APPENDIX

Appendix A

Composition of Ca and Na ion containing and Cation Exchange Capacity (CEC) in bentonite clay before and after preparation of saturated Na-bentonite

Table A-1 Composition of Ca and Na ion containing in bentonite clay

Sample* **(g/100g)**	**Ion containing**	
	Commercial bentonite	**Na-bentonite**
Ca	3.4	0.74
Na	2.21	2.00
K	1.10	0.35
Mg	2.50	0.87
Fe	1.05	0.75
CEC	83.67	87.79

*Source: Soil Science Laboratory, Division of Soil Science and Conservation, Faculty of Agricultural, Chiang Mai University.

Appendix B

Calculation of berberine content in Alk precipitate (%)

The berberine content in Alk precipitate extracted from *C. fenestratum* was calculated in percentage, corresponding of berberine standard.

20 ppm of berberine chloride and Alk precipitate were prepared for using in HPLC analysis. (standard berberine chloride = 98% (w/w))

$$\%\ \text{berberine (A)} = \frac{\text{peak area of Alk precipitate}}{\text{peak area of berberine chloride}} \times 100$$

(Comparison with 100% berberine chloride)

But, Standard berberine chloride (98%)

$$\%\ \text{berberine content in Alk precipitate} = \frac{98}{100} \times \text{A}$$

Appendix C

Preparation of Dragendroff's reagent

Dissolve bismuth subnitrate [$Bi_5O(OH)_9(NO_3)_4$] 8 g with nitric acid [HNO_3] 20 ml and potassium iodide [KI] 27.2 g in the solution. Dilute the mixture by adding distill water up to 100 ml. Store the reagent in a dark bottle.

Appendix D

Standard curve of pesticides

Information of carbaryl curve concentration obtained from HPLC chromatograms

Table D-1 Concentrations of carbaryl pesticide for calibration curve

Concentration (ppm)	Peak area (mAU*s)			Average Peak area (mAU*s)
	1st	2nd	3rd	
5	170.1	217.9	167.8	35.6 ± 9.87
10	351.2	367.1	349.5	184.6 ± 28.0
15	493.0	466.1	493.7	484.0 ± 15.6
20	507.6	564.5	545.7	538.6 ± 29.0
25	670.9	604.6	656.0	643.3 ± 34.8

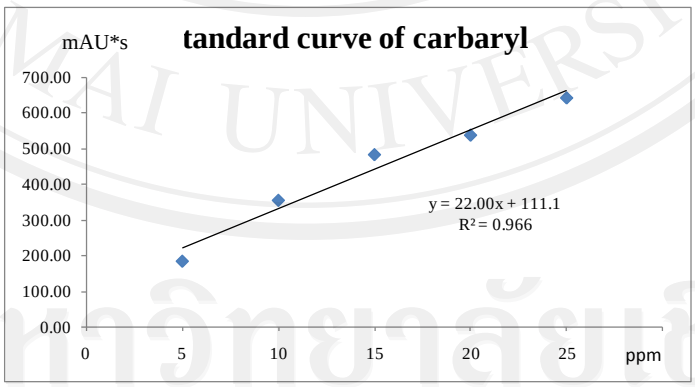
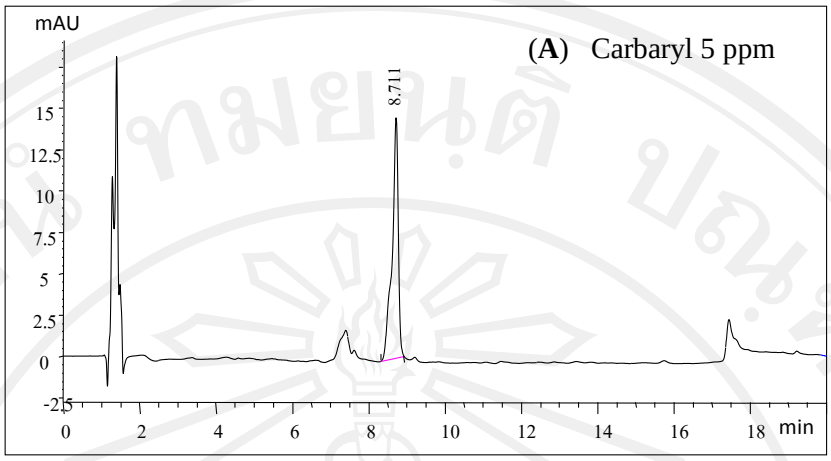
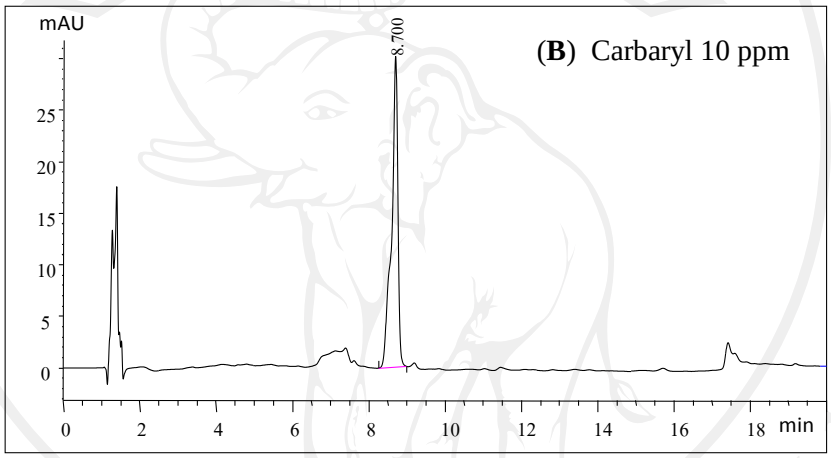
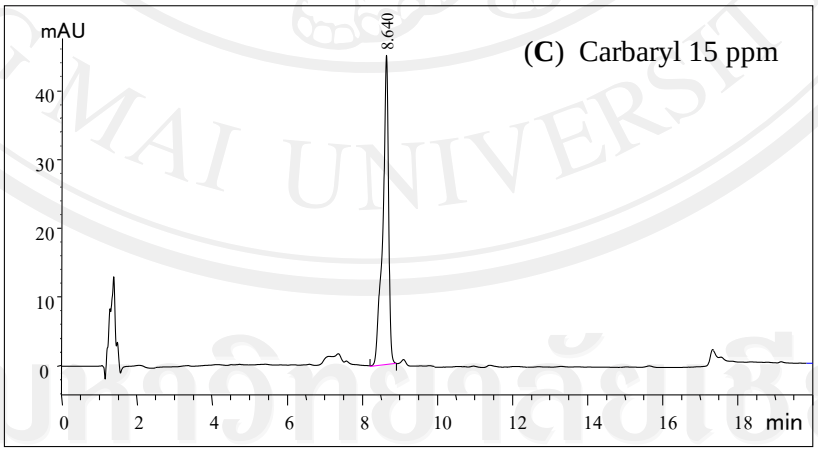


