REFERENCES

1. http://www.photodermatology.com
2. Urbach, F. Ultraviolet radiation and skin cancer of humans. *J. Photochem. Photobiol. B.* 40 (1997): 3-7.
3. Lowe, N.J.; Shaath, N.A.; and Pathak, M.A. *Sunscreen development, evaluation, and regulatory aspects.* 2nd ed. New York: Marcel Dekker, 1997, pp 216-233.
4. Carbonare, M.; and Pathak, M. Skin photosensitizing agents and the role of reactive oxygen species in photoaging. *J. Photochem. Photobiol. B* 14 (1992): 105-124.
5. Steinberg, D. Regulatory Review: Canadian cosmetic regulations Part 2. *Cosmet. Toil.* 116 (July 2001): 22-27.
6. Ricci, C.; Pazzaglia, M.; and Tosti, A. Photocontact dermatitis from UV filters. *Contact Dermatitis* 38 (1998): 343-344.
7. Darvay, A.; White, I.R.; Rycroft, R.J.G.; Jones, A.B.; Hawk, J.L.M.; and McFadden, J.P. Photoallergic contact dermatitis is common. *Br. J. Dermatol.* 145 (2001): 597-601.
8. Hanny, J.; and Nagel, R. Detection of sunscreen agents in human breast milk. *Deutsche Lebensmittel-Rundschau* 91 (1995): 341-345.
9. Hagedorn-Leweke, U., and Lippold, B. Absorption of sunscreens and other compounds through human skin in vivo: derivation of a method to predict maximum fluxes. *Pharm. Res.* 12 (1995): 1354-1360.
10. Hayden, C.G.J.; Roberts, M.S.; and Benson, H.A.E. Systemic absorption of sunscreen after topical application. *Lancet* 350 (1997): 863-864.
11. Gupta, V.K.; Zatz, J.L.; Rerek, M. Percutaneous absorbtion of sunscreens though Micro-Yucatan Pig skin. *In Vitro*. *Pharm. Res.* 16 (1999): 1602-1607.
12. Potard, G.; Laugel, C.; Baillet, A.; Schaefer, H.; and Marty, J.-P. Quantitative HPLC analysis of sunscreens and caffeine during in vitro percutaneous penetration studies. *Int. J. Pharm.* 189 (1999): 249-260.
13. Potard, G.; Laugel, C.; Schaefer, H.; and Marty, J.-P. The stripping technique: In vitro absorption of five UV filters on excised fresh human skin. *Skin Pharmacol. and Appl. Skin Physiol.* 13 (2000): 336-344.

14. Sarveiya, V.; Risk, S.; and Benson, H.A.E. Liquid chromatographic assay for common sunscreen agents: application to in vivo assessment of skin penetration and systemic absorption in human volunteers. *J. Chromatogr. B* 803 (2004): 225-231.

15. Anselmi, C.; Centini, M.; Rossi, C.; Ricci, M.; Rastrelli, A.; Andreassi, M.; Buonocore, A.; and Rosa, C. New microencapsulated sunscreen: Technology and comparative evaluation. *Int. J. Pharm.* 242 (2002): 207-211.

16. Fairhurst, D.; and Mitchnick, M. Submicron encapsulation of organic sunscreen. *Cosmet. Toil.* 110 (September 1995): 47-50.

17. Godwin, D.A.; Kim, N.; and Felton, L.A. Influence of Transcutol® CG on the skin accumulation and transdermal permeation of ultraviolet absorbers. *Eur. J. Phar. Biopharm.* 53 (2002): 23-27.

18. Yener, G.; Incegul, T.; and Yener, N. Importance of using solid liquid microspheres as carriers for UV filters on the example octyl methoxy cinnamte. *Int. J. Pharm.* 258 (2003): 203-207.

19. Jimenez, M.M.; Pelletier, J.; Bobin, M.F.; and Martini, M.C. Influence of encapsulation on the in vitro percutaneous absorption of octyl methoxycinnamate. *Int. J. Pharm.* 272 (2004): 45-55.

20. Pattanaargson, S.; Hongchinnagorn, N.; Hirunsupachot, P.; and Sritana-anant, Y. UV absorption and photoisomerization of *p*-methoxycinnamate grafted silicone. *Photochem. Photobiol.* 80 (2004): 322-325.

21. Hossel, P.; Wunsch, T.; and Dieing, R. Cosmetic or dermatological sunscreen preparations. US Patent 2001/0021375A1, 2001.

22. Odian, G. *Principles of polymerization.* 3rd ed. Singapore: John Wiley & Sons. Inc., 1993, pp 1-9.

23. Yadav, G.D.; and Rahuman, M.S.M. Cation-exchange resin-catalysed acrylations and esterifications in fine chemical and perfumery industries. *Org. Process Res. Dev.* 6 (2002): 706-713.

24. Makita, A.; Nihira, T; and Yamada, Y. Lipase catalyzed synthesis of macrocyclic lactones inorganic solvents. *Tetrahedron Lett.* 28(1987): 805-808.

25. Safari, M.; and Kremasha, S. Interesterification of butterfat by commercial microbial lipases in a cosurfactant-free microemulsion system. *J. Am. Oil. Chem. Soc.* 71(1994): 951-954.

26. Zhi-Wei, G.; Ngooi, T.K.; Scilimati, A.; Fulling, G.; and Sih, C.J. Macrocyclic lactoned via biocatalysis in non-aqueous media. *Tetrahedron Lett.* 29(1988): 5583-5586.

27. Haam, S.; Park, D.; Ahn, I.; Lee, T.; Kim, H.; and Kim, W. Enzymatic esterification of β-methylglucoside with acrylic/methacrylic acid in organic solvents. *J. Biotechnol.* 107(2004): 151-160.

28. Chaudhary, A.K.; Lopez, J.; Beckman, E.J.; and Russell, A.J. Biocatalytic solvent-free polymerization to produce high molecular weight polyesters. *Biotechnol. Prog.* 13(1997): 318-325.

29. Gross, R.A.; Mahapatro, A.; Kumar, A.; and Kalra, B. Solvent-free adipic acid/1,8-octanediol condensation polymerizations catalyzed by *Candida antartica* Lipase B. *Macromolecules* 37 (2004): 35-40.

30. Gross, R.A: Kulshrestha, A.S.; and Gao, W. Glycerol copolyesters: control of branching and molecular weight using a lipase catalyst. *Macromolecules* 38 (2005): 3193-3204.

31. Mouloungui, Z.; and Lucaze-Dufaure, C. Catalysed or uncatalysed esterification reaction of oleic acid with 2-ethyl hexanol. *App. Cat. A: General* 204 (2000): 223-227.

32. Tsukruk, V.V.; Zhai, X.; Peleshanko, S.; Klimenko, N.S.; Genson, K.I.; Vaknin, D.; Vortman, M.Y.; and Shevehenko, V.V. Amphiphilic dendritic molecules: hyperbranched polyesters with alkyl-terminated branches. *Macromolecules* 36 (2003): 3101-3110.

33. Wang, G.J.L.; Chen, T.; Yu, H.; Dong, X.; and Chen, C. Synthesis and self-assembly of hyperbranched polyester peripherally modified by touluene-4-sulfonyl groups. *Polymer* 46 (2005): 9501-9507.

34. Takasu, A.; Takemoto, A.; and Hirabayashi, T. Polycondensation of dicarboxylic acids and diols in water catalyzed by surfactant-combined catalysts and successive chain extension. *Biomacromolecules* 7 (2006): 6-9.

35. Scigalski, F.; Toczek, M.; andPaczkowski, J. Cinnamates VI. Light-sensitive polymers with pendent *o*-, *m*- and *p*-hdroxycinnamate moieties. *Polymer* 35 (1994): 692-698.

36. Tsutsumi, H.; Shibasaki, Y.; Onimura, K.; and Oishi, T. Preparation of photo-patterned polymer-hydroxyapatite composites. *Polymer* 44 (2003): 6297-6301.

37. Sung, S.; Cho, K.; Yoo, J.; Kim, W.S.; Chang, H.; Cho, I.; and Park, J. Dimerization behavior of cinnamate group attached to flexible polymer backbone and its effect on the molecular orientation. *Chem. Phys. Lett.* 394 (2004): 238-243.

38. Agrapidis-Paloympis, L. E.; and Nash, R. A. The effect of solvents on the ultraviolet absorbance of sunscreens. *J. Soc. Cosmet. Chem.* 38 (1987): 209-227.

39. Skoog, D. A.; West, D. M.; and Holler, F. J. *Fundamentals of analytical chemistry*. 7th ed. New York: Saunders College Publishing, 1997, pp 510-511.

40. Patanaargson, S.; and Limpong, P. Stability of octyl methoxycinnamate and identification of its photo-degradation product. *Int. Cosmet. Sci.* 23 (2001): 153-160.

APPENDICES

APPENDIX A

A.1 Calculation of molar absorptivity of polymer

$$X \text{ ppm} = \frac{X\times10^{-3}}{\text{Molecular weight}} \quad \text{moles of polymer/1000 mL}$$

$$= \frac{X\times10^{-3}}{\text{Molecular weight}} \times \text{(Repeating unit)} \quad \text{moles of monomer/1000 mL}$$

A.2 Calculation of percent penetration of octyl methoxycinnamate

$$A = \varepsilon bc$$

Where A is absorbance

b is the cell path length (1 cm)

c is the concentration of the absorbing species in mol per litre

Molar absorptivity (ε) of octyl methoxycinnmate are 23,000 $M^{-1}cm^{-1}$.

$$c_{OMC} = \frac{A}{23000}$$

$$= \mathbf{X} \quad \text{mole/ litre}$$

Receptor volume is 13 mL, and molecular weight of OMC is 290.4:

$$\text{Weight of Penetrated OMC} = \mathbf{X} \times \frac{13}{1000} \times 290.4$$

Weight of initial OMC is 0.005 g:

$$\text{Percent penetration} = \frac{\text{Weight of penetrated OMC}}{\text{Weight of initial OMC}} \times 100$$

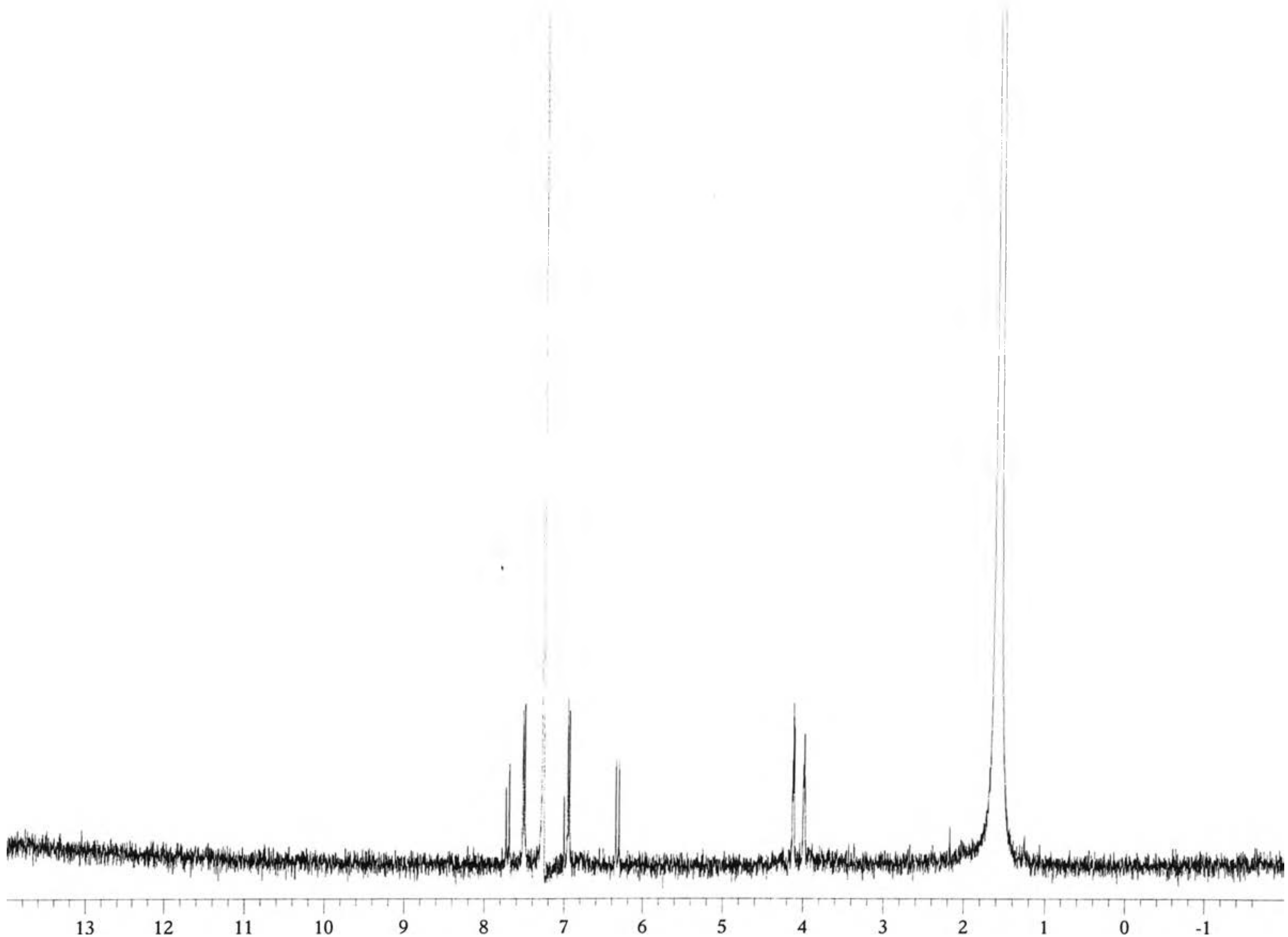

Figure B.1 ^{1}H-NMR ($CDCl_3$) spectrum of *p*-(2-hydroxy ethoxy) cinnamic acid (M-2)

