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## **APPENDICES**

## Appendix A

### Calibration curve

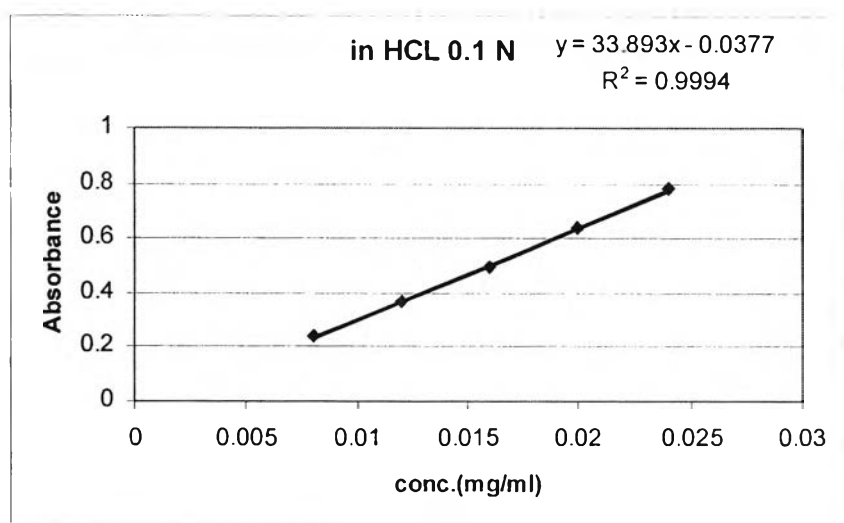
#### 1. Calibration curve of diclofenac sodium for dissolution studies

The concentrations (mg/ml) versus absorbance of diclofenac sodium in 0.1 N HCl and in pH 6.8 phosphate buffer at a maximum wavelength of 275 nm are presented in Table 25 – 26. The standard curves of diclofenac sodium in these media are illustrated in Figure 120 – 121.

**Table 25** Absorbance of diclofenac sodium in 0.1 N HCl at a maximum wavelength of 275 nm

Concentration (mg/ml)	Absorbance at 275 nm
0.008	0.2391
0.012	0.3664
0.016	0.4969
0.02	0.6411
0.024	0.7796

**Figure 120** Calibration curve of diclofenac sodium in 0.1 N HCl at a maximum wavelength of 275 nm

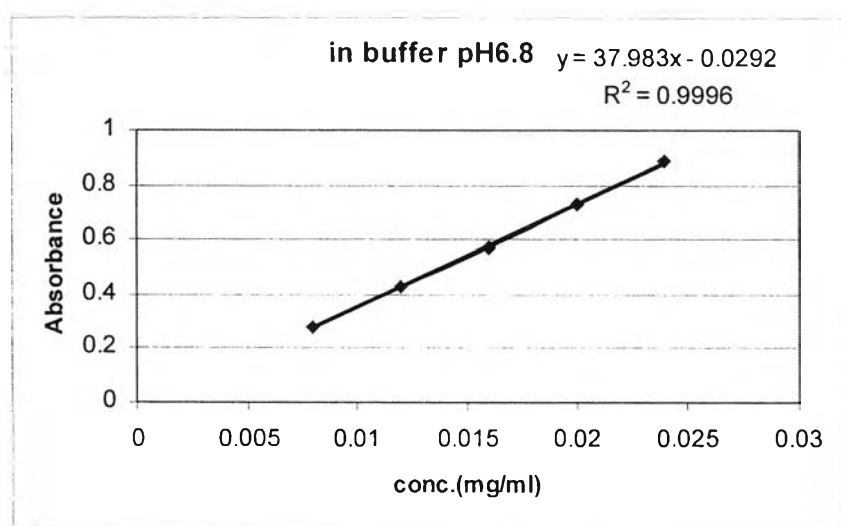




**Table 26** Absorbance of diclofenac sodium in pH 6.8 phosphate buffer at a maximum wavelength of 275 nm

Concentration(mg/ml)	Absorbance at 275 nm
0.008	0.2785
0.012	0.4266
0.016	0.5717
0.02	0.7287
0.024	0.8871

**Figure 121** Calibration curve of diclofenac sodium in pH 6.8 phosphate buffer at a maximum wavelength of 275 nm



## 2. Validation of HPLC method

The diclofenac sodium concentrations for drug content and content uniformity of diclofenac pellets could be determined by HPLC assay with UV detection. The wavelength used to analyze diclofenac sodium in this study was 254 nm. The validation of HPLC methods used are presented as follows:

### 1.1 Specificity

From Figures 122 – 123, diclofenac related compound A and diclofenac sodium were eluted at 9 - 10 min and 18 – 19 min, respectively. Figures 124 -130 shows the chromatogram in presence of diclofenac sodium, diclofenac related compound A and non-active ingredients, including lactose, dbcp, GMS, Precirol® ATO 5, Compritol 888 ATO®, Gelucire50/02 and Tristearin®. It indicated that the other ingredients did not interfere the peaks of diclofenac sodium and diclofenac related compound A.

