284	0.3537
	0.6156	22.7113	6.5151		
	0.6109	22.5379	6.5334		
60	0.6092	22.4752	7.3041	6.8959	0.3553
	0.6142	22.6596	6.7278		
	0.6101	22.5084	6.6558		
90	0.6087	22.4567	7.3802	7.2250	0.4949
	0.6083	22.4420	7.6238		
	0.6100	22.5047	6.6711		
120	0.6018	22.2021	8.4301	8.2103	0.4468
	0.6025	22.2280	8.5046		
	0.6033	22.2575	7.6962		
180	0.5262	19.4129	19.9341	18.7576	1.0427
	0.5374	19.8261	18.3912		
	0.5363	19.7855	17.9477		
240	0.4935	18.2064	24.9100	24.5891	0.3850
	0.4994	18.4241	24.1622		
	0.4922	18.1585	24.6953		
360	0.4790	17.6714	27.1164	27.6671	0.5648
	0.4765	17.5792	27.6400		
	0.4690	17.3025	28.2450		
540	0.4572	16.8671	30.4337	30.7486	0.2792
	0.4546	16.7712	30.9659		
	0.4520	16.6753	30.8461		

Time (min)	Absorbance at 664 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.4488	16.5572	31.7119	31.6113	0.2132
	0.4494	16.5793	31.7556		
	0.4486	16.5498	31.3663		
1020	0.4486	16.5498	31.7423	31.6876	0.1343
	0.4492	16.5720	31.7860		
	0.4475	16.5092	31.5347		
1260	0.4357	16.0739	33.7053	33.1962	0.4577
	0.4424	16.3211	32.8187		
	0.4375	16.1403	33.0647		
1500	0.4332	15.9817	34.0857	33.9475	0.1436
	0.4349	16.0444	33.9577		
	0.4327	15.9632	33.7992		

Table D4 Methylene blue adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 20:80

Time (min)	Absorbance at 662 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.6524	25.4506	0.0000	0.0000	0.0000
	0.6562	25.5988	0.0000		
	0.6551	25.5559	0.0000		
10	0.6405	24.9863	1.8240	0.6894	0.9869
	0.6560	25.5910	0.0305		
	0.6537	25.5013	0.2137		
20	0.6387	24.9161	2.0999	1.8541	0.2355
	0.6455	25.1814	1.6306		
	0.6431	25.0878	1.8318		
30	0.6339	24.7289	2.8357	2.5924	0.2126
	0.6398	24.9590	2.4992		
	0.6391	24.9317	2.4424		
45	0.6278	24.4909	3.7707	3.0262	0.6495
	0.6393	24.9395	2.5754		
	0.6372	24.8576	2.7324		
60	0.6160	24.0306	5.5794	4.3511	1.1033
	0.6336	24.7172	3.4441		
	0.6287	24.5260	4.0299		
90	0.6159	24.0267	5.5947	4.3969	1.0700
	0.6330	24.6938	3.5355		
	0.6285	24.5182	4.0604		
120	0.6132	23.9214	6.0086	5.0333	1.1103
	0.6311	24.6196	3.8251		
	0.6206	24.2100	5.2664		
180	0.6107	23.8238	6.3918	6.5739	0.2859
	0.6109	23.8316	6.9034		
	0.6130	23.9136	6.4265		
240	0.6102	23.8043	6.4684	7.1639	0.6023
	0.6069	23.6756	7.5130		
	0.6059	23.6366	7.5103		
360	0.5885	22.9578	9.7946	9.3808	0.3956
	0.5949	23.2075	9.3417		
	0.5961	23.2543	9.0063		
540	0.5838	22.7744	10.5150	10.2210	0.2660
	0.5906	23.0397	9.9969		
	0.5886	22.9617	10.1511		

Time (min)	Absorbance at 662 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.5818	22.6964	10.8216	10.5265	0.2572
	0.5879	22.9344	10.4084		
	0.5873	22.9110	10.3496		
1020	0.5811	22.6691	10.9289	11.0145	0.4393
	0.5808	22.6574	11.4904		
	0.5855	22.8408	10.6243		
1260	0.5797	22.6145	11.1435	11.2437	0.3301
	0.5800	22.6262	11.6123		
	0.5832	22.7510	10.9754		
1500	0.5794	22.6028	11.1894	11.8693	0.5908
	0.5764	22.4858	12.1609		
	0.5748	22.4233	12.2577		

Table D5 Methyl orange adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 100:0

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.3450	34.7084	0.0000	0.0000	0.0000
	0.3420	34.4065	0.0000		
	0.3429	34.4971	0.0000		
10	0.3396	34.1651	1.5654	1.1640	0.4724
	0.3398	34.1852	0.6433		
	0.3385	34.0544	1.2833		
20	0.3381	34.0142	2.0002	1.5331	0.4048
	0.3375	33.9538	1.3159		
	0.3385	34.0544	1.2833		
30	0.3365	33.8532	2.4640	1.7072	0.6568
	0.3376	33.9638	1.2867		
	0.3382	34.0242	1.3708		
45	0.3366	33.8673	2.4234	2.4729	0.5453
	0.3316	33.3602	3.0412		
	0.3362	33.8230	1.9541		
60	0.3372	33.9236	2.2611	2.6328	0.4471
	0.3313	33.3300	3.1290		
	0.3343	33.6318	2.5083		
90	0.3333	33.5312	3.3916	3.0584	0.4799
	0.3308	33.2797	3.2752		
	0.3343	33.6318	2.5083		
120	0.3305	33.2495	4.2033	4.7788	0.5973
	0.3258	32.7766	4.7373		
	0.3244	32.6357	5.3957		
180	0.3244	32.6357	5.9716	5.4655	0.5660
	0.3254	32.7364	4.8543		
	0.3238	32.5754	5.5707		
240	0.3220	32.3943	6.6673	7.1473	1.0945
	0.3202	32.2132	6.3749		
	0.3141	31.5994	8.3998		
360	0.3201	32.2031	7.2181	8.9659	2.1350
	0.3135	31.5391	8.3341		
	0.3040	30.5832	11.3455		
540	0.3081	30.9957	10.6967	10.4859	1.2122
	0.3106	31.2473	9.1822		
	0.3032	30.5027	11.5788		

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.3026	30.4424	12.2910	12.4385	1.3476
	0.3038	30.5631	11.1707		
	0.2954	29.7179	13.8538		
1020	0.2858	28.7521	17.1611	15.4061	1.5655
	0.2936	29.5368	14.1534		
	0.2918	29.3557	14.9038		
1260	0.2842	28.5911	17.6249	16.5835	0.9754
	0.2858	28.7521	16.4343		
	0.2891	29.0841	15.6912		
1500	0.2834	28.5106	17.8568	17.0593	0.7587
	0.2861	28.7822	16.3466		
	0.2847	28.6414	16.9745		

Table D6 Methyl orange adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 80:20