Figure D-1 Standard curve of carbaryl pesticide







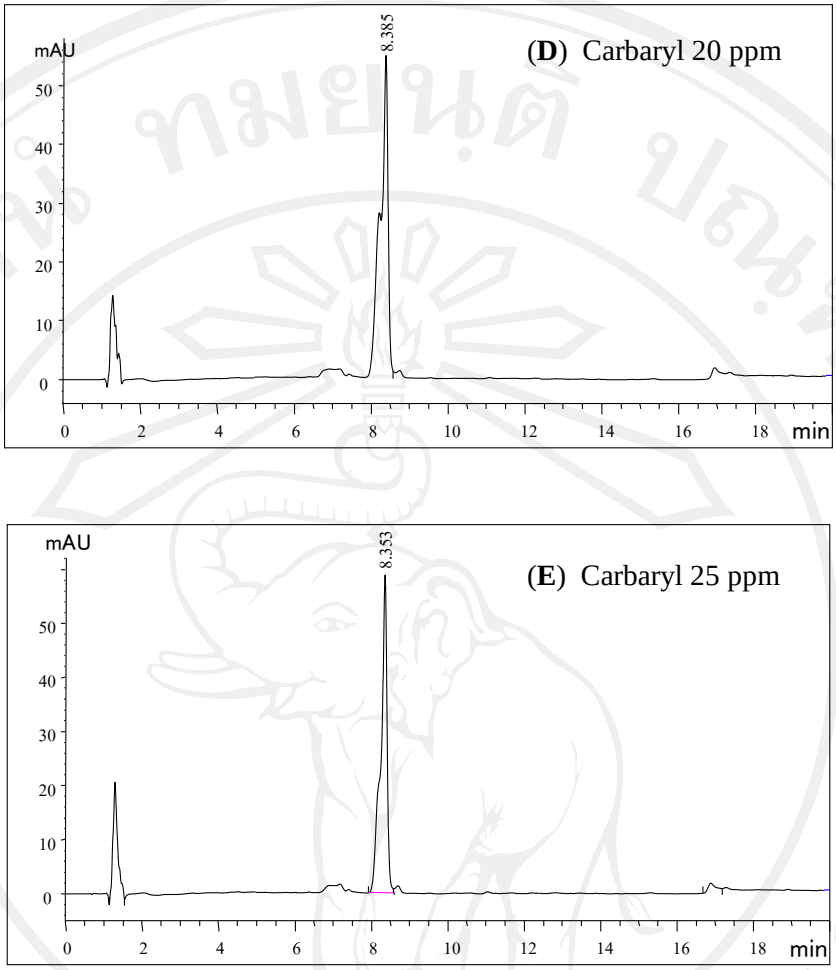


Figure D-1.1 Chromatogram of carbaryl pesticide standard concentrations showed at 5 ppm (**A**), 10 ppm (**B**), 15 ppm (**C**), 20 ppm (**D**) and 25 ppm (**E**)

Table D-2 Concentrations of methomyl pesticide for calibration curve

Concentration (ppm)	Peak area (mAU*s)			Average Peak area (mAU*s)
	1st	2nd	3rd	
5	657.6	640.5	646.6	647.6 ± 8.6
10	973.0	991.3	992.8	985.3 ± 10.7
15	1287.3	1308.7	1304.4	1299.6 ± 11.2
20	1603.5	1636.0	1611.9	1616.6 ± 17.2
25	1994.1	2005.1	2044.6	2014.3 ± 26.3

