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APPENDICES

Appendix A FTIR results

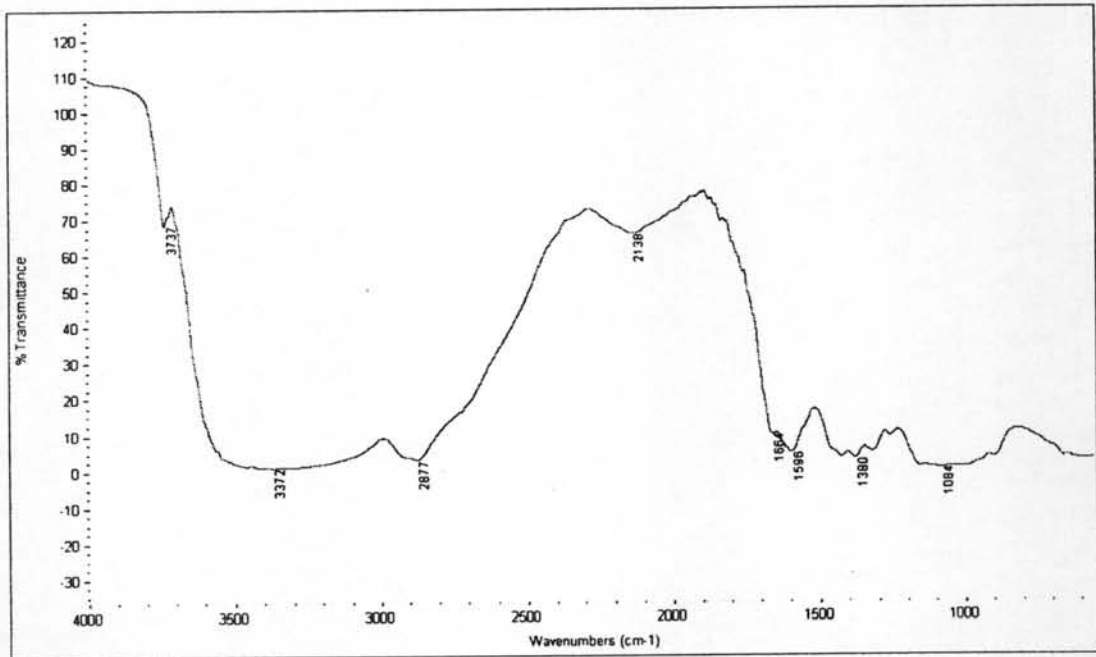


Figure A1 FTIR spectrum of unmodified low molecular weight chitosan.

