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## APPENDIX

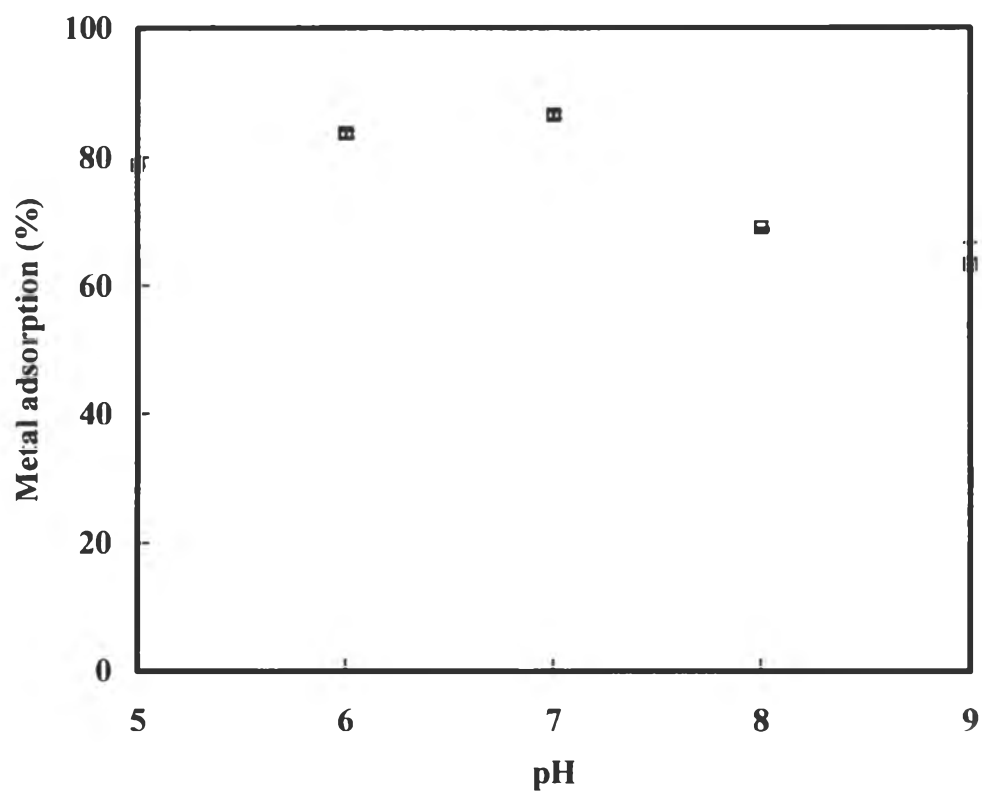
**Table A1** Degree of deacetylation of chitosan at various concentration of NaOH and reaction time (at 110°C).

Time (min)	Specimens	%NaOH					
		0	10	20	-30	40	50
10	1	33.737	36.067	37.891	50.045	64.000	78.868
	2	32.069	33.706	37.552	50.308	63.761	78.926
	3	33.439	35.207	36.283	49.413	63.571	77.983
	average	33.082	34.993	37.242	49.922	63.777	78.592
	STD	0.890	1.195	0.848	0.460	0.215	0.528
20	1	34.584	38.551	39.695	50.267	65.423	82.162
	2	33.976	39.132	38.579	49.682	66.853	82.771
	3	34.408	37.440	38.105	49.396	64.327	81.766
	average	34.323	38.374	38.793	49.782	65.534	82.233
	STD	0.313	0.860	0.816	0.444	1.267	0.506
30	1	33.733	36.618	42.387	51.185	66.349	80.151
	2	32.297	36.506	43.957	48.194	67.407	79.236
	3	-	35.959	41.107	51.634	66.203	79.403
	average	33.015	36.361	42.484	50.338	66.653	79.597
	STD	1.015	0.353	1.427	1.870	0.657	0.487
40	1	30.583	37.717	43.989	49.366	72.442	79.813
	2	31.973	34.873	40.575	52.679	73.728	80.296
	3	30.068	37.066	40.702	53.161	73.176	80.084
	average	30.875	36.552	41.755	51.735	73.115	80.064
	STD	0.985	1.490	1.935	2.066	0.645	0.242
60	1	35.864	32.75	40.547	53.869	70.931	81.159
	2	32.549	40.96	43.135	52.525	72.446	80.12
	3	32.182	38.759	42.122	51.594	70.568	78.747
	average	33.532	37.490	41.935	52.663	71.315	80.009
	STD	2.028	4.250	1.304	1.144	0.996	1.210

**Table A2** Elemental analysis results.

Derivatives	specimens	%C	%H	%N
H-1 chitosan	1	60.764	8.903	2.979
	2	60.657	9.086	2.823
	average	60.711	8.995	2.901
H-2 chitosan	1	65.992	9.378	2.346
	2	65.983	9.435	2.319
	3	65.939	9.621	2.269
	average	65.971	9.478	2.311
H-3 chitosan	1	66.057	8.773	2.249
	2	65.992	8.929	2.284
	average	66.024	8.851	2.266
Ph-chitosan	1	54.106	4.146	3.083
	2	54.022	4.136	3.323
	average	54.064	4.141	3.203
H-Ph-chitosan	1	64.595	7.070	2.540
	2	64.507	7.096	2.440
	average	64.551	7.083	2.490
H-P chitosan	1	49.821	6.830	2.408
	2	49.872	7.001	2.432
	average	49.847	6.916	2.420

