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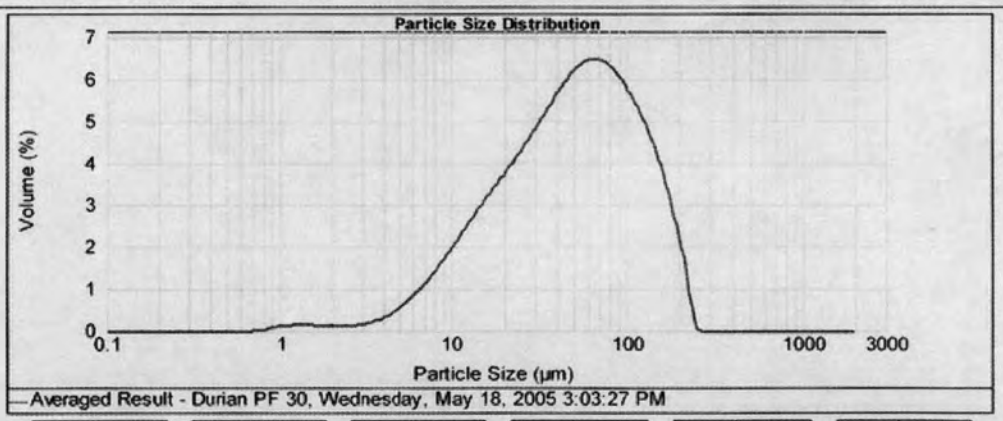
APPENDICES

APPENDIX I

The details of particle size distribution of MCC prepared from durian fruit-hulls; (a) 30-g batch isolation, (b) 300-g batch isolation, (c) 3000-g batch isolation, (d) commercial MCC (Avicel PH101®).

(a) 30-g batch isolation

Sample Name: Averaged Result - Durian PF 30	**SOP Name:**	**Measured:** Wednesday, May 18, 2005 3:03:27 PM	
Sample Source & type:	**Measured by:** Owner	**Analysed:** Wednesday, May 18, 2005 3:03:28 PM	
Sample bulk lot ref:	**Result Source:** Averaged		
Particle Name: Default	**Accessory Name:** Scirocco 2000 (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.520	**Absorption:** 0.1	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 0.13 %
Dispersant Name: Dry dispersion	**Dispersant RI:** 1.000	**Weighted Residual:** 3.361 %	**Result Emulation:** Off
Concentration: 0.0001 %Vol	**Span :** 2.548	**Uniformity:** 0.777	**Result units:** Volume
Specific Surface Area: 0.246 m²/g	**Surface Weighted Mean D[3,2]:** 24.387 um	**Vol. Weighted Mean D[4,3]:** 63.549 um	
d(0.1): 11.946 um	d(0.5): 49.781 um	d(0.9): 138.812 um	



Size (µm)	Volume In %
0.010	0.00
0.011	0.00
0.013	0.00
0.015	0.00
0.017	0.00
0.020	0.00
0.023	0.00
0.026	0.00
0.030	0.00
0.035	0.00
0.040	0.00
0.046	0.00
0.052	0.00
0.060	0.00
0.069	0.00
0.079	0.00
0.091	0.00
0.105	0.00

Size (µm)	Volume In %
0.105	0.00
0.120	0.00
0.138	0.00
0.158	0.00
0.182	0.00
0.209	0.00
0.240	0.00
0.275	0.00
0.316	0.00
0.363	0.00
0.417	0.00
0.479	0.00
0.550	0.00
0.631	0.00
0.724	0.00
0.832	0.01
0.955	0.07
1.096	0.11

Size (µm)	Volume In %
1.096	0.13
1.259	0.13
1.445	0.13
1.660	0.12
1.905	0.11
2.188	0.11
2.512	0.12
2.884	0.15
3.311	0.21
3.802	0.30
4.365	0.42
5.012	0.58
5.754	0.78
6.607	1.02
7.586	1.31
8.710	1.61
10.000	1.94
11.482	1.90

Size (µm)	Volume In %
11.482	2.27
13.183	2.60
15.136	2.91
17.378	3.22
19.953	3.52
22.909	3.84
26.303	4.17
30.200	4.53
34.674	4.90
39.811	5.25
45.709	5.56
52.481	5.77
60.256	5.86
69.183	5.80
79.433	5.61
91.201	5.30
104.713	4.90
120.226	0.00

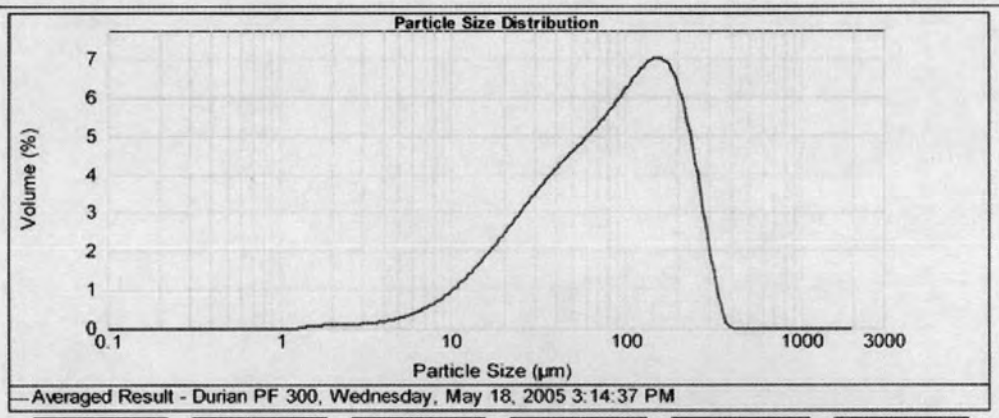
Size (µm)	Volume In %
120.226	4.43
138.038	3.85
158.489	3.10
181.970	2.17
208.930	1.04
239.883	0.00
275.423	0.00
316.228	0.00
363.078	0.00
416.869	0.00
478.630	0.00
549.541	0.00
630.957	0.00
724.436	0.00
831.764	0.00
954.993	0.00
1096.478	0.00
1258.925	0.00

Size (µm)	Volume In %
1258.925	0.00
1445.440	0.00
1659.587	0.00
1905.461	0.00
2187.762	0.00
2511.886	0.00
2884.032	0.00
3311.311	0.00
3801.894	0.00
4365.158	0.00
5011.872	0.00
5754.399	0.00
6606.934	0.00
7585.776	0.00
8709.636	0.00
10000.000	0.00