Time (min)	Absorbance at 468 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2547	24.4434	0.0000	0.0000	0.0000
	0.2537	24.3474	0.0000		
	0.2474	23.7428	0.0000		
10	0.2461	23.6180	3.3765	2.6058	1.3465
	0.2451	23.5221	3.3898		
	0.2448	23.4933	1.0509		
20	0.2441	23.4261	4.1618	3.6009	1.0902
	0.2428	23.3013	4.2964		
	0.2416	23.1862	2.3444		
30	0.2411	23.1382	5.3396	4.5833	0.7924
	0.2419	23.2150	4.6512		
	0.2381	22.8503	3.7591		
45	0.2389	22.9271	6.2034	5.0171	1.1440
	0.2412	23.1478	4.9271		
	0.2377	22.8119	3.9208		
60	0.2378	22.8215	6.6353	5.4541	1.1206
	0.2402	23.0518	5.3212		
	0.2365	22.6967	4.4058		
90	0.2378	22.8215	6.6353	5.5885	0.9535
	0.2401	23.0422	5.3607		
	0.2356	22.6104	4.7696		
120	0.2376	22.8023	6.7138	6.0004	0.6904
	0.2386	22.8983	5.9519		
	0.2342	22.4760	5.3355		
180	0.2359	22.6392	7.3812	6.4348	0.9228
	0.2375	22.7927	6.3855		
	0.2337	22.4280	5.5376		
240	0.2345	22.5048	7.9309	6.7787	1.0423
	0.2372	22.7639	6.5037		
	0.2328	22.3417	5.9014		
360	0.2343	22.4856	8.0094	7.3466	0.9444
	0.2340	22.4568	7.7651		
	0.2319	22.2553	6.2652		
540	0.2329	22.3512	8.5591	7.6760	1.0833
	0.2334	22.3992	8.0016		
	0.2314	22.2073	6.4673		

Time (min)	Absorbance at 468 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2327	22.3321	8.6376	7.9693	0.8647
	0.2327	22.3321	8.2775		
	0.2301	22.0825	6.9927		
1020	0.2327	22.3321	8.6376	8.6020	1.3492
	0.2285	21.9290	9.9330		
	0.2295	22.0250	7.2353		
1260	0.2259	21.6795	11.3074	10.9208	0.7789
	0.2247	21.5643	11.4308		
	0.2226	21.3628	10.0243		
1500	0.2229	21.3916	12.4853	12.2048	0.7470
	0.2213	21.2380	12.7710		
	0.2193	21.0461	11.3581		

Table D7 Methyl orange adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 50:50

Time (min)	Absorbance at 448 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2571	26.1733	0.0000	0.0000	0.0000
	0.2580	26.2649	0.0000		
	0.2566	26.1224	0.0000		
10	0.2542	25.8780	1.1280	1.0095	0.7237
	0.2537	25.8271	1.6667		
	0.2560	26.0613	0.2338		
20	0.2497	25.4199	2.8783	1.3865	1.3161
	0.2557	26.0307	0.8915		
	0.2556	26.0206	0.3897		
30	0.2491	25.3589	3.1116	1.9811	1.4183
	0.2517	25.6235	2.4419		
	0.2556	26.0206	0.3897		
45	0.2498	25.4301	2.8394	1.5437	1.3236
	0.2575	26.2140	0.1938		
	0.2525	25.7050	1.5978		
60	0.2525	25.7050	1.7892	2.1233	1.0078
	0.2496	25.4098	3.2558		
	0.2532	25.7762	1.3250		
90	0.2557	26.0307	0.5445	2.1390	1.5428
	0.2522	25.6744	2.2481		
	0.2473	25.1756	3.6243		
120	0.2405	24.4834	6.4566	3.4606	2.5952
	0.2528	25.7355	2.0155		
	0.2517	25.6235	1.9096		
180	0.2472	25.1654	3.8506	4.0775	2.4063
	0.2410	24.5343	6.5891		
	0.2520	25.6541	1.7927		
240	0.2333	23.7504	9.2571	5.5861	3.1793
	0.2484	25.2876	3.7209		
	0.2469	25.1349	3.7802		
360	0.2377	24.1983	7.5457	6.3379	1.1600
	0.2445	24.8906	5.2326		
	0.2406	24.4935	6.2354		
540	0.2388	24.3103	7.1178	6.2313	1.2875
	0.2404	24.4732	6.8217		
	0.2444	24.8804	4.7545		

Time (min)	Absorbance at 448 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2400	24.4325	6.6511	6.2606	0.9349
	0.2446	24.9007	5.1938		
	0.2388	24.3103	6.9369		
1020	0.2366	24.0863	7.9736	8.1650	0.7219
	0.2385	24.2798	7.5581		
	0.2336	23.7809	8.9634		
1260	0.2356	23.9845	8.3625	9.0317	0.5866
	0.2336	23.7809	9.4574		
	0.2328	23.6995	9.2751		
1500	0.2304	23.4552	10.3851	10.6256	0.2341
	0.2300	23.4144	10.8527		
	0.2293	23.3432	10.6391		

Table D8 Methyl orange adsorption on CM-chitin film in the mixture of distilled water and ethanol with volume ratio as 20:80

Time (min)	Absorbance at 430 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2589	24.7870	0.0000	0.0000	0.0000
	0.2674	25.6008	0.0000		
	0.2763	26.4528	0.0000		
10	0.2532	24.2413	2.2016	1.1477	0.9559
	0.2665	25.5146	0.3366		
	0.2738	26.2135	0.9048		
20	0.2509	24.0211	3.0900	1.8745	1.0626
	0.2644	25.3135	1.1219		
	0.2724	26.0795	1.4115		
30	0.2485	23.7913	4.0170	2.4143	1.4294
	0.2640	25.2753	1.2715		
	0.2709	25.9359	1.9544		
45	0.2481	23.7530	4.1715	3.1933	1.3853
	0.2631	25.1891	1.6081		
	0.2658	25.4476	3.8002		
60	0.2475	23.6955	4.4032	3.4555	1.2934
	0.2621	25.0933	1.9821		
	0.2653	25.3997	3.9812		
90	0.2470	23.6477	4.5964	3.9441	1.5552
	0.2616	25.0455	2.1690		
	0.2623	25.1125	5.0670		
120	0.2467	23.6190	4.7122	4.0933	1.5251
	0.2611	24.9976	2.3560		
	0.2619	25.0742	5.2117		
180	0.2466	23.6094	4.7509	4.4922	0.9129
	0.2581	24.7104	3.4779		
	0.2618	25.0646	5.2479		
240	0.2449	23.4466	5.4075	4.7851	1.0034
	0.2577	24.6721	3.6275		
	0.2616	25.0455	5.3203		
360	0.2421	23.1786	6.4890	5.5357	1.3416
	0.2567	24.5764	4.0015		
	0.2594	24.8348	6.1165		
540	0.2378	22.7669	8.1499	6.8288	2.1584
	0.2558	24.4902	4.3381		
	0.2542	24.3370	7.9986		

Time (min)	Absorbance at 430 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2342	22.4222	9.5404	7.3530	2.6716
	0.2557	24.4806	4.3755		
	0.2538	24.2987	8.1433		
1020	0.2425	23.2169	6.3345	8.0112	2.5372
	0.2493	23.8679	6.7689		
	0.2461	23.5615	10.9302		
1260	0.2383	22.8147	7.9567	10.2171	1.9583
	0.2372	22.7094	11.2939		
	0.2448	23.4371	11.4007		
1500	0.2396	22.9392	7.4546	10.4740	3.0785
	0.2397	22.9488	10.3590		
	0.2387	22.8530	13.6084		

Appendix E Dye Adsorption Characteristics at Various Blend Ratios

Table E1 Methylene blue adsorption on CM-chitin/CTW composite film at the blend ratio of 90:10

