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APPENDIX

APPENDIX A

GC Chromatogram and Standard Curve of Carboxylic acid and Esters

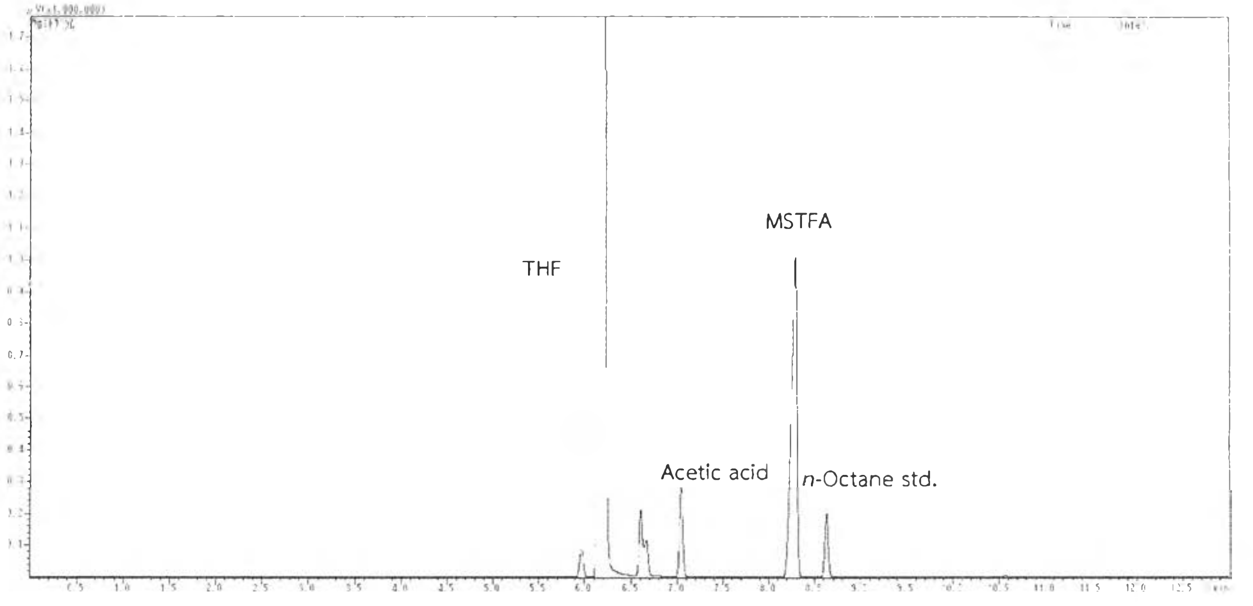

Figure A-1 Chromatogram of acetic acid by using *n*-octane as internal standard.