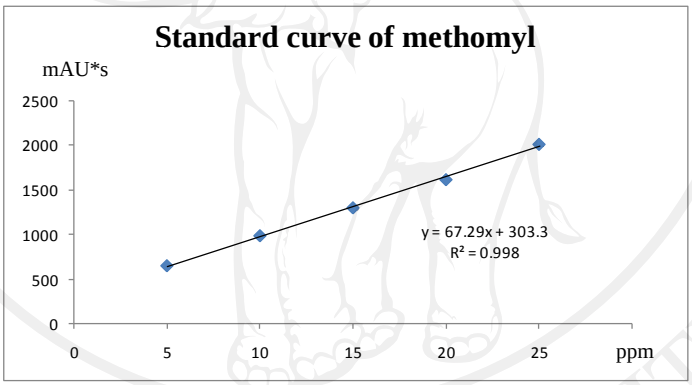
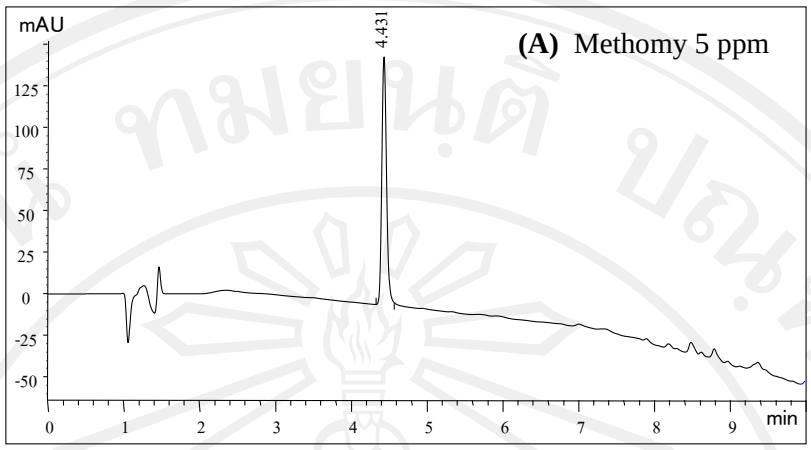
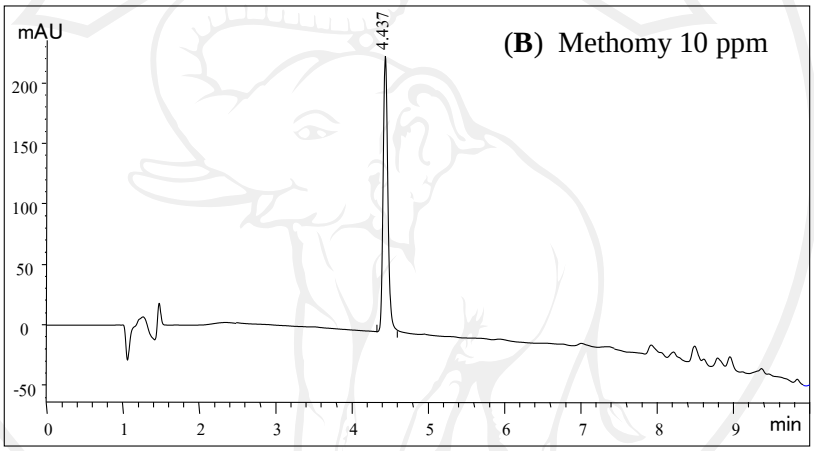
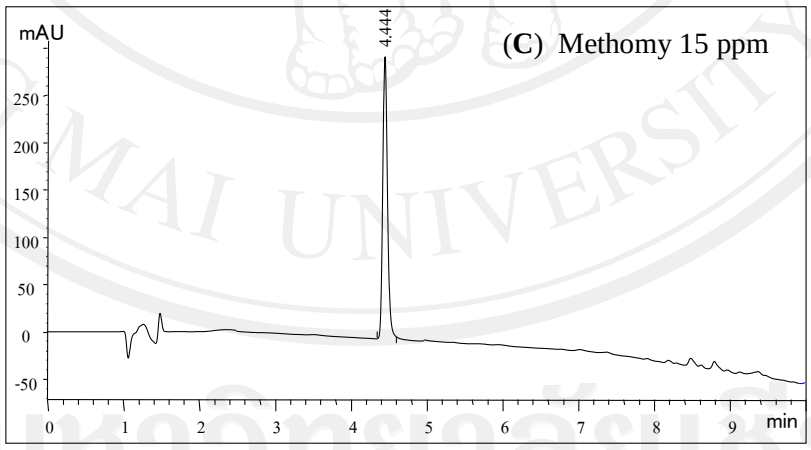


Figure D-2 Standard curve of methomyl pesticide







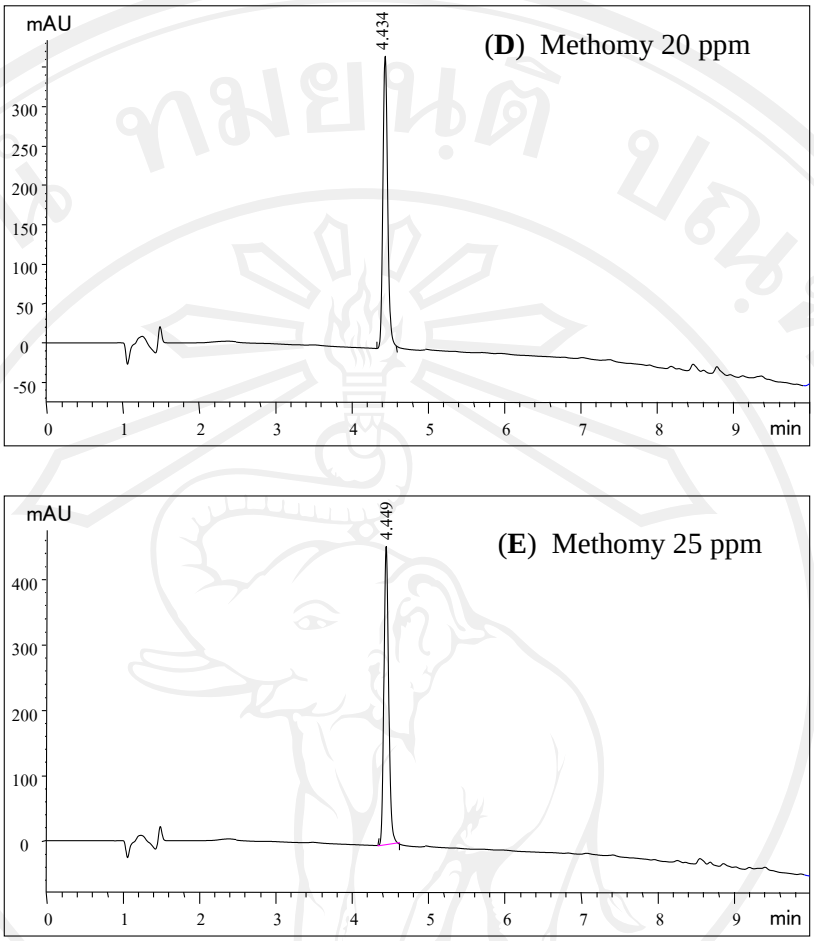


Figure D-2.1 Chromatogram of methomyl pesticide standard concentrations showed at 5 ppm (**A**), 10 ppm (**B**), 15 ppm (**C**), 20 ppm (**D**) and 25 ppm (**E**)