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.3889	24.6430	0.0000	0.0000	0.0000
	0.3883	24.6050	0.0000		
	0.3885	24.6177	0.0000		
10	0.3637	23.0461	6.4804	5.6618	1.1055
	0.3712	23.5213	4.4042		
	0.3648	23.1158	6.1009		
20	0.3606	22.8496	7.2776	7.7043	0.7517
	0.3601	22.8179	7.2631		
	0.3552	22.5074	8.5722		
30	0.3448	21.8483	11.3407	11.6338	0.9268
	0.3391	21.4871	12.6717		
	0.3462	21.9371	10.8890		
45	0.3324	21.0625	14.5294	15.4342	1.6602
	0.3323	21.0562	14.4231		
	0.3211	20.3464	17.3503		
60	0.3041	19.2691	21.8070	20.9329	1.1533
	0.3121	19.7761	19.6257		
	0.3055	19.3578	21.3661		
90	0.2928	18.5530	24.7128	24.4594	0.2241
	0.2940	18.6291	24.2874		
	0.2938	18.6164	24.3779		
120	0.2759	17.4820	29.0588	29.5727	1.3915
	0.2776	17.5898	28.5113		
	0.2675	16.9497	31.1481		
180	0.2685	17.0131	30.9618	31.7523	0.8388
	0.2616	16.5758	32.6322		
	0.2655	16.8230	31.6629		
240	0.2591	16.4174	33.3791	33.3650	1.2060
	0.2541	16.1005	34.5639		
	0.2636	16.7026	32.1521		
360	0.2410	15.2704	38.0336	39.8345	1.9188
	0.2258	14.3071	41.8527		
	0.2346	14.8648	39.6173		

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
540	0.2044	12.9507	47.4469	46.3793	1.4631
	0.2147	13.6037	44.7115		
	0.2060	13.0524	46.9796		
780	0.2042	12.9383	47.4970	49.3277	1.5858
	0.1933	12.2504	50.2116		
	0.1932	12.2412	50.2746		
1020	0.1913	12.1208	50.8143	50.8320	1.2101
	0.1956	12.3933	49.6308		
	0.1863	11.8040	52.0508		
1260	0.1915	12.1335	50.7629	50.8066	0.5808
	0.1887	11.9561	51.4080		
	0.1933	12.2476	50.2488		
1500	0.1903	12.0575	51.0715	50.8063	0.4603
	0.1931	12.2349	50.2747		
	0.1901	12.0448	51.0726		

Table E2 Methylene blue adsorption on CM-chitin/CTW composite film at the blend ratio of 80:20

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.3554	22.5201	0.0000	0.0000	0.0000
	0.3441	21.8040	0.0000		
	0.3459	21.9180	0.0000		
10	0.3292	20.8597	7.3727	4.6488	2.6845
	0.3372	21.3667	2.0054		
	0.3301	20.9168	4.5682		
20	0.3216	20.3781	9.5113	7.7777	1.8600
	0.3241	20.5365	5.8128		
	0.3182	20.1627	8.0089		
30	0.3201	20.2831	9.9334	7.6968	2.0621
	0.3239	20.5239	5.8710		
	0.3207	20.3211	7.2860		
45	0.3143	19.9155	11.5655	9.1209	2.1323
	0.3178	20.1373	7.6439		
	0.3177	20.1310	8.1534		
60	0.3065	19.4212	13.7604	15.2353	1.2779
	0.2890	18.3122	16.0143		
	0.2908	18.4263	15.9310		
90	0.3047	19.3071	14.2670	11.8288	2.1115
	0.3076	19.4909	10.6084		
	0.3092	19.5923	10.6110		
120	0.2866	18.1601	19.3603	17.5291	1.9905
	0.2828	17.9193	17.8163		
	0.2926	18.5403	15.4106		
180	0.2726	17.2729	23.2999	21.6514	1.4738
	0.2737	17.3426	20.4611		
	0.2726	17.2729	21.1931		
240	0.2683	17.0004	24.5099	23.2649	1.4615
	0.2628	16.6519	23.6291		
	0.2710	17.1715	21.6557		
360	0.2501	15.8471	29.6314	31.3030	2.5019
	0.2265	14.3515	34.1794		
	0.2418	15.3211	30.0983		
540	0.2333	14.7824	34.3589	33.0565	1.7930
	0.2374	15.0422	31.0114		
	0.2290	14.5099	33.7992		

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2106	13.3439	40.7466	39.4776	1.1986
	0.2121	13.4390	38.3647		
	0.2099	13.2995	39.3215		
1020	0.2086	13.2172	41.3094	40.6128	0.6165
	0.2060	13.0524	40.1376		
	0.2062	13.0651	40.3913		
1260	0.2051	12.9954	42.2943	40.9409	1.1914
	0.2063	13.0714	40.0504		
	0.2059	13.0461	40.4780		
1500	0.2022	12.8116	43.1104	40.8070	2.0135
	0.2086	13.2172	39.3819		
	0.2078	13.1665	39.9287		

Table E3 Methylene blue adsorption on CM-chitin/CTW composite film at the blend ratio of 70:30

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.3606	22.8496	0.0000	0.0000	0.0000
	0.3614	22.9003	0.0000		
	0.3629	22.9954	0.0000		
10	0.3481	22.0575	3.4668	3.8322	1.5568
	0.3524	22.3300	2.4905		
	0.3428	21.7216	5.5392		
20	0.3351	21.2336	7.0722	6.9680	0.8878
	0.3396	21.5188	6.0327		
	0.3346	21.2019	7.7990		
30	0.3254	20.6189	9.7624	9.4859	0.2516
	0.3279	20.7774	9.2704		
	0.3287	20.8281	9.4249		
45	0.3100	19.6430	14.0335	13.3472	1.4785
	0.3193	20.2324	11.6502		
	0.3108	19.6937	14.3579		
60	0.3009	19.0663	16.5573	16.8399	1.0971
	0.3039	19.2564	15.9118		
	0.2974	18.8445	18.0507		
90	0.2994	18.9713	16.9733	16.5193	0.5667
	0.3040	19.2628	15.8841		
	0.3023	19.1550	16.7003		
120	0.2961	18.7621	17.8885	18.5447	1.2443
	0.2972	18.8319	17.7659		
	0.2904	18.4009	19.9798		
180	0.2882	18.2615	20.0795	20.1969	0.1939
	0.2888	18.2995	20.0904		
	0.2888	18.2995	20.4207		
240	0.2877	18.2298	20.2182	21.4021	1.2817
	0.2847	18.0397	21.2250		
	0.2803	17.7609	22.7632		
360	0.2780	17.6151	22.9084	22.2261	0.6059
	0.2828	17.9193	21.7508		
	0.2830	17.9320	22.0191		
540	0.2714	17.1969	24.7388	26.4358	1.4762
	0.2623	16.6202	27.4237		
	0.2644	16.7533	27.1450		

Time (min)	Absorbance at 668 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2581	16.3540	28.4275	29.9396	1.4300
	0.2484	15.7393	31.2702		
	0.2536	16.0689	30.1213		
1020	0.2546	16.1322	29.3982	29.8375	1.1486
	0.2567	16.2653	28.9733		
	0.2499	15.8344	31.1409		
1260	0.2542	16.1069	29.5091	29.6451	0.5047
	0.2558	16.2083	29.2224		
	0.2533	16.0499	30.2039		
1500	0.2506	15.8787	30.5075	30.5491	0.1887
	0.2516	15.9421	30.3847		
	0.2513	15.9231	30.7551		

Table E4 Methyl orange adsorption on CM-chitin/CTW composite film at the blend ratio of 90:10