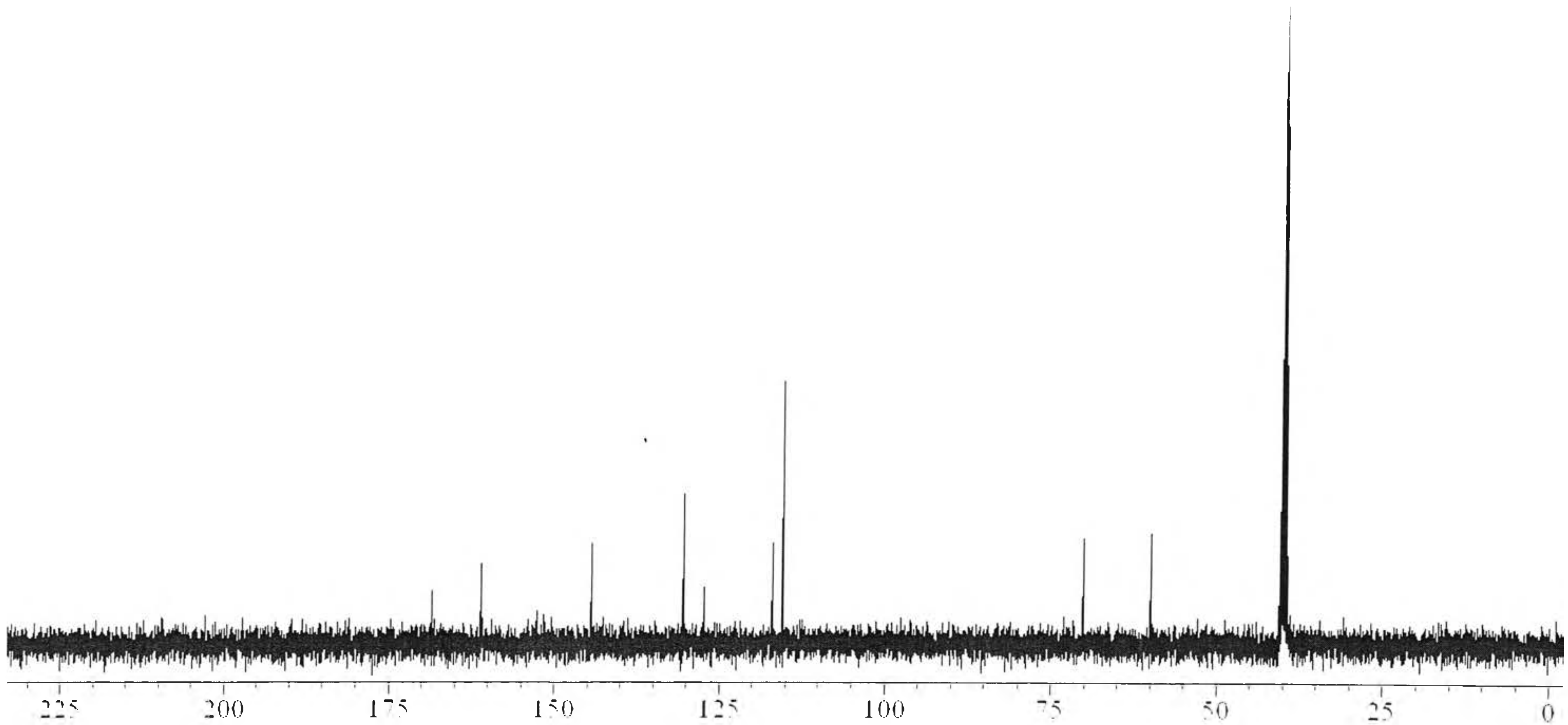

Figure B.2 ^{13}C-NMR (DMSO-d_6) spectrum of *p*-(2-hydroxy ethoxy) cinnamic acid (M-2)

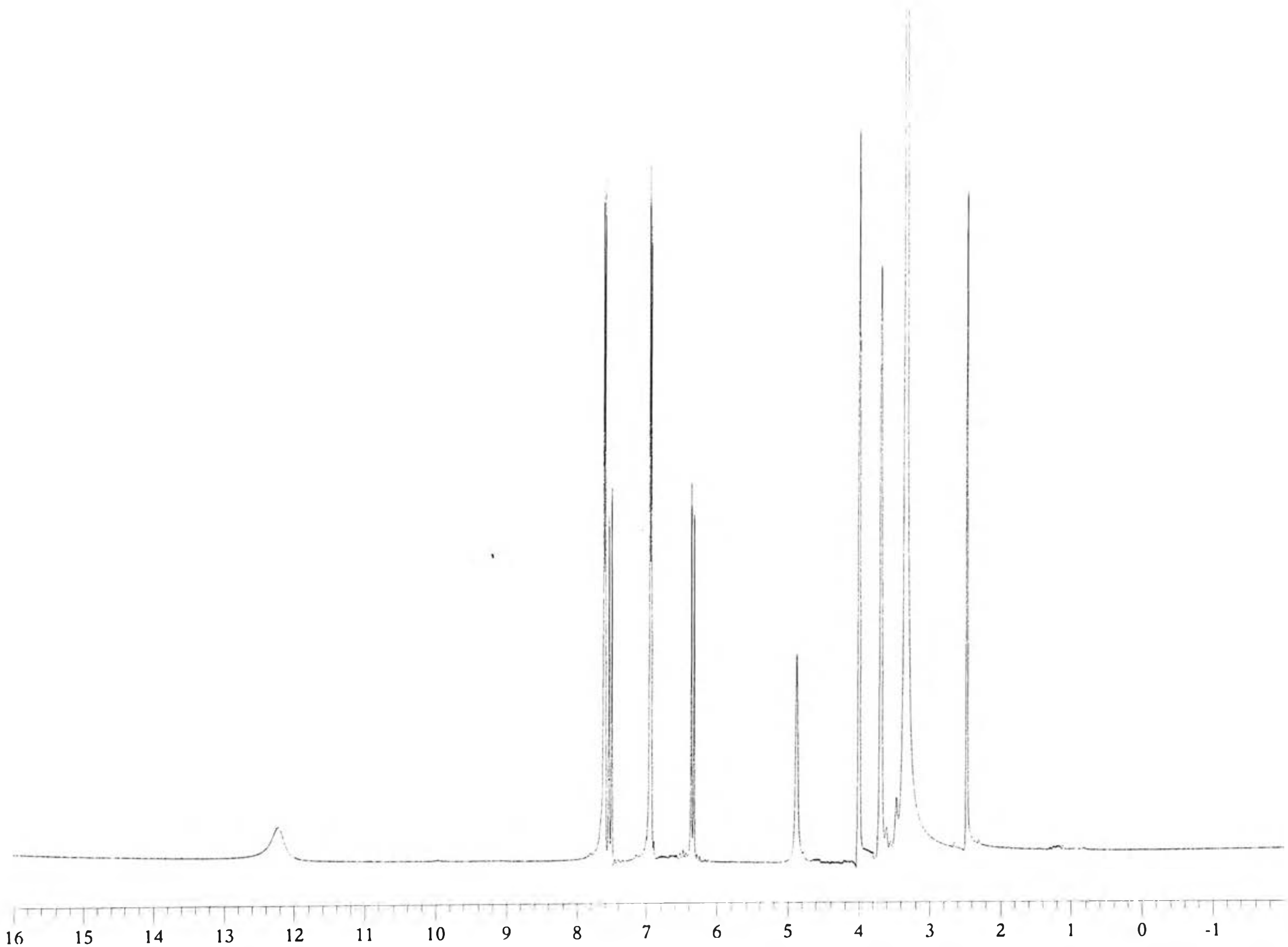

Figure B.3 ^{1}H-NMR (DMSO-d_6) spectrum of *p*-(2-hydroxy ethoxy) cinnamic acid (M-2)

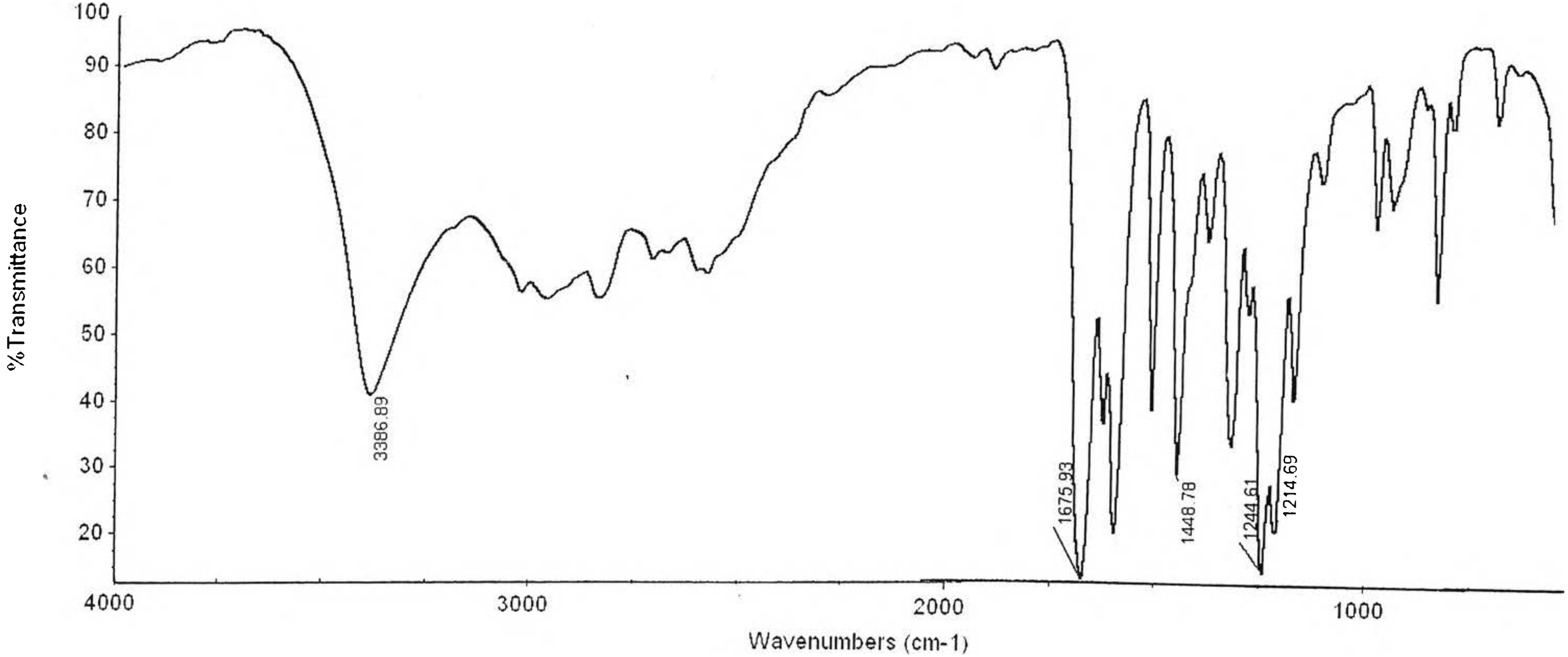

Figure B.4 IR spectrum of *p*-(2-hydroxy ethoxy) cinnamic acid (M-2)