### 1.2 Accuracy

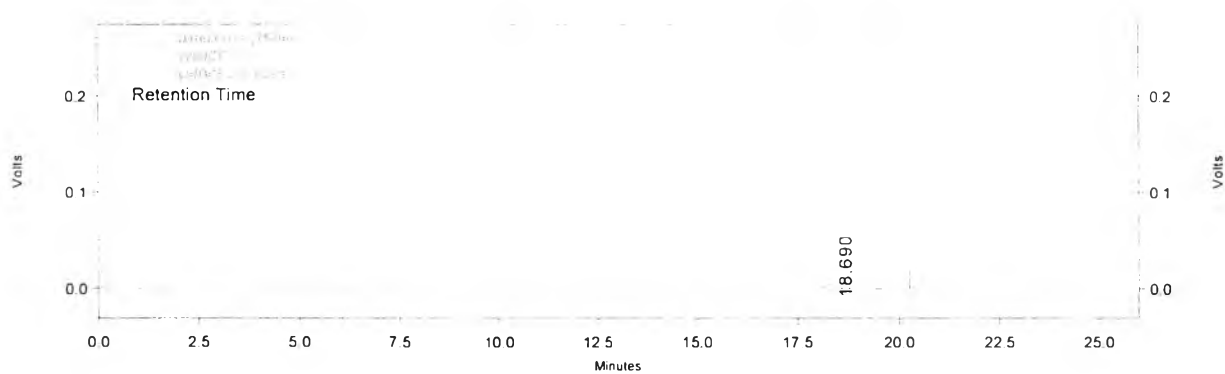
Table 27 and Table 28 shows the percentage of analytical recovery of diclofenac sodium and diclofenac related compound A. The mean percentage of analytical recovery closely to 100% (95-105%) with a low %RSD (<2.00%) indicated the high accuracy of this method.

### 1.3 Precision

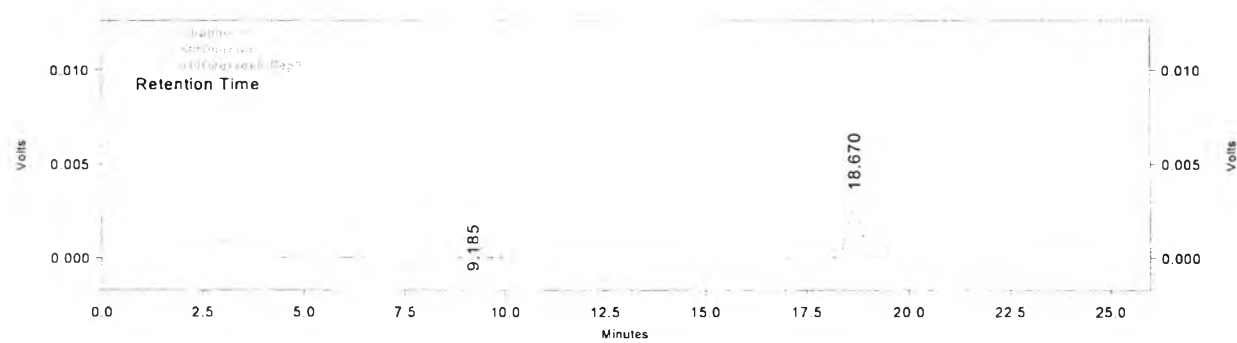
Table 29 and Table 30 shows data of within run precision of diclofenac sodium and diclofenac related compound A by HPLC method. Table 31 – 32 shows data of between run precision of diclofenac sodium and diclofenac related compound A by HPLC method. The percentage of coefficient of variation(%RSD) values of peak area ratio both within run and between run were low (<2.00%) which indicated that the HPLC methods could be to determine the amount of diclofenac sodium over period of time studied.

### 1.4 Linearity

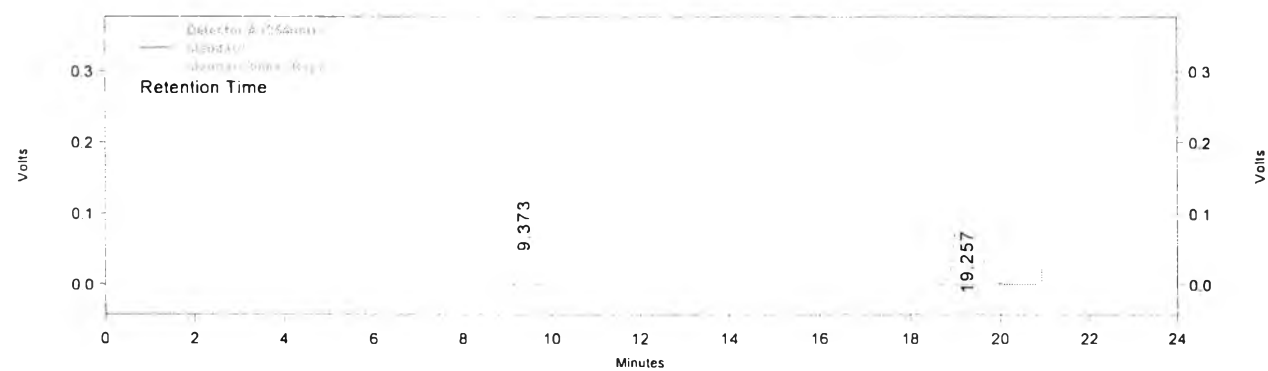
The linearity of analysis method is its ability to elicit test results that directly, or by well-defined mathematical transformation, proportional to the concentration of analysis in samples within a given range. Figure 131 showed that the relationship between area and diclofenac sodium concentrations is linearity with correlation of determination value of 1. Figure 121 showed that the relationship between area and diclofenac related compound A concentrations is linearity with correlation of determination value of 1. This result indicated that HPLC method was acceptable for qualitative analysis of diclofenac sodium in range studied.