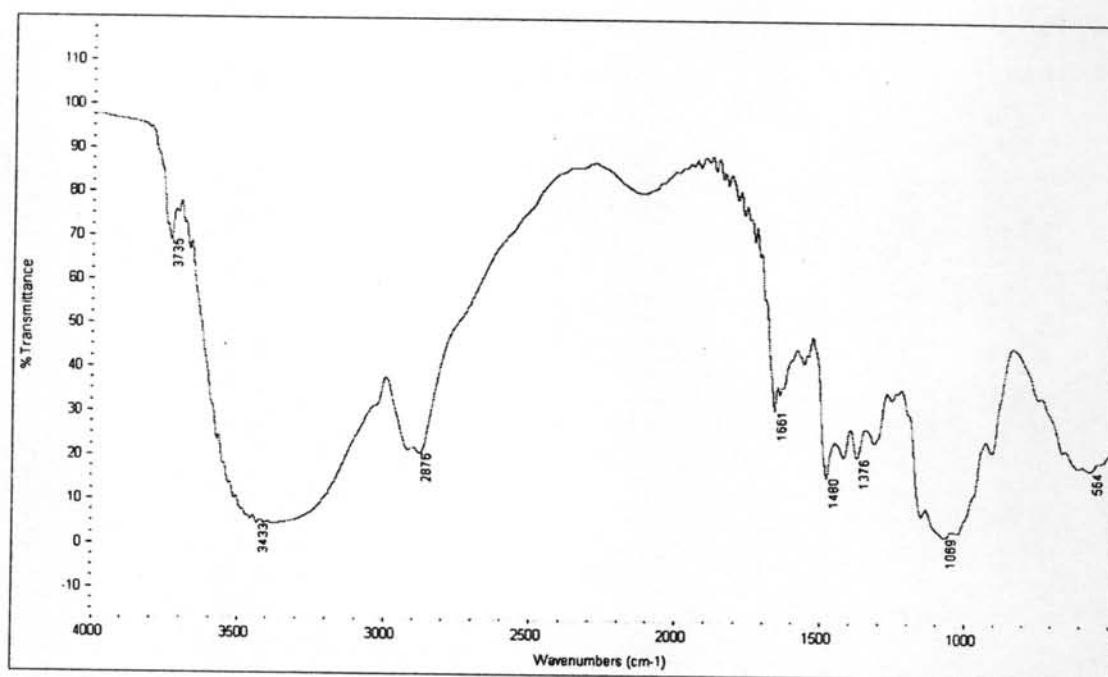


Figure A2 FTIR spectrum of modified low molecular weight chitosan (1:1 ratio).

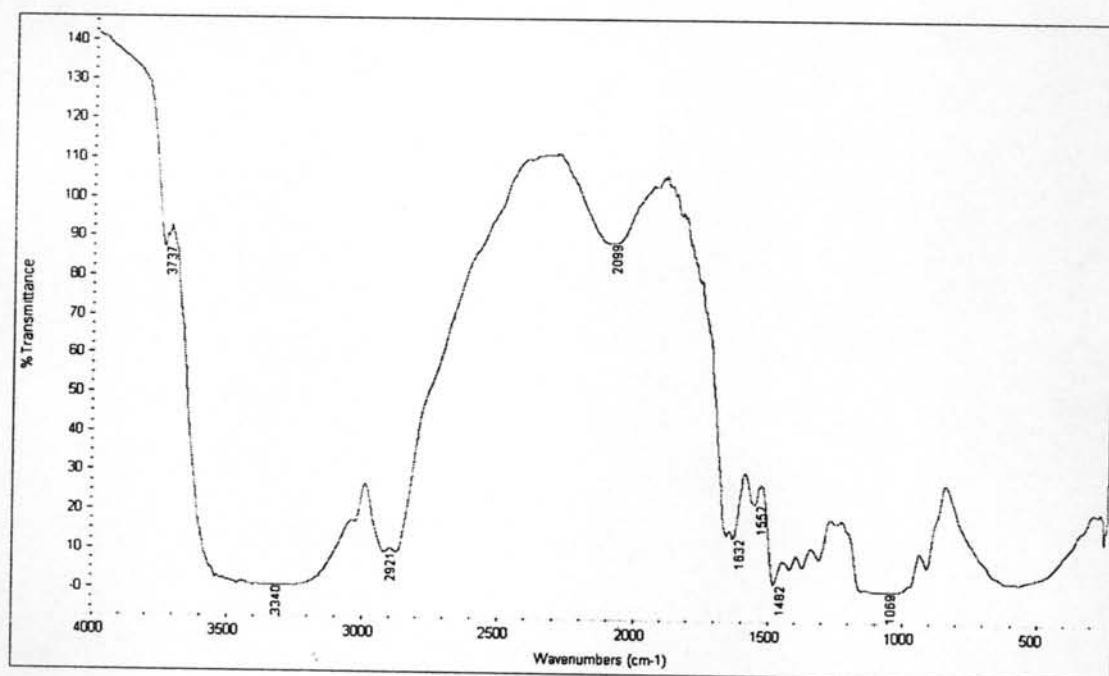


Figure A3 FTIR spectrum of modified low molecular weight chitosan (1:1.5 ratio).