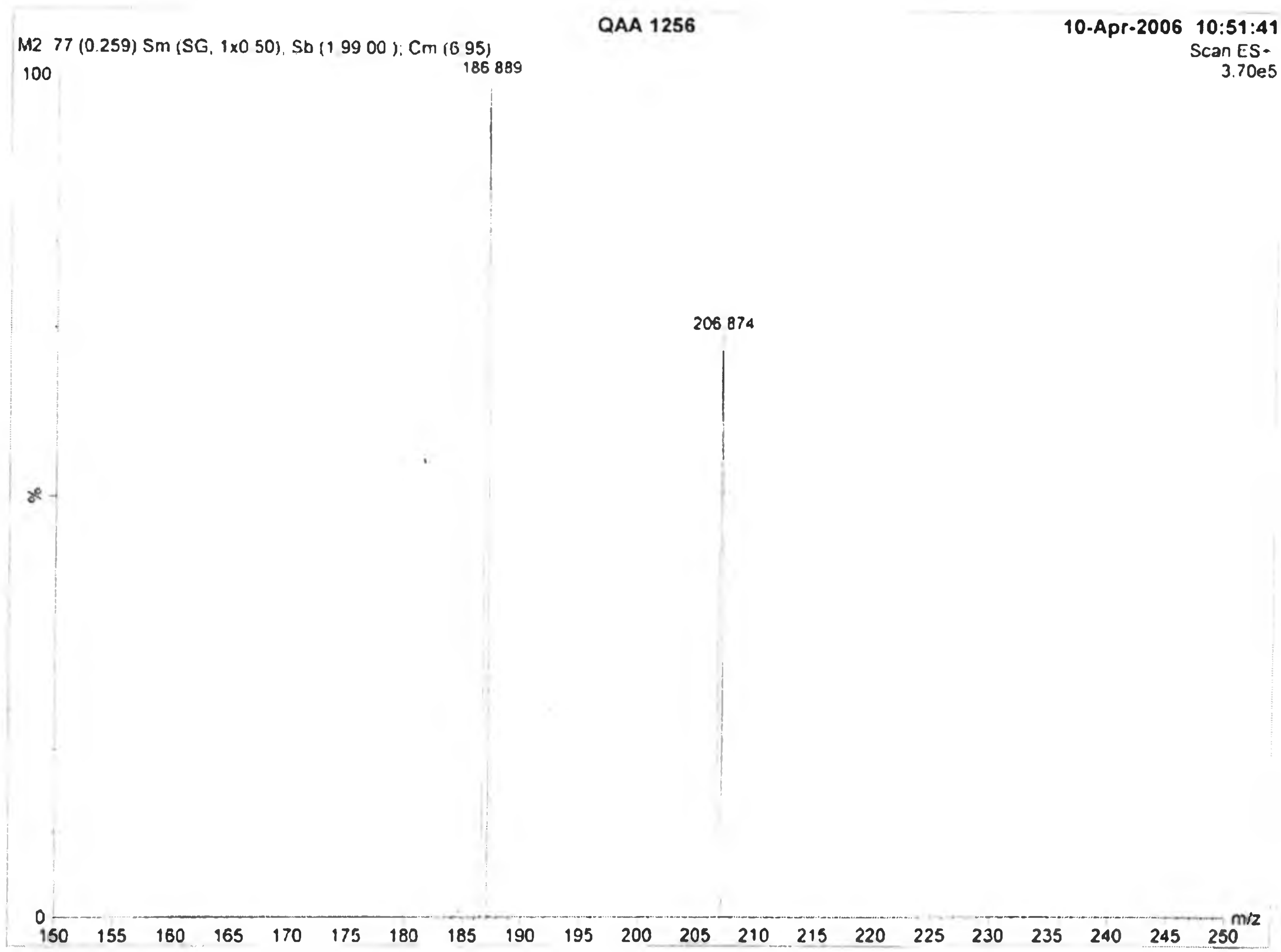

Figure B.5 Mass spectrum of *p*-(2-hydroxy ethoxy) cinnamic acid (M-2)

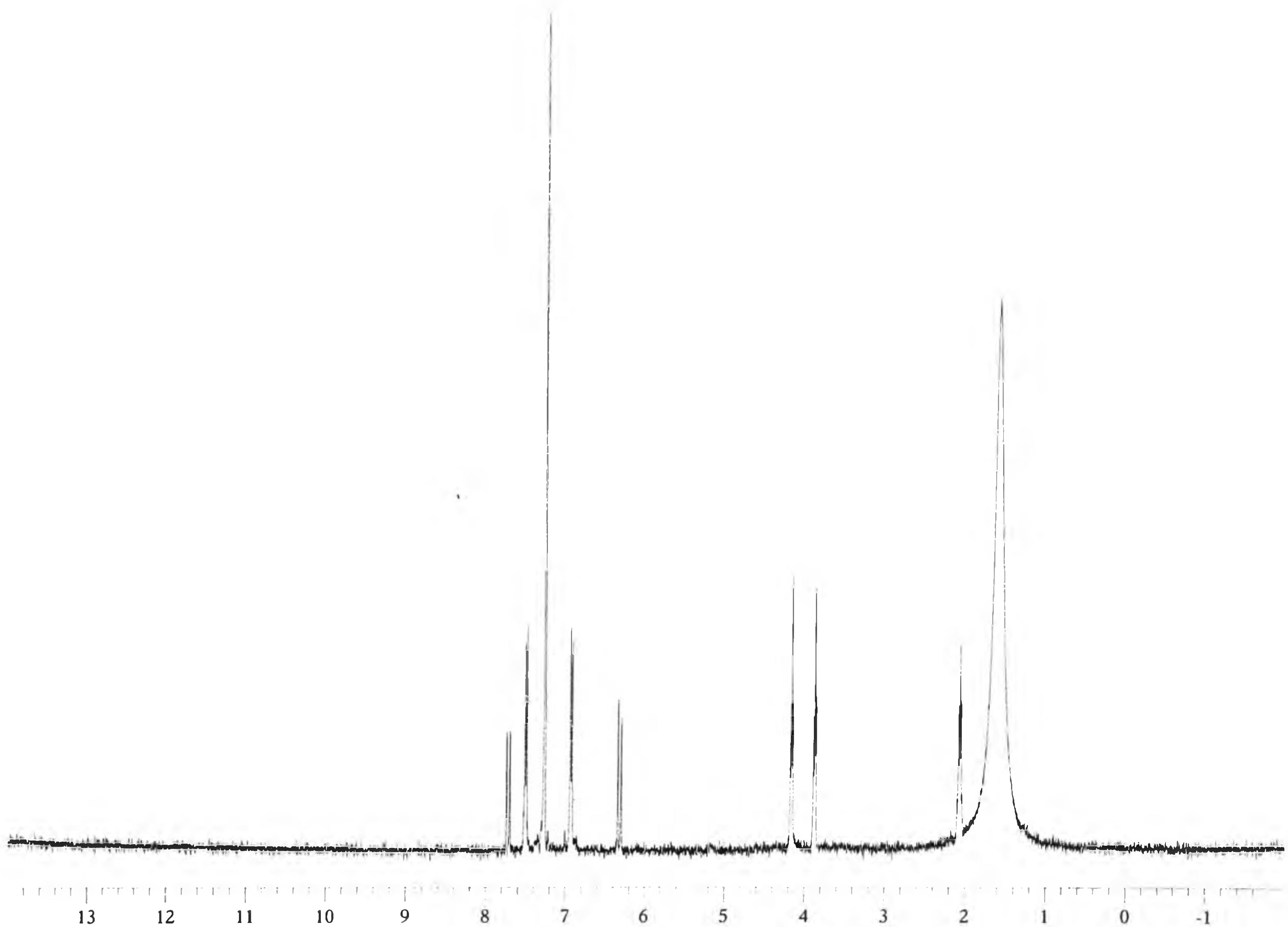

Figure B.6 ^{1}H-NMR ($CDCl_3$) spectrum of *p*-(3-hydroxy propoxy) cinnamic acid (M-3)

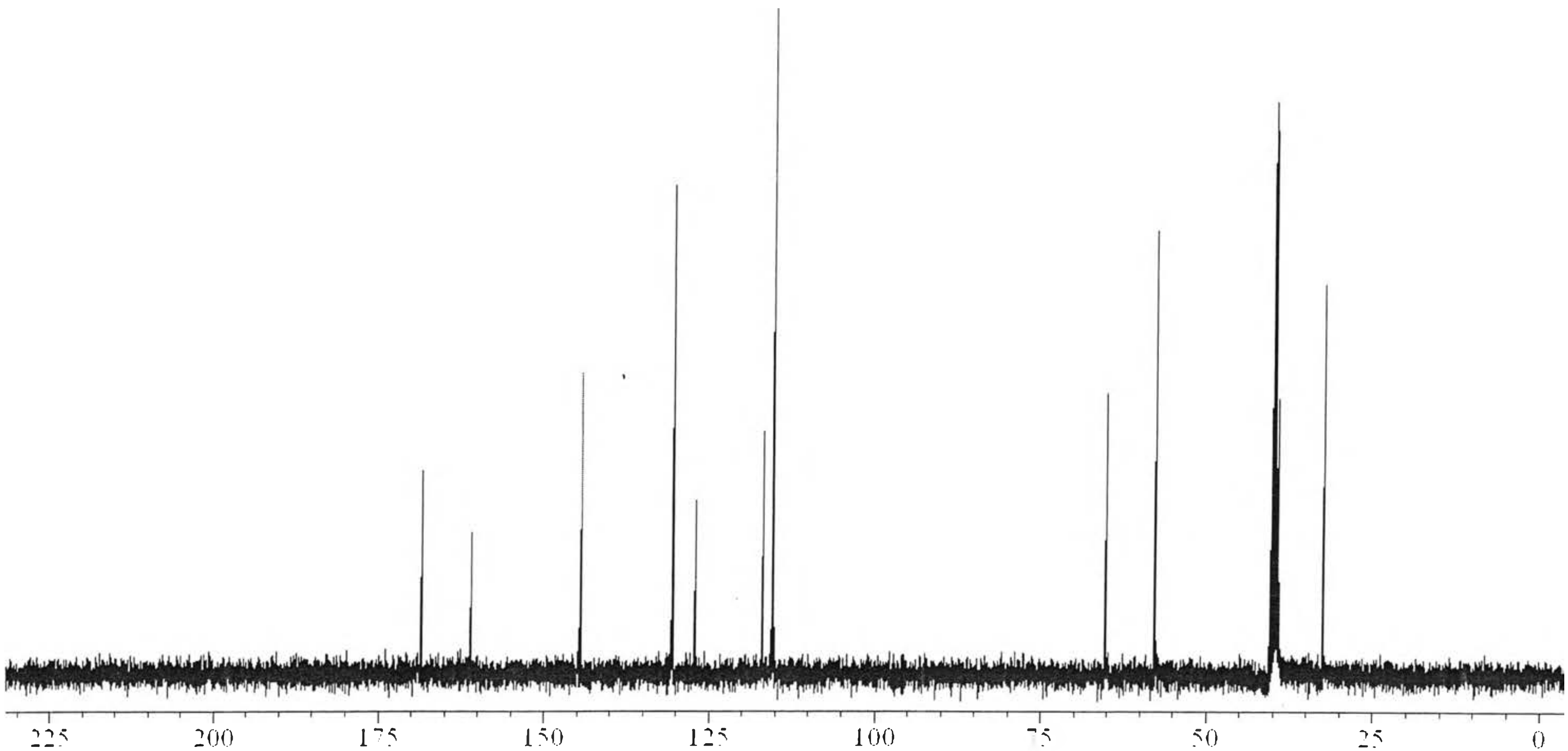

Figure B.7 ^{13}C-NMR (DMSO-d_6) spectrum of *p*-(3-hydroxy propoxy) cinnamic acid (M-3)

