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Appendix A

Characteristic of Materials

Zinc stearate

Density	0.1-0.2	g/ml.
Moisture	1.0% max	
Melting point	115-125	°C
Free fatty acid	1.0% max	

Glycerol monostearate

Acid value	5.0 max
saponification value	160-175%
Melting point	57-63 °C
Free glycerol	1% max.

Epolene E-43 wax

Ring and ball softening point,	C:157	
Density	0.934	g/cm^3
Acid number	47	
Molecular weight	4500	

Table A-1 Physical Properties of LDPE JJ4324

Physical properties	Test Method	Unit	LDPE JJ 4324
Melt Index (2.16kg/190°C)	ASTM D1238	g/10min	5.50
Density	ASTM D1505	g/cm^3	0.921
Tensile Strength (at yield)	ASTM D638	N/mm^2	11.0
Ultimate elongation	ASTM D638	%	600
Vicat Softening	ASTM D1552	°C	95
Impact Resistance	ASTM D1709A	g	152
Haze	ASTM D1003	%max	8.0
Gloss	ASTM D2457	%min	88

Figure A-1 The average size diameter of tapioca starch.

Result: Analysis Report

Sample Details

Sample ID: strach
Sample File: (Result Not Saved)
Sample Path: A:\
Sample Notes:

Run Number: 2

Measurement Date: Wed, Jun 04, 1997 4:00PM
Analysis Date: Wed, Jun 04, 1997 4:00PM
Result Source: Analysed

System Details

Range Lens: 300RF mm
Presentation: 3OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 14.30 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.0 %
Residual: 0.398 %

Result Statistics

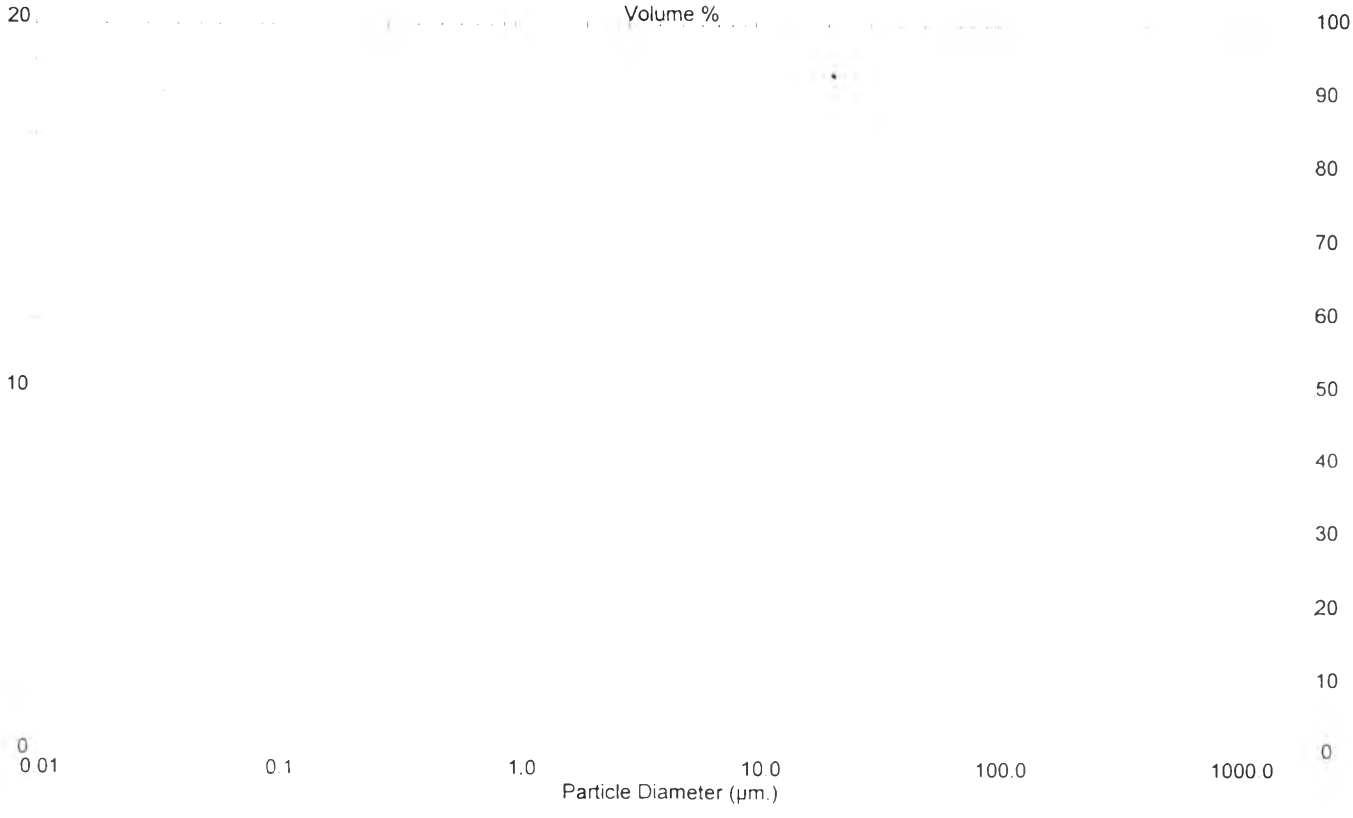
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 12.96 um

