

REFERENCES

- Aiba, S., Izume, M., Minoura, N., and Fujiwara, A. (1985), Studied on chitin. 2. preparation and properties of chitin membranes. Carbohydrate Polymer, 5, 285-295.
- Andre, M.S.(1997), Theory and application of dimethylacetamide / LiCl in the analysis of polysaccharides. Carbohydrates Polymers, 34, 267-274
- Austin *et al.* chitin film and fiber. U.S.patent, 4,029,727
- Bianchi, E., Marsano, E., Baldini, M., Conio, G., and Tealdi, A.(1995). Chitin- cellulose blend: preparation and characterization, Polymer for Advance Technologies, 6, 727-732.
- Bianchi, E., Marsano, E., and Tacchino, A.(1997). Thermoreversible gels of chitin, Carbohydrate polymers, 32, 23-26.
- Brine, C.J., Sanford, P. A., and Zikakis, J.F. (1986). Chitin and Chitosan. London: Elsvier Applied Science. pp 78.
- Chen, X., Li, W., Zhong, W., Lu, Y., and Yu, T.(1997). pH sensitivity and ionsensitivity of hydrogels based on complex-forming chitosan/silk fibroin interpenetrating polymer network, Journal of Applied Polymer Science. 65, 2257-2262.
- Domszy, J.G., and Roberts, G.A.F. (1985). Macromolecular Chemistry, 186, 1671.
- Elizabeth, P. (1993). Chitin craze. Science News, 144(5), 72-74.
- Freddi, G., Romano, M., Massafra, M.R., and Tsukada, M.(1995). Silk fibroin/cellulose blend films: preparation, structure and physical properties, Journal of Applied Polymer Science, 56, 1537.

- Hasegawa, M., Isogai, A., Onabe, F., Usuda, M., and Atalla, R.H.(1992). Characterization of cellulose-chitosan blend films, Journal of Applied Polymer Science, 45, 1873-1879.
- Hasegawa, M., Isogai, A., Kuga, S., Onabe, F.(1994). Preparation of cellulose-chitosan blend film using chloral/dimethylformamide, Polymer, 35(5), 983-987.
- Hosogawa, I., Nishiyama, M., Yoshihara, K., and Kubo, T.(1990). Biodegradable film derived from chitosan and homogenized cellulose, Ind. Eng. Chem. Res. 29(5), 800.
- Khor, E., Wan, A.C.A**, Tee, C.F., and Hastings, G.W. (1997). Reversible water swellable chitin gel, Journal of Polymer Science: Part A: Polymer Chem. 35, 2049-2053.
- Kenji Tomihata and Yoshiito Ikada (1997). in vitro and in vivo degradation of film of chitin and its deacetylated derivatives, Biomaterials, 18(7).
- Kibune, K., and Yamaguchi, Y.(1986). Japanese patent .61,108,631.
- Kim, S.S., Kim, S.H., and Lee, Y.M.(1996). Preparation, characterization and properties of β -chitin and N-deacetylated β -chitin, Journal of Polymer Science: Part B: Polymer Physics, 34, 2367-2374.
- Kurita, K., Tomita, K., Tada, T., Ishii, S., Nishimura, S., and Shimoda, K. (1993). Squid chitin as a potential alternative chitin source: Deacetylation behavior and characteristic properties, Journal of Polymer Science: Part A : Polymer Chemistry, 31, 485-491.
- Lee, Y.M., Kim, S.H., and Kim, S.J. (1996). Preparation and characterization of β -chitin and poly (vinyl alcohol) blend, Polymer, 37(26), 5897.
- Mathur, N.K., and Narang, C.K. (1990). Chitin and chitosan, versatile polysaccharides from marine animals, Journal of Chemical Education, 67(11), 938.