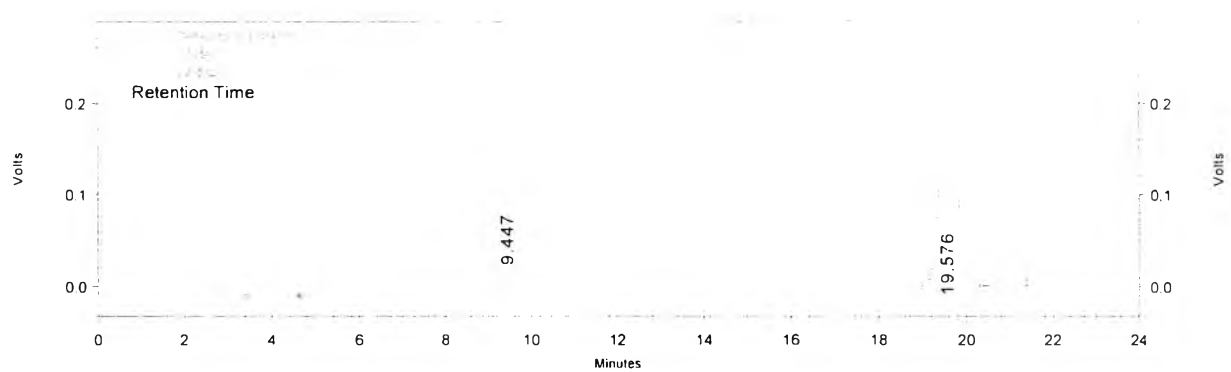
**Figure 122** The chromatogram in presence of diclofenac sodium



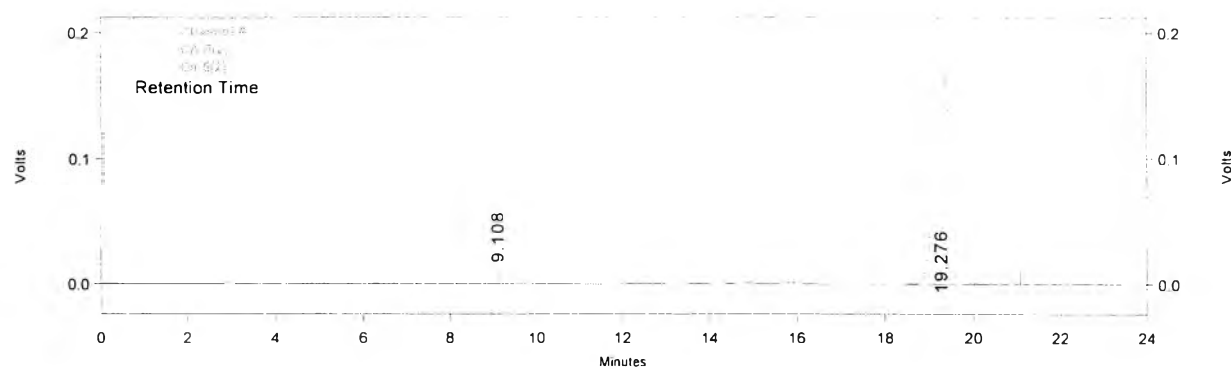
**Figure 123** The chromatogram in presence of diclofenac related compound A



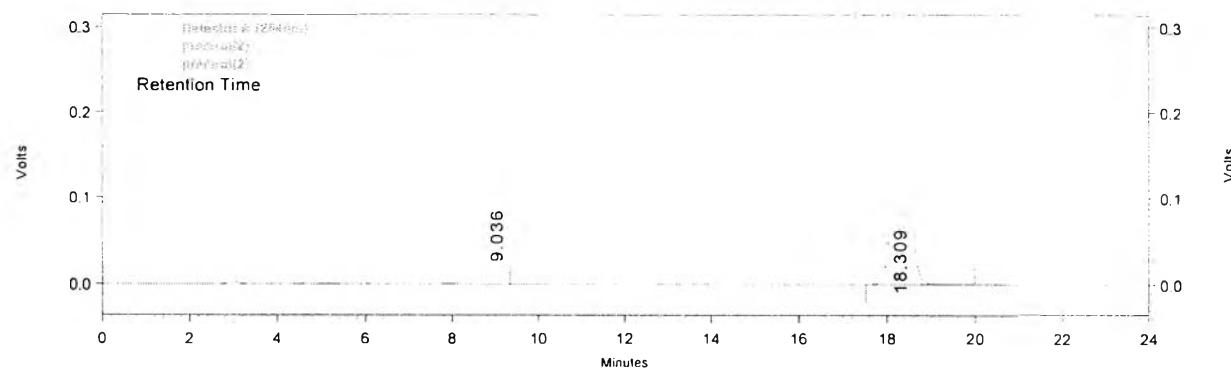
**Figure 124** The chromatogram in presence of diclofenac related compound A and diclofenac sodium



