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APPENDIX

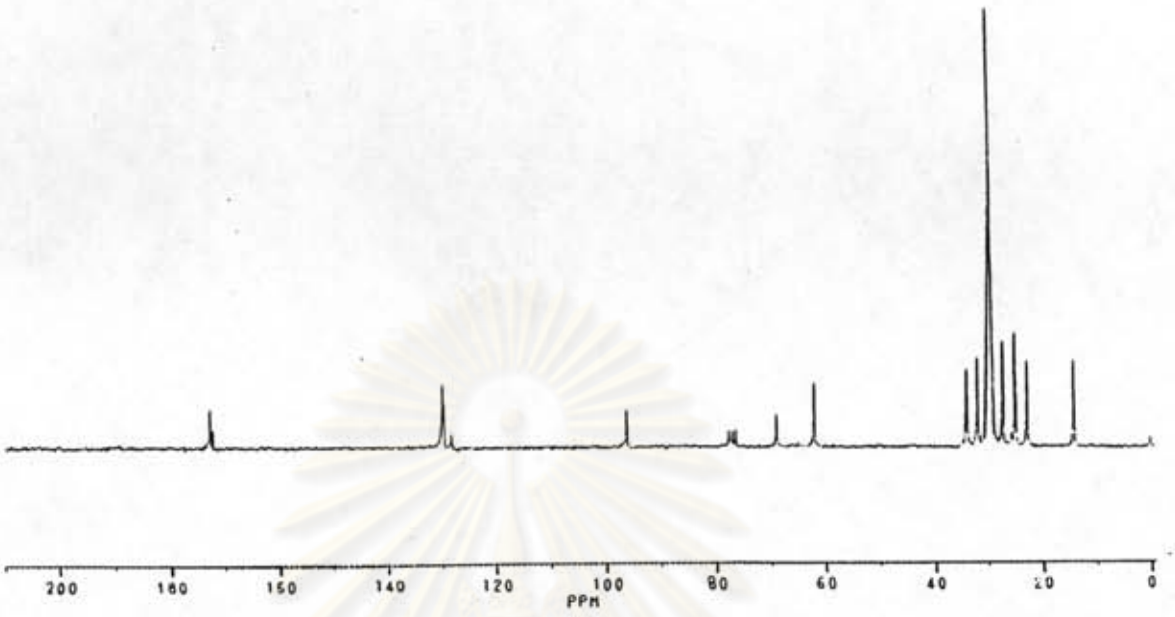

Figure A1 ^{13}C NMR ($CDCl_3$) spectrum of palm oil

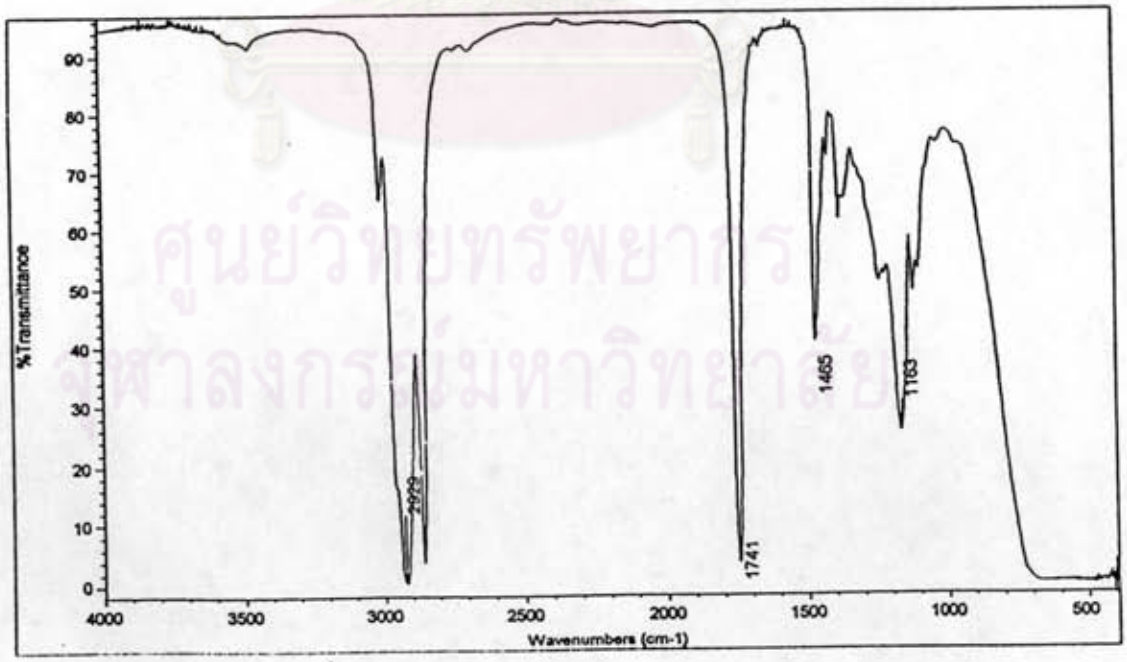

Figure B1 IR spectrum of palm oil

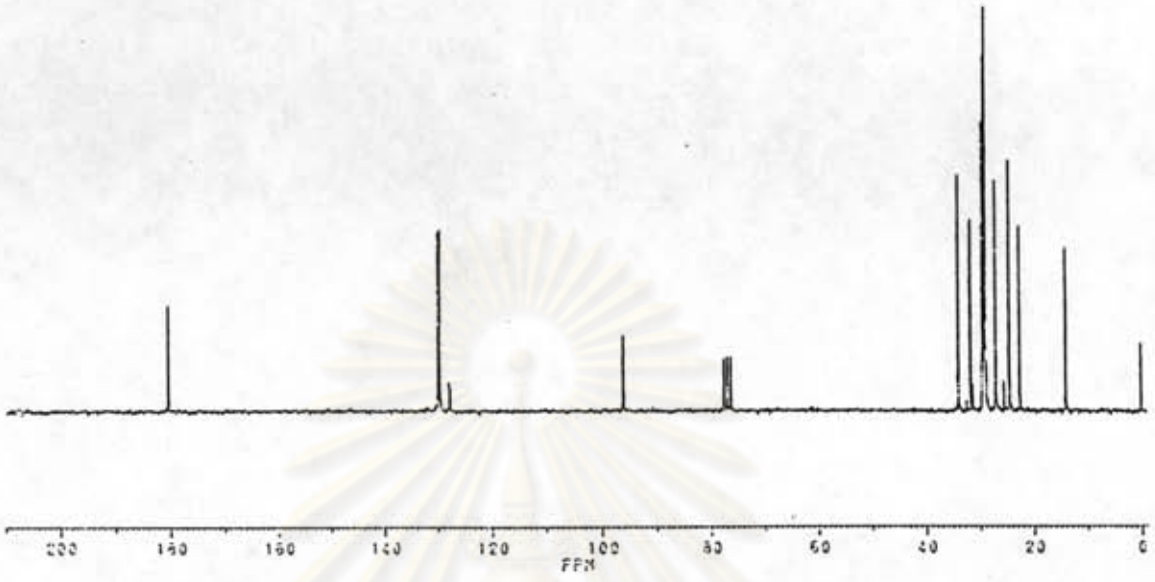

Figure A2 ^{13}C NMR ($CDCl_3$) spectrum of oleic acid

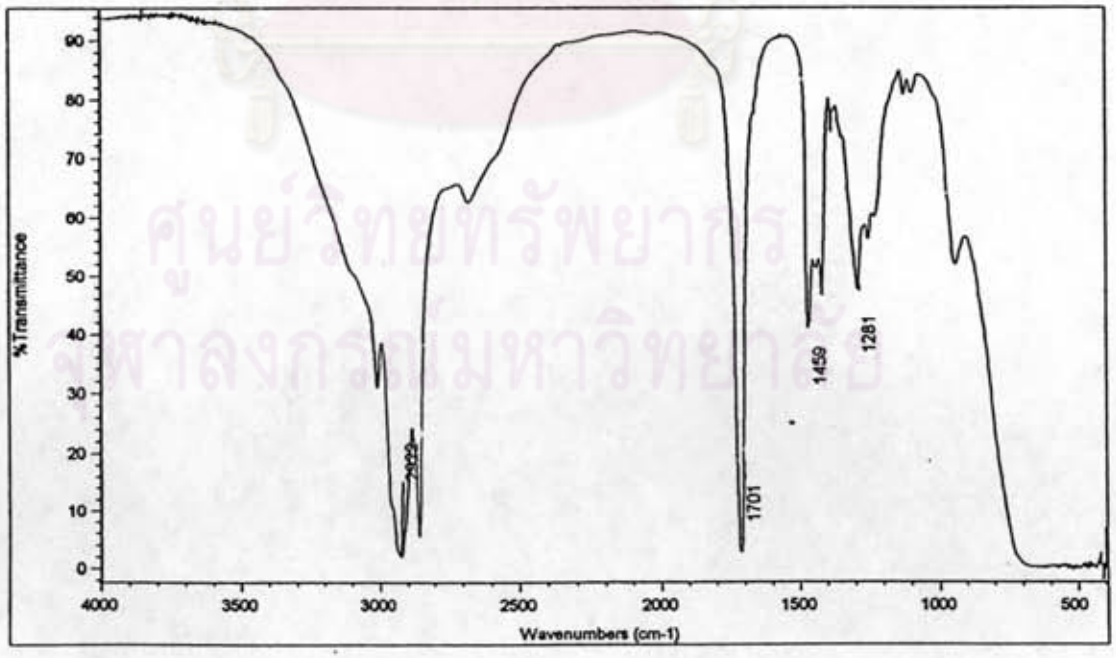

Figure B2 IR spectrum of oleic acid

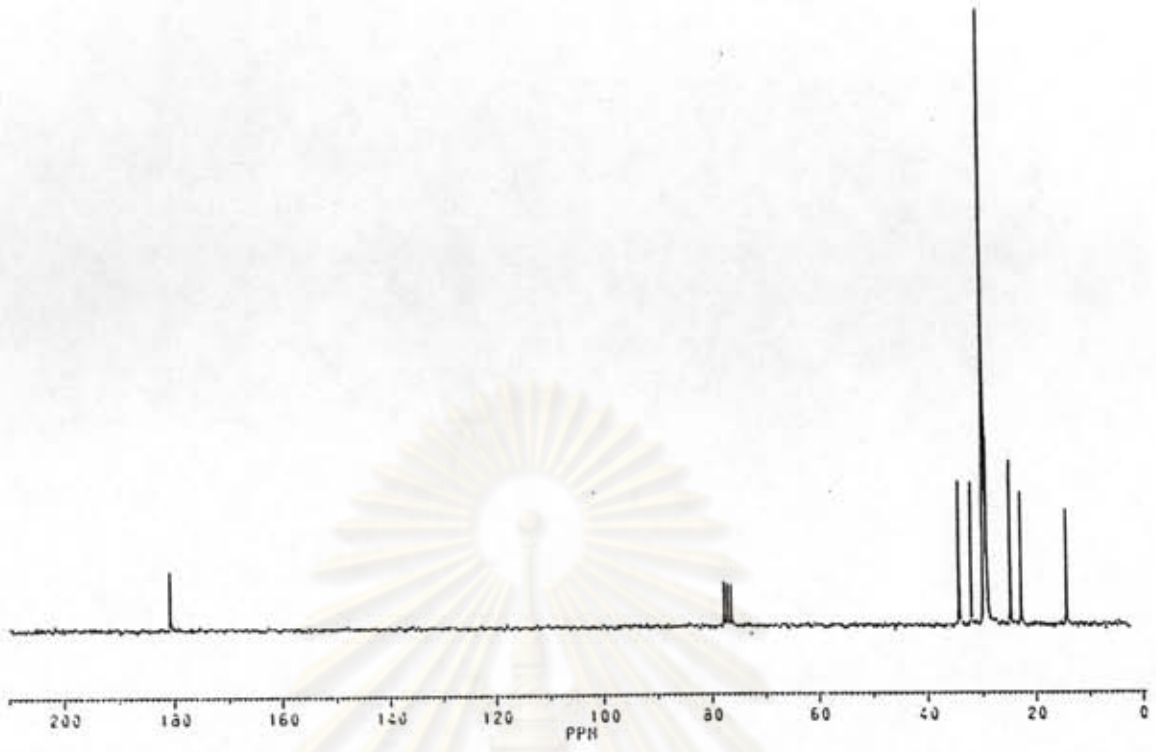

Figure A3 ^{13}C NMR ($CDCl_3$) spectrum of stearic acid

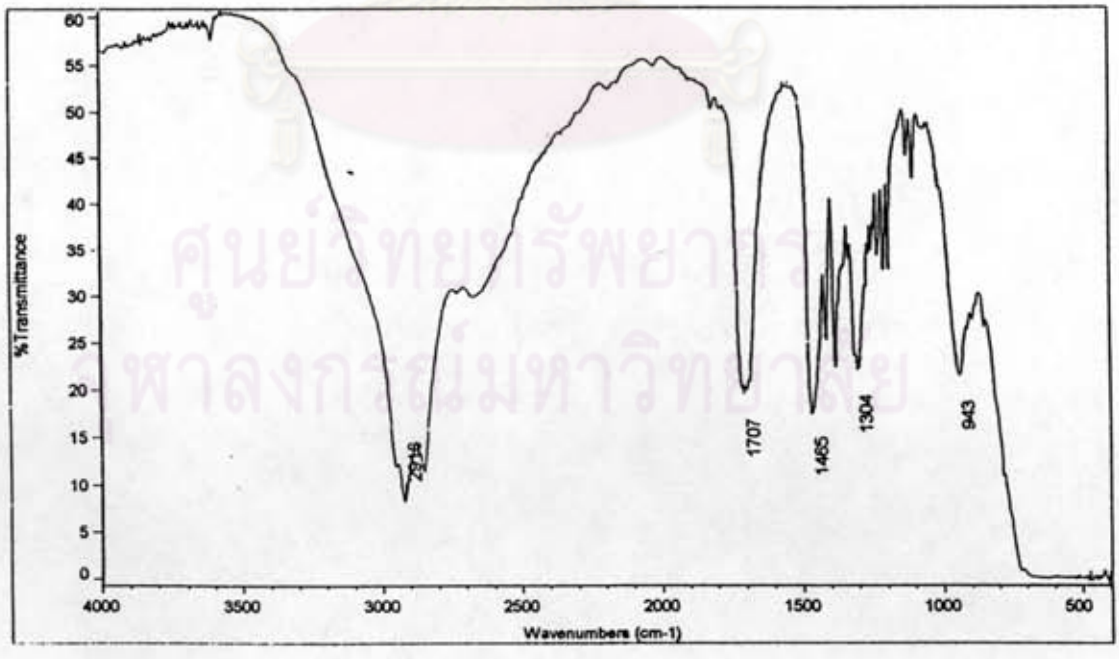

Figure B3 IR spectrum of stearic acid

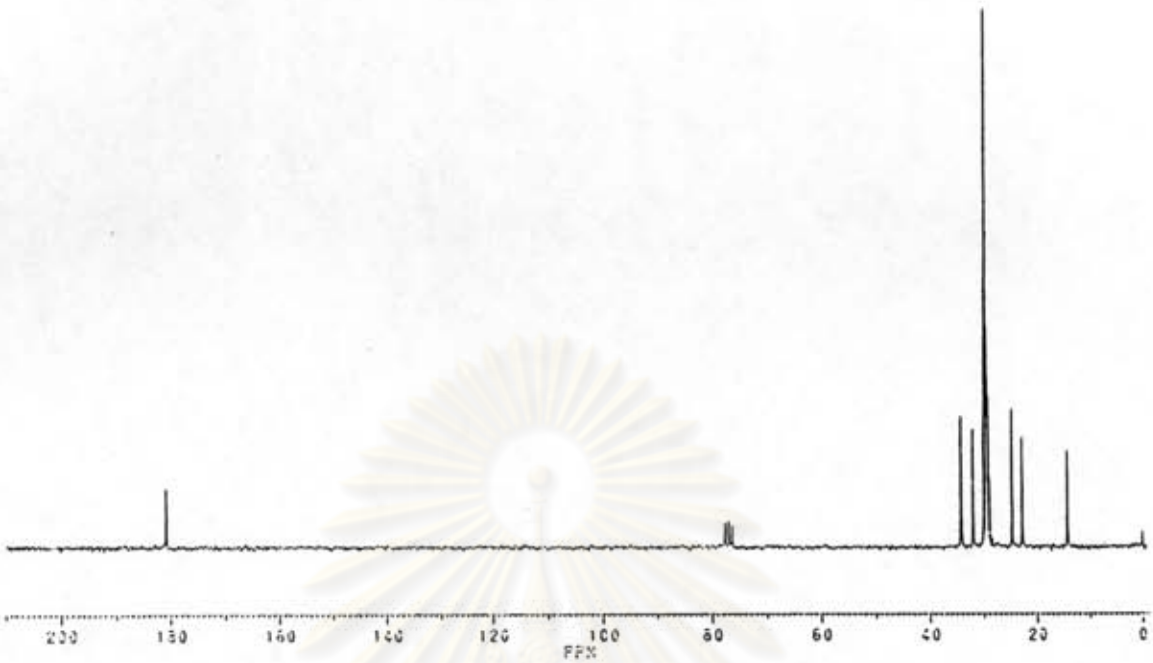

Figure A4 ^{13}C NMR ($CDCl_3$) spectrum of palmitic acid

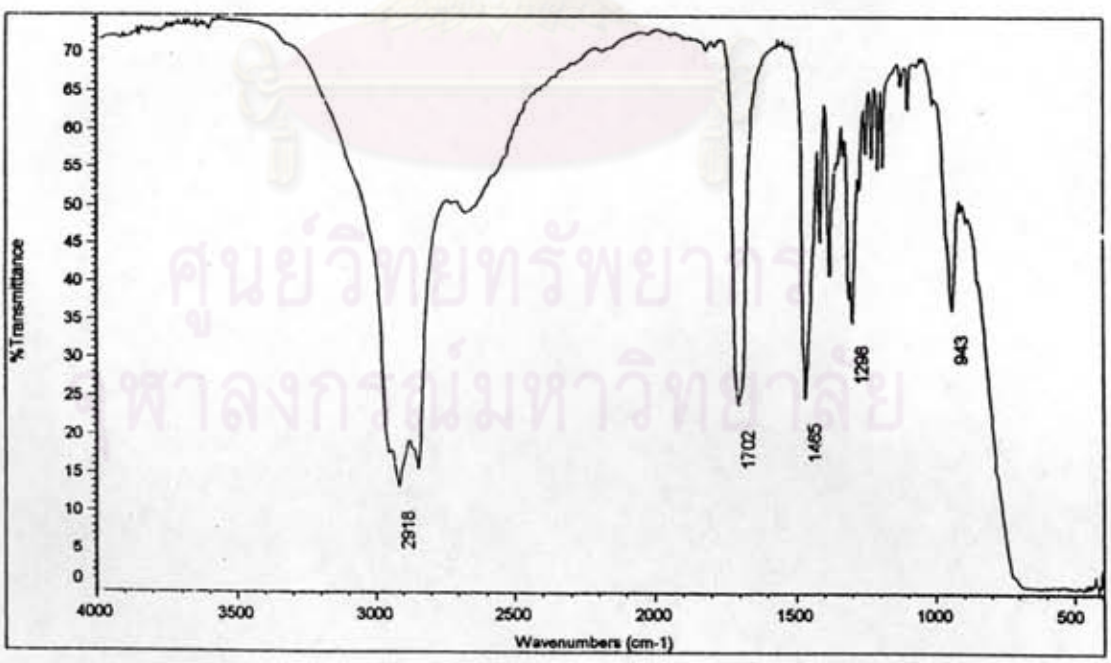

Figure B4 IR spectrum of palmitic acid

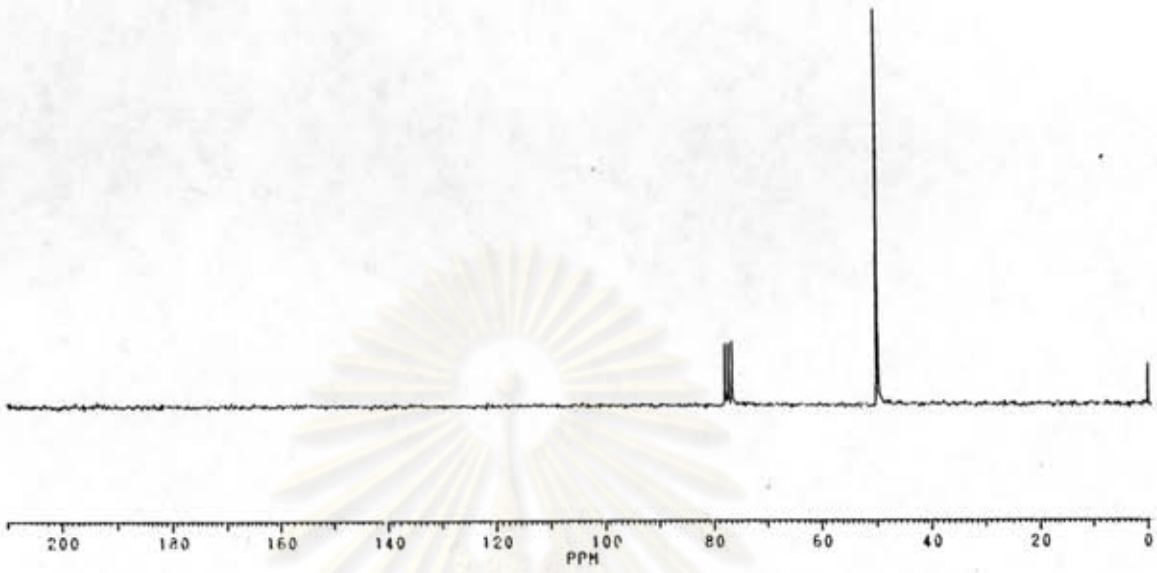

Figure A5 ^{13}C NMR ($CDCl_3$) spectrum of methanol

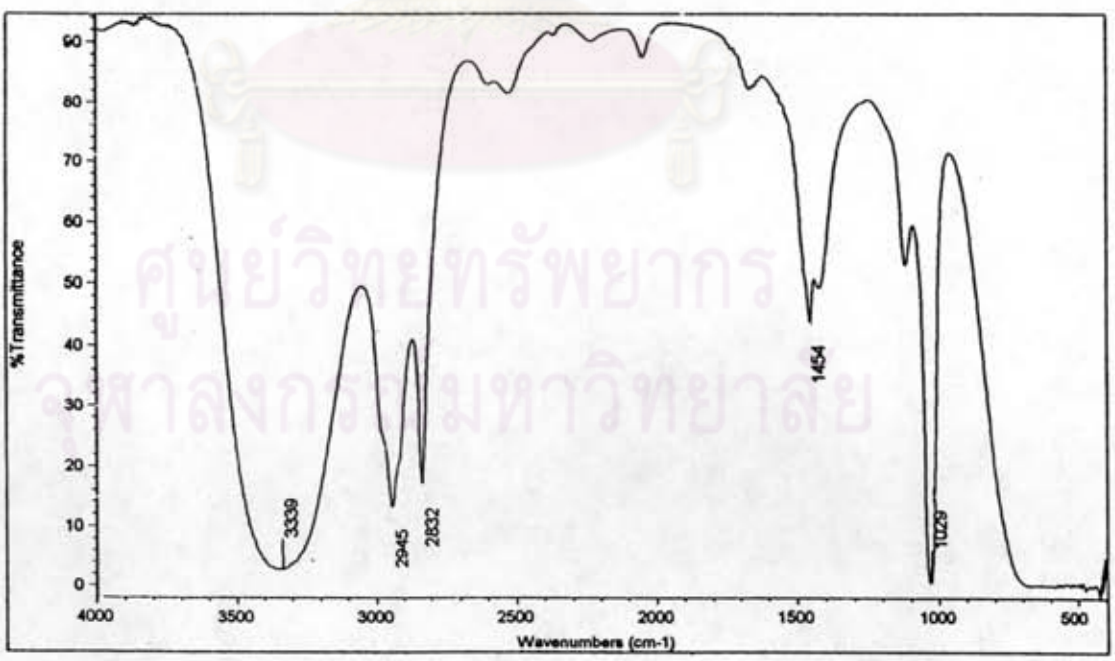

Figure B5 IR spectrum of methanol

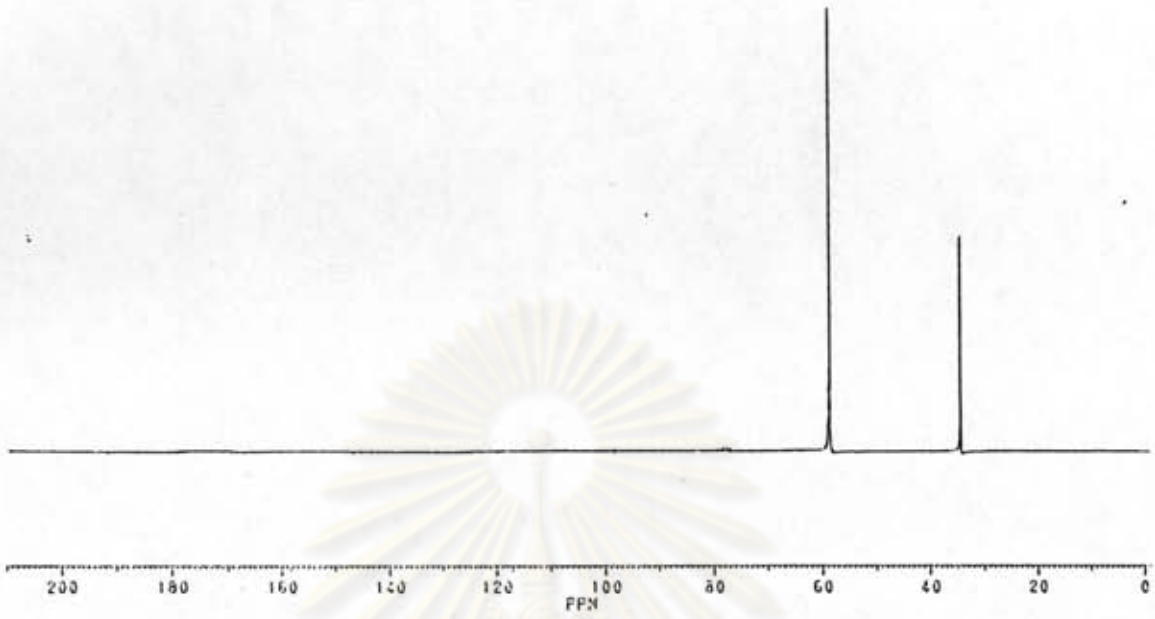

Figure A6 ^{13}C NMR ($CDCl_3$) spectrum of 1,3-propanediol

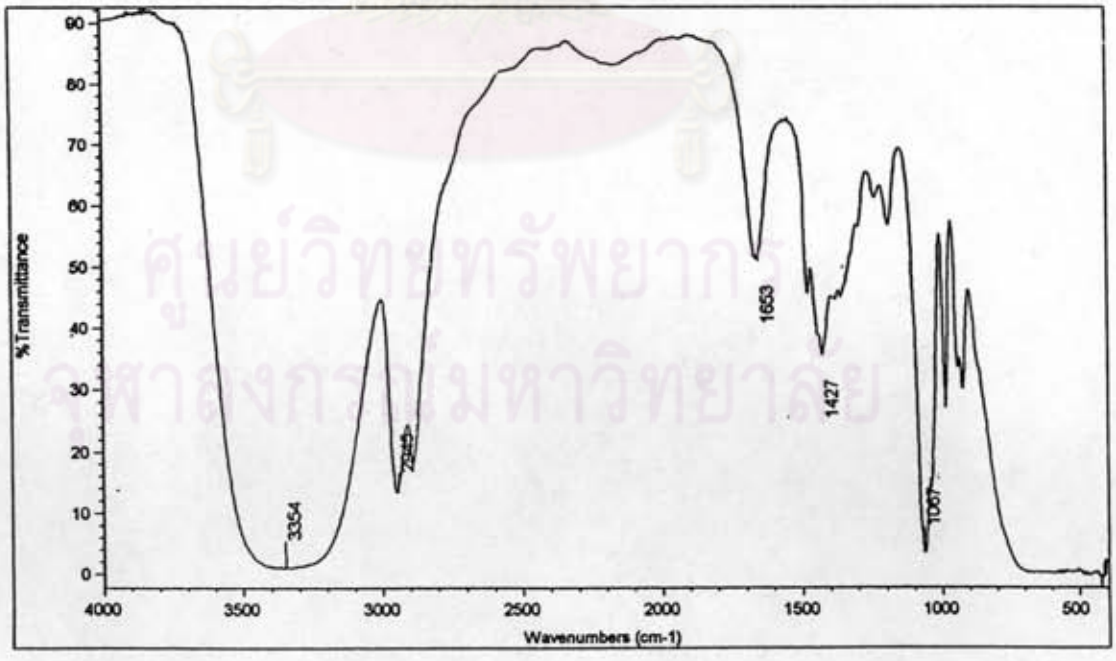

Figure B6 IR spectrum of 1,3-propanediol

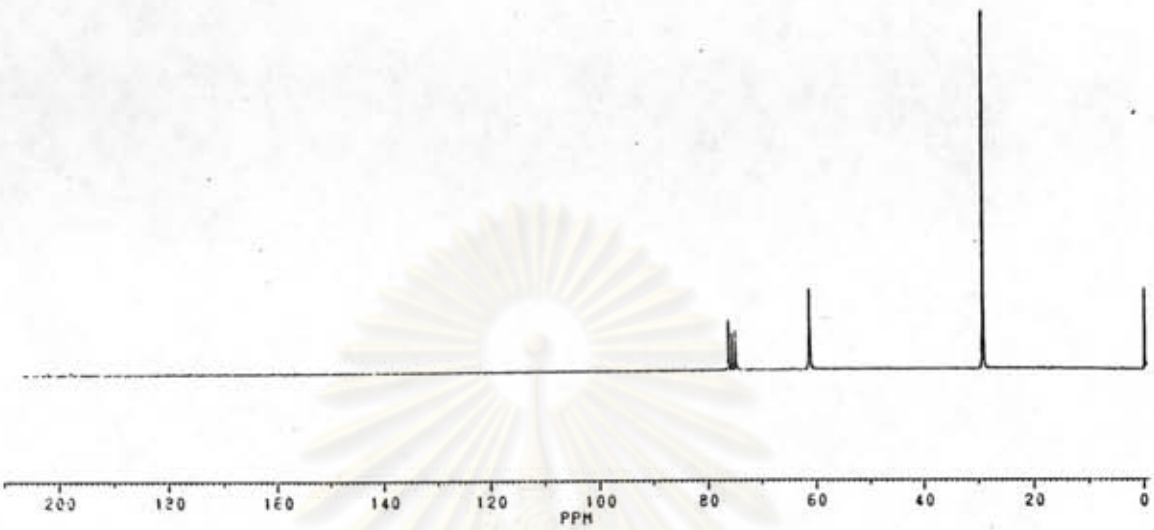

Figure A7 ^{13}C NMR ($CDCl_3$) spectrum of 1,4-butanediol

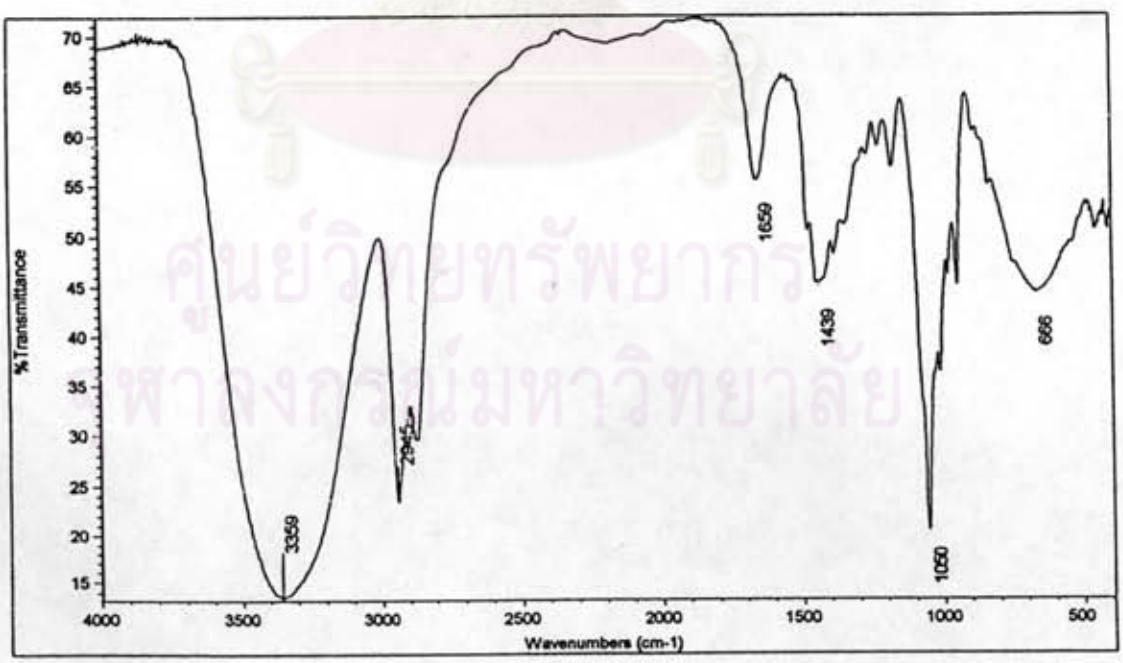

Figure B7 IR spectrum of 1,4-butanediol

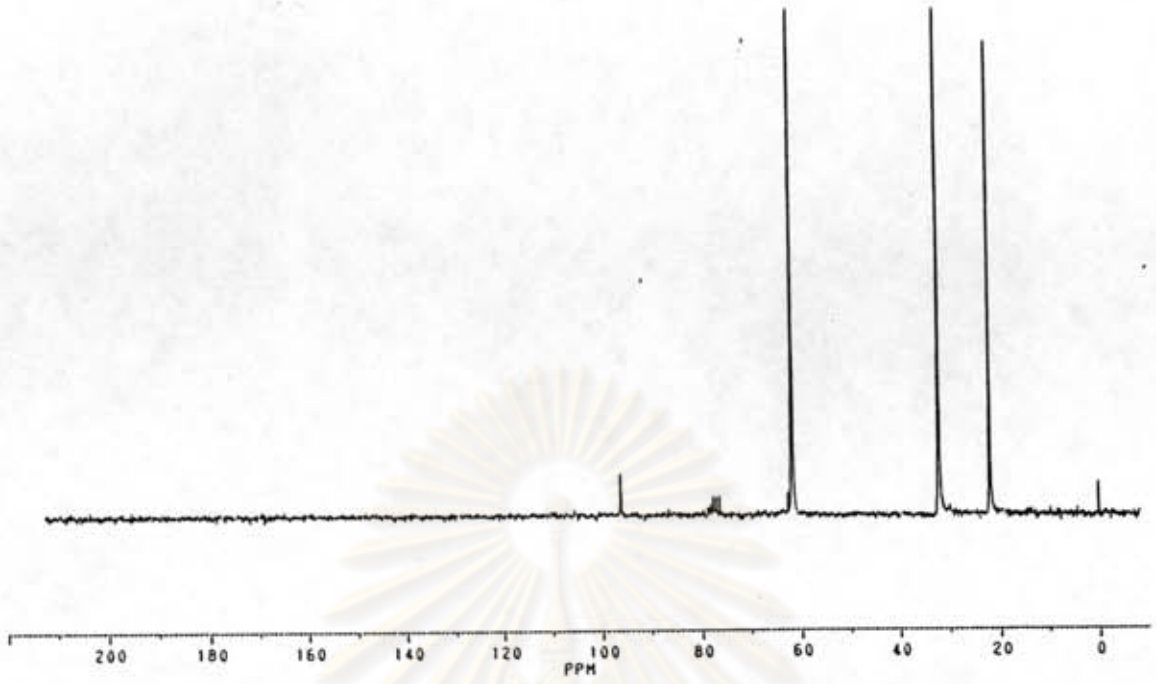

Figure A8 ^{13}C NMR ($CDCl_3$) spectrum of 1,5-pentanediol

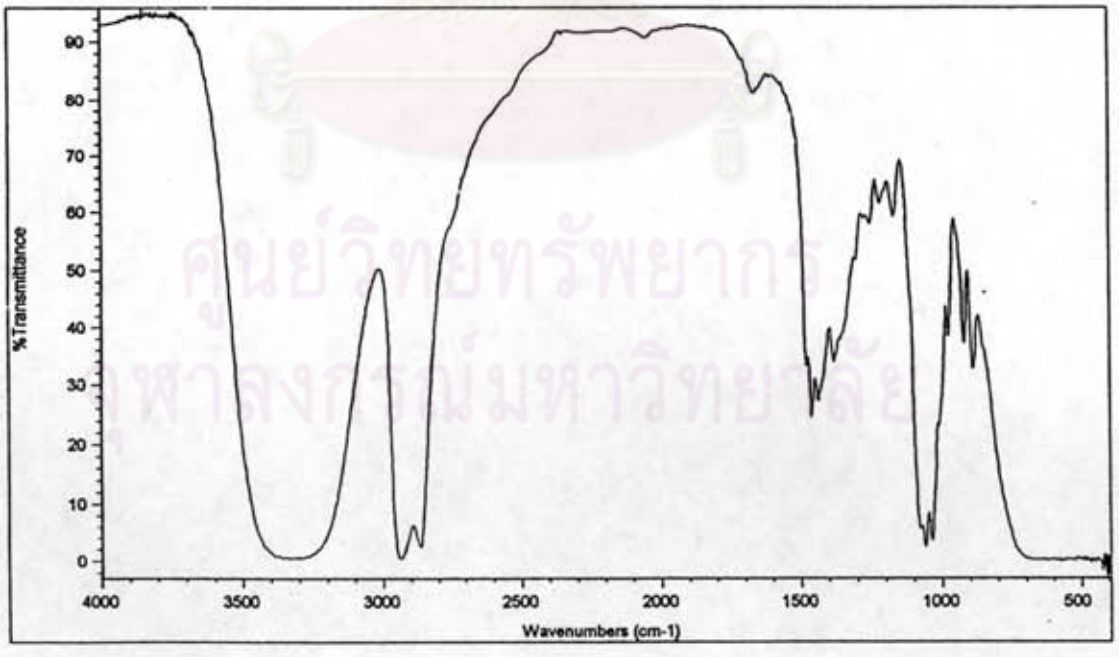

Figure B8 IR spectrum of 1,5-pentanediol

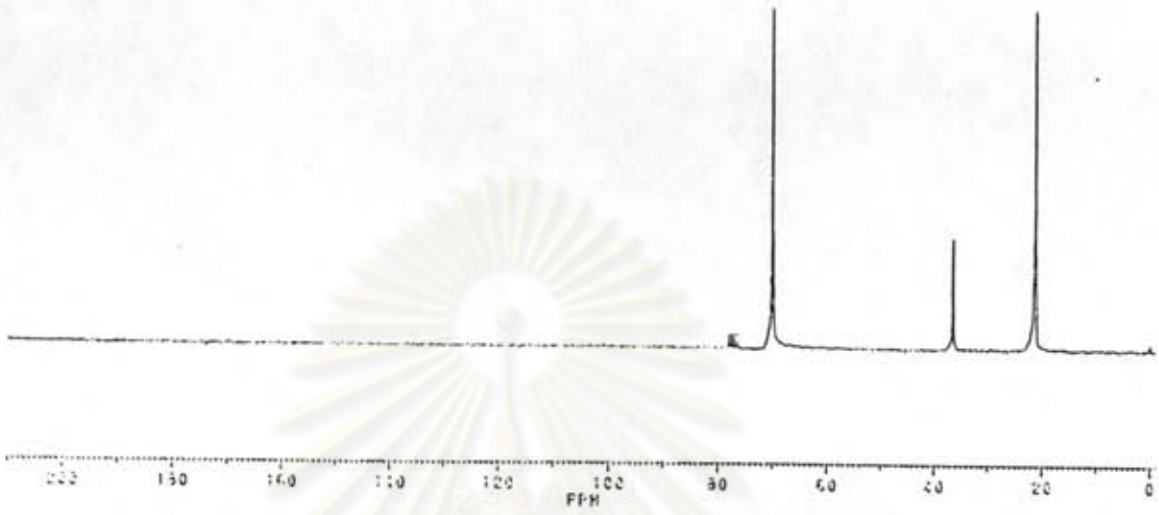

Figure A9 ^{13}C NMR ($CDCl_3$) spectrum of 2,2-dimethyl-1,3-propanediol

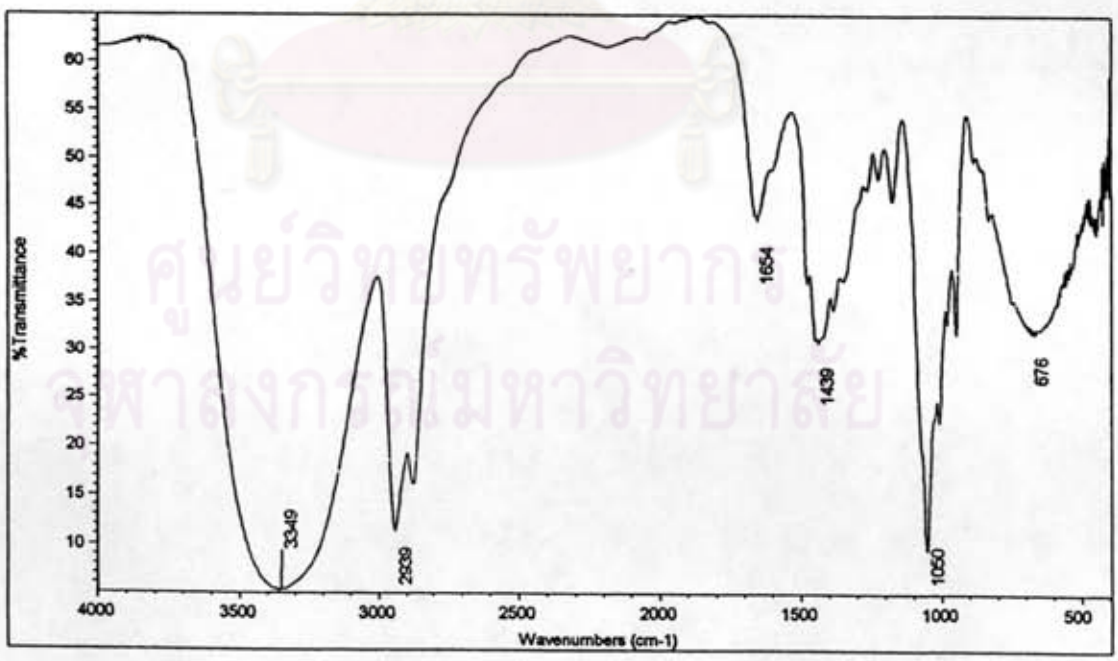

Figure B9 IR spectrum of 2,2-dimethyl-1,3-propanediol

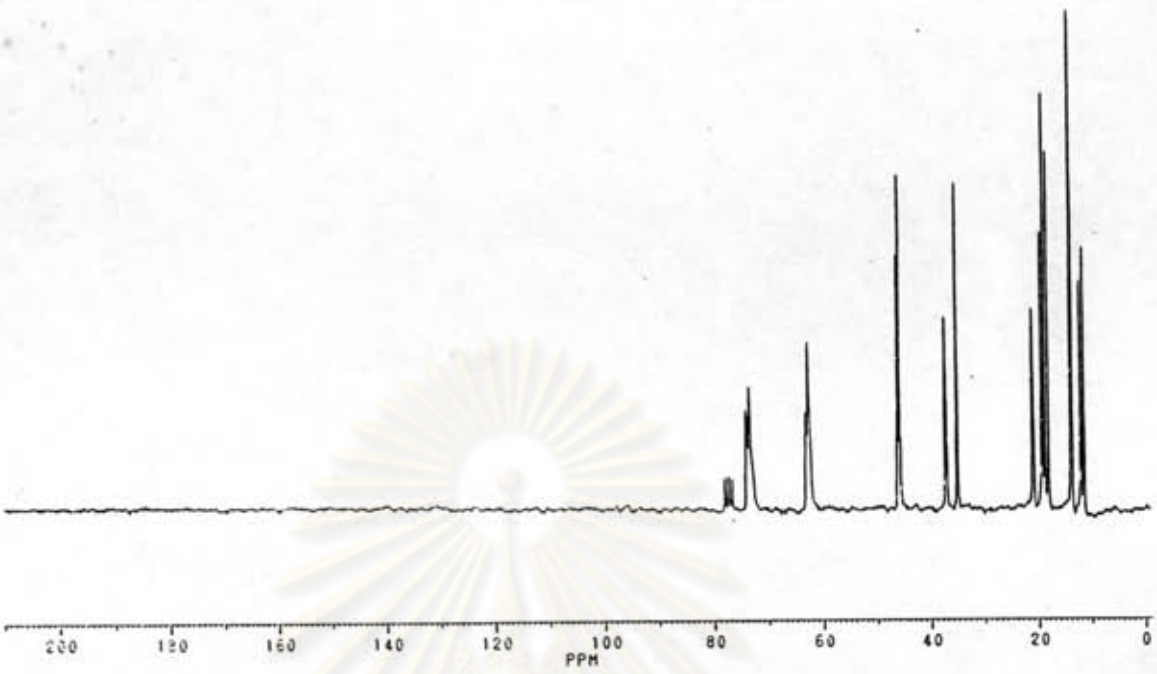

Figure A10 ^{13}C NMR ($CDCl_3$) spectrum of 2-ethyl-1,3-hexanediol

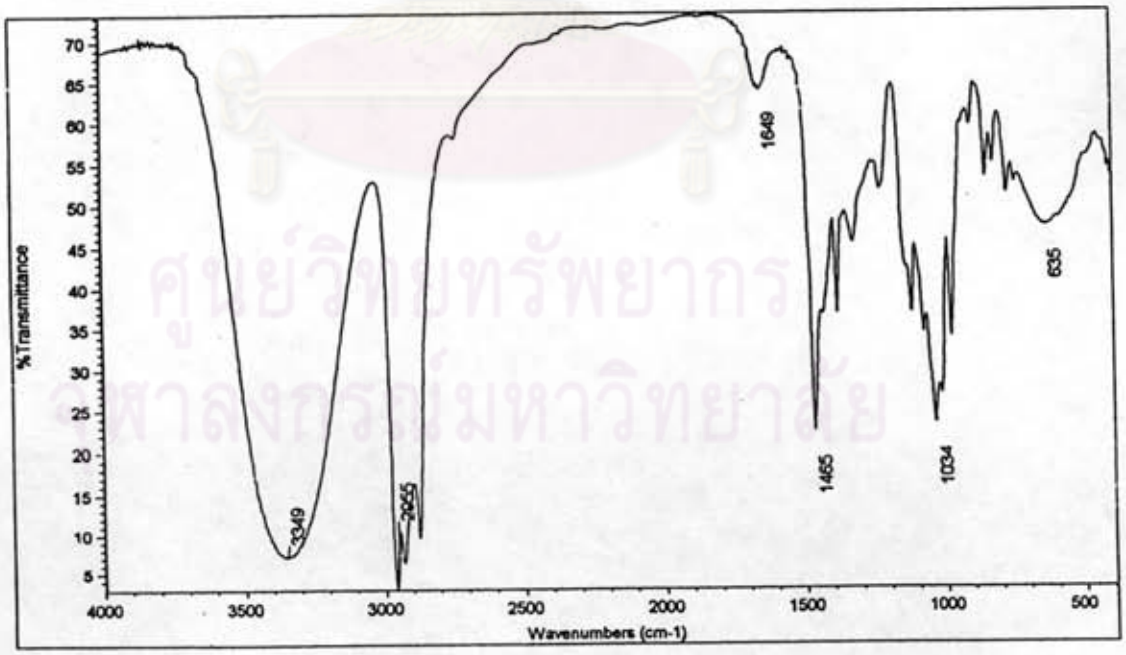

Figure B10 IR spectrum of 2-ethyl-1,3-hexanediol

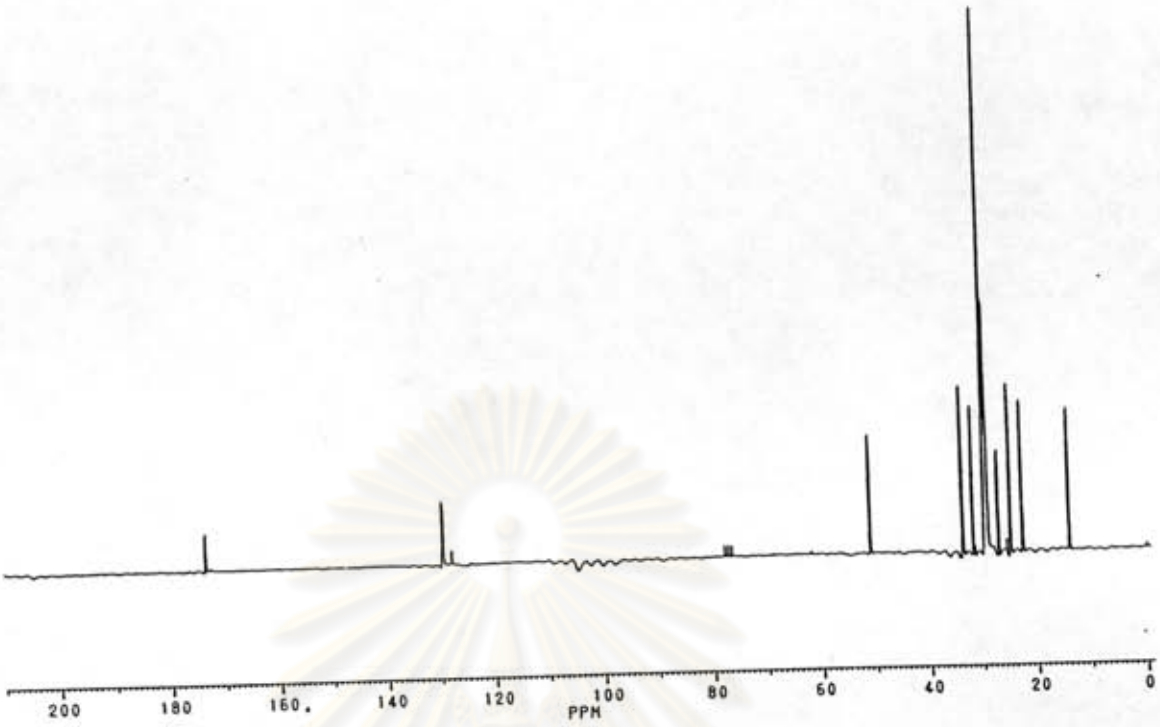

Figure A11 ^{13}C NMR ($CDCl_3$) spectrum of methyl ester of palm oil

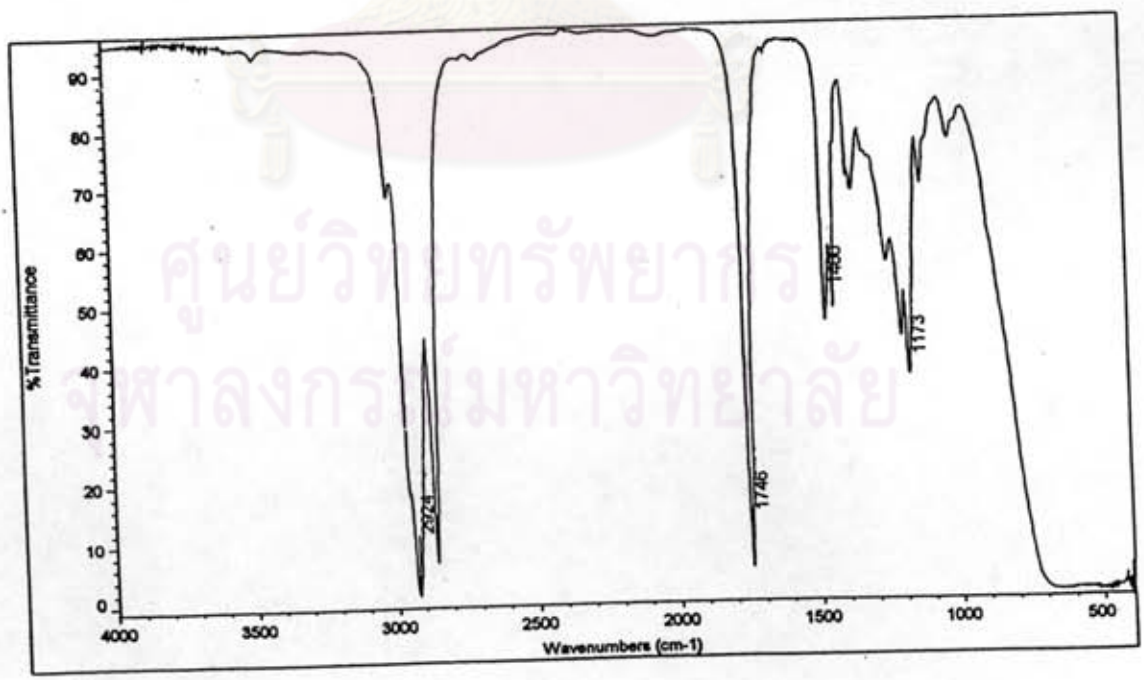

Figure B11 IR spectrum of methyl ester of palm oil