Table D-3 Concentrations of methomyl pesticide for calibration curve

Concentration (ppm)	Peak area (mAU*s)			Average peak area (mAU*s)
	1st	2nd	3rd	
5	349.9	372.1	339.2	353.5 ± 16.9
10	743.4	692.2	695.0	710.2 ± 28.8
15	995.3	965.4	998.4	986.4 ± 18.2
20	1333.0	1308.8	1277.9	1306.6 ± 27.6
25	2227.4	2191.0	2190.1	2202.9 ± 21.3

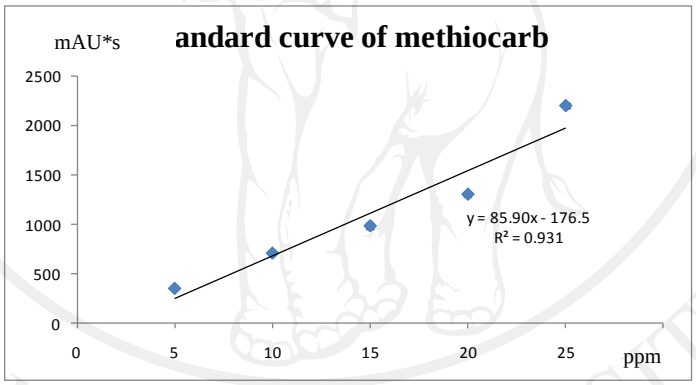
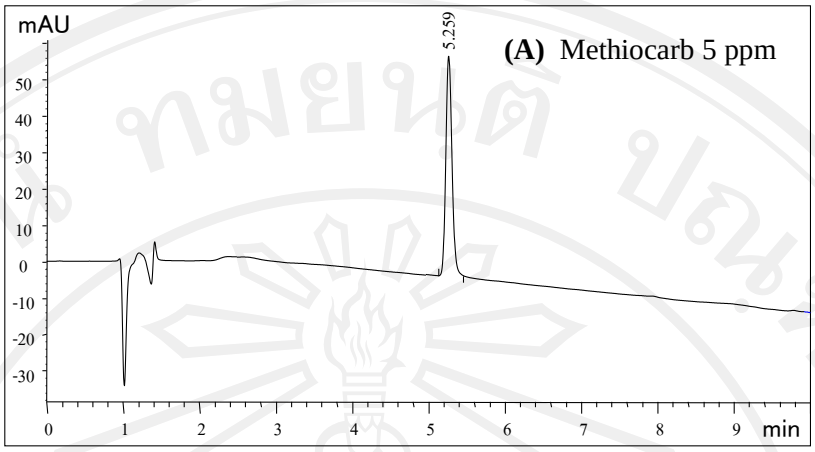
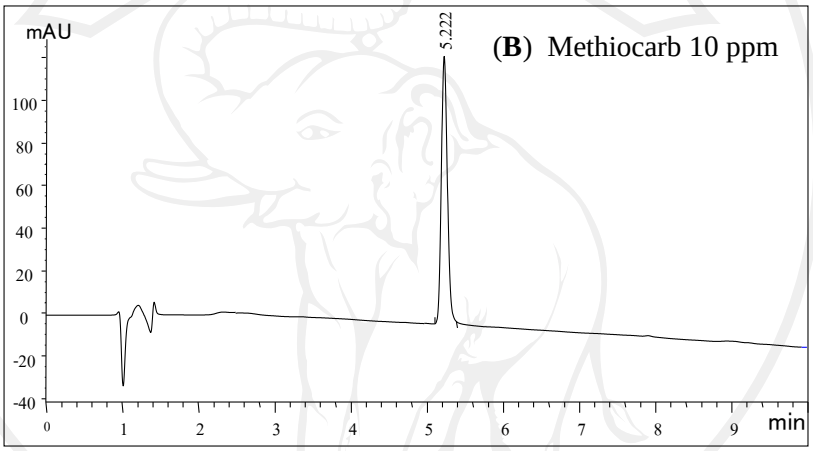
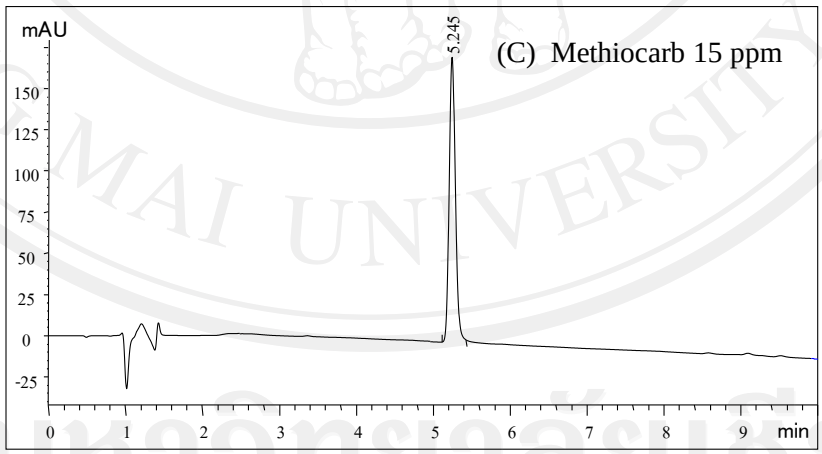