Concentration = 0.0024 %Vol
D (v, 0.1) = 3.46 um
D [3, 2] = 5.86 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 13.21 um
Span = 1.299E+00

Specific S.A. = 1.0232 sq. m / g
D (v, 0.9) = 20.62 um
Uniformity = 3.579E-01

Size Low (um)	In %	Size High (um)	Under%
0.05	0.00	0.06	0.00
0.06	0.00	0.07	0.00
0.07	0.00	0.08	0.00
0.08	0.00	0.09	0.00
0.09	0.00	0.11	0.00
0.11	0.00	0.13	0.00
0.13	0.00	0.15	0.00
0.15	0.00	0.17	0.00
0.17	0.00	0.20	0.00
0.20	0.00	0.23	0.00
0.23	0.00	0.27	0.00
0.27	0.01	0.31	0.01
0.31	0.03	0.36	0.04
0.36	0.09	0.42	0.13
0.42	0.19	0.49	0.33
0.49	0.37	0.58	0.70
0.58	0.56	0.67	1.26
0.67	0.83	0.78	2.09
0.78	1.02	0.91	3.11
0.91	1.24	1.06	4.35
1.06	1.42	1.24	5.77
1.24	1.39	1.44	7.16
1.44	1.11	1.68	8.27
1.68	0.75	1.95	9.02
1.95	0.49	2.28	9.52
2.28	0.32	2.65	9.84
2.65	0.11	3.09	9.94
3.09	0.09	3.60	10.03
3.60	0.22	4.19	10.25
4.19	0.53	4.88	10.78
4.88	1.10	5.69	11.88
5.69	1.99	6.63	13.87
6.63	3.39	7.72	17.26
7.72	5.49	9.00	22.75
9.00	8.34	10.48	31.09
10.48	11.72	12.21	42.81
12.21	14.61	14.22	57.42
14.22	15.94	16.57	73.36
16.57	12.73	19.31	86.08
19.31	8.26	22.49	94.35
22.49	4.47	26.20	98.82
26.20	1.18	30.53	100.00
30.53	0.00	35.56	100.00
35.56	0.00	41.43	100.00
41.43	0.00	48.27	100.00
48.27	0.00	56.23	100.00
56.23	0.00	65.51	100.00
65.51	0.00	76.32	100.00
76.32	0.00	88.91	100.00
88.91	0.00	103.58	100.00
103.58	0.00	120.67	100.00
120.67	0.00	140.58	100.00
140.58	0.00	163.77	100.00
163.77	0.00	190.80	100.00
190.80	0.00	222.28	100.00
222.28	0.00	258.95	100.00
258.95	0.00	301.68	100.00
301.68	0.00	351.46	100.00
351.46	0.00	409.45	100.00
409.45	0.00	477.01	100.00
477.01	0.00	555.71	100.00
555.71	0.00	647.41	100.00
647.41	0.00	754.23	100.00
754.23	0.00	878.67	100.00