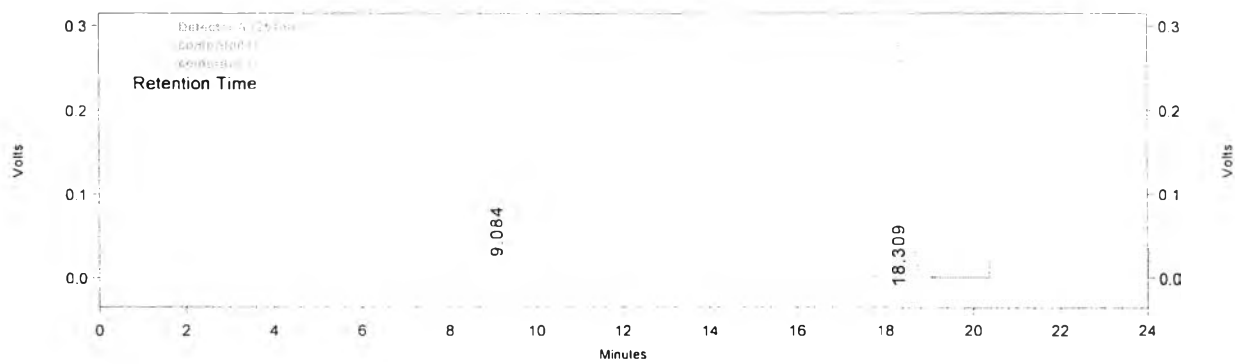
**Figure 125** The chromatogram in presence of LA-5 formulation



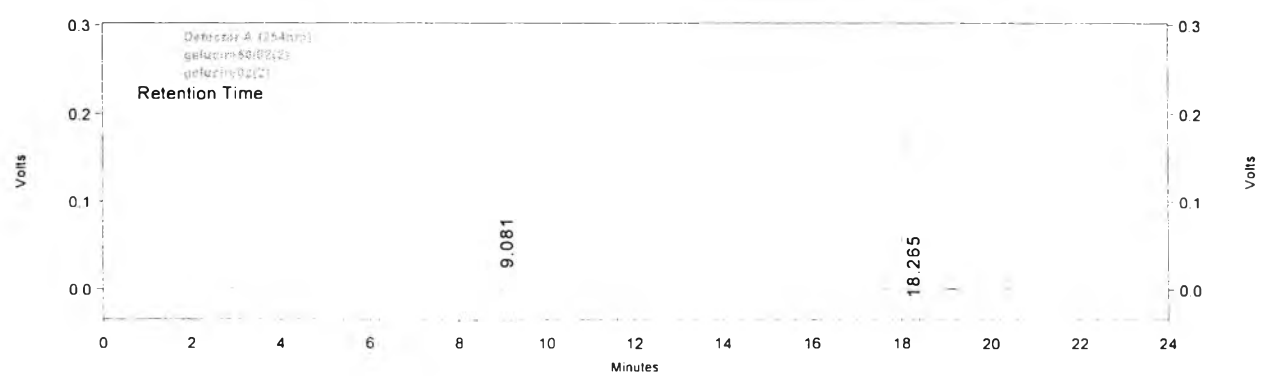
**Figure 126** The chromatogram in presence of CA-5 formulation



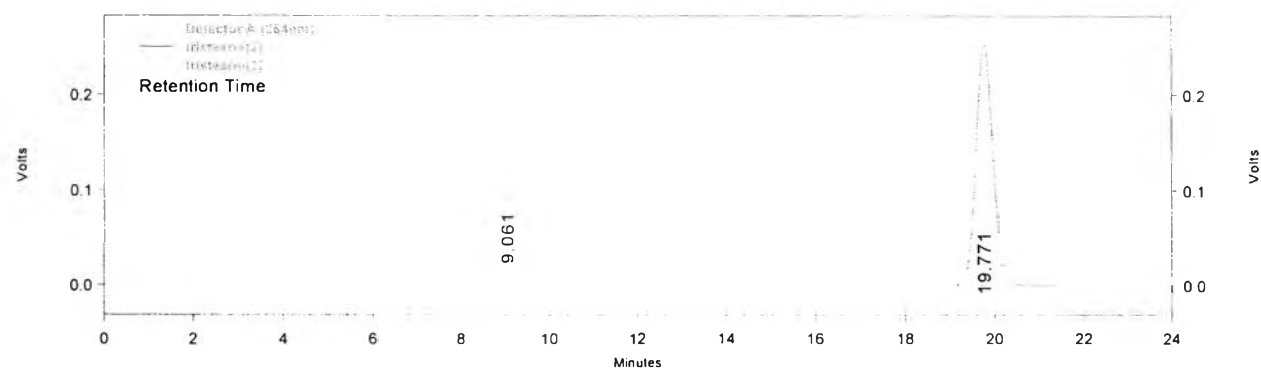
**Figure 127** The chromatogram in presence of PR formulation



**Figure 128** The chromatogram in presence of CP formulation



**Figure 129** The chromatogram in presence of GL formulation



**Figure 130** The chromatogram in presence of TS formulation

**Table 27** Percentage of analytical recovery of diclofenac sodium

Actual concentration (µg/ml)	Area	Analytical concentration (µg/ml)	%recovery	Mean (SD)	%RSD
105.40	2313471	106.30	101.46	102.71 (1.11)	1.08
	2352305	108.07	103.12		
	2370444	108.89	103.92		
	2367577	108.76	103.80		
	2378290	109.25	104.26		
210.80	4665169	213.29	101.48	101.34 (0.25)	0.25
	4663912	213.23	101.46		
	4668265	213.43	101.55		
	4692251	214.52	102.07		
	4673706	213.68	101.67		
316.20	6952355	317.34	100.56	100.49 (0.36)	0.36
	6936959	316.64	100.34		
	6950005	317.24	100.53		
	7002251	319.61	101.28		
	6965354	317.93	100.75		
421.60	9103195	415.19	98.63	98.76 (0.32)	0.32
	9092220	414.69	98.51		
	9138383	416.79	99.01		
	9157878	417.68	99.22		
	9152685	417.44	99.17		
527.00	11463781	522.58	99.28	99.28 (0.25)	0.26
	11449476	521.93	99.16		
	11469285	522.84	99.33		
	11526892	525.46	99.83		
	11476105	523.15	99.39		