Figure D-3 Standard curve of methiocarb







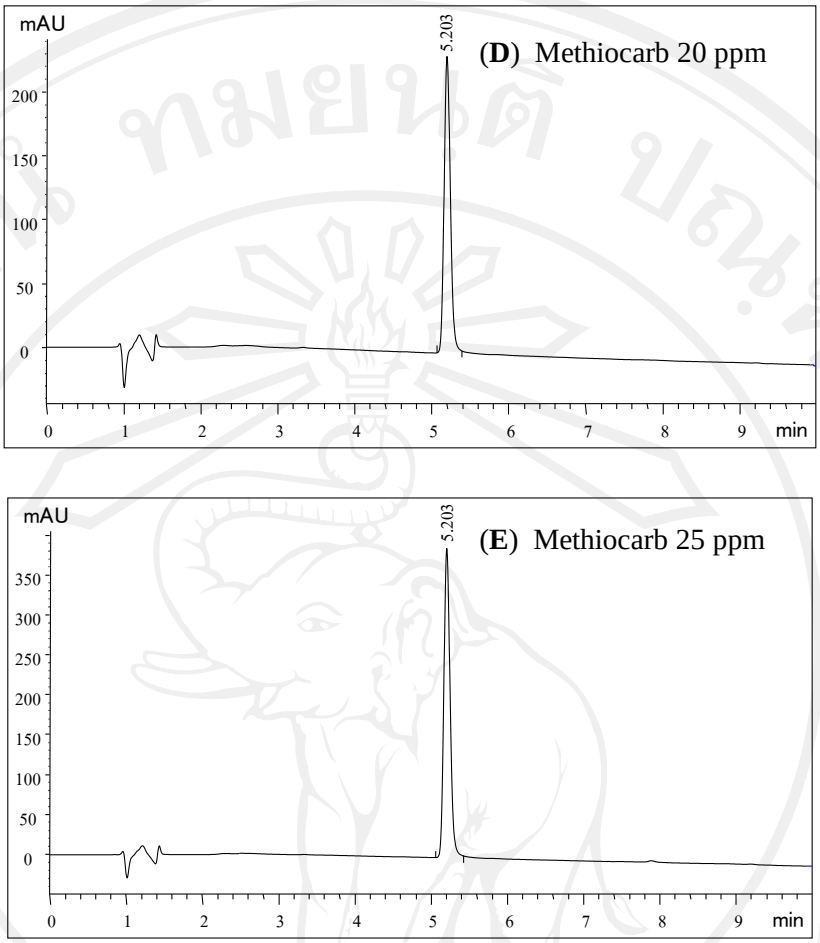


Figure D-3.1 Chromatogram of methiocarb pesticide standard concentrations showed at 5 ppm (**A**), 10 ppm (**B**), 15 ppm (**C**), 20 ppm (**D**) and 25 ppm (**E**)

Appendix E

Table E-1 Organobentonite adsorption of carbaryl pesticide obtained from HPLC analysis

Sample	Retention time (min)	Peak area (mAU*s)	Concentration residue (ppm)	Average concentration residue (ppm)	Concentration adsorption (ppm)[a]	Average concentration adsorption (ppm)	Average adsorption (%)
Control	9.051 6.052 9.039	254.6 289.2 316.0	42.3 41.2 48.6	44.0 ± 3.99	163.1 156.5 152.5	156.0	**78 ± 1.99**
Alk-Bent (1:500)	9.005 8.981 8.986	311.8 265.7 227.6	44.4 37.9 32.4	39.5 ± 6.0	153.1 160.0 165.8	161.8	**81 ± 1.91**
Alk-Bent (1:200)	9.023 9.063 9.043	215.7 285.2 265.2	33.0 40.6 44.9	38.2 ± 6.00	167.6 157.1 160.1	160.5	**80 ± 1.51**
Alk-Bent (1:100)	8.761 8.614 8.888	224.2 279.2 228.6	31.9 39.8 32.6	34.8 ± 4.36	166.3 158.0 165.6	165.2	**83 ± 4.36**
BbrCl-Bent (1:500)	9.068 8.931 9.039	108.7 90.3 118.5	15.5 12.9 16.9	15.1 ± 2.04	183.7 186.4 182.2	184.9	**92 ± 1.02**
BbrCl-Bent (1:200)	8.980 8.972 9.013	46.5 56.0 42.8	6.6 8.0 6.1	6.9 ± 0.97	193.0 191.6 193.6	193.1	**97 ± 0.48**
BbrCl-Bent (1:100)	9.063 9.009 9.034	193.9 298.2 228.0	58.8 42.5 32.5	44.6 ± 7.08	170.8 155.2 165.7	155.4	**78 ± 3.53**

[a] Initial concentration was 200 ppm

Table E-2 Organobentonite adsorption of methomyl pesticide obtained from HPLC analysis