Malvern Instruments Ltd.
Malvern, UK
Tel:0684 892456 Fax:0684 892789

Mastersizer S long bed Ver. 2.11
Serial Number: 32734/42

04 Jun 97 1

Figure A-2 The average size diameter of corn starch

Result: Analysis Report

Sample Details

Sample ID: AL-20(8/7/96)
Sample File: AOO
Sample Path: A:\
Sample Notes: Test by Pranee Scientific and Technological Research Equipment Centre Chulalongkorn University Liquid medium water

Run Number 9
Record Number 1

Measurement Date: Mon, Jul 08, 1996 1:56PM
Analysis Date: Mon, Jul 08, 1996 1:56PM
Result Source: Analysed

System Details

Range Lens: 300RF mm
Presentation: 3PHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5960, 0.1000) Dispersant R.I. = 1.3300)

Sampler: MS1

Obscuration: 20.0 %
Residual: 0.462 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D [4, 3] = 16.30 um

Concentration = 0.0199 %Vol
D (v, 0.1) = 5.46 um
D [3, 2] = 6.41 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 14.88 um
Span = 1.356E+00

Specific S.A. = 0.9354 sq. m / g
D (v, 0.9) = 25.64 um
Uniformity = 4.786E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.05	0.00	0.06	0.00	6.63	2.91	7.72	15.12
0.06	0.00	0.07	0.00	7.72	4.37	9.00	19.49
0.07	0.00	0.08	0.00	9.00	6.32	10.48	25.81
0.08	0.00	0.09	0.00	10.48	8.80	12.21	34.61
0.09	0.00	0.11	0.00	12.21	11.46	14.22	46.07
0.11	0.00	0.13	0.00	14.22	13.72	16.57	59.78
0.13	0.00	0.15	0.00	16.57	13.06	19.31	72.84
0.15	0.00	0.17	0.00	19.31	10.57	22.49	83.41
0.17	0.00	0.20	0.00	22.49	7.48	26.20	90.89
0.20	0.00	0.23	0.00	26.20	4.67	30.53	95.56
0.23	0.00	0.27	0.00	30.53	2.49	35.56	98.06
0.27	0.03	0.31	0.03	35.56	0.98	41.43	99.04
0.31	0.10	0.36	0.14	41.43	0.07	48.27	99.11
0.36	0.18	0.42	0.32	48.27	0.00	56.23	99.11
0.42	0.29	0.49	0.61	56.23	0.00	65.51	99.11
0.49	0.45	0.58	1.05	65.51	0.00	76.32	99.11
0.58	0.56	0.67	1.61	76.32	0.00	88.91	99.11
0.67	0.74	0.78	2.35	88.91	0.08	103.58	99.19
0.78	0.82	0.91	3.17	103.58	0.18	120.67	99.37
0.91	0.92	1.06	4.09	120.67	0.21	140.58	99.58
1.06	0.96	1.24	5.05	140.58	0.18	163.77	99.76
1.24	0.90	1.44	5.95	163.77	0.13	190.80	99.90
1.44	0.74	1.68	6.69	190.80	0.08	222.28	99.97
1.68	0.56	1.95	7.25	222.28	0.03	258.95	100.00
1.95	0.42	2.28	7.68	258.95	0.00	301.68	100.00
2.28	0.30	2.65	7.98	301.68	0.00	351.46	100.00
2.65	0.21	3.09	8.19	351.46	0.00	409.45	100.00
3.09	0.19	3.60	8.38	409.45	0.00	477.01	100.00
3.60	0.29	4.19	8.67	477.01	0.00	555.71	100.00
4.19	0.58	4.88	9.26	555.71	0.00	647.41	100.00
4.88	1.10	5.69	10.35	647.41	0.00	754.23	100.00
5.69	1.85	6.63	12.21	754.23	0.00	878.67	100.00