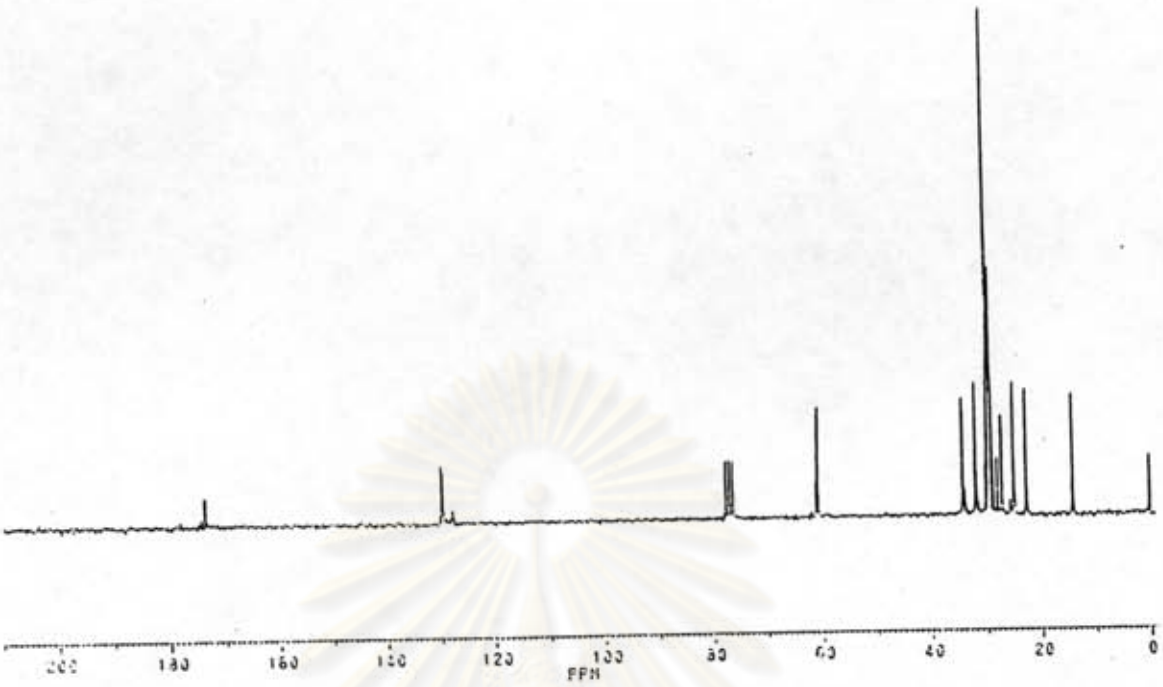

Figure A12 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from methyl ester of palm oil and 1,3-propanediol

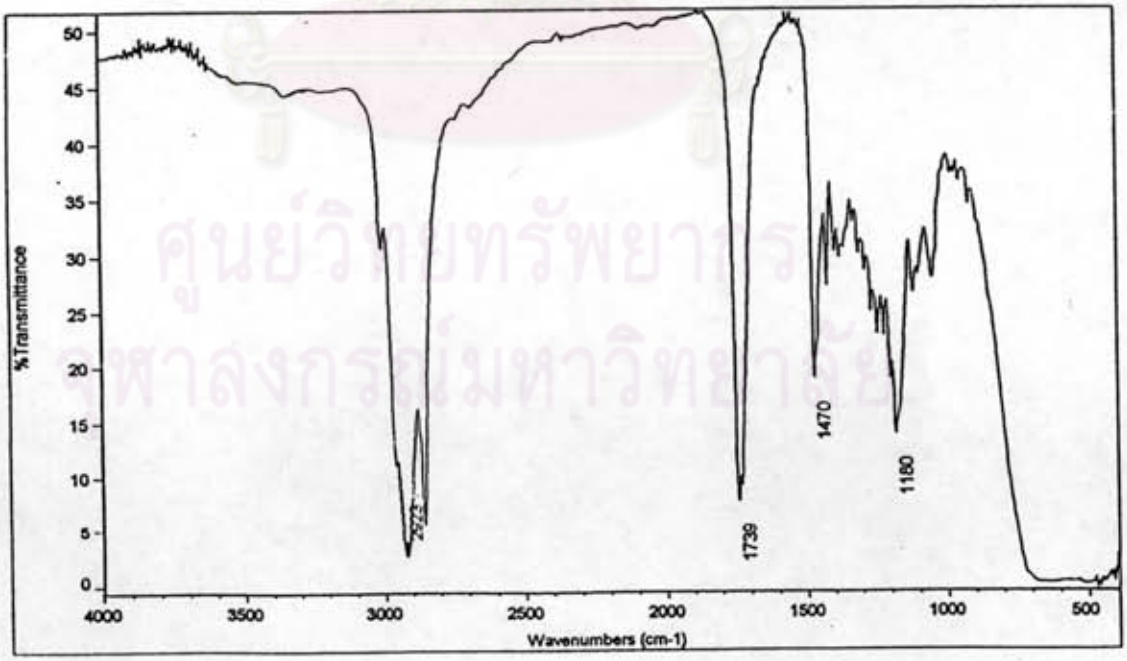

Figure B12 IR spectrum of diester obtained from methyl ester of palm oil and 1,3-propanediol

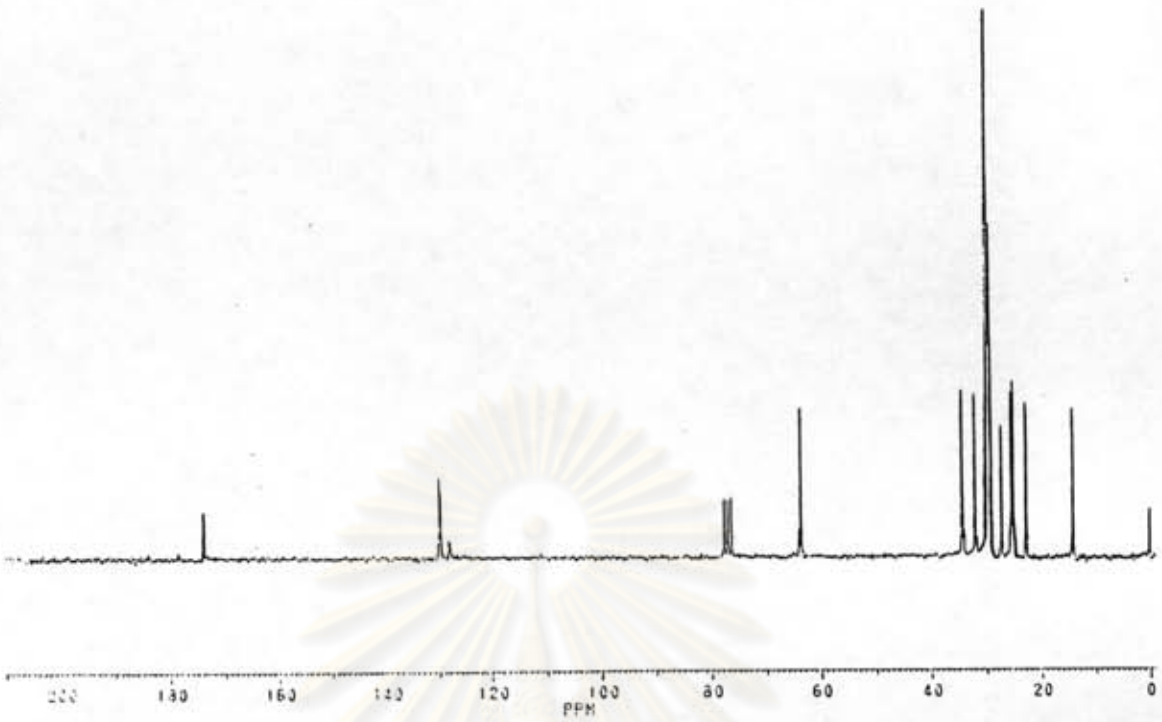

Figure A13 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from methyl ester of palm oil and 1,4-butanediol

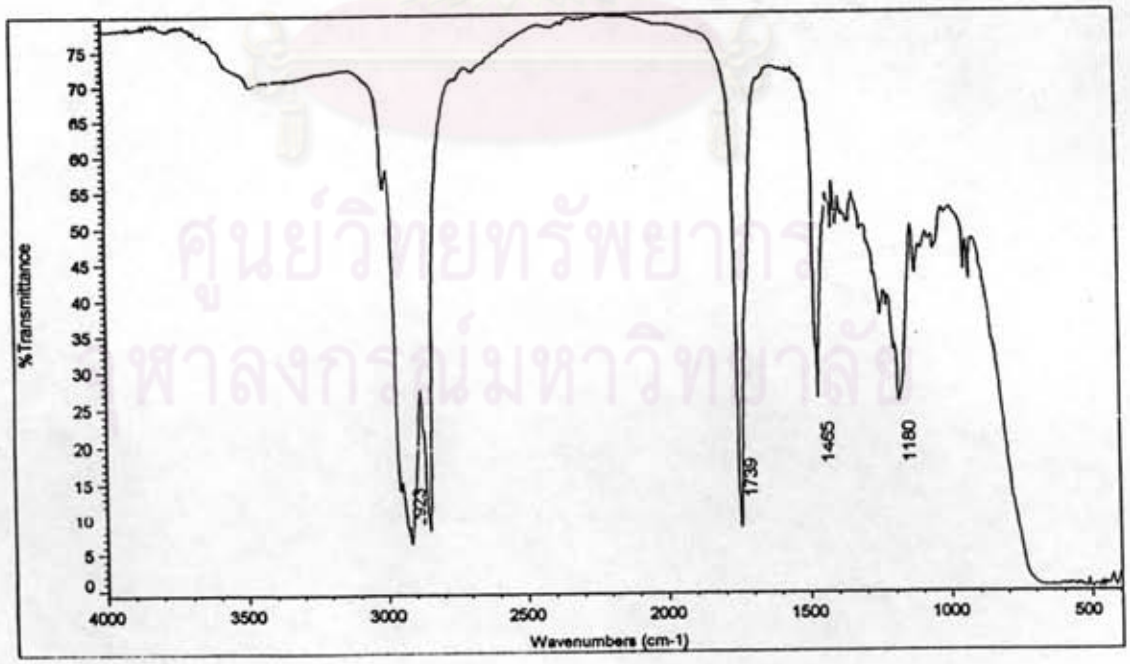

Figure B13 IR spectrum of diester obtained from methyl ester of palm oil and 1,4-butanediol

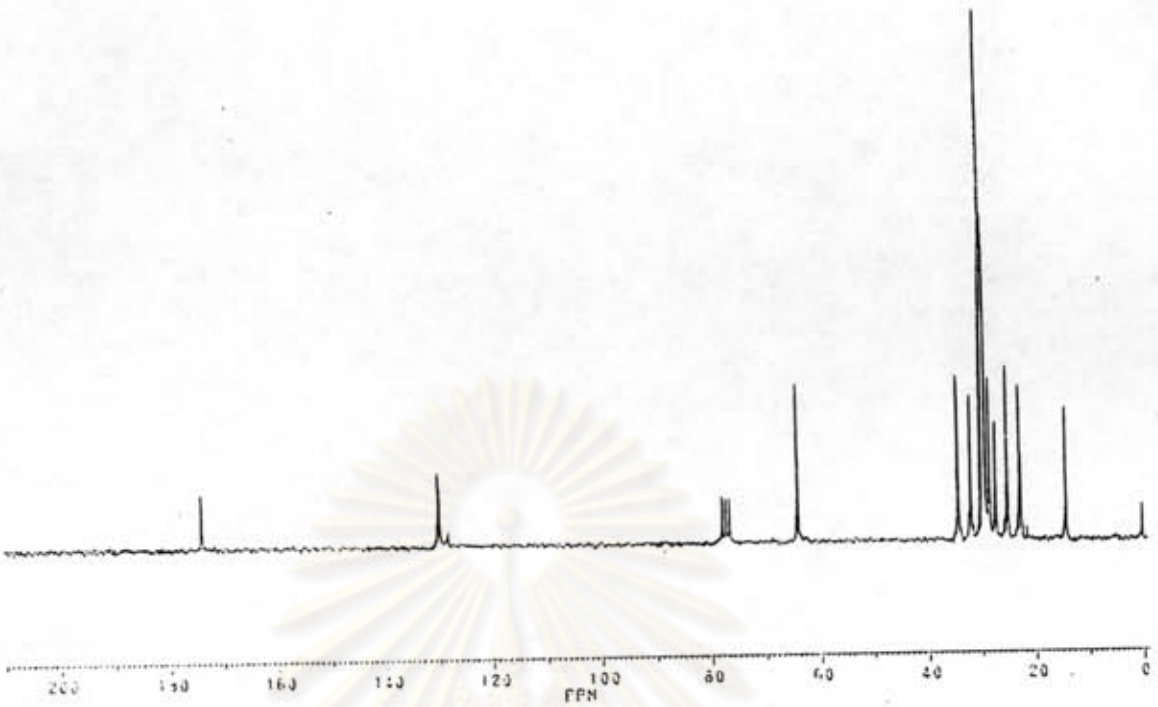

Figure A14 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from methyl ester of palm oil and 1,5-pentanediol

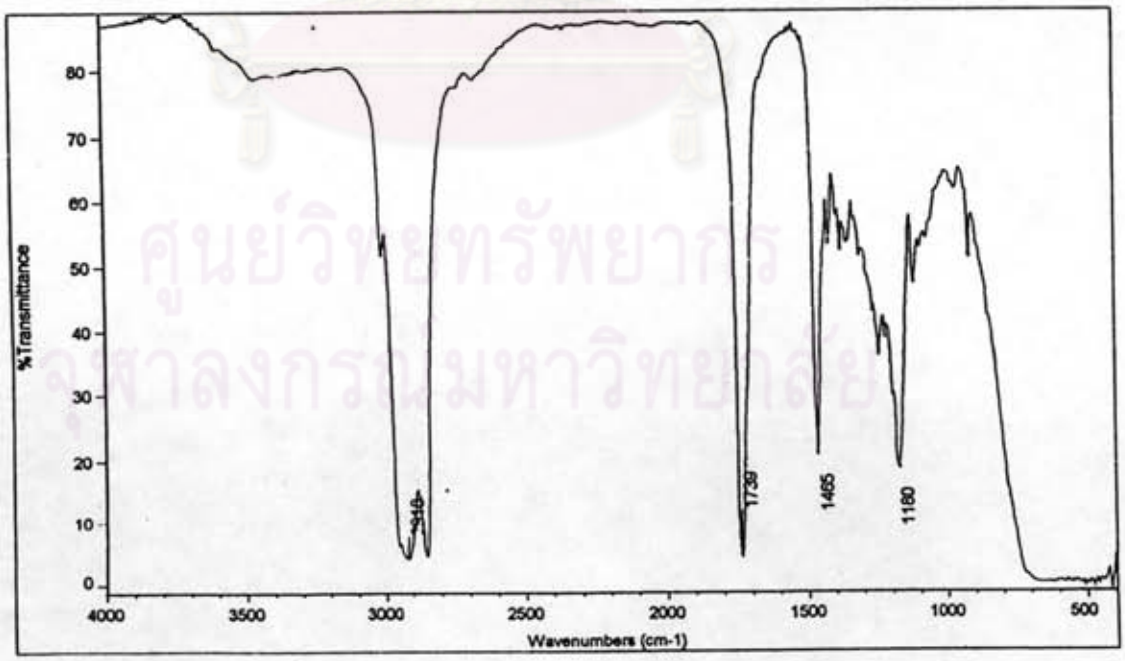

Figure B14 IR spectrum of diester obtained from methyl ester of palm oil and 1,5-pentanediol

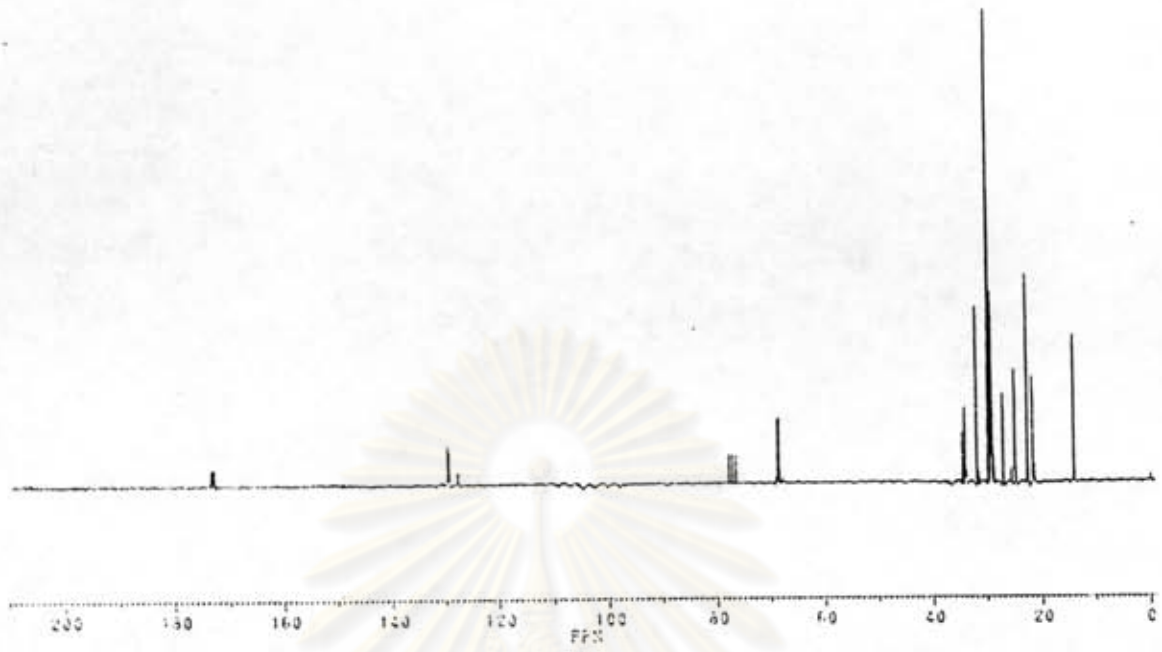

Figure A15 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from methyl ester of palm oil and 2,2-dimethyl-1,3-propanediol

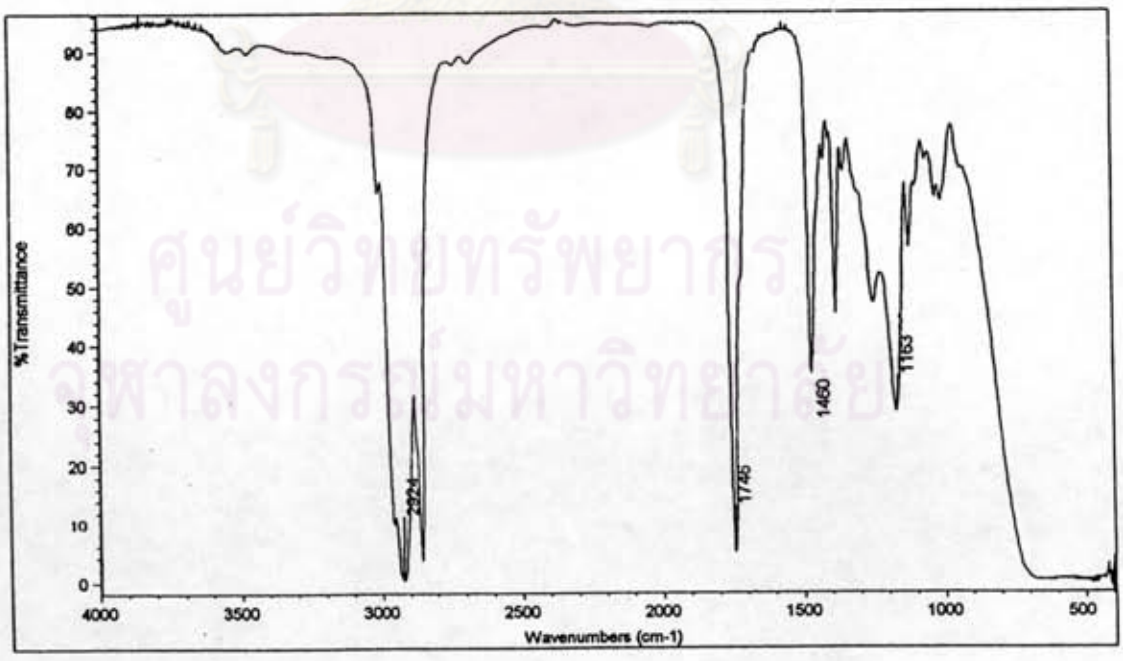

Figure B15 IR spectrum of diester obtained from methyl ester of palm oil and 2,2-dimethyl-1,3-propanediol

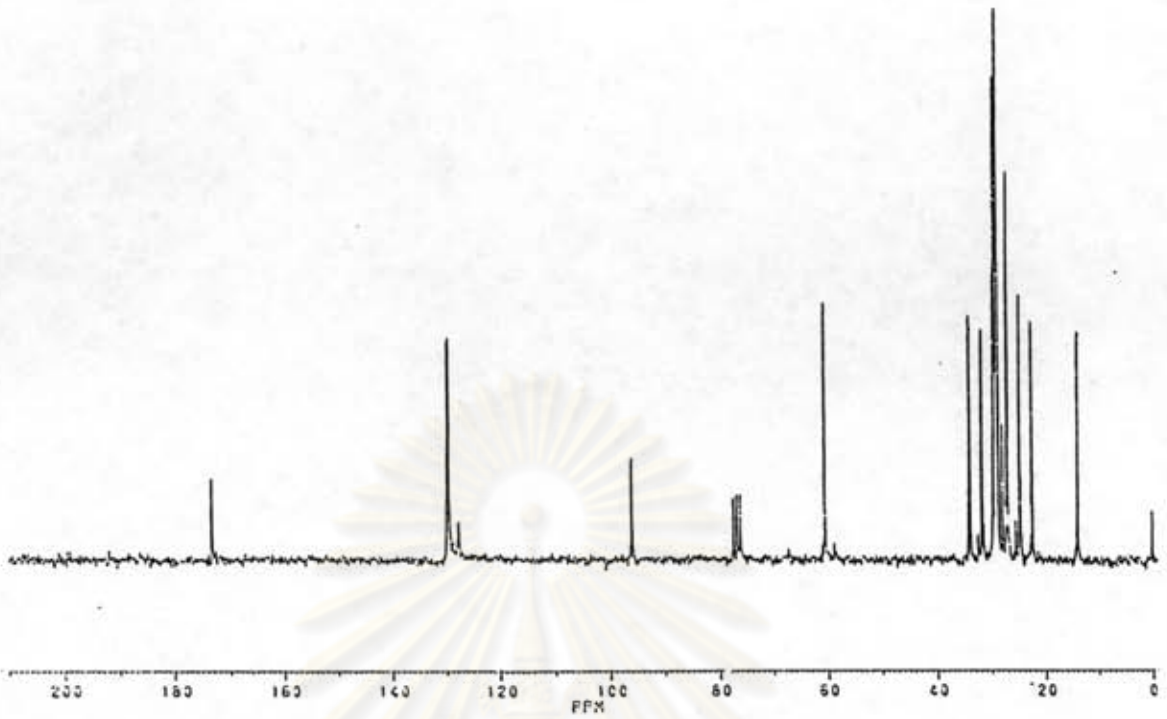

Figure A17 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from oleic acid and 1,3-propanediol

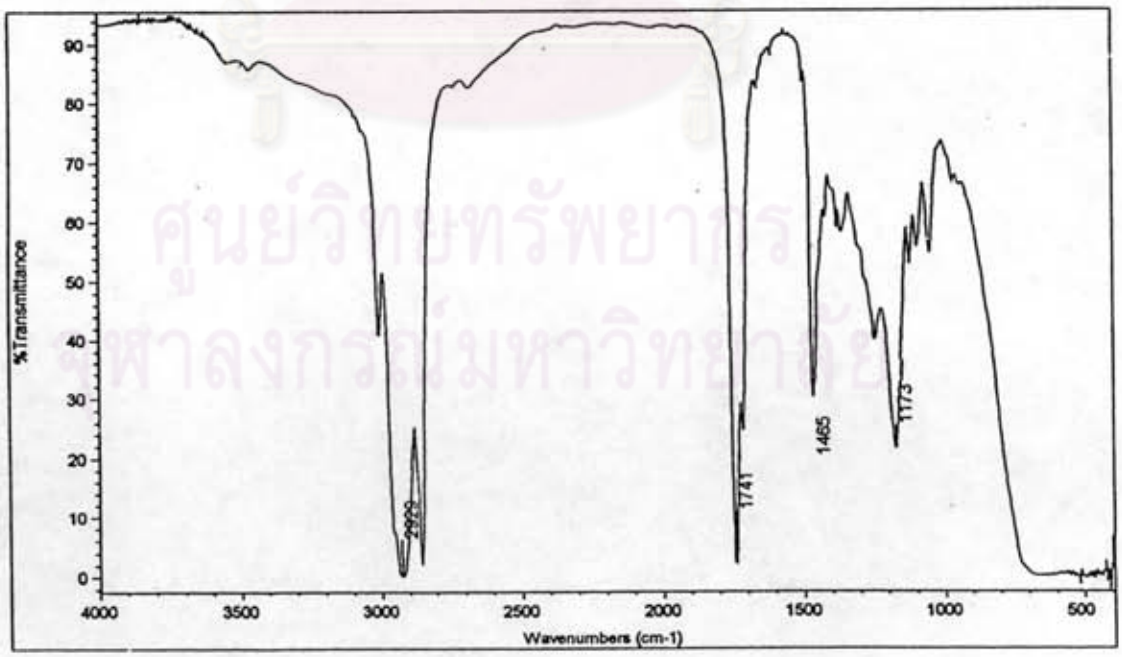

Figure B17 IR spectrum of diester obtained from oleic acid and 1,3-propanediol

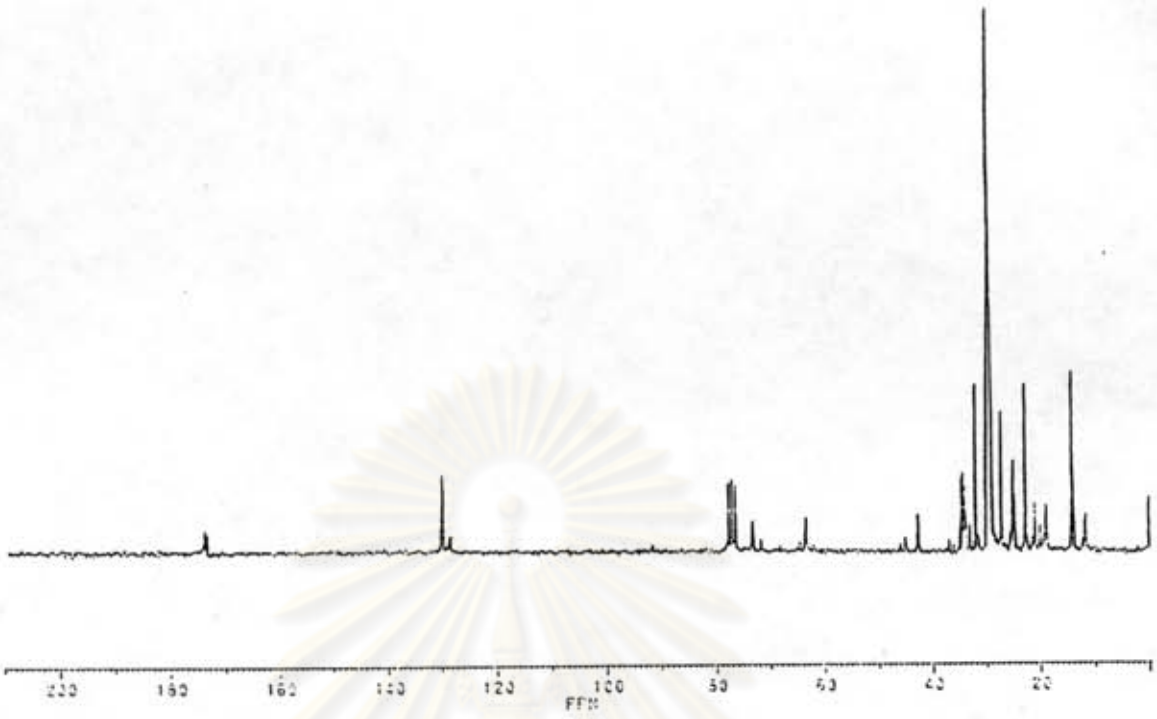

Figure A16 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from methyl ester of palm oil and 2-ethyl-1,3-hexanediol

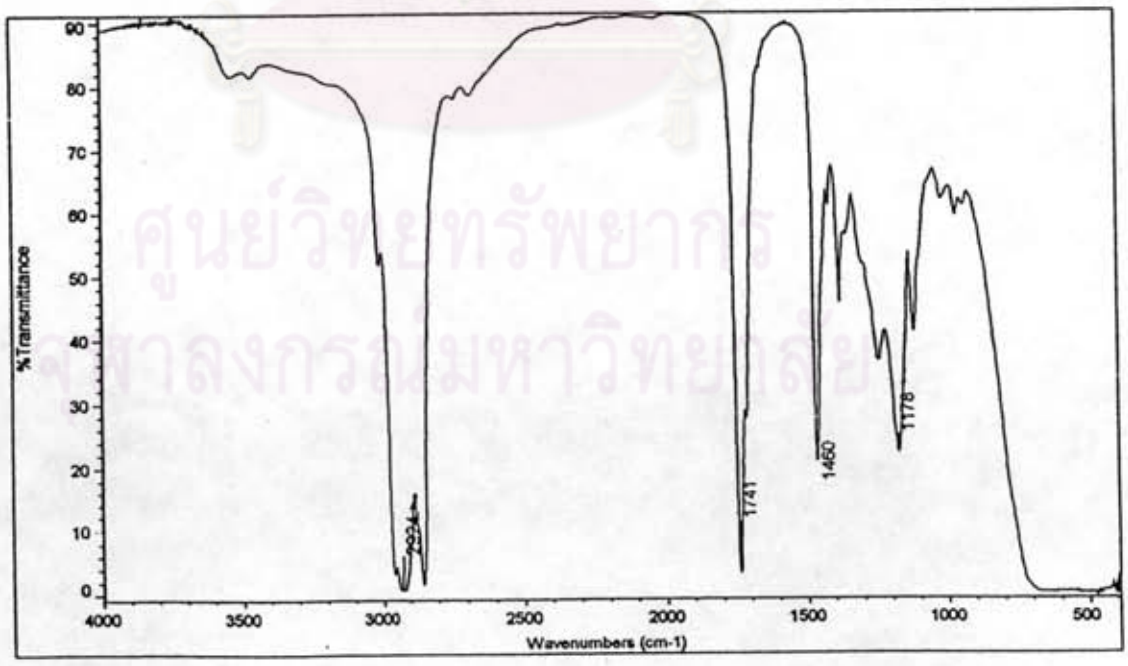

Figure B16 IR spectrum of diester obtained from methyl ester of palm oil and 2-ethyl-1,3-hexanediol

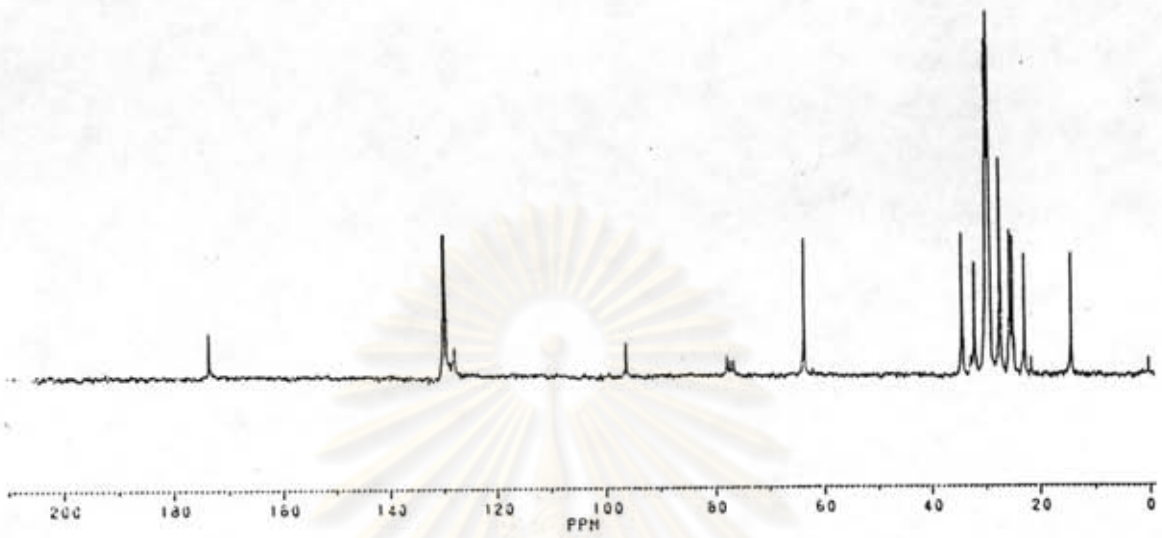

Figure A18 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from oleic acid and 1,4-butanediol

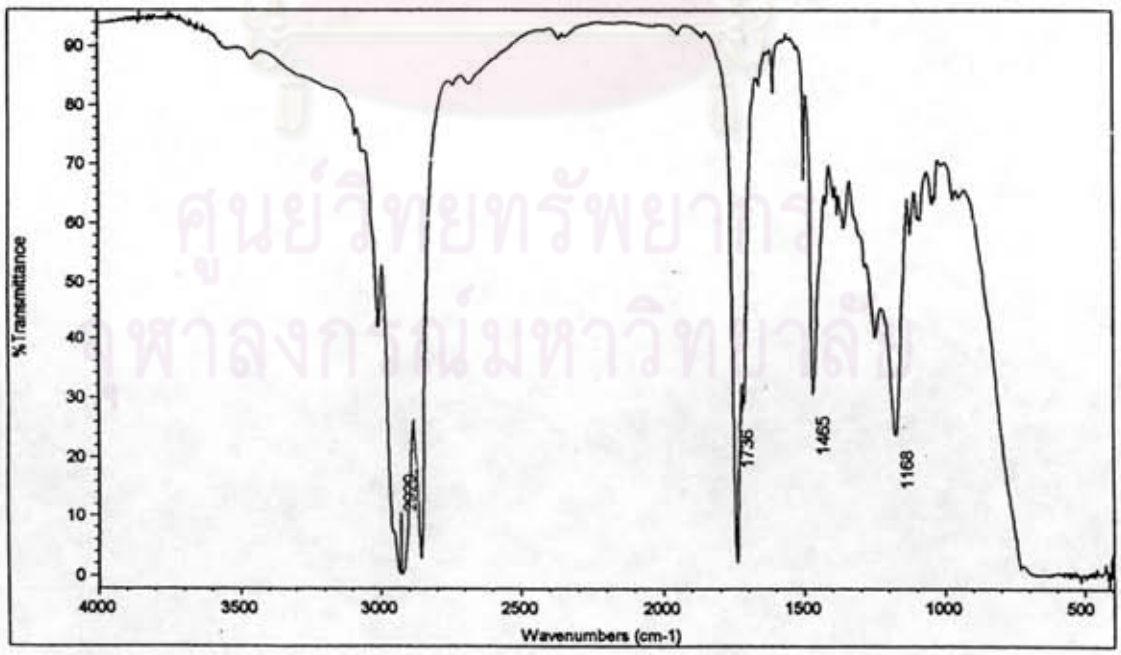

Figure B18 IR spectrum of diester obtained from oleic acid and 1,4-butanediol

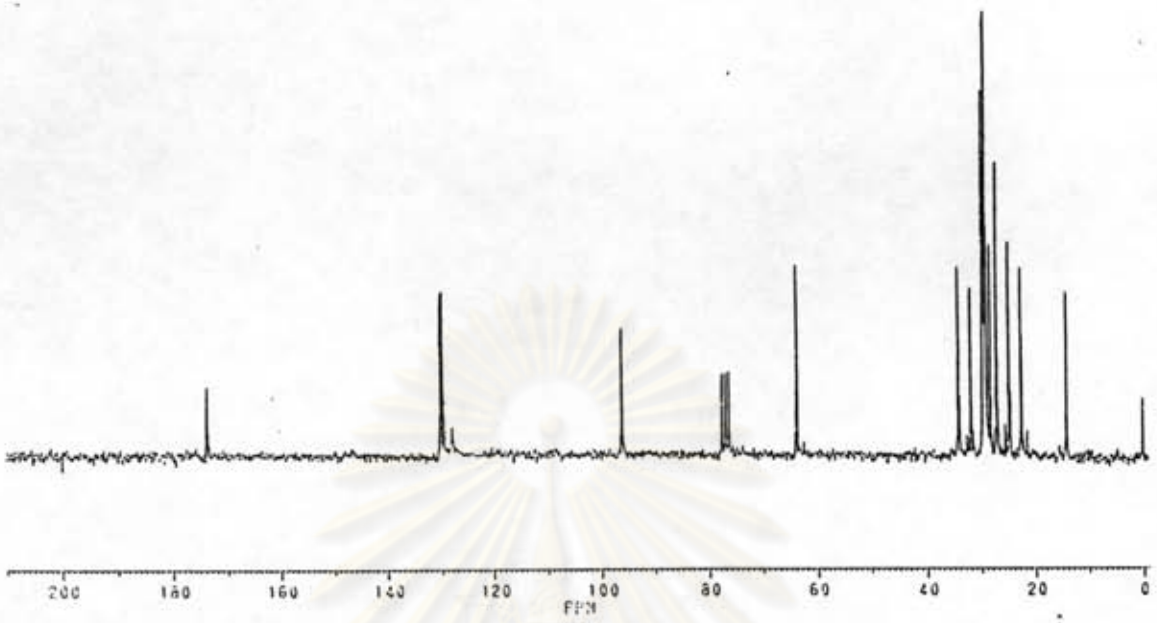

Figure A19 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from oleic acid and 1,5-pentanediol