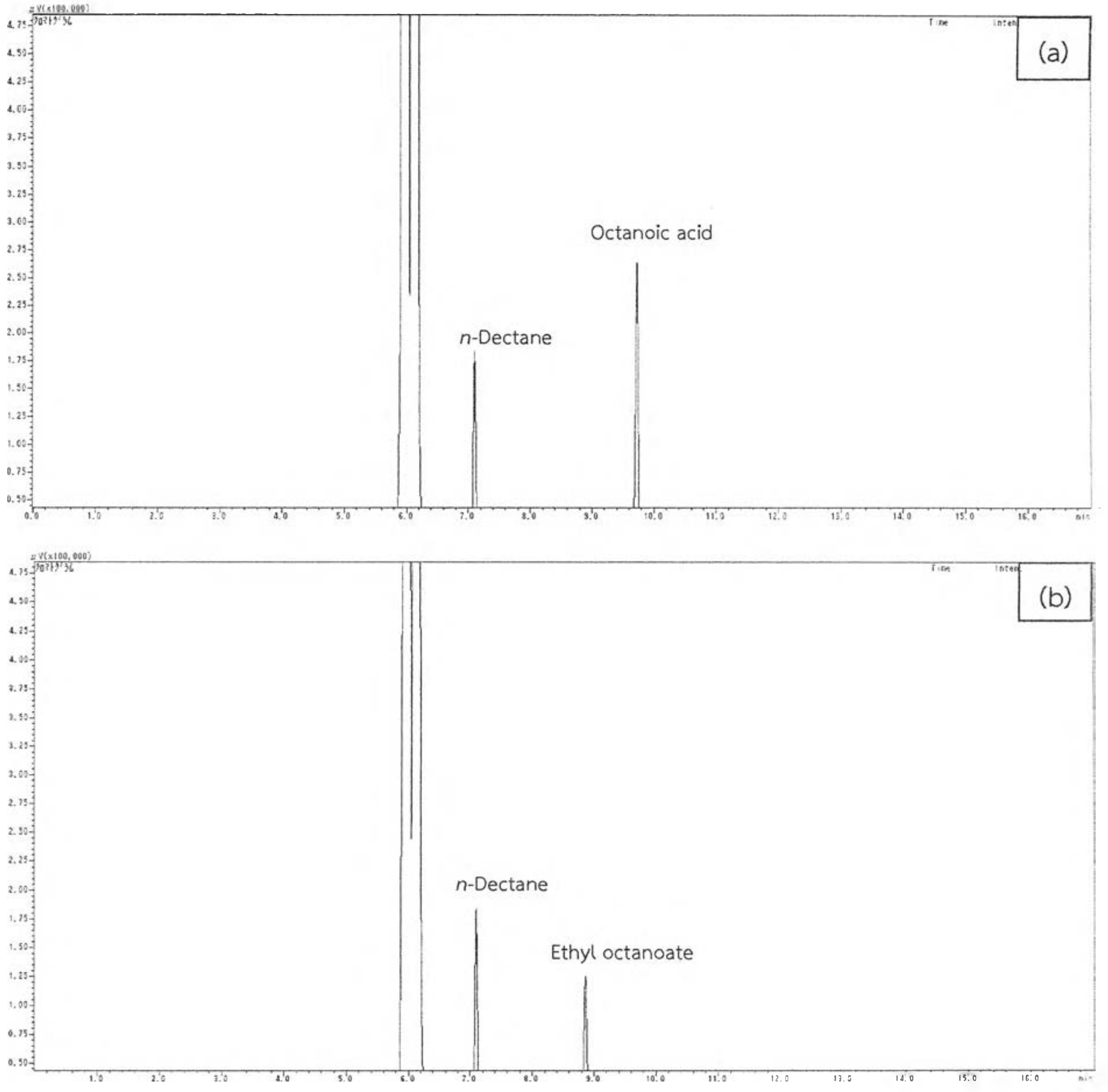

Figure A-2 Chromatogram of (a) octanoic acid and (b) ethyl octanoate by using *n*-decane as internal standard.