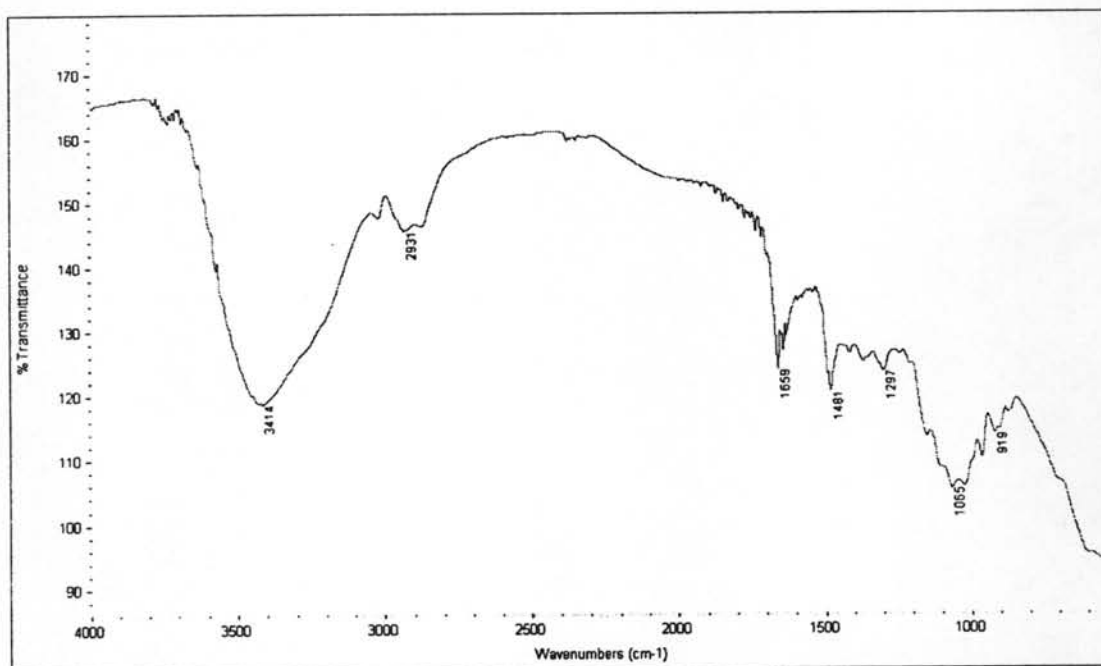


Figure A4 FTIR spectrum of modified low molecular weight chitosan (1:4 ratio).

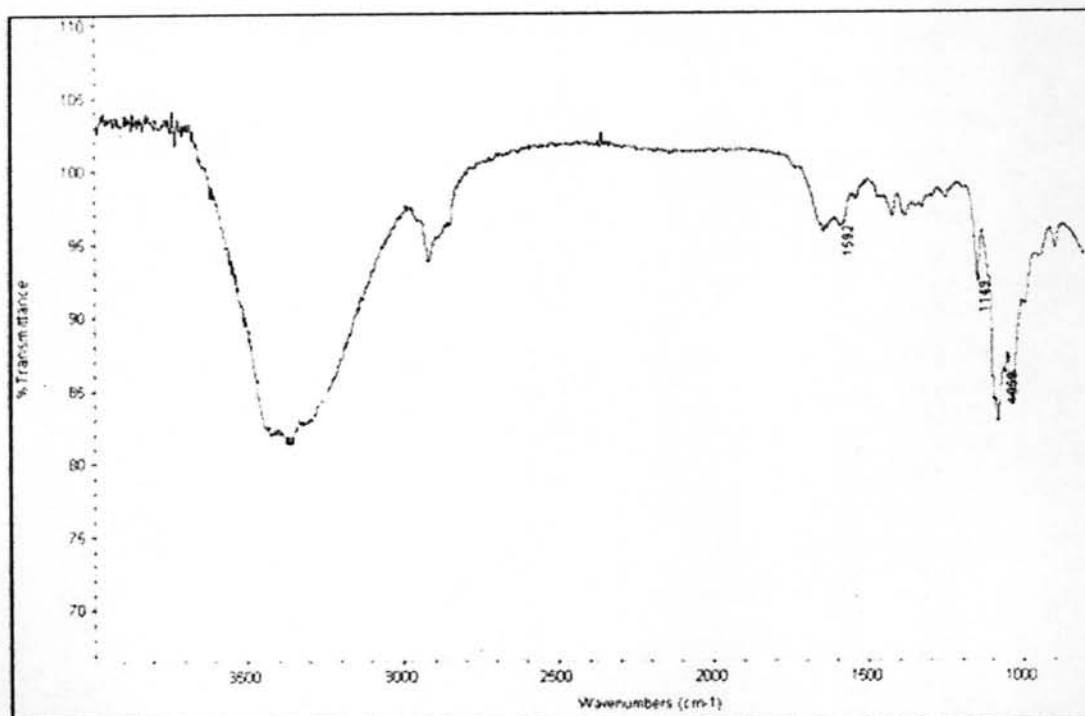


Figure A5 FTIR spectrum of unmodified medium molecular weight chitosan.