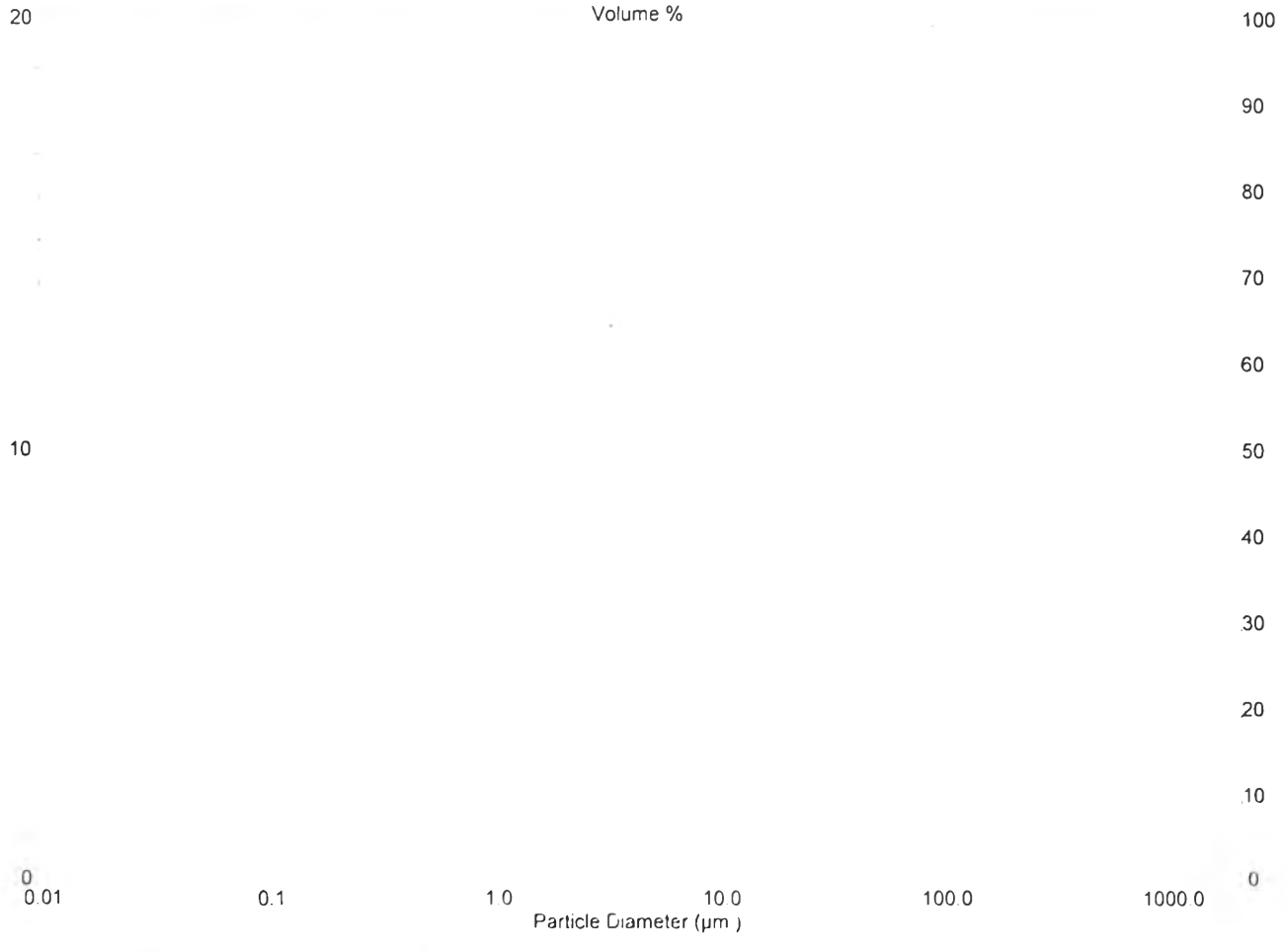


Figure A-3 The