- McCormick, C.L., Callais, P.A., and Hutchison, B.H.(1985). Solution studies of cellulose in Lithium chloride and N,N-dimethylacetamide. Macromolecules, 18, 2394-2401.
- Motosuji, K., Yamaguchi, Y., and Kibune, K. (1996). Japanese patent. 1978
- Muzzareli, R.A.A. in Encyclopedia of polymer science and engineering. vol.3, Wiley, New York, 1985, 430-440.
- Muzzarelli, R. A.A.(1977). Chitin, Oxford: Pergamon Press.
Patent. 61, 129, 005.
- Rathke, T.D., and Hudson, S.M. (1994). Review of chitin and chitosan as fiber and film formers, J.M.S-REV. Macromol. Chem.Phys., 34(3), 375-437.
- Sannan, T., Kurita, K., Ogura, K., and Iwakura, Polymer, 19,458(1978).
- Shimahara, K., and Takigushi, Y.(1988). Preparation of crustacean chitin. In W.A. Wood and S.T. Kellogg (Eds.). Methods in enzymology Volume 161 .Biomass part B: Lignin, pectin, and chitin (pp.417-423). New York: Academic Press.
- Tokura, S., Nishi, N., Takahashi, K., Shirai, A., and Uraki, Y.(1995). Novel drug derivary system by chitin derivated. Macromol. Symp, 99, 201-208.
- Wang, H., Li, W., Lu, Y., and Wang, Z.(1996). Studies on chitosan and poly (acrylic acid) interpolymer complex. I. Preparation, structure, pH-sensitivity, and salt sentivity of complex-forming poly(acrylic acid): chitosan semi-interpenatrating polymer network, Journal of applied polymer science, 71, 989-998.
- Williamson, S.L., Armentrout, S., Stafford, C.M., and McCormick, C.L. (1999). Electrolyte and pH responsive surfactant association in ionic semi-interpenetrating networks containing cellulose or chitin

synthesized in Lithium chloride/N,N-dimethylacetamide. Journal of Applied Polymer Science, 71, 989-998.

- Williamson, S.L., Armentrout, S., Poster, R.S., and McCormick, C.L.(1998). Microstructural examination of semi-interpenetrating network of poly(N,N-dimethylacrylamide) with cellulose or chitin synthesized in Lithium chloride/N,N-dimethylacetamide, Macromolecules, 31, 8134-8141.
- Yang, Y.C., and Zall , R. R. (1984). Absorption of metals by natural polymers generated from seafood processing waste, Industrial and Engineering Chemistry Product Research and Development, 23, 168-172.

APPENDIX A

Table A1 Equilibrium water content (EWC) of chitin/cellulose blend films.

Cellulose content (%)	1	2	3	Average	SD
0	59.62	60.29	55.59	58.50	2.54
20	57.20	54.71	54.84	55.58	1.40
40	53.70	55.36	50.66	53.24	2.38
60	45.63	45.12	47.37	46.04	1.18
80	41.96	41.98	42.87	42.27	0.52
100	42.05	39.65	37.37	39.69	2.34

APPENDIX B

Table B1 Degree of swelling of the chitin/cellulose blend films when the blend films immersed in 0.05, 0.125, 0.25 and 0.50 M NaCl solutions.

NaCl concentrations (M)	Samples	Cellulose content (%)					
		0	20	40	60	80	100
0.05	1	129.23	131.50	134.37	132.60	104.49	60.65
	2	125.81	135.54	141.30	144.05	103.09	57.14
	3	128.75	136.21	135.89	134.38	104.44	56.49
	Average	127.93	134.42	137.19	137.01	104.01	58.09
	SD	1.85	2.55	3.64	6.16	0.79	2.24
0.125	1	134.00	115.70	120.24	150.00	122.00	59.68
	2	131.00	126.30	120.51	146.00	117.00	50.00
	3	138.00	120.00	115.00	141.30	120.00	49.71
	Average	134.33	120.67	118.58	145.77	119.67	53.13
	SD	3.51	5.33	3.11	4.35	2.52	5.67
0.25	1	132.95	115.56	114.63	131.74	109.09	63.33
	2	125.64	126.83	120.00	131.60	106.85	67.16
	3	131.91	107.31	105.13	123.63	96.92	63.64
	Average	130.17	116.57	113.25	128.99	104.29	64.71
	SD	3.95	9.80	7.53	4.64	6.48	2.13
0.50	1	131.91	124.77	125.00	130.50	125.74	56.04
	2	138.00	122.96	123.08	139.41	124.39	60.43
	3	131.48	119.15	125.32	132.98	120.90	52.30
	Average	133.80	122.29	124.47	134.30	123.68	56.26
	SD	3.65	2.87	1.21	4.60	2.50	4.07

Table B2 Degree of swelling of chitin/cellulose blend films when the blend films immersed in 0.05, 0.125, 0.25, 0.50 M LiCl solutions.