**Table 28** Percentage of analytical recovery of diclofenac related compound A

Actual concentration (µg/ml)	Area	Analytical concentration (µg/ml)	%recovery	Mean	%RSD
2.64	81736	2.60	98.53	100.47 (1.16)	1.15
	83275	2.65	100.36		
	83861	2.67	101.06		
	83746	2.66	100.92		
	84222	2.68	101.49		
5.28	171735	5.43	102.81	103.11 (0.31)	0.30
	171919	5.43	102.92		
	172057	5.44	103.01		
	173049	5.47	103.60		
	172376	5.45	103.20		
7.92	258575	8.16	102.99	103.07 (0.37)	0.36
	257908	8.14	102.73		
	258571	8.16	102.99		
	260376	8.21	103.71		
	25844	8.15	102.94		
10.56	339045	10.68	101.18	101.98 (0.62)	0.61
	339941	10.71	101.45		
	342959	10.81	102.35		
	343729	10.83	102.58		
	343003	10.81	102.36		
13.20	422672	13.31	100.85	100.99 (0.21)	0.21
	422143	13.30	100.72		
	423431	13.34	101.03		
	424375	13.37	101.26		
	423726	13.35	101.10		

**Table 29** Data within run precision of diclofenac sodium

	<b>Area under the curve</b>				
<b>Concentration (µg/ml)</b>	<b>101.60</b>	<b>203.20</b>	<b>304.80</b>	<b>406.40</b>	<b>508.00</b>
<b>1</b>	2233319	4324877	6664894	8761243	11035194
<b>2</b>	2239552	4516577	6670625	8919610	11076852
<b>3</b>	2229033	4415706	6585583	9002187	11173658
<b>4</b>	2219967	4459706	6654775	8961984	11230880
<b>5</b>	2267858	4338041	6675585	8999943	11210479
<b>Mean</b>	2237946	4410981	6650292	8928993	11145413
<b>SD</b>	18175.55	81057.25	36992.35	99634.05	85417.81
<b>%RSD</b>	0.81	1.84	0.56	1.16	0.77

**Table 30** Data within run precision of diclofenac related compound A.

	<b>Area under the curve</b>				
<b>Concentration (µg/ml)</b>	<b>2.63</b>	<b>5.25</b>	<b>7.88</b>	<b>10.50</b>	<b>13.13</b>
<b>1</b>	82878	163059	247736	327963	411814
<b>2</b>	83322	169569	249203	334156	415112
<b>3</b>	82500	165972	245763	335551	418689
<b>4</b>	82395	168195	248938	335647	419372
<b>5</b>	84490	163446	249945	336000	420672
<b>Mean</b>	83117	166048.2	248317	333863.4	417131.8
<b>SD</b>	849.45	2859.95	1634.13	3372.49	3617.15
<b>%RSD</b>	1.02	1.72	0.66	1.01	0.87

