REFERENCES

Chien, Y.W. (1987). Drugs and the Pharmaceutical Sciences. New York: Academic Press, 4, 468-487.

Gomzalez-Rodriguez, M.L., Holgado. M.A., Sanchez-Lafuente, C., Rabasco, A.M., and Fini, A. (2002). Alginate/chitosan particulate systems for sodium diclofenac release. Internation Journal of Pharmaceutics, 232, 225-234.

Gupta, K.C., and Ravi Kumar, M.N.V. (2000a). Drug release behavior of beads and microgranules of chitosan. Biomaterial, Vol.21, 1115-1119.

Gupta, K.C., and Ravi Kumar, M.N.V. (2000b) Semi-interpenetrating polymer network beads of crosslinked chitosan-glycine for controlled released of chlorphenramine. Journal of Applied Polymer Science, Vol.76, 672-683.

Hata, H., Onishi, H., and Machida, Y. (2000). Preparation of CM-chitin microspheres by complexation with iron (III) in w/o emulsion and their biodesposition characteristics on mice. Biomaterial, 21, 1779-1788.

Hirano, S. in Applications of Chitin and Chitosan in the Ecological and Environmental Fields; Goosen, M.F.A. Ed.; Lancaster: Technomic, 1992.

Hong, Y., Chirilla, T.V., Vijayasekaran, S.,Shen, W., Lou, X., and Dalton, P. (1998). Biodegradation in vitro and retension in the rabbit eye of crosslinked poly(1-vinyl-2-pyrrilidone) hydrogel as vitreous substitute. J. Biomed. Mater. Res, 39, 650-659.

Howard, E.G., (1998). World Patent 8, 909, 246.

Kaneko, M., Inoue, Y., and Tokura, S. (1982). Report in Progress Polymer Physics Japan, xxv, 759

Kao, F., Manivannan, G.,and Sawan, S. (1997). UV curable bio-adhesive: copolymer of N-vinyl pyrrolidone. Journal of Biomedical Material Research, 38, 191-196.

Katayama, H., Issiki, M., and Yoshitomi, H. (2000). Application of fibroin controlled release tablets containing theophylline. Biological & Pharmaceutical Bulletin, 23(10), 1229-1234.

Khoo, C.G.L., Frantzich, S., Rosinski, A., Sjostrom, M., and Hoogstraate, J. (2003). Oral gingival delivery systems from chitosan blends with hydrophilic polymers. European Journal of Pharmaceutics and Biopharmaceutics., 55. 47-56

Kim, J.H., Kim, J.Y., and Lee, Y.M. (1992). Controlled release of riboflavin and insulin through crosslinked poly(vinyl alcohol)/chitosan blend membrane. Journal of Applied Polymer Science, 44, 1823-1828.

Ko, J.A., Park, H.J., Hwang, S.J., Park, J.B., Lee, J.S. (2002). Preparation and characterization of chitosan microparticles intended for controlled drug delivery. International Journal of Pharmaceutics, Vol.249, 165-174.

Lau, C., and Mi, Y. (2003). A study of blending and complexation of poly(acrylic acid)/poly(vinyl pyrrolidone). Polymer, 43, 823-829.

Li, X., Kresse, I., Springer, J., Nissen, J., and Yang, Y. (2001). Morphology and gas permselectivity of blend membranes of polyvinylpyridine with ethylcellulose. Polymer, 42, 6859-6869.

Nakatsuka, S., and Andrady, A.L. (1992). Permeability of vitamin B-12 in chitosan membranes. Effect of crosslinking and blending with poly(vinyl alcohol) on permeability. Journal of Applied Polymer Science, 44, 17-28.

Nishimura, S., Nishi, N., Tokura, S., Nishimura, K., and Azuma, I. (1986). Bioactive chitin derivatives. Activation of mouse peritoneal macrophages by o-(carboxymethyl)chitins. Carbohydrate Research, 146, 251-258.

Novikov, M.B., Roo, A., Creton, C., and Feldstein, M.M. (2003). Dynamic mechanical and tensile properties of poly(N-vinyl pyrrolidone)-poly(ethylene glycol)blends. Polymer, 44, 3561-3578.

Oungbho, K., and Muller, B.W. (1997). Chitosan sponges as sustained release drug carriers. International Journal of Pharmaceutics, 156, 229-237.

Puttipipatkachorn, S., Nanthanid, J., Yamamoto, K., and Peck, G.E. (2001) Drug physical state drug polymer interaction on drug release from chitosan and matrix films. Journal of Controlled Release, Vol.75, 143-153.

Ranade, V.V. and Hollinger, M.A. (1995). Drug Delivery System, Florida U.S.A., CSC.

Rao, PR., and Diwan, PV. (1996). Drug diffusion from cellulose acetate-polyvinyl pyrrolidone free films for transdermal administration. Indian Journal of Pharmaceutical Sciences, 58(6), 264-50

Ridbus, M.V., Hardikar, A.A., Bhat, S.V., and Bhonde, R.R. (2000). PH-sensitive freeze-dried chitosan-polyvinyl pyrrolidone hydrogels as controlled release system for antibiotic delivery. Journal of Controlled Release, 68, 23-30.

Sakurai, K. Maegawa, T., and Takahashi, T. (2000). Glass transition temperature of chitosan and miscibility of chitosan/poly(*N*-vinyl pyrrolidone) blends. Polymer, 41, 7051-7056.

Sannan, T., Kurita, K., Ogura, K., and Iwakura, T. (1978). "Studies on chitin: 7.IR spectroscopic determination of degree of deacetylation". Polymer, 19, pp 458-462.

Shimahara, K. and Takigushi, Y. (1988). Biomass part B: Lignin, Pectin and Chitin. New York:Academic Press.

Shiraishi, S., Imai, T., and Otagiri, M. (1993). Controlled release of indomethacin by chitosan-polyelectrolyte complex: optimization and in vivo/in vitro evaluation. Journal of Controlled Release, 25, 217-225.

Thacharodi, D., and Panduranga, R. (1996). Rate-controlling biopolymer membranes as trandermal delivery systems for nifedipine: development and *in vitro* evaluation. Biomaterial, 17, 1307-1311.

Tokura, S., Nishi, N., Tasutsumi, A., and Somorin, O. (1983). Studied on chitin VIII. Some properties of water soluble chitin derivatives. Polymer Journal, 15(6), 484-489.

Tokura, S., Kaneda, Y., Miura, Y., and Uraki,.Y. (1992). Two-step hydrolases of a polymeric drug under a model system, Carbohydr. Polym., 19, 189-190.

Tokura, S.,Baba, S.,Uraki, Y.,Nishi, N., and Hasegawa, O. (1990). Carboxymethyl-Chitin as a drug carrier of sustained release. Carbohydrate. Polymer, 13, 273-281.

Tokura, S., Miura, Y., Johmen, M., Nishi, N., and Nishimura, S-I. (1994). Induction of drug specific antibody and the controlled release of drug by 6-O-carboxymethyl-chitin, Journal of Control Release, 28, 235-241.

Torre, P.M., Enobakhare, Y., Torrado, G., and Torrado, S. (2003). Release of amoxicillin from polyionic complexes of chitosan and poly(acrylic acid). Study of polymer/polymer and polymer/drug interactions with on the network structure. Biomaterial, 14, 1499-1506.

Wang, H.F., Li, W.J., Lu, Y.H., and Wang, Z.L. (1997). Studied on chitosan and poly(acrylic acid) interpolymer complex. I. Preparation, structure, pH-sensitivity and salt sensitivity of complex forming poly(acrylic acid): chitosan semi-interpenetrating polymer network. Journal of Applied Polymer Science, 65, 1445-1450

Watanabe, K., Saiki, I., Matsumoto, Y., and Azuma, I. (1992). Antimetastatic activity of neocarzinostatin incorporated into controlled release gels of CM-chitin. Carbohydrate Polymer, 17, 29-37.

Yao, K.D., Peng, T., Feng, H.B., and He, Y.Y. (1994). Swelling kinetics and release characteristic of crosslinked chitosan: polyether polymer network (Semi-IPN) hydrogels. Journal of Applied Polymer Science: Part A: Polymer Chemistry, 32, 1213-1233.

Yin, Y., Yang, Y., and Xu, H. (2002). Swelling behavior of hydrogils for colon-site drug delivery. Journal of Applied Polymer Science, 83, 2835-2842.

Zhang, L., Jin, Y., Liu, H., and Du, Y. (2001). Structure and control release of chitosan/carboxymethyl cellulose microcapsules. Journal of Applied Polymer Science, 82, 584-592.