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2792	28.0914	0.0000	0.0000	0.0000
	0.2866	28.8359	0.0000		
	0.2862	28.7957	0.0000		
10	0.2752	27.6889	1.4327	2.9680	1.4695
	0.2741	27.5782	4.3615		
	0.2773	27.9002	3.1097		
20	0.2700	27.1657	3.2951	5.3232	1.7564
	0.2684	27.0047	6.3503		
	0.2681	26.9745	6.3242		
30	0.2658	26.7431	4.7994	5.3947	1.4925
	0.2743	27.5983	4.2917		
	0.2659	26.7532	7.0929		
45	0.2577	25.9282	7.7006	8.8510	1.8549
	0.2551	25.6666	10.9909		
	0.2637	26.5318	7.8616		
60	0.2556	25.7169	8.4527	9.9748	1.8283
	0.2522	25.3748	12.0028		
	0.2591	26.0690	9.4689		
90	0.2589	26.0489	7.2708	8.7202	1.2709
	0.2601	26.1696	9.2463		
	0.2586	26.0187	9.6436		
120	0.2574	25.8980	7.8080	9.9934	1.9031
	0.2554	25.6968	10.8862		
	0.2539	25.5458	11.2858		
180	0.2537	25.5257	9.1332	11.0406	1.8641
	0.2547	25.6263	11.1305		
	0.2494	25.0931	12.8581		
240	0.2523	25.3848	9.6347	11.8148	1.9022
	0.2489	25.0478	13.1368		
	0.2499	25.1464	12.6730		
360	0.2464	24.7912	11.7478	11.4109	0.9794
	0.2517	25.3245	12.1773		
	0.2567	25.8275	10.3075		
540	0.2492	25.0729	10.7450	13.1829	2.5749
	0.2411	24.2580	15.8758		
	0.2492	25.0729	12.9280		

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2423	24.3787	13.2163	14.6592	1.2608
	0.2430	24.4491	15.2128		
	0.2417	24.3183	15.5486		
1020	0.2423	24.3787	13.2163	14.7754	1.3963
	0.2410	24.2479	15.9107		
	0.2427	24.4190	15.1992		
1260	0.2417	24.3183	13.4312	14.6495	1.1528
	0.2442	24.5699	14.7941		
	0.2412	24.2680	15.7233		
1500	0.2414	24.2882	13.5387	14.9650	1.6041
	0.2446	24.6101	14.6546		
	0.2384	23.9863	16.7016		

Table E5 Methyl orange adsorption on CM-chitin/CTW composite film at the blend ratio of 80:20

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2739	27.5581	0.0000	0.0000	0.0000
	0.2695	27.1154	0.0000		
	0.2703	27.1959	0.0000		
10	0.2732	27.4877	0.2556	0.3072	0.2627
	0.2693	27.0953	0.0742		
	0.2687	27.0349	0.5919		
20	0.2694	27.1053	1.6429	2.1282	0.5343
	0.2640	26.5620	2.0408		
	0.2630	26.4614	2.7007		
30	0.2594	26.0992	5.2939	4.5804	0.6216
	0.2583	25.9885	4.1558		
	0.2587	26.0288	4.2915		
45	0.2580	25.9583	5.8050	5.7019	0.1348
	0.2540	25.5559	5.7514		
	0.2553	25.6867	5.5494		
60	0.2551	25.6666	6.8638	7.1537	0.3802
	0.2506	25.2138	7.0130		
	0.2498	25.1333	7.5842		
90	0.2535	25.5056	7.4480	7.8424	0.4445
	0.2486	25.0126	7.7551		
	0.2478	24.9321	8.3241		
120	0.2515	25.3044	8.1782	8.2094	0.1387
	0.2477	24.9220	8.0891		
	0.2477	24.9220	8.3611		
180	0.2514	25.2943	8.2147	8.7150	0.8470
	0.2473	24.8818	8.2375		
	0.2441	24.5598	9.6929		
240	0.2487	25.0226	9.2004	9.1916	0.9127
	0.2472	24.8717	8.2746		
	0.2430	24.4491	10.0999		
360	0.2481	24.9623	9.4195	9.9072	0.6861
	0.2436	24.5095	9.6104		
	0.2414	24.2882	10.6918		
540	0.2470	24.8516	9.8211	10.3501	0.5683
	0.2418	24.3284	10.2783		
	0.2407	24.2177	10.9508		

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2447	24.6202	10.6608	10.6793	0.3735
	0.2417	24.3183	10.3154		
	0.2404	24.1875	11.0618		
1020	0.2421	24.3586	11.6101	11.3289	0.7292
	0.2412	24.2680	10.5009		
	0.2382	23.9662	11.8757		
1260	0.2418	24.3284	11.7196	11.4273	0.6463
	0.2407	24.2177	10.6865		
	0.2382	23.9662	11.8757		
1500	0.2416	24.3083	11.7926	11.5010	0.6459
	0.2405	24.1976	10.7607		
	0.2380	23.9461	11.9497		

Table E6 Methyl orange adsorption on CM-chitin/CTW composite film at the blend ratio of 70:30

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
0	0.2702	27.1858	0.0000	0.0000	0.0000
	0.2762	27.7895	0.0000		
	0.2716	27.3267	0.0000		
10	0.2638	26.5419	2.3686	2.0216	1.6909
	0.2665	26.8136	3.5119		
	0.2711	27.2764	0.1841		
20	0.2600	26.1596	3.7750	4.5714	1.7939
	0.2579	25.9483	6.6256		
	0.2626	26.4212	3.3137		
30	0.2557	25.7269	5.3664	4.7176	2.9740
	0.2560	25.7571	7.3135		
	0.2676	26.9242	1.4727		
45	0.2587	26.0288	4.2561	5.1833	1.6570
	0.2566	25.8175	7.0963		
	0.2602	26.1797	4.1973		
60	0.2597	26.1294	3.8860	4.9106	0.8978
	0.2616	26.3206	5.2860		
	0.2565	25.8074	5.5596		
90	0.2555	25.7068	5.4404	6.2608	1.4134
	0.2544	25.5961	7.8928		
	0.2568	25.8376	5.4492		
120	0.2545	25.6062	5.8105	6.8951	1.5651
	0.2522	25.3748	8.6894		
	0.2548	25.6364	6.1856		
180	0.2609	26.2501	3.4419	6.5204	2.8706
	0.2510	25.2541	9.1238		
	0.2526	25.4150	6.9956		
240	0.2590	26.0590	4.1451	6.4324	1.9814
	0.2554	25.6968	7.5308		
	0.2509	25.2440	7.6215		
360	0.2585	26.0087	4.3301	6.9650	2.3657
	0.2516	25.3144	8.9066		
	0.2508	25.2339	7.6583		
540	0.2541	25.5660	5.9585	7.1857	1.9630
	0.2501	25.1635	9.4497		
	0.2549	25.6464	6.1487		

Time (min)	Absorbance at 466 nm	Dye Concentration (ppm)	Cumulative Adsorption (%)	Average	SD
780	0.2512	25.2742	7.0318	7.7185	1.0037
	0.2517	25.3245	8.8704		
	0.2519	25.3446	7.2533		
1020	0.2479	24.9421	8.2531	9.1694	1.5286
	0.2460	24.7510	10.9341		
	0.2490	25.0528	8.3211		
1260	0.2437	24.5196	9.8075	10.0322	0.6389
	0.2465	24.8013	10.7531		
	0.2457	24.7208	9.5361		
1500	0.2436	24.5095	9.8446	10.5553	0.9136
	0.2442	24.5699	11.5858		
	0.2438	24.5296	10.2356		

Appendix F Standard Calibration Curve of Dye Solution in 0.1M Tris-HCl Buffer Solution

Table F1 Standard calibration of methylene blue in 0.1M tris-HCl buffer solution

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0474	0
0.1	0.0510	0.0035
1	0.0835	0.0361
5	0.2090	0.1616
10	0.3584	0.3110
25	0.7602	0.7128

Table F2 Standard calibration of methyl orange in 0.1M tris-HCl buffer solution

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0539	0
0.1	0.0584	0.0045
1	0.0627	0.0088
5	0.1241	0.0702
10	0.1999	0.1460
25	0.4073	0.3534

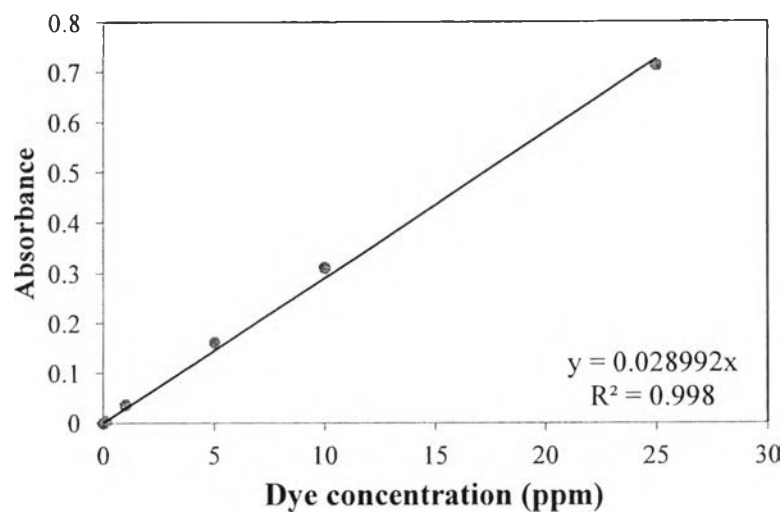


Figure F1 Standard curve of methylene blue in 0.1M tris-HCl buffer solution.