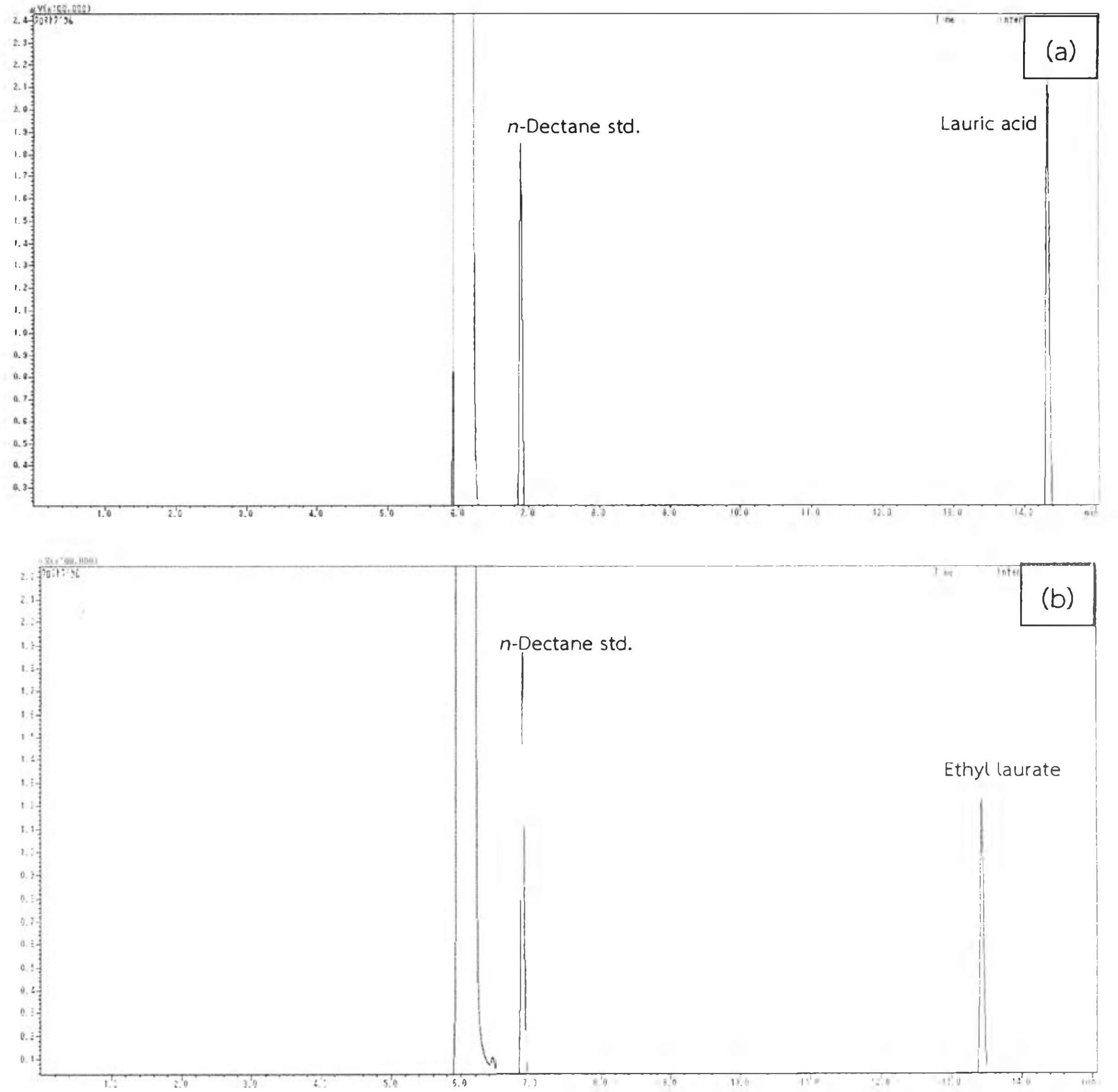

Figure A-3 Chromatogram of (a) lauric acid and (b) ethyl laurate by using *n*-decane as internal standard.

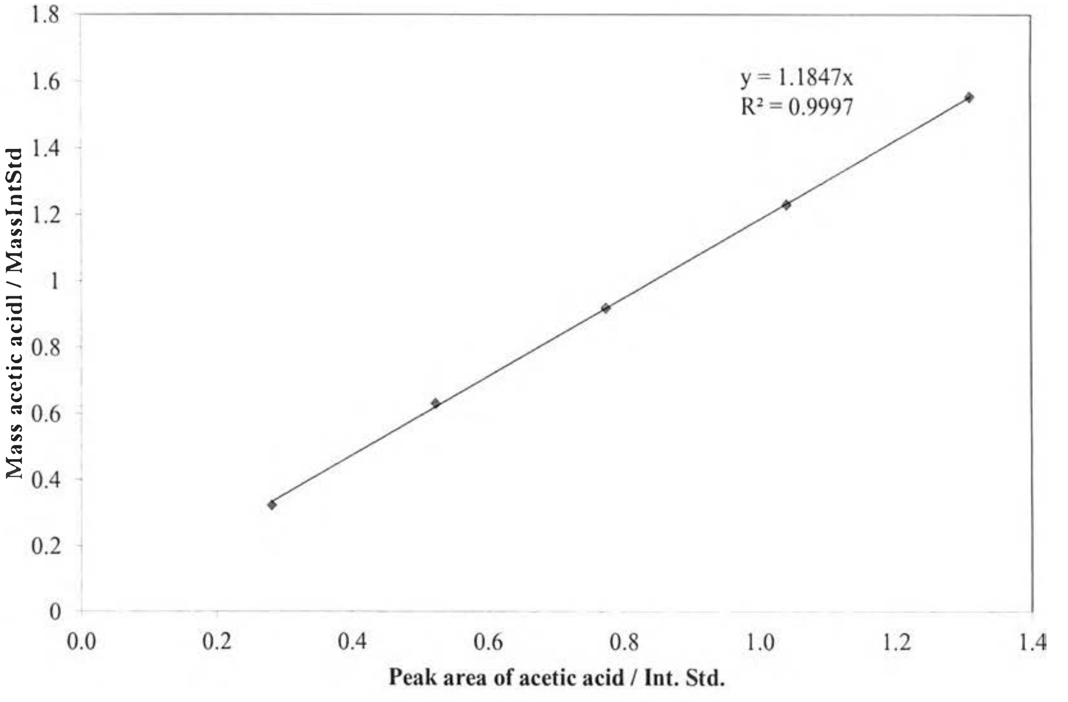

Figure A-4 The standard curves of acetic acid by using *n*-octane as internal standard.