(b) 300-g batch isolation

Sample Name: Averaged Result - Durian PF 300	**SOP Name:**	**Measured:** Wednesday, May 18, 2005 3:14:37 PM	
Sample Source & type:	**Measured by:** Owner	**Analysed:** Wednesday, May 18, 2005 3:14:38 PM	
Sample bulk lot ref:	**Result Source:** Averaged		
Particle Name: Default	**Accessory Name:** Scirocco 2000 (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.520	**Absorption:** 0.1	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 0.13 %
Dispersant Name: Dry dispersion	**Dispersant RI:** 1.000	**Weighted Residual:** 4.963 %	**Result Emulation:** Off
Concentration: 0.0002 %Vol	**Span :** 2.325	**Uniformity:** 0.731	**Result units:** Volume
Specific Surface Area: 0.148 m^2/g	**Surface Weighted Mean D[3,2]:** 40.560 um	**Vol. Weighted Mean D[4,3]:** 103.691 um	

d(0.1): 18.940 um d(0.5): 85.483 um d(0.9): 217.666 um

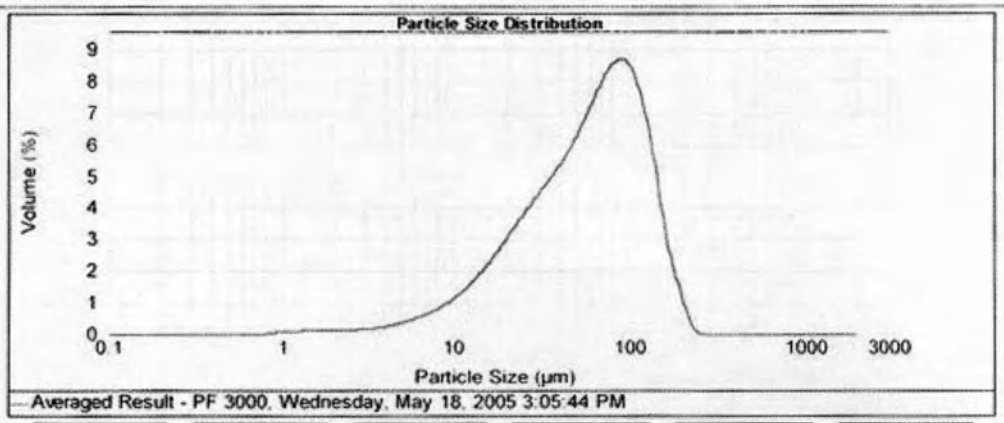


Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	1.19	120.226	6.15	1258.925	0.00
0.011	0.00	0.123	0.00	1.259	0.01	13.183	1.45	138.038	6.33	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.01	15.136	1.72	158.489	6.27	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.01	17.378	2.02	181.970	5.83	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.02	19.953	2.33	208.930	4.95	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.03	22.909	2.66	239.883	3.65	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.04	26.303	2.97	275.423	2.11	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.05	30.200	3.27	316.228	0.81	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.07	34.674	3.56	363.078	0.05	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.09	39.811	3.83	416.869	0.00	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.11	45.709	4.08	478.630	0.00	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.13	52.481	4.33	549.541	0.00	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.16	60.256	4.59	630.957	0.00	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.21	69.183	4.88	724.436	0.00	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.27	79.433	5.18	831.764	0.00	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.35	91.201	5.51	954.993	0.00	10000.000	
0.091	0.00	0.955	0.00	10.000	0.46	104.713	5.85	1096.478	0.00		
0.105	0.00	1.096	0.00	11.482	0.60	120.226		1258.925	0.00		

(c) 3000-g batch isolation

Sample Name: Averaged Result - PF 3000	**SOP Name:**	**Measured:** Wednesday, May 18, 2005 3:05:44 PM	
Sample Source & type:	**Measured by:** Owner	**Analysed:** Wednesday, May 18, 2005 3:05:45 PM	
Sample bulk lot ref:	**Result Source:** Averaged		
Particle Name: Default	**Accessory Name:** Scirocco 2000 (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.520	**Absorption:** 0.1	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 0.08 %
Dispersant Name: Dry dispersion	**Dispersant RI:** 1.000	**Weighted Residual:** 6.160 %	**Result Emulation:** Off
Concentration: 0.0001 %Vol	**Span :** 1.873	**Uniformity:** 0.593	**Result units:** Volume
Specific Surface Area: 0.196 m²/g	**Surface Weighted Mean D[3,2]:** 30.664 um	**Vol. Weighted Mean D[4,3]:** 68.881 um	

d(0.1): 16.324 um d(0.5): 61.750 um d(0.9): 131.982 um

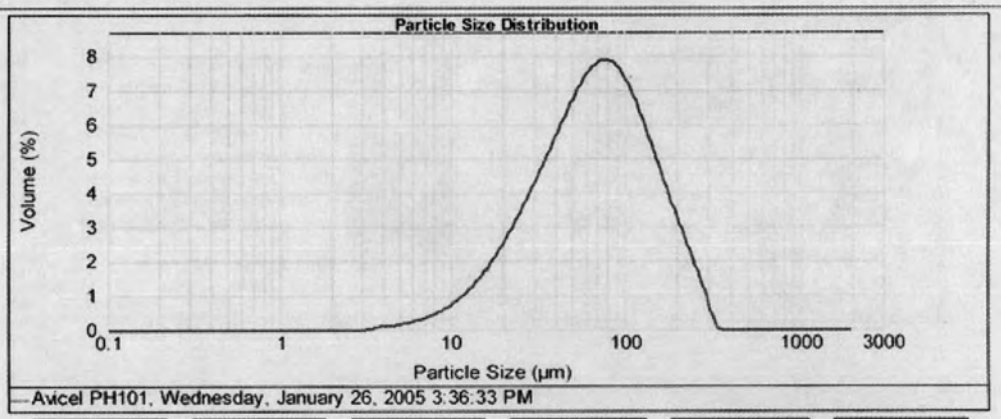


Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.100	0.00	1.000	0.08	11.482	1.40	120.226	5.66	1258.925	0.00
0.011	0.00	0.120	0.00	1.259	0.09	13.183	1.72	138.038	4.17	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.11	15.136	2.08	158.489	2.39	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.11	17.378	2.48	181.970	1.30	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.11	19.953	2.91	208.930	0.37	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.11	22.909	3.33	239.883	0.00	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.12	26.303	3.75	275.423	0.00	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.14	30.200	4.15	316.228	0.00	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.17	34.674	4.55	363.078	0.00	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.22	39.811	5.00	416.869	0.00	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.28	45.709	5.53	478.630	0.00	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.35	52.481	6.15	549.541	0.00	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.45	60.256	6.83	630.957	0.00	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.57	69.183	7.43	724.436	0.00	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.73	79.433	7.85	831.764	0.00	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.94	91.201	7.77	954.993	0.00	10000.000	0.00
0.091	0.00	0.955	0.02	10.000	1.19	104.713	7.14	1096.478	0.00		
0.105	0.00	1.096	0.07	11.482	1.53	120.226	6.14	1258.925	0.00		

(d) commercial MCC (Avicel PH101®)