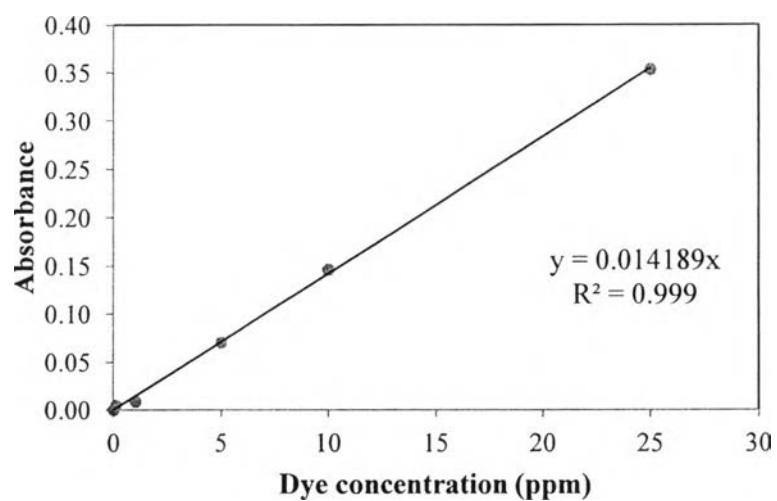


Figure F2 Standard curve of methyl orange in 0.1M tris-HCl buffer solution.

Table F3 Standard calibration of methylene blue in 0.1M tris-HCl buffer solution with 0.001%w/v of lysozyme

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0401	0
0.1	0.0476	0.0075
1	0.0850	0.0449
5	0.2524	0.2123
10	0.4285	0.3884
25	0.8911	0.8510

Table F4 Standard calibration of methyl orange in 0.1M tris-HCl buffer solution with 0.001%w/v of lysozyme

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0427	0
0.1	0.0453	0.0026
1	0.0559	0.0132
5	0.1065	0.0638
10	0.1654	0.1227
25	0.3536	0.3109

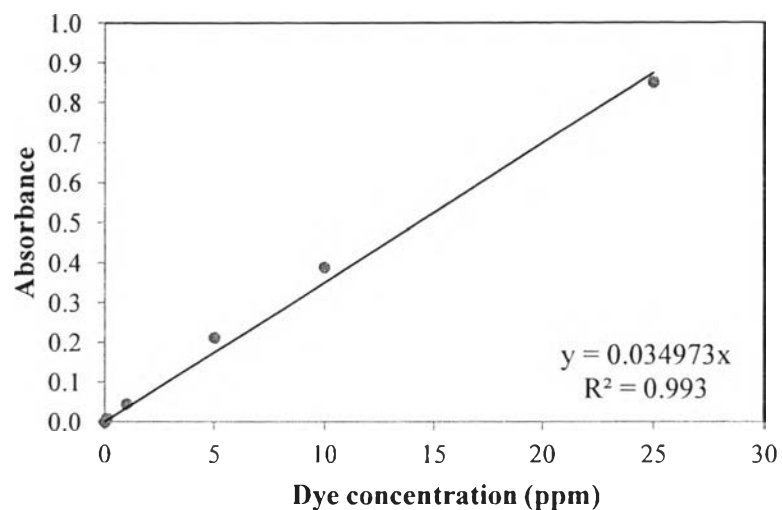


Figure F3 Standard curve of methylene blue in 0.1M tris-HCl buffer solution with 0.001%w/v of lysozyme.

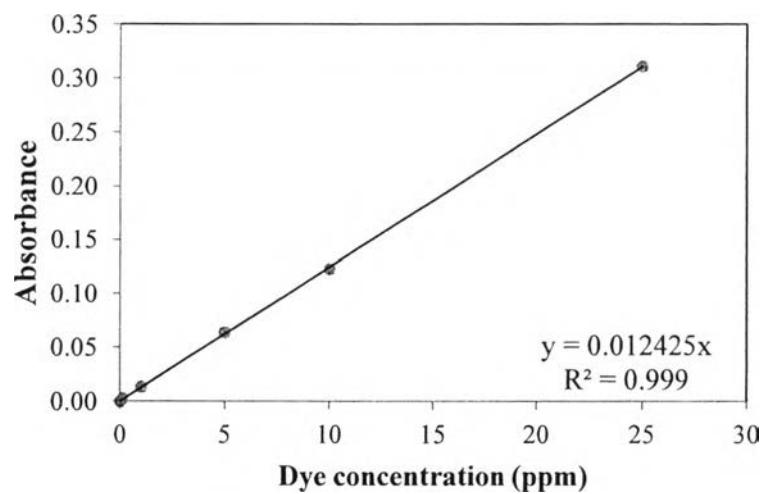


Figure F4 Standard curve of methyl orange in 0.1M tris-HCl buffer solution with 0.001%w/v of lysozyme.

Table F5 Standard calibration of methylene blue in 0.1M tris-HCl buffer solution with 0.01M NaCl

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0415	0
0.1	0.0475	0.0061
1	0.0927	0.0512
5	0.2457	0.2042
10	0.4302	0.3887
25	0.9268	0.8853

Table F6 Standard calibration of methyl orange in 0.1M tris-HCl buffer solution with 0.01M NaCl

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0432	0
0.1	0.0464	0.0032
1	0.0642	0.0210
5	0.1432	0.1000
10	0.2390	0.1958
25	0.5588	0.5156

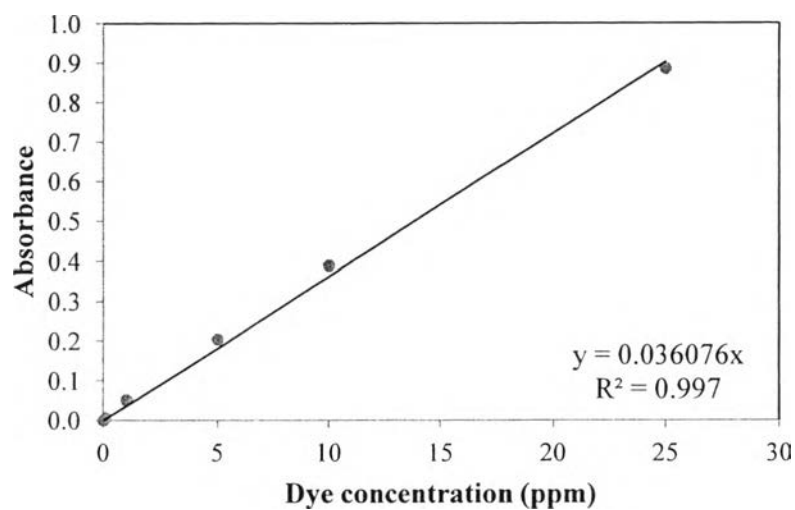


Figure F5 Standard curve of methylene blue in 0.1M tris-HCl buffer solution with 0.01M NaCl.