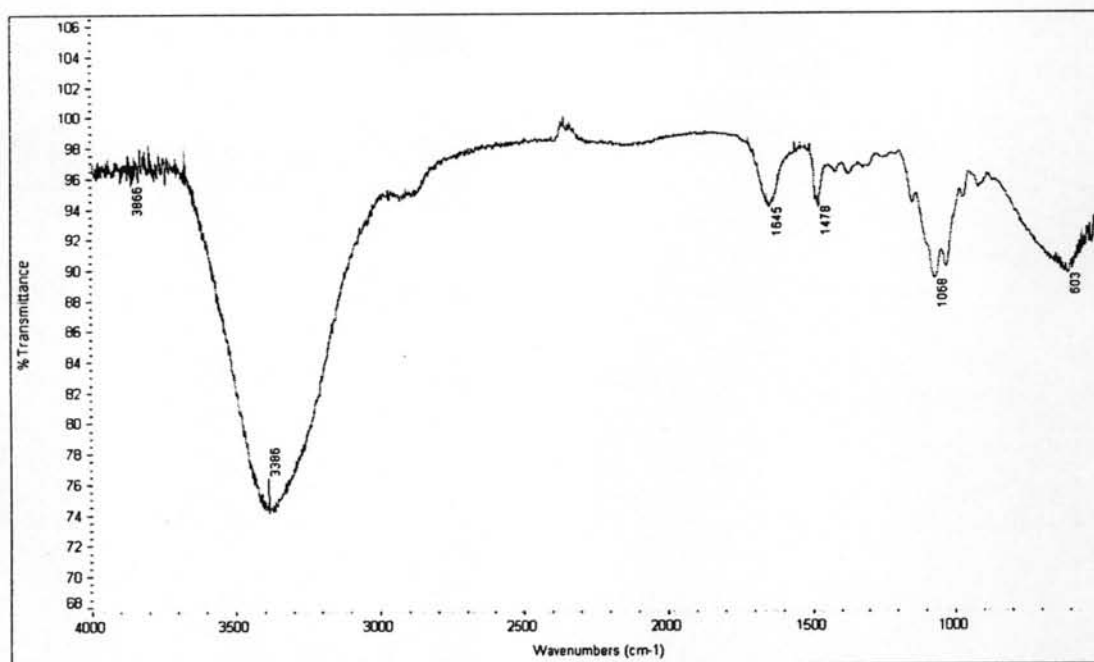


Figure A6 FTIR spectrum of modified medium molecular weight chitosan (1:1 ratio).