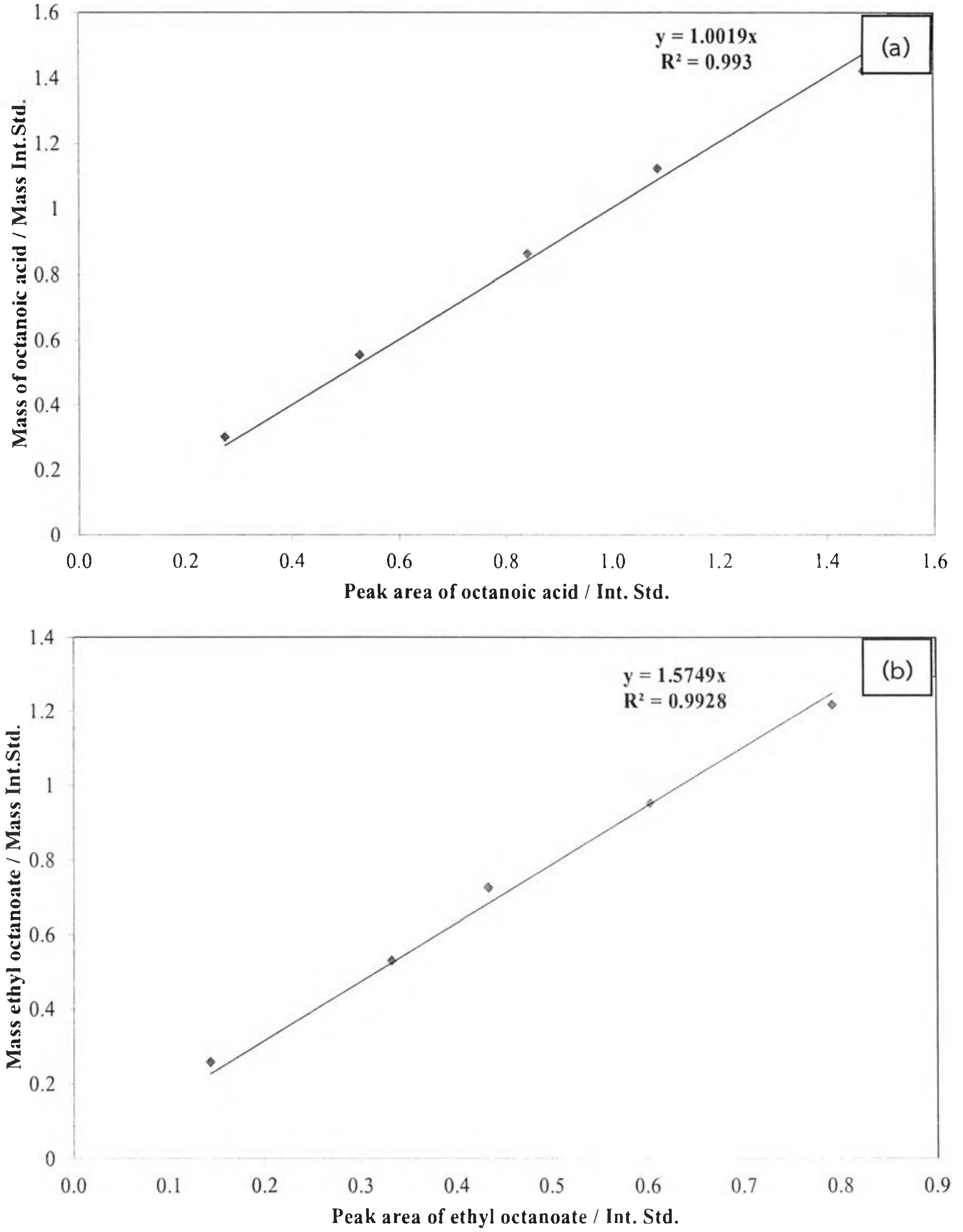

Figure A-5 The standard curves of (a) octanoic acid and (b) ethyl octanoate by using *n*-decane as internal standard.