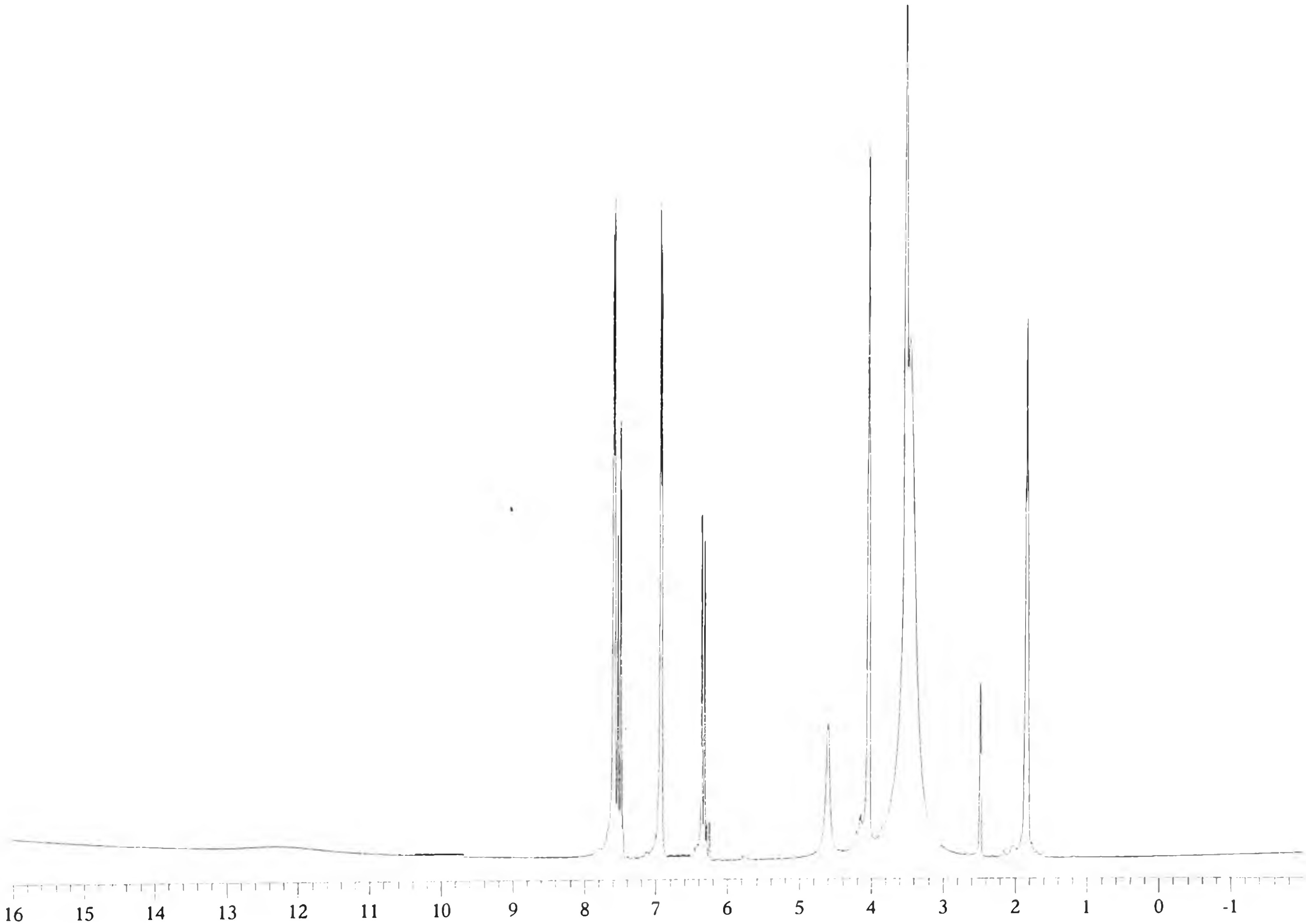

Figure B.8 ^{1}H-NMR (DMSO-d_6) spectrum of *p*-(3-hydroxy propoxy) cinnamic acid (M-3)

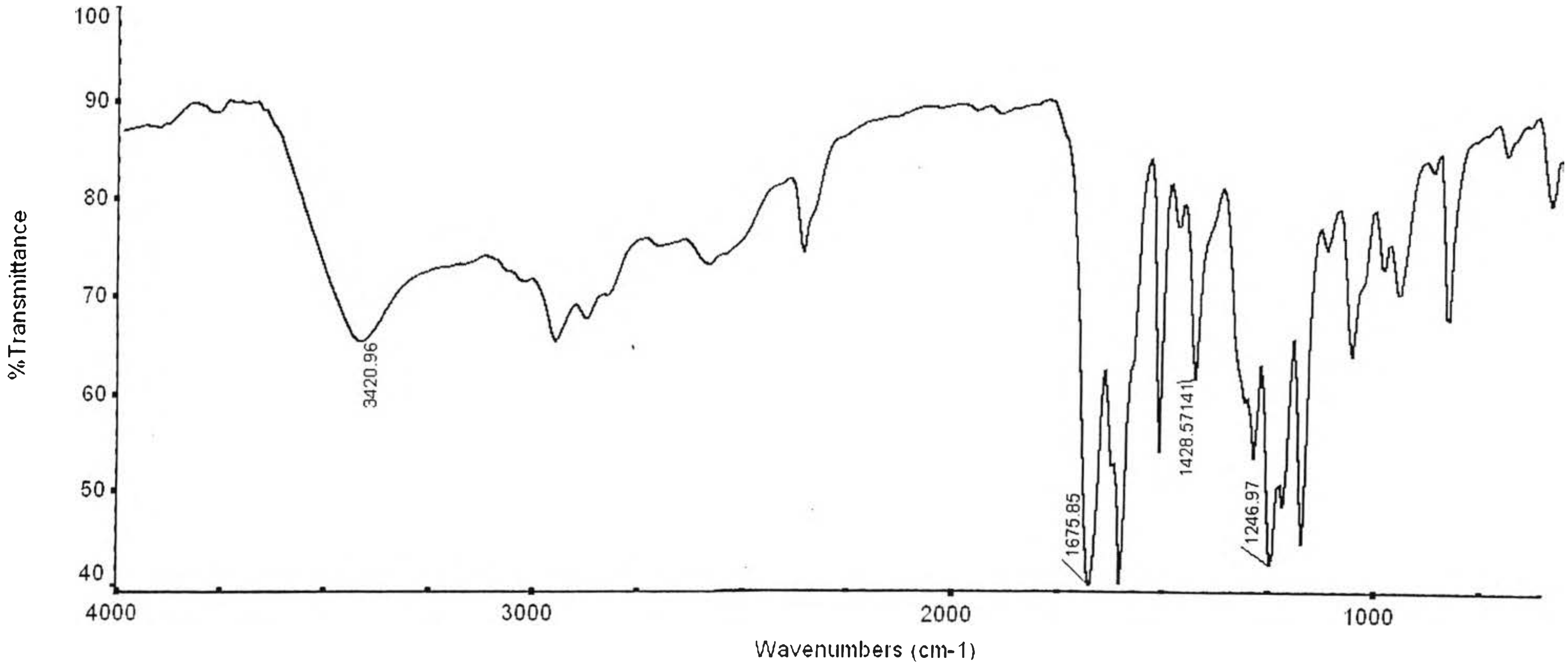

Figure B.9 IR spectrum of *p*-(3-hydroxy propoxy) cinnamic acid (M-3)

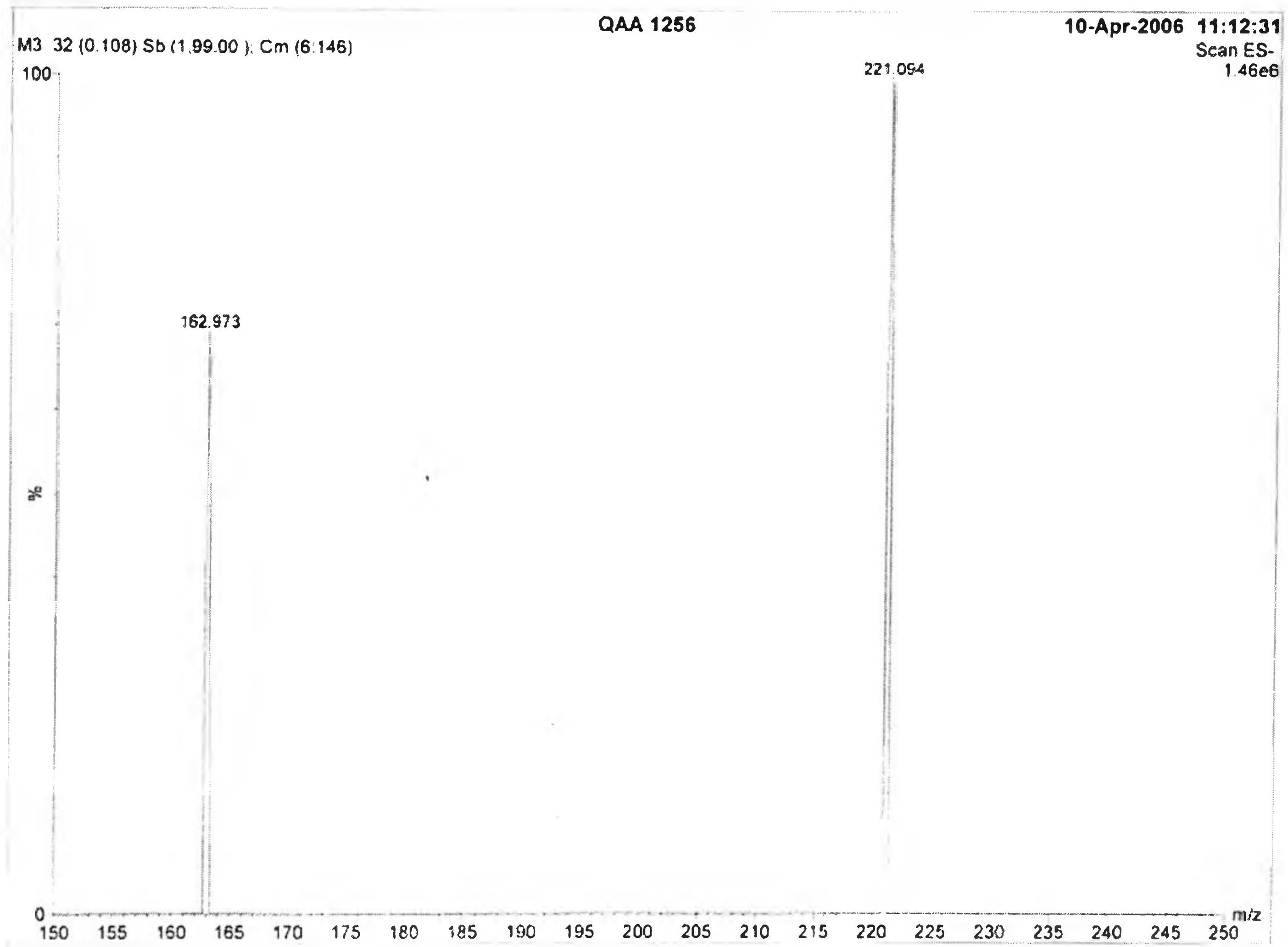

Figure B.10 Mass spectrum of *p*-(3-hydroxy propoxy) cinnamic acid (M-3)

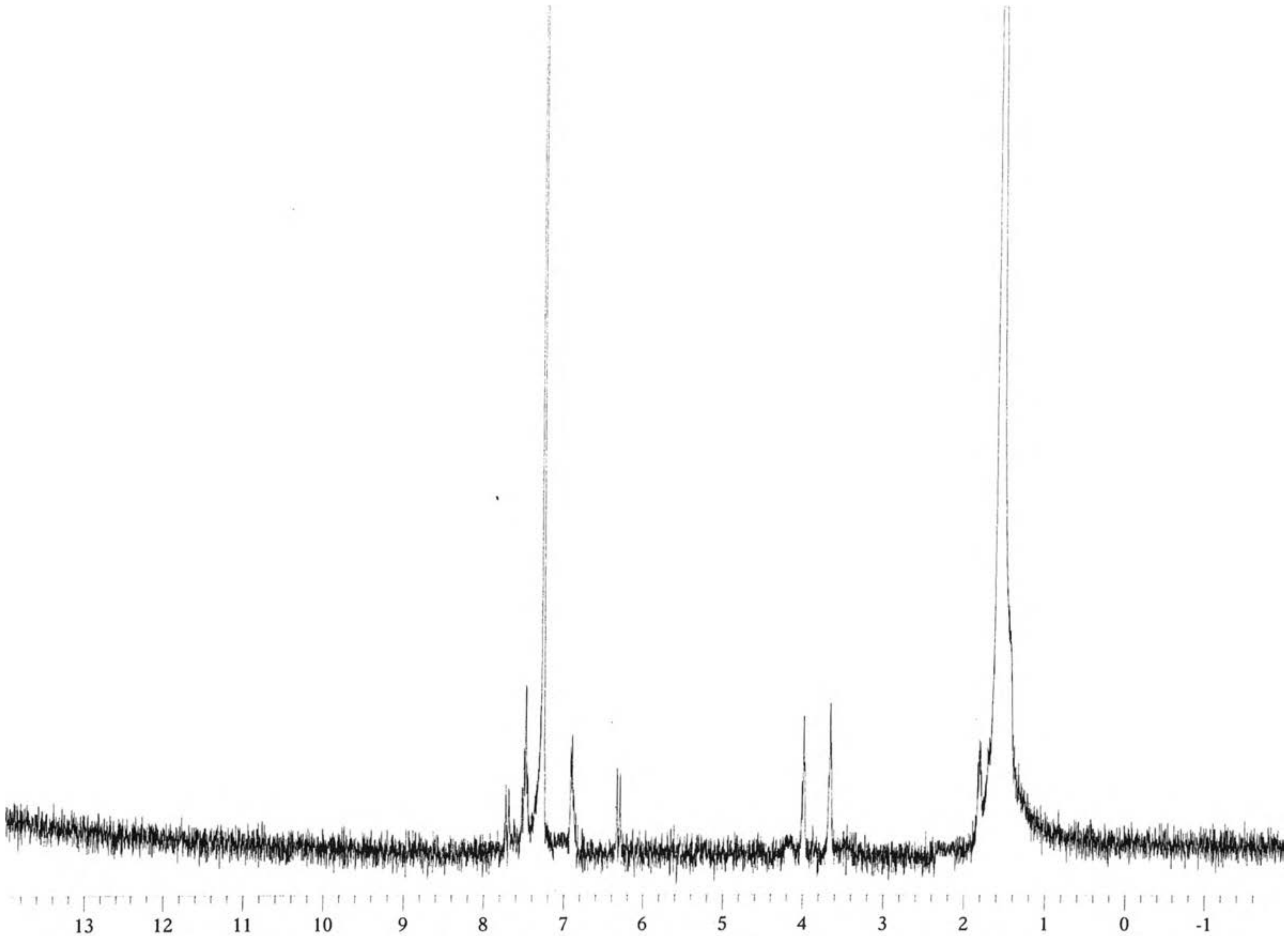

Figure B.11 ^{1}H-NMR ($CDCl_3$) spectrum of *p*-(6-hydroxy hexyloxy) cinnamic acid (M-6)