Sample Name: Avicel PH101	**SOP Name:**	**Measured:** Wednesday, January 26, 2005 3:36:33 PM	
Sample Source & type:	**Measured by:** Owner	**Analysed:** Wednesday, January 26, 2005 3:36:34 PM	
Sample bulk lot ref:	**Result Source:** Measurement		
Particle Name: Default	**Accessory Name:** Scirocco 2000 (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.520	**Absorption:** 0.1	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 0.10 %
Dispersant Name: Dry dispersion	**Dispersant RI:** 1.000	**Weighted Residual:** 2.438 %	**Result Emulation:** Off
Concentration: 0.0001 %Vol	**Span :** 2.157	**Uniformity:** 0.66	**Result units:** Volume
Specific Surface Area: 0.135 m²/g	**Surface Weighted Mean D[3,2]:** 44.499 um	**Vol. Weighted Mean D[4,3]:** 82.924 um	

d(0.1): 21.734 um **d(0.5):** 67.725 um **d(0.9):** 167.827 um

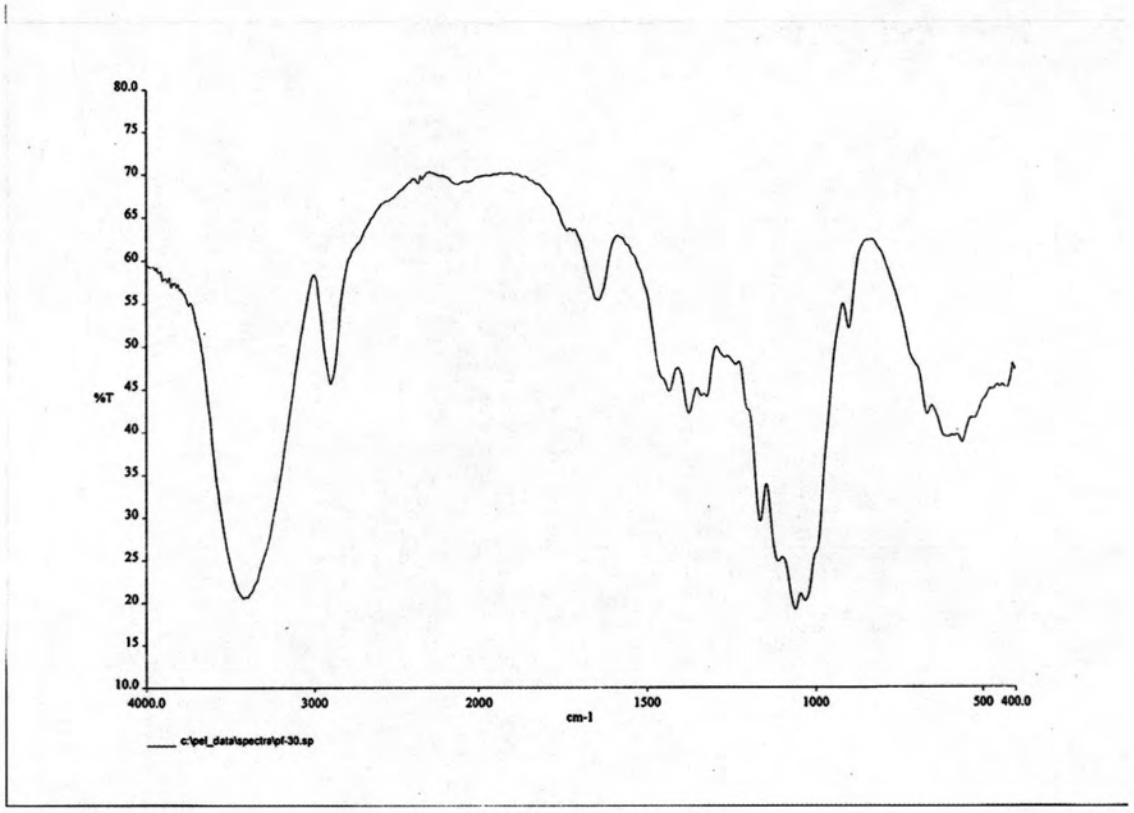


Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %	Size (µm)	Volume In %
0.010	0.00	0.105	0.00	1.096	0.00	11.482	0.97	120.226	5.46	1258.925	0.00
0.011	0.00	0.120	0.00	1.259	0.00	13.183	1.26	138.038	4.66	1445.440	0.00
0.013	0.00	0.138	0.00	1.445	0.00	15.136	1.61	158.489	3.86	1659.587	0.00
0.015	0.00	0.158	0.00	1.660	0.00	17.378	2.02	181.970	3.08	1905.461	0.00
0.017	0.00	0.182	0.00	1.905	0.00	19.953	2.48	208.930	2.33	2187.762	0.00
0.020	0.00	0.209	0.00	2.188	0.00	22.909	2.99	239.883	1.57	2511.886	0.00
0.023	0.00	0.240	0.00	2.512	0.00	26.303	3.53	275.423	0.82	2884.032	0.00
0.026	0.00	0.275	0.00	2.884	0.00	30.200	4.12	316.228	0.04	3311.311	0.00
0.030	0.00	0.316	0.00	3.311	0.04	34.674	4.73	363.078	0.00	3801.894	0.00
0.035	0.00	0.363	0.00	3.802	0.09	39.811	5.35	416.869	0.00	4365.158	0.00
0.040	0.00	0.417	0.00	4.365	0.11	45.709	5.96	478.630	0.00	5011.872	0.00
0.046	0.00	0.479	0.00	5.012	0.16	52.481	6.50	549.541	0.00	5754.399	0.00
0.052	0.00	0.550	0.00	5.754	0.23	60.256	6.91	630.957	0.00	6606.934	0.00
0.060	0.00	0.631	0.00	6.607	0.31	69.183	7.11	724.436	0.00	7585.776	0.00
0.069	0.00	0.724	0.00	7.586	0.42	79.433	7.06	831.764	0.00	8709.636	0.00
0.079	0.00	0.832	0.00	8.710	0.56	91.201	6.74	954.993	0.00	10000.000	
0.091	0.00	0.955	0.00	10.000	0.74	104.713	6.16	1096.478	0.00		
0.105		1.096		11.482		120.226		1258.925			