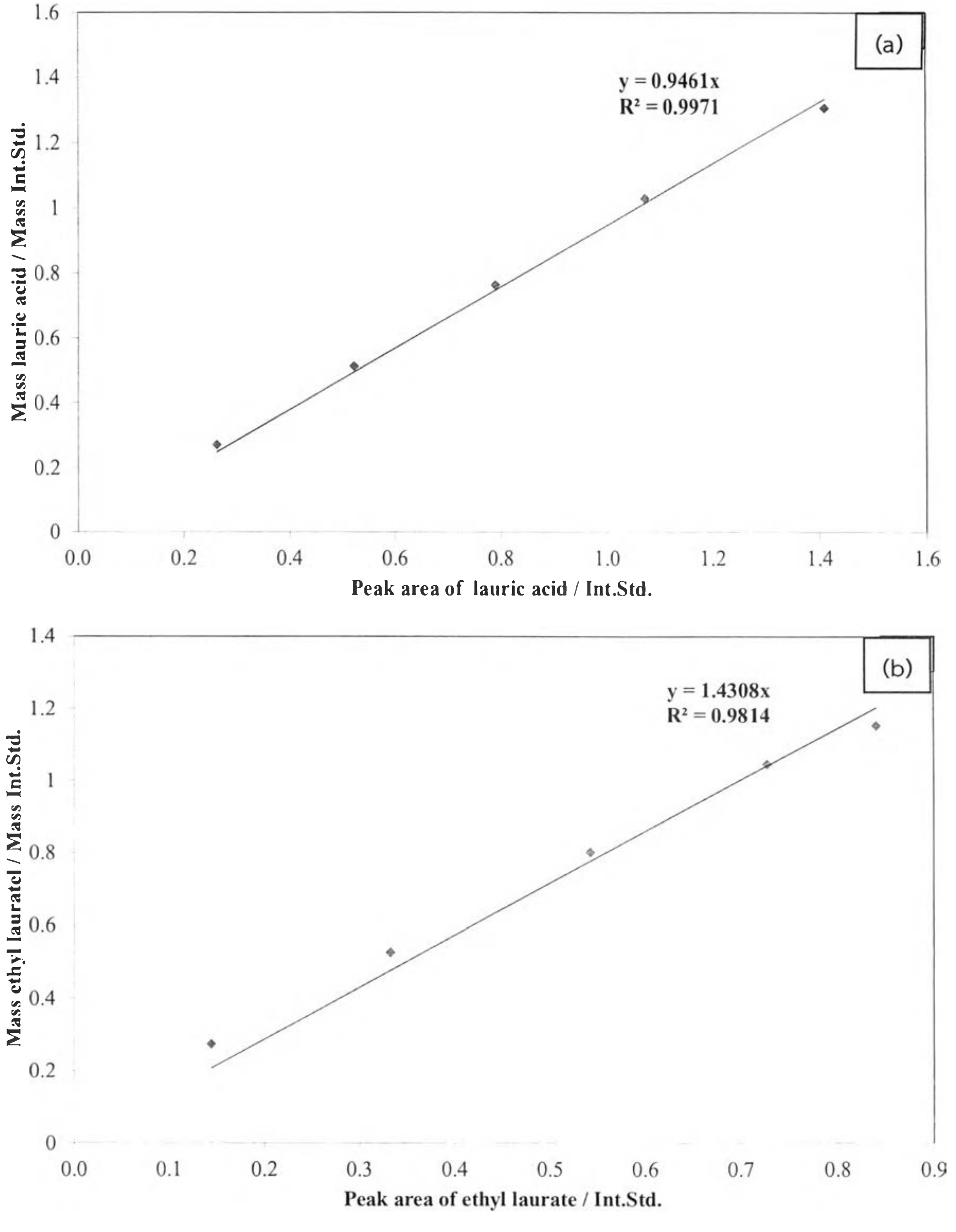

Figure A-6 The standard curves of (a) lauric acid and (b) ethyl laurate by using *n*-decane as internal standard.

Appendix B

Gas chromatography analyzer was used to determine products of carboxylic acid and ethanol esterification. Ester products were identified using internal standard method.

The percent ester yield and carboxylic acid conversion were calculated based on the results obtained from gas chromatography. *n*-Octane (for acetic acid esterification) and *n*-decane (for octanoic acid and lauric acid esterification) were used as internal standard.