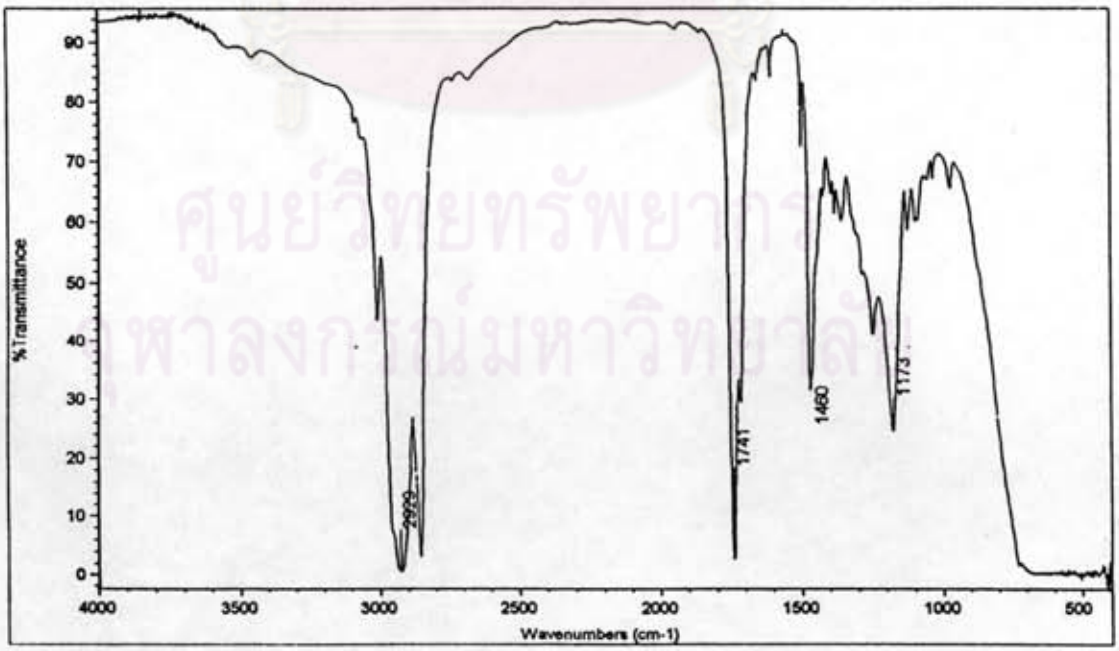

Figure B19 IR spectrum of diester obtained from oleic acid and 1,5-pentanediol

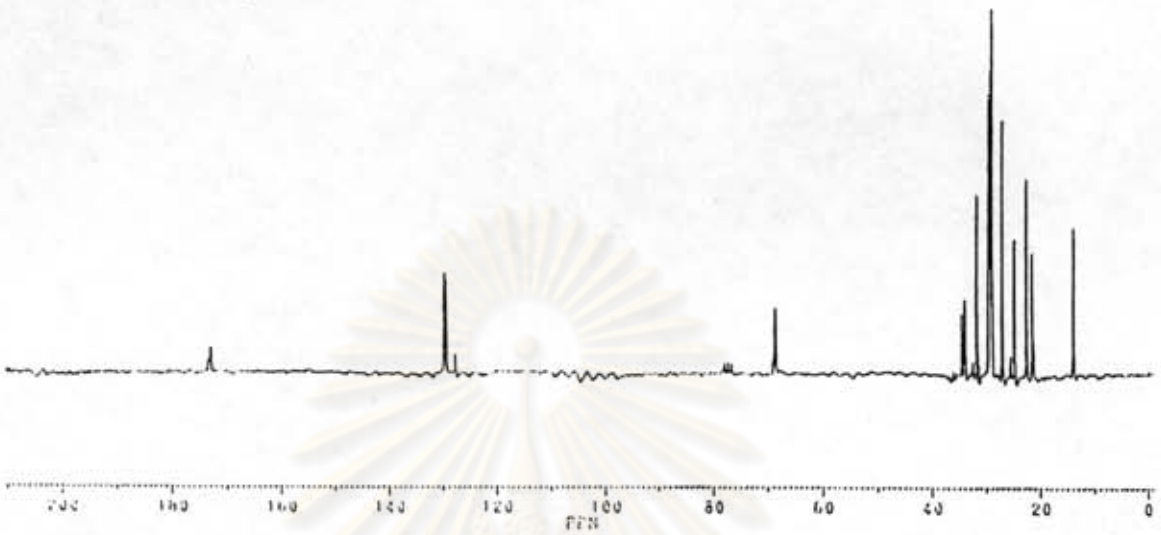

Figure A20 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from oleic acid and 2,2-dimethyl-1,3-propanediol

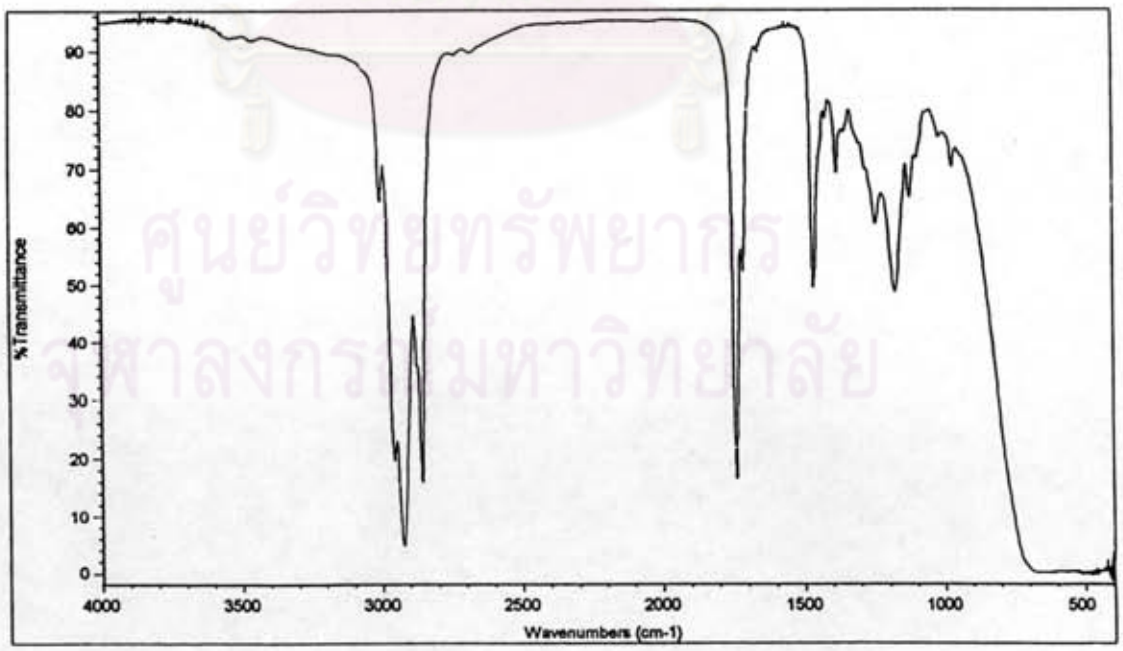

Figure B20 IR spectrum of diester obtained from oleic acid and 2,2-dimethyl-1,3-propanediol

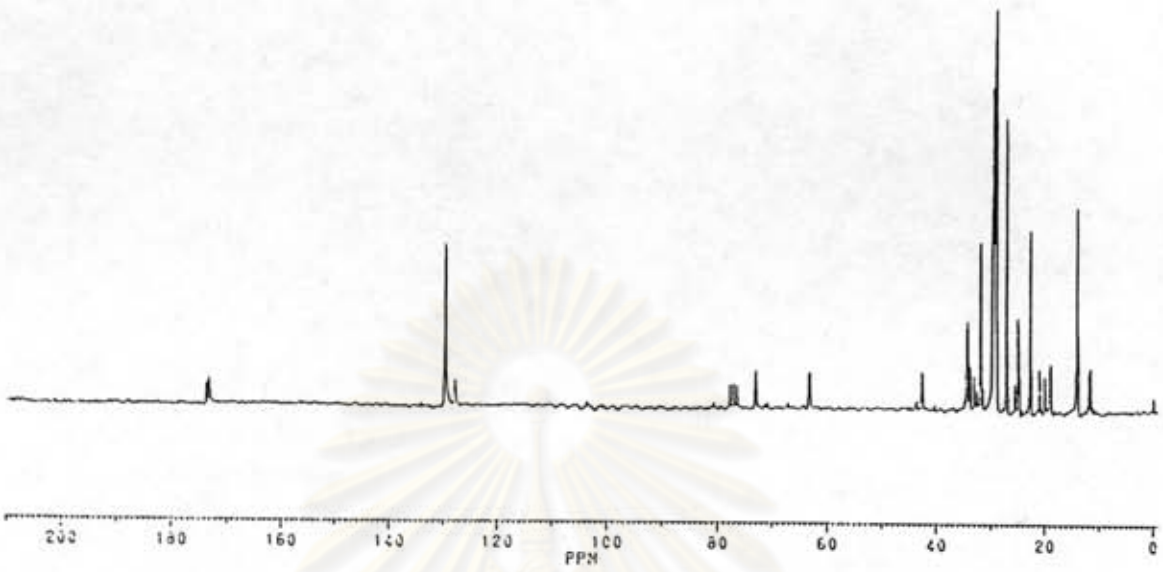

Figure A21 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from oleic acid and 2-ethyl-1,3-hexanediol

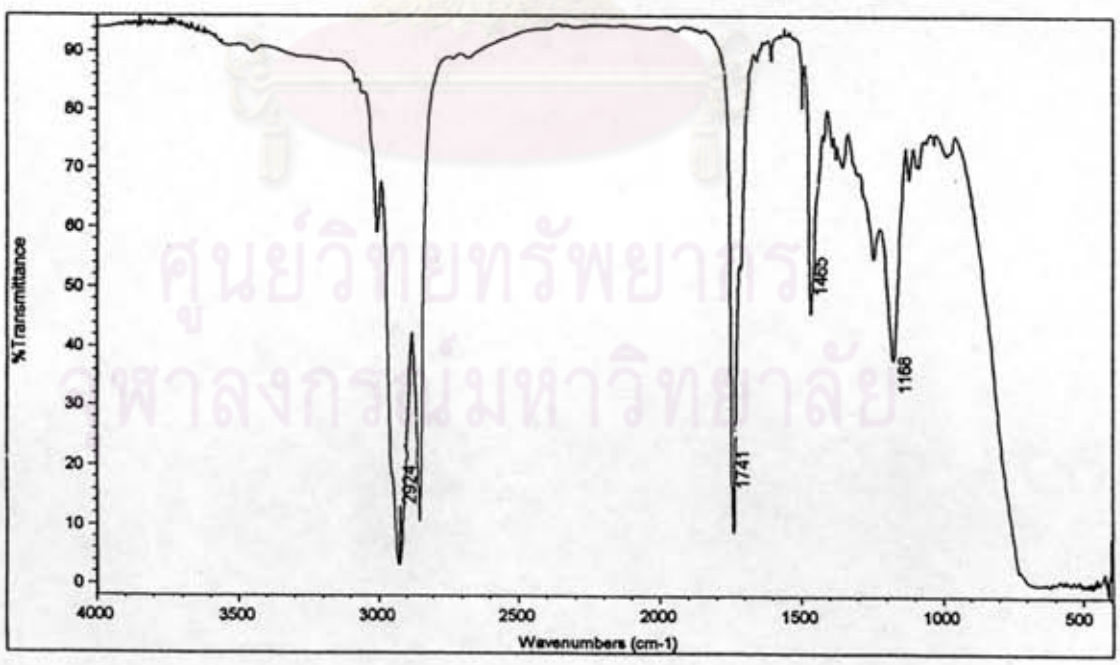

Figure B21 IR spectrum of diester obtained from oleic acid and 2-ethyl-1,3-hexanediol

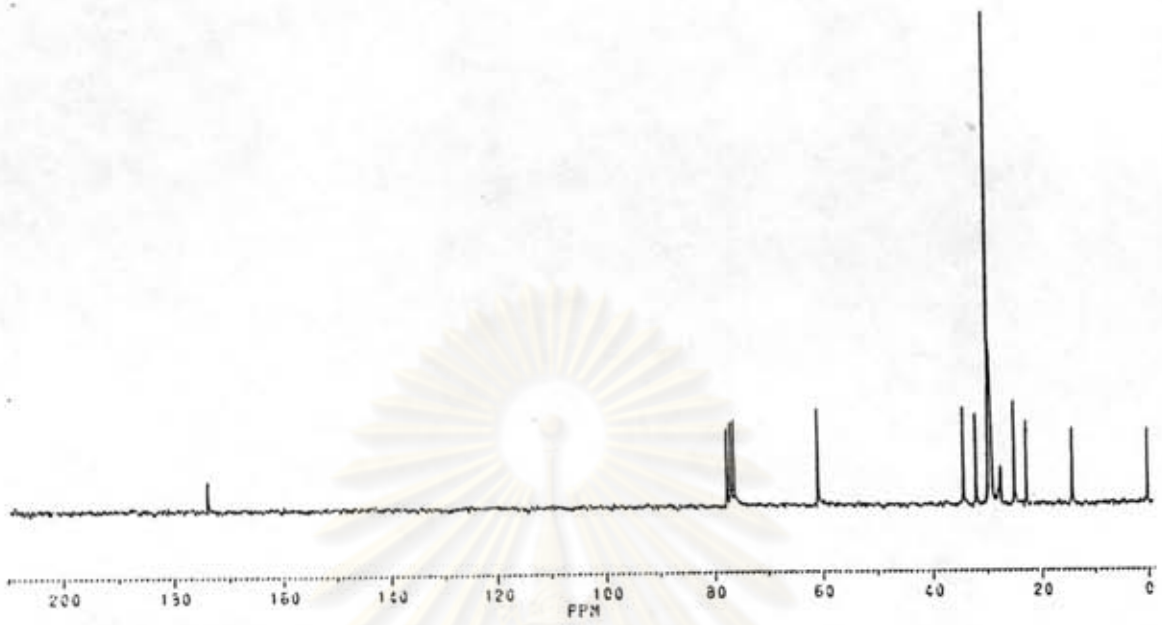

Figure A22 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from stearic acid and 1,3-propanediol

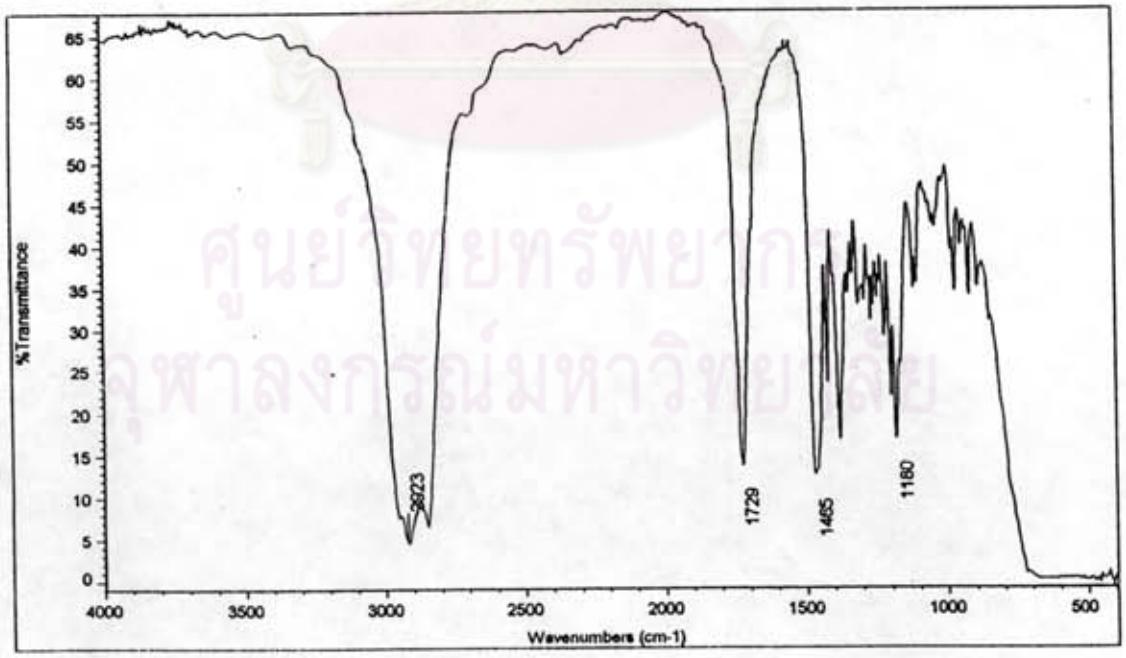

Figure B22 IR spectrum of diester obtained from stearic acid and 1,3-propanediol

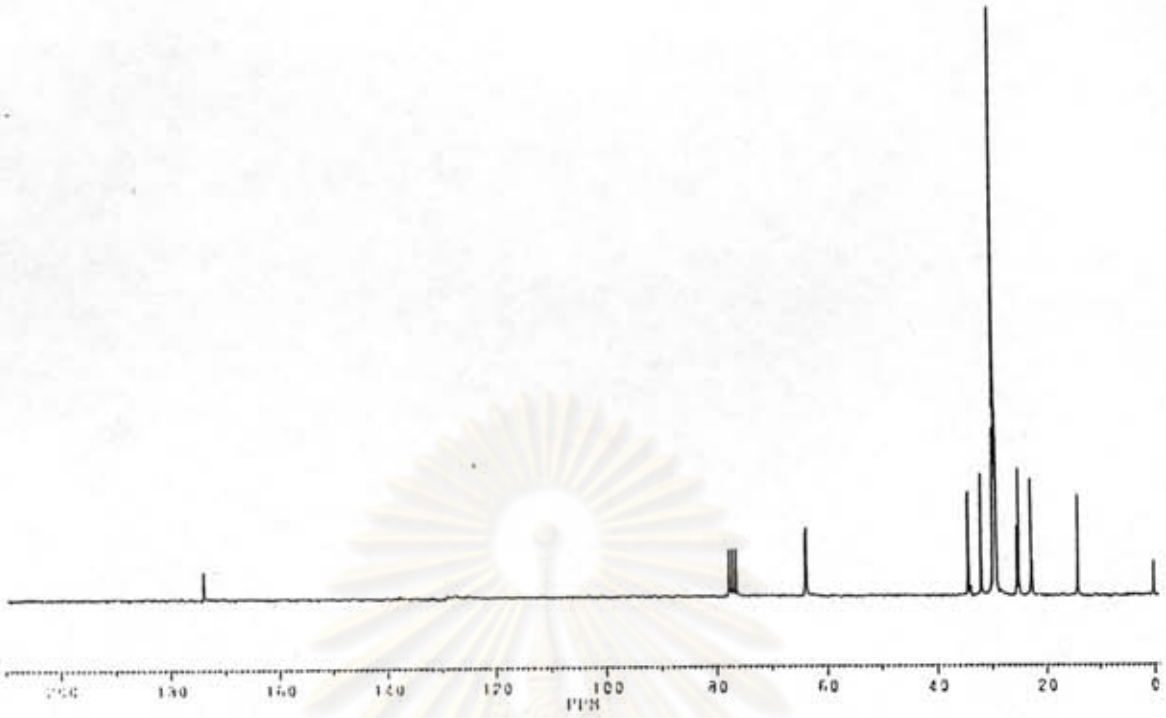

Figure A23 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from stearic acid and 1,4-butanediol

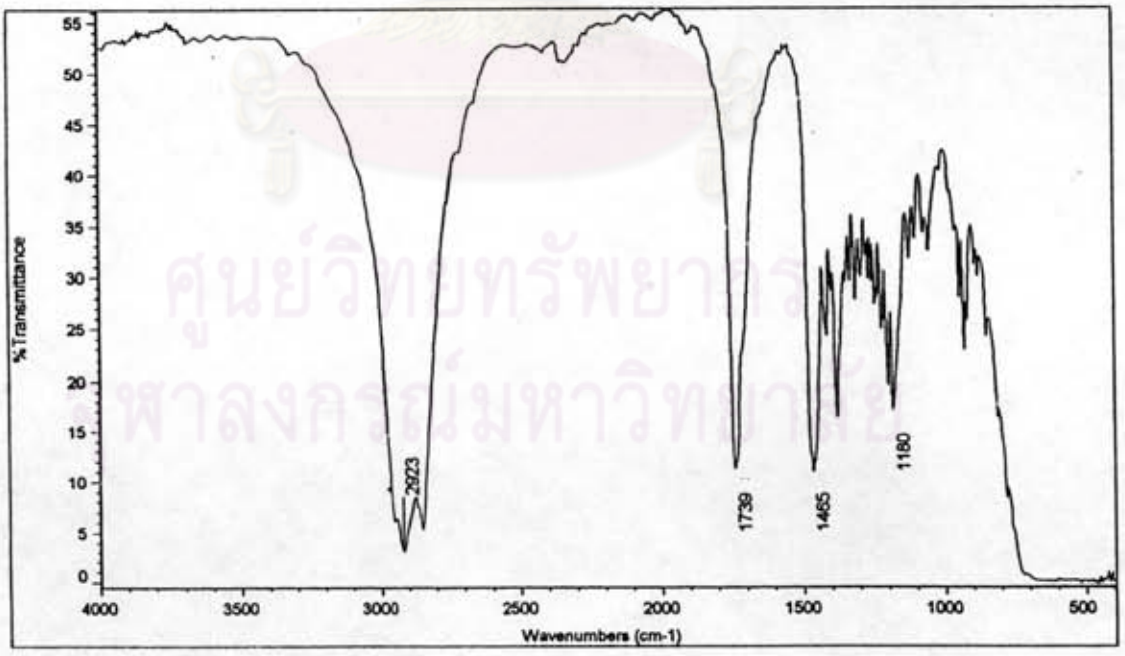

Figure B23 IR spectrum of diester obtained from stearic acid and 1,4-butanediol

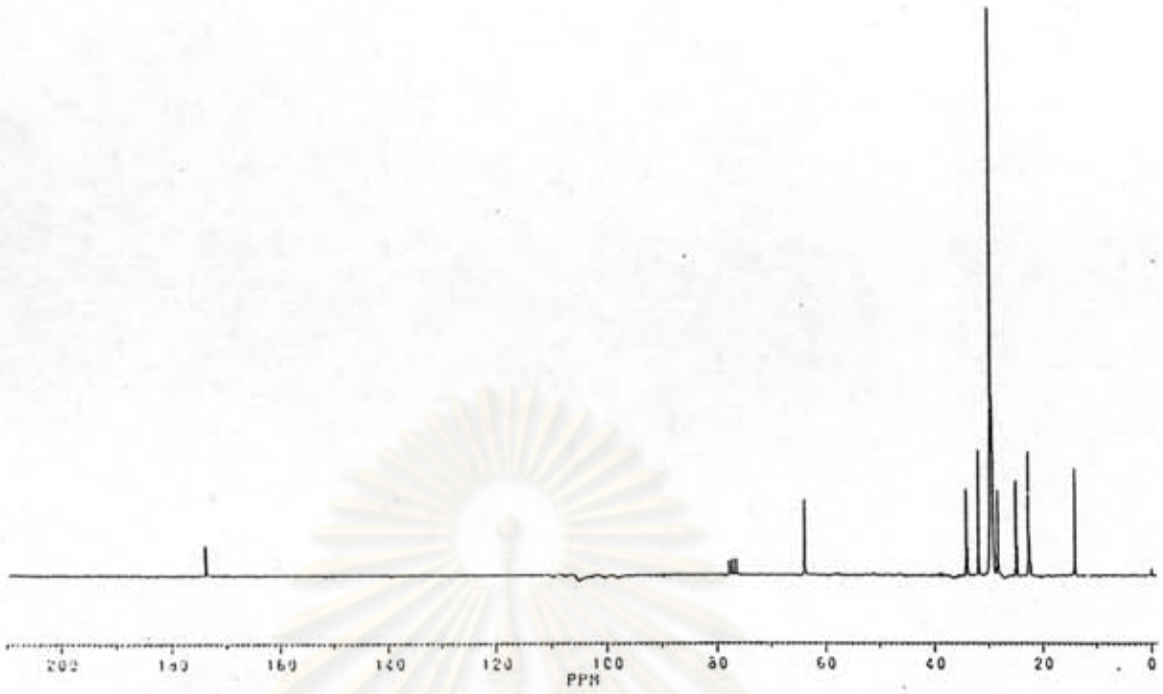

Figure A24 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from stearic acid and 1,5-pentanediol

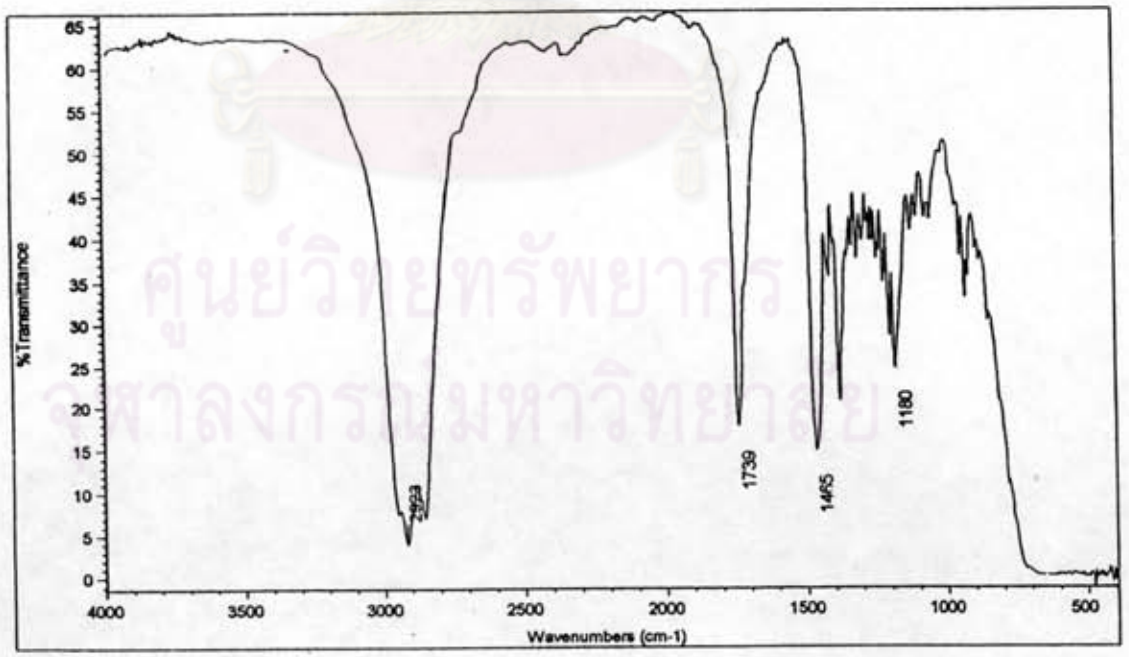

Figure B24 IR spectrum of diester obtained from stearic acid and 1,5-pentanediol

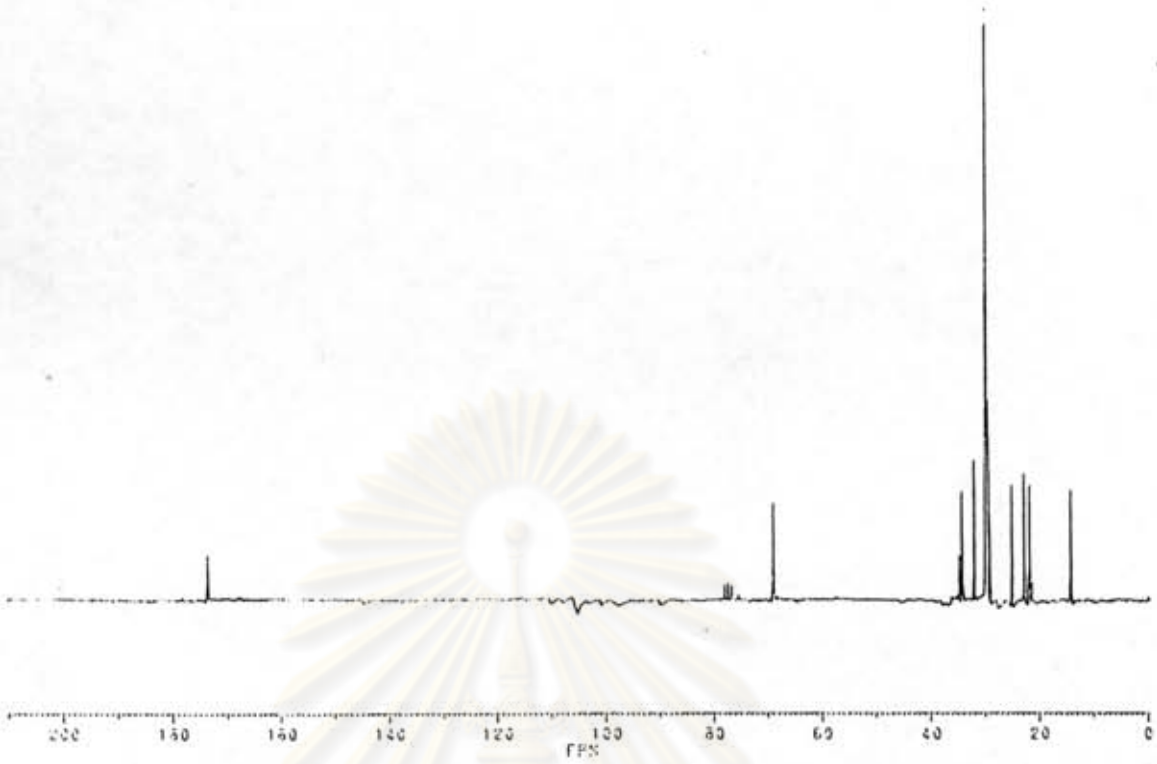

Figure A25 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from stearic acid and 2,2-dimethyl-1,3-propanediol

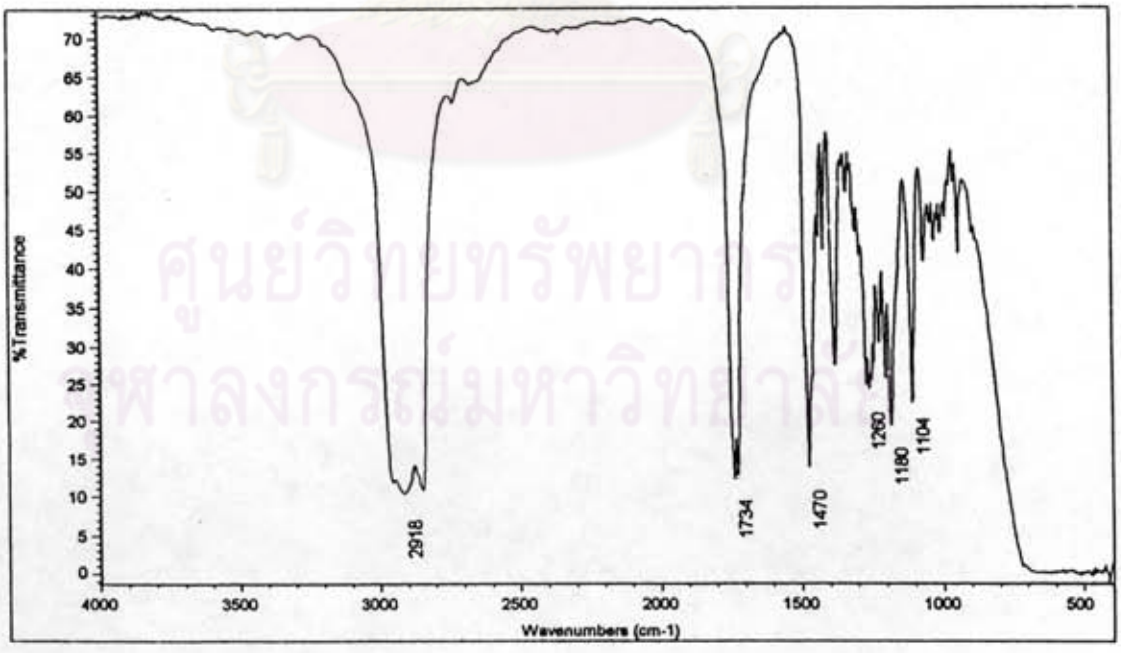

Figure B25 IR spectrum of diester obtained from stearic acid and 2,2-dimethyl-1,3-propanediol

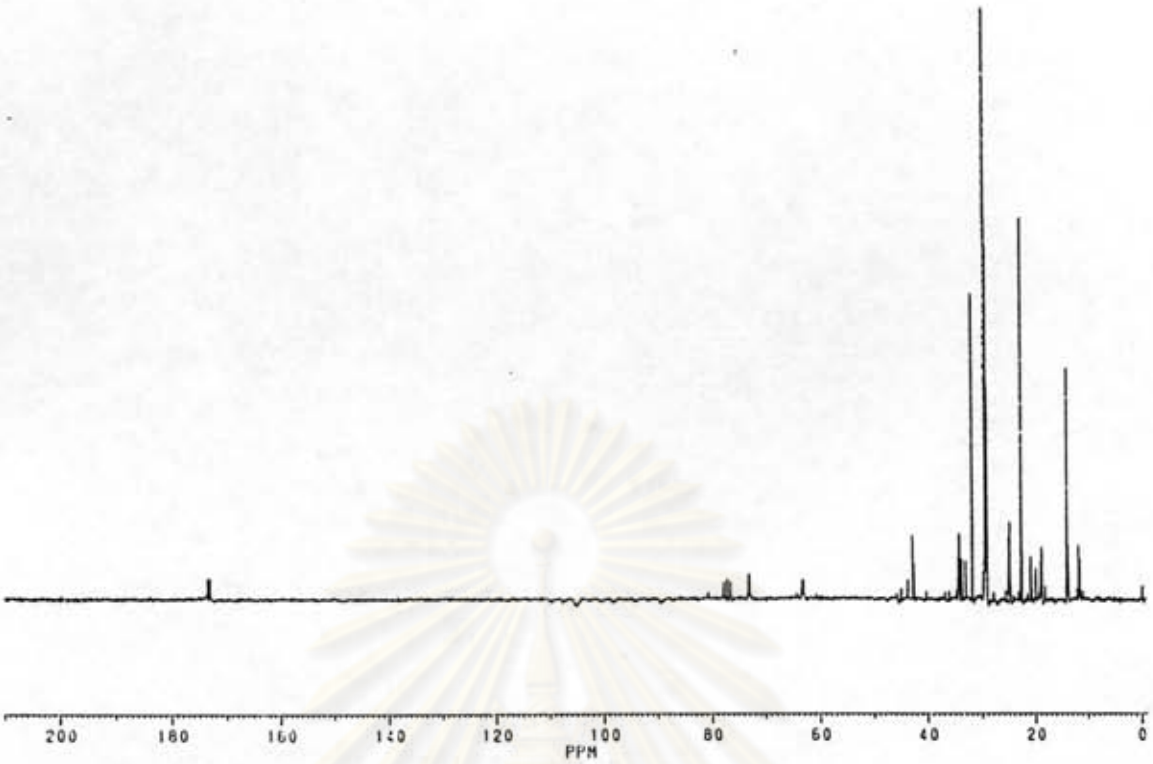

Figure A26 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from stearic acid and 2-ethyl-1,3-hexanediol

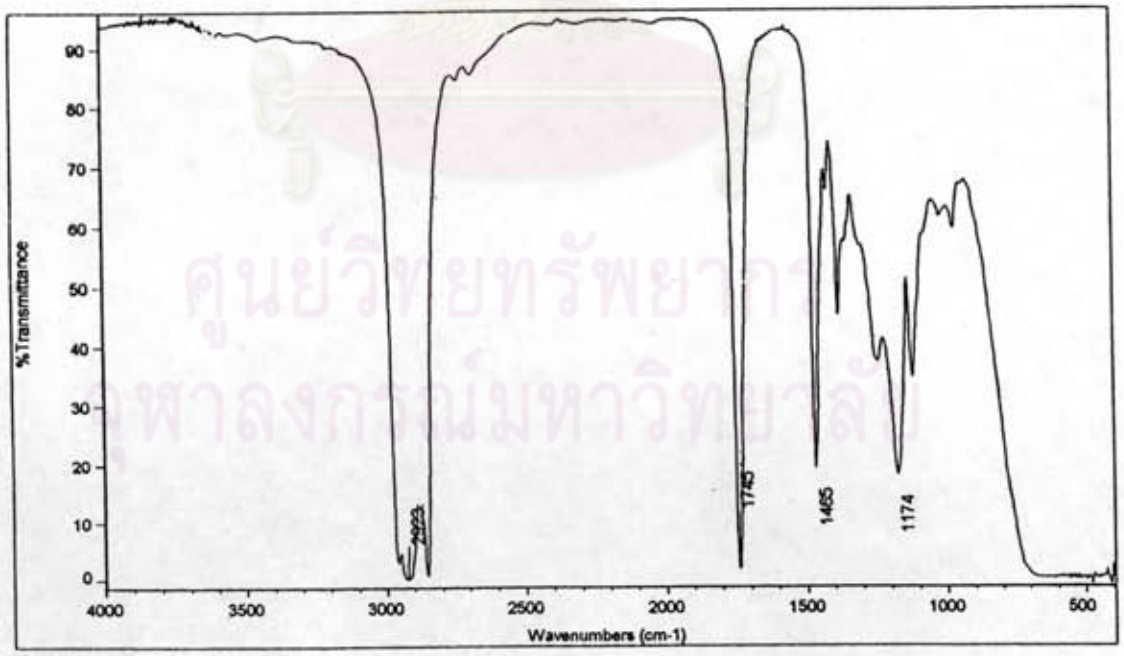

Figure B26 IR spectrum of diester obtained from stearic acid and 2-ethyl-1,3-hexanediol

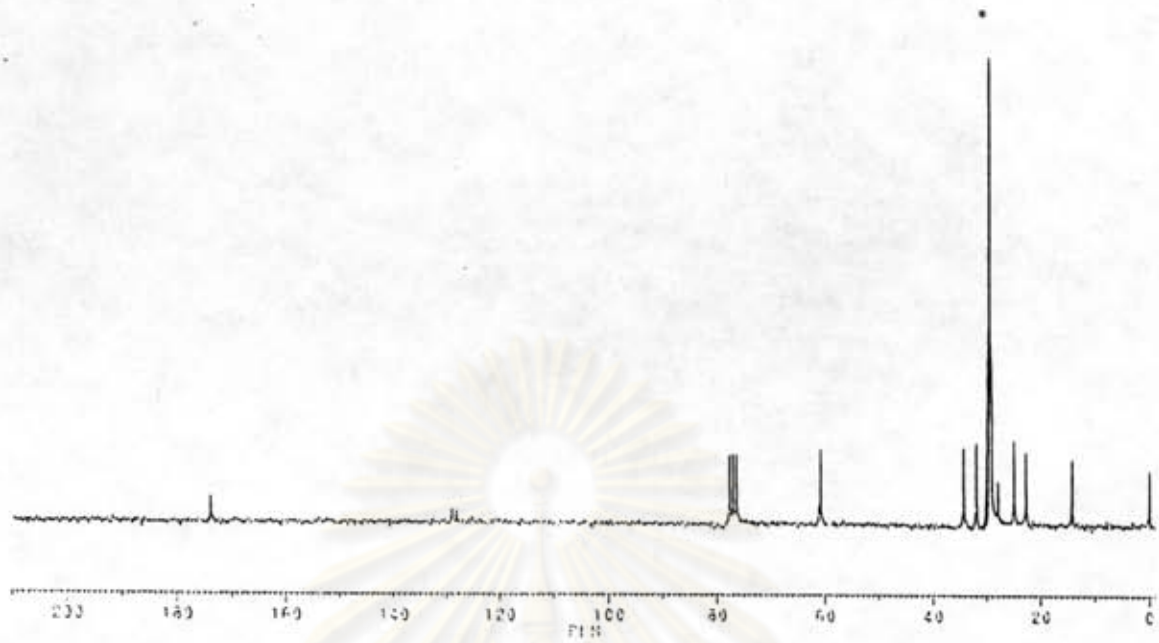

Figure A27 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from palmitic acid and 1,3-propanediol

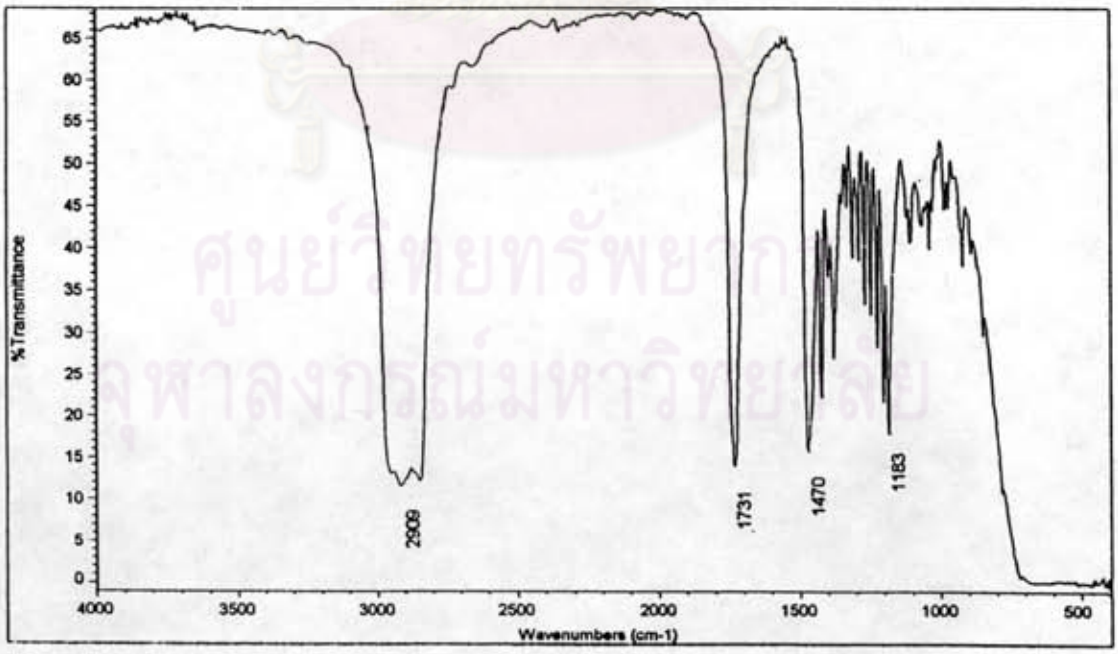

Figure B27 IR spectrum of diester obtained from palmitic acid and 1,3-propanediol

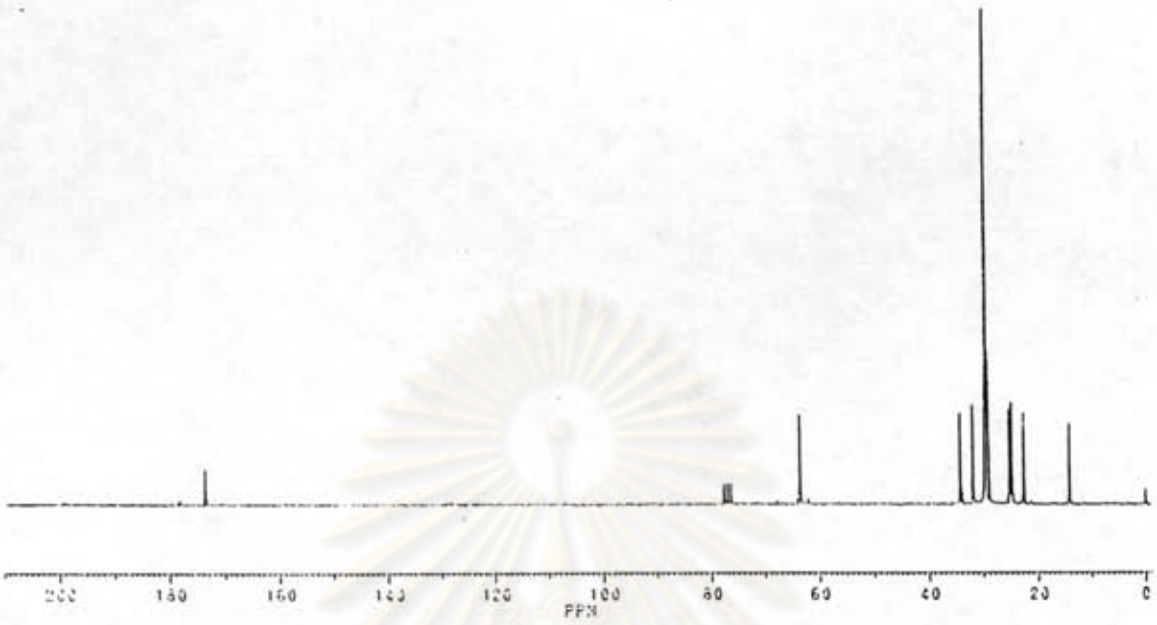

Figure A28 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from palmitic acid and 1,4-butanediol

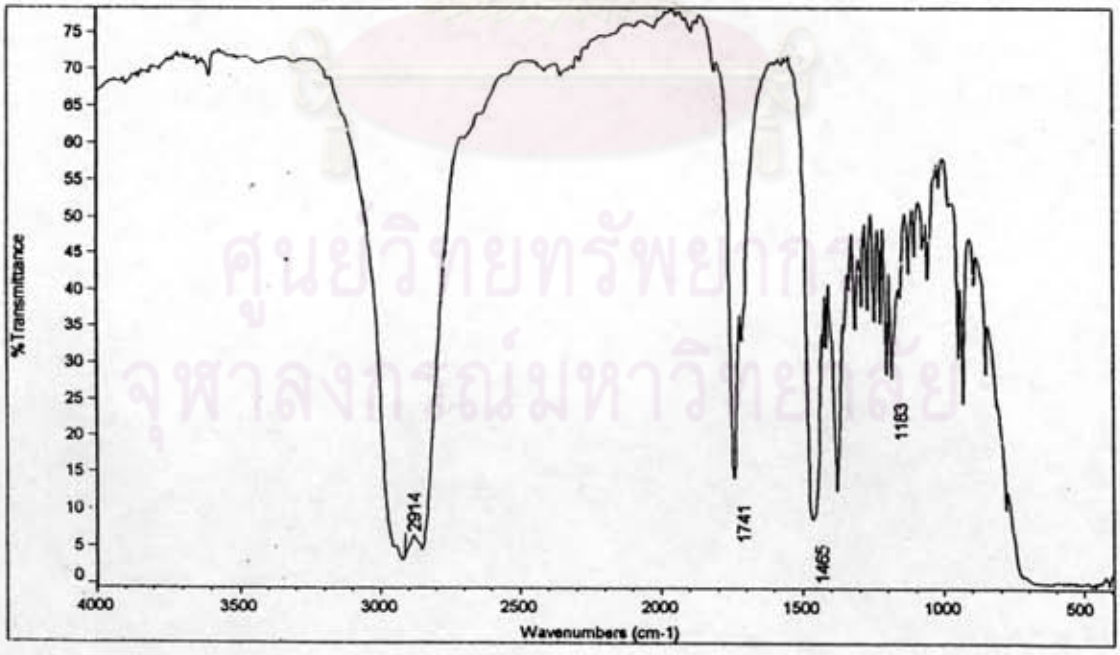

Figure B28 IR spectrum of diester obtained from palmitic acid and 1,4-butanediol

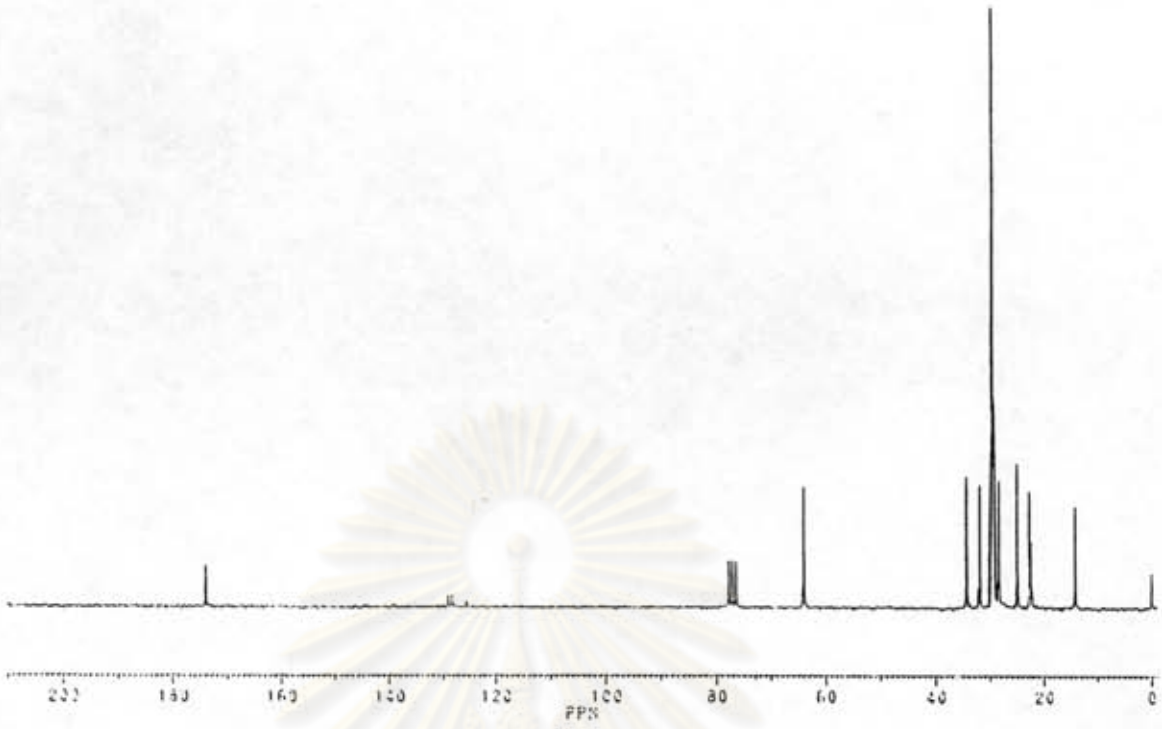

Figure A29 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from palmitic acid and 1,5-pentanediol