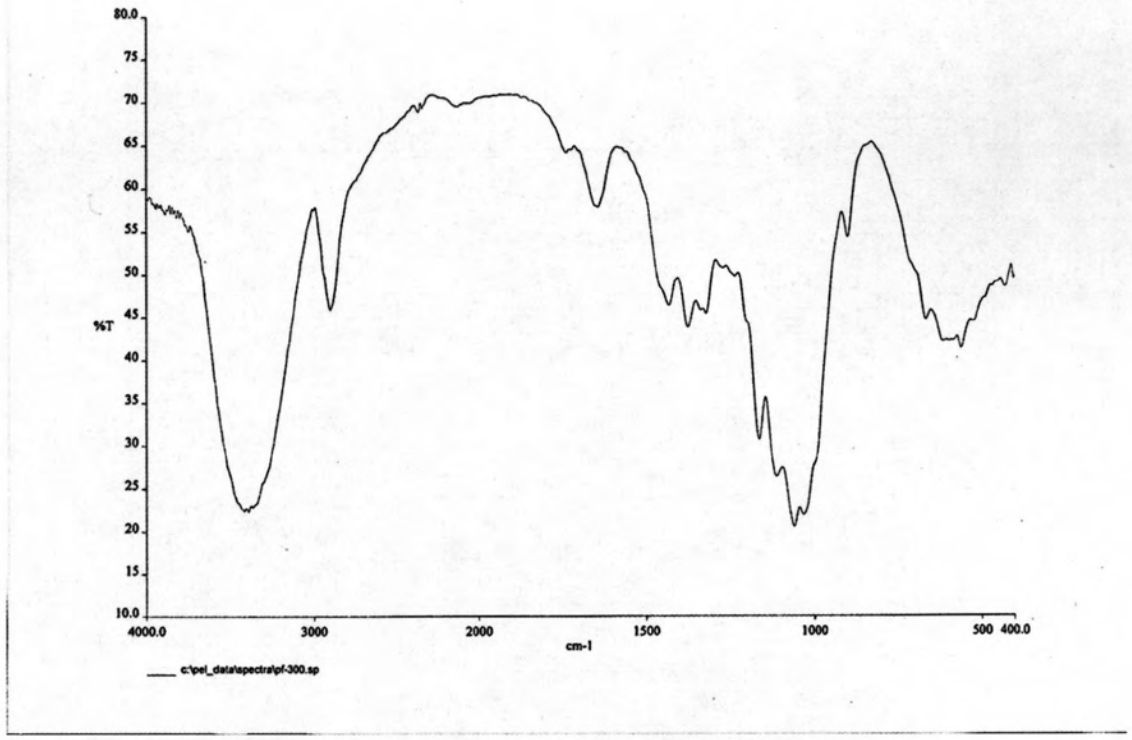
APPENDIX II

The spectra patterns of of MCC prepared from durian fruit-hulls; (a) 30-g batch isolation, (b) 300-g batch isolation, (c) 3000-g batch isolation, (d) commercial MCC (Avicel PH101®). Scan rate 10°C /min.

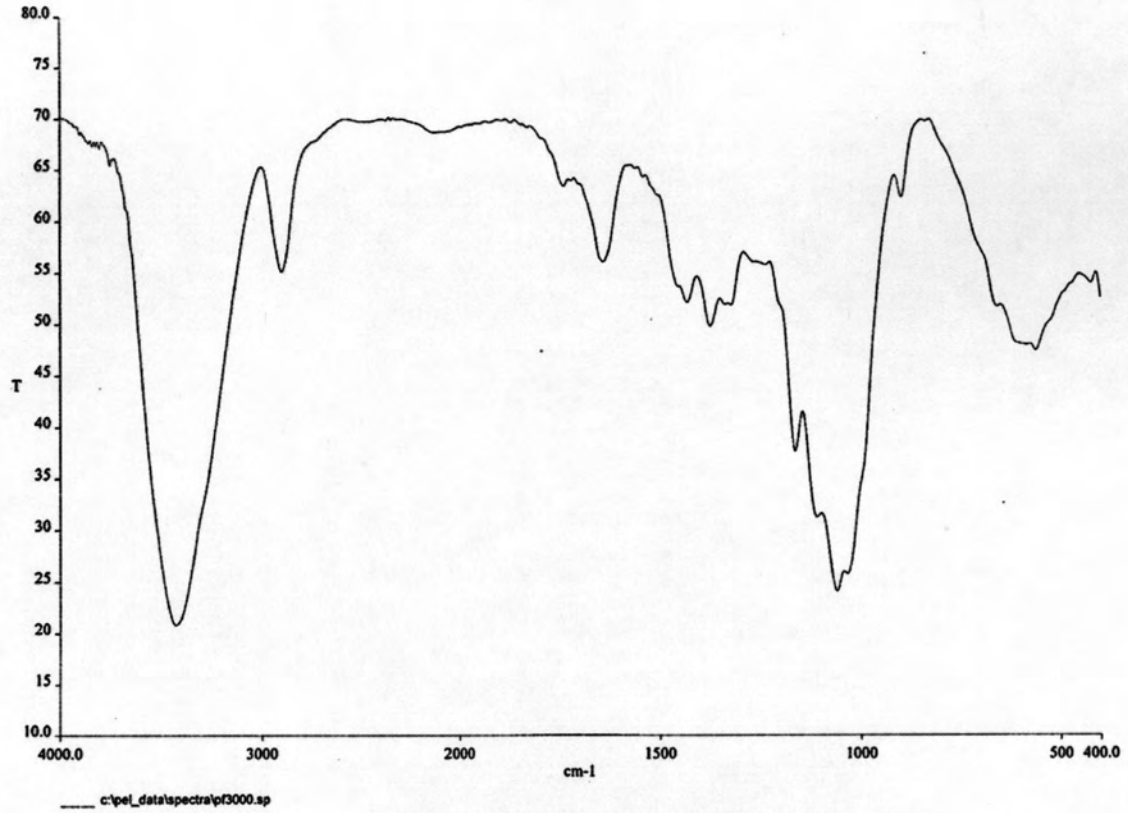
(a) 30-g batch isolation



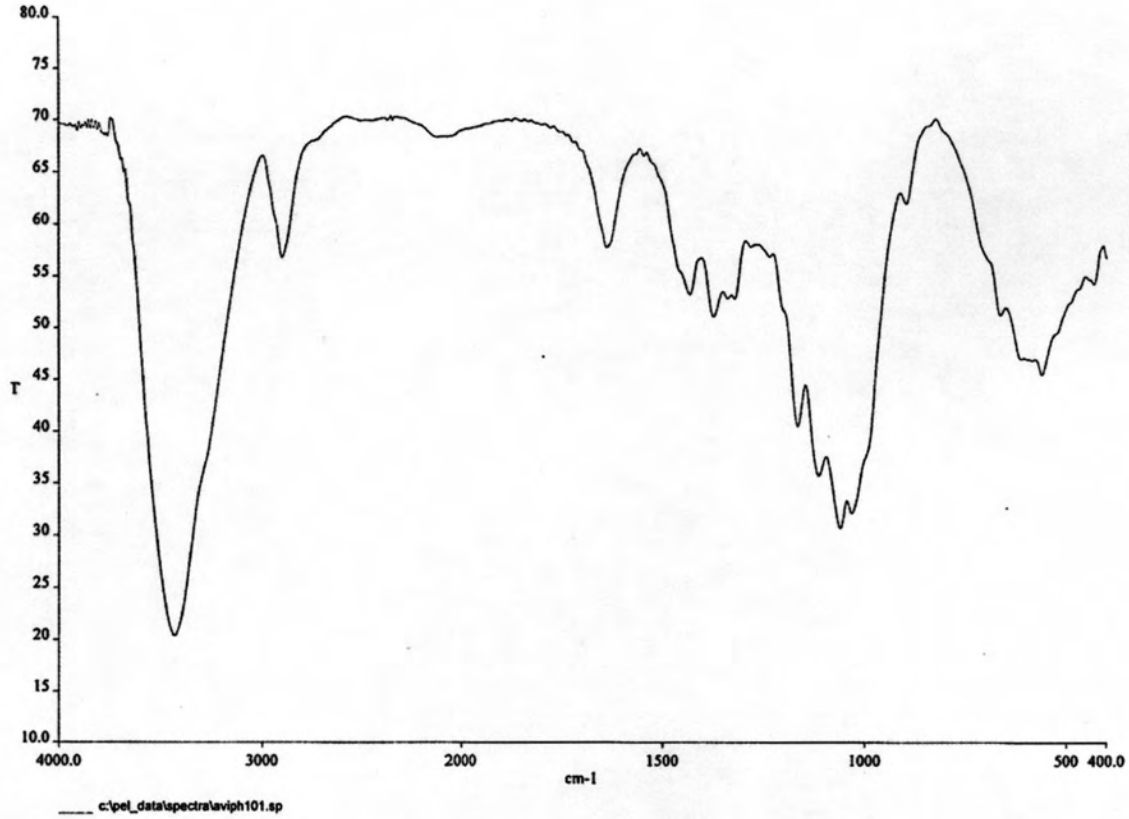
(b) 300-g batch isolation



(c) 3000-g batch isolation



(d) commercial MCC (Avicel PH101®)



APPENDIX III

The detail of costs used for the calculation of; (a) material costs, (b) labor costs, (c) electrical power costs and (d) depreciation costs in the isolation of MCC from durian fruit-hulls 3000-g batch isolation.