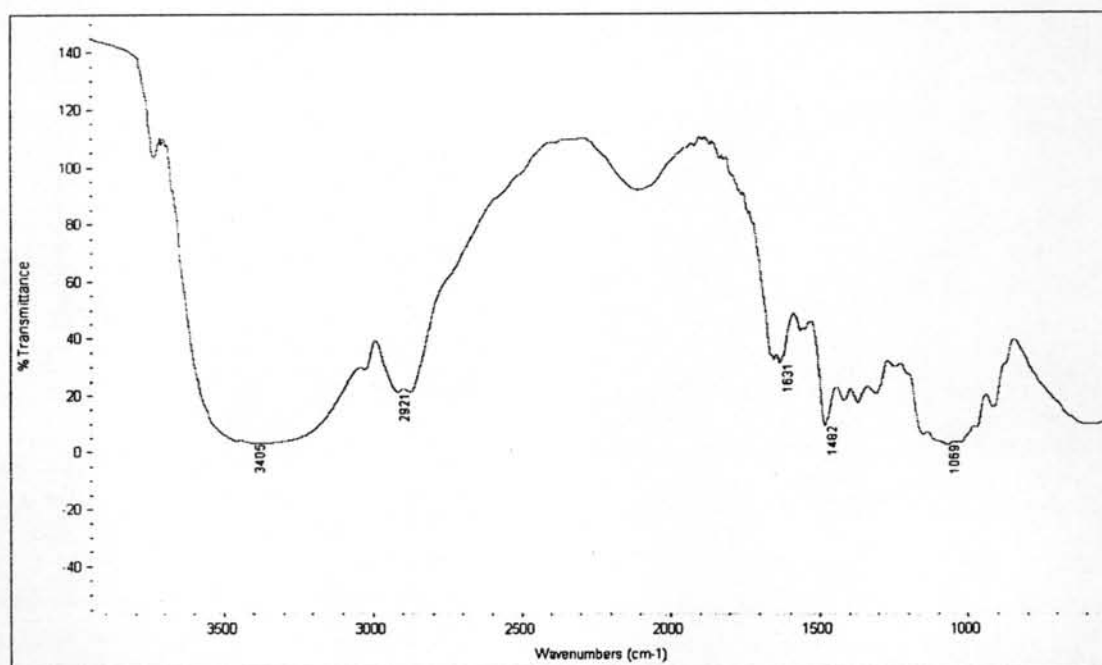


Figure A7 FTIR spectrum of modified medium molecular weight chitosan (1:1.5 ratio).

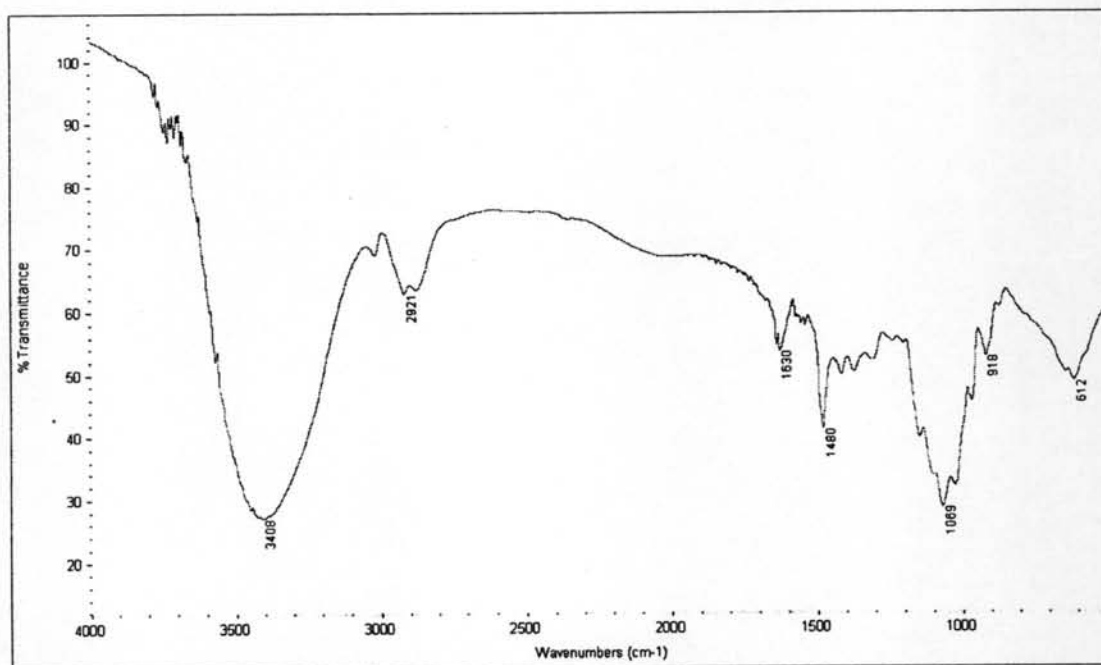


Figure A8 FTIR spectrum of modified medium molecular weight chitosan (1:4 ratio).