moisture content in tapioca starch granules

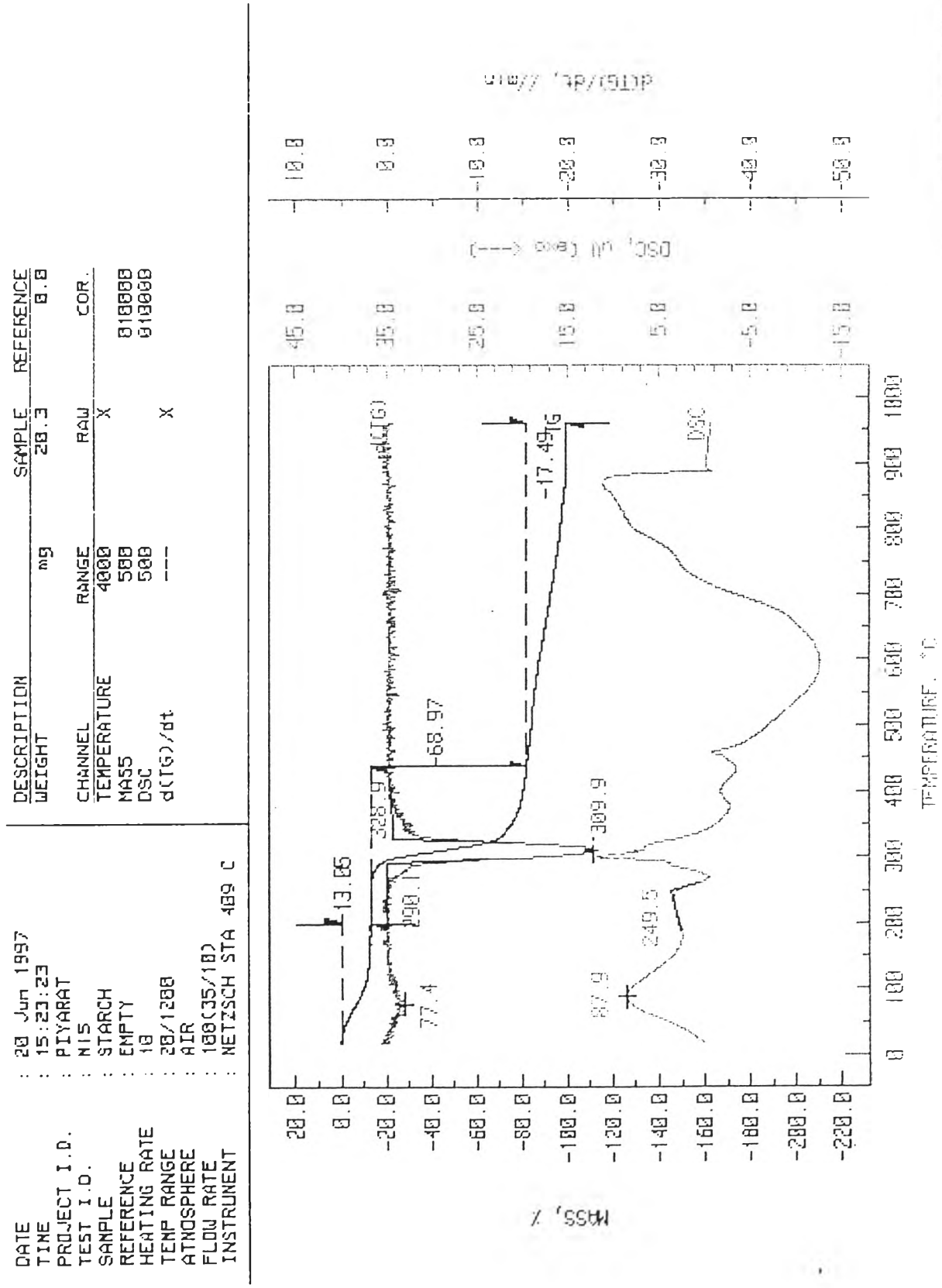