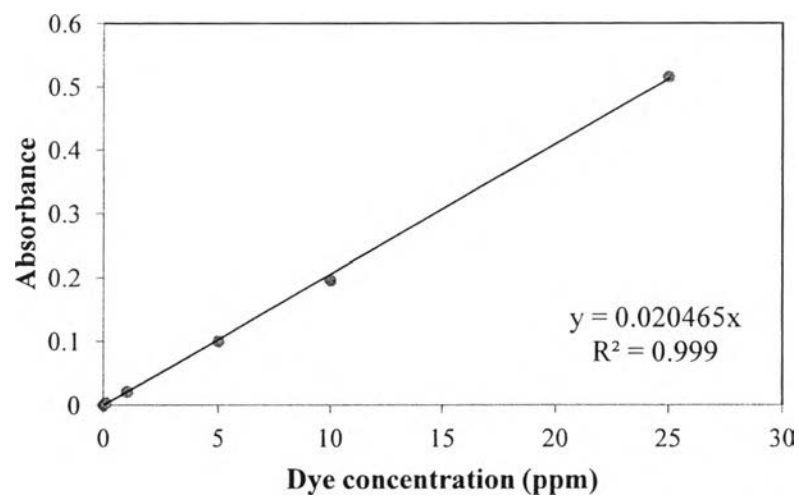


Figure F6 Standard curve of methyl orange in 0.1M tris-HCl buffer solution with 0.01M NaCl.

Table F7 Standard calibration of methylene blue in 0.1M tris-HCl buffer solution with 0.1M NaCl

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0414	0
0.1	0.0458	0.0044
1	0.0844	0.0430
5	0.2195	0.1781
10	0.3897	0.3483
25	0.8385	0.7971

Table F8 Standard calibration of methyl orange in 0.1M tris-HCl buffer solution with 0.1M NaCl

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0455	0
0.1	0.0494	0.0039
1	0.0666	0.0211
5	0.1436	0.0981
10	0.2515	0.2060
25	0.5438	0.4983

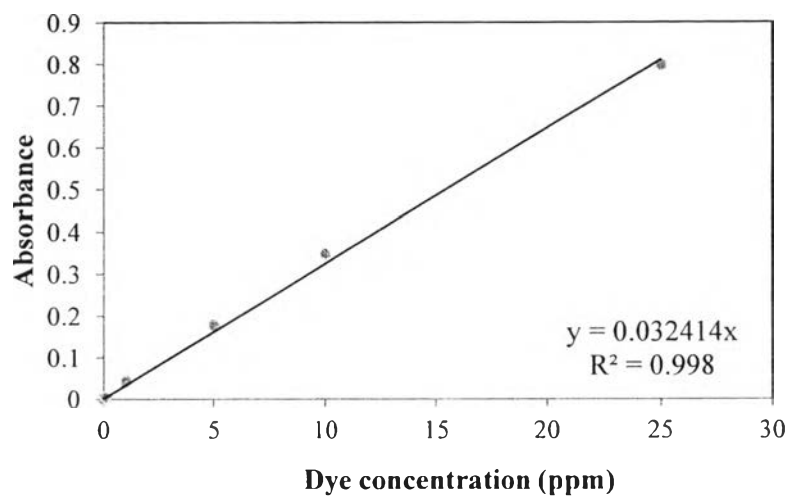


Figure F7 Standard curve of methylene blue in 0.1M tris-HCl buffer solution with 0.1M NaCl.

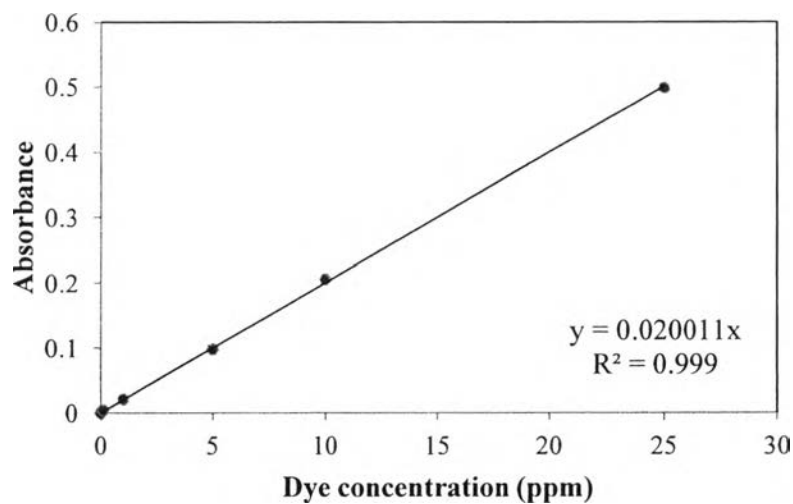


Figure F8 Standard curve of methyl orange in 0.1M tris-HCl buffer solution with 0.1M NaCl.

Table F9 Standard calibration of methylene blue in 0.1M tris-HCl buffer solution with 0.5M NaCl

Dye Concentration	Absorbance at 668 nm	Absolute Absorbance
0	0.0447	0
0.1	0.0523	0.0076
1	0.0928	0.0481
5	0.2043	0.1595
10	0.3580	0.3133
25	0.7650	0.7202

Table F10 Standard calibration of methyl orange in 0.1M tris-HCl buffer solution with 0.5M NaCl

Dye Concentration	Absorbance at 466 nm	Absolute Absorbance
0	0.0482	0
0.1	0.0521	0.0039
1	0.0649	0.0167
5	0.1432	0.0951
10	0.2434	0.1953
25	0.5283	0.4801

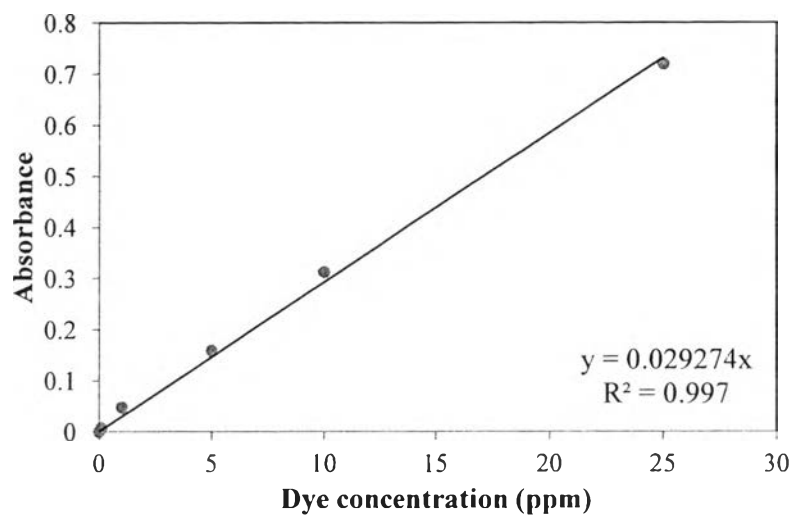


Figure F9 Standard curve of methylene blue in 0.1M tris-HCl buffer solution with 0.5M NaCl.