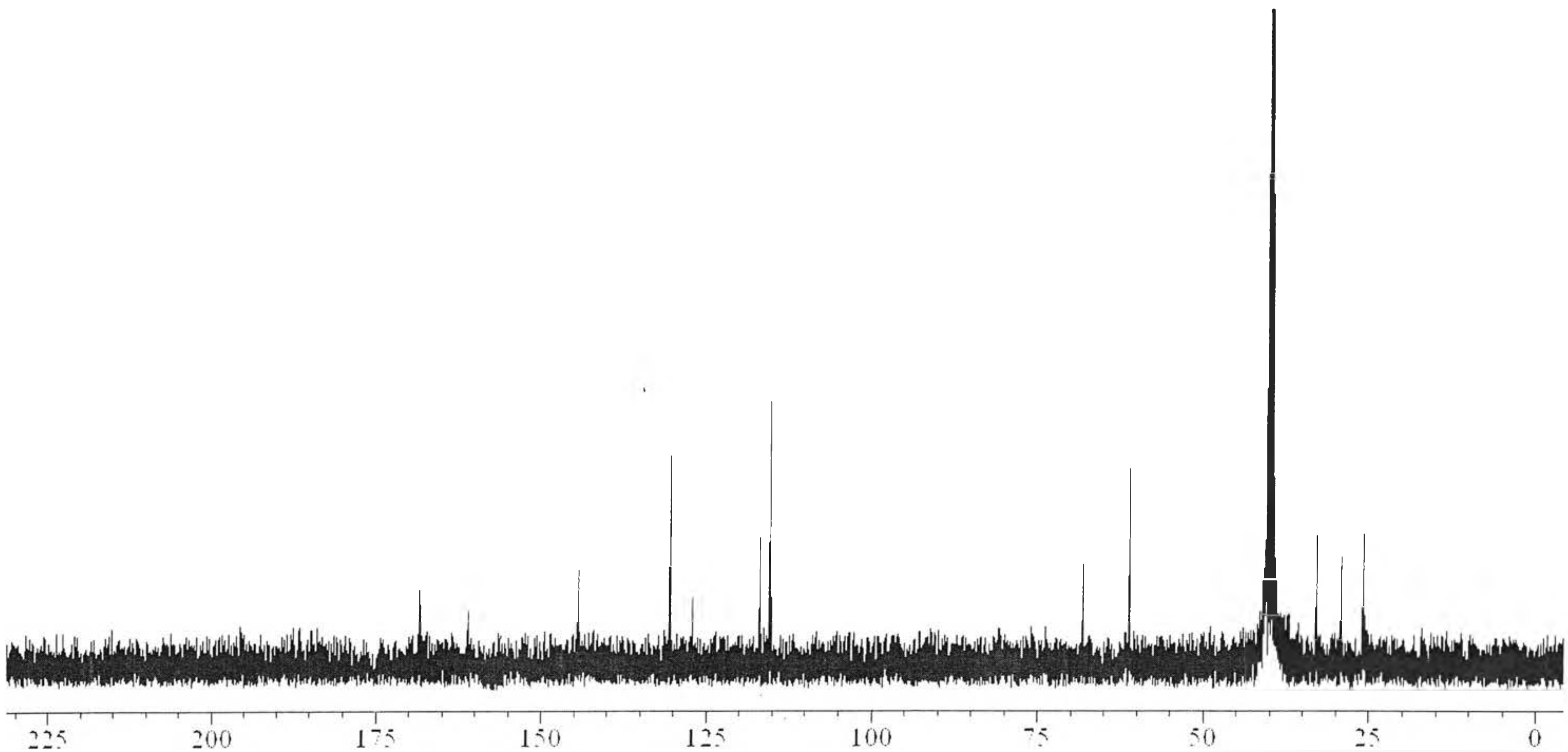

Figure B.12 ^{13}C-NMR (DMSO-d_6) spectrum of *p*-(6-hydroxy hexyloxy) cinnamic acid (M-6)

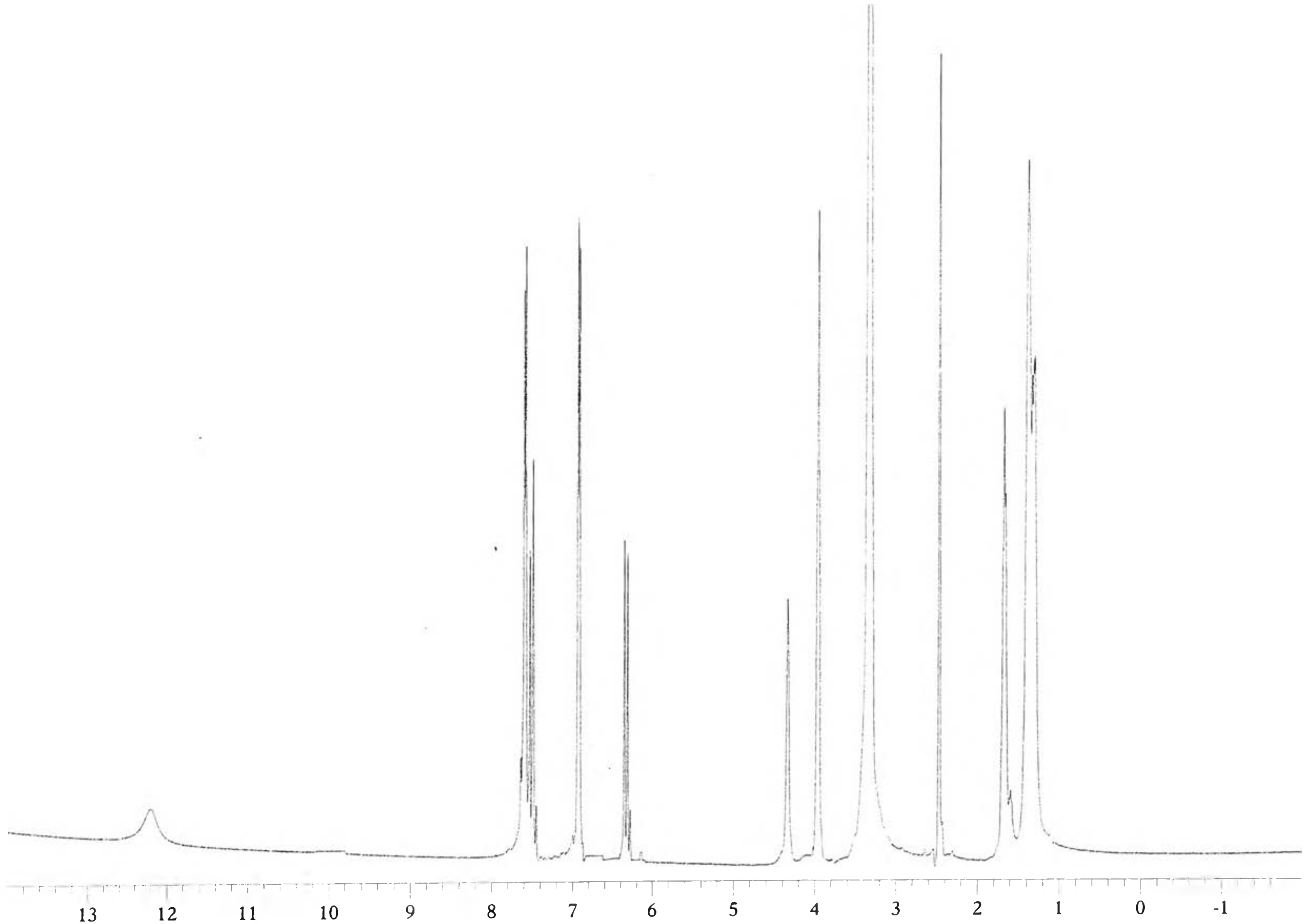

Figure B.13 ^{1}H-NMR (DMSO-d_6) spectrum of *p*-(6-hydroxy hexyloxy) cinnamic acid (M-6)

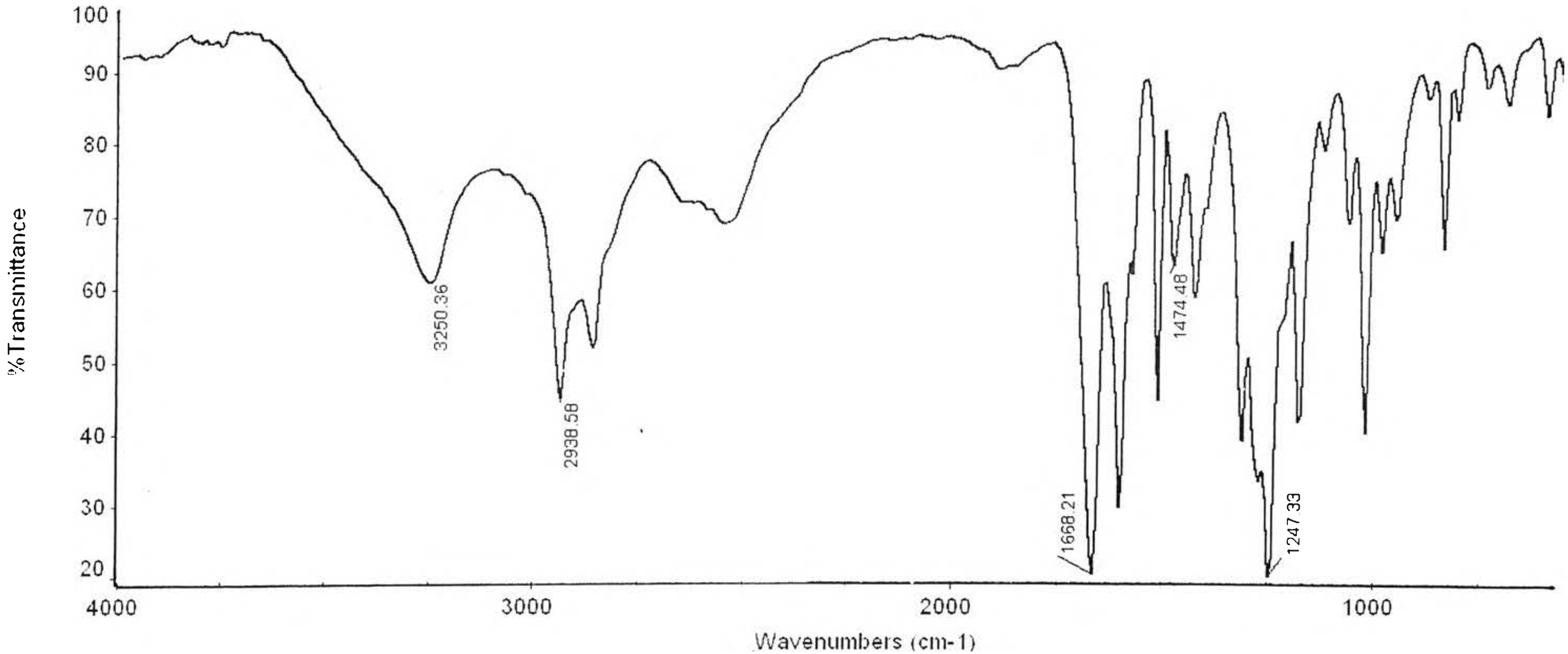

Figure B.14 IR spectrum of *p*-(6-hydroxy hexyloxy) cinnamic acid (M-6)