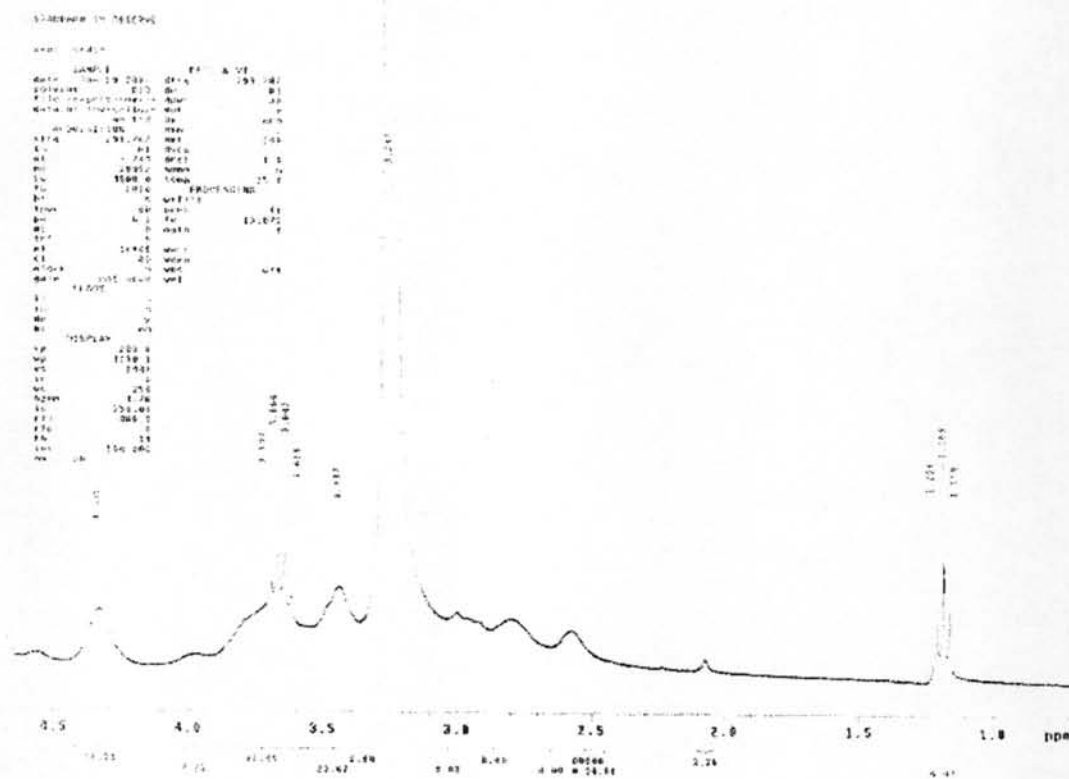


Figure B4 $^1\text{H-NMR}$ of modified low molecular weight chitosan (1:4 ratio).