(a) Material cost:

Durian fruit-hulls	0	baht/kg
Ethanol 95%	30.67	baht/L
Sodium hydroxide (NaOH) 50%	18.5	baht/L
Hydrochloric acid (HCl) 35%	12.5	baht/L
Sodium hypochlorite (NaOCl) 10%	35	baht/L
Sodium chloride (NaCl)	100	baht/kg
Tap water	0.004	baht/L
Deionized water	0.17	baht/L
Distilled water	4.94	baht/L
Plastic bag	2	baht/pc

(b) Labor cost:

Labor cost (240 baht/8 working hr)	30	baht/hr

(c) Electrical cost:

Electrical power cost per unit	2.80	baht/unit

(d) Depreciation cost:

	Actual cost (baht)	Depreciation costs		
		Baht per day (8 working hr)	Baht per working hr	Baht per min
Colander	30	0.01	0.001	0.00002
Stirring rod	200	0.05	0.007	0.00011
Aluminium tray	150	0.04	0.005	0.00009
Plastic spoon	20	0.01	0.001	0.00001
Brush	50	0.01	0.002	0.00003
Filter cloth	0	0.00	0.000	0.00000
Plastic tank 30 litres	2,000	0.55	0.068	0.00114
Plastic tank 50 litres	3,000	0.82	0.103	0.00171
Plastic tank 100 litres	5,000	1.37	0.171	0.00285
Coated stainless steel tank	20,000	5.48	0.685	0.01142
Weighing machine	20,000	5.48	0.685	0.01142
Hammer mill	100,000	27.40	3.425	0.05708
Hot air oven	200,000	54.79	6.849	0.11416
Autoclave	3,000,000	821.92	102.740	1.71233
Centrifuge	20,000	5.48	0.685	0.01142
Mixer	20,000	5.48	0.685	0.01142
Ball mill	150,000	41.10	5.137	0.08562
Nest sieve shaker	50,000	13.70	1.712	0.02854

The calculation of (a) material and labor cost, (b) electrical cost and (c) depreciation cost in the isolation of MCC from durian fruit-hulls 3000-g batch isolation.

(a) Material costs and labor cost:

Treatment	Activity	Calculation of material costs									Labor hour	
		Materials	Amount			Unit cost			Material costs			
1. Cleaning	Prepare ethanol 75%	Ethanol 95%	15.8	L	x	30.67	bht	=	484.28	bht	20	min
		DI water	4.2	L	x	0.17	bht	=	0.71	bht	-	
		*Ethanol 75% can be used for 10 times cleaning, hence, material costs per each cleaning						=	48.50			
	Soak & clean	Durian hulls	3	kg	x	0	bht	=	0	bht	10	min
	Collect & prepare drying	-	-			-			-		20	min
	Drying	-	-			-			-		-	
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	20	min
	Collect	Plastic bag	1	pc	x	2	bht	=	2	bht	20	min
2. Hammer milling	Hammer milling & Collect	Plastic bag	1	pc	x	2	bht	=	2	bht	30	min
	Clean hammer mill	-	-			-			-		10	min
3. Alkali hydrolysis	Prepare NaOH & autoclave	NaOH 50%	1.11	L	x	18.5	bht	=	20.54	bht	20	min
		DI water	30	L	x	0.17	bht	=	5.1	bht		
	Weighing durian hulls	Plastic bag	1	pc	x	2	bht	=	2	bht	20	min
	Autoclave	-	-			-			-		15	min

Treatment	Activity	Calculation of material costs									Labor hour	
		Materials	Amount			Unit cost			Material costs			
	Centrifuge & washing											
	Centrifuge 1.1	DI water	5	L	x	0.17	bht	=	0.85	bht	15	min
	Collect 1.1	-	-			-			-		5	min
	Centrifuge 1.2	DI water	5	L	x	0.17	bht	=	0.85	bht	15	min
	Collect 1.2	-	-			-			-		5	min
	Wash 1	DI water	30	L	x	0.17	bht	=	5.1	bht	10	min
	Centrifuge 2	-	-			-			-		30	min
	Collect 2	-	-			-			-		5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 3	-	-			-			-		30	min
	Collect 3	-	-			-			-		5	min
	Wash 3	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 4	-	-			-			-		30	min
	Collect 4	-	-			-			-		5	min
	Wash 4	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 5	-	-			-			-		30	min
	Collect 5	-	-			-			-		5	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	30	min
4. Bleaching 1	Prepare NaOCl & mixer	NaOCl 10%	10.6	L	x	35	bht	=	371	bht	20	min
		DI water	35	L	x	0.17	bht	=	5.95	bht		
	Bleaching	-	-			-			-		10	min
	Centrifuge & washing											
	Centrifuge 1	-	-			-			-		30	min
	Collect 1	-	-			-			-		5	min
	Wash 1	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min

Treatment	Activity	Calculation of material costs								Labor hour	
		Materials	Amount			Unit cost			Material costs		
	Centrifuge 2	-	-			-			-	30	min
	Collect 2	-	-			-			-	5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min
	Centrifuge 3	-	-			-			-	30	min
	Collect 3	-	-			-			-	5	min
	Wash 3	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min
	Centrifuge 4	-	-			-			-	30	min
	Collect 4	-	-			-			-	5	min
	Wash 4	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min
	Centrifuge 5	-	-			-			-	30	min
	Collect 5	-	-			-			-	5	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4 bht	30	min
5. Acid hydrolysis	Prepare HCl & autoclave	HCl 35%	3.7	L	x	12.5	bht	=	46.25 bht	30	min
		DI water	35	L	x	0.17	bht	=	5.95 bht		
	Autoclave	-	-			-			-	-	
	Centrifuge & washing										
	Centrifuge 1	-	-			-			-	30	min
	Collect 1	-	-			-			-	5	min
	Wash 1	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min
	Centrifuge 2	-	-			-			-	30	min
	Collect 2	-	-			-			-	5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min
	Centrifuge 3	-	-			-			-	30	min
	Collect 3	-	-			-			-	5	min
	Wash 3	DI water	50	L	x	0.17	bht	=	8.5 bht	10	min

Treatment	Activity	Calculation of material costs									Labor hour	
		Materials	Amount			Unit cost			Material costs			
	Centrifuge 4	-	-			-			-		30	min
	Collect 4	-	-			-			-		5	min
	Wash 4	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 5	-	-			-			-		30	min
	Collect 5	-	-			-			-		5	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	30	min
6. Bleaching 2	Prepare NaOCl & mixer	NaOCl 10%	5.6	L	x	35	bht	=	196	bht	20	min
		DI water	25	L	x	0.17	bht	=	4.25	bht		
	Bleaching	-	-			-			-		-	
	Centrifuge & washing											
	Centrifuge 1	-	-			-			-		30	min
	Collect 1	-	-			-			-		5	min
	Wash 1	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 2	-	-			-			-		30	min
	Collect 2	-	-			-			-		5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 3	-	-			-			-		30	min
	Collect 3	-	-			-			-		5	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	30	min
7. Sodium chloride treat	Prepare NaCl & mixer	NaCl	0.7	Kg	x	100	bht	=	70	bht	20	min
		DI water	25	L	x	0.17	bht	=	4.25	bht		
	Mix	-	-			-			-		-	
	Centrifuge & washing											
	Centrifuge 1	-	-			-			-		30	min
	Collect 1	-	-			-			-		5	min
	Wash 1	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min