Sample	Retention time (min) (1)[a]	Retention time (min) (2)[b]	Peak area (mAU) (1)	Peak area (mAU) (2)	Concentration residue (ppm)	Average concentration residue (ppm)[c]	Concentration adsorption (ppm)	Average concentration adsorption (ppm)	Average adsorption (%)
Control	4.510 4.513 4.507	3.394 3.397 3.390	971 786 831	350 439 416	11.5 9.3 9.9	10.2 ± 1.15	118.4 190.6 190.0	189.7	**95 ± 0.79**
Alk-Bent (1:500)	4.515 4.478 4.503	3.398 3.360 3.385	1075 894 992	181 280 292	12.8 10.6 11.8	11.7 ± 1.08	187.1 189.3 188.1	186.9	**94 ± 0.54**
Alk-Bent (1:200)	4.518 4.515 4.493	3.403 3.398 3.372	1072 940 1056	290 286 261	12.7 11.2 12.5	12.1 ± 0.85	187.2 188.7 187.4	187.2	**94 ± 0.43**
Alk-Bent (1:100)	4.409 4.463 4.450	3.274 3.338 3.323	992 997 1030	269 267 273	11.8 11.8 12.2	12.0 ± 0.24	188.1 188.1 187.7	187.6	**94 ± 0.12**
BbrCl-Bent (1:500)	4.422 4.508 4.503	3.291 3.390 3.386	1069 909 1108	200 311 197	12.7 10.8 13.2	12.2 ± 1.25	187.2 189.1 186.7	188.8	**94 ± 0.63**
BbrCl-Bent (1:200)	4.394 4.391 4.490	3.258 3.250 3.253	1173 1057 948	175 269 263	13.9 12.6 11.3	12.6 ± 1.34	186.0 187.3 188.6	187.7	**94 ± 0.67**
BbrCl-Bent (1:100)	4.513	3.391 3.373 3.347	1043 1012 1013	236 254 259	12.4 12.0 12.0	12.1 ± 0.21	187.5 187.9 187.9	187.8	**94 ± 0.11**

[a] Retention time of methomyl residue

[b] Retention time of unknown

[c] Initial concentration of methomyl was 200 ppm

[d] Calculation only methomyl residue

Table E-3 Organobentonite adsorption of methiocarb pesticide obtained from HPLC analysis

Sample	Retention time (min) (1)[a]	Retention time (min) (2)[b]	Peak area (mAU) (1)	Peak area (mAU) (2)	Concentration residue (ppm)	Average concentration residue (ppm)	Concentration adsorption (ppm)[c]	Average concentration adsorption (ppm)[d]	Average adsorption (%)
Control	5.259 5.301 5.290	3.384 3.408 3.402	37.6 41.2 13.5	81.0 82.5 107.0	1.97 2.16 0.71	1.62 ± 0.19	23.0 22.8 24.3	23.4	**98 ± 0.78**
Alk-Bent (1:500)	5.267 5.263 5.193	3.401 3.396 3.323	48.6 40.6 45.1	85.7 84.4 84.2	2.90 3.40 3.20	3.17 ± 0.06	22.1 21.6 21.8	21.8	**96 ± 0.25**
Alk-Bent (1:200)	5.188 5.233 5.241	3.326 3.373 3.369	73.0 73.8 28.2	46.8 44.4 42.6	3.00 4.07 4.07	3.71 ± 0.15	22.0 20.9 20.9	21.3	**96 ± 0.61**
Alk-Bent (1:100)	5.247 5.154 5.139	3.375 3.292 3.278	55.5 19.4 54.6	49.1 62.3 49.2	7.53 7.81 2.83	6.06 ± 0.69	17.5 17.5 22.2	18.9	**94 ± 2.79**
BbrCl-Bent (1:500)	5.133 5.271 5.278	3.274 3.397 3.398	55.3 64.8 61.1	62.7 55.8 65.1	2.55 2.16 2.37	2.35 ± 0.05	22.5 22.9 22.6	22.6	**97 ± 0.20**
BbrCl-Bent (1:200)	5.125 5.276 5.275	3.267 3.398 3.396	57.2 77.5 77.6	59.5 47.3 50.1	3.83 3.87 1.48	3.06 ± 0.34	21.2 21.1 23.5	21.9	**97 ± 1.36**
BbrCl-Bent (1:100)	5.127 5.271 5.277	3.267 3.405 3.398	143.6 148.9 53.9	101.1 102.5 45.2	2.91 1.02 2.86	2.27 ± 0.27	22.1 24.0 22.1	22.7	**98 ± 1.08**