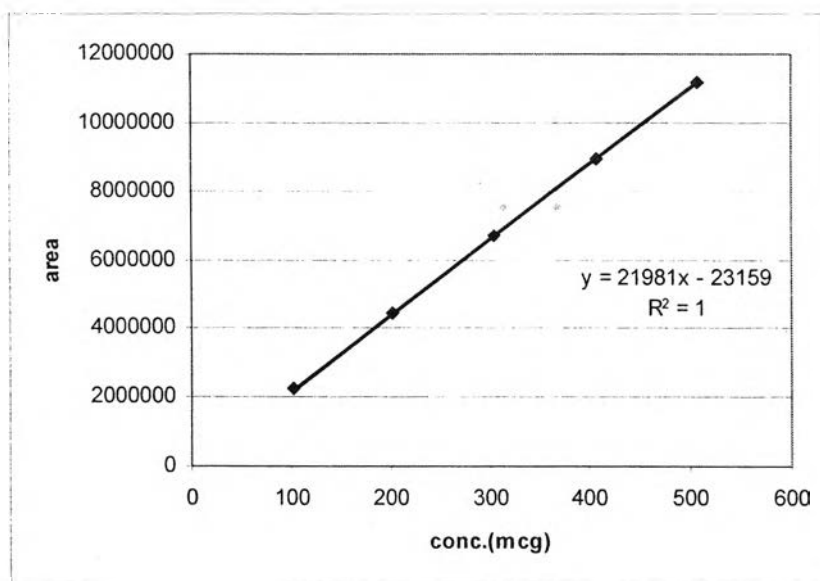


**Table 31** Data between run precision of diclofenac sodium

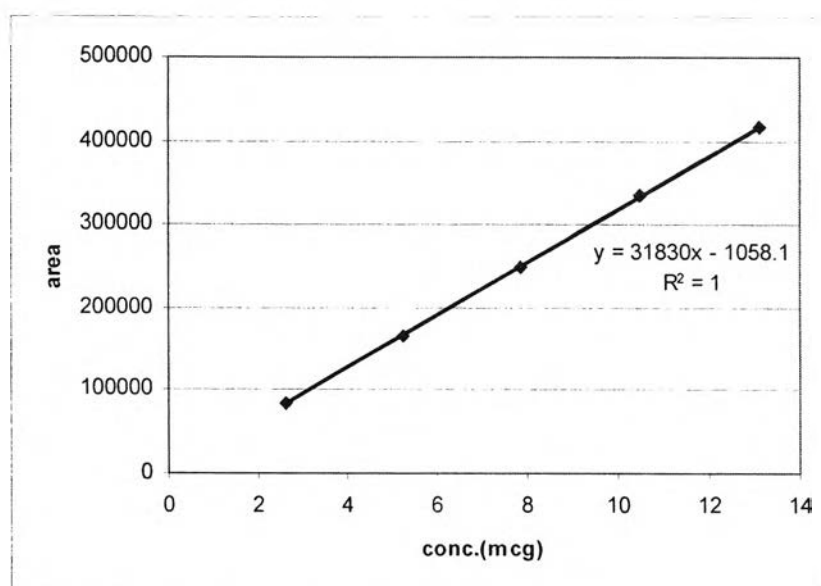
Concentration (µg/ml)	Area under the curve									
	Day 1					Day 2				
	101.60	203.20	304.80	406.40	508.00	105.40	210.80	316.20	421.60	527.00
1	2233319	4324877	6664894	8761243	11035194	2313471	4665169	6952355	9103195	11463781
2	2239552	4516577	6670625	8919610	11076852	2352305	4663912	6936959	9192220	11449476
3	2229033	4415706	6585583	9002187	11173658	2370444	4668265	6950005	9138383	11469285
4	2219967	4459706	6654775	8961984	11230880	2367577	4692251	7002251	9157878	11526892
5	2267858	4338041	6675585	8999943	11210479	2378290	4673706	6965354	9152685	11476105
Mean	2237946	4410981	6650292	8928993	11145413	2356417	4672661	6961385	9128866	11477108
SD	18175.55	81057.25	36992.35	99634.05	85417.81	25792.43	11585.12	24967.27	29584.76	29503.34
%RSD	0.81	1.84	0.56	1.16	0.77	1.09	0.25	0.36	0.32	0.26

**Table 32** Data between run precision of diclofenac related compound A.

Concentration (µg/ml)	Area under the curve									
	Day 1					Day 2				
	2.63	5.25	7.88	10.50	13.13	2.64	5.28	7.92	10.56	13.20
1	82878	163059	247736	327963	411814	81736	171735	258575	339045	422672
2	83322	169569	249203	334156	415112	83275	171919	257908	339941	422143
3	82500	165972	245763	335551	418689	83861	172057	258571	342959	423431
4	82395	168195	248938	335647	419372	83746	173049	260376	343729	424375
5	84490	163446	249945	336000	420672	84222	172376	258444	343003	423726
Mean	83117	166048.2	248317	333863.4	417131.8	83368	172227.2	258774.8	341735.4	423269.4
SD	849.45	2859.95	1634.13	3372.49	3617.15	973.0522	515.6823	936.2247	2093.834	877.8686
%RSD	1.02	1.72	0.66	1.01	0.87	1.17	0.30	0.36	0.61	0.21

**Calibration curve of diclofenac sodium for HPLC studied**

**Figure 131** Calibration curve showing linearity between area and diclofenac sodium concentrations.

**Calibration curve of diclofenac related compound A for HPLC studied**

**Figure 132** Calibration curve showing linearity between area and diclofenac related compound A concentrations.

## Appendix B

### Percentage of drug release

**Table 33** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
LA-1	0.00	0.00	0.00		
	0.50	11.95	0.69		
	1.00	12.38	0.46		
	2.00	12.85	0.29		
	2.08			40.59	3.12
	2.17			47.50	0.64
	2.25			54.02	0.86
	2.50			65.13	1.04
	2.75			72.12	1.22
	3.00			75.39	1.93
	3.50			79.44	2.03
	4.00			80.70	1.65
	4.50			81.86	1.84
	5.00			83.01	2.03
	6.00			83.71	2.19
7.00			84.56	1.80	
8.00			84.66	1.64	
LA-2	0.00	0.00	0.00		
	0.50	9.85	0.72		
	1.00	10.82	0.75		
	2.00	12.01	0.50		
	2.08			45.44	3.18
	2.17			56.64	3.07
	2.25			64.19	2.38
	2.50			73.63	2.36
	2.75			79.71	1.01
	3.00			81.96	1.11
	3.50			84.72	1.55
	4.00			85.82	1.44
	4.50			86.55	1.35
	5.00			86.58	1.59
	6.00			86.80	1.86
7.00			88.07	1.81	
8.00			88.72	1.54	

**Table 34** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
LA-3	0.00	0.00	0.00		
	0.50	9.66	0.58		
	1.00	10.38	0.46		
	2.00	11.57	0.35		
	2.08			33.38	0.10
	2.17			41.04	0.76
	2.25			48.17	1.18
	2.50			61.84	1.55
	2.75			70.24	1.58
	3.00			74.64	1.50
	3.50			76.50	1.62
	4.00			83.86	1.79
	4.50			88.39	1.61
	5.00			91.13	1.32
	6.00			93.74	1.50
7.00			97.18	1.31	
8.00			98.35	1.66	
LA-4	0.00	0.00	0.00		
	0.50	8.91	0.22		
	1.00	9.05	0.23		
	2.00	10.34	0.28		
	2.08			34.03	1.66
	2.17			43.00	1.30
	2.25			50.12	1.61
	2.50			63.49	1.57
	2.75			70.54	1.54
	3.00			75.15	1.37
	3.50			80.03	1.14
	4.00			82.26	0.99
	4.50			84.06	0.83
	5.00			84.84	0.88
	6.00			85.90	0.92
7.00			86.56	0.65	
8.00			87.57	0.57	
LA-5	0.00	0.00	0.00		
	0.50	10.66	1.54		
	1.00	11.27	1.06		
	2.00	12.16	0.98		
	2.08			37.68	1.78
	2.17			45.37	2.06
	2.25			50.16	1.76
	2.50			58.97	1.83
	2.75			63.89	1.66
	3.00			66.57	1.75
	3.50			71.51	1.78
	4.00			73.62	1.85
	4.50			75.59	1.98
	5.00			76.98	2.02
	6.00			78.74	2.24
7.00			80.22	2.24	
8.00			81.58	1.49	