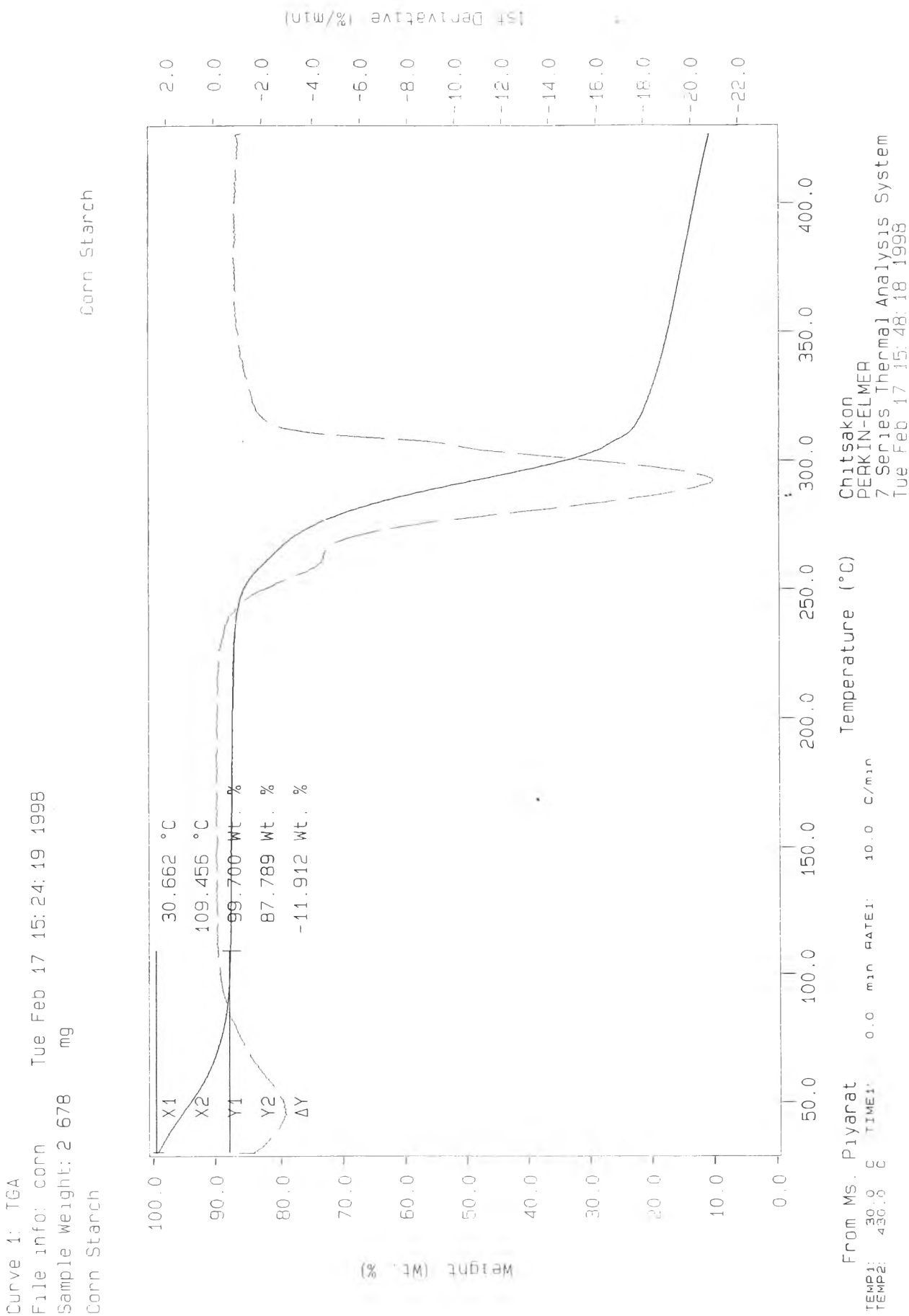