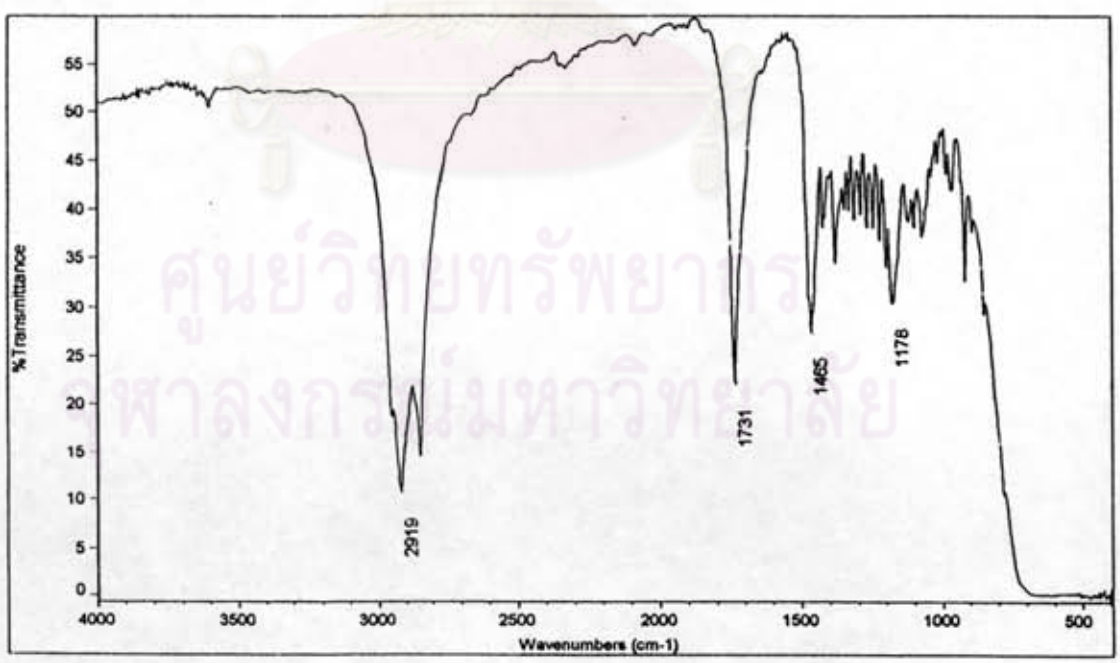

Figure B29 IR spectrum of diester obtained from palmitic acid and 1,5-pentanediol

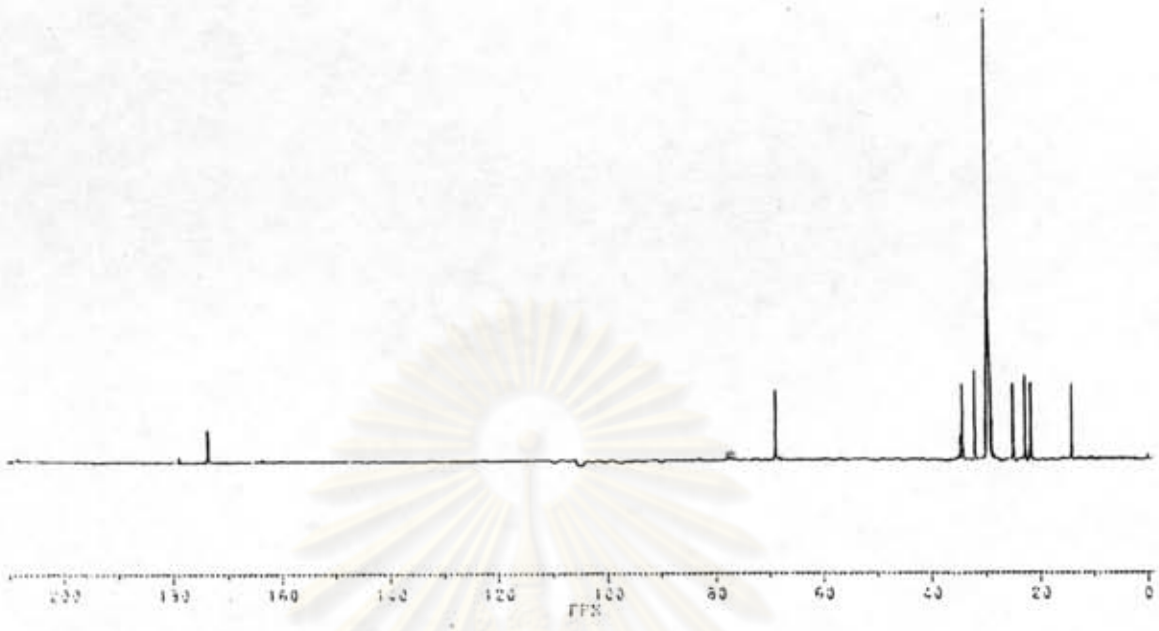

Figure A30 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from palmitic acid and 2,2-dimethyl-1,3-propanediol

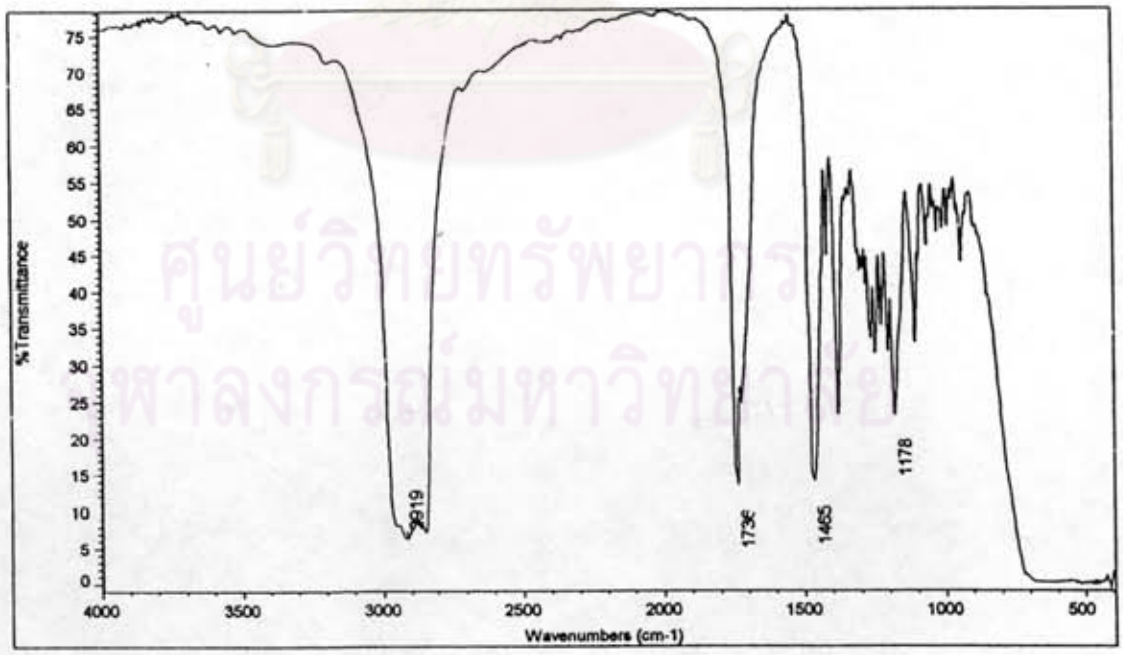

Figure B30 IR spectrum of diester obtained from palmitic acid and 2,2-dimethyl-1,3-propanediol

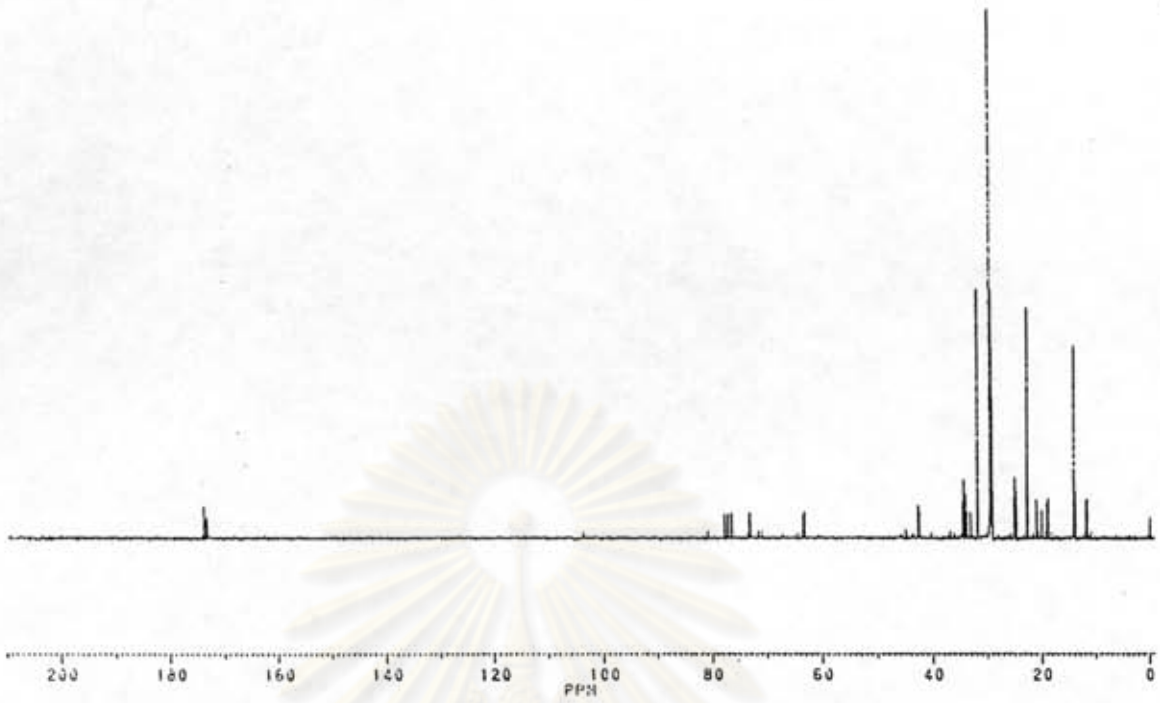

Figure A31 ^{13}C NMR ($CDCl_3$) spectrum of diester obtained from palmitic acid and 2-ethyl-1,3-hexanediol

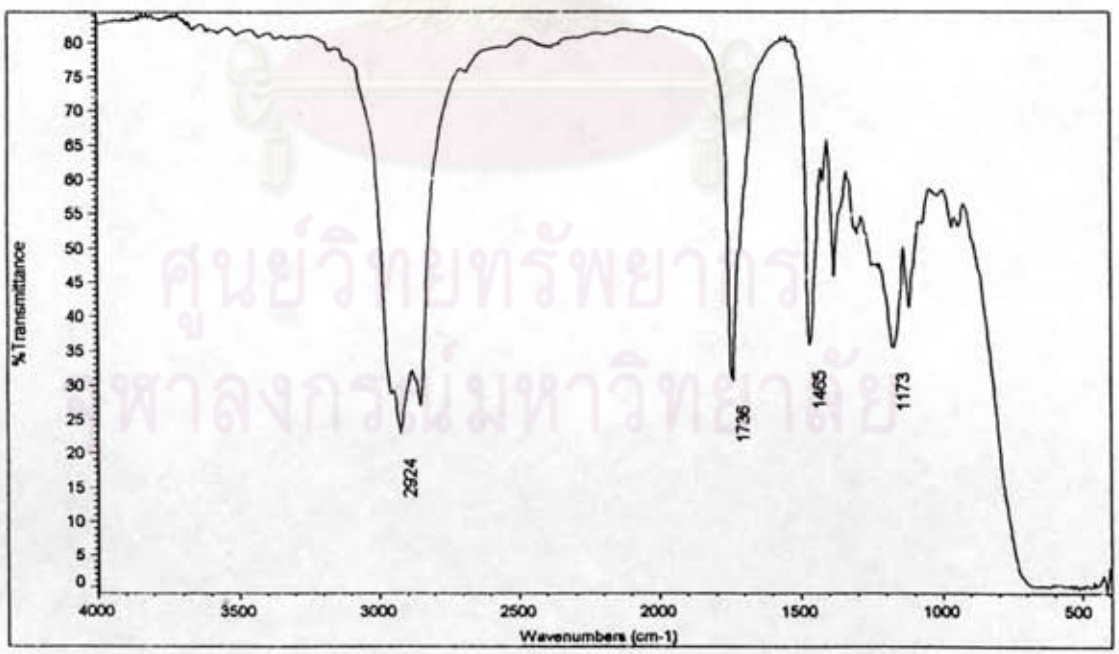

Figure B31 IR spectrum of diester obtained from palmitic acid and 2-ethyl-1,3-hexanediol

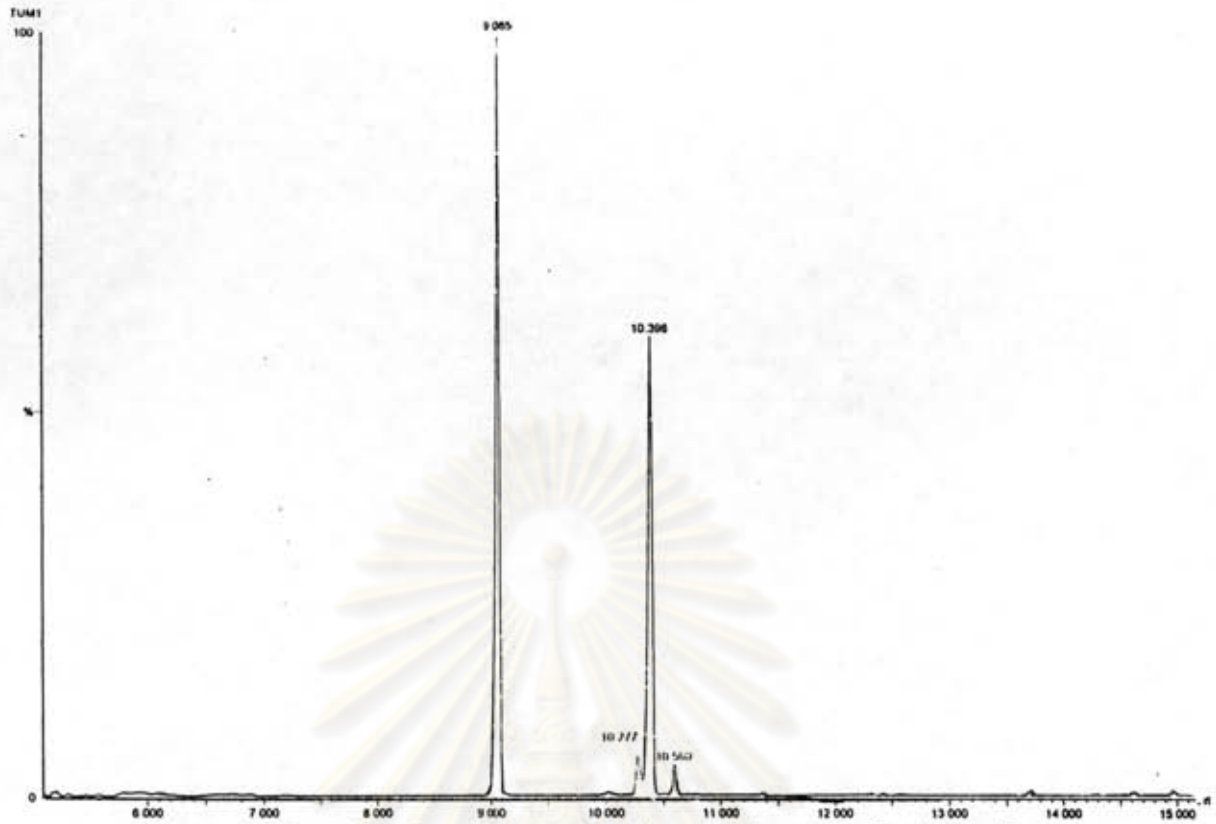

Figure C1 GC-chromatogram of methyl ester of palm oil

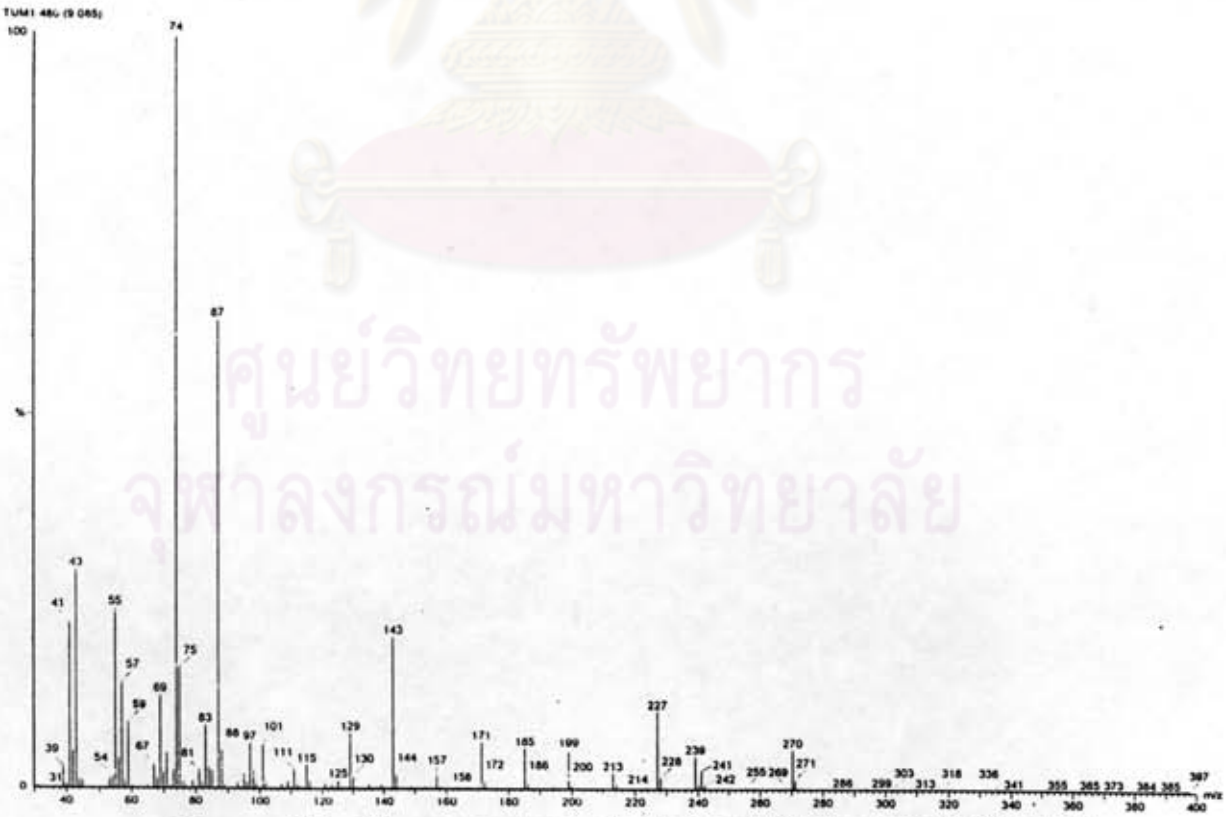

Figure D1 Mass spectrum of ethyl palmitate at retention time 9.085 min

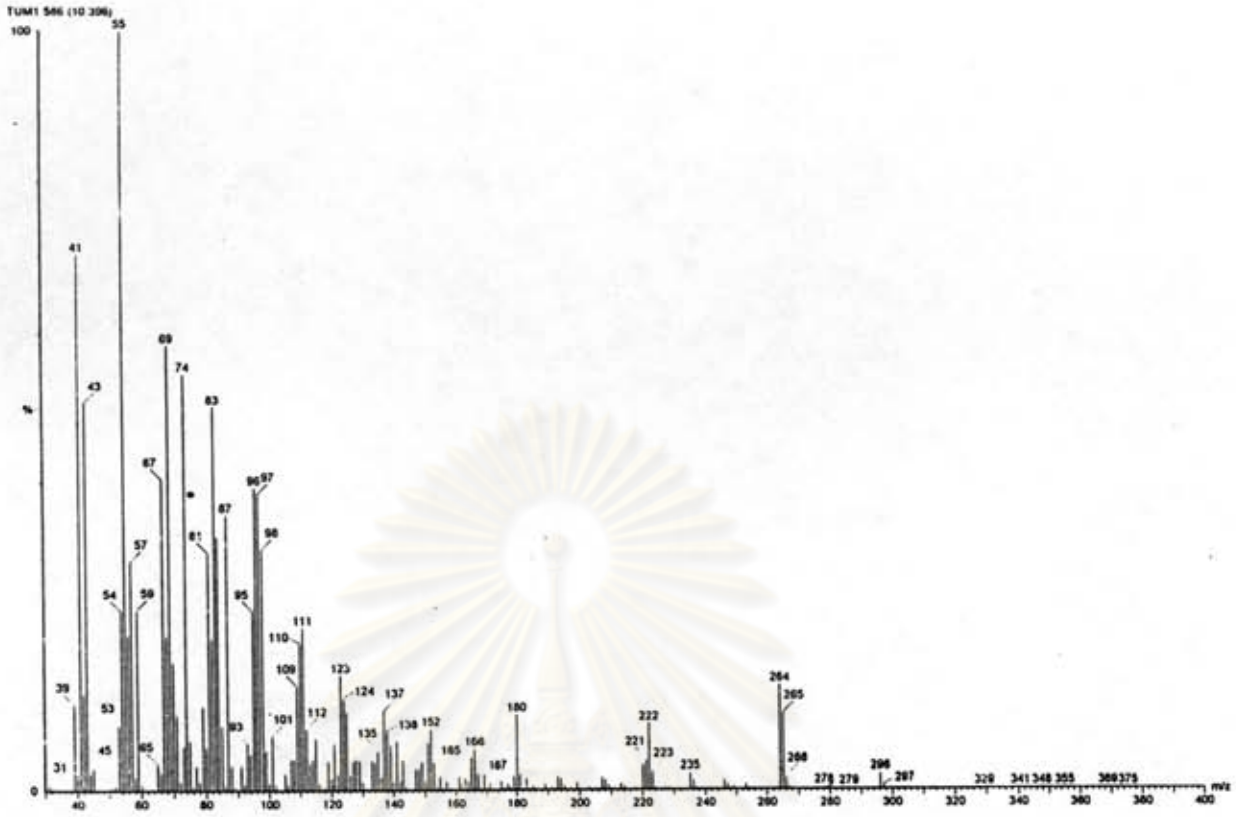

Figure D2 Mass spectrum of ethyl oleate at retention time 10.396 min

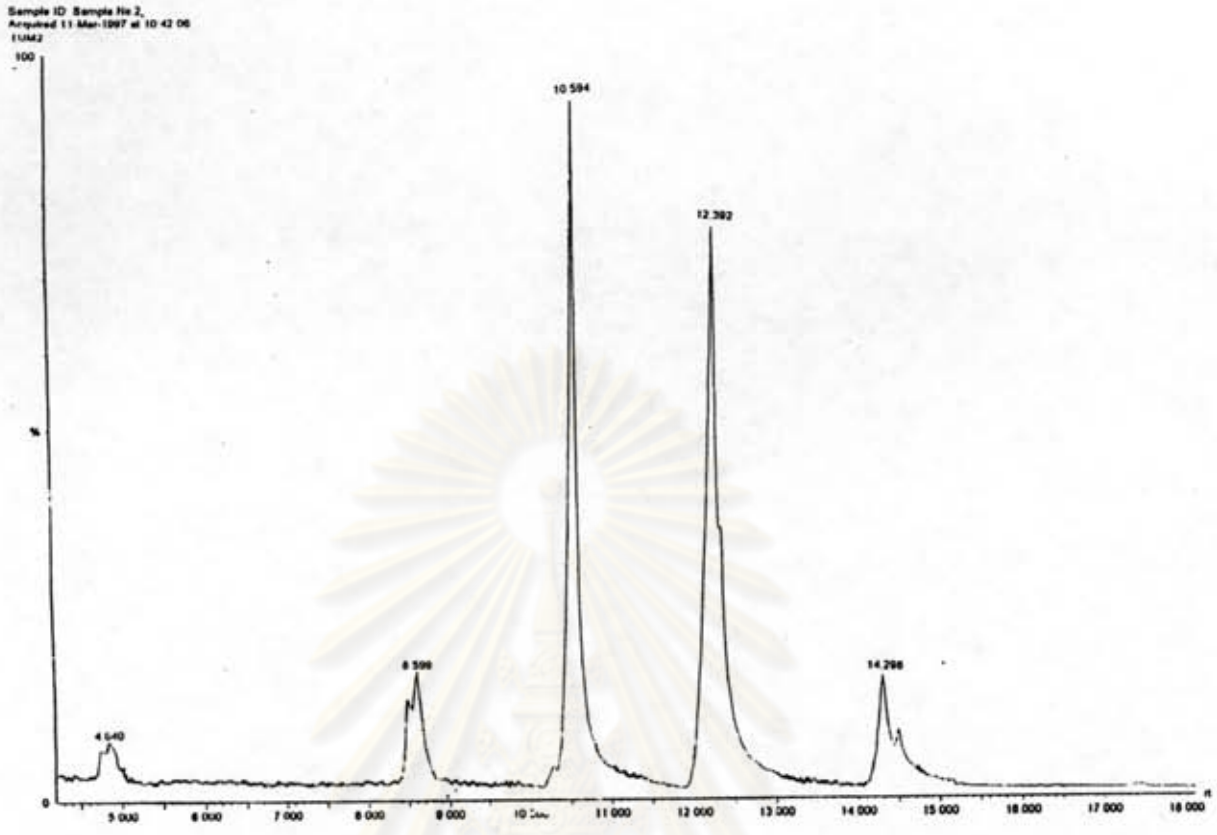

Figure C2 GC-chromatogram of diester obtained from methyl ester of palm oil and1,3-propanediol

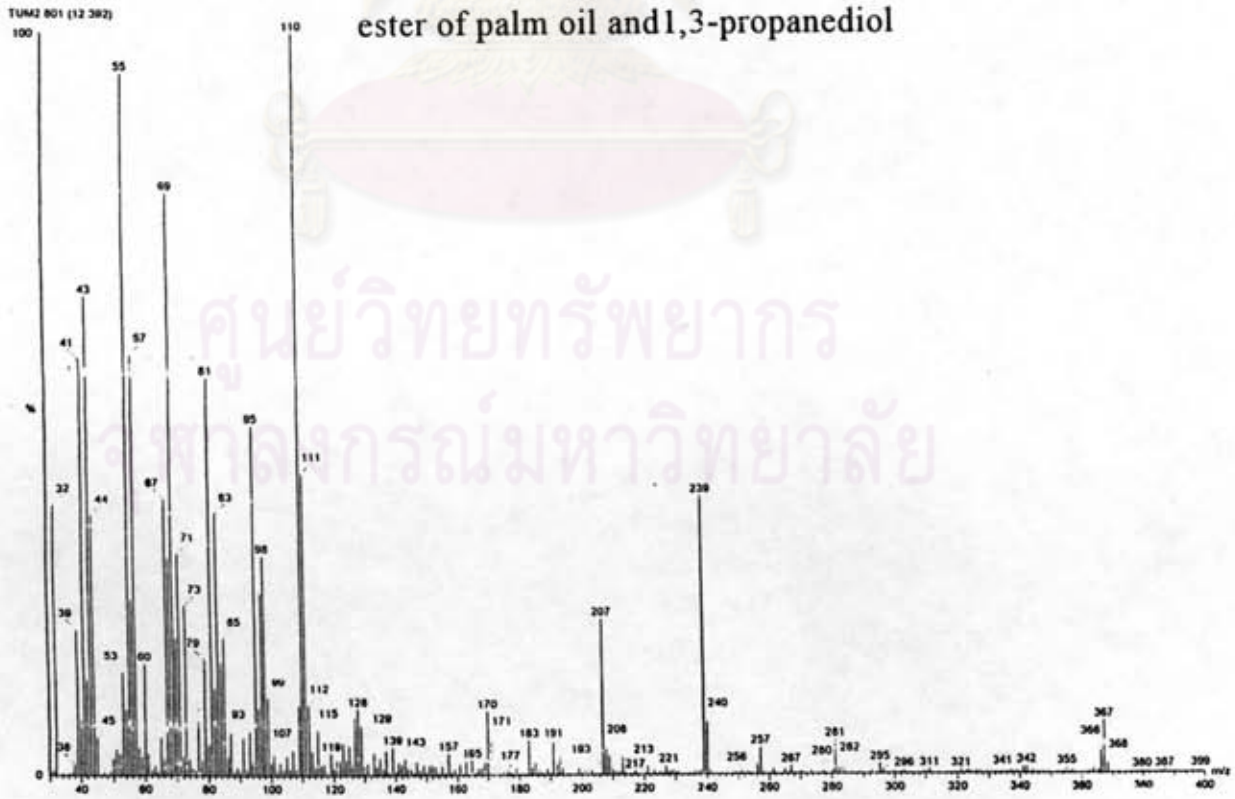

Figure D3 Mass spectrum of 1,3-propanedipalmite at retention time 10.594 min

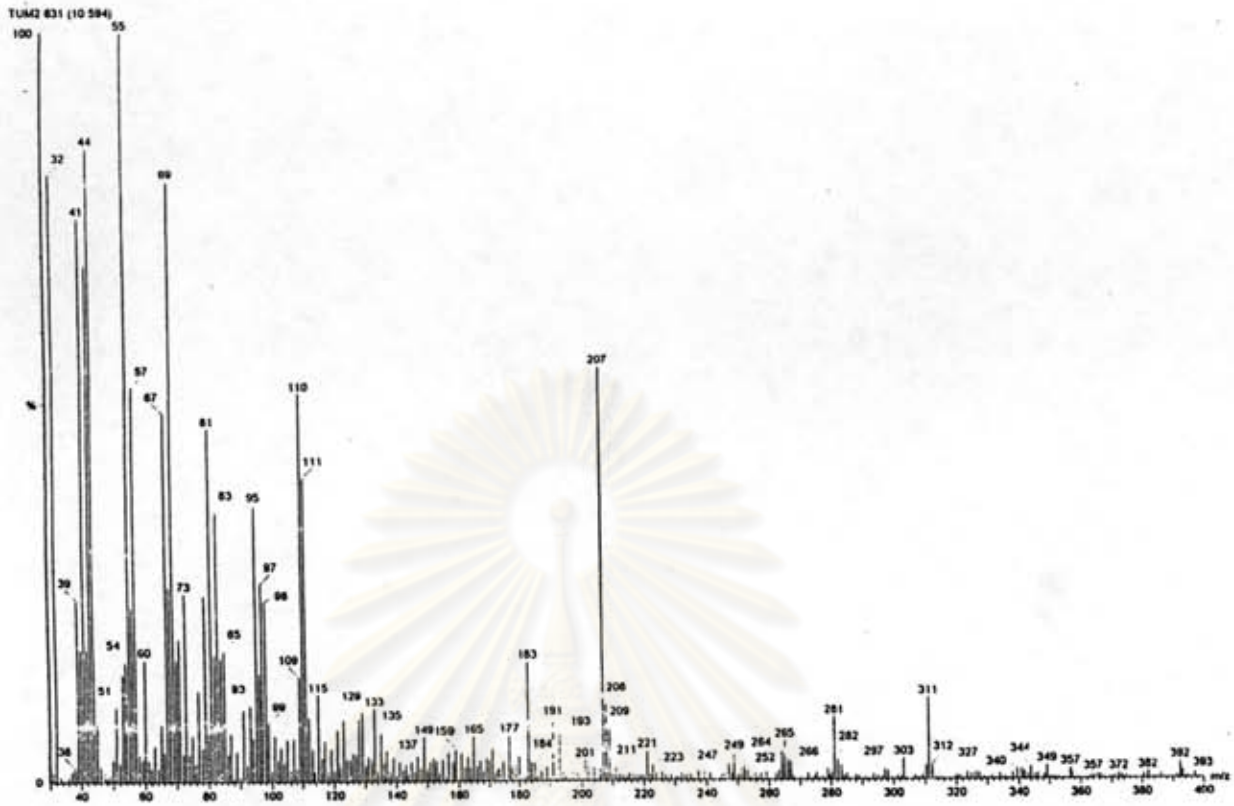

Figure D4 Mass spectrum of 1,3-propanepalmitate-oleate at retention time 12.392 min

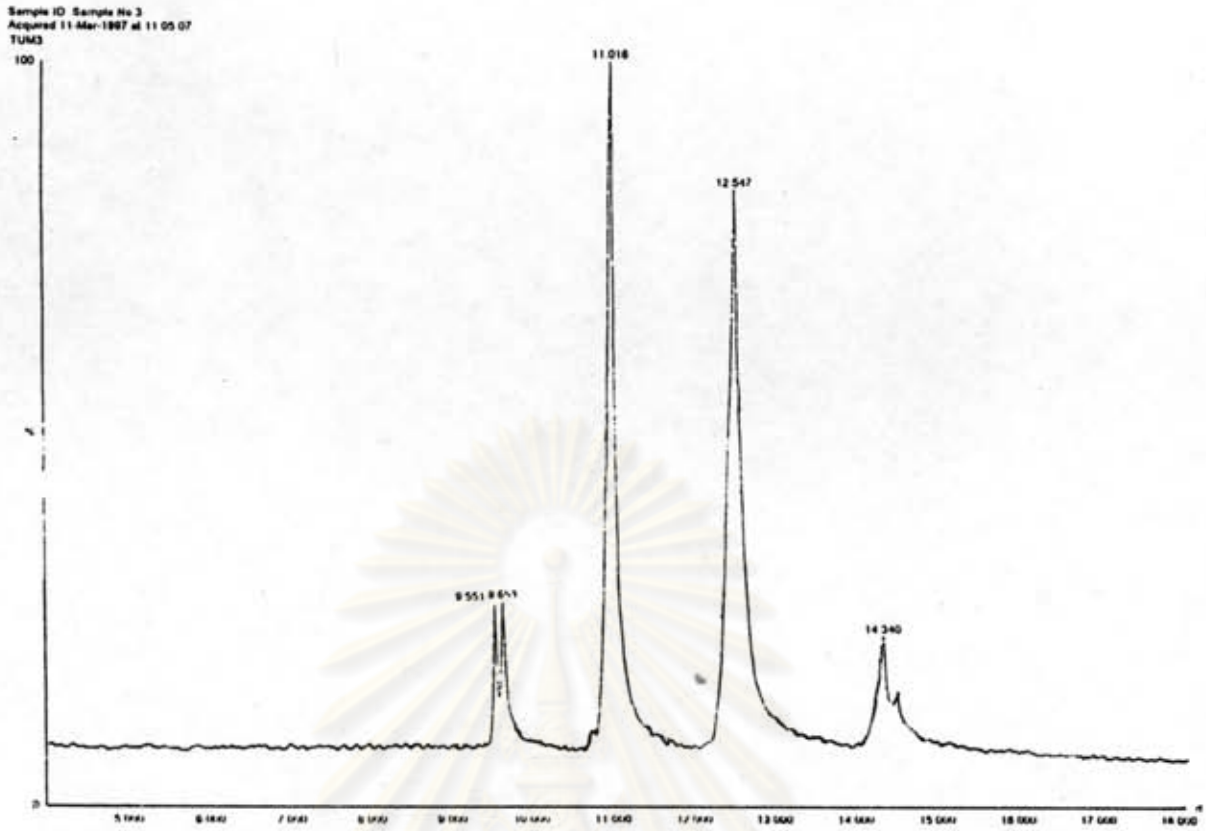

Figure C3 GC-chromatogram of diester obtained from methyl ester of palm oil and 1,4-butanediol

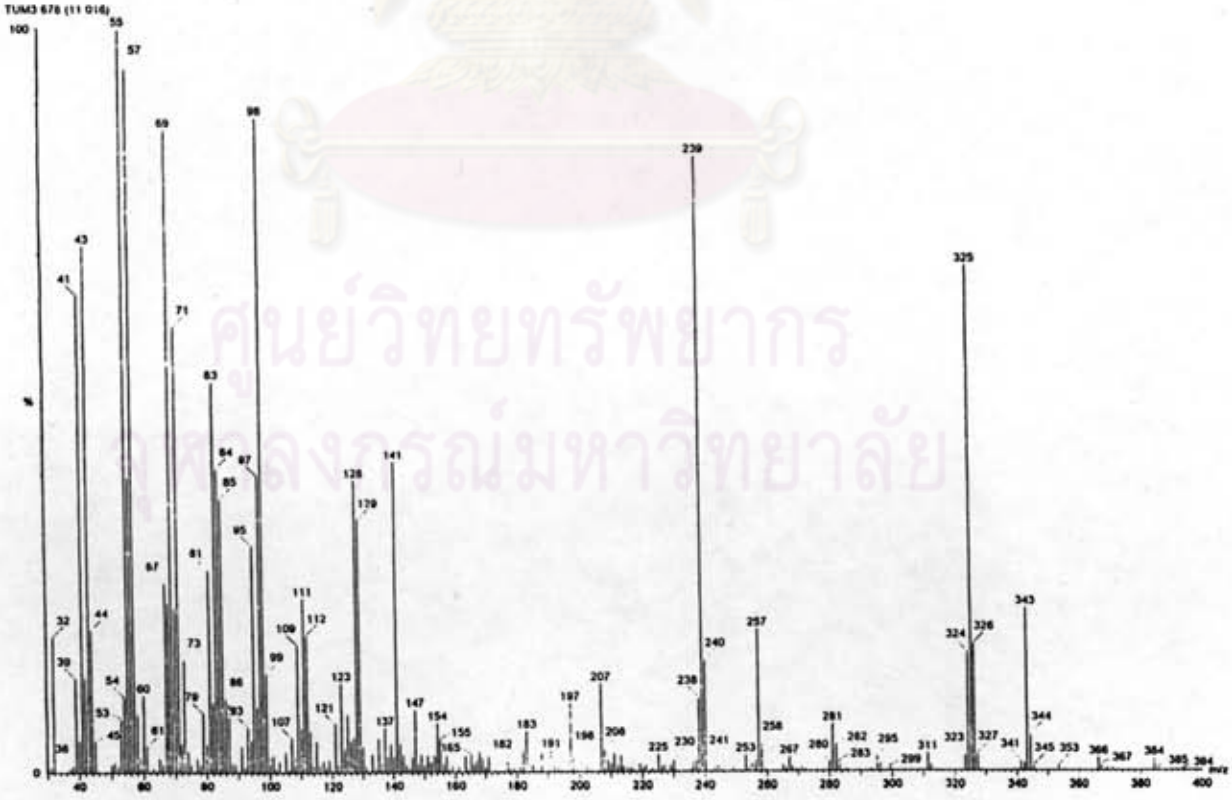

Figure D5 Mass spectrum of 1,4-butanepalmitate at retention time 11.016 min

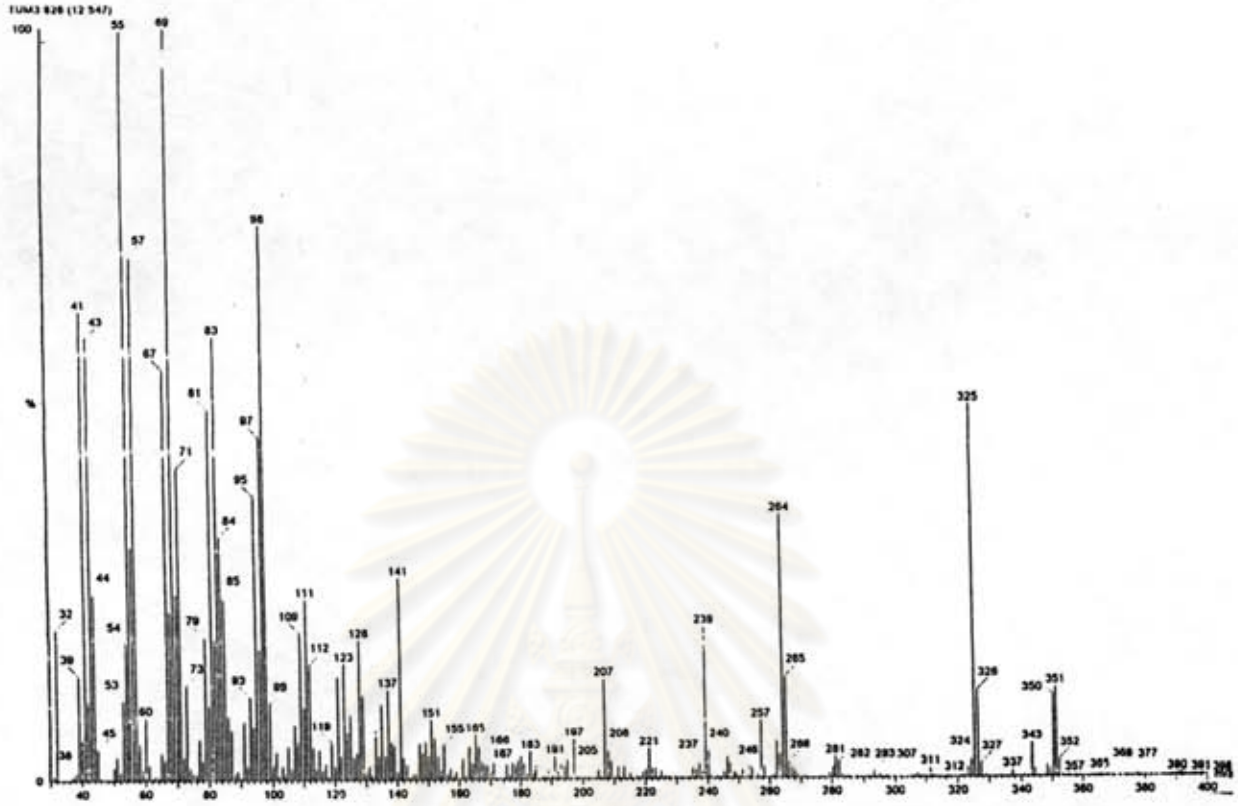

Figure D6 Mass spectrum of 1,4-butanepalmitate-oleate at retention time 12.547 min

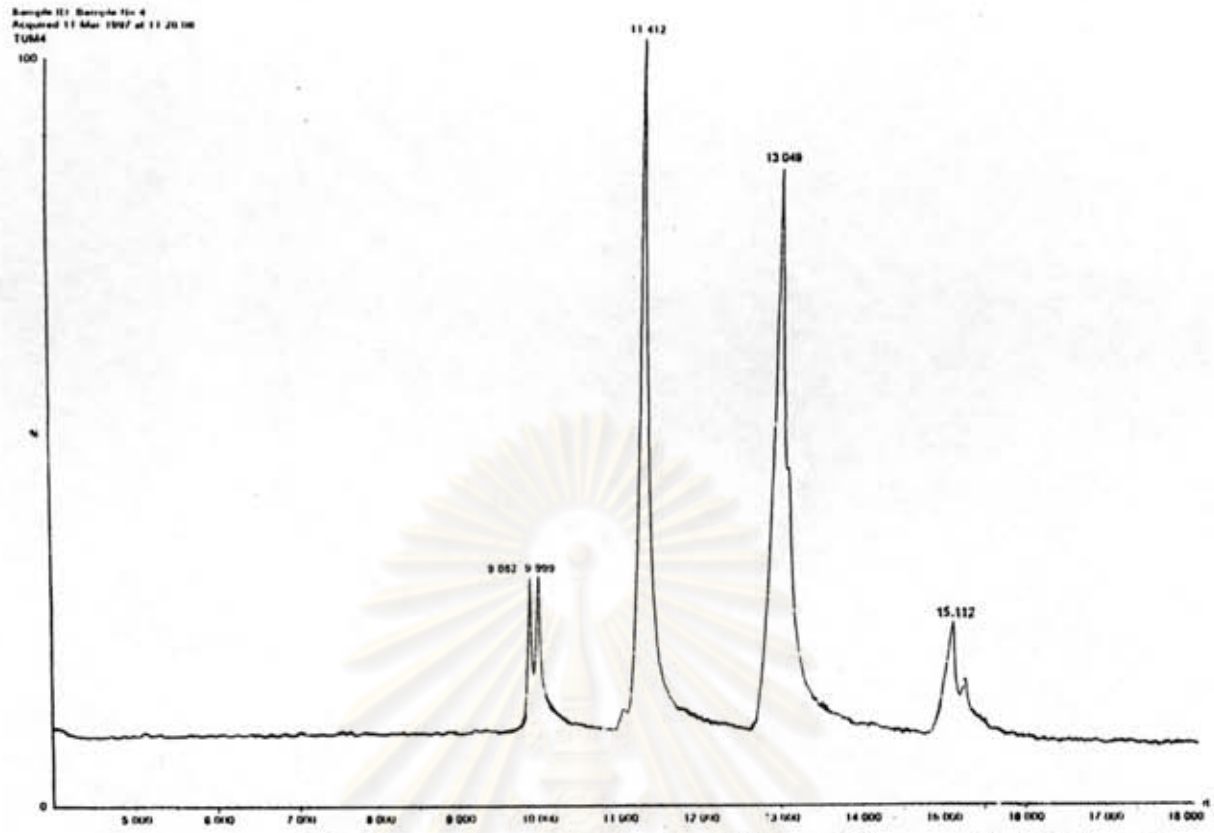

Figure C4 GC-chromatogram of diester obtained from methyl ester of palm oil and 1,5-pentanediol