APPENDICES

Appendix A Characterization of Chitin

Table A1 Viscosity-average molecular weight of chitin

Time (sec.)	conc. (g/100ml)					
	0	0.01	0.02	0.03	0.04	0.05
X1	311.40	363.91	431.41	503.41	588.13	677.72
X2	311.40	363.19	431.19	503.65	588.69	677.87
X3	311.40	363.12	431.72	503.28	588.35	677.47
Average	311.40	363.41	431.44	503.45	588.39	677.69
η_{rel}		1.1670	1.3855	1.6167	1.8895	2.1763
η_{sp}		0.1670	0.3855	0.6167	0.1895	1.1763
η_{sp}/c		16.7009	19.2742	20.5573	22.2375	23.5252
η_{rel}/c		15.4444	16.3025	16.0133	15.9078	15.5521

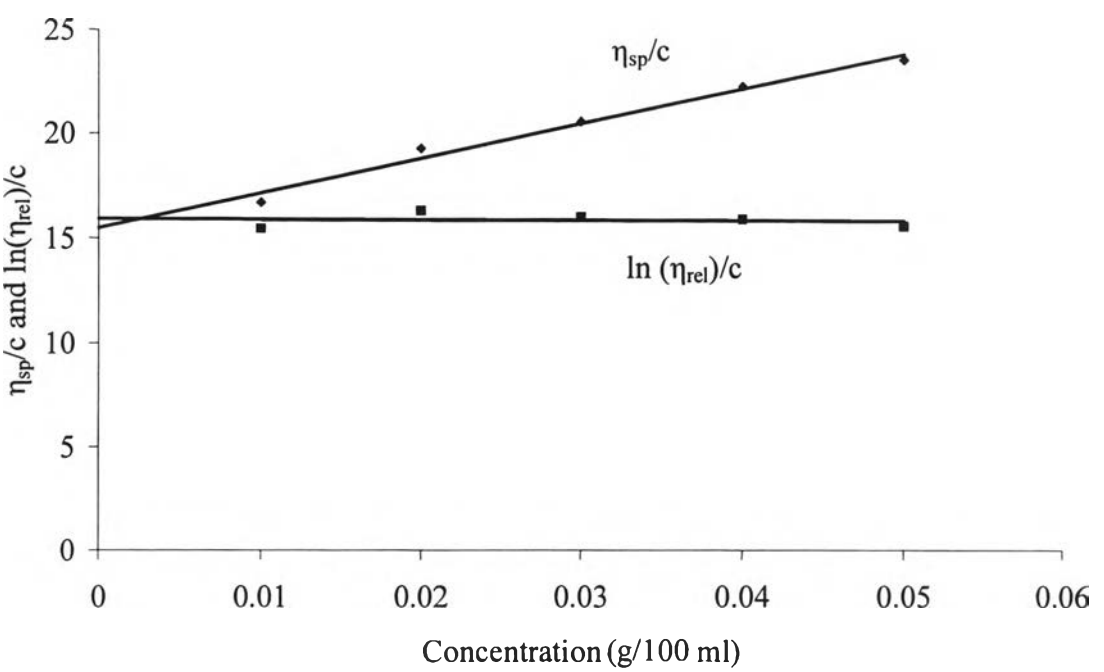


Figure A1 η_{sp}/c and $\ln(\eta_{rel})/c$ against concentration of chitin solution.

The viscosity-average molecular weight of chitin was determined based on Mark-Houwink equation. The K and a values were according to Lee *et al.* (1974)

$$[\eta] = 8.93 \times 10^{-4} M^{0.71}$$

Where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight.

Interception: $[\eta] = 15.69$

From calculation; $M = 9.52 \times 10^{5}$

The viscosity-average molecular weight of chitin obtained from calculation was 9.52×10^{5} g/mol.

Appendix B Characterization of CM-chitin

Table B1 Viscosity-average molecular weight of CM-chitin

Time (sec.)	conc. (g/100ml)					
	0	0.01	0.02	0.03	0.04	0.05
X1	109.95	117.27	124.57	132.68	141.16	150.08
X2	109.95	117.08	124.53	132.95	140.93	149.87
X3	109.95	117.18	124.49	132.90	140.90	149.90
Average	109.95	117.18	124.53	132.84	141.00	149.95
η_{rel}		1.0649	1.1326	1.2055	1.2817	2.3638
η_{sp}		0.0649	0.1326	0.2055	0.2817	1.3638
η_{sp}/c		6.4939	6.6303	6.8506	7.0426	7.2760
η_{rel}/c		6.2917	6.2260	6.2303	6.2048	6.2055

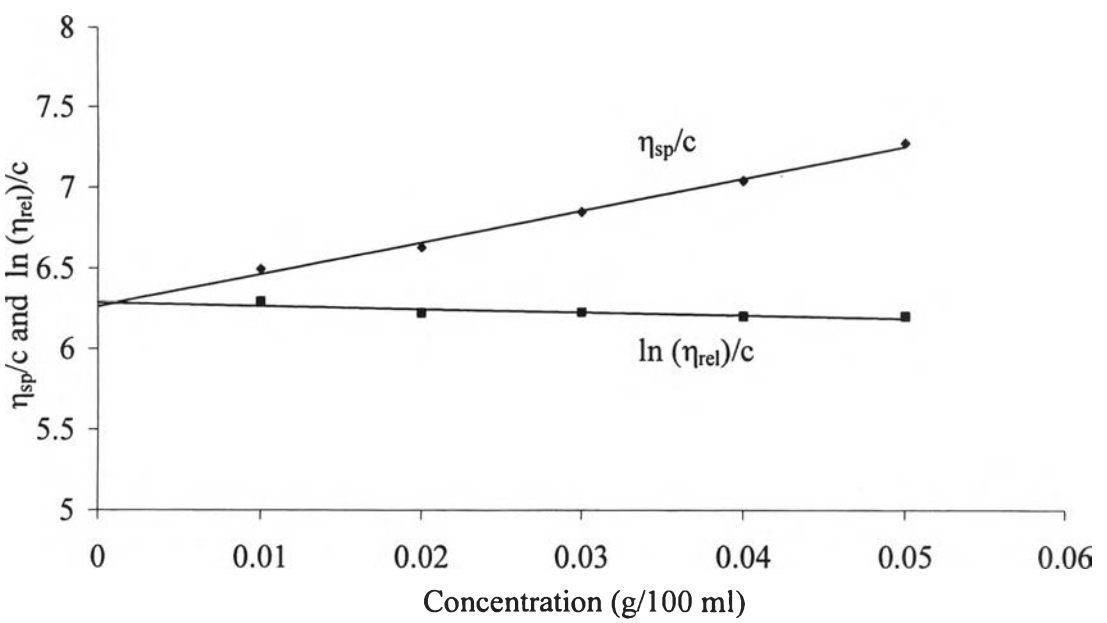


Figure B1 η_{sp}/c and $\ln(\eta_{rel})/c$ against concentration of CM-chitin solution.

The viscosity-average molecular weight of CM-chitin was determined based on Mark-Houwink equation. The K and a values were according to Kaneko *et al.* (1982)

$$[\eta] = 7.92 \times 10^{-5} M^{1}$$

Where $[\eta]$ = intrinsic viscosity

M = viscosity-average molecular weight.

Interception: $[\eta] = 6.28$

From calculation; $M = 7.93 \times 10^{4}$

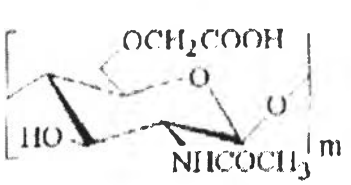
The viscosity-average molecular weight of CM-chitin obtained from calculation was 7.93×10^{4}

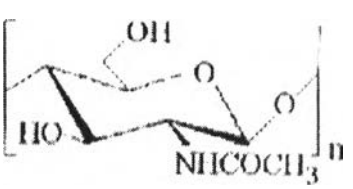
Table B2 Degree of substitution of CM-chitin from elemental analysis

Experimental values

	%C	%N	%H
1	42.734	6.115	6.023
2	42.465	6.298	6.332
Average	42.600	6.207	6.178

Calculation of Degree of Substitution of CM-chitin





MW = $C_{10}H_{11}O_3$ NNa = 283

MW = $C_8H_{13}O_5$NNa =203

$283m + 203n = 7.93x10^4$ (1)

From EA, %C = 42.600

%H = 6.178

%N = 6.207

We can find that in CM-chitin structure has N

That: $N = \frac{7.93x10^4 \times 6.027}{100} = 4779.411$

Thus, $14m + 14n = 4779.411$ (2)

Divide (2) by 14 $m + n = 341.387$

$m = 341.387 - n$ (3)

Replace (3) in (1), $283(341.387) - 283n + 203n = 7.93x10^4$

$80n = 17313$

$n = 216.41$

$m = 124.97$

Therefore, fraction $m = 124.97/341.387 = 0.37$

$n = 216.41/341.387 = 0.63$

The degree of carboxymethylation was estimated to be 0.37

Appendix C UV Spectrum of Model drugs and Glutaraldehyde

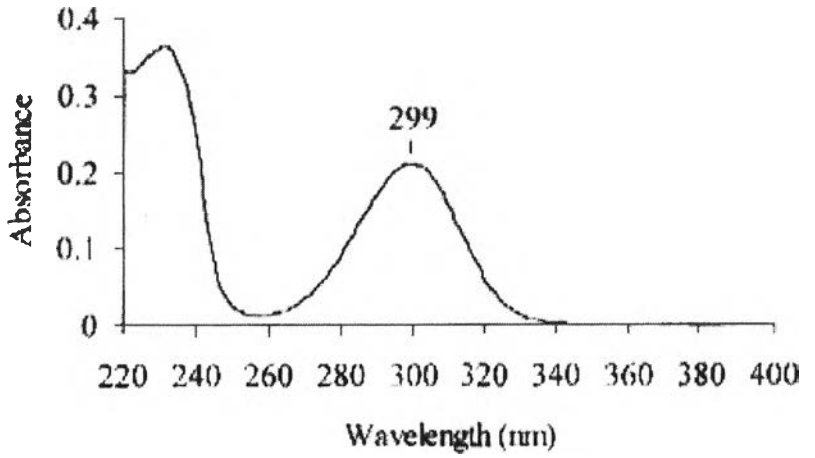


Figure C1 UV spectrum of salicylic acid.