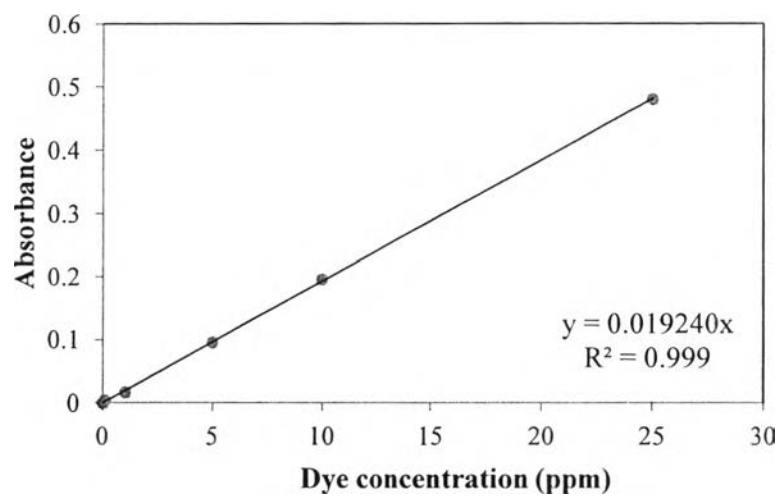


Figure F10 Standard curve of methyl orange in 0.1M tris-HCl buffer solution with 0.5M NaCl.

Appendix G Dye Desorption Characteristics in 0.1M Tris-HCl Buffer Solution With and Without Lysozyme

Table G1 Methylene blue desorption from CM-chitin/CTW films at various weight ratios in 0.1M tris-HCl buffer

Time (min)	Cumulative Desorption (%)							
	100:0		90:10		80:20		70:30	
	Average	SD	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	29.9822	0.8688	25.8508	0.7875	25.9953	0.6065	11.2505	0.9285
20	33.6785	2.1293	38.6198	0.5242	38.8436	1.1886	16.5067	0.3280
30	41.0321	0.8070	47.1187	1.7219	49.8633	0.6140	24.1769	0.4356
45	44.3424	2.4162	51.1528	0.4725	49.7736	0.1675	42.5479	0.9880
60	55.1136	0.8350	52.3847	0.5284	50.6581	0.1082	48.0351	0.9682
90	57.9174	2.3171	54.9477	1.5821	50.3473	0.1896	48.3701	0.7404
120	58.2219	2.1687	55.6056	0.5742	50.4395	0.9629	48.5983	0.5005
180	58.9525	0.8042	55.9666	0.2018	50.6853	1.3076	48.7084	0.6918
240	58.7033	0.7900	55.8732	0.2366	50.7672	0.9106	48.7031	0.3028
360	58.5564	0.3273	55.6115	0.1517	50.7143	1.0332	48.9117	0.4564
540	58.3968	0.2382	55.3716	0.2420	50.3849	1.1069	48.7136	0.5100
780	58.5148	0.9753	55.5160	0.8663	50.5532	0.6787	48.6303	0.6694
1020	59.2946	1.1484	55.4247	1.1931	50.8741	0.1194	48.3662	0.6056
1260	59.3727	0.2497	55.6784	0.7102	50.7154	0.2376	48.2611	0.6546
1500	59.5501	0.1634	56.3763	0.1024	50.6071	0.2836	48.9191	0.4483

Table G2 Methyl orange desorption from CM-chitin/CTW films at various weight ratios in 0.1M tris-HCl buffer

Time (min)	Cumulative Desorption (%)							
	100:0		90:10		80:20		70:30	
	Average	SD	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	11.5496	1.8529	7.9549	1.2644	0.4538	0.4347	0.4552	0.2369
20	13.8737	0.3480	8.5224	1.3885	1.1465	0.4314	1.0918	0.4923
30	14.3581	0.3004	8.8509	0.9851	1.6660	0.7143	1.5319	0.6818
45	14.5082	0.3137	9.2059	0.6094	2.0564	0.6286	2.4100	0.3853
60	14.6220	0.1118	9.2638	0.8236	2.5606	0.4215	3.3479	0.4595
90	14.6361	0.0961	9.7361	0.7254	3.0171	0.5370	3.5043	0.4426
120	14.6483	0.0550	9.8185	0.8597	4.3325	0.5829	4.4184	0.3259
180	15.0998	0.5541	10.5604	0.6841	4.8062	0.3101	5.1020	0.5094
240	16.6993	2.1646	11.4768	1.4655	5.4268	0.2421	5.2039	0.4661
360	16.8752	2.2160	12.3151	0.1612	6.1906	0.3708	5.9045	0.3674
540	17.6614	1.7611	12.5230	0.3242	7.3990	0.9177	6.5230	0.2190
780	18.3410	2.1646	13.1530	0.2943	8.0573	0.4947	7.7219	0.9863
1020	19.4005	1.0946	15.4054	0.5001	8.8537	0.6199	8.3481	0.4140
1260	19.4193	0.4442	15.2773	0.6758	8.2965	0.6540	8.3472	1.2158
1500	19.6435	0.2062	15.1493	0.8296	8.8910	1.2732	8.4469	1.5579

Table G9 Methylene blue desorption from CM-chitin/CTW films at various weight ratios in 0.1M tris-HCl buffer with 0.001%w/v of lysozyme

Time (min)	Cumulative Desorption (%)							
	100:0		90:10		80:20		70:30	
	Average	SD	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	35.1864	0.6949	36.8501	0.0841	28.3345	0.7708	24.0060	1.1608
20	57.1749	1.1668	64.8401	0.8552	51.3973	0.5258	40.0438	0.4872
30	66.0199	1.1356	65.9703	0.8285	52.1415	0.6556	44.3266	1.0577
45	69.2225	1.2131	67.0841	1.3208	55.1659	1.5227	46.9795	0.7726
60	71.6631	0.9237	66.9800	1.2908	57.9292	0.2853	47.7473	0.7597
90	74.9756	1.2509	68.3384	1.2728	58.8195	1.1236	47.9123	0.2794
120	75.6911	2.2154	68.2681	1.5155	59.3559	0.3532	47.9186	0.3216
180	76.6324	0.5706	69.6694	1.6647	59.5041	0.1164	47.7765	0.7748
240	78.3641	1.1038	69.4988	1.7043	59.4744	0.3249	47.6709	1.4775
360	78.5423	0.9589	69.0699	1.7630	59.3626	0.5857	47.5009	1.4344
540	78.5571	1.2402	69.9293	0.1694	59.4927	0.6011	47.4531	0.9917
780	78.5313	1.7517	69.5176	0.1801	59.5883	0.2284	47.8656	0.4762
1020	78.1404	1.5552	69.2065	0.0836	59.4711	0.1599	47.7639	0.6442
1260	78.2244	1.4203	68.9382	0.1803	59.3073	0.4388	47.6379	0.5914
1500	78.1119	1.2437	68.6491	0.0619	59.5696	0.9113	47.5203	0.3142

Table G13 Methyl orange desorption from CM-chitin/CTW films at various weight ratios in 0.1M tris-HCl buffer with 0.001%w/v of lysozyme

Time (min)	Cumulative Desorption (%)							
	100:0		90:10		80:20		70:30	
	Average	SD	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	12.1943	2.3642	3.9593	0.5764	3.8782	1.8744	3.7288	1.4093
20	12.8020	2.2949	5.5894	1.2374	5.6504	1.8588	5.1487	0.2512
30	13.0721	2.5155	6.5061	0.7507	7.1109	1.5242	5.6284	0.4318
45	13.7826	1.3990	7.9461	1.9114	8.1450	0.9239	6.4171	0.5446
60	14.3196	1.6908	8.5417	2.1912	7.9620	0.8516	6.8392	0.3537
90	14.9663	1.8703	10.6347	1.5985	8.4160	0.7657	6.9029	0.4218
120	14.9280	1.9240	10.4299	2.4225	9.4133	0.6719	7.3130	0.5060
180	16.4990	0.1179	11.1895	2.3700	9.9640	0.3101	7.4470	0.7493
240	17.2636	1.2501	13.3283	0.3004	10.1559	0.5736	7.9969	0.2285
360	17.7433	0.9057	13.9314	0.5840	11.6891	0.6559	8.6880	0.3980
540	19.3632	0.7028	14.9146	0.7701	12.3953	0.5159	9.1796	0.3947
780	24.1488	0.9292	17.6658	0.4091	13.9962	2.7196	10.7397	0.6720
1020	25.0058	0.6789	18.4058	2.3343	13.6933	1.7807	11.0934	0.2783
1260	25.7331	1.8243	19.5512	2.4310	13.6539	1.1291	11.7322	0.2901
1500	25.1836	0.6327	19.6145	1.8918	13.5026	1.0144	11.8151	1.1977