Treatment	Activity	Calculation of material costs									Labor hour	
		Materials	Amount			Unit cost			Material costs			
	Centrifuge 2	-	-			-			-		30	min
	Collect 2	-	-			-			-		5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 3	-	-			-			-		30	min
	Collect 3	-	-			-			-		5	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	30	min
8. Acid treat	Prepare HCl & mixer	HCl 35%	0.2	L	x	12.5	bht	=	2.5	bht	20	min
		DI water	25	L	x	0.17	bht	=	4.25	bht		
	Mix	-	-			-			-			
	Centrifuge & washing											
	Centrifuge 1	-	-			-			-		30	min
	Collect 1	-	-			-			-		5	min
	Wash 1	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 2	-	-			-			-		30	min
	Collect 2	-	-			-			-		5	min
	Wash 2	DI water	50	L	x	0.17	bht	=	8.5	bht	10	min
	Centrifuge 3	-	-			-			-		30	min
	Collect 3	-	-			-			-		5	min
	Prepare drying	-	-			-			-		60	min
	Drying	-	-			-			-		-	
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	30	min
	Collect	Plastic bag	1	pc	x	2	bht	=	2	bht	20	min
9. Ball milling	Load material	-	-			-			-		15	min
	Milling	-	-			-			-		-	
	Collect MCC	Plastic bag	1	pc	x	2	bht	=	2	bht	20	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	45	min

Treatment	Activity	Calculation of material costs									Labor hour	
		Materials	Amount			Unit cost			Material costs			
10. Sieving	Prepare Sieving	-	-			-			-		10	min
	Sieving	-	-			-			-		-	
	Collect MCC	Plastic bag	1	pc	x	2	bht	=	2	bht	20	min
	Clean equipment	Tap water	100	L	x	0.004	bht	=	0.4	bht	20	min
	Total								**951.43**	**bht**	**1,720 (28.67**	**min hr)**

Direct material cost = **951.43** **baht**

Direct labor cost = **860.00** **baht** (28.67 hrs x 30 bht/hr)

(b) Electrical power cost:

Treatment	Activity	Calculation of electrical power consumption					
		Device consuming power	Watt		Time		Device electrical cost
1. Cleaning	Prepare ethanol 75%	-	-		-		-
	Soak & clean	-	-		-		-
	Collect & prepare drying	-	-		-		-
	Drying	Oven 80^{O}C	3000	W	180	min	9.000 bht
	Clean equipment	-	-		-		-
	Collect	-	-		-		-
2. Hammer milling	Hammer milling & Collect	Hammer mill	200	W	20	min	0.067 bht
	Clean hammer mill	-	-		-		-
3. Alkali hydrolysis	Prepare NaOH & autoclave	-	-		-		-
	Weighing durian hulls	Weighing machine	30	W	20	min	0.010 bht
	Autoclave	Autoclave	6000	W	80	min	8.000 bht
	Centrifuge & washing						
	Centrifuge 1.1	Centrifuge	200	W	30	min	0.100 bht
	Collect 1.1						
	Centrifuge 1.2	Centrifuge	200	W	30	min	0.100 bht
	Collect 1.2	-	-		-		-
	Wash 1	-	-		-		-
	Centrifuge 2	Centrifuge	200	W	30	min	0.100 bht
	Collect 2	-	-		-		-
	Wash 2	-	-		-		-
	Centrifuge 3	Centrifuge	200	W	30	min	0.100 bht
	Collect 3	-	-		-		-
	Wash 3	-	-		-		-

Treatment	Activity	Calculation of electrical power consumption					
		Device consuming power	Watt		Time	Device electrical cost	
	Centrifuge 4	Centrifuge	200	W	30 min	0.100	bht
	Collect 4	-	-		-	-	
	Wash 4	-	-		-	-	
	Centrifuge 5	Centrifuge	200	W	30 min	0.100	bht
	Collect 5	-	-		-	-	
	Clean equipment	-	-		-	-	
4. Bleaching 1	Prepare NaOCl & mixer	-					
	Bleaching	Mixer	746	W	240 min	2.984	bht
	Centrifuge & washing						
	Centrifuge 1	Centrifuge	200	W	30 min	0.100	bht
	Collect 1	-	-		-	-	
	Wash 1	-	-		-	-	
	Centrifuge 2	Centrifuge	200	W	30 min	0.100	bht
	Collect 2	-	-		-	-	
	Wash 2	-	-		-	-	
	Centrifuge 3	Centrifuge	200	W	30 min	0.100	bht
	Collect 3	-	-		-	-	
	Wash 3	-	-		-	-	
	Centrifuge 4	Centrifuge	200	W	30 min	0.100	bht
	Collect 4	-	-		-	-	
	Wash 4	-	-		-	-	
	Centrifuge 5	Centrifuge	200	W	30 min	0.100	bht
	Collect 5	-	-		-	-	
	Clean equipment	-	-		-	-	

Treatment	Activity	Calculation of electrical power consumption					
		Device consuming power	Watt		Time	Device electrical cost	
5. Acid hydrolysis	Prepare HCl & autoclave	-	-		-	-	
	Autoclave	Autoclave	6000		80 min	8.000	bht
	Centrifuge & washing						
	Centrifuge 1	Centrifuge	200	W	30 min	0.100	bht
	Collect 1	-	-		-	-	
	Wash 1	-	-		-	-	
	Centrifuge 2	Centrifuge	200	W	30 min	0.100	bht
	Collect 2	-	-		-	-	
	Wash 2	-	-		-	-	
	Centrifuge 3	Centrifuge	200	W	30 min	0.100	bht
	Collect 3	-	-		-	-	
	Wash 3	-	-		-	-	
	Centrifuge 4	Centrifuge	200	W	30 min	0.100	bht
	Collect 4	-	-		-	-	
	Wash 4	-	-		-	-	
	Centrifuge 5	Centrifuge	200	W	30 min	0.100	bht
	Collect 5	-	-		-	-	
	Clean equipment	-	-		-	-	
6. Bleaching 2	Prepare NaOCl & mixer	-	-		-	-	
	Bleaching	Mixer	746	W	240 min	2.984	bht
	Centrifuge & washing						
	Centrifuge 1	Centrifuge	200	W	30 min	0.100	bht
	Collect 1	-	-		-	-	
	Wash 1	-	-		-	-	
	Centrifuge 2	Centrifuge	200	W	30 min	0.100	bht
	Collect 2	-	-		-	-	
	Wash 2	-	-		-	-	