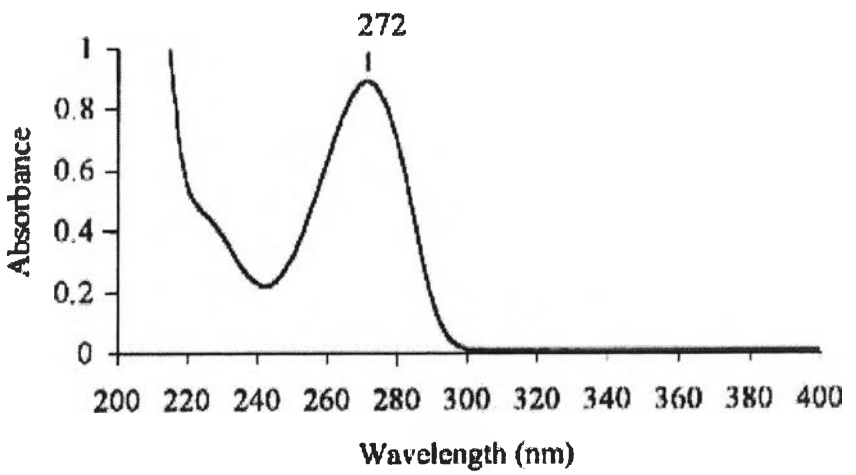


Figure C2 UV spectrum of theophylline.

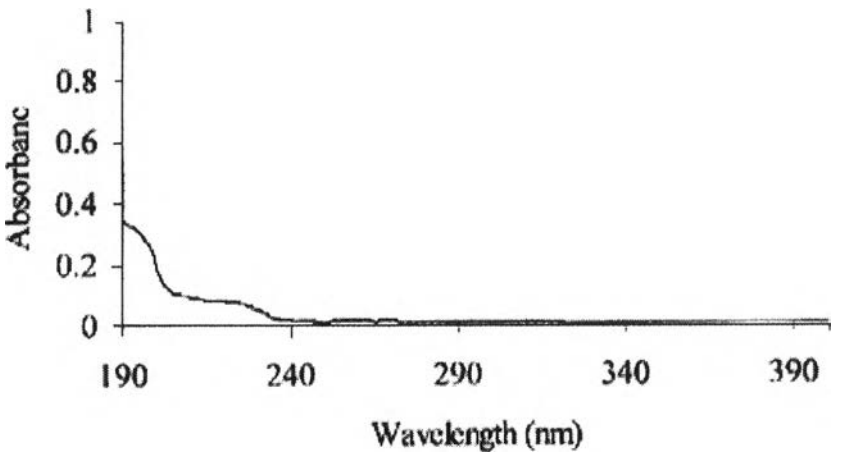


Figure C3 UV spectrum of glutaraldehyde.

Table C1 Summary of maximum wavelength (λ_{max}) of each type of model drugs and glutaraldehyde

Model drug	λ_{max} (nm)
Salicylic acid	299
Theophylline	272
glutaraldehyde	No observed

Appendix D Calibration curve of model drugs

Table D1 Data of calibration curve of salicylic acid solution

Concentration (mg/100ml)	Absorbance at 296 nm (A_{296})			Average	Standard deviation
	X1	X2	X3		
0.0	0.000	0.000	0.000	0.0000	0.0000
0.2	0.418	0.419	0.419	0.4187	0.0006
0.4	0.625	0.627	0.625	0.6257	0.0012
0.6	0.837	0.839	0.838	0.8380	0.0010
0.8	0.837	0.839	0.838	0.8380	0.0010
1.0	1.045	1.045	1.046	1.0453	0.0006

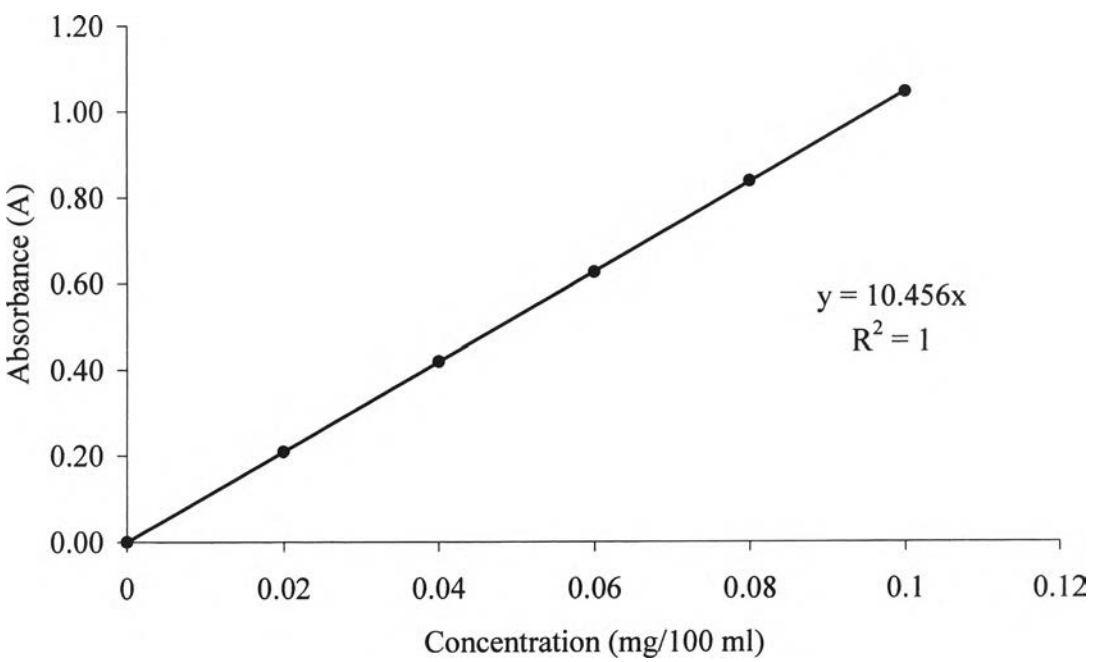


Figure D1 Calibration curve of salicylic acid solution.

Table D2 Data of calibration curve of theophylline solution

Concentration (mg/100ml)	Absorbance at 272 nm (A_{272})			Average	Standard deviation
	X1	X2	X3		
0.0	0.000	0.000	0.000	0.0000	0.0000
0.2	0.056	0.057	0.057	0.0567	0.0006
0.4	0.115	0.116	0.117	0.1160	0.0010
0.6	0.177	0.179	0.180	0.1787	0.0015
0.8	0.236	0.238	0.238	0.2373	0.0012
1.0	0.299	0.297	0.300	0.2987	0.0015

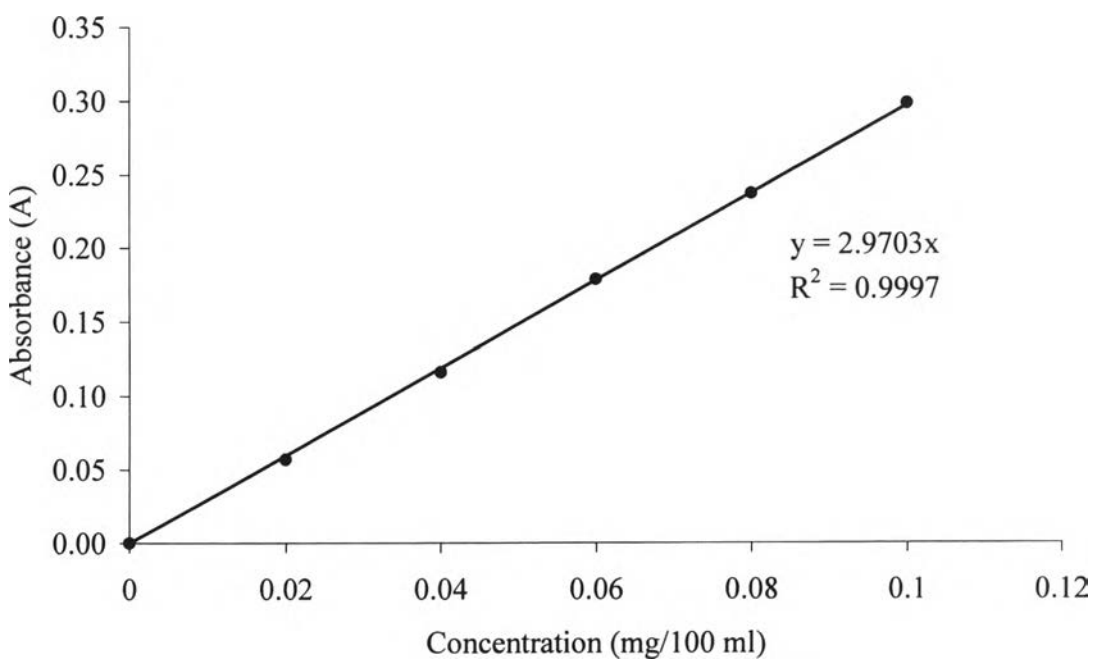


Figure D2 Calibration curve of theophylline solution.