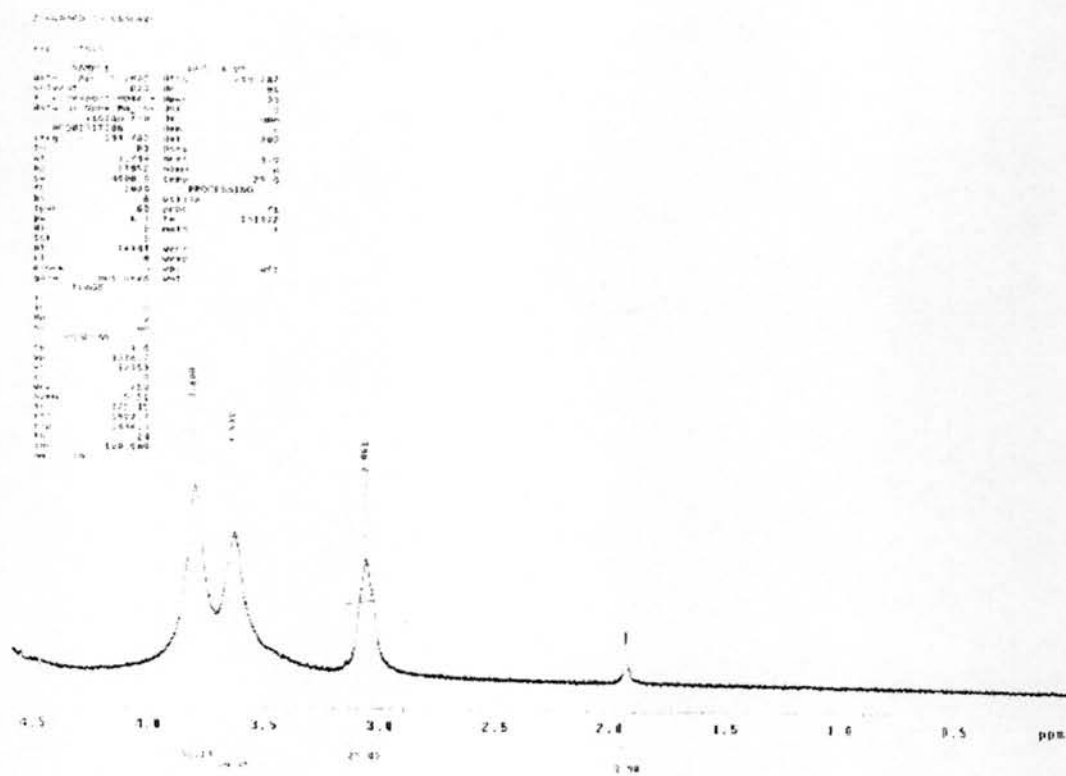


Figure B5 $^1\text{H-NMR}$ of unmodified medium molecular weight.

Appendix C Adsorption of modified chitosan on pulp

Table C1 Adsorption amount of modified chitosan on pulp

Amount of chitosan added (mg)	Amount of chitosan adsorb(mg)
MLC	
2	0.85
6	0.80
10	0.82
14	0.88
MMC	
2	0.70
6	0.75
10	0.98
14	1.15

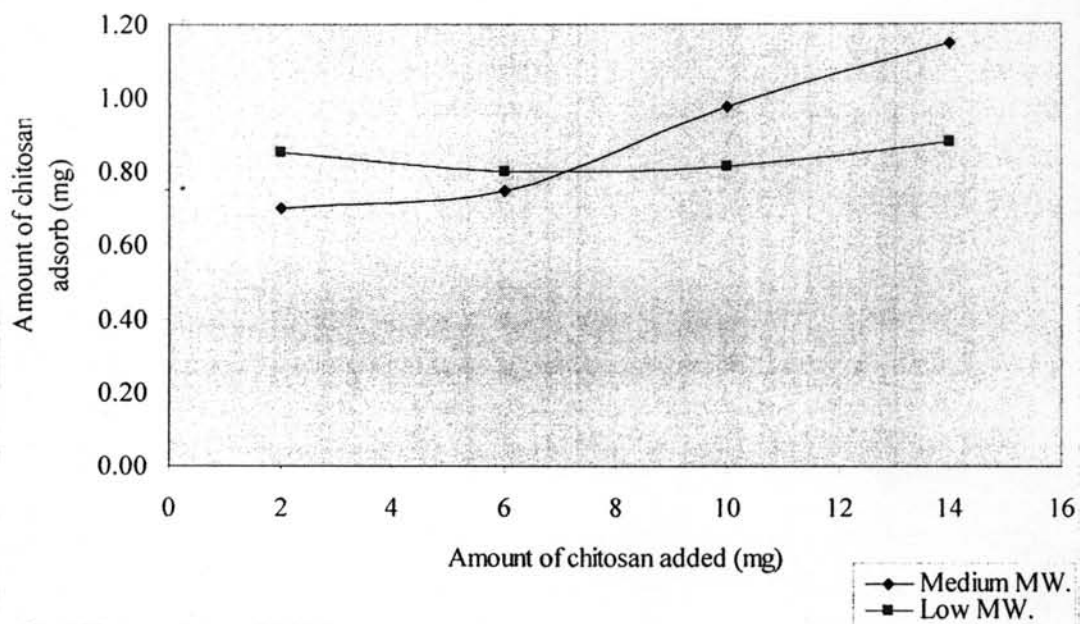


Figure C1 Adsorption curve of modified chitosan.

Appendix D Calculation of charge density

D1 Charge density calculation

$$\text{Charge density} = \frac{V_a \times C_a}{C_s \times V_s}$$

Where

Charge density = Charge density of sample, meq/g

V_a = Volume of opposite charge solution, ml

V_s = Volume of sample, ml

C_a = Concentration of opposite charge solution, mN

C_s = Concentration of sample, g/ml

Appendix E Mechanical and optical properties of handsheets

Table E1 Mechanical and optical properties of handsheets of blank and CMC samples

Conditions	tensile index, N-m/kg	burst index, kPa-m ² /g	tear index, N-m ² /kg	scattering coefficient, %	brightness,% ISO
Blank	11.73	0.65	9.70	37.91	90.66
CMC9	10.85	0.66	9.63	39.00	91.47
CMC25	12.24	0.74	10.32	38.88	90.02