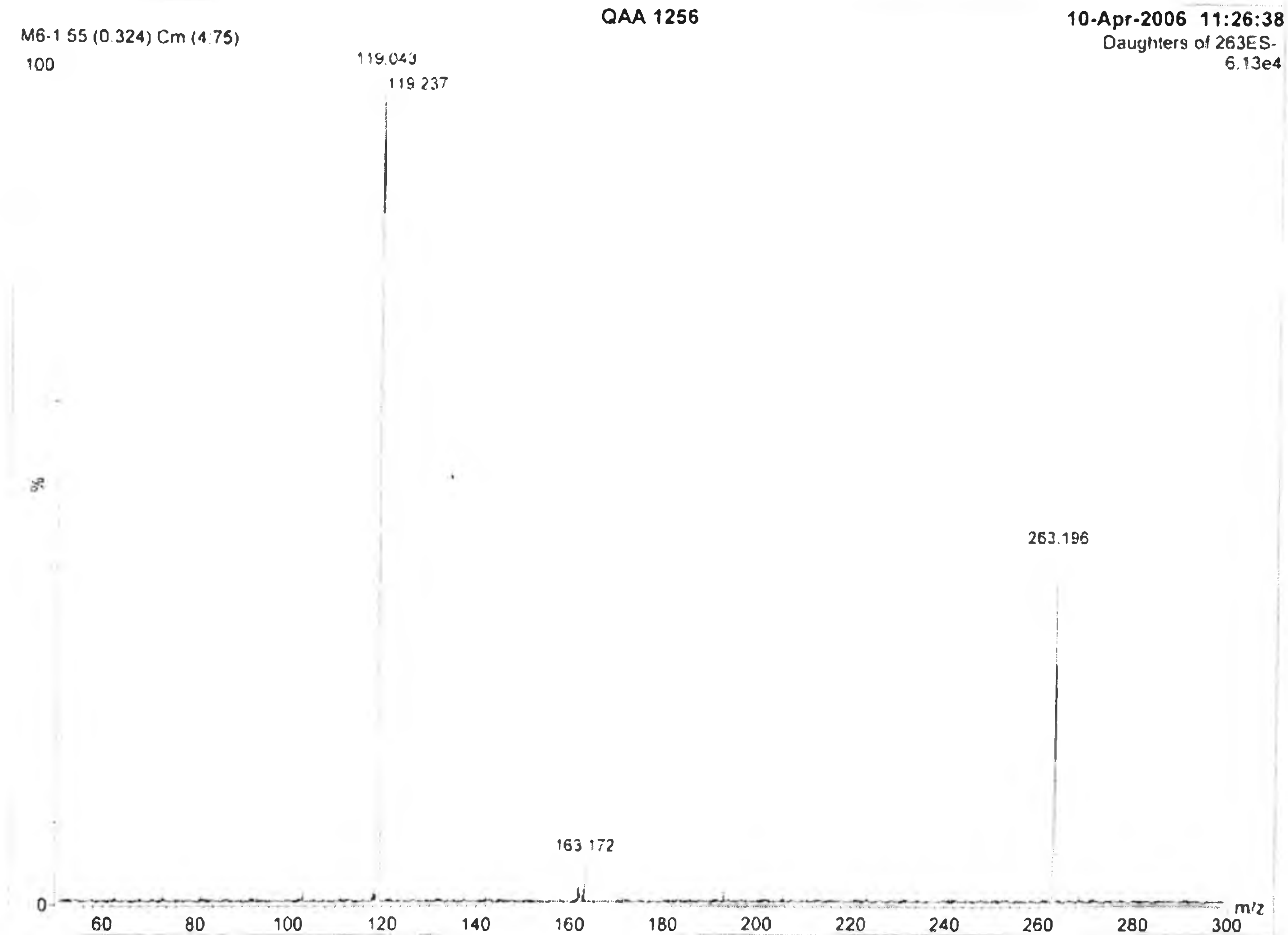

Figure B.15 Mass spectrum of *p*-(6-hydroxy hexyloxy) cinnamic acid (M-6)

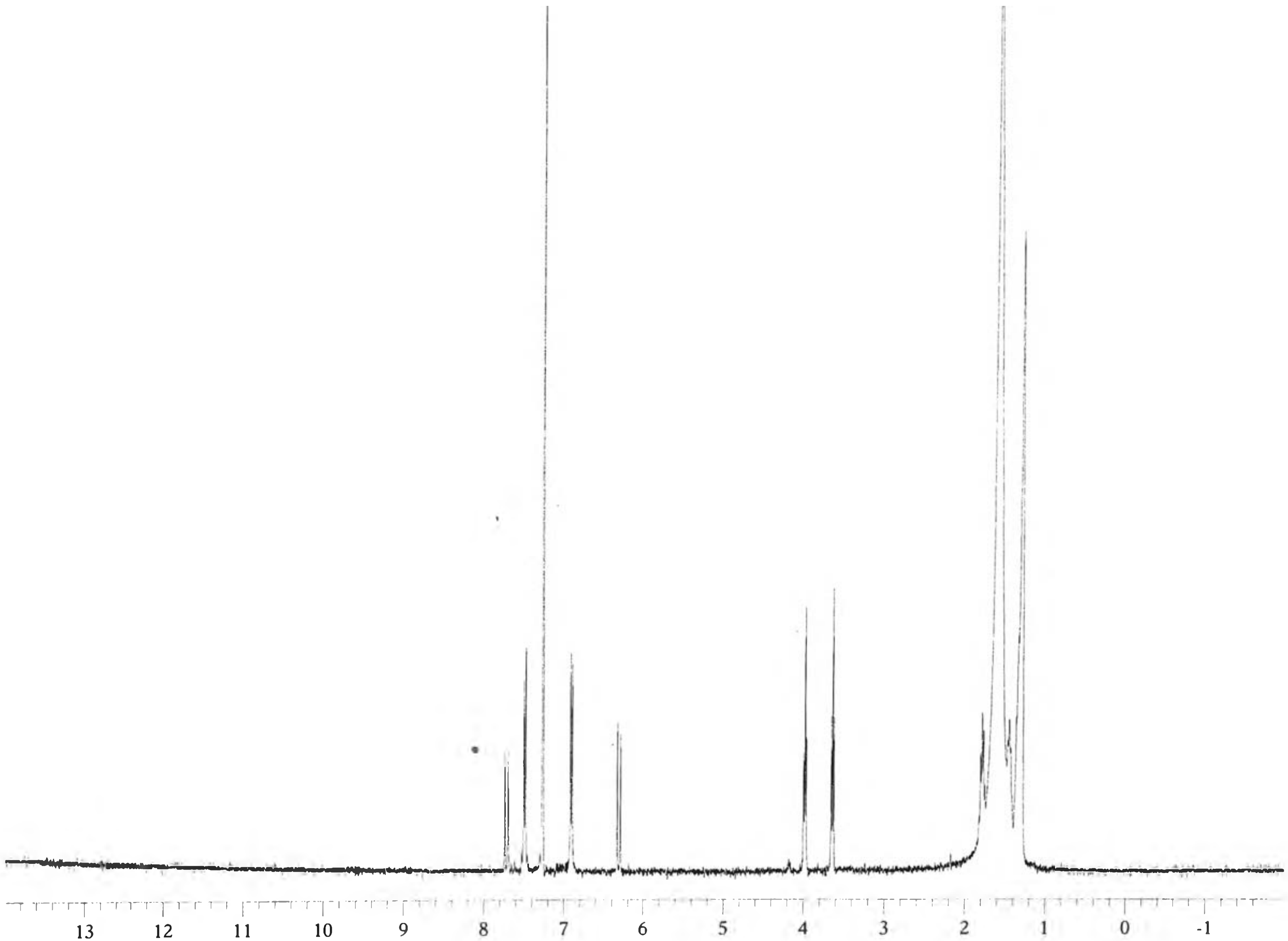

Figure B.16 ^{1}H-NMR ($CDCl_3$) spectrum of *p*-(11-hydroxy undecyloxy) cinnamic acid (M-11)

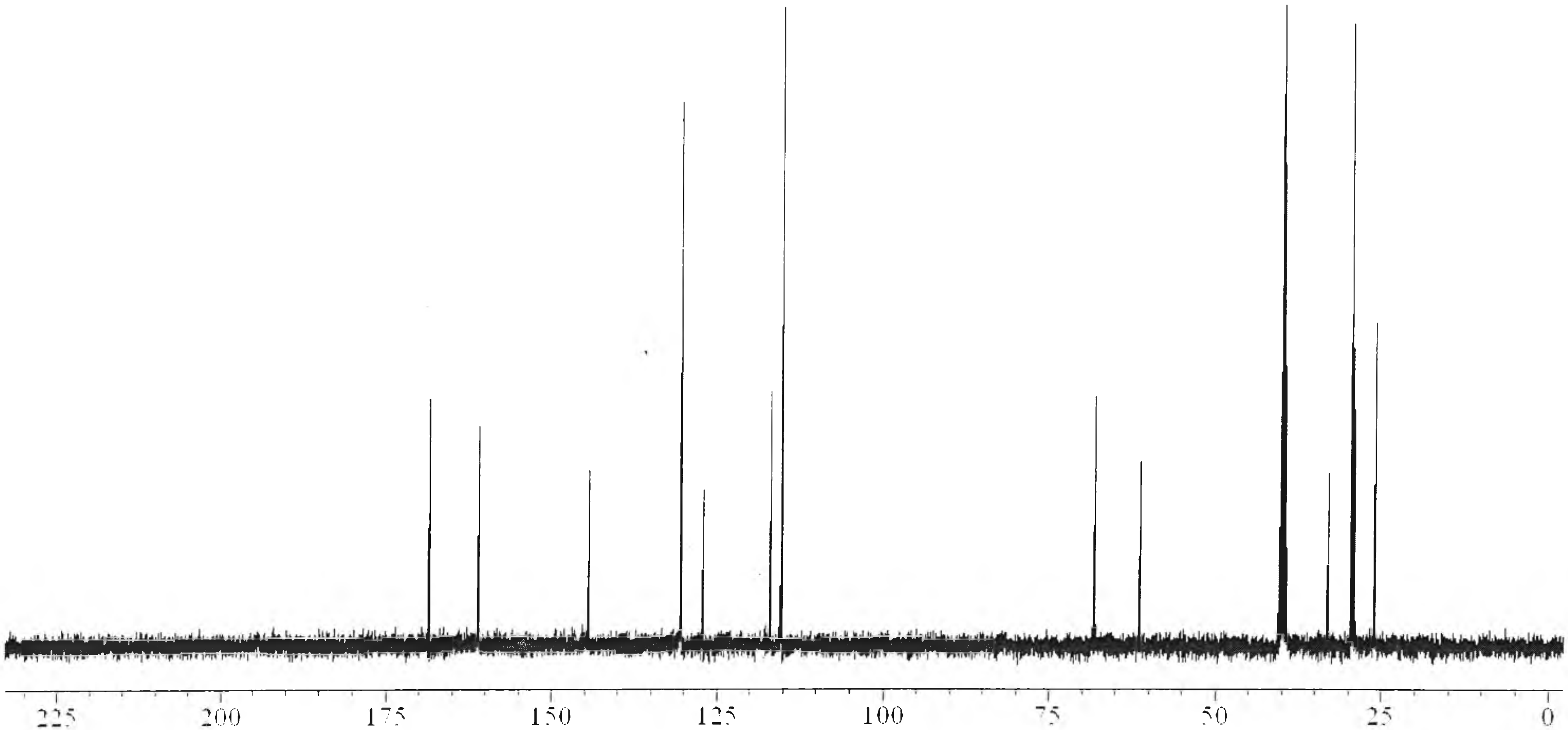

Figure B.17 ^{13}C-NMR (DMSO-d_6) spectrum of *p*-(11-hydroxy undecyloxy) cinnamic acid (M-11)