Appendix E Data of drug release from pure CM-chitin and chitosan films

Table E1 Release of 0.1% salicylic acid from CM-chitin films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	1.0468	0.9095	0.9882	0.9815	0.0689
30	1.7159	1.8086	1.7093	1.7446	0.0555
45	3.6801	3.7322	3.6000	3.6708	0.0666
60	5.7629	5.2272	5.8956	5.6286	0.3539
90	7.6407	6.5549	7.8279	7.3412	0.6873
120	9.0005	9.0639	9.1231	9.0625	0.0613
150	12.0654	10.9875	13.4543	12.1691	1.2366
180	13.2309	12.6184	13.5561	13.1352	0.4761
240	16.5333	15.8384	17.2862	16.5526	0.7241
300	18.4327	17.6888	18.882	18.3345	0.6026
360	20.0731	20.1769	20.1004	20.1168	0.0538
480	21.6055	22.0692	21.4781	21.7176	0.3111
600	23.2135	24.8396	22.9867	23.6799	1.0107
720	25.0697	25.4355	25.3335	25.2796	0.1887
840	26.2676	26.4182	26.7387	26.4748	0.2406
960	27.9728	28.5718	27.5608	28.0351	0.5084
1080	29.3649	29.3036	29.5217	29.3967	0.1125
1200	30.4657	30.1713	30.436	30.3577	0.1621
1320	30.9514	30.5999	30.9003	30.8172	0.1899
1440	31.3830	31.9485	31.5447	31.6254	0.2913

Table E2 Release of 0.2% salicylic acid from CM-chitin films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.4319	0.4056	0.4459	0.4278	0.0205
30	0.5829	0.5703	0.5914	0.5815	0.0106
45	0.9628	0.9595	0.9567	0.9597	0.0030
60	1.4207	1.4116	1.4283	1.4202	0.0084
90	2.5292	2.4560	2.5560	2.5137	0.0518
120	3.8979	3.7998	3.8885	3.8621	0.0541
150	6.1721	5.9720	6.2108	6.1183	0.1282
180	8.1445	7.9435	8.1002	8.0627	0.1056
240	11.3451	11.0508	11.2295	11.2085	0.1483
300	13.5673	13.6438	13.4572	13.5561	0.0938
360	14.9464	14.9002	14.8729	14.9065	0.0371
480	18.2302	18.0158	18.2673	18.1711	0.1358
600	20.4420	20.4226	20.5607	20.4751	0.0748
720	21.7638	21.6612	21.8191	21.7480	0.0801
840	24.1785	24.1650	24.1825	24.1753	0.0092
960	25.7190	25.6564	25.7312	25.7022	0.0401
1080	26.7078	26.6109	26.7307	26.6831	0.0636
1200	27.9880	27.9005	28.0572	27.9819	0.0785
1320	28.8207	28.7763	28.9302	28.8424	0.0792
1440	29.1485	29.0598	29.2536	29.1540	0.0970

Table E3 Release of 0.5% salicylic acid from CM-chitin films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.2281	0.2866	0.1859	0.2335	0.0505
30	0.4193	0.5032	0.3778	0.4334	0.0639
45	0.5529	0.6498	0.5348	0.5792	0.0619
60	0.8426	1.0267	0.7903	0.8865	0.1241
90	1.8332	2.2135	1.7435	1.9301	0.2495
120	3.1034	3.1296	2.9800	3.0710	0.0799
150	4.1988	4.2714	4.0243	4.1648	0.1270
180	5.2942	5.0318	5.1381	5.1547	0.1320
240	7.6495	8.5540	7.5407	7.9147	0.5563
300	9.5362	9.8018	9.4381	9.5920	0.1882
360	10.7734	11.8709	10.0394	10.8946	0.9217
480	14.0699	15.2508	14.1282	14.4830	0.6656
600	17.6398	18.1617	17.4261	17.7426	0.3784
720	19.7608	21.2959	19.4839	20.1802	0.9761
840	22.5353	22.2729	22.2048	22.3377	0.1745
960	23.0471	23.6109	23.4259	23.3613	0.2874
1080	24.2268	24.5857	24.0562	24.2896	0.2703
1200	25.2133	25.0753	25.1789	25.1558	0.0718
1320	25.4846	25.4160	25.4007	25.4338	0.0446
1440	25.8216	25.9847	25.7529	25.8531	0.1190

Table E4 Release of 0.1% theophylline from CM-chitin films and 0.01%glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	4.9349	4.5768	5.3092	4.9403	0.3662
30	5.8559	5.7232	5.9008	5.8266	0.0923
45	7.4474	7.4412	7.3736	7.4207	0.0410
60	8.9890	8.7527	9.1120	8.9512	0.1826
90	10.3604	10.2904	10.4271	10.3593	0.0684
120	11.2613	11.0067	11.5318	11.2666	0.2626
150	13.7938	13.7551	13.8402	13.7964	0.0426
180	14.3343	14.2546	14.5118	14.3669	0.1317
240	16.1762	16.0253	16.2452	16.1489	0.1125
300	17.1171	16.9862	17.1554	17.0862	0.0887
360	19.0591	18.8732	19.1064	19.0129	0.1233
480	21.4414	21.1980	21.4367	21.3587	0.1392
600	22.0621	22.1788	22.1122	22.1177	0.0586
720	23.5335	23.4560	23.5993	23.5296	0.0717
840	24.3443	24.3112	24.5358	24.3971	0.1212
960	25.3754	25.4008	25.2866	25.3543	0.0600
1080	26.2362	26.4438	26.2298	26.3033	0.1217
1200	27.2573	27.4562	27.2198	27.3111	0.1271
1320	27.5075	27.6774	27.3871	27.5240	0.1459
1440	27.6677	27.7992	27.6023	27.6897	0.1003

Table E5 Release of 0.2% theophylline from CM-chitin films and 0.01%glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	3.7925	3.5396	3.8436	3.7252	0.1628
30	4.4492	4.4980	4.2119	4.3864	0.1531
45	5.3098	5.0927	5.4780	5.2935	0.1932
60	6.2426	5.9204	6.2291	6.1307	0.1823
90	7.8953	7.5439	8.0102	7.8165	0.2429
120	9.9503	9.6371	10.1120	9.8998	0.2414
150	10.9011	10.7609	11.2935	10.9852	0.2761
180	12.7938	12.4456	12.8781	12.7058	0.2293
240	13.8853	13.7841	13.9045	13.8580	0.0647
300	16.4329	16.1783	16.5647	16.3920	0.1964
360	17.0499	17.3703	17.0113	17.1438	0.1971
480	18.9733	18.6382	18.9940	18.8685	0.1997
600	20.6331	20.5103	20.8499	20.6644	0.1720
720	21.5551	21.2781	21.6672	21.5001	0.2003
840	22.3003	22.2602	22.7481	22.4362	0.2709
960	23.5001	23.6472	23.8248	23.6574	0.1626
1080	24.1496	24.3568	24.2976	24.2680	0.1067
1200	25.0012	25.2209	25.1986	25.1402	0.1209
1320	25.1654	25.3790	25.2358	25.2601	0.1089
1440	25.3530	25.4006	25.3228	25.3588	0.0392

Table E6 Release of 0.5% theophylline from CM-chitin films and 0.01%glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	1.5020	1.3740	1.6520	1.5093	0.1391
30	2.6450	2.5670	2.8872	2.6997	0.1670
45	5.4222	5.1792	5.6720	5.4245	0.2464
60	6.9241	6.5549	7.1032	6.8607	0.2796
90	8.0955	7.7397	7.9935	7.9429	0.1832
120	10.1123	9.8346	10.0536	10.0002	0.1463
150	11.3970	11.1270	11.7245	11.4162	0.2992
180	12.3605	12.2041	12.6529	12.4058	0.2278
240	13.5129	13.4251	13.6826	13.5402	0.1309
300	14.5284	14.3941	14.5883	14.5036	0.0994
360	15.0385	14.9563	15.2342	15.0763	0.1428
480	16.3799	16.2932	16.4639	16.3790	0.0854
600	16.6019	16.6341	16.7238	16.6533	0.0632
720	18.0802	17.9243	18.1562	18.0536	0.1182
840	18.9162	18.8831	18.9548	18.9180	0.0359
960	19.7758	19.4846	19.8230	19.6945	0.1833
1080	19.9459	19.7738	20.0038	19.9078	0.1196
1200	20.3095	20.0783	20.5672	20.3183	0.2446
1320	21.7029	21.2503	21.4782	21.4771	0.2263
1440	21.8918	21.5572	21.7830	21.7440	0.1707

Table E7 Release of 0.2% salicylic acid from chitosan filmsand 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.3324	0.2920	0.3213	0.3152	0.0209
30	0.5408	0.3675	0.4110	0.4398	0.0902
45	0.6450	0.5286	0.5859	0.5865	0.0582
60	0.7244	0.6192	0.7701	0.7046	0.0774
90	1.3446	1.3039	1.2237	1.2907	0.0615
120	2.2277	2.1245	2.1592	2.1704	0.0525
150	3.1307	3.2572	3.3167	3.2349	0.0950
180	4.1924	4.3295	4.2428	4.2549	0.0693
240	6.2365	6.4640	6.2697	6.3234	0.1229
300	7.9532	8.5331	8.5281	8.3381	0.3334
360	9.6351	10.3555	9.8321	9.9409	0.3723
480	12.4334	13.8795	12.6527	12.9885	0.7793
600	14.5420	16.8749	14.8639	15.4269	1.2642
720	16.3678	18.5362	16.4089	17.1043	1.2402
840	19.3397	20.1774	18.3696	19.2956	0.9047
960	19.7466	21.1540	19.8437	20.2481	0.7860
1080	19.9252	21.8387	20.5619	20.7752	0.9744
1200	20.0939	22.5837	20.9965	21.2247	1.2605
1320	20.1137	22.8153	21.7336	21.5542	1.3597
1440	20.1336	23.2281	21.9698	21.7772	1.5562