**Table 35** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
LA-6	0.00	0.00	0.00		
	0.50	10.39	0.08		
	1.00	11.69	0.86		
	2.00	12.04	0.48		
	2.08			43.61	1.96
	2.17			52.65	2.21
	2.25			58.03	2.43
	2.50			67.43	2.48
	2.75			72.41	2.37
	3.00			76.04	2.13
	3.50			79.95	1.92
	4.00			82.48	1.69
	4.50			83.98	1.80
	5.00			85.52	1.78
	6.00			86.21	2.03
	7.00			87.04	1.79
8.00			87.30	2.10	
LA-7	0.00	0.00	0.00		
	0.50	6.60	0.43		
	1.00	6.97	0.34		
	2.00	7.72	0.34		
	2.08			24.32	0.69
	2.17			31.13	0.71
	2.25			37.28	0.85
	2.50			48.26	1.12
	2.75			53.40	0.77
	3.00			60.58	1.15
	3.50			66.70	1.08
	4.00			70.60	0.70
	4.50			72.68	0.78
	5.00			74.49	0.44
	6.00			77.05	0.65
	7.00			79.48	1.00
8.00			80.18	1.93	
LA-8	0.00	0.00	0.00		
	0.50	11.12	0.51		
	1.00	11.28	0.48		
	2.00	11.64	0.44		
	2.08			39.44	1.77
	2.17			49.14	2.67
	2.25			55.25	2.66
	2.50			66.85	3.13
	2.75			72.33	3.00
	3.00			75.40	3.10
	3.50			78.95	2.81
	4.00			80.76	2.44
	4.50			82.00	2.40
	5.00			83.06	2.23
	6.00			84.11	2.32
	7.00			84.94	2.32
8.00			85.51	2.44	

**Table 36** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
LA-9	0.00	0.00	0.00		
	0.50	8.07	0.34		
	1.00	8.61	0.24		
	2.00	9.66	0.25		
	2.08			29.77	1.20
	2.17			37.46	1.43
	2.25			44.09	1.40
	2.50			55.59	1.57
	2.75			62.09	1.73
	3.00			66.64	1.97
	3.50			71.71	1.80
	4.00			74.83	1.83
	4.50			76.85	1.96
	5.00			78.52	1.91
	6.00			80.59	2.05
	7.00			82.10	1.82
8.00			83.31	1.63	
CA-1	0.00	0.00	0.00		
	0.50	7.29	0.20		
	1.00	8.54	0.10		
	2.00	9.76	0.42		
	2.08			20.34	0.49
	2.17			24.13	0.43
	2.25			28.98	1.83
	2.50			37.39	0.78
	2.75			44.92	0.65
	3.00			51.44	0.50
	3.50			60.44	0.66
	4.00			66.45	0.92
	4.50			71.79	0.70
	5.00			76.06	0.37
	6.00			82.71	0.57
	7.00			86.13	0.56
8.00			89.49	0.77	
CA-2	0.00	0.00	0.00		
	0.50	6.75	0.36		
	1.00	7.16	0.27		
	2.00	7.92	0.13		
	2.08			21.02	0.85
	2.17			28.45	0.89
	2.25			33.91	1.00
	2.50			48.44	0.91
	2.75			59.91	0.86
	3.00			68.59	0.83
	3.50			80.75	0.90
	4.00			88.12	0.77
	4.50			92.44	1.28
	5.00			94.62	1.13
	6.00			96.41	1.40
	7.00			97.19	1.24
8.00			97.84	1.31	

**Table 37** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
CA-3	0.00	0.00	0.00		
	0.50	9.31	0.29		
	1.00	9.58	0.34		
	2.00	10.51	0.52		
	2.08			25.95	1.02
	2.17			31.22	0.85
	2.25			36.04	0.66
	2.50			49.36	0.81
	2.75			60.14	0.63
	3.00			68.67	0.89
	3.50			79.92	0.57
	4.00			87.48	0.93
	4.50			92.07	0.89
	5.00			94.99	1.17
	6.00			97.67	1.34
7.00			98.94	1.05	
8.00			99.47	1.12	
CA-4	0.00	0.00	0.00		
	0.50	8.58	0.32		
	1.00	8.71	0.24		
	2.00	9.68	0.26		
	2.08			18.35	0.20
	2.17			20.23	0.62
	2.25			23.33	0.39
	2.50			30.64	0.44
	2.75			37.18	0.53
	3.00			42.05	0.56
	3.50			50.13	0.70
	4.00			56.31	0.81
	4.50			61.60	0.93
	5.00			66.12	0.88
	6.00			73.45	1.04
7.00			79.50	0.91	
8.00			83.65	1.10	
CA-5	0.00	0.00	0.00		
	0.50	8.25	0.43		
	1.00	9.22	0.28		
	2.00	9.80	0.46		
	2.08			22.46	1.11
	2.17			27.16	0.37
	2.25			32.21	0.73
	2.50			42.92	0.59
	2.75			50.41	0.52
	3.00			55.96	0.88
	3.50			63.14	0.55
	4.00			68.79	0.81
	4.50			73.41	0.76
	5.00			76.26	0.68
	6.00			81.06	0.68
7.00			84.44	0.74	
8.00			86.53	0.89	