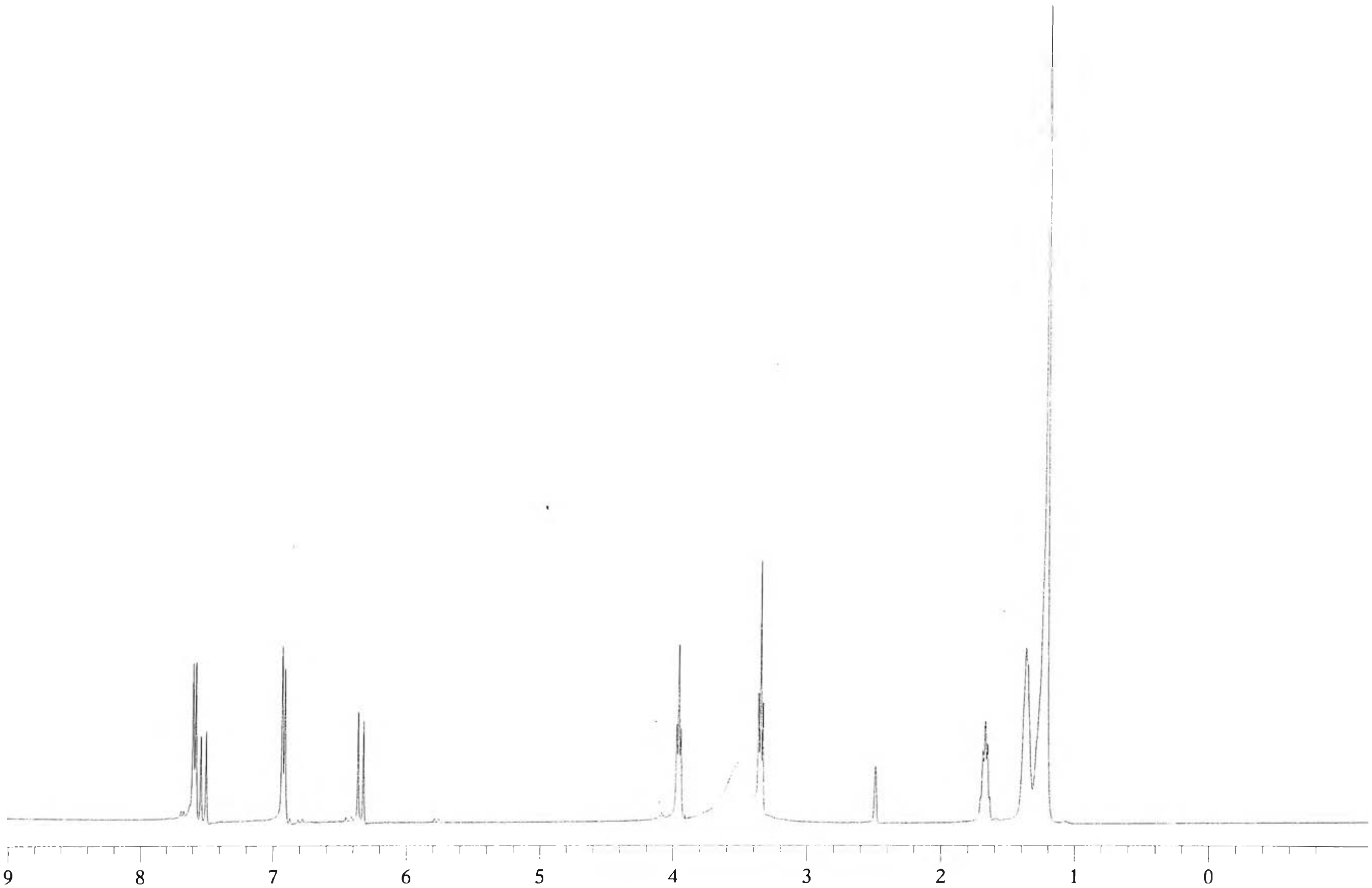

Figure B.18 ^{1}H-NMR (DMSO-d_6) spectrum of *p*-(11-hydroxy undecyloxy) cinnamic acid (M-11)

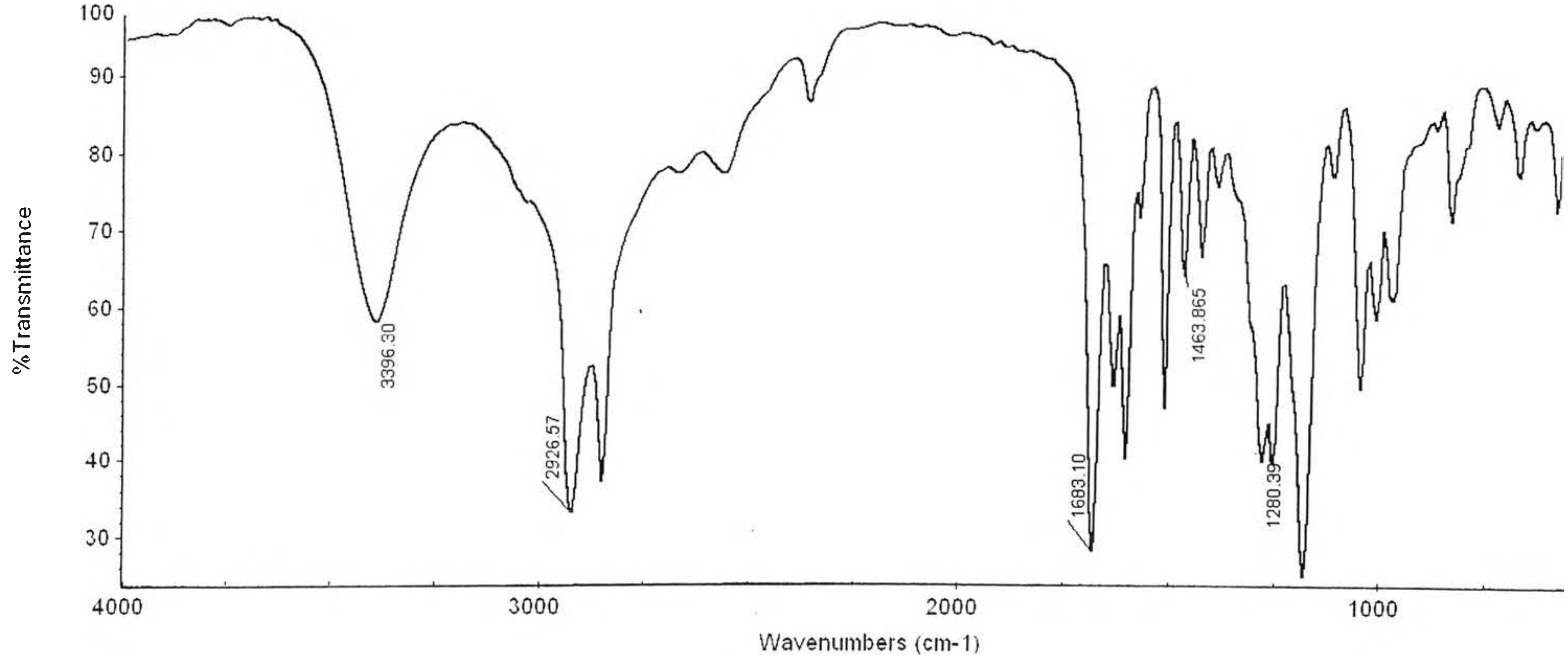

Figure B.19 IR spectrum of *p*-(11-hydroxy undecyloxy) cinnamic acid (M-11)

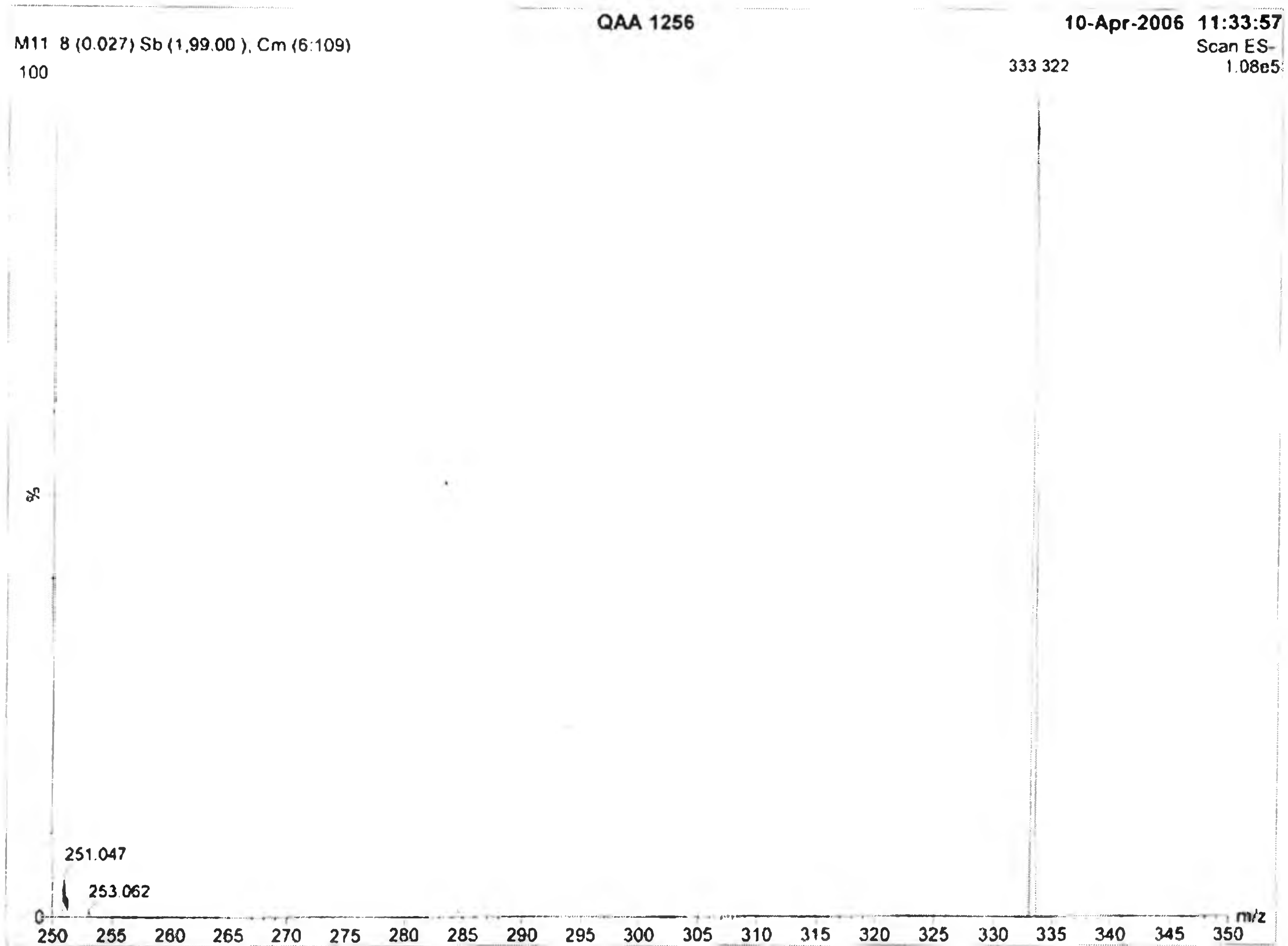

Figure B.20 Mass spectrum of *p*-(11-hydroxy undecyloxy) cinnamic acid (M-11)