Table E8 Release of 0.5% salicylic acid from chitosan films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.1591	0.1647	0.1096	0.1261	0.0303
30	0.1816	0.1931	0.1664	0.1714	0.0134
45	0.3856	0.3748	0.1796	0.2483	0.1159
60	0.5148	0.5300	0.2514	0.3392	0.1566
90	1.2355	1.2321	0.7241	0.8945	0.2943
120	2.3474	2.4208	1.4897	1.7756	0.5177
150	3.5585	3.6416	2.3669	2.7641	0.7132
180	4.6330	4.7753	3.4936	3.8734	0.7025
240	7.0834	7.1695	6.2443	6.5240	0.5111
300	9.1275	9.0963	7.9250	8.3258	0.6855
360	11.1080	11.1253	10.1331	10.4581	0.5679
480	14.5599	14.7176	13.3280	13.7386	0.7609
600	19.2341	19.4759	18.9579	19.0500	0.2592
720	21.3550	21.5086	21.0072	21.1231	0.2569
840	25.3272	24.3496	24.5670	24.8204	0.5133
960	26.6282	26.4221	25.0680	25.5881	0.8476
1080	27.3583	26.9710	26.1361	26.5435	0.6246
1200	27.9292	27.1413	26.6749	27.0930	0.6340
1320	28.0134	27.5577	28.1684	28.1167	0.3175
1440	28.0790	28.8637	28.9908	28.6868	0.4938

Table E9 Release of 1.0% salicylic acid from chitosan films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0735	0.0575	0.0621	0.0644	0.0082
30	0.1063	0.0770	0.0892	0.0908	0.0147
45	0.2188	0.1085	0.1427	0.1567	0.0564
60	0.4695	0.2087	0.4265	0.3682	0.1398
90	1.1932	0.5120	0.8923	0.8658	0.3414
120	2.2128	1.1613	1.5454	1.6398	0.5320
150	3.2474	1.9034	2.9785	2.7098	0.7112
180	4.2643	2.7493	3.5448	3.5195	0.7578
240	6.2698	4.5349	5.4149	5.4065	0.8675
300	8.4002	7.5217	7.433	7.7850	0.5347
360	10.0239	9.0466	9.831	9.6338	0.5176
480	12.4085	12.2439	12.0014	12.2180	0.2048
600	15.0943	15.7362	15.804	15.5449	0.3916
720	16.1254	17.1749	17.5646	16.9550	0.7444
840	19.8733	22.4463	20.0091	20.7762	1.4479
960	21.5218	23.1967	21.9987	22.2391	0.8629
1080	22.7124	24.9405	23.1115	23.5881	1.1881
1200	23.5344	24.6437	23.6103	23.9295	0.6197
1320	23.9667	25.2002	24.4892	24.5520	0.6192
1440	24.1651	25.4748	24.9193	24.8531	0.6574

Table E10 Release of 0.2% theophylline from chitosan films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.2974	0.2377	0.4480	0.3978	0.1084
30	0.3948	0.4006	0.9531	0.7670	0.3207
45	0.5692	0.4798	1.2429	1.0184	0.4172
60	0.7486	0.6207	1.4713	1.2304	0.4587
90	1.2409	1.0785	2.3058	1.9508	0.6667
120	1.7536	1.5451	3.1096	2.6576	0.8495
150	2.6510	2.2758	3.8913	3.4779	0.8455
180	3.4047	2.8788	4.9367	4.4260	1.0691
240	4.8661	4.2522	6.0874	5.6803	0.9342
300	6.4300	6.2594	7.6509	7.2440	0.7589
360	7.8862	6.8229	9.1618	8.7366	1.1711
480	10.1526	9.0238	11.5028	11.0527	1.2411
600	12.5831	12.1359	14.2083	13.6665	1.0905
720	14.8085	13.6546	15.4380	15.2282	0.9045
840	16.4698	14.6362	16.4043	16.4261	1.0403
960	17.2698	15.1952	17.6780	17.5419	1.3313
1080	18.2132	16.3397	18.9297	18.6909	1.3374
1200	19.0747	17.3081	19.6105	19.4319	1.2048
1320	20.5514	18.5934	20.2253	20.3340	1.0491
1440	21.0437	19.1393	21.0818	21.0691	1.1107

Table E11 Release of 0.5% theophylline from chitosan films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.1271	0.0769	0.1168	0.1069	0.0265
30	0.2210	0.1126	0.1849	0.1728	0.0552
45	0.2467	0.1389	0.2081	0.1979	0.0547
60	0.3443	0.1989	0.3042	0.2825	0.0751
90	0.6924	0.3791	0.5887	0.5534	0.1596
120	1.1693	0.6963	0.8992	0.9216	0.2373
150	1.7659	1.1729	1.1560	1.3649	0.3473
180	2.4858	1.6872	2.2285	2.1338	0.4077
240	3.6717	2.9352	3.4693	3.3587	0.3805
300	5.1540	4.1363	4.5321	4.6074	0.5130
360	6.4890	6.0918	6.0067	6.1958	0.2574
480	8.9306	8.6235	8.5138	8.6893	0.2160
600	11.1697	12.1386	11.0347	11.4477	0.6022
720	12.7477	13.1764	13.3112	13.0784	0.2942
840	14.4068	14.4732	14.2307	14.3702	0.1253
960	14.5173	15.6574	14.9051	15.0266	0.5797
1080	16.1377	17.1382	15.6712	16.3157	0.7495
1200	17.0510	18.0352	17.4554	17.5139	0.4947
1320	18.5241	19.8932	18.6931	19.0368	0.7465
1440	18.9108	20.4562	19.4197	19.5956	0.7876

Table E12 Release of 1.0% theophylline from chitosan films and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0451	0.0434	0.0843	0.0576	0.0231
30	0.0685	0.0664	0.2713	0.1354	0.1177
45	0.0818	0.0962	0.3885	0.1888	0.1730
60	0.1127	0.1490	0.5022	0.2546	0.2152
90	0.2204	0.3115	0.7575	0.4298	0.2874
120	0.3748	0.5303	1.1173	0.6742	0.3916
150	0.5735	0.7882	1.5302	0.9640	0.5020
180	0.8106	1.0947	2.1336	1.3463	0.6964
240	1.4092	1.4045	3.0007	1.9381	0.9202
300	2.0362	2.4140	4.0919	2.8474	1.0942
360	2.6448	3.6909	5.0474	3.7944	1.2047
480	4.5541	5.5329	6.9779	5.6883	1.2194
600	6.6621	7.7878	9.2295	7.8931	1.2869
720	7.9720	8.4500	10.3629	8.9283	1.2651
840	9.2385	9.5694	11.3049	10.0376	1.1099
960	10.4841	11.4531	12.2731	11.4034	0.8956
1080	12.5128	12.4490	13.8177	12.9265	0.7725
1200	13.4119	13.4577	14.5053	13.7916	0.6185
1320	14.2777	14.0799	15.1701	14.5092	0.5808
1440	15.3137	15.2521	16.4307	15.6655	0.6634

Table E13 Release of 0.1% salicylic acid from CM-chitin films and 0.005% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.7742	0.7284	0.7942	0.7656	0.0337
30	3.1423	2.8293	3.3748	3.1155	0.2737
45	5.9658	5.8192	6.2738	6.0196	0.2320
60	9.7639	9.5273	9.8390	9.7101	0.1627
90	13.7077	13.5738	13.7455	13.6757	0.0902
120	16.9502	16.7280	17.1037	16.9273	0.1889
150	18.2526	17.8390	18.3692	18.1536	0.2786
180	20.8667	20.8364	20.4532	20.7188	0.2305
240	21.9961	21.6731	21.8448	21.8380	0.1616
300	22.9069	22.7829	23.2412	22.9770	0.2371
360	25.6758	25.7583	25.4256	25.6199	0.1732
480	27.0875	27.3257	27.1217	27.1783	0.1288
600	28.2989	28.4536	28.1463	28.2996	0.1537
720	29.6560	29.8829	29.3352	29.6247	0.2752
840	30.4939	30.3023	30.5119	30.4360	0.1162
960	30.8947	31.0121	30.9841	30.9636	0.0613
1080	32.4704	32.9720	31.8923	32.4449	0.5403
1200	33.1808	33.4289	33.0421	33.2173	0.1960
1320	33.7182	34.0026	33.5649	33.7619	0.2221
1440	34.1463	34.3103	33.8293	34.0953	0.2445

Table E14 Release of 0.1% salicylic acid from CM-chitin films and 0.05% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	1.1341	0.9356	1.3209	1.1302	0.1927
30	1.5049	1.3782	1.7289	1.5373	0.1776
45	2.2901	2.4329	2.2292	2.3174	0.1046
60	3.5878	3.3320	3.6573	3.5257	0.1713
90	5.0818	4.8020	5.3201	5.0680	0.2593
120	6.3795	6.3849	6.6211	6.4618	0.1380
150	7.5791	7.3821	7.6830	7.5481	0.1528
180	11.2977	11.1920	11.5637	11.3511	0.1915
240	14.2421	14.0288	14.3443	14.2051	0.1610
300	16.2050	16.1189	16.5563	16.2934	0.2317
360	18.1897	18.4632	18.0388	18.2306	0.2151
480	19.6074	19.7880	19.4399	19.6118	0.1741
600	21.1014	21.7027	21.3455	21.3832	0.3024
720	22.3991	22.2733	22.5218	22.3981	0.1243
840	23.5115	23.3722	23.7492	23.5443	0.1906
960	23.9586	23.8725	24.1728	24.0013	0.1546
1080	24.2421	24.0102	24.5920	24.2814	0.2929
1200	25.5943	25.4081	25.7463	25.5829	0.1694
1320	26.1614	26.0035	26.4728	26.2126	0.2388
1440	26.4776	26.2637	26.6739	26.4717	0.2052