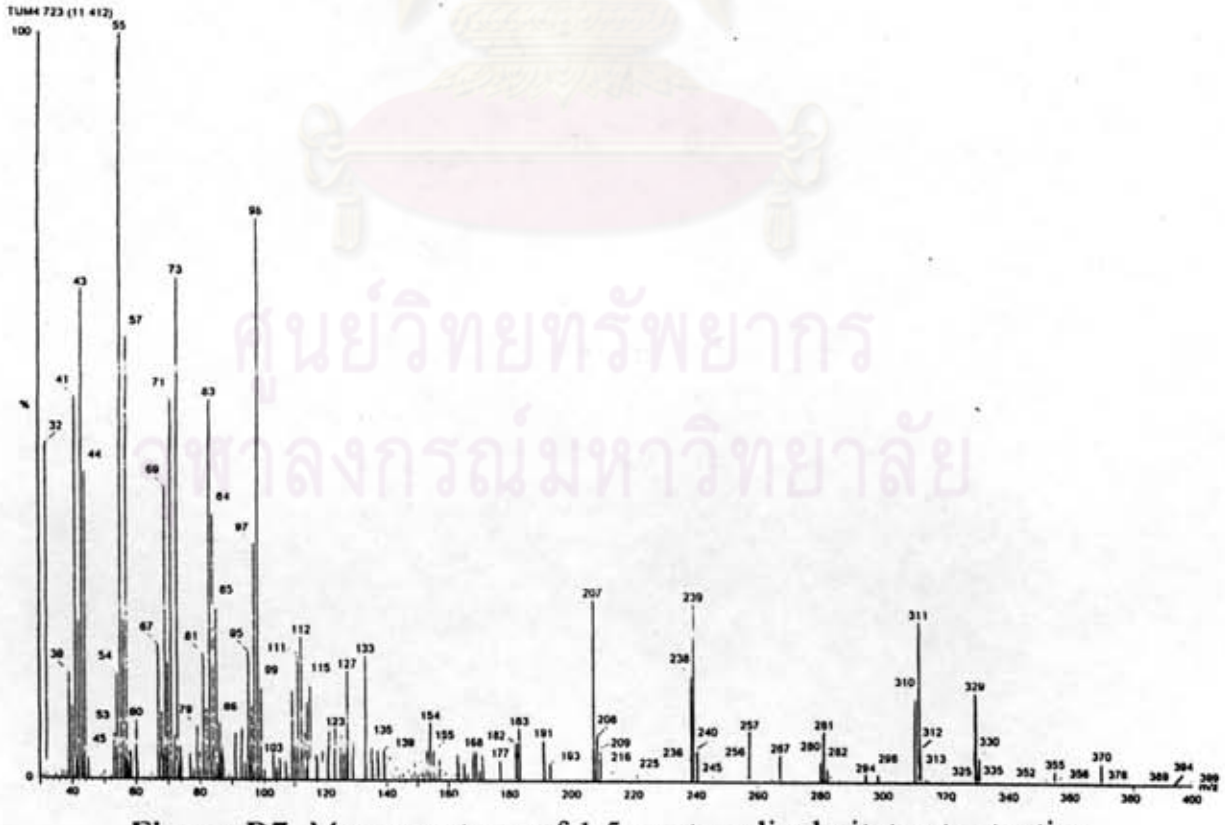

Figure D7 Mass spectrum of 1,5-pentanedipalmitate at retention time 11.412 min

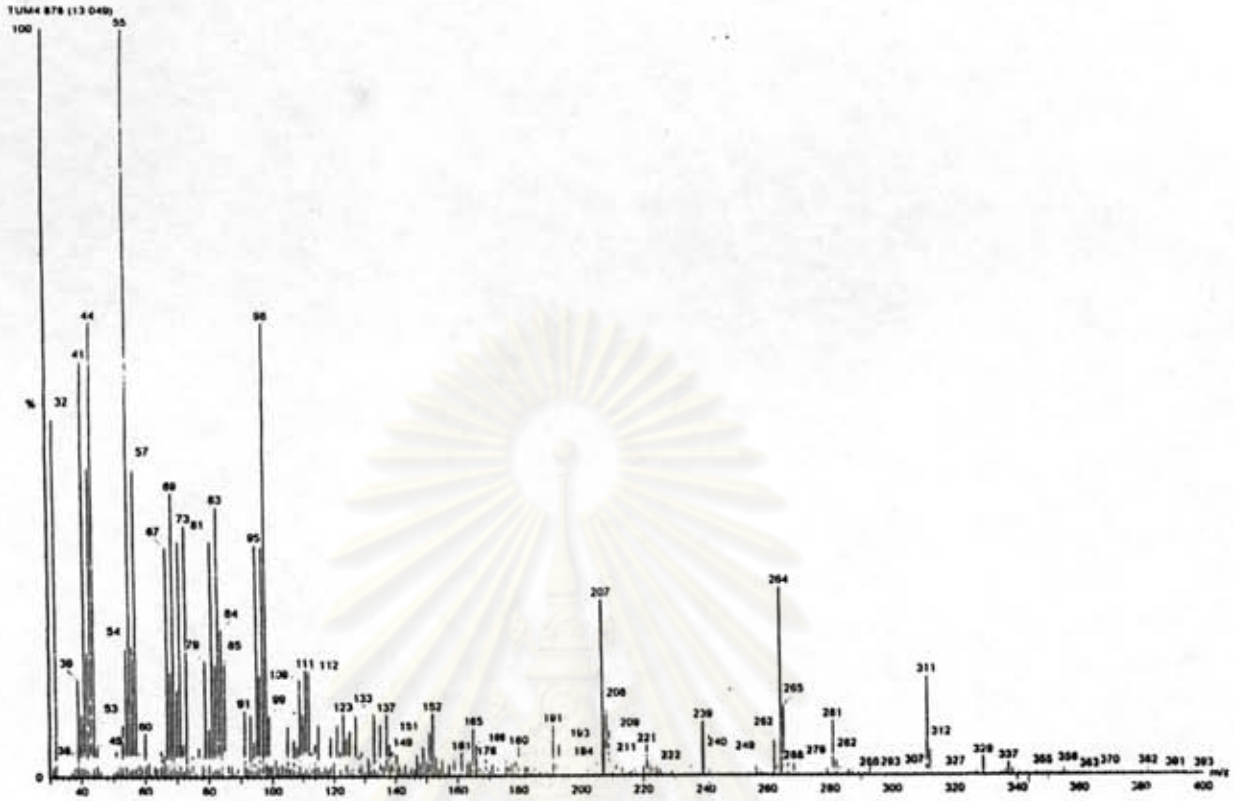

Figure D8 Mass spectrum of 1,5-pentanepalmitate-oleate at retention time 13.049 min

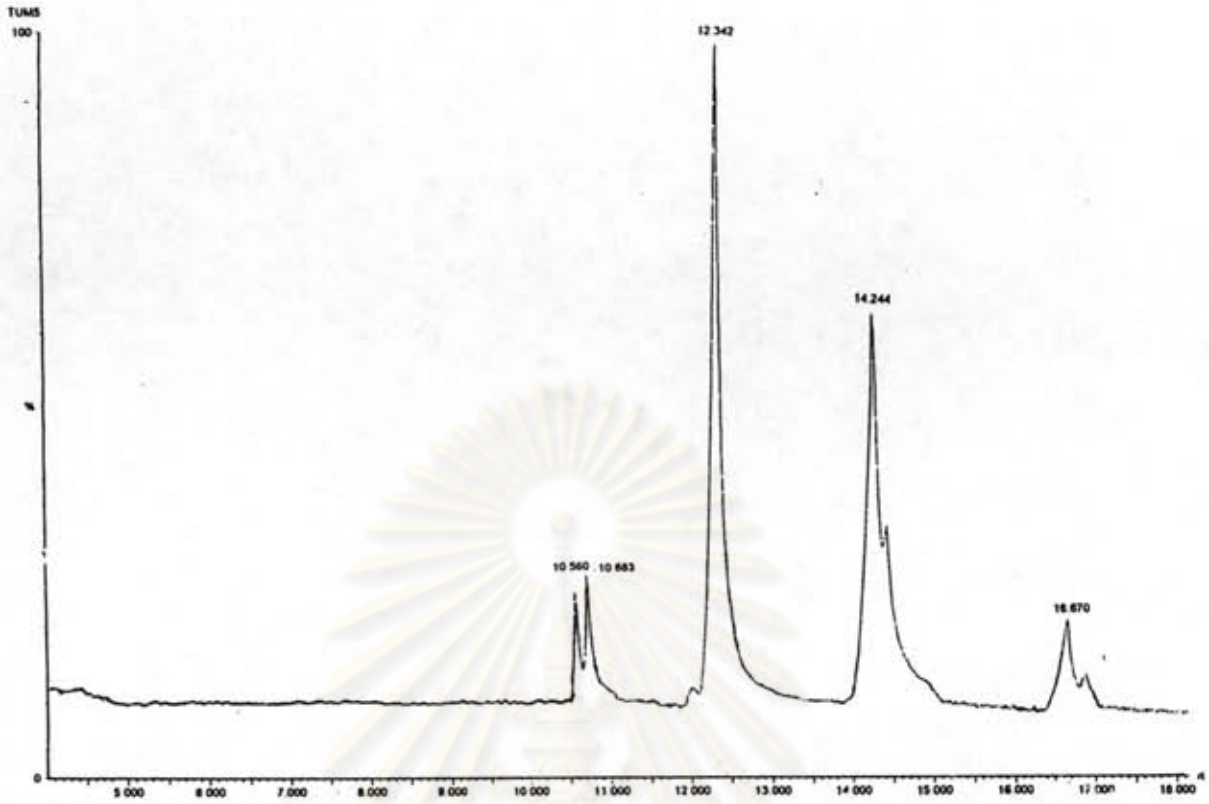

Figure C5 GC-chromatogram of diester obtained from methyl ester of palm oil and 2,2-dimethyl-1,3-propanediol

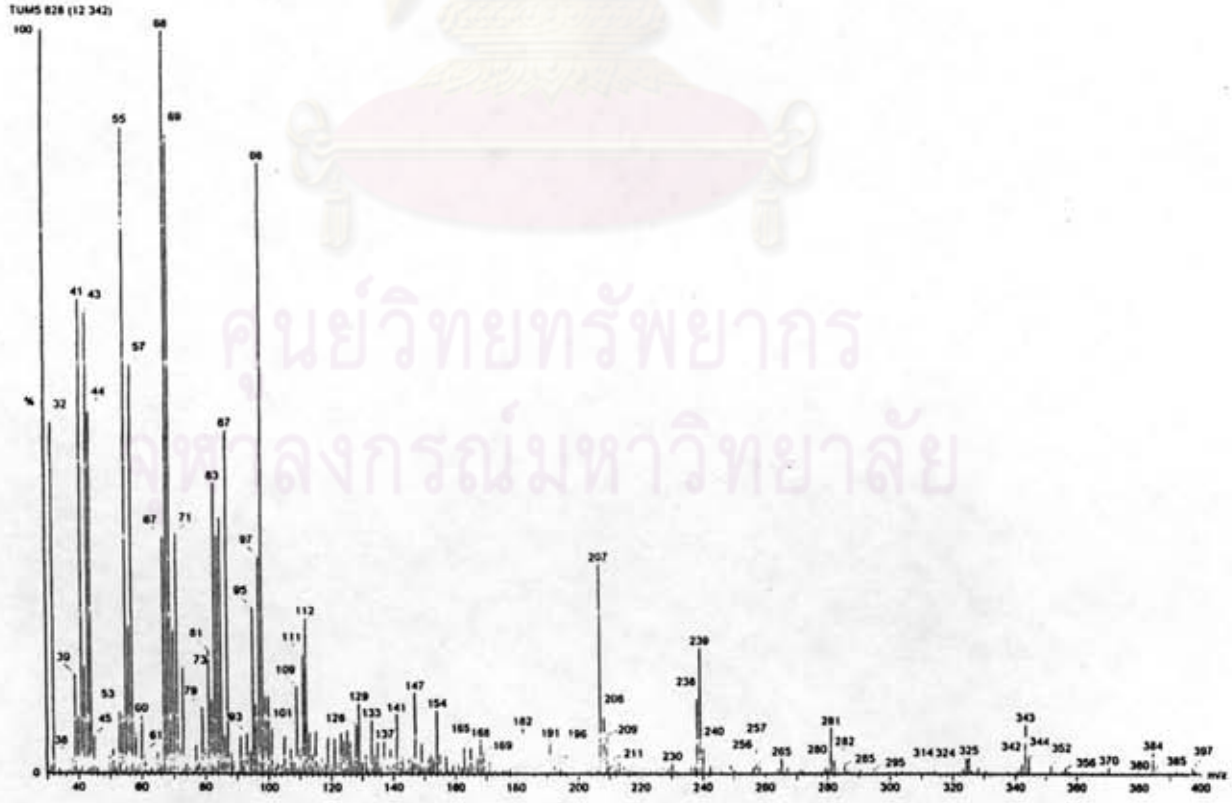

Figure D9 Mass spectrum of 2,2-dimethyl-1,3-propanedipalmitate at retention time 12.342 min

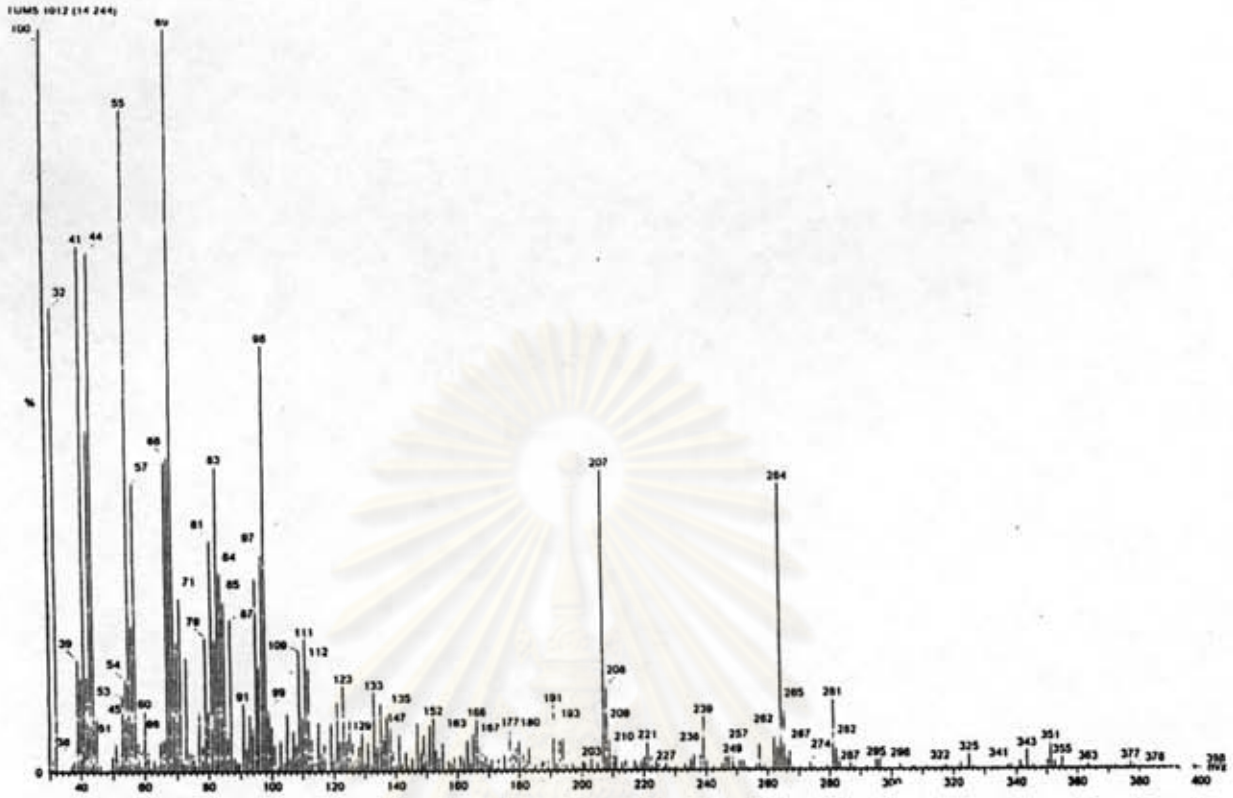

Figure D10 Mass spectrum of 2,2-dimethyl-1,3-propanepalmitate-oleate at retention time 14.244 min

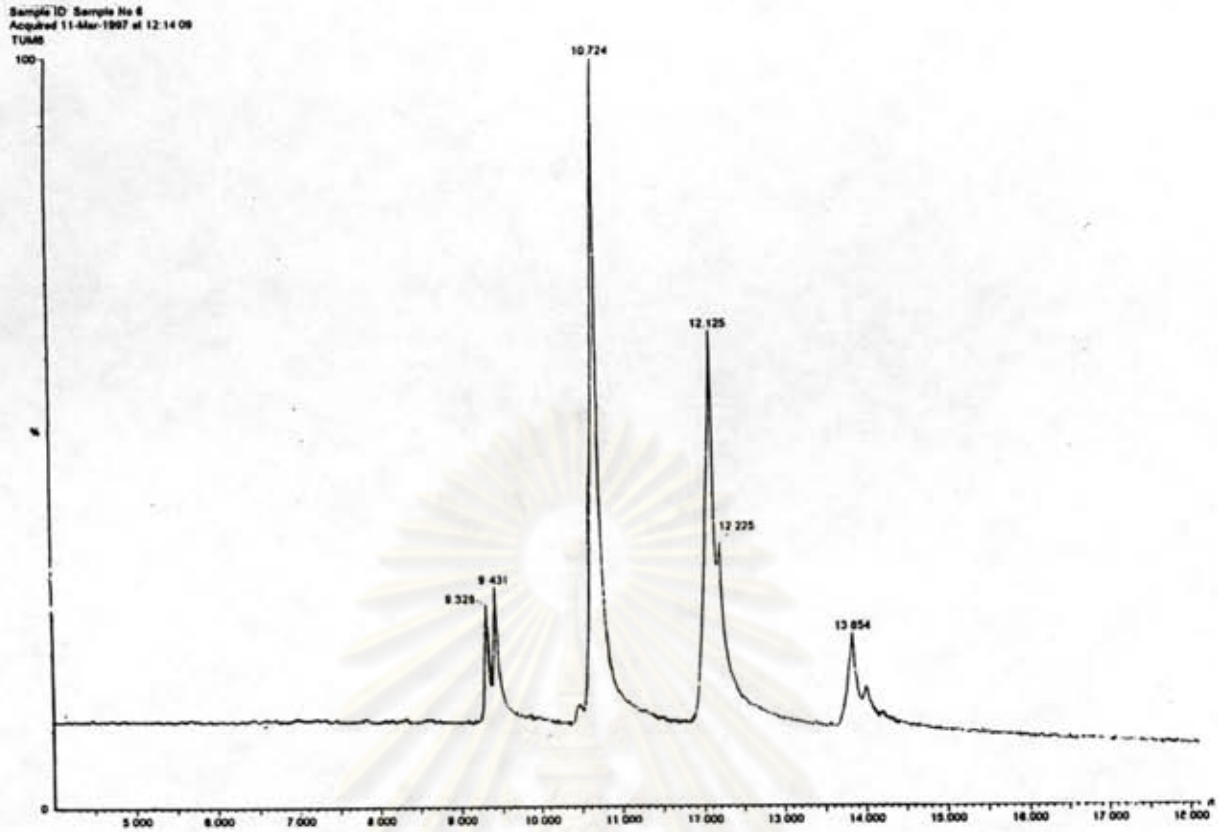

Figure C6 GC-chromatogram of diester obtained from methyl ester of palm oil and 2-ethyl-1,3-hexandiol

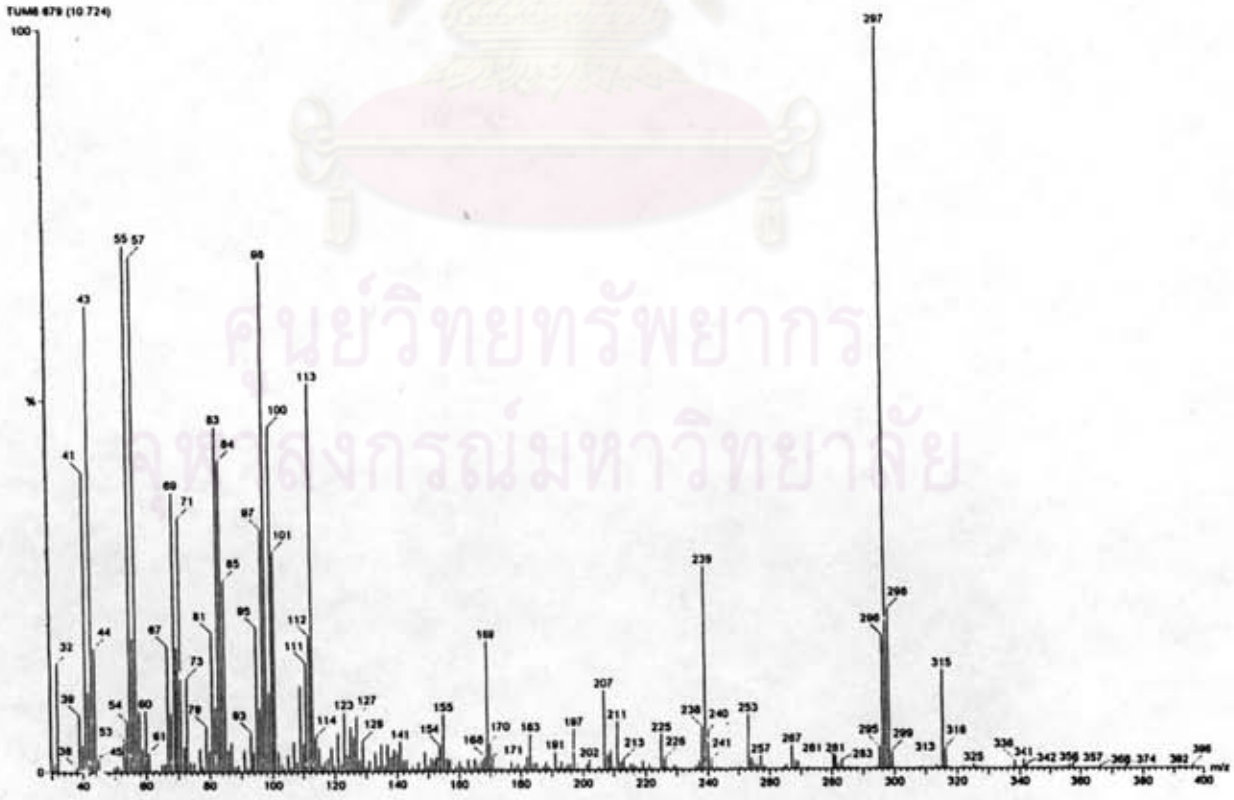

Figure D11 Mass spectrum of 2-ethyl-1,3-hexanedipalmitate at retention time 10.724 min

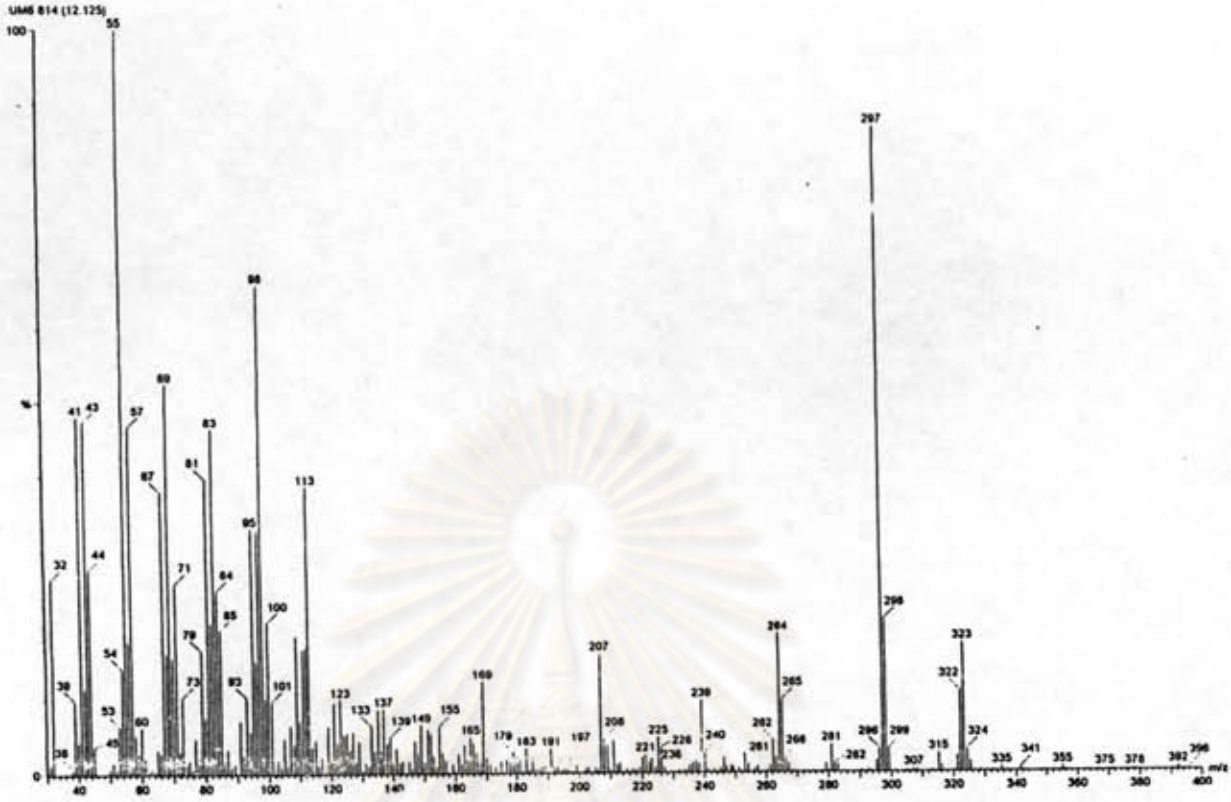

Figure D12 Mass spectrum of 2-ethyl-1,3-hexanepalmitate oleate at retention time 12.125 min

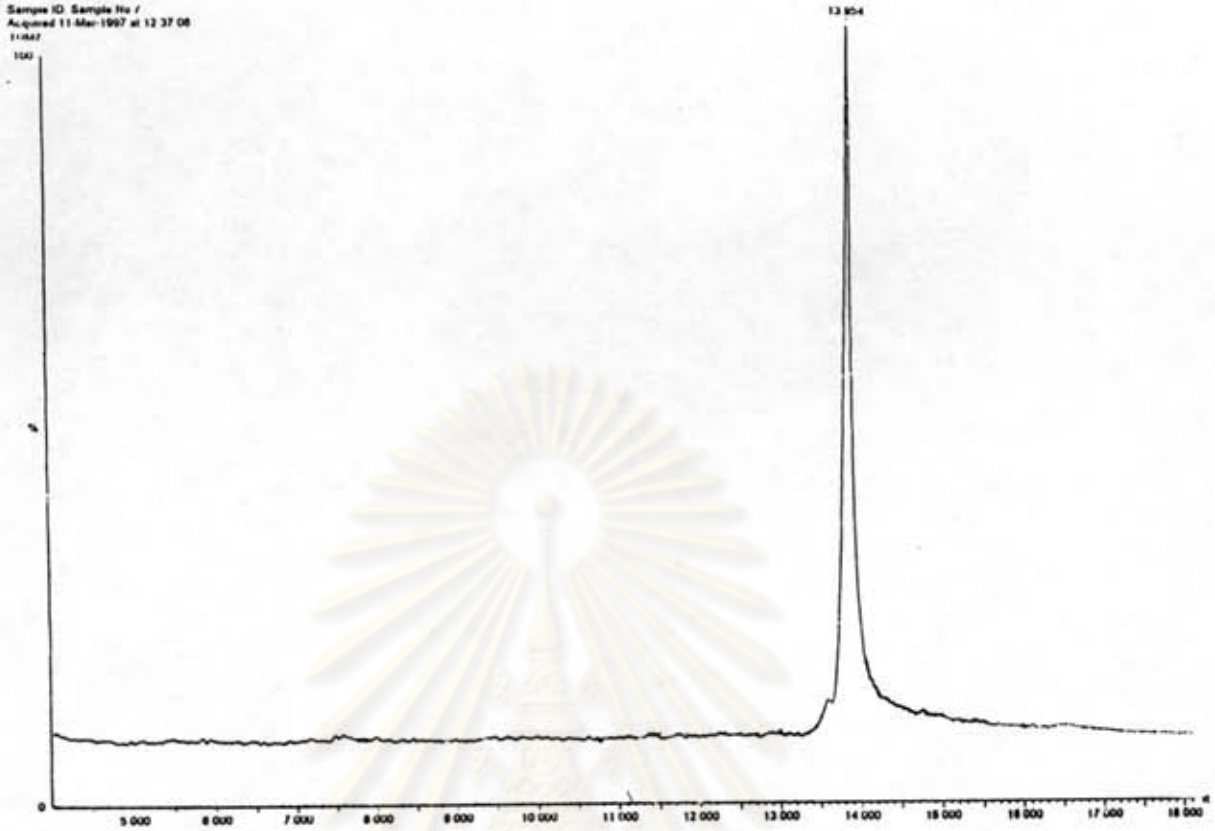

Figure C7 GC-chromatogram of diester obtained from oleic acid and 1,3-propanediol

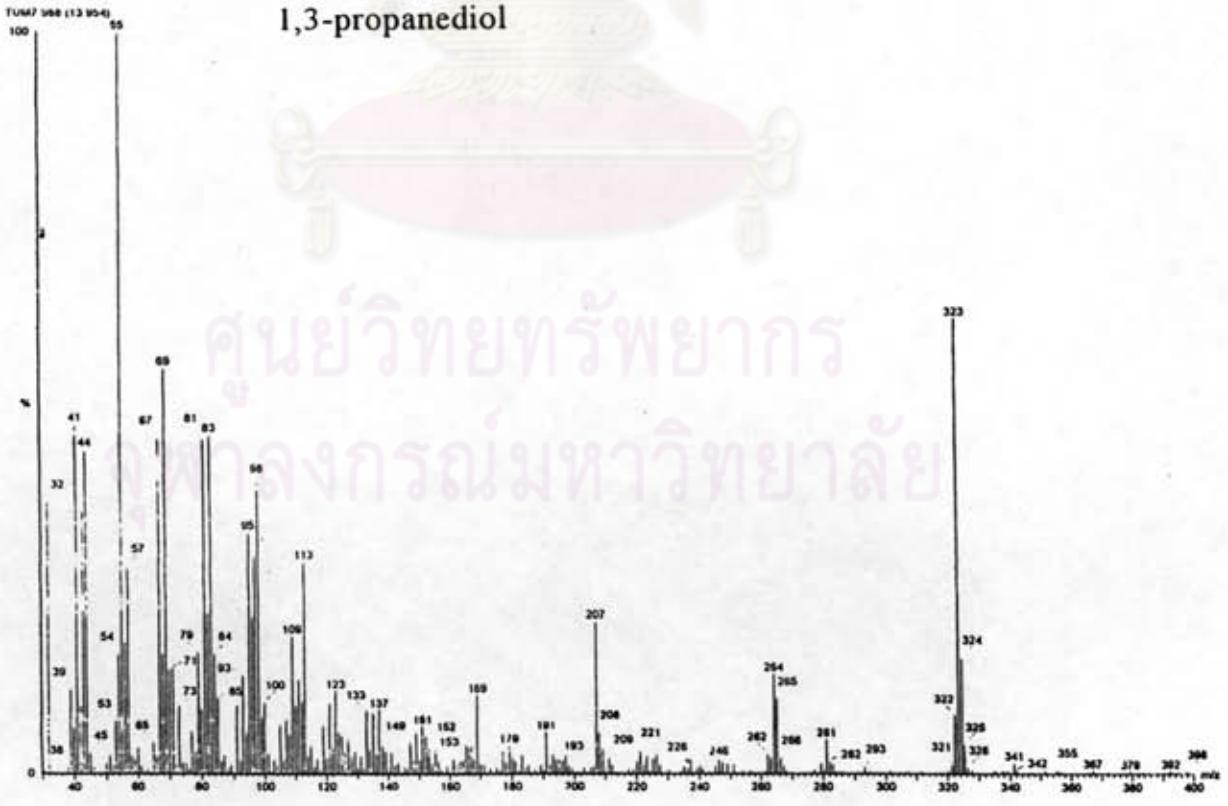

Figure D13 Mass spectrum of 1,3-propanedioleate at retention time 13.354 min

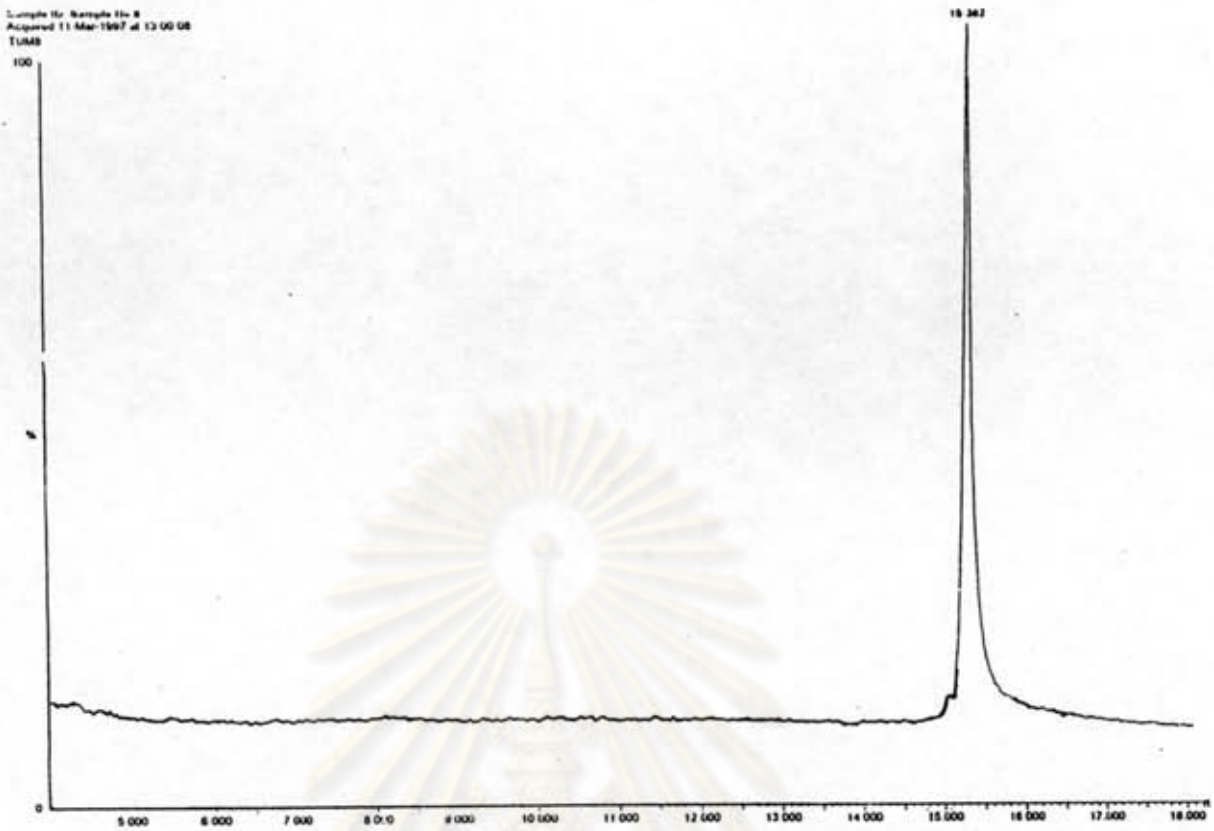

Figure C8 GC-chromatogram of diester obtained from oleic acid and 1,4-butanediol

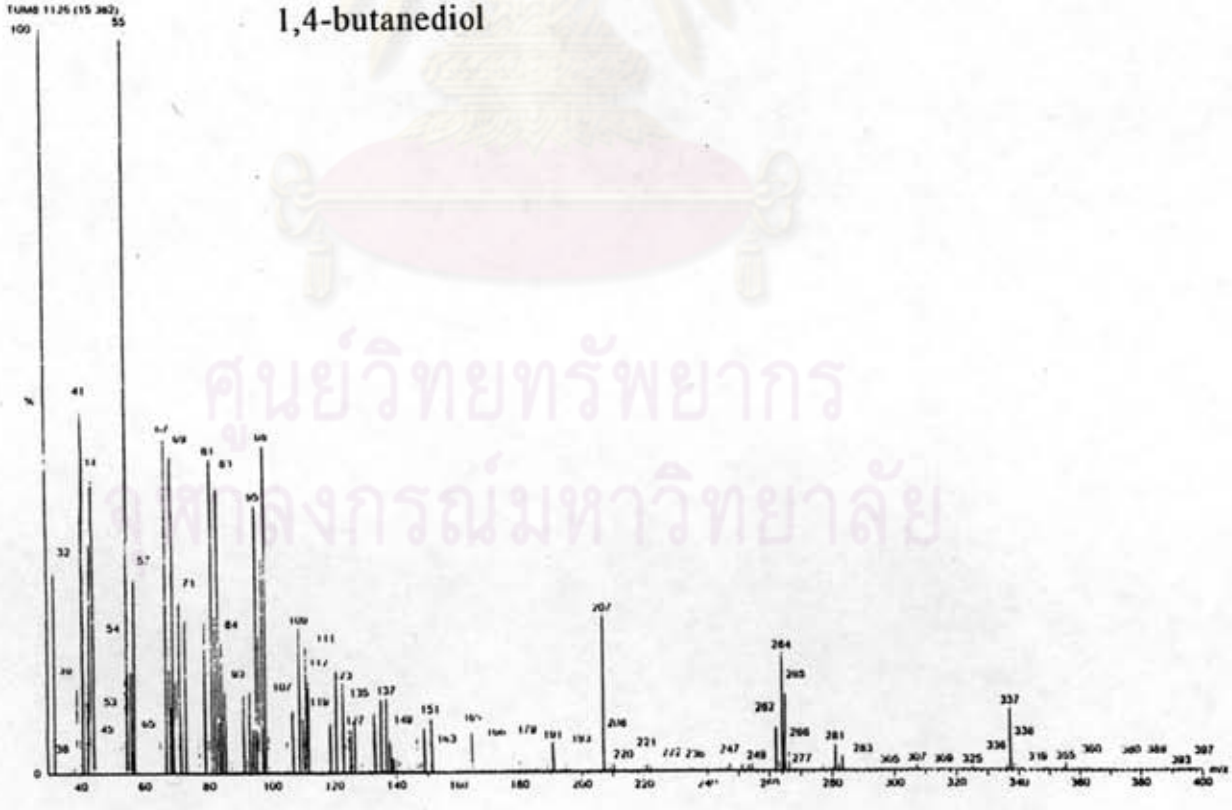

Figure D14 Mass spectrum of 1,4-butanedioleate at retention time 15.382 min

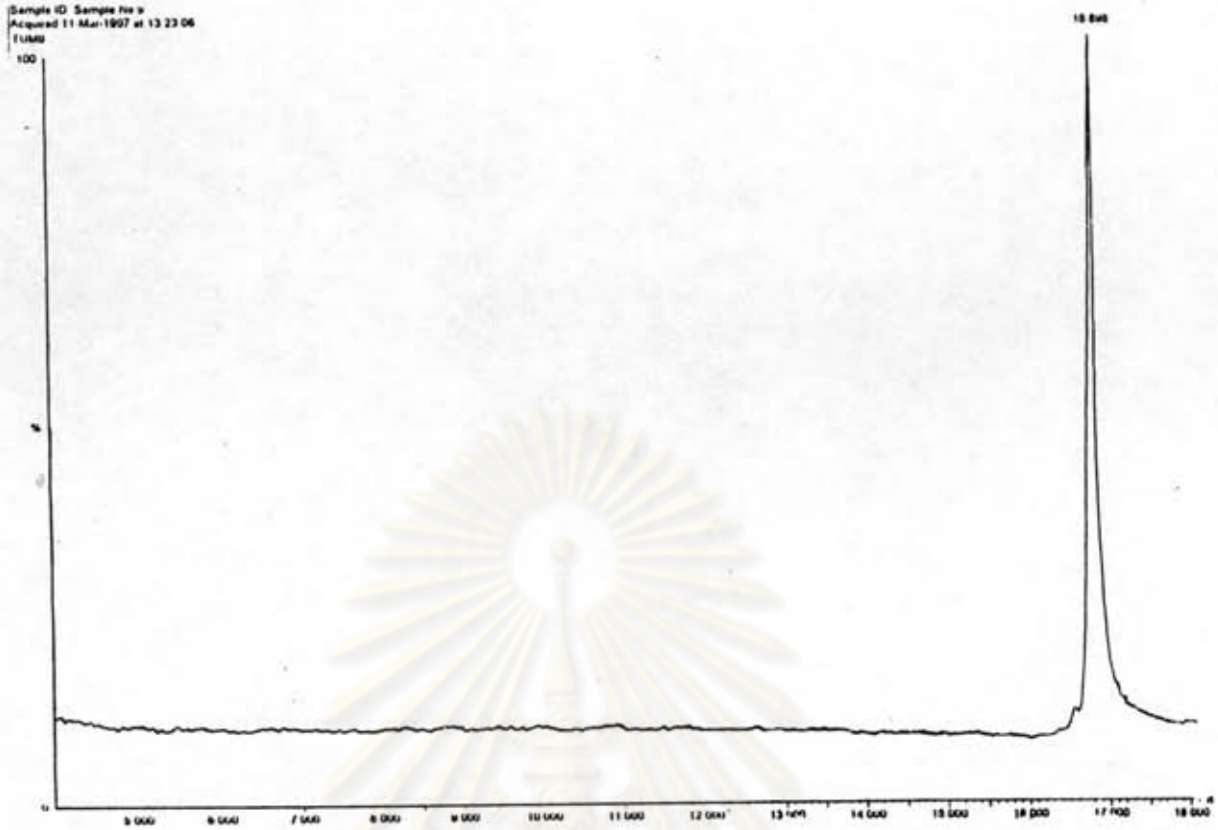

Figure C9 GC-chromatogram of diester obtained from oleic acid and 1,5-pentanediol

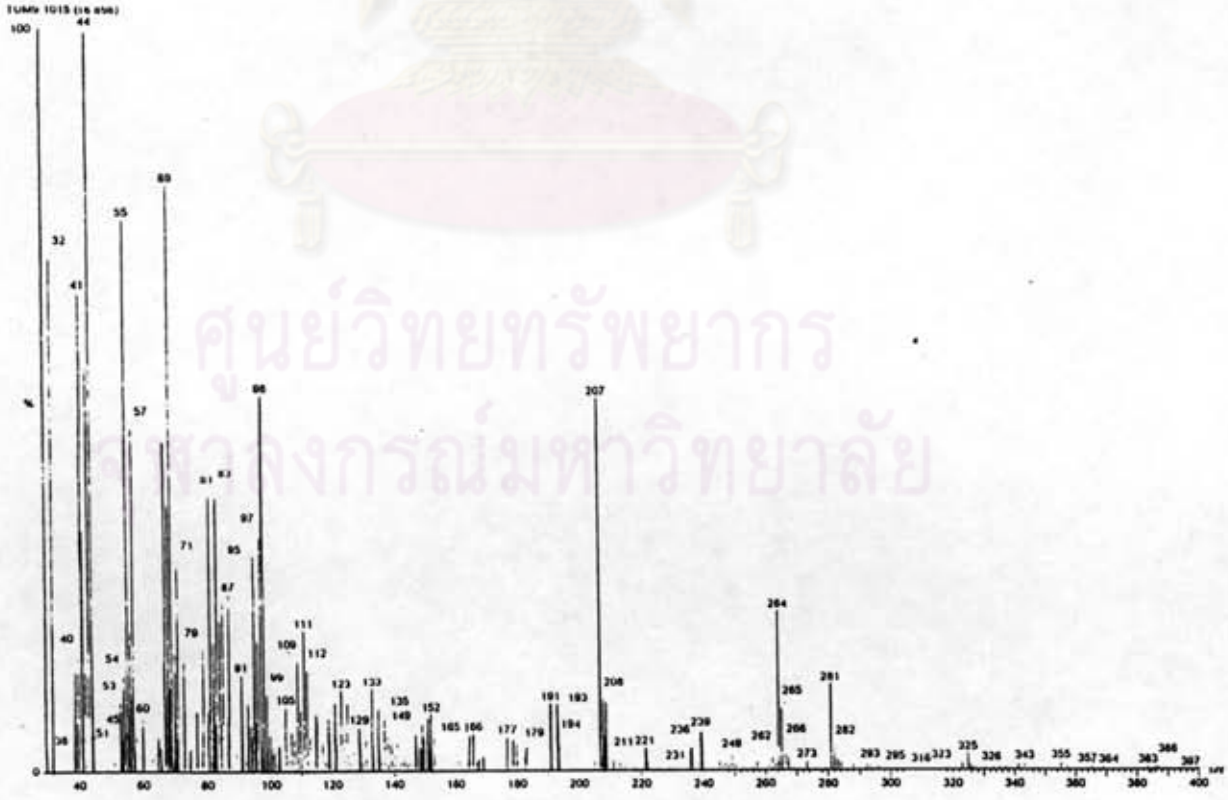

Figure D15 Mass spectrum of 1,5-pentanedioleate at retention time 16.898 min

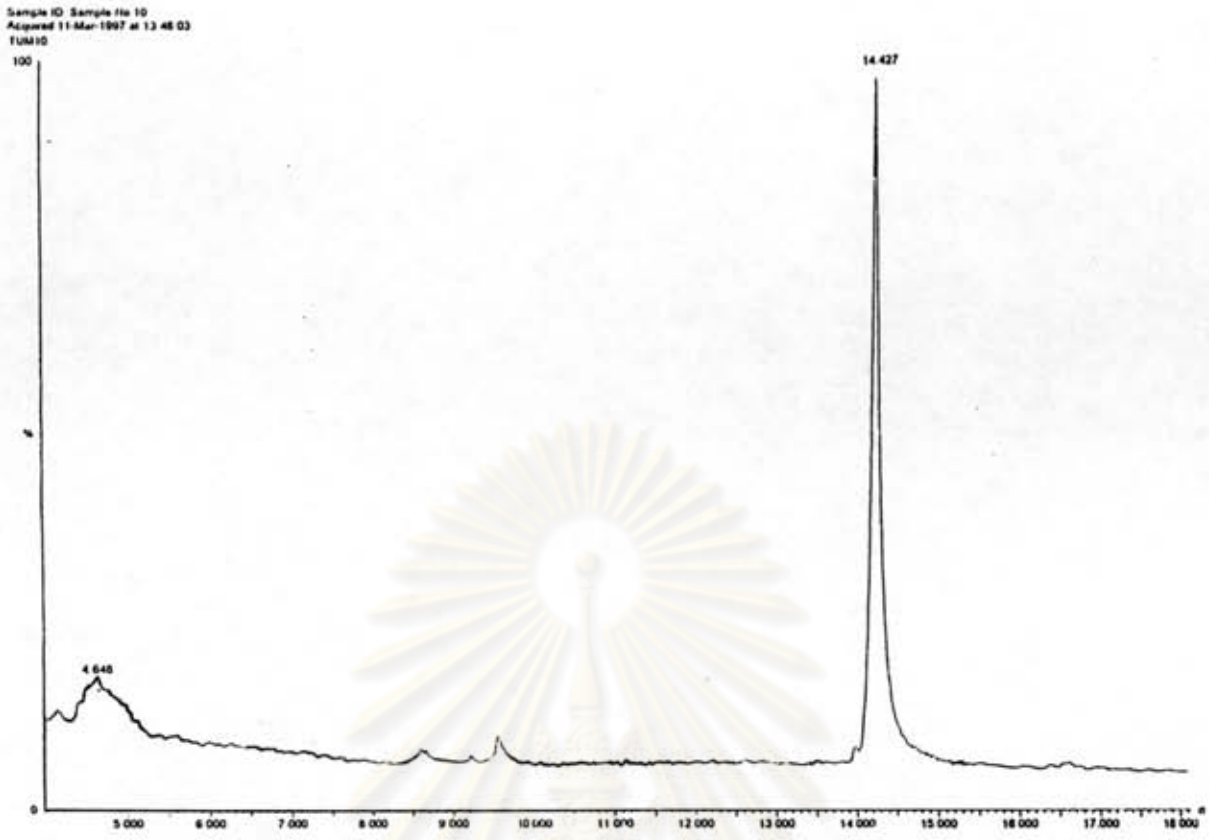

Figure C10 GC-chromatogram of diester obtained from oleic acid and 2,2-dimethyl-1,3-propanediol