**Table 38** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
CA-6	0.00	0.00	0.00		
	0.50	9.37	0.35		
	1.00	10.87	0.49		
	2.00	12.52	0.42		
	2.08			27.19	1.16
	2.17			33.25	1.06
	2.25			38.79	0.66
	2.50			51.55	0.90
	2.75			60.84	0.94
	3.00			67.35	0.67
	3.50			77.12	1.13
	4.00			83.65	0.81
	4.50			88.85	1.19
	5.00			92.06	1.21
	6.00			96.13	1.30
	7.00			98.60	1.33
8.00			99.91	1.42	
CA-7	0.00	0.00	0.00		
	0.50	9.36	0.49		
	1.00	11.09	0.52		
	2.00	13.04	0.48		
	2.08			22.74	1.08
	2.17			25.77	0.51
	2.25			29.11	0.50
	2.50			37.49	0.64
	2.75			42.41	1.03
	3.00			47.10	0.95
	3.50			54.94	0.97
	4.00			60.76	0.71
	4.50			65.31	0.58
	5.00			69.65	0.66
	6.00			75.71	0.59
	7.00			80.76	0.42
8.00			84.77	0.64	
CA-8	0.00	0.00	0.00		
	0.50	9.46	0.23		
	1.00	9.23	0.48		
	2.00	10.07	0.37		
	2.08			19.28	0.44
	2.17			21.04	0.63
	2.25			23.55	0.62
	2.50			30.53	1.13
	2.75			35.95	1.97
	3.00			40.62	1.71
	3.50			47.22	1.84
	4.00			52.11	1.83
	4.50			56.56	1.98
	5.00			60.61	1.98
	6.00			66.62	1.83
	7.00			71.84	1.75
8.00			76.11	1.70	



**Table 39** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
CA-9	0.00	0.00	0.00		
	0.50	7.56	0.31		
	1.00	7.90	0.62		
	2.00	8.62	0.29		
	2.08			16.82	0.62
	2.17			18.82	0.43
	2.25			21.26	0.43
	2.50			27.30	0.46
	2.75			32.37	0.52
	3.00			36.40	0.67
	3.50			43.66	0.54
	4.00			48.04	1.40
	4.50			53.72	1.13
	5.00			57.28	0.71
	6.00			63.13	0.96
	7.00			68.11	1.21
8.00			72.51	1.22	
PR	0.00	0.00	0.00		
	0.50	7.67	0.71		
	1.00	8.18	0.52		
	2.00	9.47	0.54		
	2.08			28.80	1.39
	2.17			39.03	1.15
	2.25			44.83	1.15
	2.50			57.40	0.26
	2.75			66.17	0.84
	3.00			71.33	0.83
	3.50			79.37	1.61
	4.00			84.45	1.60
	4.50			87.38	1.24
	5.00			90.47	1.45
	6.00			93.18	0.70
	7.00			95.14	0.71
8.00			96.81	0.86	
CP	0.00	0.00	0.00		
	0.50	6.07	0.48		
	1.00	9.74	0.99		
	2.00	11.66	0.70		
	2.08			28.47	2.00
	2.17			41.62	1.43
	2.25			45.79	1.73
	2.50			60.83	3.23
	2.75			70.83	2.68
	3.00			77.84	2.05
	3.50			86.01	1.30
	4.00			90.41	1.26
	4.50			93.02	1.23
	5.00			94.27	1.60
	6.00			95.20	1.74
	7.00			96.04	1.85
8.00			96.55	1.69	

**Table 40** Percentage amount of diclofenac sodium release from pellets,  
based on assayed content (continued)

Formulation	time	Dissolution medium			
		0.1 N HCl		Phosphate buffer pH 6.8	
		Mean %	SD	Mean %	SD
GL	0.00	0.00	0.00		
	0.50	12.80	0.75		
	1.00	13.03	0.97		
	2.00	13.52	0.58		
	2.08			51.91	2.74
	2.17			64.46	2.52
	2.25			71.03	1.60
	2.50			78.38	1.58
	2.75			79.63	1.50
	3.00			79.87	1.76
	3.50			79.95	1.89
	4.00			79.79	2.10
	4.50			80.10	2.28
	5.00			80.14	2.48
	6.00			80.48	2.32
	7.00			80.37	2.51
8.00			80.65	2.34	
TS	0.00	0.00	0.00		
	0.50	14.11	0.50		
	1.00	17.10	0.36		
	2.00	18.19	0.86		
	2.08			44.45	3.74
	2.17			53.29	4.40
	2.25			60.41	5.16
	2.50			75.50	5.81
	2.75			83.22	6.60
	3.00			86.09	5.21
	3.50			90.89	4.04
	4.00			92.35	2.44
	4.50			93.63	2.15
	5.00			94.60	2.12
	6.00			95.33	2.56
	7.00			95.68	2.82
8.00			95.90	2.96	

## VITA

Miss Soonthariya Rongrongmuang was born on December 8, 1977. She received her bachelor of Science in Pharmacy degree in 1999 from the Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok, Thailand. After graduation, she worked at Bangbautong Hospital for three year before entering the Master's degree program in manufacturing pharmacy at Chulalongkorn University.