Table E15 Release of 0.5% salicylic acid from chitosan films and 0.005% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.1991	0.2182	0.1867	0.2013	0.0159
30	0.4461	0.4745	0.4371	0.4525	0.0195
45	1.3554	1.7097	1.2690	1.4447	0.2335
60	2.5691	2.8429	2.2892	2.5671	0.2768
90	4.8990	5.1152	4.7738	4.9293	0.1727
120	7.3360	7.3555	7.3071	7.3329	0.0243
150	9.6639	9.2053	9.6028	9.4907	0.2490
180	11.3142	11.3595	11.2430	11.3056	0.0587
240	14.3964	14.9752	14.5632	14.6449	0.2979
300	15.7250	16.2085	14.8730	15.6021	0.6761
360	19.0560	19.4117	18.8835	19.1171	0.2693
480	22.8581	21.6780	21.9947	22.1769	0.6108
600	24.2747	24.1685	24.5081	24.3171	0.1737
720	26.1202	25.6100	26.6573	26.1292	0.5237
840	27.8355	26.8833	27.9801	27.5663	0.5959
960	30.0850	29.3979	30.5627	30.0152	0.5856
1080	30.3817	30.6671	30.7418	30.5969	0.1901
1200	30.7263	31.9605	31.0673	31.2514	0.6373
1320	31.3581	32.2568	31.6734	31.7627	0.4560
1440	31.6682	32.6912	31.5763	31.9786	0.6189

Table E16 Release of 0.5% salicylic acid from chitosan films and 0.05% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0869	0.0934	0.0816	0.0873	0.0059
30	0.2405	0.2337	0.2489	0.2410	0.0076
45	0.5538	0.5671	0.5438	0.5549	0.0117
60	0.9175	0.9376	0.9094	0.9215	0.0145
90	1.9988	2.013	2.1012	2.0377	0.0555
120	3.2033	3.3711	3.1563	3.2436	0.1129
150	4.4584	4.5008	4.4398	4.4663	0.0313
180	5.5517	5.5787	5.5449	5.5584	0.0179
240	7.8416	7.8402	7.8397	7.8405	0.0010
300	9.7555	9.8114	9.6949	9.7539	0.0583
360	11.6411	11.6347	11.6485	11.6414	0.0069
480	13.9491	14.0326	13.8967	13.9595	0.0685
600	16.0954	15.9953	16.1007	16.0638	0.0594
720	18.8985	18.9789	18.8653	18.9142	0.0584
840	20.4931	20.3269	20.3817	20.4006	0.0847
960	21.4996	21.3432	21.4931	21.4453	0.0885
1080	22.9911	22.6547	22.2219	22.6226	0.3856
1200	23.4196	23.4089	23.5125	23.4470	0.0570
1320	25.1091	24.9832	24.8794	24.9906	0.1150
1440	25.3597	25.3369	25.3814	25.3593	0.0223

Appendix F Data of drug release from the blend films

Table F1 Release of 0.1% salicylic acid from CM-chitin/PVA blend films with 25% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	4.5287	3.9438	5.0389	4.5038	0.5480
30	6.6589	6.2738	6.8930	6.6086	0.3127
45	7.8917	7.5012	8.1029	7.8319	0.3053
60	9.4852	9.2378	9.7389	9.4873	0.2506
90	12.6805	11.9302	12.4890	12.3666	0.3898
120	14.8107	14.3200	15.1831	14.7713	0.4329
150	16.5047	16.3842	16.8832	16.5907	0.2604
180	17.8550	17.7422	17.9037	17.8336	0.0828
240	19.3981	19.4930	19.3546	19.4152	0.0708
300	20.7819	20.6473	20.9482	20.7925	0.1507
360	22.9121	22.3209	22.9942	22.7424	0.3673
480	23.9604	24.0074	23.5643	23.8440	0.2434
600	25.0842	25.5022	25.4117	25.3327	0.2199
720	26.0235	26.7384	26.2208	26.3276	0.3692
840	27.0383	27.5520	27.2119	27.2674	0.2613
960	27.8937	28.2004	28.0027	28.0323	0.1555
1080	28.0614	28.8202	28.7738	28.5518	0.4253
1200	28.7659	29.5641	29.0372	29.1224	0.4059
1320	28.8498	29.7482	29.3352	29.3111	0.4497
1440	29.3026	29.8920	29.7603	29.6516	0.3093

Table F2 Release of 0.1% salicylic acid from CM-chitin/PVA blend films with 50% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	4.1031	3.7809	4.3988	4.0943	0.3090
30	6.0739	5.7391	6.2839	6.0323	0.2748
45	8.0770	7.8820	7.9254	7.9615	0.1024
60	9.7086	9.3984	9.8110	9.6393	0.2148
90	11.4775	11.4001	11.5278	11.4685	0.0643
120	13.0848	12.9572	13.2681	13.1034	0.1563
150	13.9814	13.7382	13.9920	13.9039	0.1436
180	14.7891	14.5429	14.8902	14.7407	0.1786
240	16.9860	16.8223	16.7601	16.8561	0.1167
300	18.9972	18.5721	19.0352	18.8682	0.2571
360	19.4899	19.4449	19.6582	19.5310	0.1124
480	20.7903	20.6329	20.8116	20.7449	0.0976
600	21.8484	21.7293	21.9302	21.8360	0.1010
720	22.8661	22.8004	22.9431	22.8699	0.0714
840	23.5203	23.4881	23.7848	23.5977	0.1628
960	24.6511	24.5832	24.6990	24.6444	0.0582
1080	25.2246	25.0053	25.4361	25.2220	0.2154
1200	25.9758	25.8307	25.9916	25.9327	0.0887
1320	26.4846	26.2556	26.4563	26.3988	0.1249
1440	26.9612	26.7709	26.9904	26.9075	0.1192

Table F3 Release of 0.1% salicylic acid from CM-chitin/PVA blend films with100% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	3.4661	3.4038	3.5028	3.4576	0.0500
30	4.4845	4.3885	4.4772	4.4501	0.0535
45	5.9394	5.7620	5.9890	5.8968	0.1194
60	6.3759	6.4724	6.5029	6.4504	0.0663
90	7.9592	7.8391	7.9802	7.9262	0.0761
120	8.8835	8.6054	8.9103	8.7997	0.1688
150	9.6537	9.5830	9.7128	9.6498	0.0650
180	10.5695	10.4381	10.6119	10.5398	0.0906
240	11.4510	11.3021	11.5008	11.4180	0.1034
300	12.2212	12.1894	12.3006	12.2371	0.0573
360	13.1369	13.0792	13.2430	13.1530	0.0831
480	13.9585	13.8831	14.0521	13.9646	0.0847
600	14.9085	14.7802	14.9583	14.8823	0.0919
720	15.9697	15.8213	15.9678	15.9196	0.0851
840	16.3976	16.3040	16.4228	16.3748	0.0626
960	17.8697	17.7793	17.9759	17.8749	0.0984
1080	17.8953	17.9561	18.0738	17.9751	0.0907
1200	18.7084	18.3481	18.6570	18.5712	0.1949
1320	18.8367	18.5539	18.8009	18.7305	0.1540
1440	18.9480	18.6839	18.9609	18.8643	0.1563

Table F4 Release of 0.5% salicylic acid from chitosan/PVA blend films with 25% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.2611	0.2327	0.2413	0.2451	0.0146
30	1.1360	0.9934	1.0444	1.0580	0.0722
45	2.5007	2.2594	2.3246	2.3615	0.1248
60	3.9835	3.1090	3.2917	3.4614	0.4613
90	6.7968	5.0031	5.7822	5.8607	0.8994
120	8.4588	6.7610	7.6090	7.6096	0.8489
150	9.6748	8.7801	9.1550	9.2033	0.4493
180	10.9518	10.2258	10.5972	10.5916	0.3631
240	13.2161	12.4775	12.5070	12.7336	0.4182
300	16.3248	15.2535	15.3406	15.6396	0.5950
360	17.9487	17.6264	17.7500	17.7750	0.1626
480	22.0028	22.3684	22.5857	22.3190	0.2946
600	23.5352	24.3723	23.4586	23.7887	0.5068
720	26.3903	26.3100	25.6852	26.1285	0.3860
840	27.3472	28.0338	27.1990	27.5267	0.4454
960	28.5860	29.1692	29.3275	29.0276	0.3905
1080	29.1521	30.4899	30.3324	29.9915	0.7312
1200	30.2233	31.8297	31.9688	31.3406	0.9701
1320	31.5937	32.8628	32.0555	32.1707	0.6424
1440	31.8701	32.9461	32.4232	32.4131	0.5381

Table F5 Release of 0.5% salicylic acid from chitosan/PVA blend films with 50% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0842	0.0918	0.0823	0.0861	0.0050
30	0.3159	0.3187	0.3039	0.3128	0.0079
45	0.9669	0.9533	0.9587	0.9596	0.0069
60	1.7742	1.7578	1.7865	1.7728	0.0144
90	3.4659	3.4692	3.4554	3.4635	0.0072
120	5.3875	5.3802	5.3914	5.3864	0.0057
150	6.9406	6.9392	6.9327	6.9375	0.0042
180	8.2585	8.2443	8.2631	8.2553	0.0098
240	10.6206	10.6118	10.6293	10.6206	0.0088
300	12.1227	12.1319	12.1257	12.1268	0.0047
360	14.5357	14.5402	14.5285	14.5348	0.0059
480	17.0838	17.0923	17.1816	17.1192	0.0542
600	19.0686	18.8792	19.2120	19.0533	0.1669
720	19.7108	19.6549	19.7882	19.7180	0.0669
840	20.2022	20.2114	20.1974	20.2037	0.0071
960	20.4760	20.6358	20.4528	20.5215	0.0996
1080	21.7044	21.9534	21.7831	21.8136	0.1273
1200	22.7714	22.9328	22.8817	22.8620	0.0825
1320	23.2066	23.3865	23.2115	23.2682	0.1025
1440	23.4874	23.5061	23.4702	23.4879	0.0180