For example: A = exact amount of reactant (mol)

B = exact amount of internal standard was added (mol)

C = exact amount of desired product prepared (mol)

D = total volume of the reaction mixture (mL)

E = peak area of the internal standard

F = peak area of the desired product

The calculation of the percent yield can be described as follows:

The amount of the product from the reaction mixture

$$= \left(\frac{B \times F}{E}\right) = G$$

The amount of the product in reaction mixture (D mL)

$$= G \times D = H$$

The correction factor of the product can be calculated as:

$$= C/H = I$$

Thus, the percentage of product can be calculated as:

$$\%\ \text{yield of product} = \left(\frac{H \times I}{A}\right) \times 100$$

Appendix C

Textural Properties of Silica-Supported Nafion® Catalyst (SAC-13)

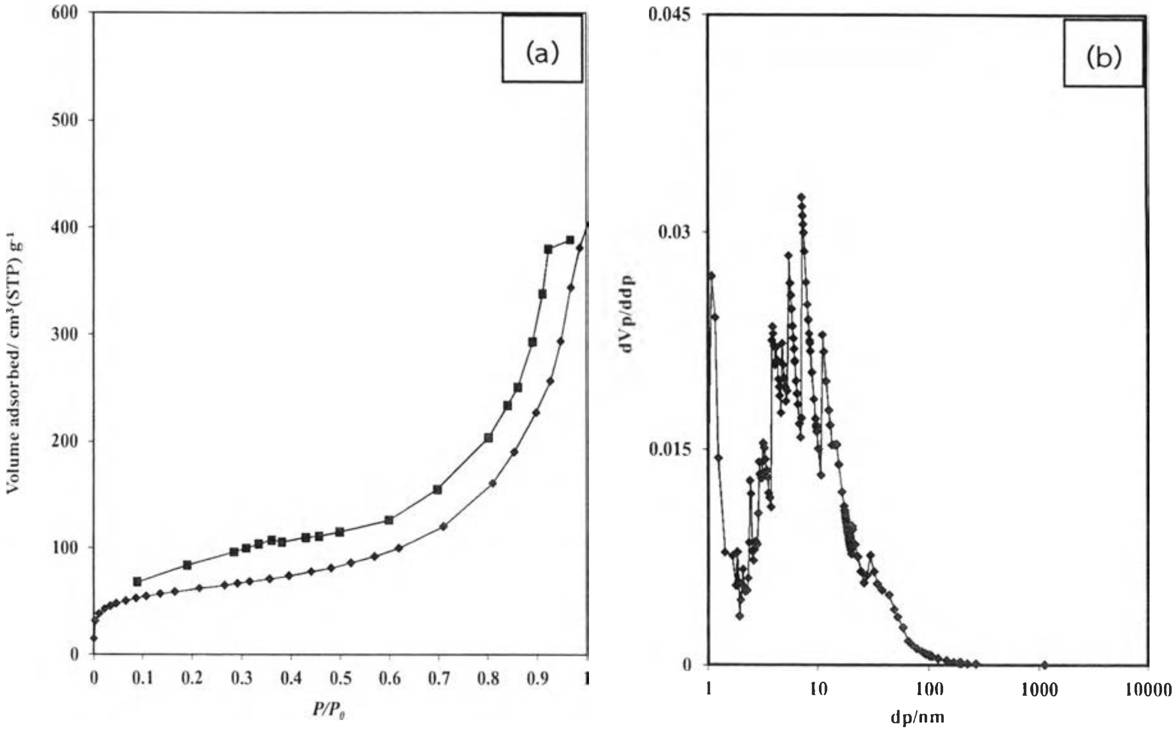

Figure C-1 N_2 adsorption-desorption isotherms (a) and BJH pore size distribution (b) of SAC-13.

Table C- 1 Textural properties of SAC-13.

Sample	S_{BET} [a] ($m^2 g^{-1}$)	S_{ext} [b] ($m^2 g^{-1}$)	D_p [c] (nm)	V_t [d] ($cm^3 g^{-1}$)	V_p [e] ($cm^3 g^{-1}$)
SAC-13	215	187	7.2	0.60	0.11

n.d. = not determined.

[a] BET surface area.

[b] External surface area from *t*-plot curves.

[c] Pore diameter calculated using the BJH method.

[d] Total pore volume.

[e] Mesopore volume.

VITA

Mr. Sakdinun Nuntang was born on June 11^{th}, 1982 at Phayao, Thailand. He graduated high school from Samakkhi Witthayakhom School, Chaingrai province, in 2000. He received the Bachelor's degree of Science in Chemical Engineering, Chulalongkorn University in 2004, and graduated the Master' s degree of Science in Chemical Technology, Chulalongkorn University in 2006. Three years later, Sakdinun joined the Department of Chemical Technology, Chulalongkorn University, as a doctoral student in 2009. He has received the Royal Golden Jubilee Scholarship from Thailand Research Fund (2009 – 2012). He finished his philosophy of Doctoral Degree in May, 2014.