Figure A-4 The moisture content in corn starch granules



APPENDIX B

Mechanical Properties Data

Table B-1 The mechanical properties data of LDPE/tapioca starch blends without compatibilizer.

% Starch	Tensile strength (MPa)	Elongation at break (%)
0%	9.283	116.6
	9.400	113.0
	9.391	123.0
	9.450	120.4
	9.439	109.1
5%	9.240	101.7
	9.243	101.6
	9.196	101.2
	9.208	100.9
	9.232	105.8
10%	9.211	89.00
	9.204	90.55
	9.033	93.58
	9.087	87.10
	9.052	92.98
15%	8.658	87.45
	8.698	86.31
	8.527	86.60
	8.857	90.45
	8.469	92.69

% Starch	Tensile strength (MPa)	Elongation at break (%)
20%	8.538	80.59
	8.648	78.14
	8.443	77.63
	8.382	79.85
	8.385	80.97

Table B-2 The mechanical properties data of LDPE/tapioca starch blends with epolene.

% Starch	Tensile strength (MPa)	Elongation at break (%)
0%	9.372	120.7
	9.028	114.3
	8.843	114.5
	8.931	117.7
	9.152	116.1
5%	7.840	90.06
	8.595	92.74
	8.063	90.88
	7.592	92.09
	8.937	94.29
10%	7.284	89.29
	8.304	89.87
	7.951	88.19
	7.937	89.85
	8.356	90.87
15%	6.615	84.61
	6.892	78.60
	6.437	78.35
	6.011	81.43
	6.102	81.17
20%	5.874	74.03
	6.056	72.21
	6.233	79.93
	6.125	76.39
	6.301	73.46

Table B-3 The mechanical properties data of LDPE/tapioca starch blends with zinc stearate.

% Starch	Tensile Strength (MPa)	Elongation at Break (%)
0%	9.475	122.7
	9.373	120.9
	9.764	116.4
	9.534	116.7
	9.558	117.0
5%	9.468	113.4
	9.502	113.9
	9.364	109.6
	9.266	106.3
	9.327	108.1
10%	8.961	105.2
	9.429	102.9
	9.204	104.4
	9.134	101.6
	9.324	104.1
15%	8.566	98.07
	8.784	99.43
	8.941	96.48
	8.652	94.55
	8.835	92.16
20%	8.892	81.25
	8.669	79.63
	8.598	76.30
	8.358	85.29
	8.784	84.46

Table B-4 The mechanical properties data of LDPE/tapioca starch blends with glycerol monostearate.

% Starch	Tensile Strength (MPa)		Elongation at Break (%)	
0%	9.411		118.6	
	9.398		119.3	
	9.376		119.9	
	9.415		121.4	
	9.402		120.2	
5%	9.366	9.356	113.6	115.1
	9.345	9.348	114.9	113.3
	9.348	9.386	115.3	114.7
	9.332	9.364	113.1	114.1
	9.316	9.372	112.8	113.3
10%	9.302	9.291	110.2	112.2
	9.279	9.253	108.6	108.6
	9.281	9.262	108.1	109.4
	9.243	9.269	109.7	109.1
	9.224	9.210	111.3	111.0
15%	8.989	8.761	94.63	98.32
	8.914	8.914	97.79	97.34
	8.778	8.778	96.33	98.54
	8.774	8.785	97.41	99.54
	8.804	8.816	96.84	97.11
20%	8.788	8.421	93.91	98.30
	8.500	8.529	96.28	98.86
	8.526	8.575	93.45	91.08
	8.649	8.611	94.62	97.98
	8.531	8.681	94.47	91.94

Table B-5 The mechanical properties data of LDPE/corn starch blends with zinc stearate.

% Starch	Tensile Strength (MPa)	Elongation at Break (%)
0%	9.372	117.3
	9.271	118.6
	9.114	123.3
	9.090	121.5
	9.257	120.1
5%	9.324	106.2
	9.118	102.5
	9.236	96.36
	9.140	93.70
	9.104	95.28
10%	8.910	94.14
	8.610	92.80
	8.747	87.60
	8.631	88.97
	8.696	90.77
15%	8.314	85.64
	8.242	82.03
	8.103	80.43
	8.061	84.71
	8.036	982.47
20%	8.005	79.75
	7.811	76.80
	7.823	76.64
	7.779	67.35
	7.750	77.63

Table B-6 The mechanical properties data of LDPE/corn starch blends with glycerol monostearate.

% Starch	Tensile Strength (MPa)	Elongation at Break (%)
0%	9.517	119.2
	9.402	114.1
	9.431	121.3
	9.361	116.2
	9.313	118.5
5%	9.383	99.41
	9.360	99.36
	9.291	96.96
	9.243	97.91
	9.311	98.82
10%	9.373	84.97
	9.242	85.04
	9.211	96.93
	9.128	95.91
	9.190	92.43
15%	8.973	86.01
	8.563	89.04
	8.844	90.13
	8.991	92.36
	8.835	88.52
20%	8.514	88.17
	8.506	86.33
	8.323	85.40
	8.391	82.09
	8.484	83.21

Biography

Miss Piyarat Reawraksa was born on October 5, 1972 at Bangkok . She received her Bachelor Degree of Science (Chemistry) from Faculty of Science, Chiang Mai University in 1994 . She began her master study in Interdisciplinary Program in Environmental Science , Chulalongkorn University in June 1994 and completed the program in April 1998 .