Table F6 Release of 0.1% salicylic acid from CM-chitin/PVP blend films with 25% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.5595	0.5892	0.5340	0.5609	0.0276
30	0.9791	0.9904	0.9672	0.9789	0.0116
45	1.9116	1.9598	1.8827	1.9180	0.0390
60	2.2845	2.3537	2.1189	2.2524	0.1207
90	4.1029	4.0772	4.1198	4.1000	0.0214
120	5.7813	5.8302	5.7556	5.7890	0.0379
150	7.3199	7.2408	7.3910	7.3172	0.0751
180	8.6720	8.5692	8.6990	8.6467	0.0685
240	11.0497	11.1728	11.0073	11.0766	0.0860
300	13.1944	13.2274	13.1667	13.1962	0.0304
360	15.3857	15.4007	15.3779	15.3881	0.0116
480	18.5561	18.5080	18.6210	18.5617	0.0567
600	19.5725	19.5921	19.5114	19.5587	0.0421
720	22.0995	22.1102	22.0874	22.0990	0.0114
840	24.7104	24.7199	24.7342	24.7215	0.0120
960	25.6429	25.4990	25.7809	25.6409	0.1410
1080	26.7618	26.6602	26.7931	26.7384	0.0695
1200	27.0416	27.0513	27.0227	27.0385	0.0145
1320	28.3936	28.3305	28.4117	28.3786	0.0426
1440	28.6268	28.5880	28.6559	28.6236	0.0341

Table F7 Release of 0.1% salicylic acid from CM-chitin/PVP blend films with 50% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	6.9371	6.9840	6.9023	6.9411	0.0410
30	7.7282	7.5809	7.8116	7.7069	0.1168
45	8.8641	8.9220	8.7361	8.8407	0.0951
60	10.4158	10.4566	10.4782	10.4502	0.0317
90	13.7120	13.6803	13.7892	13.7272	0.0560
120	15.4361	15.5268	15.3210	15.4280	0.1031
150	16.6024	16.5662	16.6228	16.5971	0.0287
180	18.1542	18.1990	18.1327	18.1620	0.0338
240	21.0751	21.0263	21.1536	21.0850	0.0642
300	21.6836	22.2704	22.1109	22.0216	0.3034
360	23.5396	24.0083	24.1270	23.8916	0.3106
480	27.2110	26.5468	27.3804	27.0461	0.4406
600	27.4645	27.7549	27.3308	27.5167	0.2168
720	29.8783	29.6478	29.9912	29.8391	0.1750
840	31.1562	31.1722	31.1931	31.1738	0.0185
960	32.0183	31.8976	31.9065	31.9408	0.0672
1080	32.9716	32.7893	32.9804	32.9138	0.1079
1200	33.3773	33.2880	33.4007	33.3553	0.0595
1320	33.4787	33.5261	33.7762	33.5937	0.1598
1440	34.1684	34.1138	34.1939	34.1587	0.0409

Table F8 Release of 0.5% salicylic acid from chitosan/PVP blend films with 25% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.4082	0.4186	0.4134	0.4134	0.0052
30	2.1362	2.2481	2.2352	2.2065	0.0612
45	4.9399	6.5247	5.5049	5.6565	0.8032
60	6.3132	7.7160	7.1090	7.0461	0.7035
90	8.8499	10.1024	9.4293	9.4605	0.6268
120	11.0624	12.7464	12.0778	11.9622	0.8479
150	12.8552	13.2805	13.1895	13.1084	0.2239
180	13.7707	15.5173	14.7244	14.6708	0.8745
240	17.9096	18.7162	18.3561	18.3273	0.4041
300	19.6262	20.1594	19.9860	19.9239	0.2720
360	21.1787	21.8791	21.6950	21.5843	0.3631
480	22.4871	24.3943	22.8522	23.2445	1.0123
600	23.1242	25.5591	23.9579	24.2137	1.2375
720	23.8718	25.8811	24.8974	24.8834	1.0047
840	24.5794	26.2788	25.6946	25.5176	0.8634
960	25.0010	26.6102	26.1060	25.9057	0.8231
1080	25.4358	26.9038	26.5155	26.2850	0.7606
1200	26.1377	27.0743	26.8043	26.6721	0.4821
1320	26.4448	27.2068	26.9744	26.8753	0.3906
1440	26.6927	27.3565	27.0931	27.0474	0.3342

Table F9 Release of 0.5% salicylic acid from chitosan/PVP blend films with 50% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Amount of drug release (%)			Average	Standard deviation
	X1	X2	X3		
0	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.6778	0.6372	0.6538	0.6563	0.0204
30	2.3585	2.2873	2.4627	2.3695	0.0882
45	4.1352	4.1953	4.1128	4.1478	0.0427
60	5.8860	5.8946	5.6322	5.8043	0.1491
90	9.8549	9.7648	9.9294	9.8497	0.0824
120	11.9087	11.8337	11.9548	11.8991	0.0611
150	15.2700	15.1217	15.2906	15.2274	0.0921
180	17.5361	17.5690	17.4119	17.5057	0.0829
240	19.3848	19.4338	19.3643	19.3943	0.0357
300	20.9288	20.9388	20.8102	20.8926	0.0715
360	22.7018	22.4593	22.8109	22.6573	0.1800
480	24.0833	24.0277	24.2331	24.1147	0.1062
600	24.4896	25.0056	25.1293	24.8748	0.3393
720	26.2700	26.5733	26.7840	26.5424	0.2584
840	28.0541	27.8198	27.9508	27.9416	0.1174
960	28.5712	28.4308	28.4556	28.4859	0.0749
1080	28.8667	28.7821	28.8003	28.8164	0.0445
1200	29.0237	29.1432	29.0037	29.0569	0.0754
1320	29.5131	29.4287	29.6334	29.5251	0.1029
1440	29.9656	29.8405	29.9890	29.9317	0.0798

Appendix G Data of degree of swelling of pure CM-chitin, chitosan, and the blend films

Table G1 Effect of time on degree of swelling of CM-chitin/PVA blend films with 0% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	327.87	326.33	329.00	327.73	1.34
1	373.77	376.82	370.00	373.53	3.42
1.5	388.52	392.20	382.00	387.57	5.17
2	400.00	405.28	401.00	402.09	2.80
2.5	408.20	415.33	410.00	411.18	3.71
3	419.67	422.94	418.00	420.20	2.51
3.5	426.23	428.39	427.00	427.21	1.09
4	431.15	435.67	431.00	432.61	2.65
4.5	436.07	441.82	435.00	437.63	3.67
5	442.62	444.89	440.00	442.50	2.45
7.5	445.90	456.14	447.00	449.68	5.62
10	455.74	461.13	454.00	456.96	3.72
15	459.02	466.28	458.00	461.10	4.52
20	465.57	471.33	463.00	466.63	4.27
25	470.49	473.82	468.00	470.77	2.92
30	473.77	476.09	471.00	473.62	2.55
40	475.98	477.95	474.00	475.98	1.98
50	477.09	479.11	476.00	477.40	1.58
60	480.33	481.04	478.00	479.79	1.59

Table G2 Effect of time on degree of swelling of CM-chitin/PVA blend films with 25% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	241.67	260.34	270.34	257.45	14.55
1	250.00	268.97	275.92	264.96	13.42
1.5	252.78	272.41	281.20	268.80	14.55
2	261.11	279.31	288.69	276.37	14.02
2.5	275.00	291.38	293.48	286.62	10.12
3	280.56	308.62	311.24	300.14	17.01
3.5	288.89	320.69	325.48	311.69	19.89
4	294.44	327.59	331.38	317.80	20.32
4.5	305.56	334.48	336.75	325.60	17.39
5	319.44	336.21	338.92	331.52	10.55
7.5	327.78	341.38	345.19	338.12	9.15
10	333.33	348.28	351.06	344.22	9.53
15	341.67	353.45	356.83	350.65	7.96
20	358.33	356.90	358.15	357.79	0.78
25	366.67	367.24	367.90	367.27	0.62
30	383.33	374.14	371.39	376.29	6.25
40	388.89	379.31	376.02	381.41	6.69
50	391.67	382.76	380.81	385.08	5.79
60	394.44	384.48	381.11	386.68	6.93

Table G3 Effect of time on degree of swelling of CM-chitin/PVA blend films with 50% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0	0.00	0.00	0.00	0.00
0.5	236	233.33	230.37	233.23	2.82
1	244	238.89	238.49	240.46	3.07
1.5	266	250.00	248.51	254.84	9.70
2	278	257.41	257.02	264.14	12.00
2.5	282	261.11	263.62	268.91	11.41
3	288	275.93	273.38	279.10	7.81
3.5	302	279.63	280.18	287.27	12.76
4	312	283.33	285.92	293.75	15.86
4.5	318	288.89	289.30	298.73	16.69
5	322	290.74	292.22	301.65	17.64
7.5	330	296.30	297.19	307.83	19.21
10	336	301.85	302.43	313.43	19.55
15	338	309.26	307.29	318.18	17.19
20	340	314.81	312.38	322.40	15.29
25	342	318.52	316.51	325.68	14.17
30	346	322.22	320.05	329.42	14.40
40	348	325.93	323.28	332.40	13.57
50	348	327.78	325.09	333.62	12.52
60	350	329.63	326.71	335.45	12.69