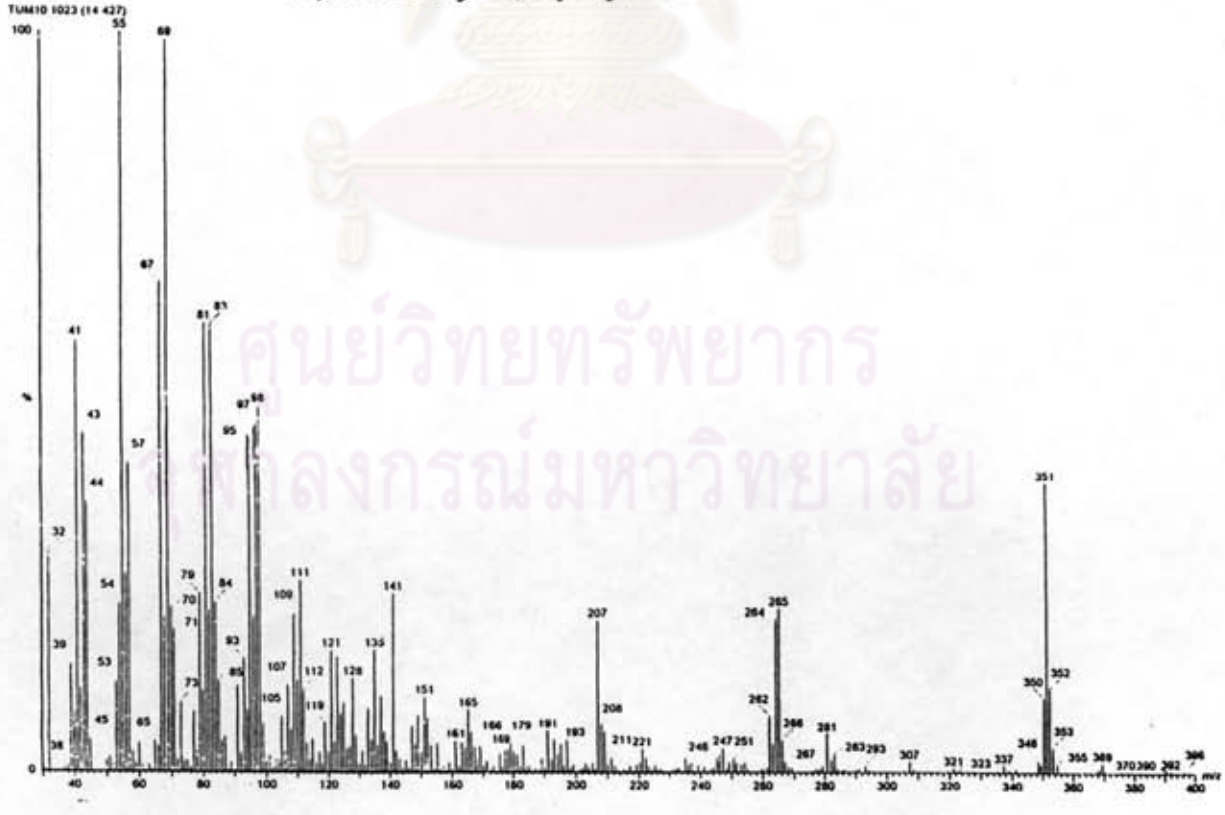

Figure D16 Mass spectrum of 2,2-dimethyl-1,3-propanedioleate at retention time 14.427 min

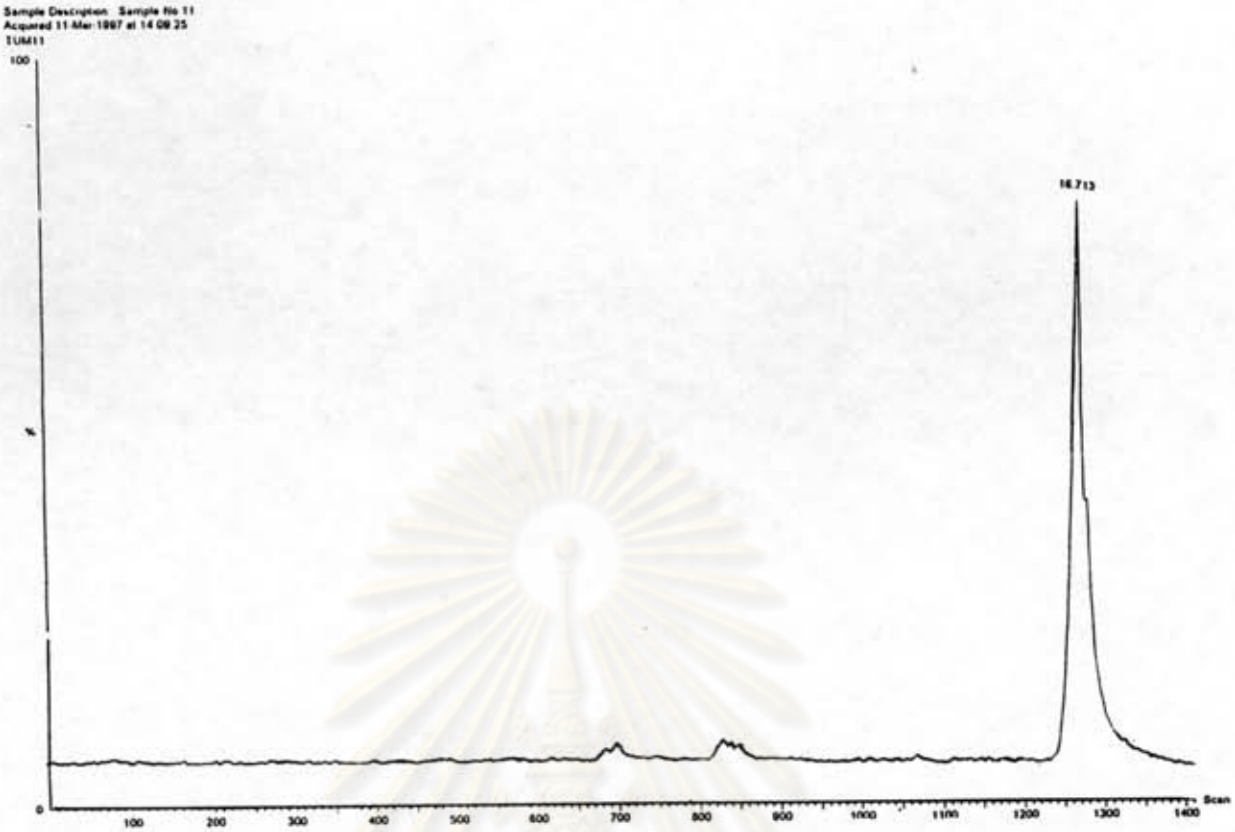

Figure C11 GC-chromatogram of diester obtained form oleic acid and 2-ethyl-1,3-hexanediol

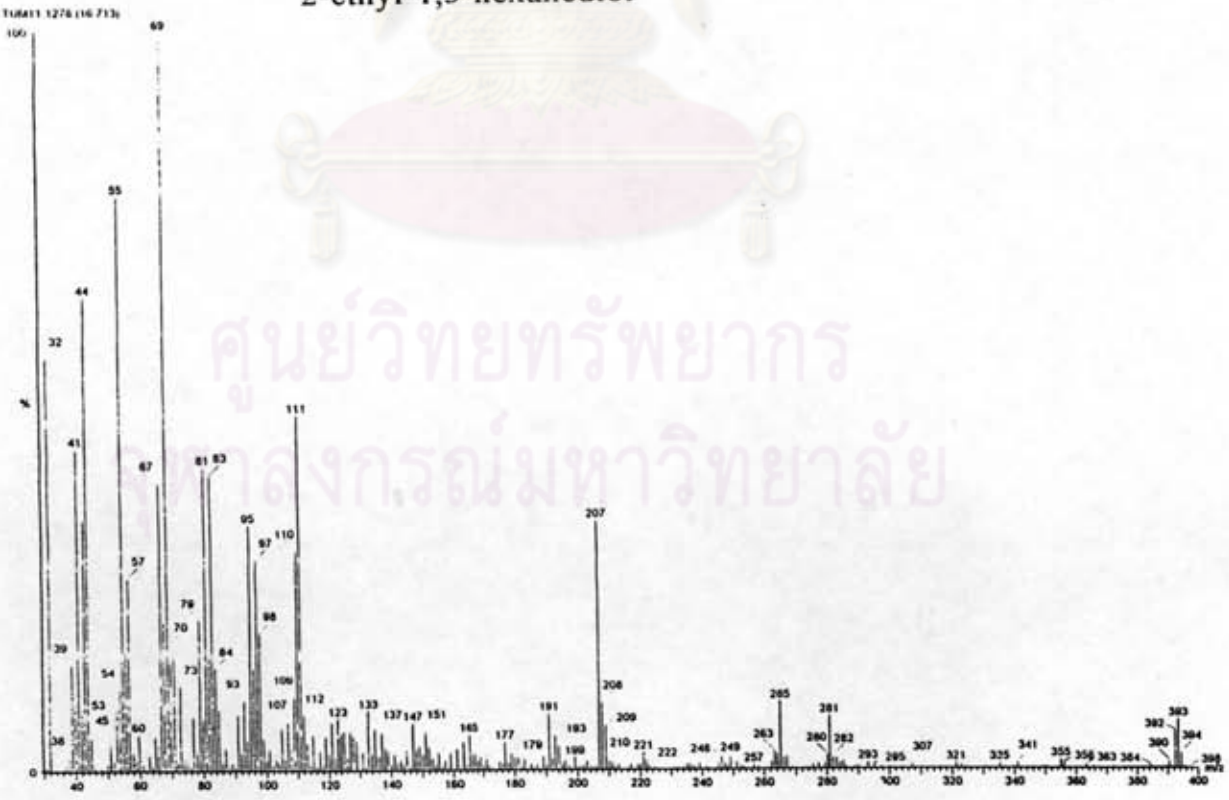

Figure D17 Mass spectrum of 2-ethyl-1,3-hexanedioleate at retention time 16.731 min

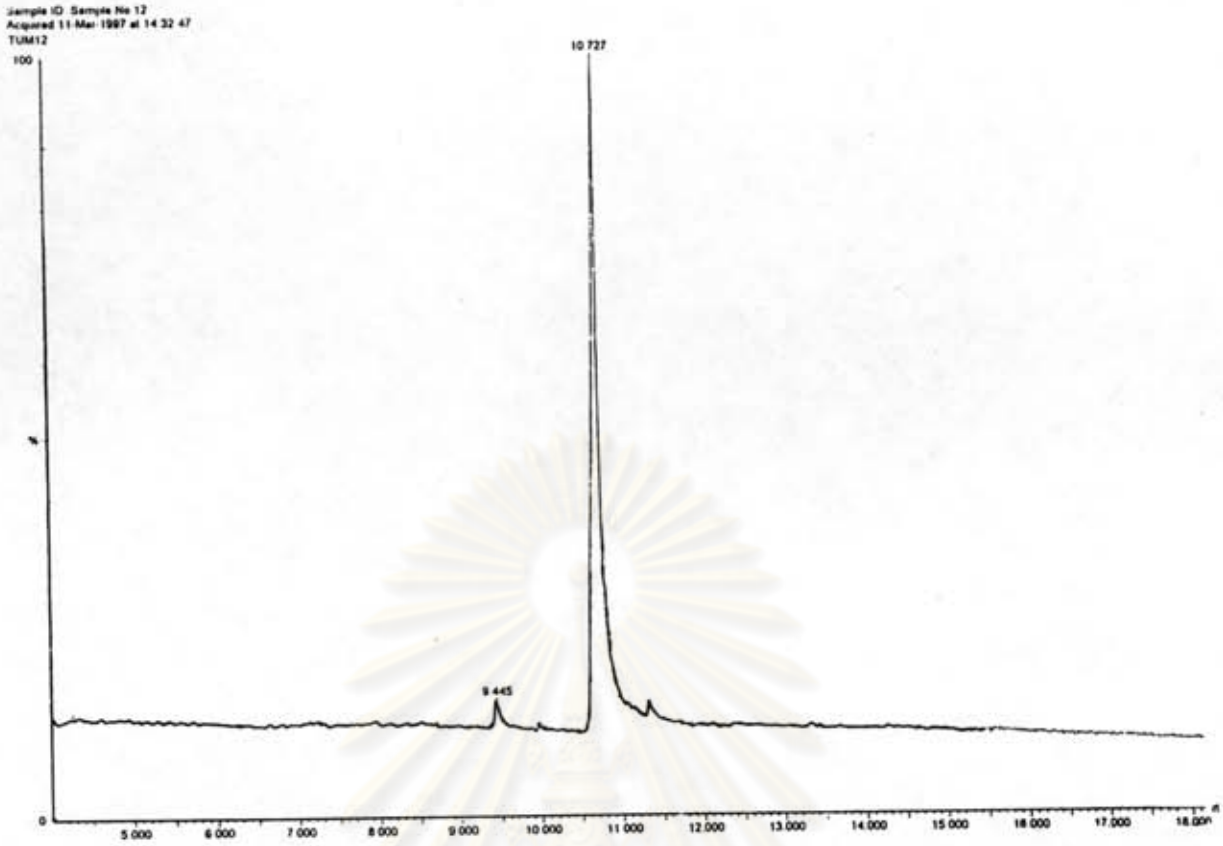

Figure C12 GC-chromatogram of diester obtained from stearic acid and 1,3-propanediol

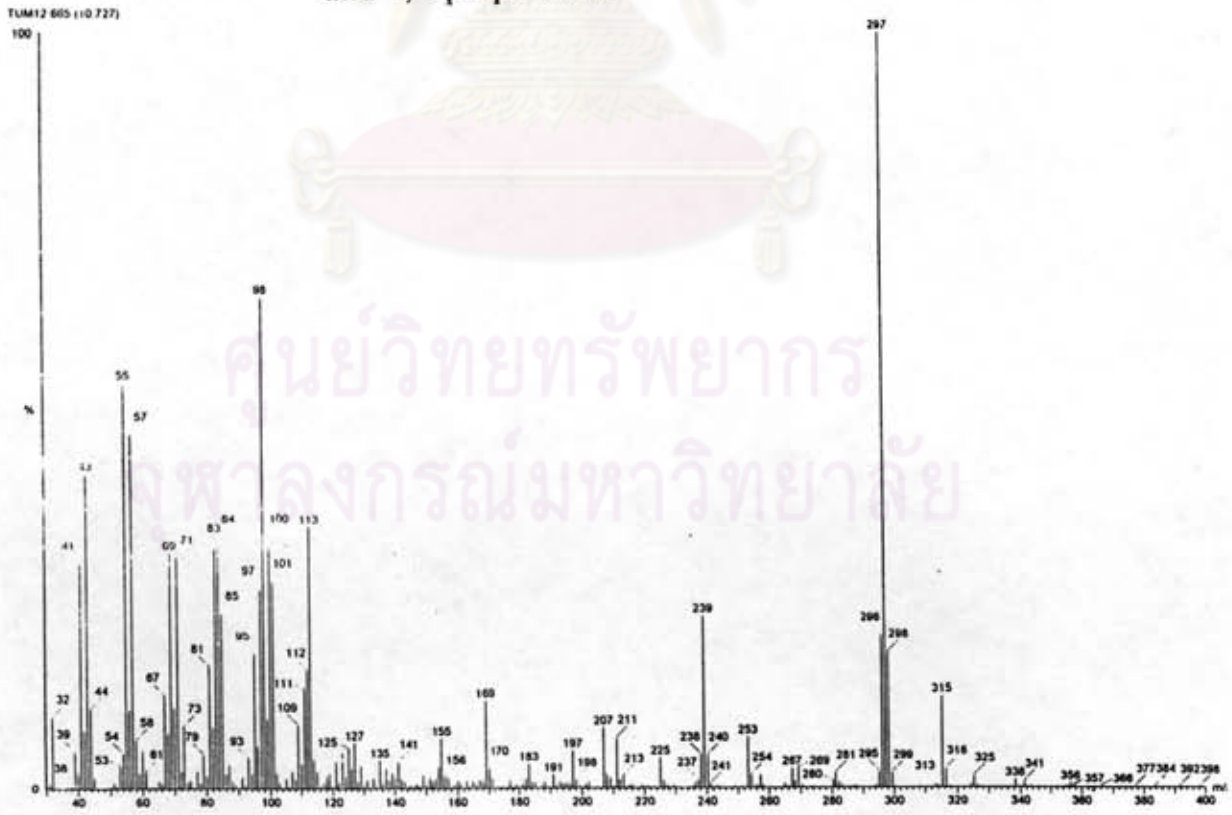

Figure D18 Mass spectrum of 1,3-propanedistearate at retention time 10.724 min

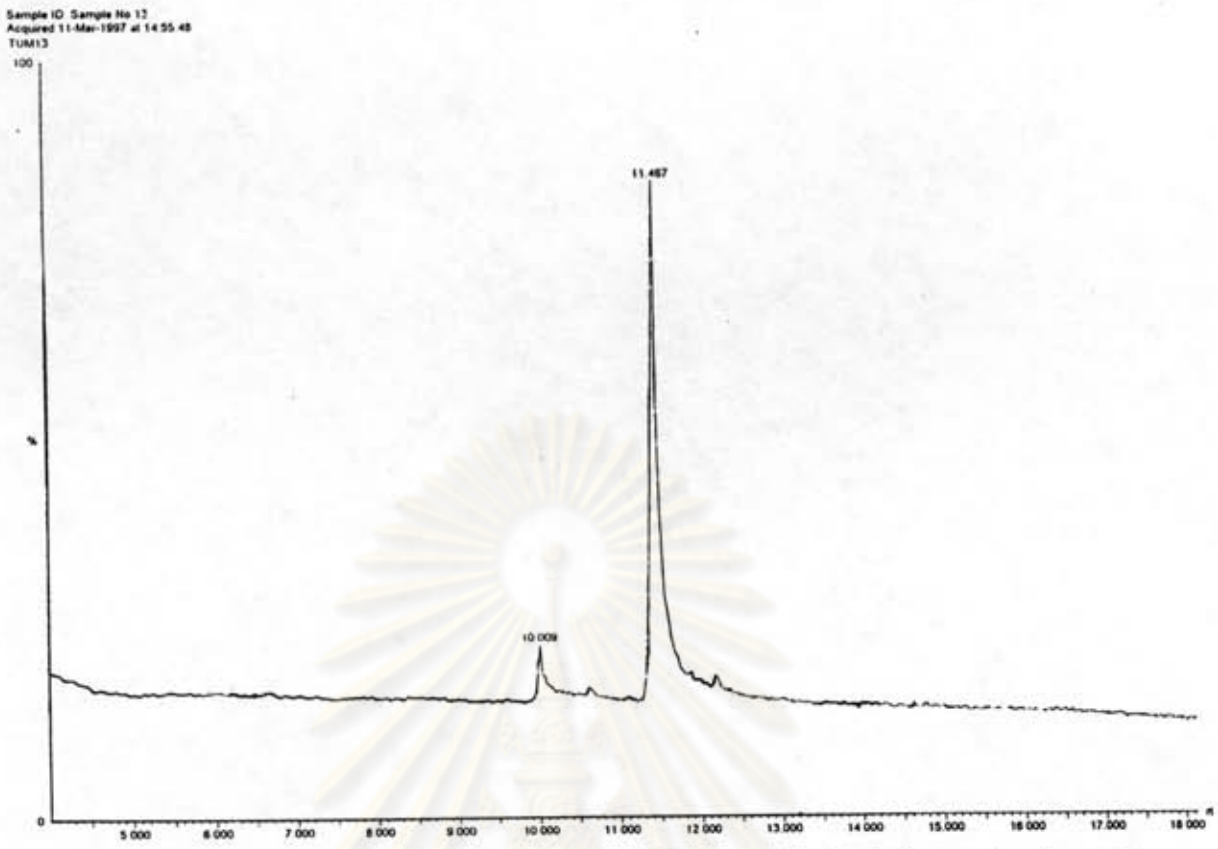

Figure C13 GC-chromatogram of diester obtained from stearic acid and 1,4-butanediol

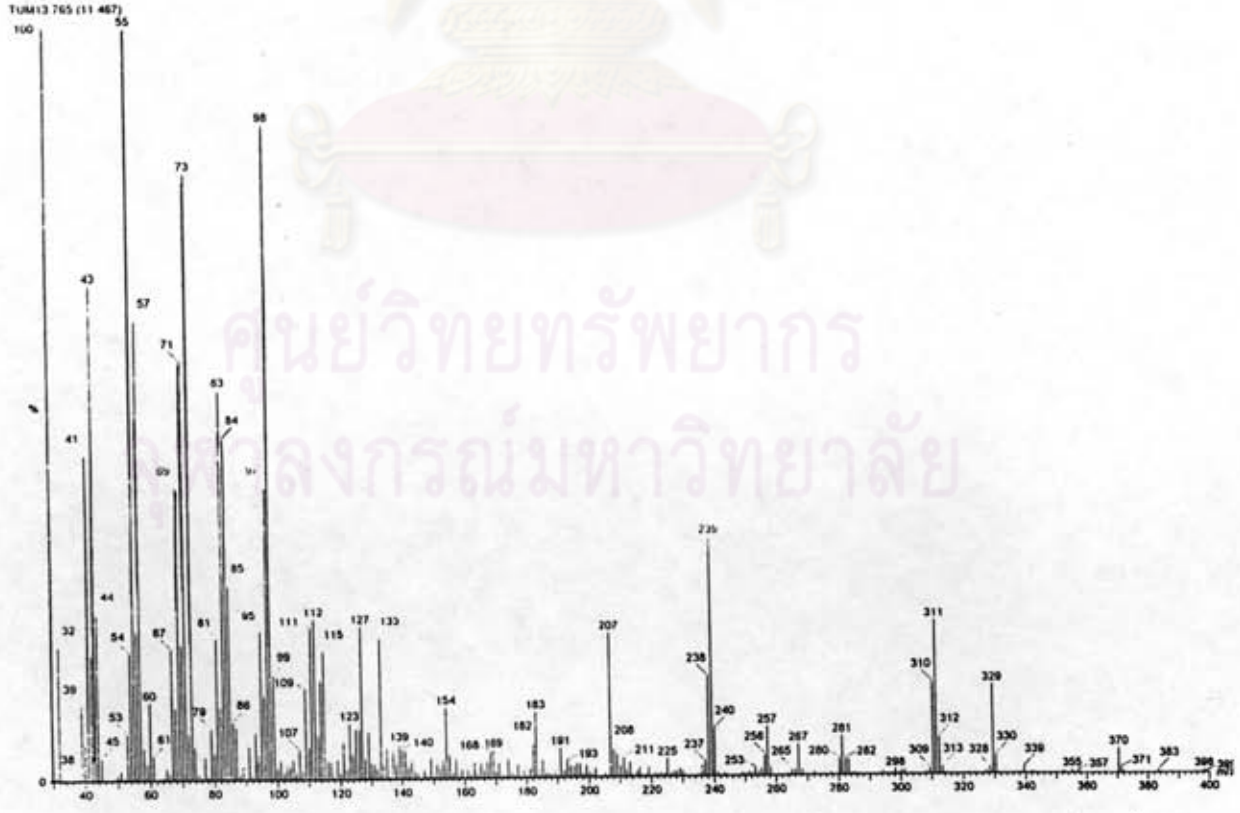

Figure D19 Mass spectrum of 1,4-butanedistearate at retention time 11.467 min

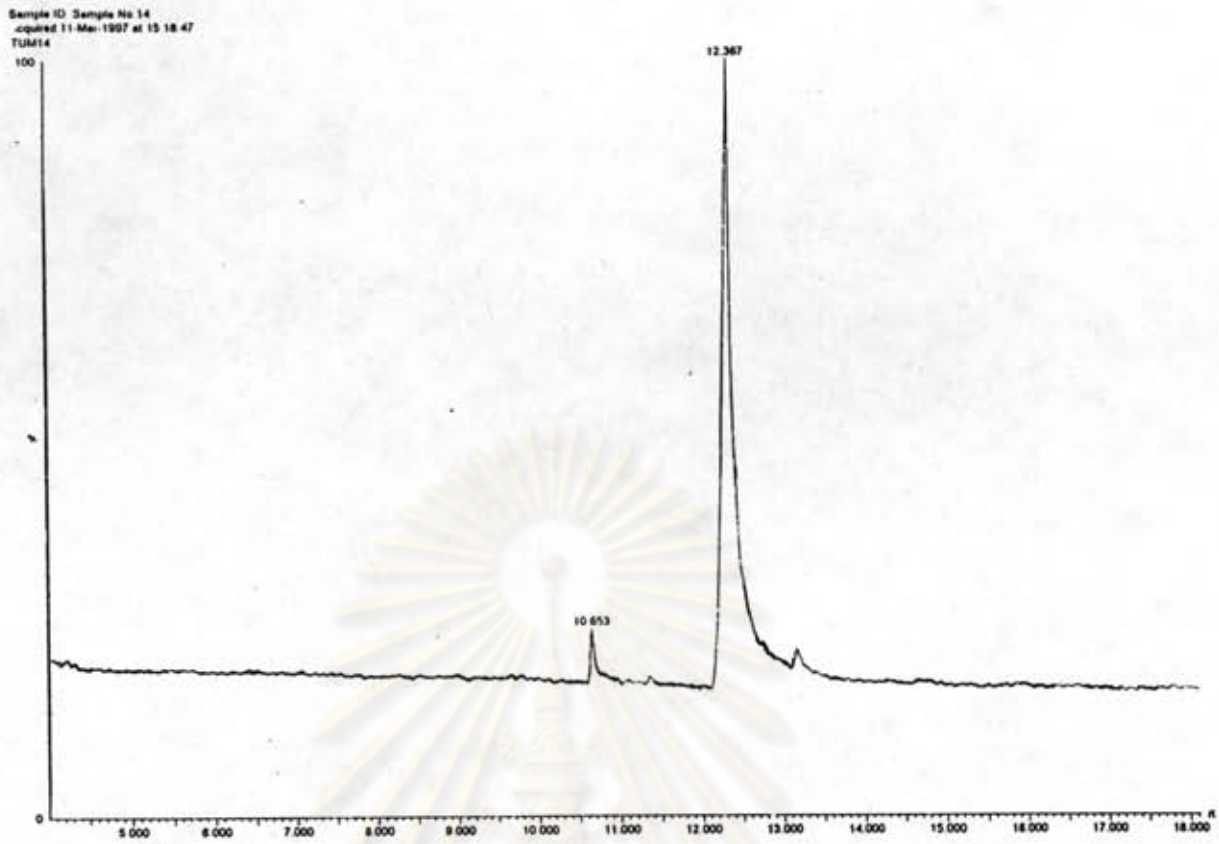

Figure C14 GC-chromatogram of diester obtained from stearic acid and 1,5-pentanediol

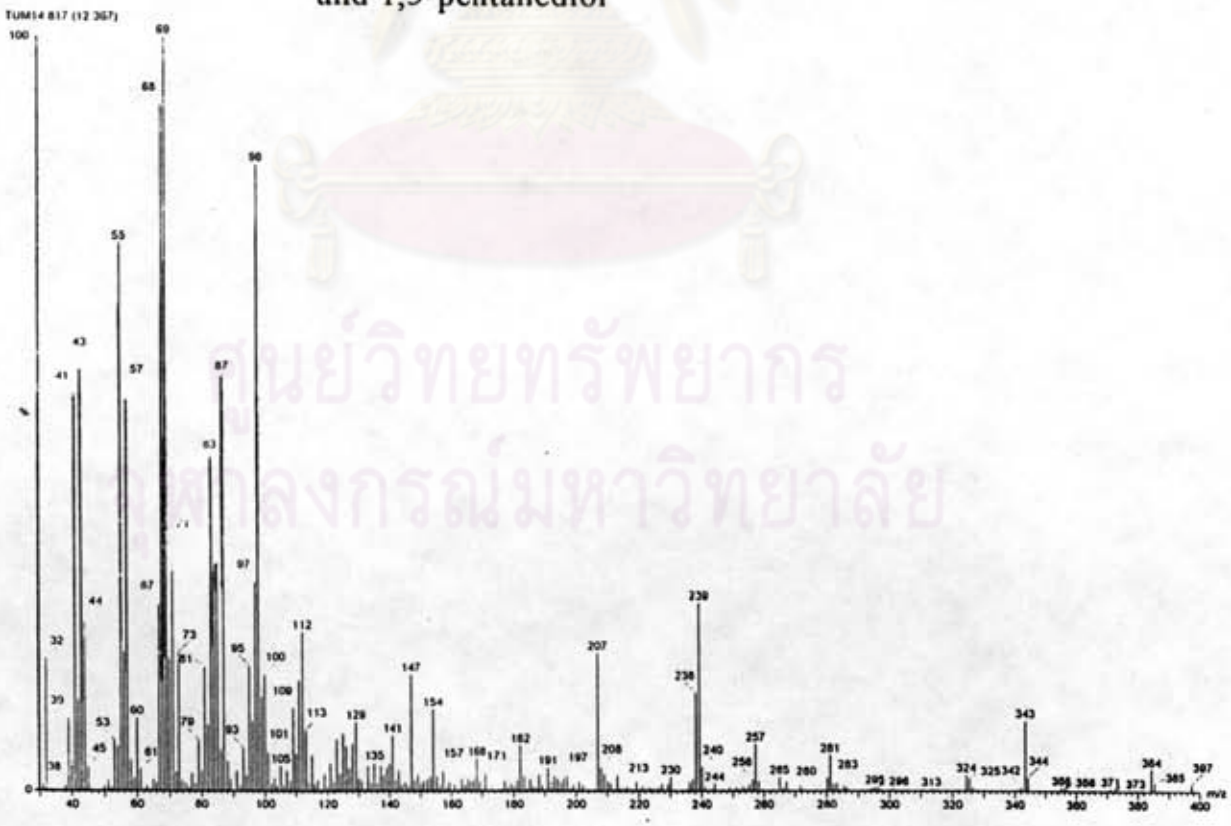

Figure D20 Mass spectrum of 1,5-pentanedistearate at retention time 11.367 min

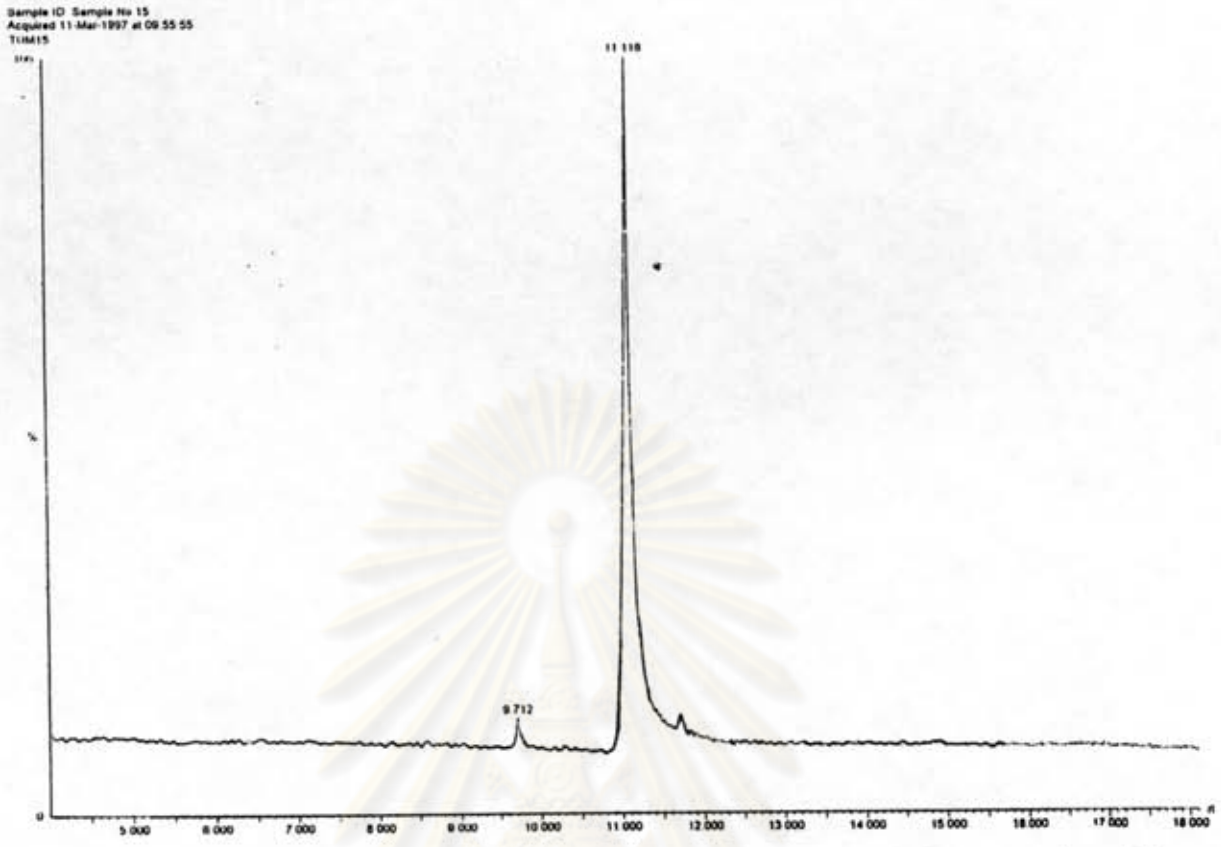

Figure C15 GC-chromatogram of diester obtained from stearic acid and 2,2-dimethyl-1,3-propanediol

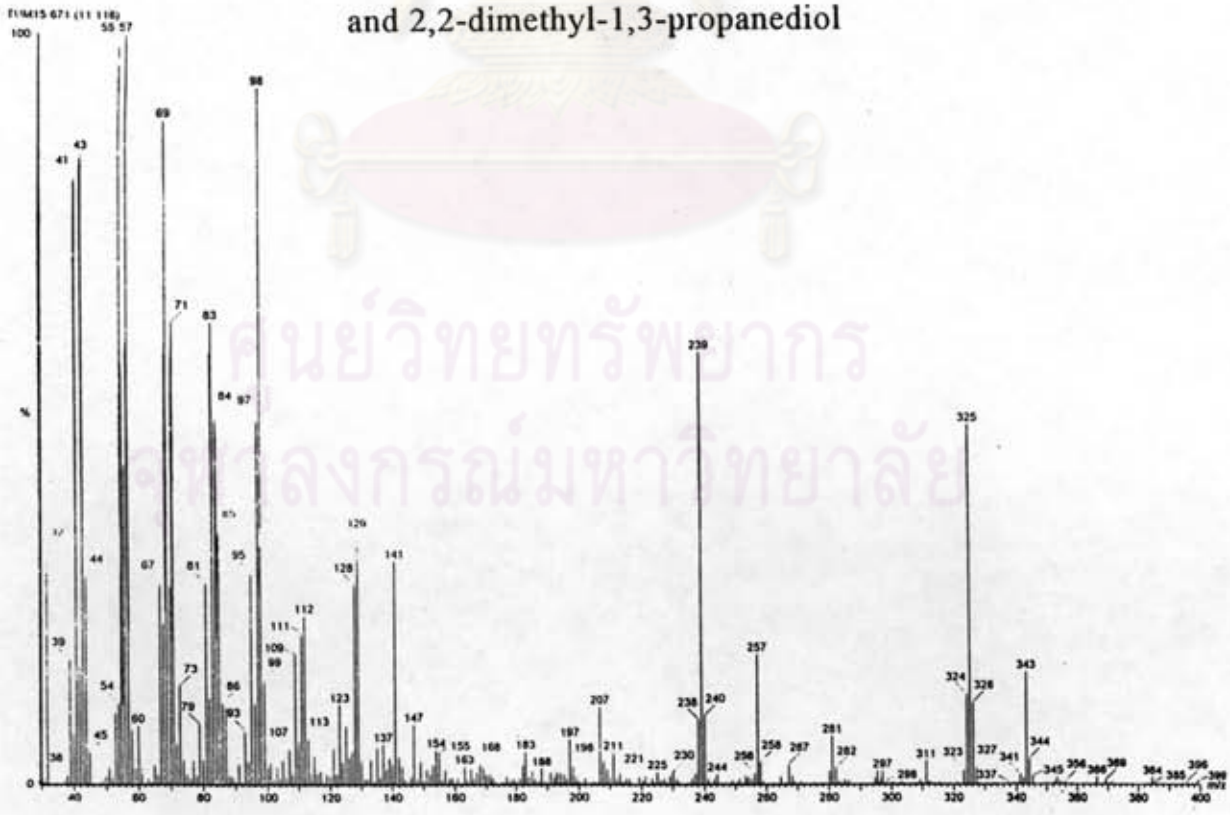

Figure D21 Mass spectrum of 2,2-dimethyl-1,3-propanedistearate at retention time 11.116 min

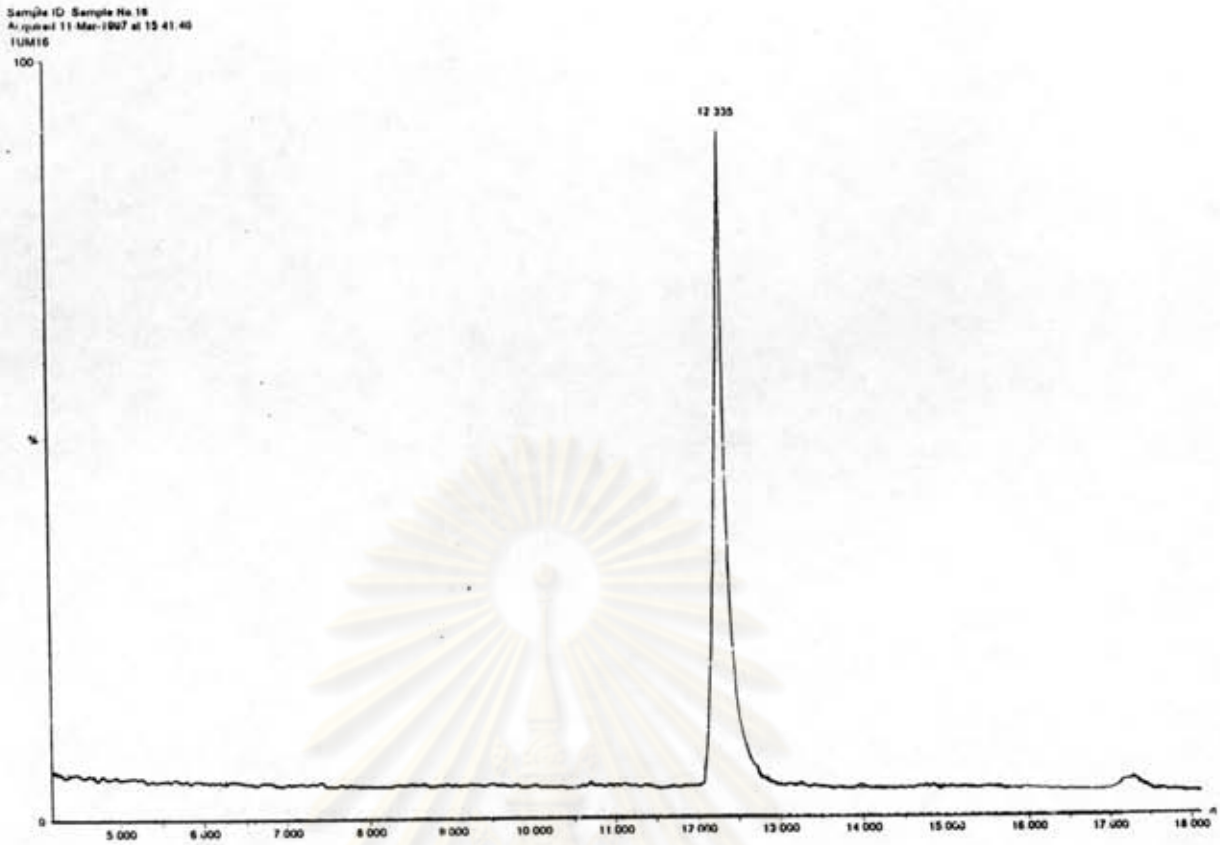

Figure C16 GC-chromatogram of diester obtained from stearic acid and 2-ethyl-1,3-hexanediol

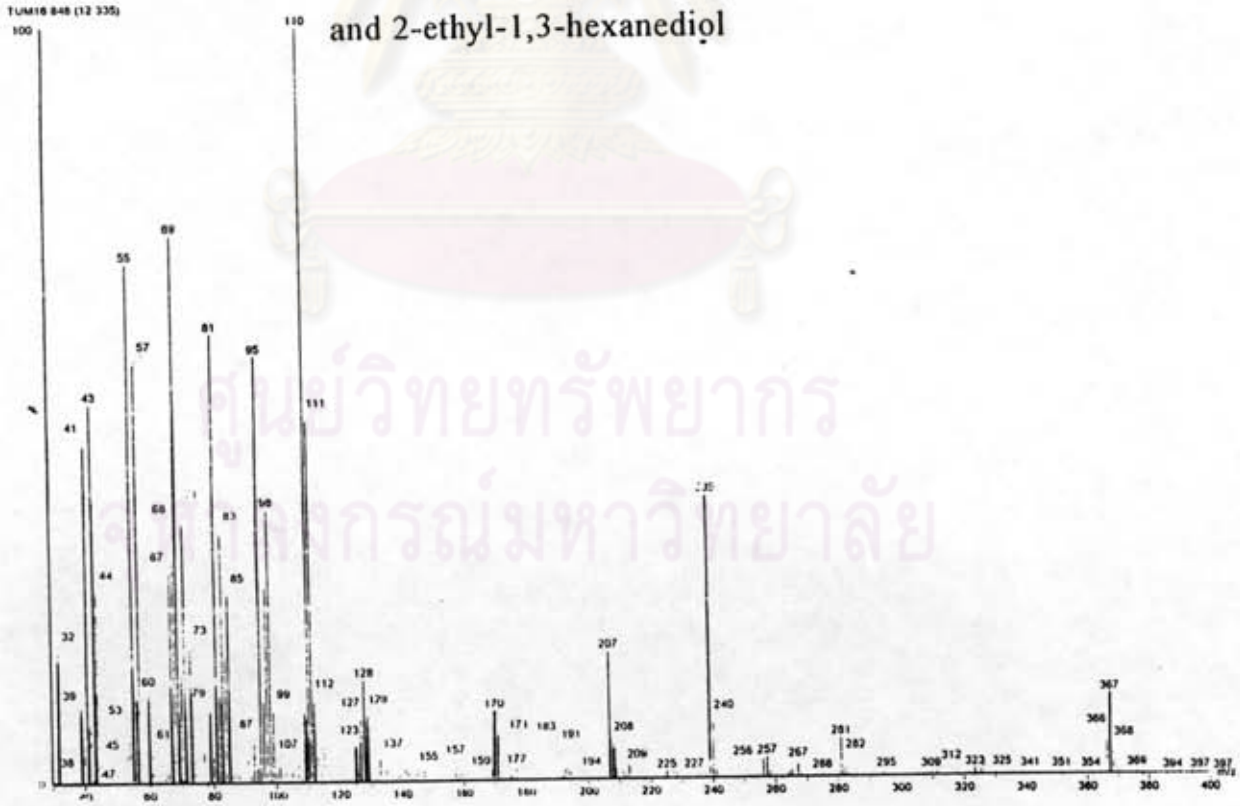

Figure D22 Mass spectrum of 2-ethyl-1,3-hexanedistearate at retention time 12.355 min