LiCl concentrations (M)	Samples	Cellulose content (%)					
		0	20	40	60	80	100
0.05	1	134.90	129.40	137.39	116.67	93.15	61.87
	2	134.96	129.65	128.56	129.37	104.41	52.65
	3	137.67	137.32	125.44	125.74	89.61	53.98
	Average	135.84	132.12	130.46	123.93	95.72	56.17
	SD	1.58	4.50	6.20	6.54	7.73	4.98
0.125	1	154.62	140.00	144.44	167.03	134.83	66.88
	2	142.80	152.76	140.15	174.67	132.09	70.45
	3	138.09	136.91	145.83	165.89	131.10	69.69
	Average	145.17	143.22	143.47	169.20	132.67	69.01
	SD	8.52	8.40	2.96	4.77	1.93	1.88
0.25	1	123.71	121.79	134.63	156.35	108.03	60.71
	2	125.24	136.25	127.66	162.31	104.00	64.15
	3	135.00	125.68	134.65	144.91	115.90	65.51
	Average	127.98	127.91	132.31	154.52	109.31	63.46
	SD	6.12	7.48	4.03	8.84	6.05	2.47
0.50	1	145.46	142.00	143.00	154.83	127.27	64.02
	2	141.41	134.09	143.00	154.54	114.62	62.77
	3	139.11	141.50	146.00	162.29	122.11	63.76
	Average	141.99	139.20	144.00	157.22	121.33	63.52
	SD	3.21	4.43	1.73	4.39	6.36	0.66

Table B3 Degree of swelling of chitin/cellulose blend films when the blend films immersed in 0.05, 0.125, 0.25, 0.50 M CaCl₂ solutions.

CaCl ₂ concentrations (M)	Samples	Cellulose content (%)					
		0	20	40	60	80	100
0.05	1	149.76	138.45	145.13	119.36	95.29	50.89
	2	154.09	130.53	135.90	135.10	89.47	54.07
	3	155.08	136.75	136.11	128.73	98.78	43.64
	Average	152.98	135.24	139.05	127.73	94.51	49.53
	SD	2.83	4.17	5.27	7.92	4.70	5.35
0.125	1	110.53	126.19	111.49	134.87	108.04	61.72
	2	112.79	116.27	119.48	134.37	107.32	58.95
	3	112.07	115.46	113.88	136.84	101.80	69.16
	Average	111.80	119.31	114.95	135.36	105.72	63.28
	SD	1.15	5.97	4.10	1.31	3.41	5.28
0.25	1	127.77	118.09	113.00	137.50	111.70	68.18
	2	118.31	122.34	118.60	122.50	118.07	67.05
	3	125.00	111.23	117.24	127.53	122.50	58.90
	Average	123.69	117.22	116.28	129.18	117.42	64.71
	SD	4.86	5.61	2.92	7.63	5.43	5.06
0.50	1	120.20	122.38	118.98	124.68	128.40	69.23
	2	115.05	123.39	119.25	125.81	126.56	69.41
	3	116.33	130.98	113.43	131.67	116.83	68.25
	Average	117.19	125.58	117.22	127.39	123.93	68.96
	SD	2.68	4.70	3.29	3.75	6.22	0.62

Table B4 Degree of swelling of the chitin/cellulose blend films when the blend films immersed in 0.05, 0.125, 0.25 and 0.50 M FeCl₃ solutions.