[a] Retention time of methomyl residue

[b] Retention time of unknown

[c] Initial concentration of methiocarb was 25 ppm

[d] Calculation only methomyl residue

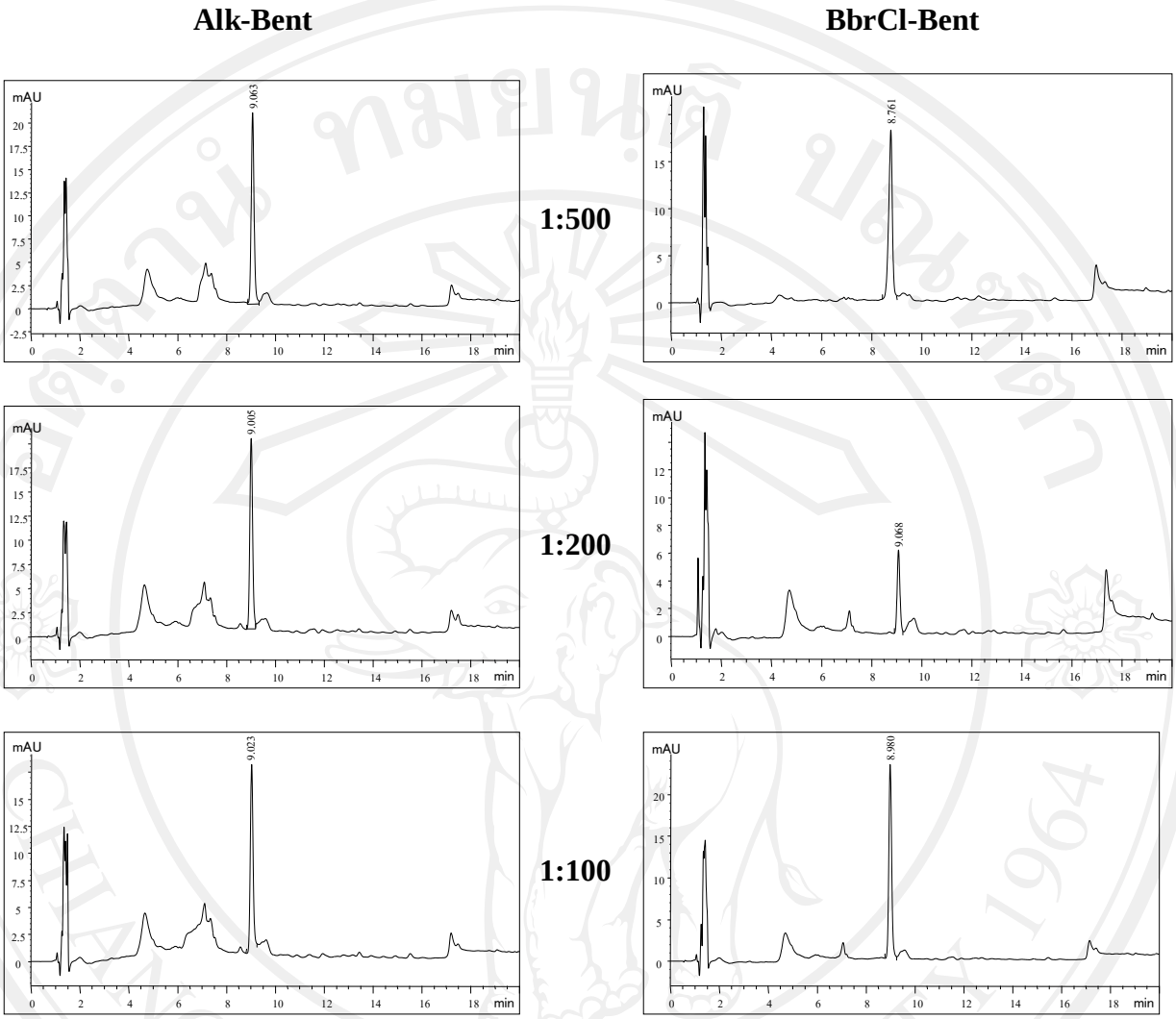


Figure E-1 Example chromatogram from HPLC of carbaryl organoclay samples with different ratio adsorption

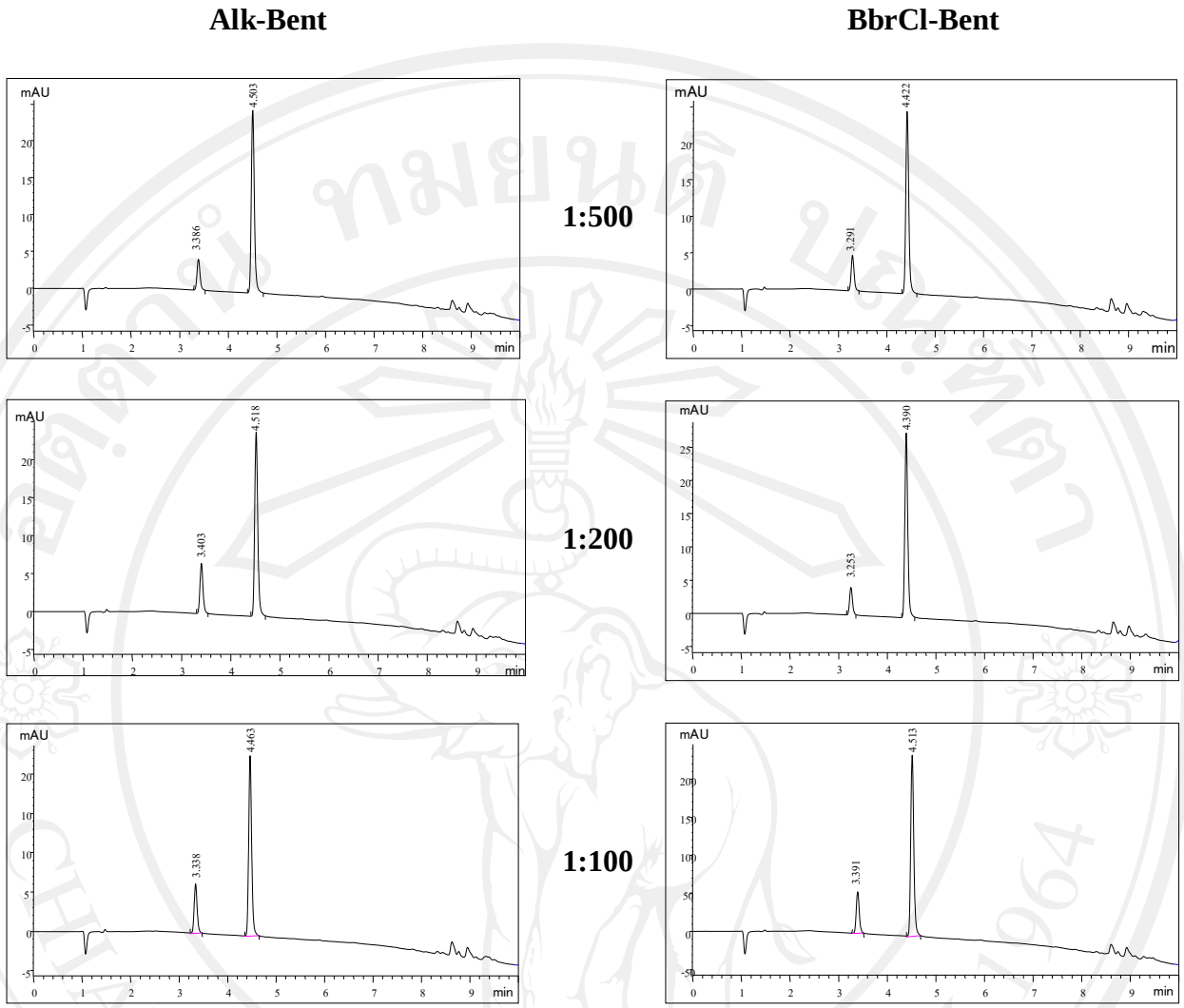


Figure E-2 Example chromatogram from HPLC of methomyl organoclay samples with different ratio adsorption