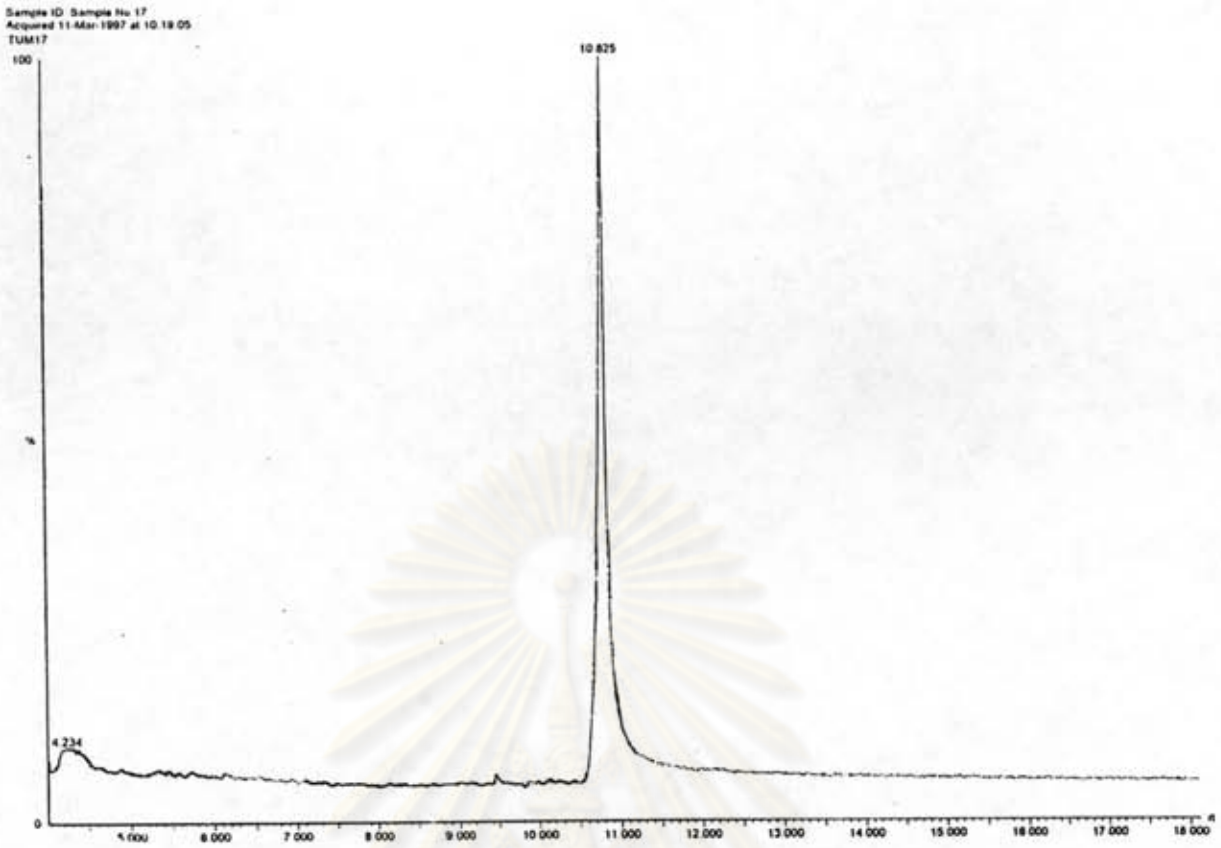

Figure C17 GC-chromatogram of diester obtained from palmitic acid and1,3-propanediol

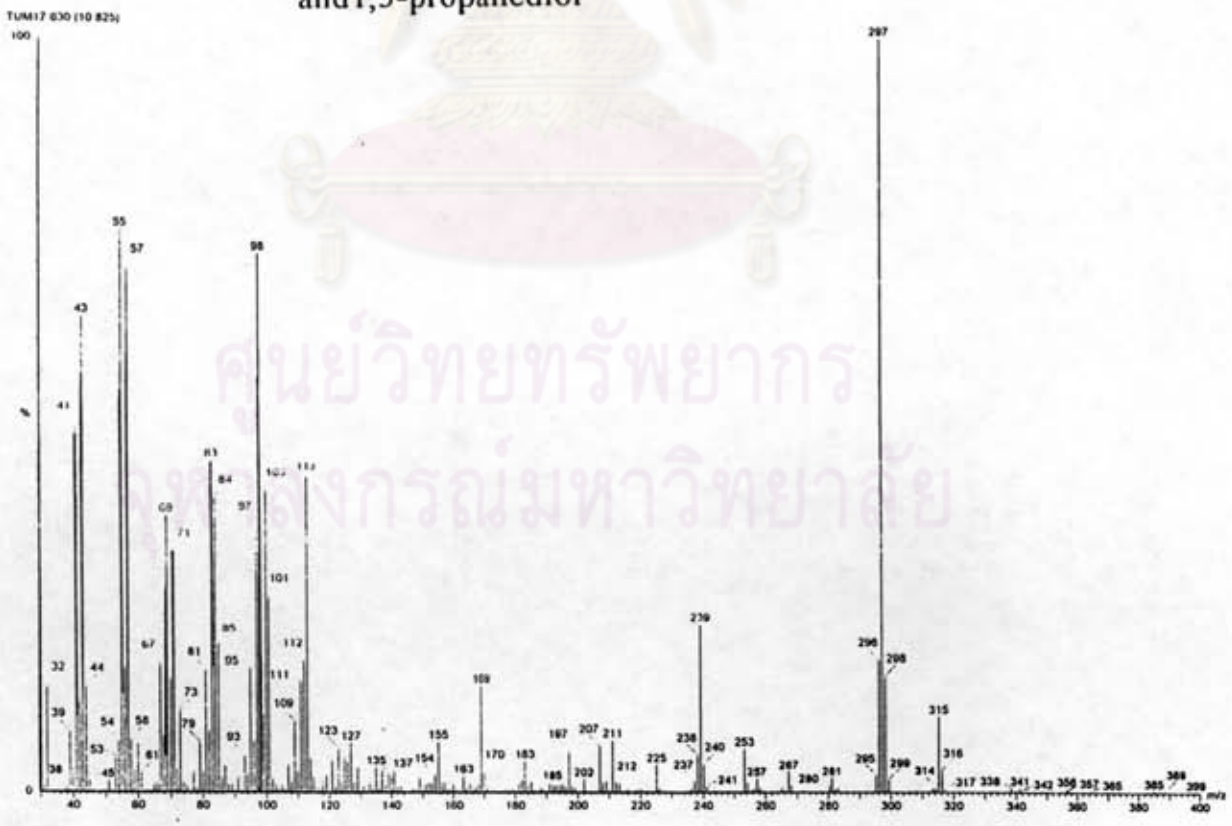

Figure D23 Mass spectrum of 1,3-propanedipalmitate at retention 10.825 min

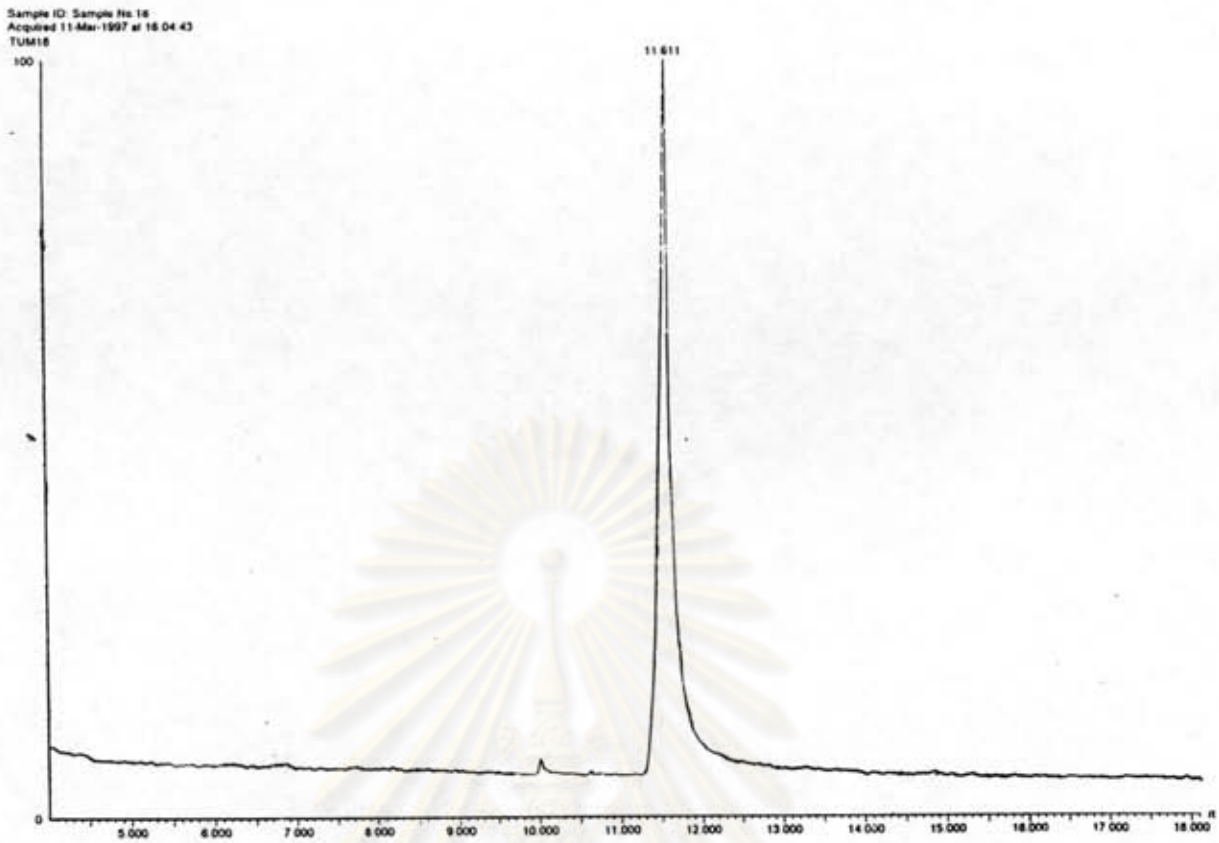

Figure C18 GC-chromatogram of diester obtained from palmitic acid and 1,4-butanediol

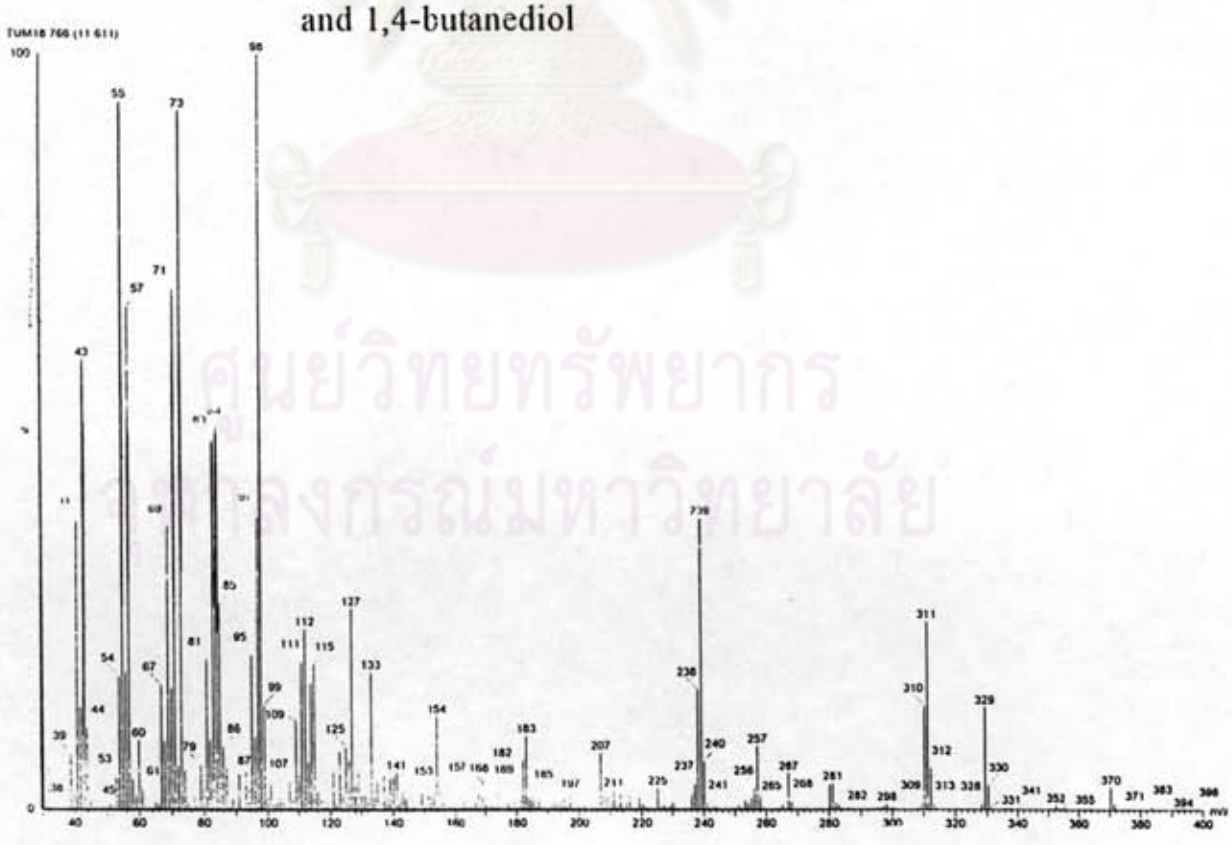

Figure D24 Mass spectrum of 1,4-butanedipalmitate at retention time 11.611 min

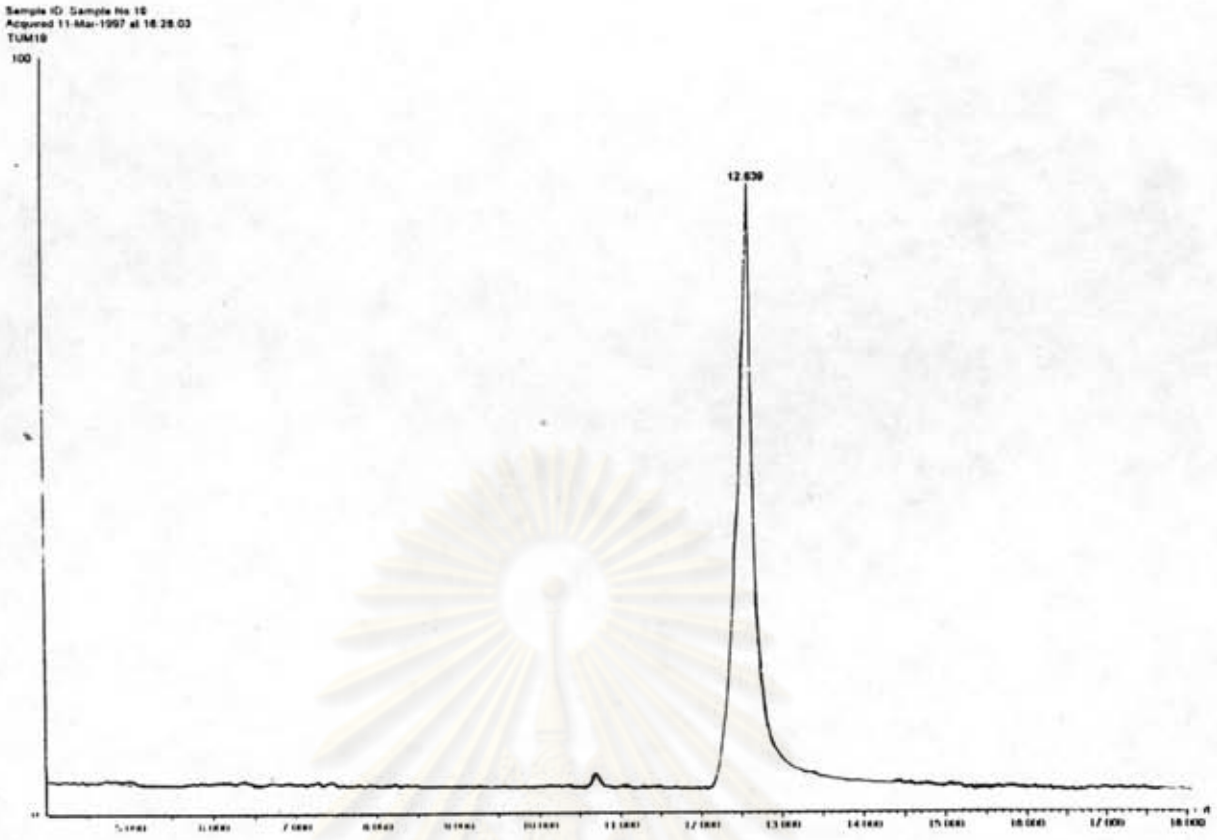

Figure C19 GC-chromatogram of diester obtained from palmitic acid and 1,5-pentanediol

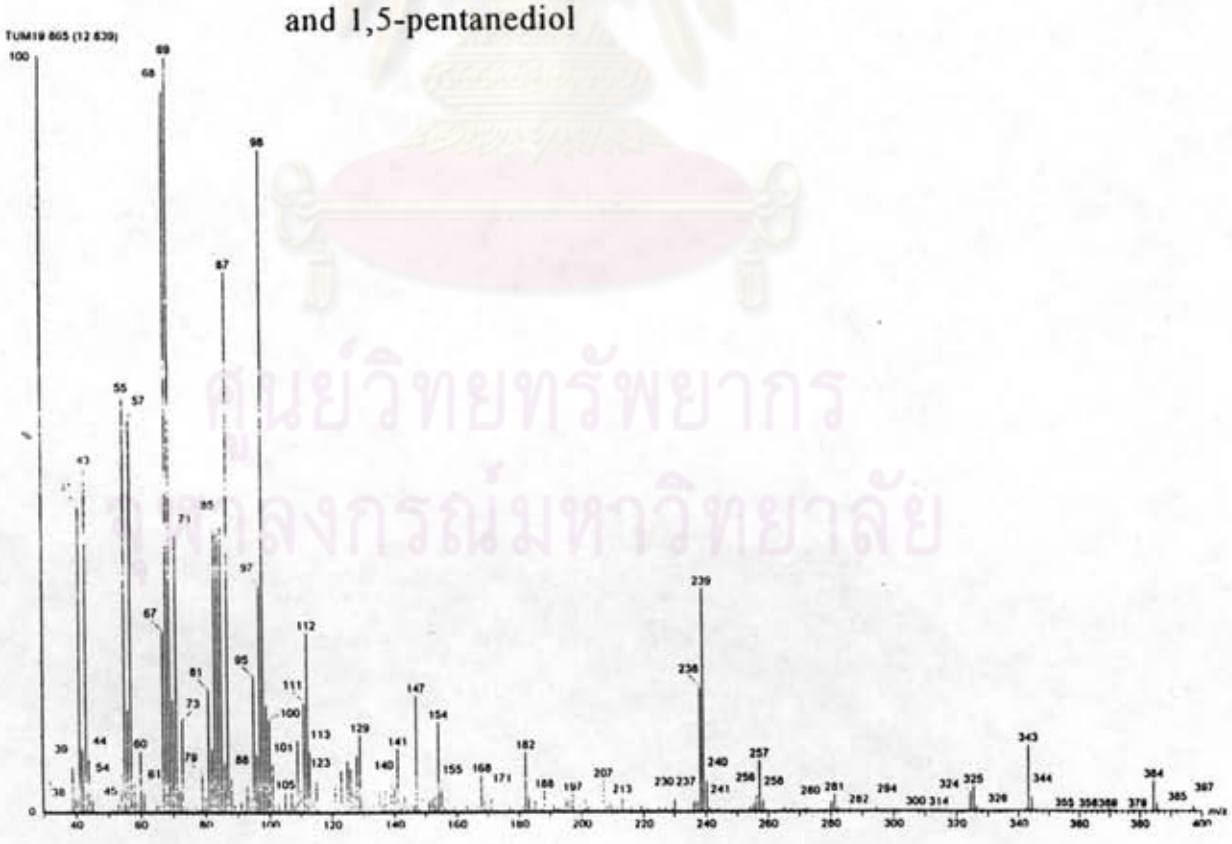

Figure D25 Mass spectrum of 1,5-pentanedipalmitate at retention time 12.639 min

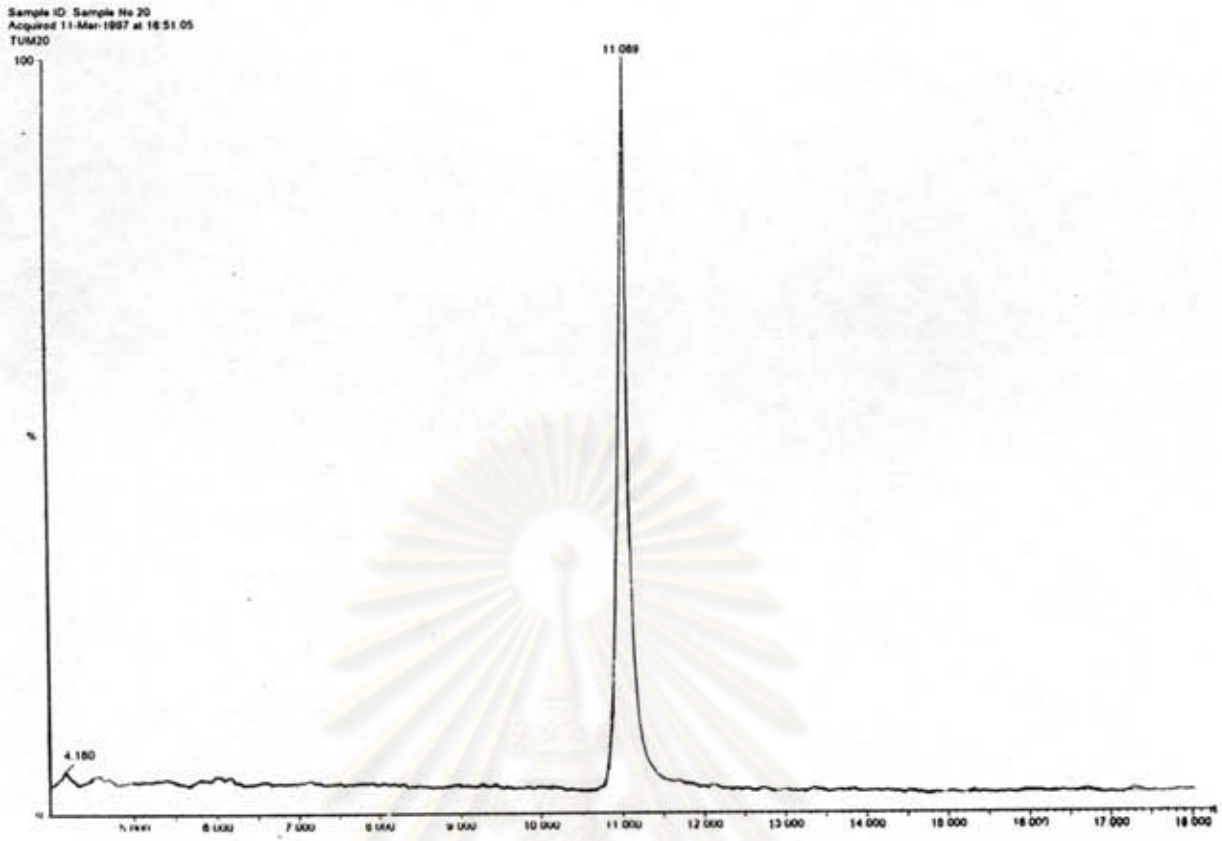

Figure C20 GC-chromatogram of diester obtained from palmitic acid and 2,2-dimethyl-1,3-propanediol

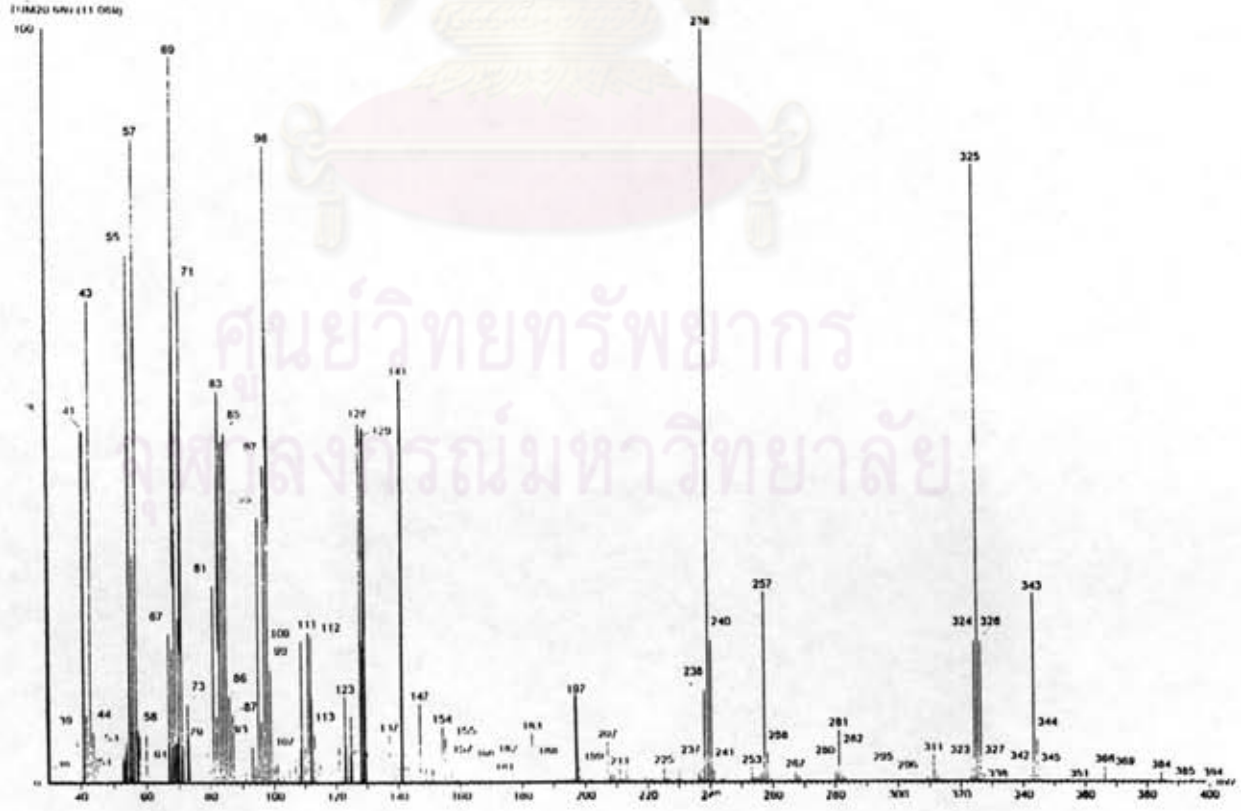

Figure D26 Mass spectrum of 2,2-dimethyl1,3-propanedipalmitate at retention time 11.089 min

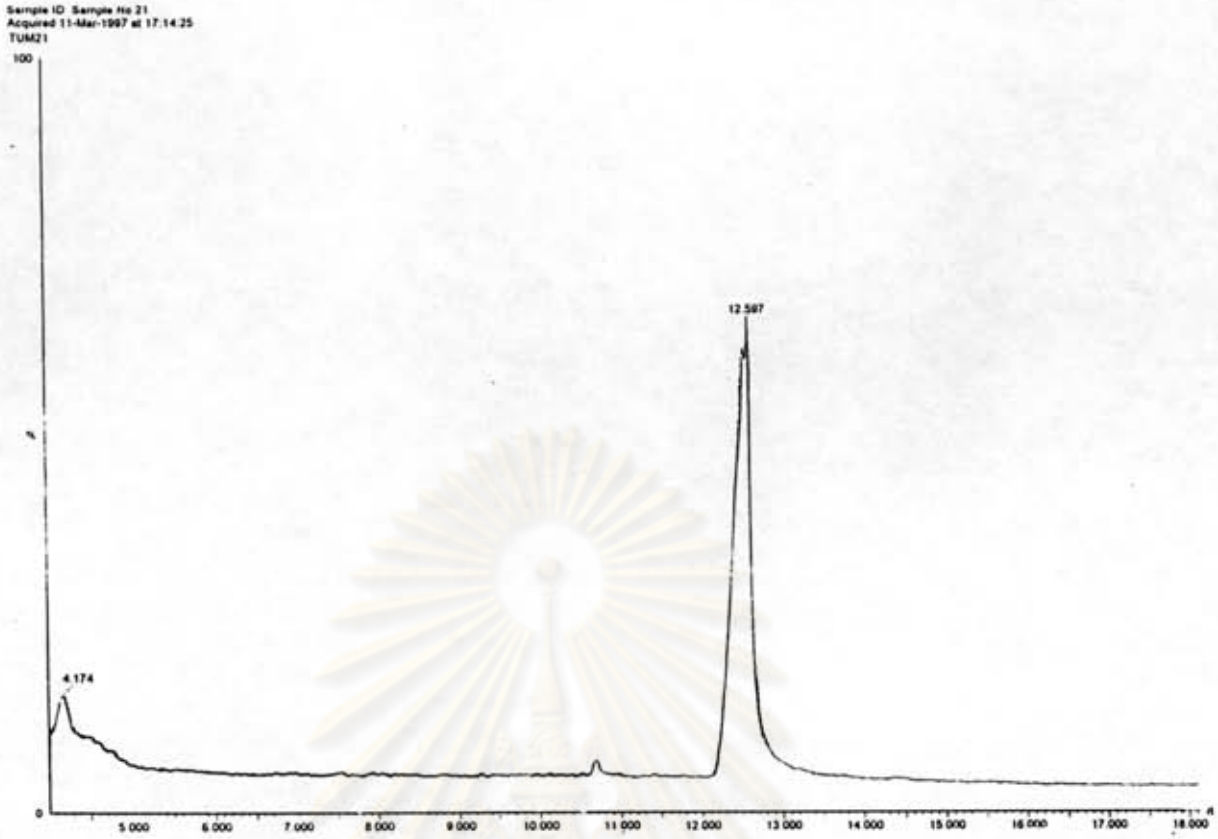

Figure C21 GC-chromatogram of diester obtained from palmitic acid and 2-ethyl-1,3-hexanediol

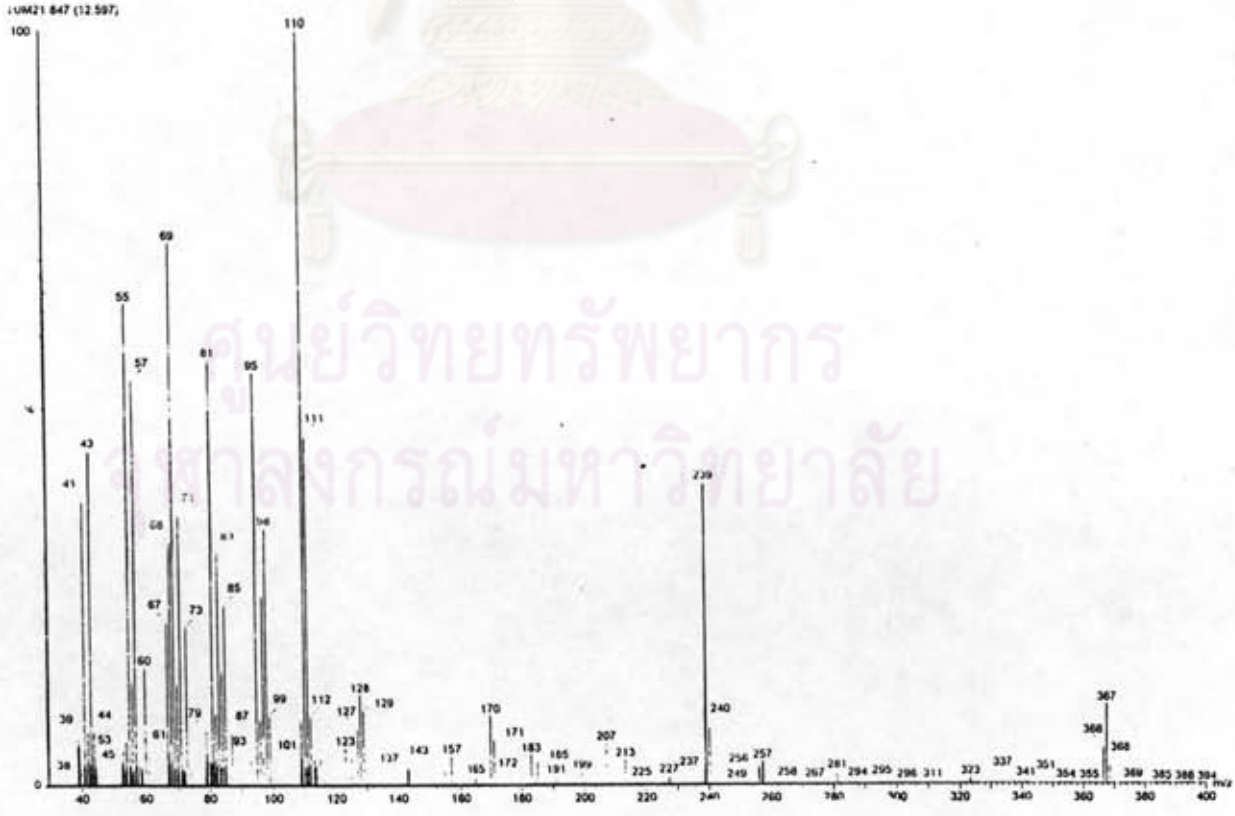

Figure D27 Mass spectrum of 2-ethyl-1,3-hexanedipalmitate at retention time 12.597 min