Treatment	Activity	Calculation of electrical power consumption					
		Device consuming power	Watt		Time		Device electrical cost
	Centrifuge 3	Centrifuge	200	W	30	min	0.100 bht
	Collect 3	-	-		-		-
	Clean equipment	-	-		-		-
7. Sodium chloride treat	Prepare NaCl & mixer	-	-		-		-
	Mix	Mixer	746	W	180	min	2.238 bht
	Centrifuge & washing						
	Centrifuge 1	Centrifuge	200	W	30	min	0.100 bht
	Collect 1	-	-		-		-
	Wash 1	-	-		-		-
	Centrifuge 2	Centrifuge	200	W	30	min	0.100 bht
	Collect 2	-	-		-		-
	Wash 2	-	-		-		-
	Centrifuge 3	Centrifuge	200	W	30	min	0.100 bht
	Collect 3	-	-		-		-
	Clean equipment	-	-		-		-
8. Acid treat	Prepare HCl & mixer	-	-		-		-
	Mix	Mixer	746	W	120	min	1.492 bht
	Centrifuge & washing						
	Centrifuge 1	Centrifuge	200	W	30	min	0.100 bht
	Collect 1	-	-		-		-
	Wash 1	-	-		-		-
	Centrifuge 2	Centrifuge	200	W	30	min	0.100 bht
	Collect 2	-	-		-		-
	Wash 2	-	-		-		-
	Centrifuge 3	Centrifuge	200	W	30	min	0.100 bht
	Collect 3	-	-		-		-

Treatment	Activity	Calculation of electrical power consumption					
		Device consuming power	Watt		Time		Device electrical cost	
	Prepare drying	-	-		-		-	
	Drying	Oven 80^{O}C	3000	W	720	min	36.000	bht
	Clean equipment	-	-		-		-	
	Collect	-	-		-		-	
9. Ball milling	Loading	-	-		-		-	
	Ball milling	Ball mill	1492	W	120	min	2.984	bht
	Collect MCC	Ball mill	1492	W	5	min	0.124	bht
	Clean equipment	-	-		-		-	
10. Sieving	Prepare Sieving							
	Sieving	Sieve shaker	50	W	60	min	0.050	bht
	Collect MCC	-	-		-		-	
	Clean equipment	-	-		-		-	
	Total						**76.43**	**bht**

Total electrical cost = **76.43** **baht**

When: Electrical cost = [(watt x working hour)/ 1000] x electrical cost per unit

Electrical cost per unit = 2.80 baht/unit

(c) Depreciation cost:

Treatment	Activity	Calculation of depreciation costs											
		Device	Amount			Using time			Dep cost per min			Device dep cost	
1. Cleaning	Prepare ethanol 75%	-	-			-			-			-	
	Soak & clean	Plastic tank 30 L	1	pc	x	10	min	x	0.00114	bht	=	0.01142	bht
		Stirring rod	1	pc	x	10	min	x	0.00011	bht	=	0.00114	bht
	Collect & prepare drying	Colander	1	pc	x	20	min	x	0.00002	bht	=	0.00034	bht
		Aluminium tray	6	pc	x	20	min	x	0.00009	bht	=	0.01027	bht
	Drying	Oven	1	mc	x	180	min	x	0.11416	bht	=	20.5479	bht
		Aluminium tray	6	pc	x	180	min	x	0.00009	bht	=	0.09247	bht
	Clean equipment	-	-			-			-			-	
	Collect	Plastic spoon	1	pc	x	20	min	x	0.00001	bht	=	0.00023	bht
2. Hammer milling	Hammer milling & Collect	Hammer mill	1	mc	x	30	min	x	0.05708	bht	=	1.71233	bht
	Clean hammer mill	Brush	1	pc	x	10	min	x	0.00003	bht	=	0.00029	bht
3. Alkali hydrolysis	Prepare NaOH & autoclave	Plastic tank 50 L	1	pc	x	20	min	x	0.00171	bht	=	0.03425	bht
		Stirring rod	1	pc	x	10	min	x	0.00011	bht	=	0.00114	bht
	Weighing durian hulls	Weighing machine	1	mc	x	20	min	x	0.01142	bht	=	0.22831	bht
		Plastic spoon	1	pc	x	20	min	x	0.00001	bht	=	0.00023	bht
	Autoclave	Autoclave	1	mc	x	80	min	x	1.71233	bht	=	136.986	bht
		Coated stainless tank	1	pc	x	80	min	x	0.01142	bht	=	0.91324	bht
	Centrifuge & washing	Centrifuge	1	mc	x	400	min	x	0.01142	bht	=	4.56621	bht
		Filter cloth	1	pc	x	400	min	x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc	x	400	min	x	0.00285	bht	=	1.14155	bht
		Stirring rod	1	pc	x	400	min	x	0.00011	bht	=	0.04566	bht
		Plastic tank 30 L	1	pc	x	400	min	x	0.00114	bht	=	0.45662	bht

Treatment	Activity	Calculation of depreciation costs											
		Device	Amount		Using time		Dep cost per min			Device dep cost	
	Centrifuge 1.1	-	-		-		-			-	
	Collect 1.1	-	-		-		-			-	
	Centrifuge 1.2	-	-		-		-			-	
	Collect 1.2	-	-		-		-			-	
	Wash 1	-	-		-		-			-	
	Centrifuge 2	-	-		-		-			-	
	Collect 2	-	-		-		-			-	
	Wash 2	-	-		-		-			-	
	Centrifuge 3	-	-		-		-			-	
	Collect 3	-	-		-		-			-	
	Wash 3	-	-		-		-			-	
	Centrifuge 4	-	-		-		-			-	
	Collect 4	-	-		-		-			-	
	Wash 4	-	-		-		-			-	
	Centrifuge 5	-	-		-		-			-	
	Collect 5	-	-		-		-			-	
	Clean equipment	-	-		-		-			-	
4. Bleaching 1	Prepare NaOCl & mixer	-	-		-		-			-	
		Plastic tank 50 L	1	pc	x	20	min	x	0.00171	bht	=	0.03425	bht
	Bleaching	Mixer	1	mc	x	240	min	x	0.01142	bht	=	2.73973	bht
		Plastic tank 100 L	1	pc	x	240	min	x	0.00285	bht	=	0.68493	bht
	Centrifuge & washing	Centrifuge	1	mc	x	365	min	x	0.01142	bht	=	4.16667	bht
		Filter cloth	1	pc	x	365	min	x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc	x	365	min	x	0.00285	bht	=	1.04167	bht
		Stirring rod	1	pc	x	365	min	x	0.00011	bht	=	0.04167	bht
		Plastic tank 30 L	1	pc	x	365	min	x	0.00114	bht	=	0.41667	bht

Treatment	Activity	Calculation of depreciation costs											
		Device	Amount		Using time			Dep cost per min			Device dep cost		
	Centrifuge 1	-	-		-			-			-		
	Collect 1	-	-		-			-			-		
	Wash 1	-	-		-			-			-		
	Centrifuge 2	-	-		-			-			-		
	Collect 2	-	-		-			-			-		
	Wash 2	-	-		-			-			-		
	Centrifuge 3	-	-		-			-			-		
	Collect 3	-	-		-			-			-		
	Wash 3	-	-		-			-			-		
	Centrifuge 4	-	-		-			-			-		
	Collect 4	-	-		-			-			-		
	Wash 4	-	-		-			-			-		
	Centrifuge 5	-	-		-			-			-		
	Collect 5	-	-		-			-			-		
	Clean equipment	-	-		-			-			-		
5. Acid hydrolysis	Prepare HCl & autoclave	-	-		-			-			-		
	Autoclave	Autoclave	1	mc	x	80	min	x	1.71233	bht	=	136.986	bht
		Coated stainless tank	1	pc	x	80	min	x	0.01142	bht	=	0.91324	bht
	Centrifuge & washing	Centrifuge	1	mc	x	365	min	x	0.01142	bht	=	4.16667	bht
		Filter cloth	1	pc	x	365	min	x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc	x	365	min	x	0.00285	bht	=	1.04167	bht
		Stirring rod	1	pc	x	365	min	x	0.00011	bht	=	0.04167	bht
		Plastic tank 30 L	1	pc	x	365	min	x	0.00114	bht	=	0.41667	bht