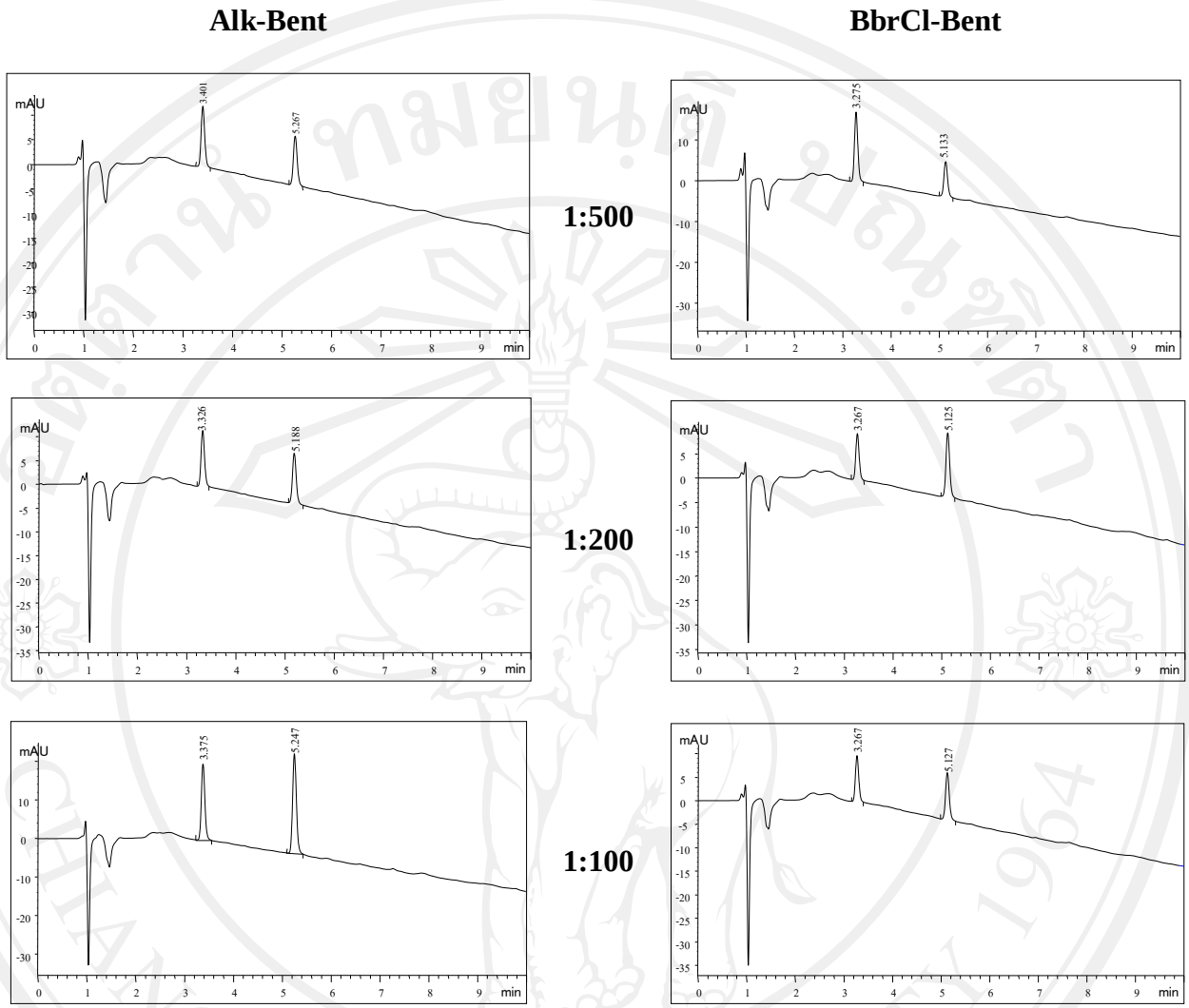


Figure E-3 Example chromatogram from HPLC of methiocarb organoclay samples with different ratio adsorption

CURRICULUM VITAE

Name Miss Suphara Tha-in

Date of Birth February 13, 1988

Education:

2009 B.Sc. (Chemistry) Faculty of Science, Mae Fah Luang University, Chiang Rai, Thailand.

2013 M.S. (Chemistry) Faculty of Science, Chiang Mai University, Chiang Mai, Thailand

Poster presentation

1. Suphara Tha-in, Kanchana Dumri. **Development of Bentonite Clay Materials with Natural Extract for Agricultural Aspects.** National Research University summit, Chiang Mai University, Chiang Mai, Thailand.
2. Suphara Tha-in, Kanchana Dumri, Dau Hung Anh. **Enhanced Pesticide Adsorption using Modified Bentonite with *Coscinium fenestratum*.** International Congress for Innovation in Chemistry (PERCH - CIC), 5-8 May 2013, Jomtien Palm Beach Hotel and Resort, Chonburi, Thailand.

Publication

1. **Tha-in S., Dau H.A., Dumri K.** The Enhanced Carbamate Adsorption of Modified Bentonite with *Coscinium fenestratum*. *International Journal of Environmental Science and Development*, 2013; 415-418