Table E2 Mechanical and optical properties of handsheets vary by % modified low molecular weight chitosan

Conditions	tensile index, N-m/kg	burst index, kPa-m ² /g	tear index, N-m ² /kg	scattering coefficient, %	brightness, %ISO
MLC 0.2%	12.91	0.71	11.13	42.02	86.83
MLC 0.6%	13.39	0.76	10.93	38.63	84.89
MLC 1.0%	13.30	0.76	10.20	40.19	84.70
MLC 0.2%+CMC9 (1.0)	13.60	0.84	11.72	38.38	88.08
MLC 0.6%+CMC9 (1.0)	15.85	0.92	11.56	38.48	87.07
MLC 1.0%+CMC9 (1.0)	18.67	1.37	11.45	38.62	86.76
MLC 0.2%+CMC25 (1.0)	15.16	1.02	11.75	37.53	88.01
MLC 0.6%+CMC25 (1.0)	20.71	1.34	11.27	38.97	87.24
MLC 1.0%+CMC25 (1.0)	25.49	1.76	9.72	36.36	86.28

Table E3 Mechanical and optical properties of handsheets vary by % modified medium molecular weight chitosan

Conditions	tensile index, N-m/kg	burst index, kPa-m ² /g	tear index, N-m ² /kg	scattering coefficient, %	brightness, %ISO
MMC 0.2%	12.52	0.77	11.45	40.79	86.32
MMC 0.6%	12.48	0.77	10.76	38.48	85.22
MMC 1.0%	13.56	0.77	10.78	38.96	84.85
MMC 0.2%+CMC9 (1.0)	14.53	0.85	11.81	40.38	88.08
MMC 0.6%+CMC9 (1.0)	18.72	1.29	11.57	37.69	86.73
MMC 1.0%+CMC9 (1.0)	20.90	1.53	10.75	38.38	86.06
MMC 0.2%+CMC25 (1.0)	14.87	0.95	11.42	39.88	87.84
MMC 0.6%+CMC25 (1.0)	17.29	1.30	10.94	39.76	86.59
MMC 1.0%+CMC25 (1.0)	20.23	1.54	10.49	39.48	85.54

Table E4 Mechanical and optical properties of handsheets vary by ratio of CMC9

Conditions	tensile index, N-m/kg	burst index, kPa-m ² /g	tear index, N-m ² /kg	scattering coefficient, %	brightness, % ISO
MLC 0.2%+CMC9 (0)	12.91	0.71	11.13	42.02	86.83
MLC 0.2%+CMC9 (0.5)	15.24	0.96	11.75	37.70	87.24
MLC 0.2%+CMC9 (1.0)	13.60	0.84	11.72	38.38	88.08
MLC 0.2%+CMC9 (1.5)	15.29	0.97	11.70	39.35	88.12
MMC 0.2%+CMC9 (0)	12.52	0.77	11.45	40.79	86.32
MMC 0.2%+CMC9 (0.5)	14.27	0.88	10.79	40.19	86.26
MMC 0.2%+CMC9 (1.0)	14.53	0.85	11.81	40.38	88.08
MMC 0.2%+CMC9 (1.5)	14.81	0.89	12.44	40.43	88.28

Table E5 Mechanical and optical properties of handsheets vary by ratio of CMC25

Conditions	tensile index, N-m/kg	burst index, kPa-m ² /g	tear index, N-m ² /kg	scattering coefficient, %	brightness, %ISO
MLC 0.2%+CMC25 (0)	12.91	0.71	11.13	42.02	86.83
MLC 0.2%+CMC25 (0.5)	14.93	1.01	11.12	39.08	86.74
MLC 0.2%+CMC25 (1.0)	15.16	1.02	11.75	37.53	87.01
MLC 0.2%+CMC25 (1.5)	15.30	0.99	12.01	38.49	87.96
MMC 0.2%+CMC25 (0)	12.52	0.77	11.45	40.79	86.32
MMC 0.2%+CMC25 (0.5)	14.26	0.91	11.21	40.39	86.44
MMC 0.2%+CMC25 (1.0)	14.87	0.95	11.42	39.88	87.84
MMC 0.2%+CMC25 (1.5)	15.08	1.02	12.03	40.10	88.10

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