Treatment	Activity	Calculation of depreciation costs										
		Device	Amount		Using time		Dep cost per min			Device dep cost	
	Centrifuge 1	-	-		-		-			-	
	Collect 1	-	-		-		-			-	
	Wash 1	-	-		-		-			-	
	Centrifuge 2	-	-		-		-			-	
	Collect 2	-	-		-		-			-	
	Wash 2	-	-		-		-			-	
	Centrifuge 3	-	-		-		-			-	
	Collect 3	-	-		-		-			-	
	Wash 3	-	-		-		-			-	
	Centrifuge 4	-	-		-		-			-	
	Collect 4	-	-		-		-			-	
	Wash 4	-	-		-		-			-	
	Centrifuge 5	-	-		-		-			-	
	Collect 5	-	-		-		-			-	
	Clean equipment	-	-		-		-			-	
		-	-		-		-			-	
6. Bleaching 2	Prepare NaOCl & mixer	-	-		-		-			-	
	Bleaching	Mixer	1	mc x	240	min x	0.01142	bht	=	2.73973	bht
		Plastic tank 100 L	1	pc x	240	min x	0.00285	bht	=	0.68493	bht
	Centrifuge & washing	Centrifuge	1	mc x	215	min x	0.01142	bht	=	2.45434	bht
		Filter cloth	1	pc x	215	min x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc x	215	min x	0.00285	bht	=	0.61358	bht
		Stirring rod	1	pc x	215	min x	0.00011	bht	=	0.02454	bht
		Plastic tank 30 L	1	pc x	215	min x	0.00114	bht	=	0.24543	bht
	Centrifuge 1	-	-		-		-			-	
	Collect 1	-	-		-		-			-	
	Wash 1	-	-		-		-			-	

Treatment	Activity	Calculation of depreciation costs											
		Device	Amount			Using time			Dep cost per min			Device dep cost	
	Centrifuge 2	-	-			-			-			-	
	Collect 2	-	-			-			-			-	
	Wash 2	-	-			-			-			-	
	Centrifuge 3	-	-			-			-			-	
	Collect 3	-	-			-			-			-	
	Clean equipment	-	-			-			-			-	
		-	-			-			-			-	
7. Sodium chloride treat	Prepare NaCl & mixer	-	-			-			-			-	
	Mix	Mixer	1	mc	x	180	min	x	0.01142	bht	=	2.05479	bht
		Plastic tank 100 L	1	pc	x	180	min	x	0.00285	bht	=	0.5137	bht
	Centrifuge & washing	Centrifuge	1	mc	x	215	min	x	0.01142	bht	=	2.45434	bht
		Filter cloth	1	pc	x	215	min	x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc	x	215	min	x	0.00285	bht	=	0.61358	bht
		Stirring rod	1	pc	x	215	min	x	0.00011	bht	=	0.02454	bht
		Plastic tank 30 L	1	pc	x	215	min	x	0.00114	bht	=	0.24543	bht
	Centrifuge 1	-	-			-			-			-	
	Collect 1	-	-			-			-			-	
	Wash 1	-	-			-			-			-	
	Centrifuge 2	-	-			-			-			-	
	Collect 2	-	-			-			-			-	
	Wash 2	-	-			-			-			-	
	Centrifuge 3	-	-			-			-			-	
	Collect 3	-	-			-			-			-	
	Clean equipment	-	-			-			-			-	
		-	-			-			-			-	

Treatment	Activity	Calculation of depreciation costs												
		Device	Amount			Using time			Dep cost per min			Device dep cost	
8. Acid treat	Prepare HCl & mixer	-	-			-			-			-	
	Mix	Mixer	1	mc	x	120	min	x	0.01142	bht	=	1.36986	bht
		Plastic tank 100 L	1	pc	x	120	min	x	0.00285	bht	=	0.34247	bht
	Centrifuge & washing	Centrifuge	1	mc	x	215	min	x	0.01142	bht	=	2.45434	bht
		Filter cloth	1	pc	x	215	min	x	0.00000	bht	=	0	bht
		Plastic tank 100 L	1	pc	x	215	min	x	0.00285	bht	=	0.61358	bht
		Stirring rod	1	pc	x	215	min	x	0.00011	bht	=	0.02454	bht
		Plastic tank 30 L	1	pc	x	215	min	x	0.00114	bht	=	0.24543	bht
	Centrifuge 1	-	-			-			-			-	
	Collect 1	-	-			-			-			-	
	Wash 1	-	-			-			-			-	
	Centrifuge 2	-	-			-			-			-	
	Collect 2	-	-			-			-			-	
	Wash 2	-	-			-			-			-	
	Centrifuge 3	-	-			-			-			-	
	Collect 3	-	-			-			-			-	
	Prepare drying	Aluminium tray	6	pc	x	60	min	x	0.00009	bht	=	0.03082	bht
	Drying	Oven	1	mc	x	720	min	x	0.11416	bht	=	82.1918	bht
		Aluminium tray	6	pc	x	720	min	x	0.00009	bht	=	0.36986	bht
	Clean equipment												
	Collect	Plastic spoon	1	pc	x	30	min	x	0.00001	bht	=	0.00034	bht
9. Ball milling	Loading	-	-			-			-			-	
	Ball milling	Ball mill	1	mc	x	120	min	x	0.08562	bht	=	10.274	bht
	Collect MCC	Plastic spoon	1	pc	x	30	min	x	0.00001	bht	=	0.00034	bht
	Clean equipment	-	-			-			-			-	

Treatment	Activity	Calculation of depreciation costs										
		Device	Amount			Using time			Dep cost per min			Device dep cost
10. Sieving	Prepare Sieving	-	-			-			-			-
	Sieving	Nest sieve shaker	1	mc	x	60	min	x	0.02854	bht	=	1.71233 bht
	Collect MCC	Plastic spoon	1	pc	x	30	min	x	0.00001	bht	=	0.00034 bht
	Clean equipment	-	-			-			-			-
	Total											**431.74 bht**

Total depreciation cost = 431.74 baht

VITA

Narin Kijkriengkrailul was born on October 24, 1974 in Bangkok, Thailand. He graduated from Debsirin High school on March 1993, and then entered Chulalongkorn University in the same year. After graduating with a Bachelors Degree in Pharmacy in March 1998, he started working as a manufacturing pharmacist in The National Blood Centre, The Thai Red Cross Society. At present, he is Chief of "Blood Bag, Equipment and Solution Production Section" of The National Blood Centre, The Thai Red Cross Society.