Table G4 Effect of time on degree of swelling of CM-chitin/PVA blend films with 100% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	194.74	192.47	196.48	194.56	2.01
1	215.79	214.37	215.92	215.36	0.86
1.5	252.63	250.58	255.67	252.96	2.56
2	289.47	288.16	287.02	288.22	1.23
2.5	310.53	306.68	312.73	309.98	3.06
3	326.32	322.47	328.53	325.77	3.07
3.5	331.58	328.21	334.18	331.32	2.99
4	336.84	333.53	340.45	336.94	3.46
4.5	347.37	346.74	349.73	347.95	1.58
5	347.37	352.37	351.23	350.32	2.62
7.5	363.16	365.53	362.23	363.64	1.70
10	373.68	372.26	370.83	372.26	1.43
15	378.95	377.79	380.16	378.97	1.19
20	384.21	386.47	389.18	386.62	2.49
25	394.74	396.37	393.46	394.86	1.46
30	394.74	410.16	405.67	403.52	7.93
40	410.53	413.53	409.82	411.29	1.97
50	405.26	415.26	410.48	410.33	5.00
60	415.79	416.74	413.23	415.25	1.82

Table G5 Effect of time on degree of swelling of chitosan/PVA blend films with 0% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	178.18	170.54	183.73	177.48	6.62
1	263.64	258.67	267.54	263.28	4.45
1.5	332.73	325.23	335.37	331.11	5.26
2	356.36	349.81	358.67	354.95	4.60
2.5	389.09	373.23	391.74	384.69	10.01
3	394.55	388.54	395.73	392.94	3.85
3.5	400.00	394.55	404.89	399.81	5.17
4	410.91	402.92	412.02	408.62	4.96
4.5	410.91	406.63	414.34	410.63	3.86
5	416.36	412.02	418.56	415.65	3.33
7.5	430.91	424.53	433.74	429.73	4.72
10	432.73	430.91	435.82	433.15	2.48
15	438.18	437.56	440.02	438.59	1.28
20	456.36	448.53	454.54	453.14	4.10
25	456.36	454.54	457.89	456.26	1.68
30	460.00	459.23	461.23	460.15	1.01
40	460.00	460.00	461.23	460.41	0.71
50	461.82	459.23	462.54	461.20	1.74
60	460.00	460.00	461.23	460.41	0.71

Table G6 Effect of time on degree of swelling of chitosan/PVA blend films with 25% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	194.76	192.33	195.92	194.34	1.83
1	258.29	256.23	258.94	257.82	1.41
1.5	301.23	300.67	302.67	301.52	1.03
2	317.67	315.13	318.37	317.06	1.71
2.5	347.94	345.13	349.47	347.51	2.20
3	351.33	349.42	353.13	351.29	1.86
3.5	374.83	372.67	375.56	374.35	1.50
4	377.35	374.26	379.45	377.02	2.61
4.5	379.13	384.68	387.82	383.88	4.40
5	400.92	396.28	401.37	399.52	2.82
7.5	410.35	407.82	411.91	410.03	2.06
10	418.67	416.34	420.07	418.36	1.88
15	425.67	422.73	426.67	425.02	2.05
20	426.00	424.23	426.67	425.63	1.26
25	426.88	425.88	425.35	426.04	0.78
30	428.10	426.67	426.67	427.15	0.83
40	429.56	428.10	427.56	428.41	1.04
50	431.77	432.28	430.23	431.43	1.07
60	432.66	432.28	431.77	432.24	0.44

Table G7 Effect of time on degree of swelling of chitosan/PVA blend films with 50% PVA content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	140.00	143.08	146.38	143.15	3.19
1	167.69	164.62	163.77	165.36	2.06
1.5	178.46	190.77	192.46	187.23	7.64
2	189.23	196.92	199.08	195.08	5.18
2.5	215.38	210.77	209.15	211.77	3.24
3	223.08	216.92	213.23	217.74	4.97
3.5	229.23	223.08	219.38	223.90	4.98
4	232.31	229.23	226.46	229.33	2.93
4.5	235.38	233.85	233.85	234.36	0.89
5	235.38	235.38	236.77	235.85	0.80
7.5	240.00	236.92	239.23	238.72	1.60
10	238.46	238.46	240.15	239.02	0.97
15	246.15	238.46	241.92	242.18	3.85
20	244.62	243.08	242.08	243.26	1.28
25	243.08	246.15	247.15	245.46	2.12
30	244.62	249.23	252.62	248.82	4.02
40	247.69	250.77	256.46	251.64	4.45
50	250.77	255.38	258.15	254.77	3.73
60	252.31	258.46	260.77	257.18	4.37

Table G8 Effect of time on degree of swelling of CM-chitin/PVP blend films with 25% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0	0.00	0.00
0.5	250.00	256.25	261	255.75	5.52
1	266.67	284.38	291	280.68	12.58
1.5	271.43	290.63	304	288.68	16.37
2	288.10	293.75	309	296.95	10.81
2.5	290.48	300.00	315	301.83	12.36
3	302.38	293.75	320	305.38	13.38
3.5	307.14	300.00	323	310.05	11.77
4	314.29	312.50	327	317.93	7.91
4.5	321.43	331.25	339	330.56	8.81
5	345.24	350.00	354	349.75	4.39
7.5	357.14	356.25	361	358.13	2.52
10	357.14	362.50	368	362.55	5.43
15	364.29	365.63	372	367.30	4.12
20	376.19	375.00	378	376.40	1.51
25	388.10	378.13	380	382.07	5.30
30	397.62	384.38	380	387.33	9.17
40	404.76	400.00	391	398.59	6.99
50	407.14	403.13	400	403.42	3.58
60	409.52	406.25	403	406.26	3.26

Table G9 Effect of time on degree of swelling of CM-chitin/PVP blend films with 50% PVP content and 0.01% glutaraldehyde at 37°C, pH 5.5

Time (minutes)	Degree of swelling (%)			Average	Standard deviation
	X1	X2	X3		
0	0.00	0.00	0.00	0.00	0.00
0.5	320.00	342.11	345.56	335.89	13.87
1	328.00	368.42	396.63	364.35	34.50
1.5	360.00	384.21	406.23	383.48	23.12
2	376.00	394.74	418.02	396.25	21.05
2.5	384.00	405.26	432.74	407.33	24.44
3	392.00	421.05	451.63	421.56	29.82
3.5	400.00	431.58	460.54	430.71	30.28
4	404.00	436.84	468.89	436.58	32.45
4.5	412.00	447.37	480.18	446.52	34.10
5	424.00	457.89	491.54	457.81	33.77
7.5	436.00	468.42	500.00	468.14	32.00
10	452.00	484.21	518.45	484.89	33.23
15	468.00	494.74	526.23	496.32	29.15
20	480.00	500.00	532.67	504.22	26.59
25	492.00	510.53	543.89	515.47	26.30
30	508.00	521.05	552.56	527.20	22.91
40	516.00	521.05	555.23	530.76	21.34
50	524.00	526.32	558.45	536.26	19.26
60	528.00	547.37	563.89	546.42	17.96

Appendix H Data of weight loss of the blend films

Table H1 Data of percent weight loss of salicylic acid-loaded blend films

Polymer	Blend ratio	Weight loss (%)			Average	Standard deviation
		X1	X2	X3		
CM-chitin/PVA	100:0	12.53	14.29	14.52	13.78	1.0886
	75:25	16.45	15.28	17.08	16.27	0.9134
	50:50	18.11	21.87	22.48	20.82	2.3667
Chitosan/PVA	100:0	9.05	12.03	11.14	10.74	1.5297
	75:25	13.32	11.86	12.92	12.70	0.7545
	50:50	17.22	18.08	19.93	18.41	1.3848
CM-chitin/PVP	100:0	12.53	14.29	14.52	13.78	1.0886
	75:25	28.54	25.23	27.26	27.01	1.6691
	50:50	37.27	37.54	34.18	36.33	1.8668
Chitosan/PVP	100:0	9.05	12.03	11.14	10.74	1.5297
	75:25	15.69	17.07	18.84	17.20	1.5790
	50:50	18.92	18.32	19.31	18.85	0.4987

Table H2 Data of percent weight loss of the blend films

Polymer	Blend ratio	Weight loss (%)			Average	Standard deviation
		X1	X2	X3		
CM-chitin/PVA	100:0	9.12	11.42	12.31	10.95	1.6461
	75:25	14.85	13.15	12.86	13.62	1.0750
	50:50	19.12	17.43	17.87	18.14	0.8768
Chitosan/PVA	100:0	4.76	6.10	5.28	5.38	0.6756
	75:25	6.41	7.22	7.16	6.93	0.4513
	50:50	11.03	10.87	12.87	11.59	1.1114
CM-chitin/PVP	100:0	9.12	11.42	12.31	10.95	1.6461
	75:25	24.51	24.99	25.98	25.16	0.7496
	50:50	34.68	33.98	33.07	33.91	0.8073
Chitosan/PVP	100:0	4.76	6.10	5.28	5.38	0.6756
	75:25	10.72	10.13	12.63	11.16	1.3068
	50:50	12.05	10.90	12.87	11.94	0.9896

CURRICULUM VITAE

Name: Ms. Lalisa Aurpongpun

Date of Birth: July 30, 1980

Nationality: Thai

University Education:

1998-2003 Bachelor Degree of Science in Chemistry, Chulalongkorn University, Bangkok, Thailand.