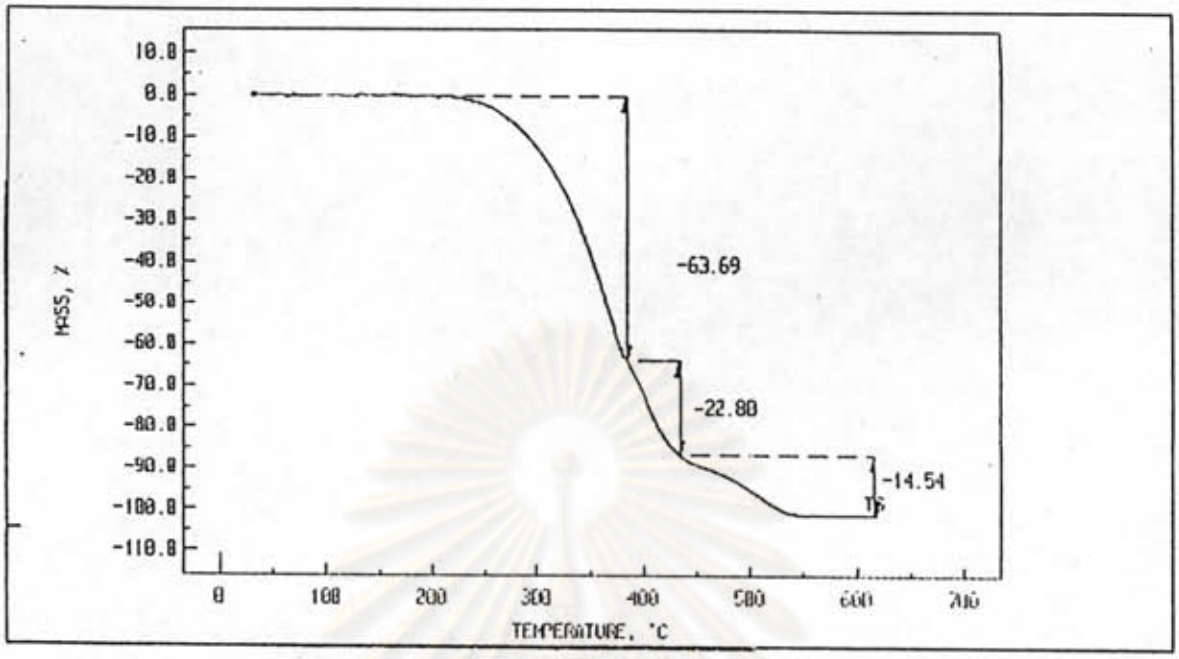

Figure E1 Thermogram of palm oil

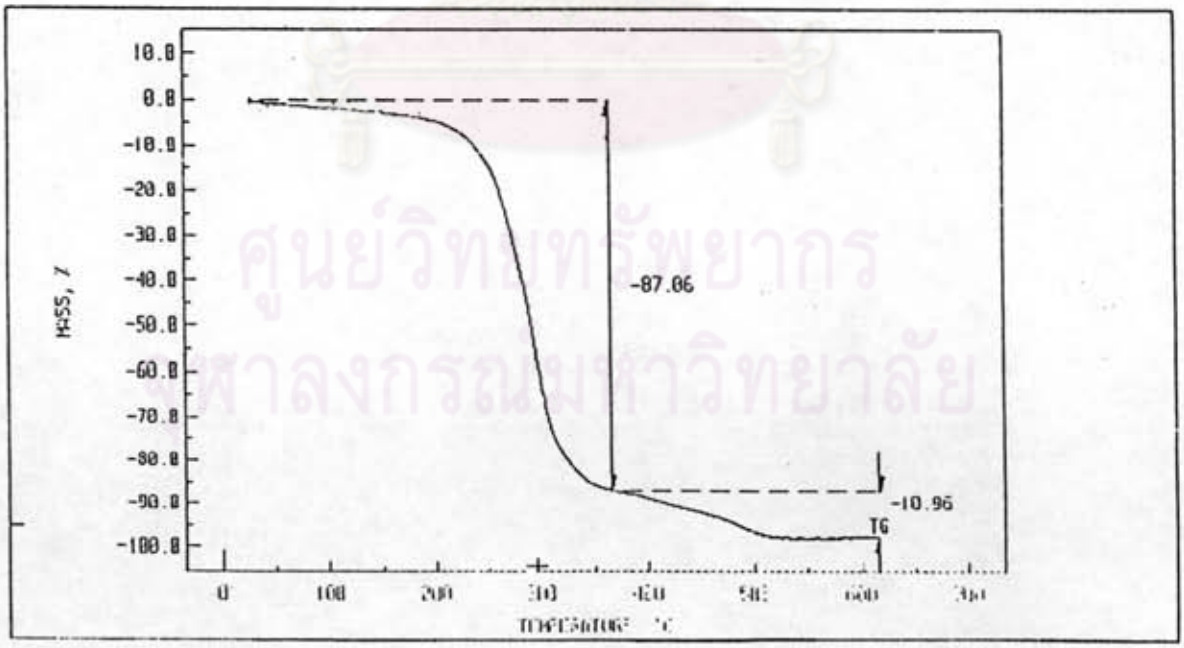

Figure E2 Thermogram of methyl ester of palm oil

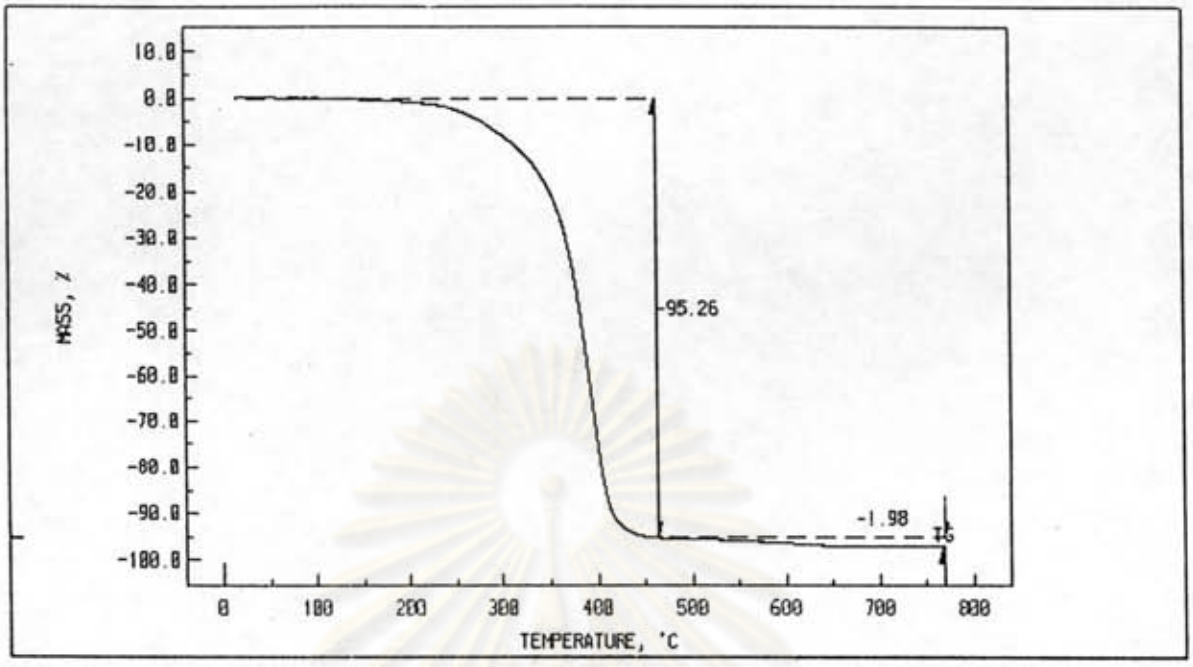

Figure E3 Thermogram of 1,3-propanediester of palm oil

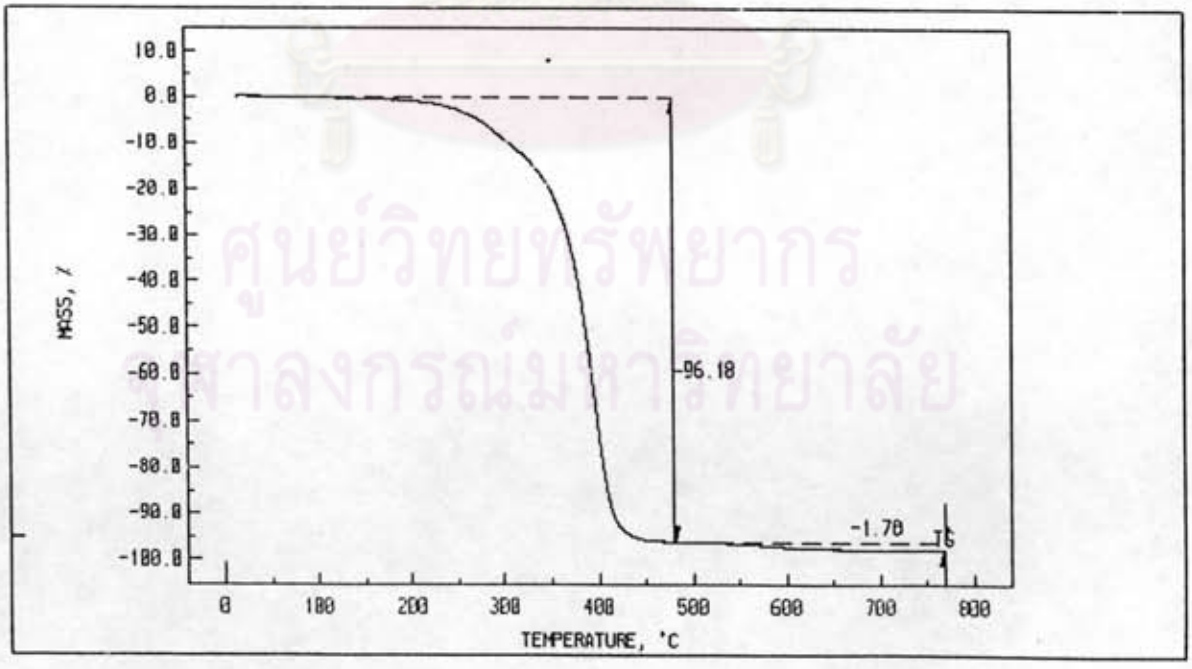

Figure E4 Thermogram of 1,4-butanediester from palm oil

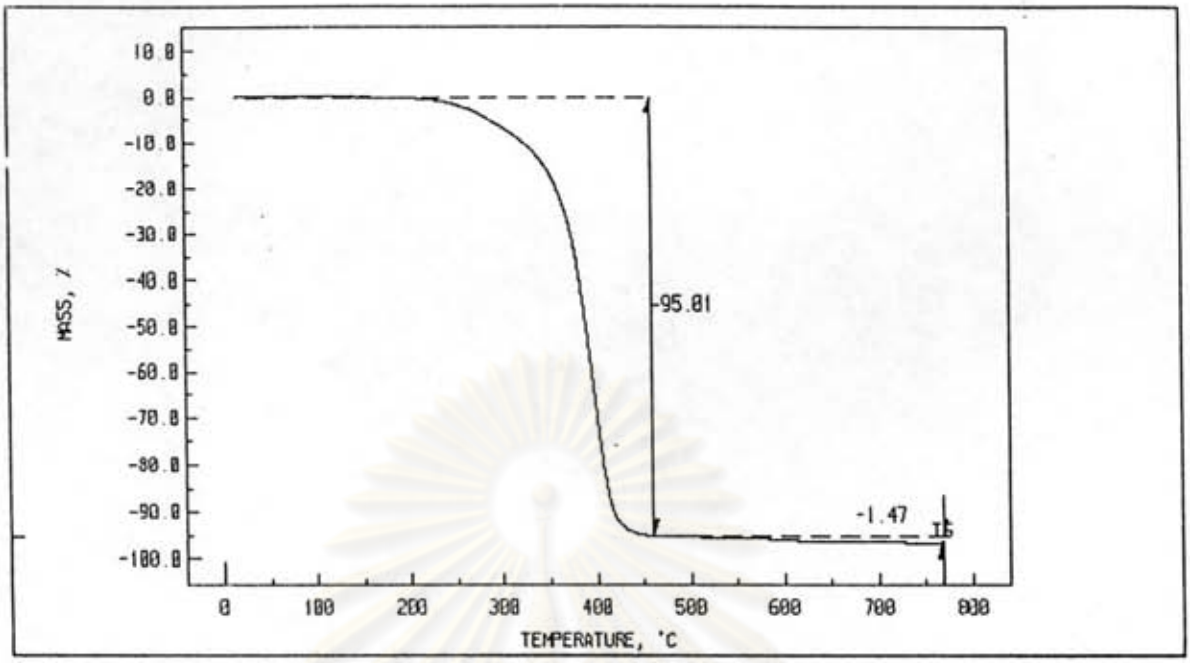

Figure E5 Thermogram of 1,5-pentanediester of palm oil

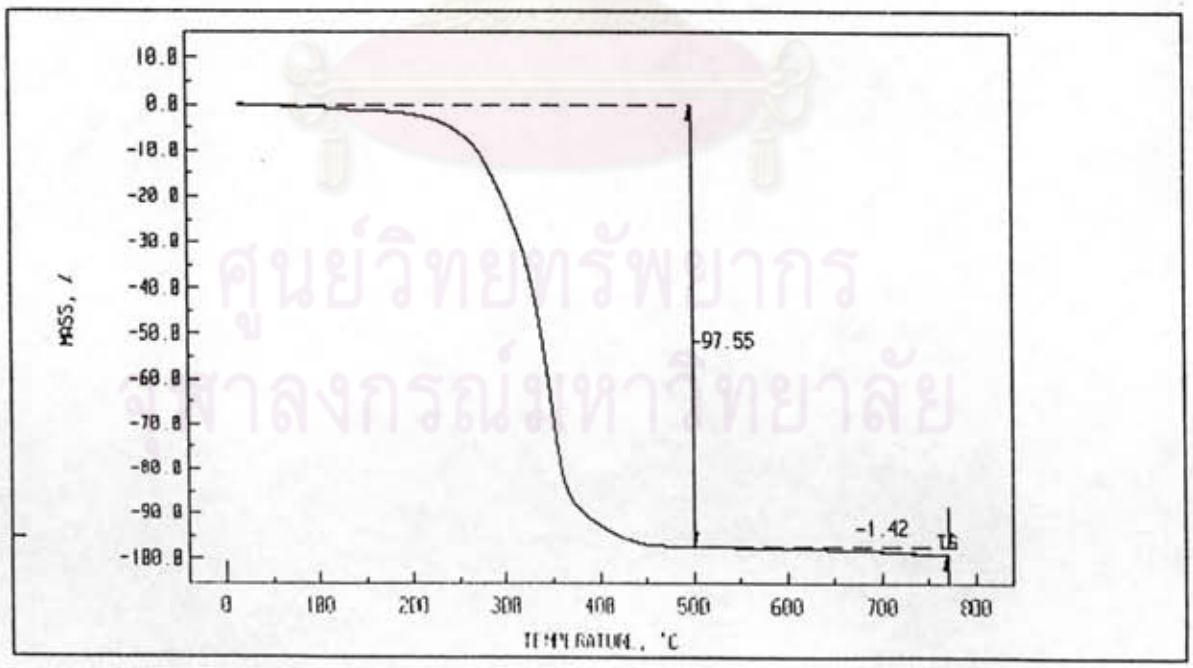

Figure E6 Thermogram of 2,2-dimethyl-1,3-propanediester of palm oil

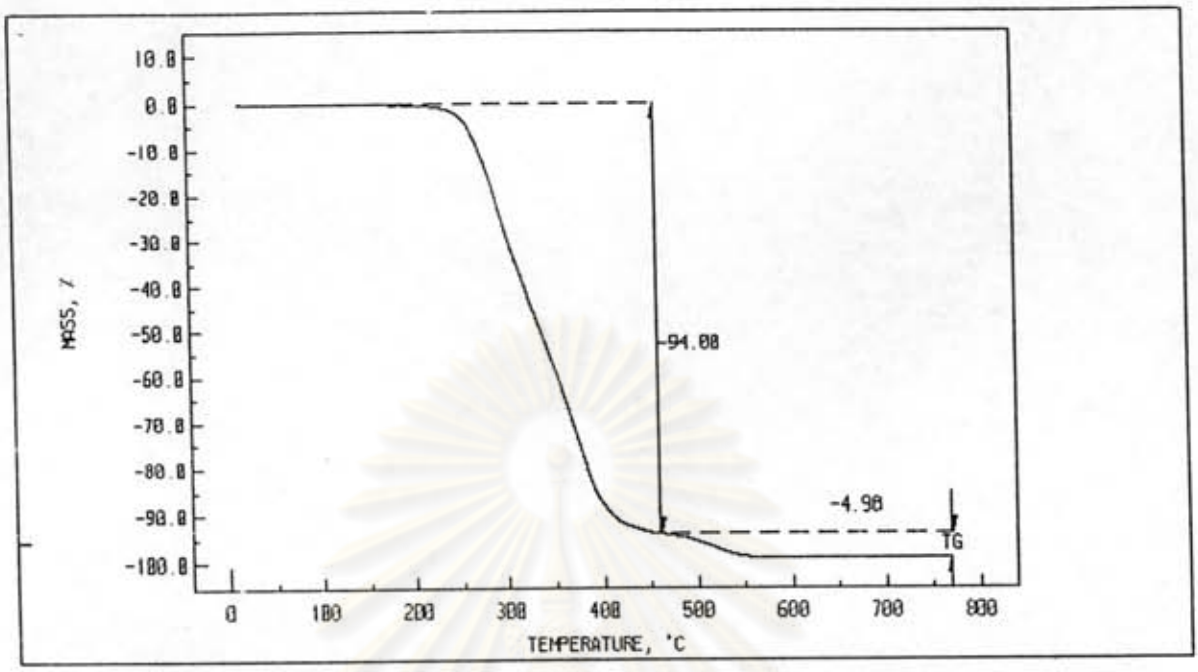

Figure E7 Thermogram of 2-ethyl-1,3-hexanediester of palm oil

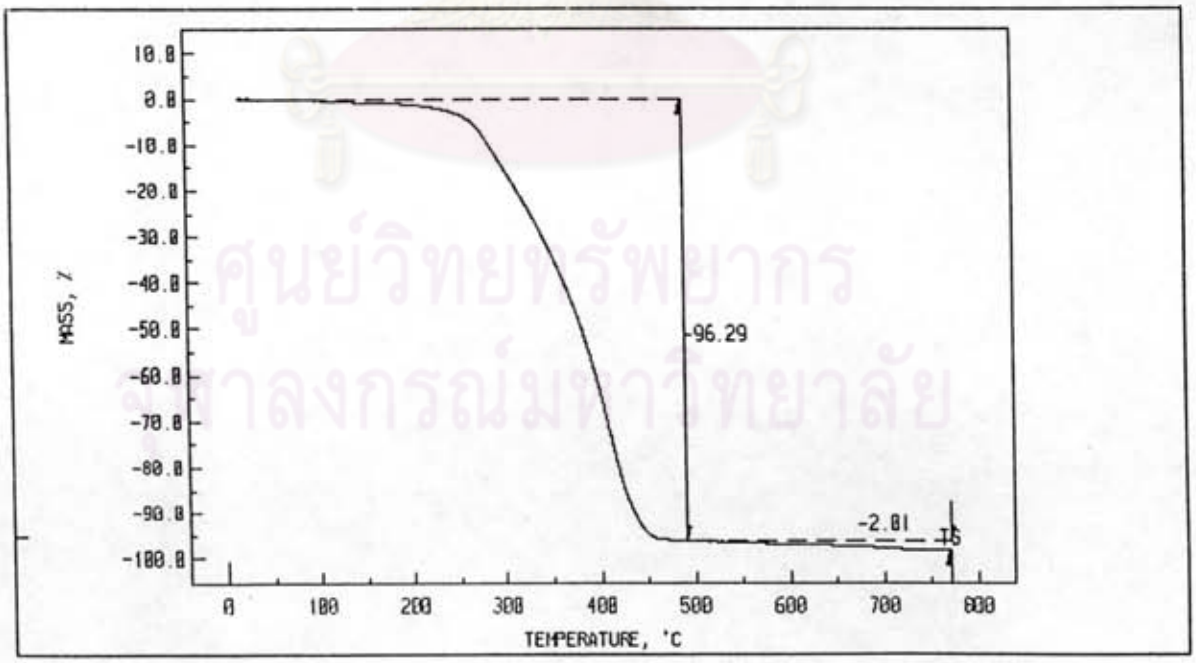

Figure E8 Thermogram of 1,3-propanedioleate

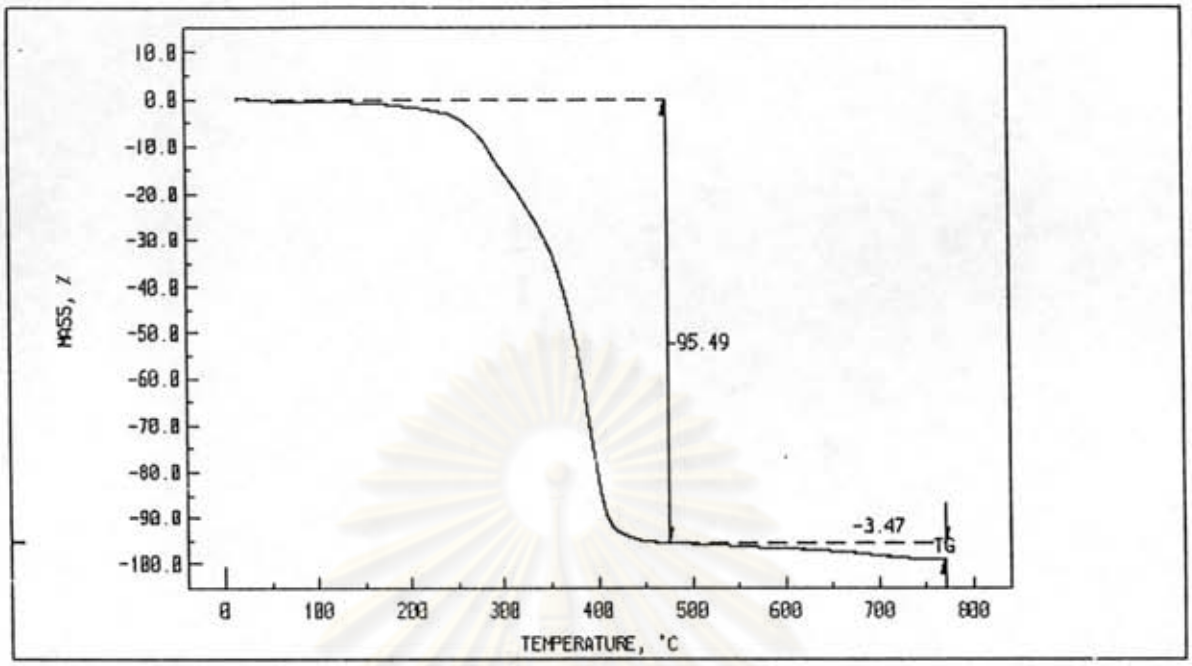

Figure E9 Thermogram of 1,4-butanedioleate

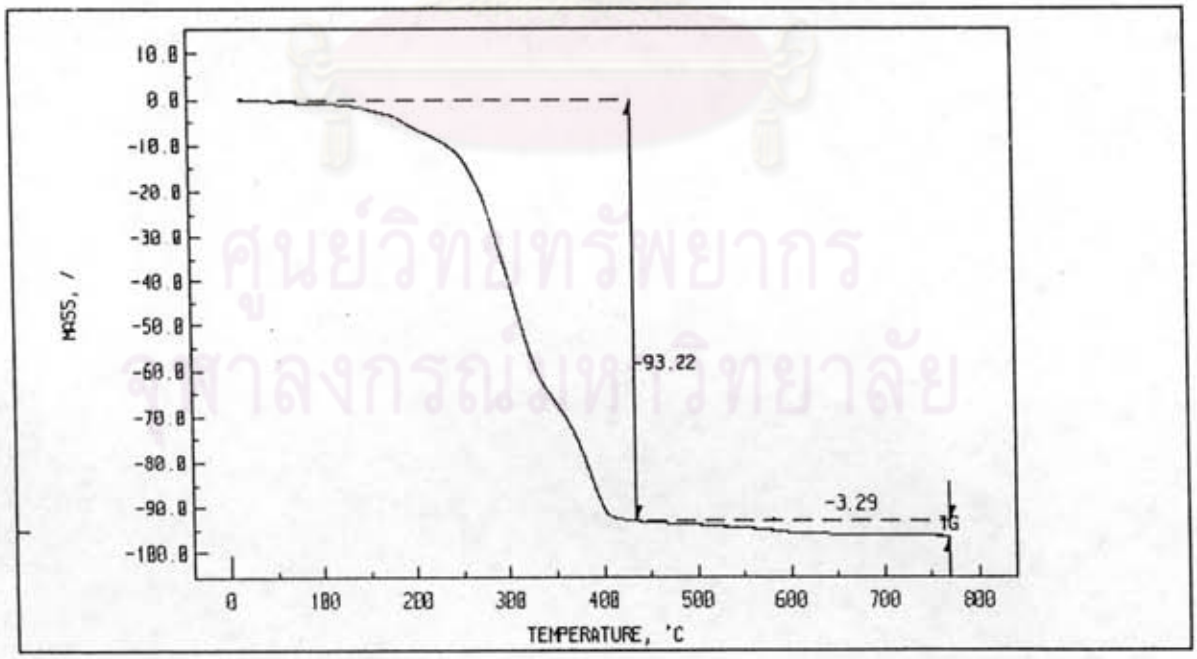

Figure E10 Thermogram of 1,5-pentanedioleate

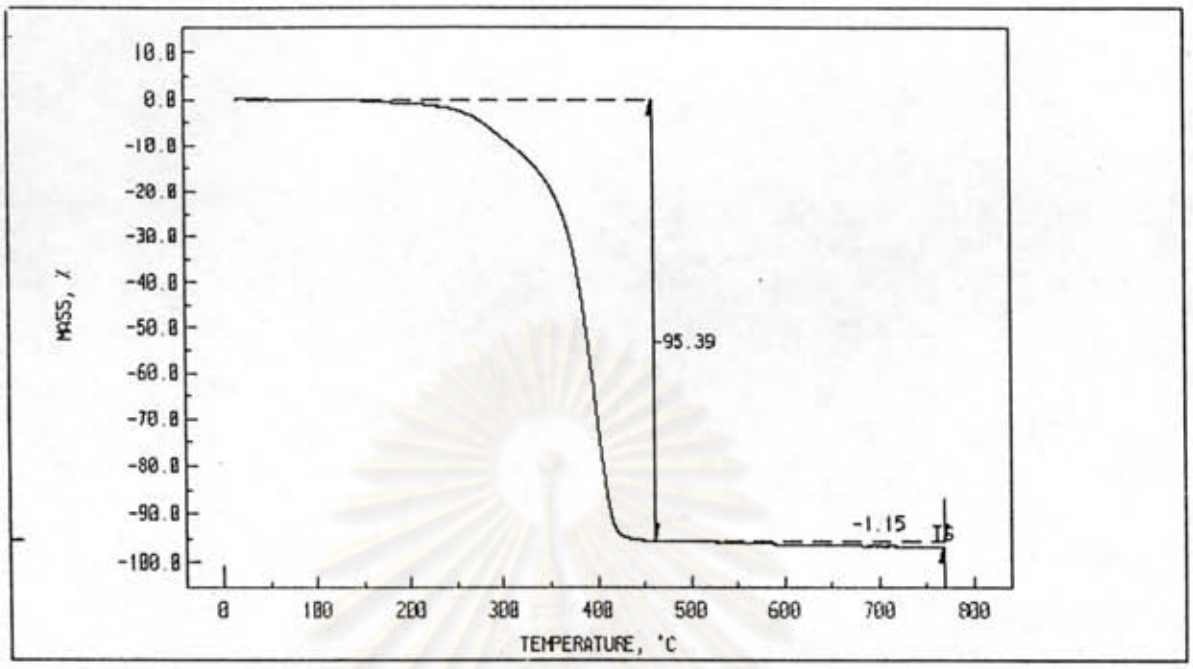

Figure E11 Thermogram of 2,2-dimethyl-1,3-propanedioleate

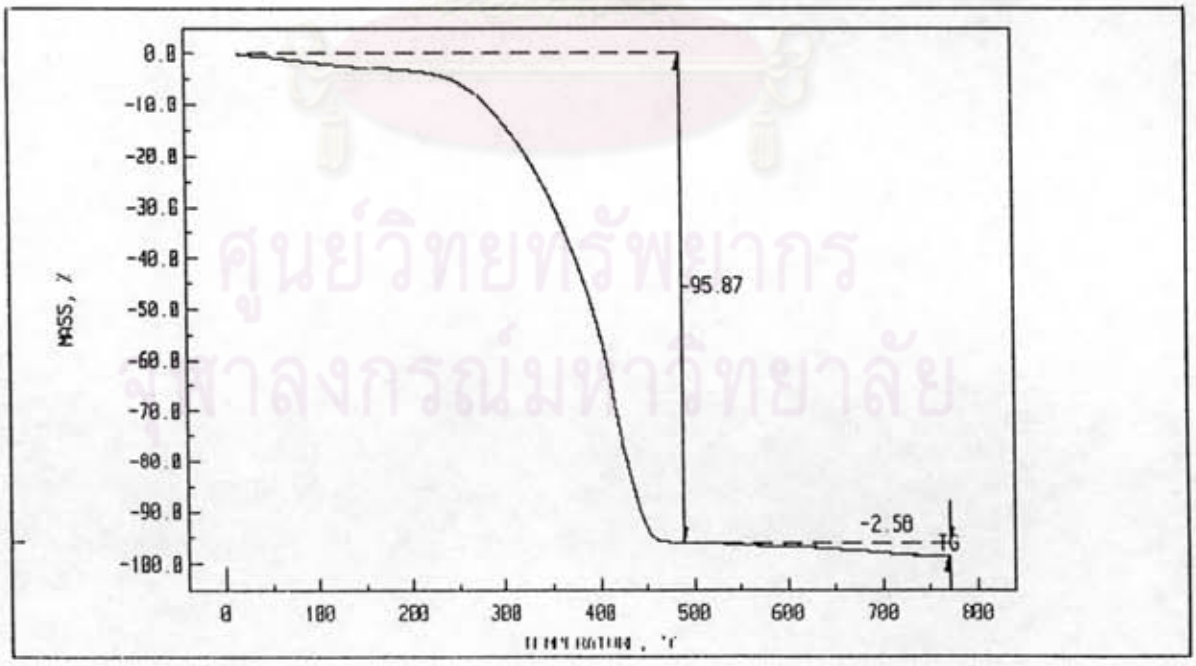

Figure E12 Thermogram of 2-ethyl-1,3-hexanedioleate

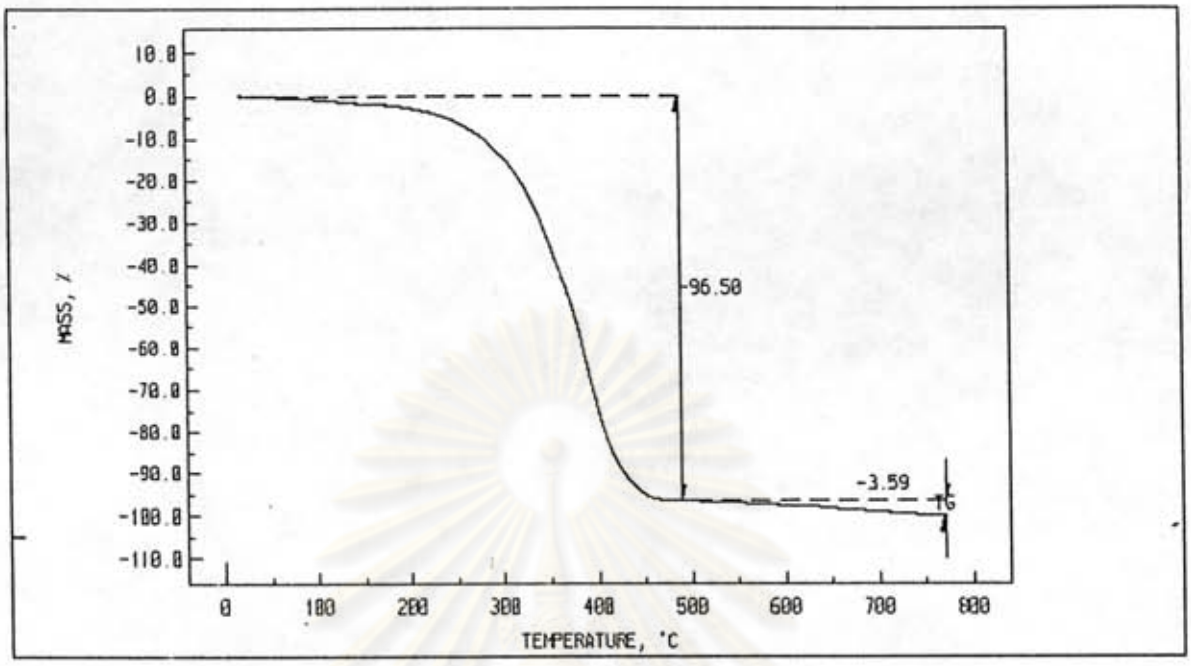

Figure E13 Thermogram of 1,3-propanedistearate

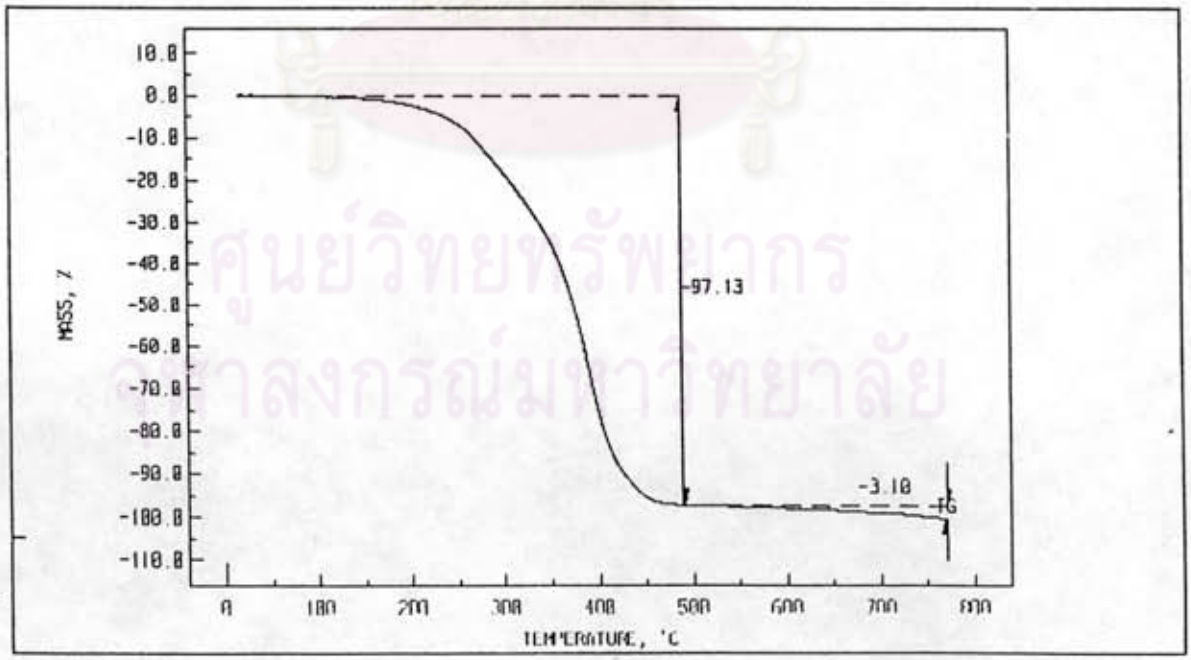

Figure E14 Thermogram of 1,4-butanedistearate

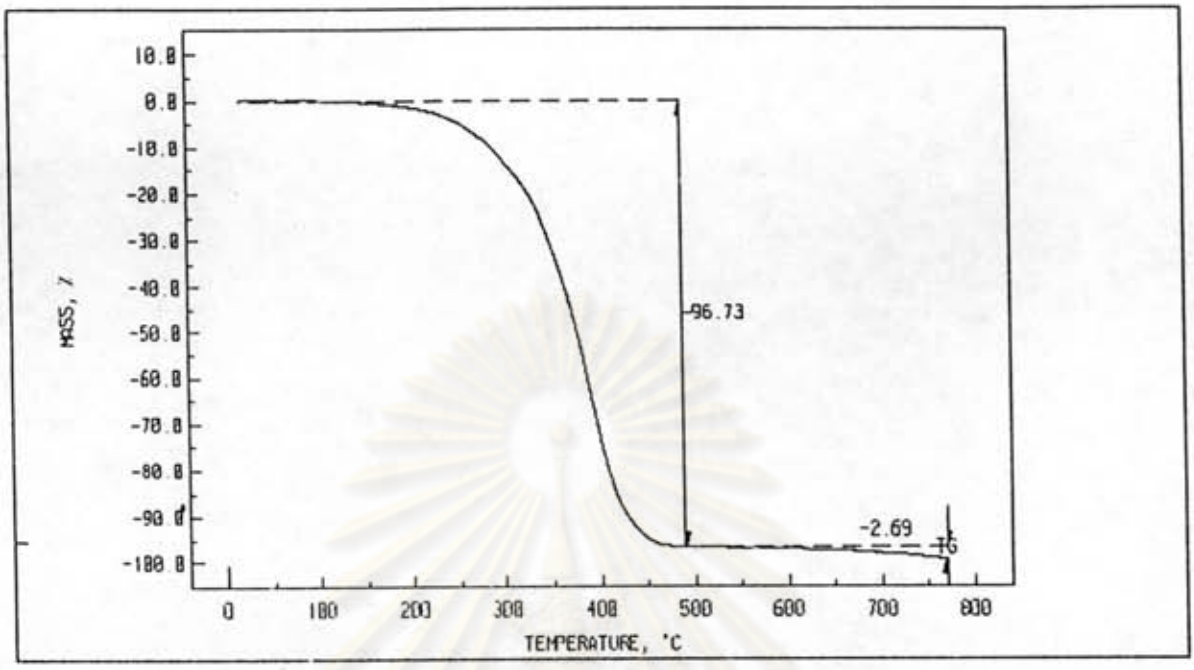

Figure E15 Thermogram of 1,5-pentanedistearate

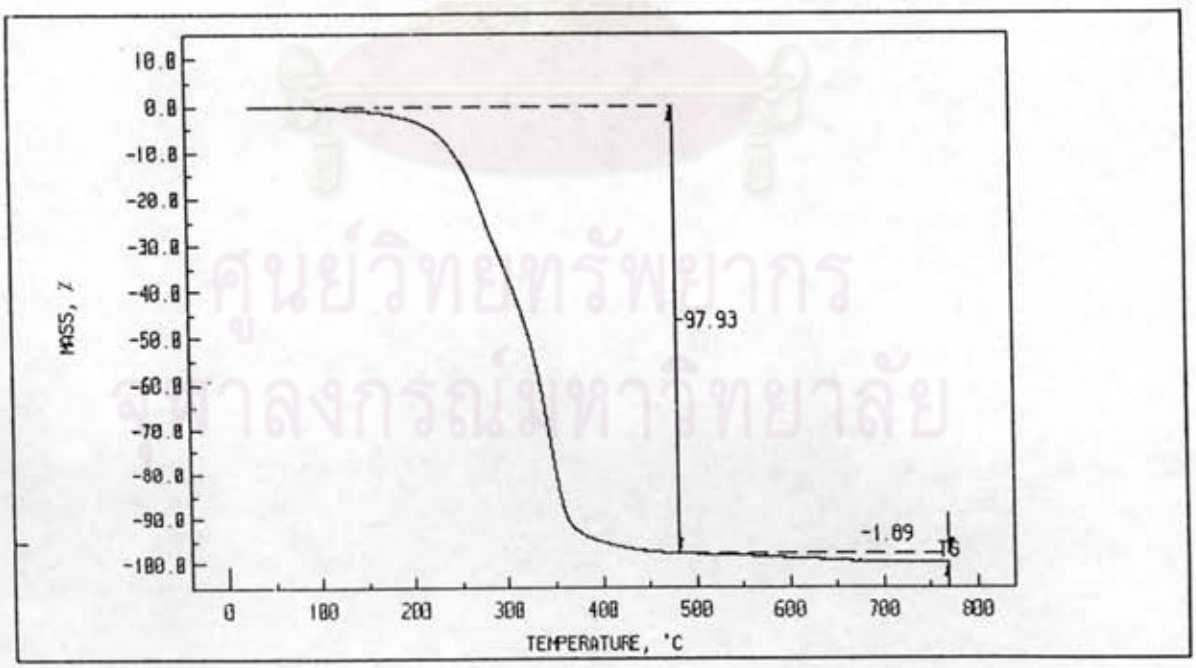

Figure E16 Thermogram of 2,2-dimethyl-1,3-propanedistearate

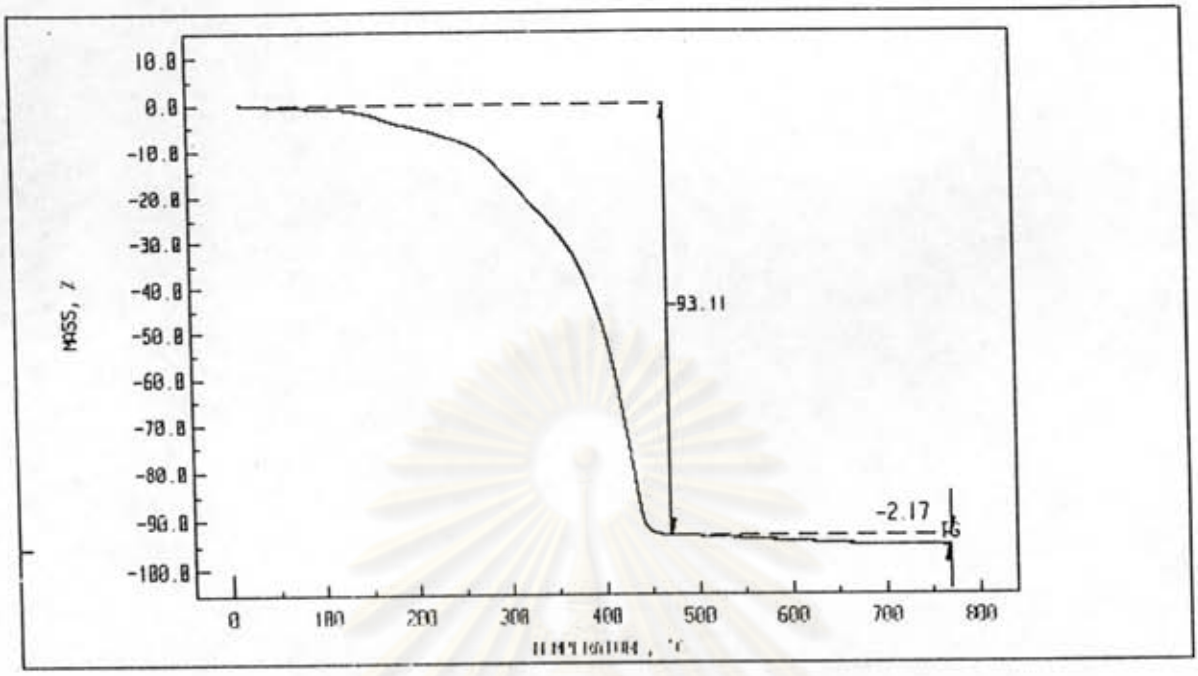

Figure E17 Thermogram of 2-ethyl-1,3-hexanedistearate

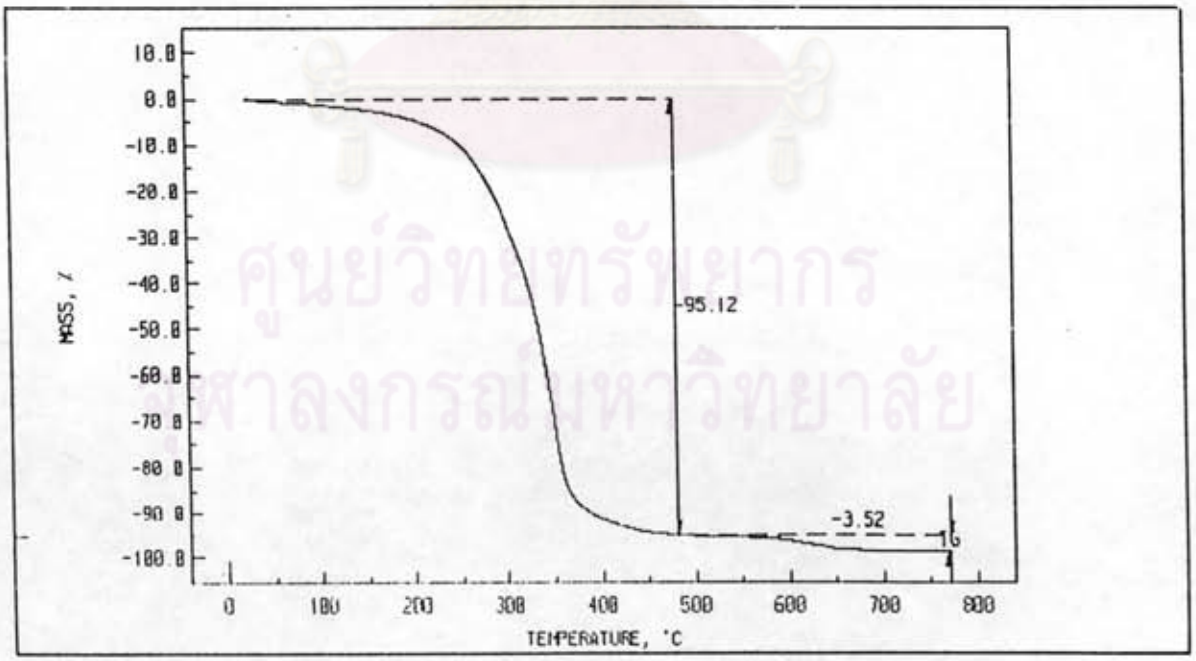

Figure E18 Thermogram of 1,3-propanedipalmitate

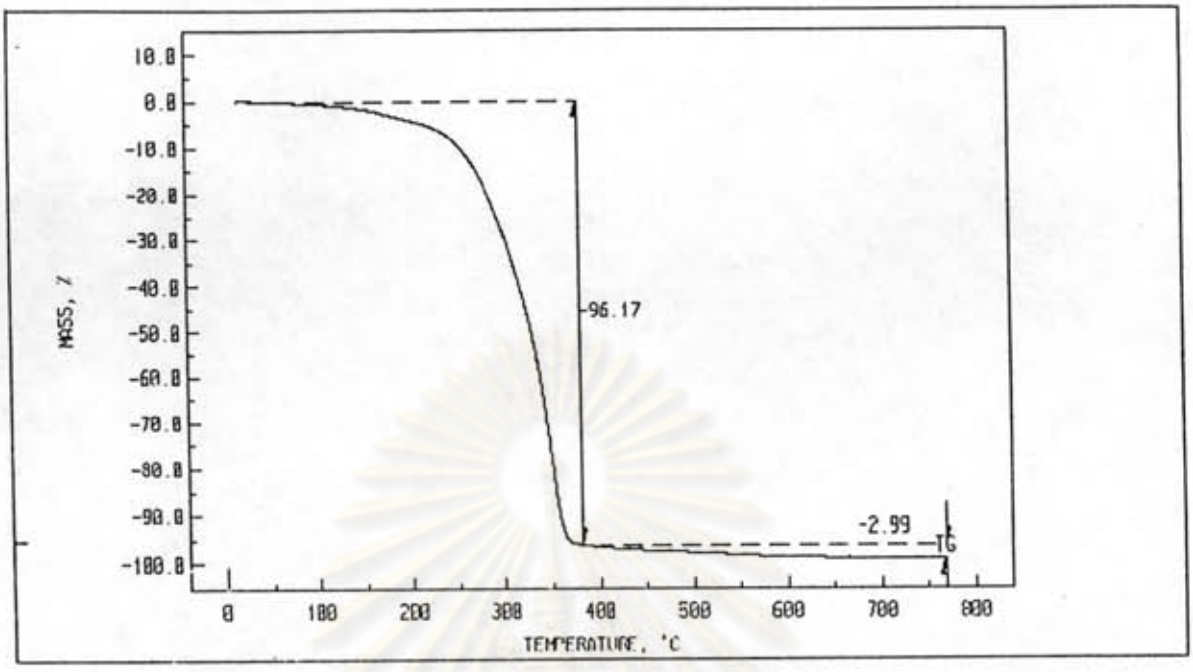

Figure E19 Thermogram of 1,4-butanedipalmitate

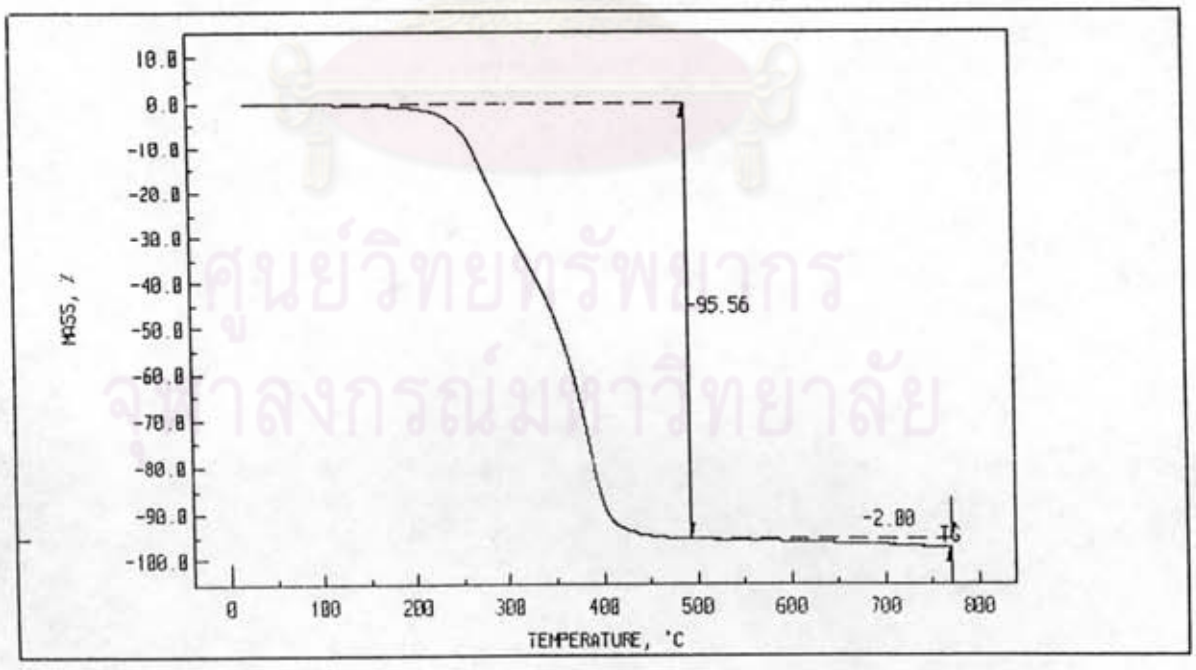

Figure E20 Thermogram of 1,5-pentanedipalmitate

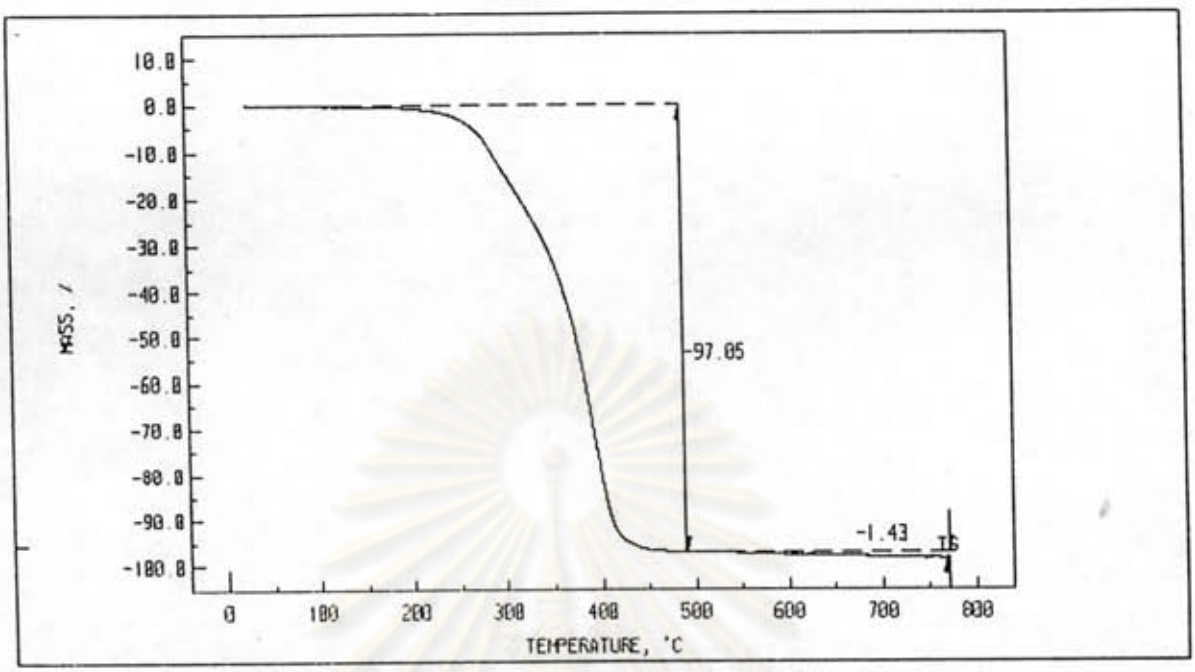

Figure E21 Thermogram of 2,2-dimethyl-1,3-propanedipalmitate

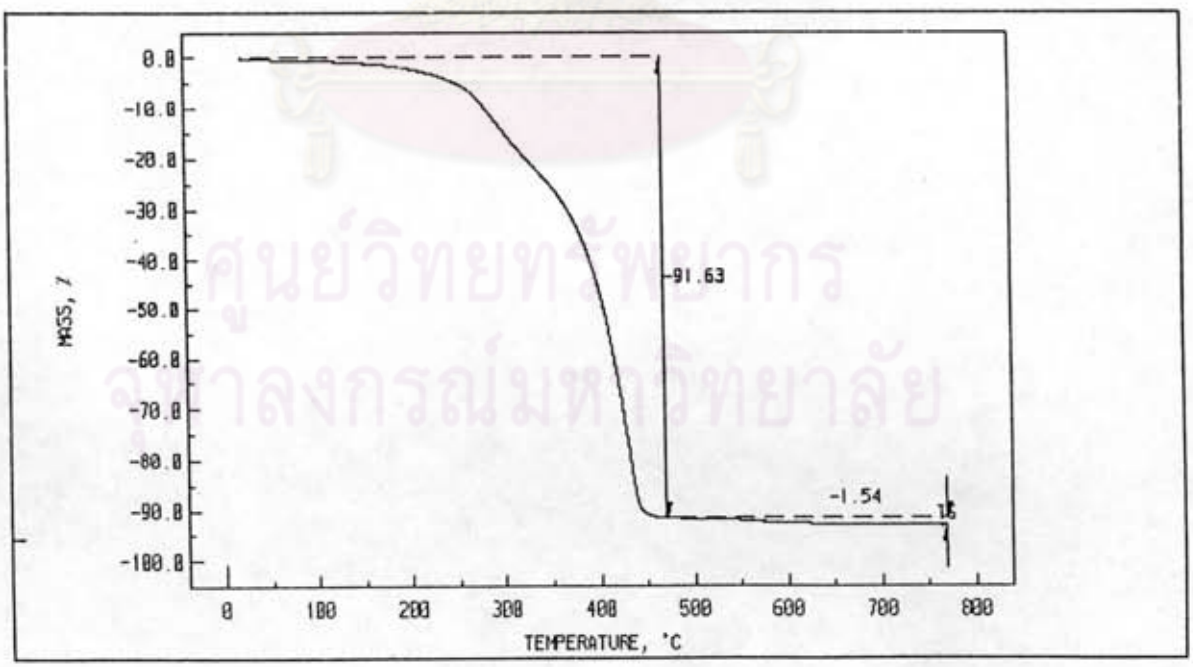

Figure E22 Thermogram of 2-ethyl-1,3-hexanedipalmitate

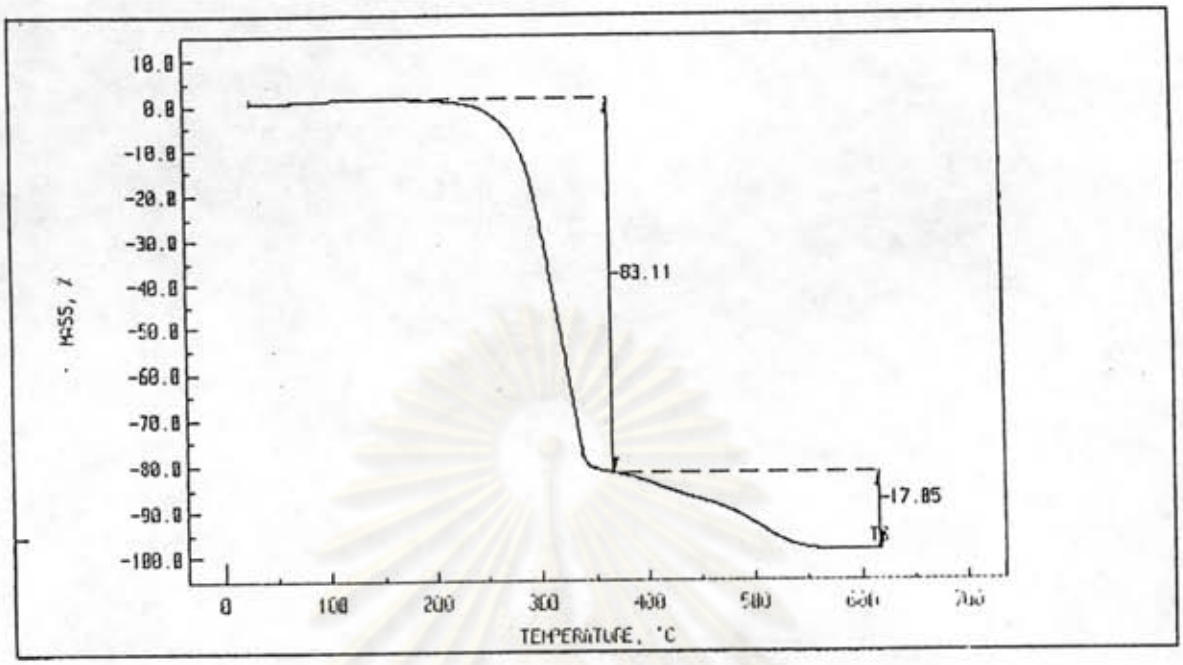

Figure E1 Thermogram of lubricating base oil (150SN)

VITA

Miss Darunee Tubthim was born on March 18, 1972 in Samutprakarn, Thailand. She received her Bachelor of Science degree in chemistry, Faculty of Science, Srinakharinwirot University Prasannmit in 1994. She began her Master study at Multidisciplinary of Petrochemistry and Polymer, Graduate School, Chulalongkorn University, in 1994 and completed the program in 1997.