Appendix H Dye Desorption Characteristics in Buffer Solution With Various NaCl Contents

Table H1 Methylene blue desorption from CM-chitin film in 0.1M tris-HCl buffer with various NaCl contents

Time (min)	Cumulative Desorption (%)					
	0.01M NaCl		0.1M NaCl		0.5M NaCl	
	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	31.1093	0.6682	36.6240	0.9502	34.5749	1.2224
20	32.0361	0.2385	37.4583	0.5407	44.5628	0.9844
30	39.6710	0.2306	44.7077	0.5093	55.7992	0.5785
45	42.0897	0.2322	46.9687	0.5477	56.7557	0.8574
60	56.0238	0.3345	60.2420	0.6406	57.4377	0.9442
90	57.8627	0.9433	61.9486	1.2066	61.4475	1.5620
120	58.4812	0.3878	62.4881	0.6603	61.6055	1.3520
180	58.5800	0.2012	62.5307	0.4443	62.1419	1.9169
240	58.8679	0.2114	62.7541	0.5163	61.8738	1.7992
360	58.5763	0.1134	62.4233	0.4227	61.7844	1.5908
540	58.7507	0.2458	62.5381	0.4499	62.1192	0.7244
780	58.5424	0.1523	62.2869	0.2757	62.5344	0.5477
1020	58.4573	0.1418	62.1536	0.4276	62.4258	0.3433
1260	58.4547	0.4217	62.0992	0.7112	63.6889	1.6233
1500	58.6023	0.9670	62.1885	1.1732	63.7053	0.0521

Table H2 Methylene blue desorption from 90:10 CM-chitin/CTW film in 0.1M tris-HCl buffer with various NaCl contents

Time (min)	Cumulative Desorption (%)					
	0.01M NaCl		0.1M NaCl		0.5M NaCl	
	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	24.3754	0.8383	26.1043	0.6423	48.8802	1.2539
20	38.0821	0.9156	40.5627	0.8150	54.2405	1.4690
30	47.2136	1.9705	50.1939	1.7717	56.2002	0.8030
45	51.5611	0.8158	54.7778	0.7823	57.5585	0.6846
60	52.9062	0.2900	56.1941	0.4103	58.2689	0.6145
90	55.6775	1.4807	59.1150	1.5416	60.4449	0.2267
120	56.4075	0.2702	58.7232	1.1552	60.2044	0.3797
180	56.8193	0.3492	59.1639	0.8476	60.0431	0.2117
240	56.7444	0.5074	59.0911	0.3534	60.0168	0.2263
360	56.4891	0.4521	58.8281	0.4410	60.3587	0.7292
540	56.2572	0.3210	58.5896	0.5165	60.7521	0.2537
780	56.4370	1.0766	58.7855	0.4182	60.6973	0.1872
1020	56.3643	1.4452	58.7151	0.7593	60.8104	0.3233
1260	56.6612	0.9021	59.0346	0.2874	60.4710	0.7078
1500	57.0482	0.5077	59.0420	0.0311	60.8651	0.4153

Table H3 Methyl orange desorption from CM-chitin film in 0.1M tris-HCl buffer with various NaCl contents

Time (min)	Cumulative Desorption (%)					
	0.01M NaCl		0.1M NaCl		0.5M NaCl	
	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	13.0904	0.7350	15.6141	0.9374	14.9326	1.3608
20	13.5862	0.5661	16.1160	0.9722	15.4305	1.2631
30	13.8556	0.9335	16.4636	0.6361	15.7765	1.0696
45	14.1500	1.3046	16.6964	0.6841	16.5753	0.9631
60	14.1630	1.1326	17.0304	0.9500	16.9035	1.2769
90	14.5686	1.5154	17.3220	1.2858	17.1898	1.6423
120	14.6047	1.5152	18.3784	0.7006	19.1974	0.9799
180	15.2659	1.2429	18.6853	1.1451	19.4912	1.4140
240	16.0924	0.9900	19.1230	1.1547	19.9139	1.1826
360	16.8449	1.7705	19.6882	1.4172	20.4622	1.4037
540	17.0000	2.0559	20.6494	1.9448	21.4006	2.1091
780	17.5551	1.4784	21.1206	1.6053	21.8563	1.7015
1020	19.6477	1.3614	21.7149	1.6478	22.4333	1.6056
1260	19.4844	1.1957	21.1038	1.7243	21.8225	1.7528
1500	19.3211	1.1551	21.5183	1.5861	22.2223	2.0470

Table H4 Methyl orange desorption from 90:10 CM-chitin/CTW film in 0.1M tris-HCl buffer with various NaCl contents

Time (min)	Cumulative Desorption (%)					
	0.01M NaCl		0.1M NaCl		0.5M NaCl	
	Average	SD	Average	SD	Average	SD
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	10.0398	0.1179	8.5191	0.5390	9.0069	0.7505
20	10.5381	0.2681	9.1111	0.8537	9.6296	0.5586
30	10.8937	0.2093	9.5014	1.0679	10.0402	0.4361
45	11.1427	0.1524	11.1394	1.4665	10.9234	1.1451
60	11.4856	0.1715	12.0341	0.6790	11.8712	0.3829
90	11.7891	0.5198	12.1274	0.7306	11.9757	0.3412
120	12.8011	0.1125	12.9978	1.3751	12.8979	0.9598
180	13.1188	0.3396	13.6317	0.9047	13.5713	0.2421
240	13.5578	0.3877	13.6691	1.0536	13.6168	0.3997
360	14.1148	0.6191	14.3206	0.8235	14.3086	0.8940
540	15.0386	1.0734	14.8877	1.0589	14.9117	0.9454
780	15.5085	0.7567	16.0500	2.0226	16.1411	1.6410
1020	16.0925	0.8424	16.6252	0.7453	16.7527	0.2955
1260	15.5598	0.8879	16.5572	2.0702	16.6873	1.4413
1500	15.9772	1.0529	16.5923	1.6312	16.7305	1.0667

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Proceedings:

1. Sopanattayanon, D.; Weder, C.; and Rujiravanit, R. (2012) Dye Adsorption and Desorption Characteristics of CM-Chitin/Chitin Whisker Bionanocomposite Films. Proceedings of the 3rd Research Symposium on Petrochemical, and Material Technology and The 18th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentations:

1. Sopanattayanon, D.; Weder, C.; and Rujiravanit, R. (2011) Fabrication of CM-Chitin/Silk Sericin/Chitin-Whisker Bionanocomposite for Biomedical Application. Paper presented at the 6th International Symposium in Science and Technology, Osaka, Japan.
2. Sopanattayanon, D.; Weder, C.; and Rujiravanit, R. (2011) Preparation and Characterization of CM-Chitin/Silk Sericin/Chitin Whiskers Bionanocomposite Sponges for Biomedical Applications. Paper presented at the Pure and Applied Chemistry International Conference 2012 (PACCON 2012), Chiang Mai, Thailand.
3. Sopanattayanon, D.; Weder, C.; and Rujiravanit, R. (2012) Dye Adsorption and Desorption Characteristics of CM-Chitin/Chitin Whisker Bionanocomposite Films. Paper presented at the 3rd Research Symposium on Petrochemical, and Material Technology and The 18th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