FeCl ₃ concentrations (M)	Samples	Cellulose content (%)					
		0	20	40	60	80	100
0.05	1	156.52	144.25	144.44	148.89	105.88	54.05
	2	150.61	147.5	148.89	142.86	101.06	49.35
	3	149.31	143.77	137.37	135.04	103.00	52.00
	Average	152.15	145.17	14.57	142.26	103.31	51.8
	SD	3.84	2.03	5.81	6.94	2.43	2.36
0.125	1	138.42	137.4	148.11	146.5	118.91	71.11
	2	147.61	133.14	147.22	141.58	117.07	73.33
	3	154.55	136.67	143.87	158.62	121.74	71.01
	Average	146.86	135.74	146.4	148.9	119.24	71.82
	SD	8.09	2.28	2.24	8.77	2.35	1.31
0.25	1	130.68	117.5	134.09	134.42	110.59	67.69
	2	120	118.29	130	140	109.41	54.34
	3	129.47	116.82	130.9	127.85	97.67	52.85
	Average	126.72	117.54	131.66	134.09	105.89	58.29
	SD	5.85	0.74	2.15	6.08	7.14	8.17
0.50	1	142.06	124.37	124.34	131.7	130.55	65.11
	2	153.27	123.33	122	136.57	129.4	61.21
	3	150	129.41	127.36	135.11	125.8	69.91
	Average	148.44	125.7	124.57	134.46	128.58	65.41
	SD	5.76	3.25	2.69	2.50	2.48	4.36

Table B5 Degree of swelling of the chitin/cellulose blend films when the blend films immersed in 0.05, 0.125, 0.25 0.50 M AlCl_3 .

AlCl_3 concentrations (M)	Samples	Cellulose content (%)					
		0	20	40	60	80	100
0.05	1	162.50	132.87	136.92	124.11	92.54	63.12
	2	157.03	134.61	132.00	122.11	101.39	54.54
	3	155.33	135.3	128.68	132.71	88.00	55.88
	Average	158.29	134.26	132.53	126.31	93.98	57.85
	SD	3.75	1.25	4.15	5.63	6.81	4.62
0.125	1	138.42	137.4	148.11	146.5	118.91	71.11
	2	147.61	133.14	147.22	141.58	117.07	73.33
	3	154.55	136.67	143.87	158.62	121.74	71.01
	Average	146.86	135.74	146.4	148.9	119.24	71.82
	SD	8.09	2.28	2.24	8.77	2.35	1.31
0.25	1	130.68	117.5	134.09	134.42	110.59	67.69
	2	120	118.29	130.00	140.00	109.41	54.34
	3	129.47	116.82	130.9	127.85	97.67	52.85
	Average	126.72	117.54	131.66	134.09	105.89	58.29
	SD	5.85	0.74	2.15	6.08	7.14	8.17
0.50	1	142.06	124.37	124.34	131.7	130.55	65.11
	2	153.27	123.33	122	136.57	129.4	61.21
	3	150	129.41	127.36	135.11	125.8	69.91
	Average	148.44	125.7	124.57	134.46	128.58	65.41
	SD	5.76	3.25	2.69	2.50	2.48	4.36

APPENDIX C

Table C Degree of swelling of the chitin/cellulose blend films at various pH solutions.

pH	Samples	Cellulose content (%)					
		0	20	40	60	80	100
3	1	172.72	205.53	192.22	164.14	109.48	68.84
	2	178.07	205.55	190.53	162.50	105.66	61.67
	3	175.10	193.61	191.86	170.00	111.75	62.50
	Average	175.30	201.56	191.54	165.55	108.96	64.34
	SD	2.68	6.89	0.89	3.94	3.08	3.92
5	1	157.81	178.70	166.41	165.17	109.35	68.03
	2	153.85	177.12	168.91	161.72	108.08	67.42
	3	150.85	173.26	161.11	163.49	107.27	66.23
	Average	154.17	176.36	165.48	163.46	108.23	67.23
	SD	3.49	2.80	3.98	1.73	1.05	0.92
7	1	134.78	161.06	164.50	159.68	103.33	62.50
	2	140.00	159.57	163.54	150.00	91.36	57.63
	3	139.47	171.76	156.96	153.38	92.86	59.09
	Average	138.08	164.13	161.67	154.35	95.85	59.74
	SD	2.87	6.65	4.10	4.91	6.52	2.50
10	1	128.13	163.64	159.33	148.86	98.44	62.59
	2	127.50	163.01	158.14	144.54	93.13	62.84
	3	139.08	163.70	153.94	154.81	83.33	62.18
	Average	131.57	163.45	157.14	149.40	91.63	62.54
	SD	6.51	0.38	2.83	5.16	7.67	0.33

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