**Table A3** Effect of pH of  $\text{Cu}^{2+}$  solution on metal adsorption of chitosan at 24 h of immersion.



**Table A4** Cu<sup>2+</sup> adsorption of chitin film 22 %DD.

Contact time (h)	Cu <sup>2+</sup> ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	2.60	1.57	2.07	2.08	0.52	0.51
1	2.60	2.09	3.11	2.60	0.51	0.51
2	2.08	2.62	3.62	2.78	0.85	0.69
3	2.60	1.57	3.11	2.43	0.68	0.86
6	1.84	2.09	1.55	1.22	0.88	1.22
12	1.04	2.09	2.07	1.74	0.36	0.69
24	1.56	1.57	2.59	1.91	0.68	0.35
48	1.04	1.05	1.55	1.21	0.34	0.17
72	0.52	1.57	1.04	1.04	0.53	0.52

**Table A5**  $\text{Cu}^{2+}$  adsorption of chitosan film 70 %DD.

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	21.28	23.40	26.74	23.81	2.93	2.53
1	33.51	36.70	39.04	36.42	2.62	2.91
2	47.87	52.66	55.61	52.05	3.57	4.18
3	59.04	63.83	64.71	62.53	2.18	3.48
6	72.34	76.06	73.26	73.89	2.18	1.55
12	76.60	78.72	75.40	76.91	1.82	1.51
24	77.13	78.72	78.94	78.26	0.67	1.13
48	81.38	81.91	81.28	81.53	0.63	0.24
72	82.98	82.45	81.82	82.41	0.56	0.60



**Table A6**  $\text{Cu}^{2+}$  adsorption of chitosan film 85 %DD.

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	44.85	44.27	43.75	44.29	0.56	0.54
1	57.73	55.20	56.77	56.57	1.16	1.36
2	73.20	71.35	73.44	72.66	0.77	1.31
3	79.38	78.65	79.69	79.24	0.45	1.04
6	83.51	83.33	83.85	83.56	0.29	0.23
12	84.02	83.85	84.38	84.08	0.29	0.52
24	86.60	85.94	86.98	86.50	0.47	0.57
48	87.11	86.46	87.50	87.02	0.48	0.57
72	86.60	85.94	85.42	85.98	0.61	0.57

**Table A7** Cu<sup>2+</sup> adsorption of chitosan film 92 %DD.

Contact time (h)	Cu <sup>2+</sup> ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	21.13	21.88	24.47	22.50	1.98	1.36
1	31.96	36.98	35.42	34.78	2.19	2.83
2	55.15	58.85	58.85	57.62	1.23	2.47
3	70.10	70.83	72.40	71.11	1.29	1.01
6	90.21	90.10	90.10	90.21	0.00	0.10
12	93.30	92.71	93.23	93.30	0.00	0.59
24	94.33	93.75	93.75	94.33	0.00	0.58
48	95.36	94.79	94.79	95.36	0.00	0.57
72	95.36	94.79	95.31	95.36	0.00	0.57

**Table A8**  $\text{Cu}^{2+}$  adsorption of H-1chitosan (powder).

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error	Error
	X1	X2	X3		+	-
0	0	0	0	0	0	0
0.5	10.39	10.61	7.92	9.64	0.97	1.72
1	12.92	8.06	9.05	10.01	2.91	1.95
2	12.92	8.06	10.18	10.39	2.53	2.33
3	13.33	10.75	10.61	11.56	1.77	0.96
6	23.45	14.14	12.45	16.68	6.77	4.23
12	19.66	20.93	13.86	18.15	2.78	4.29
24	22.18	24.47	25.32	23.99	1.33	1.81
48	33.84	27.30	25.17	28.77	5.07	3.59
72	36.36	30.83	39.60	35.60	4.00	4.77

**Table A9**  $\text{Cu}^{2+}$  adsorption of H-2 chitosan (film).

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error	Error
	X1	X2	X3		+	-
0	0	0	0	0	0	0
0.5	3.14	2.13	3.14	2.80	0.34	0.68
1	2.62	2.13	2.62	2.45	0.16	0.33
2	3.14	2.13	3.14	2.80	0.34	0.68
3	2.62	1.60	2.62	2.28	0.34	0.68
6	2.09	1.06	3.14	2.09	1.05	1.03
12	3.14	2.13	3.66	3.14	0.52	1.01
24	2.62	2.13	3.66	2.62	1.05	0.49
48	4.71	2.66	4.19	4.71	0.00	2.05
72	4.19	4.26	5.76	4.19	1.57	0.00

**Table A10**  $\text{Cu}^{2+}$  adsorption of H-3 chitosan (film).

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	0	1.60	1.61	1.07	0.54	1.07
1	1.07	0.53	0.54	0.71	0.36	0.18
2	0.53	1.60	0.54	0.89	0.71	0.36
3	1.07	0.53	1.07	0.89	0.18	0.36
6	1.07	0.53	1.07	0.89	0.18	0.36
12	1.07	2.14	1.61	1.61	0.53	0.54
24	1.60	1.60	0	1.07	0.53	1.07
48	1.07	1.60	1.08	1.25	0.35	0.18
72	1.60	1.07	1.61	1.43	0.18	0.36

**Table A11**  $\text{Cu}^{2+}$  adsorption of H-P chitosan (powder).

Contact time (h)	$\text{Cu}^{2+}$ ion collected (%)			Average	Error +	Error -
	X1	X2	X3			
0	0	0	0	0	0	0
0.5	3.78	3.01	5.45	4.21	1.63	1.20
1	2.57	5.27	6.60	4.81	1.79	2.24
2	2.27	4.37	5.40	4.01	1.39	1.74
3	4.69	7.07	5.70	5.82	1.25	1.13
6	11.64	5.12	7.35	8.04	3.61	2.92
12	10.74	8.88	5.25	8.29	2.45	3.04
24	8.17	12.04	10.50	10.23	1.81	2.07
48	10.27	10.69	10.05	10.33	0.35	0.06
72	15.57	20.47	16.04	17.36	3.11	1.79

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