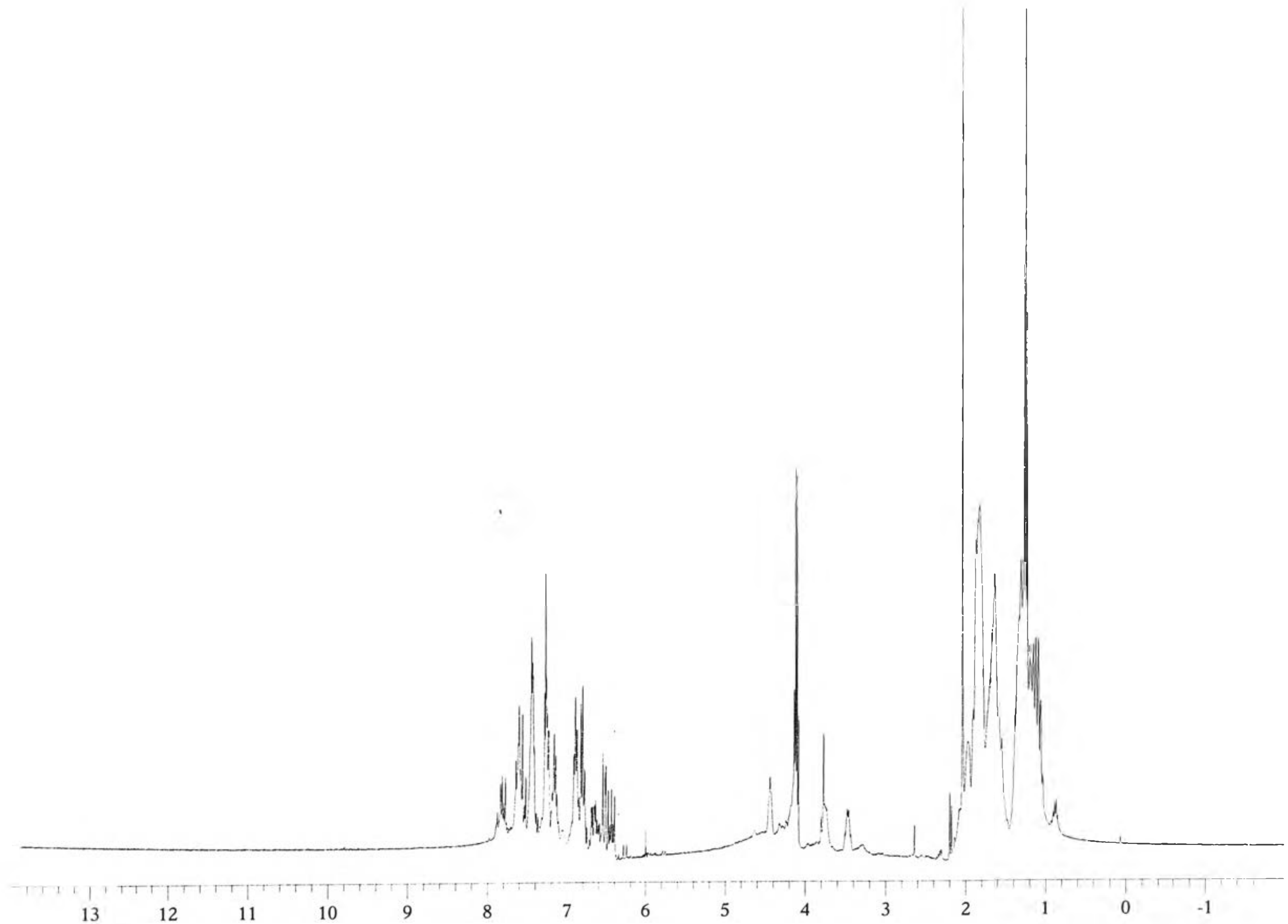

Figure B.21 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-ethoxy cinnamate), P-2

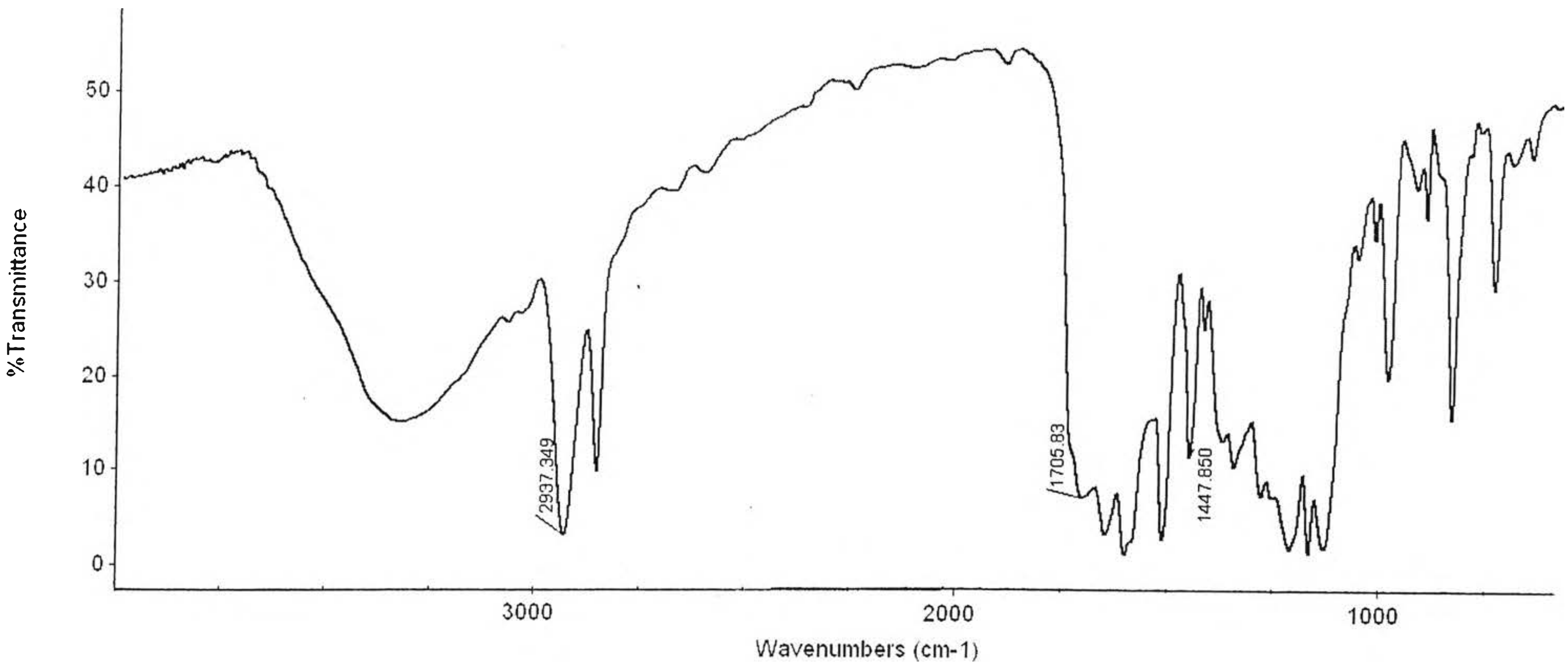

Figure B.22 IR spectrum of poly(*p*-ethoxy cinnamate), P-2

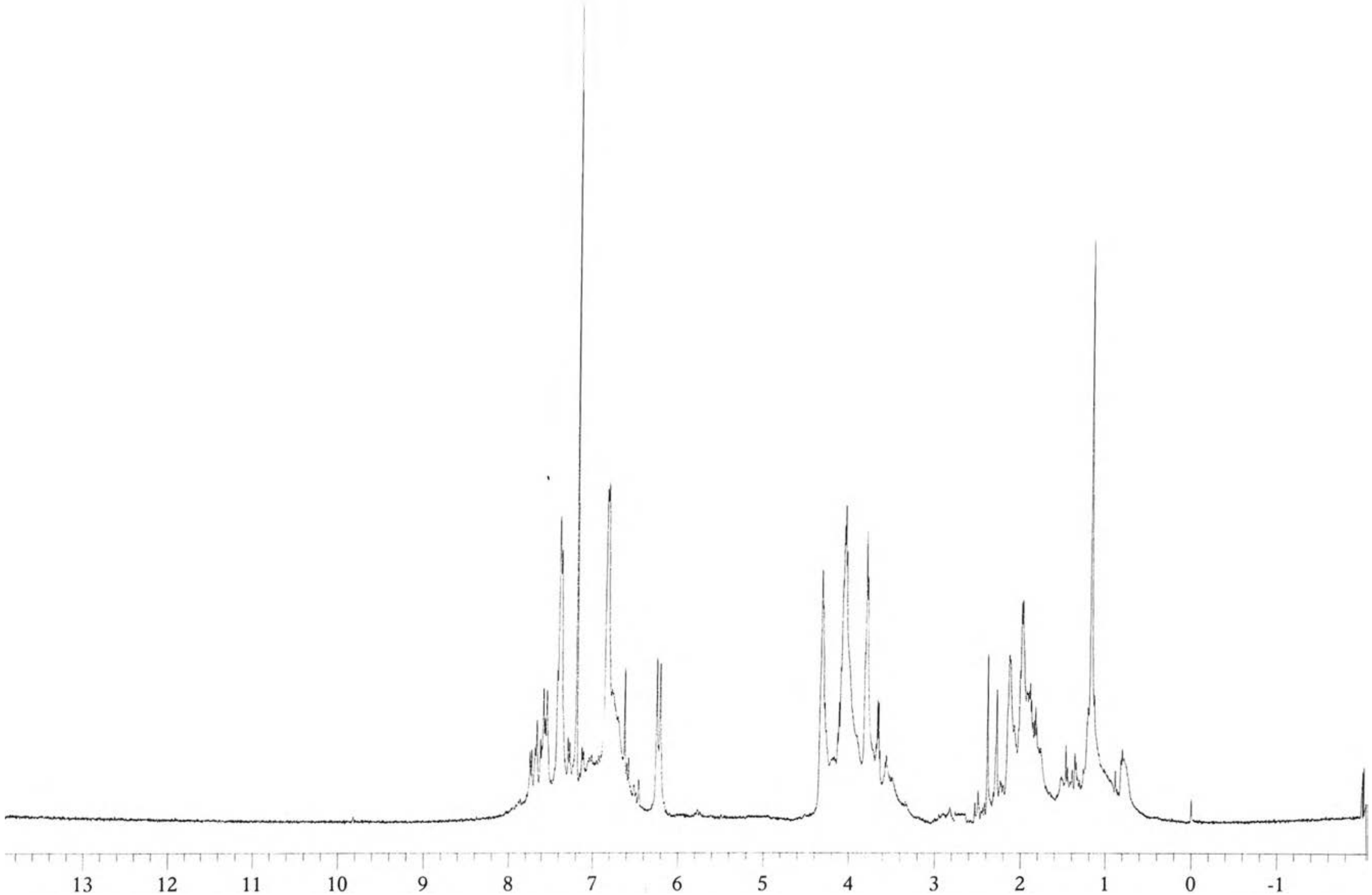

Figure B.23 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-propoxy cinnamate), P-3

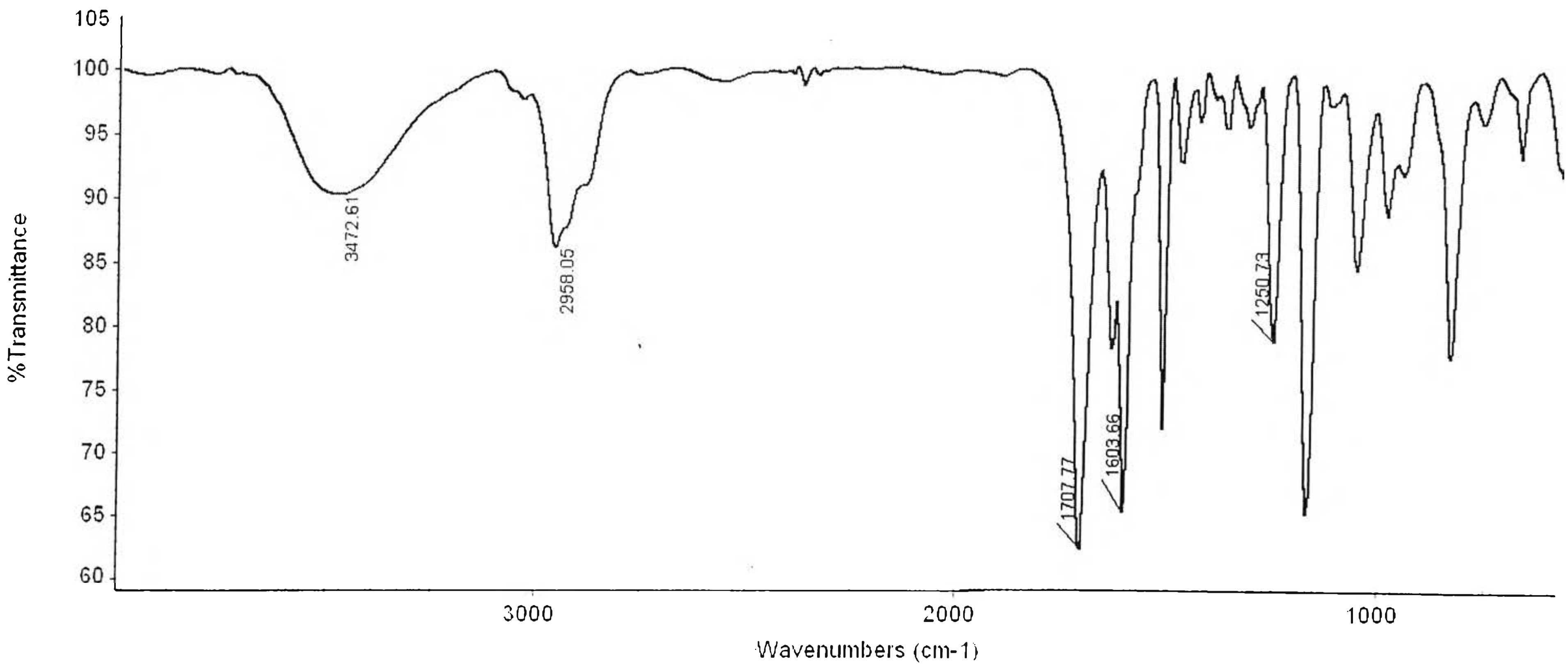

Figure B.24 IR spectrum of poly(*p*-propoxy cinnamate), P-3 (soluble part)

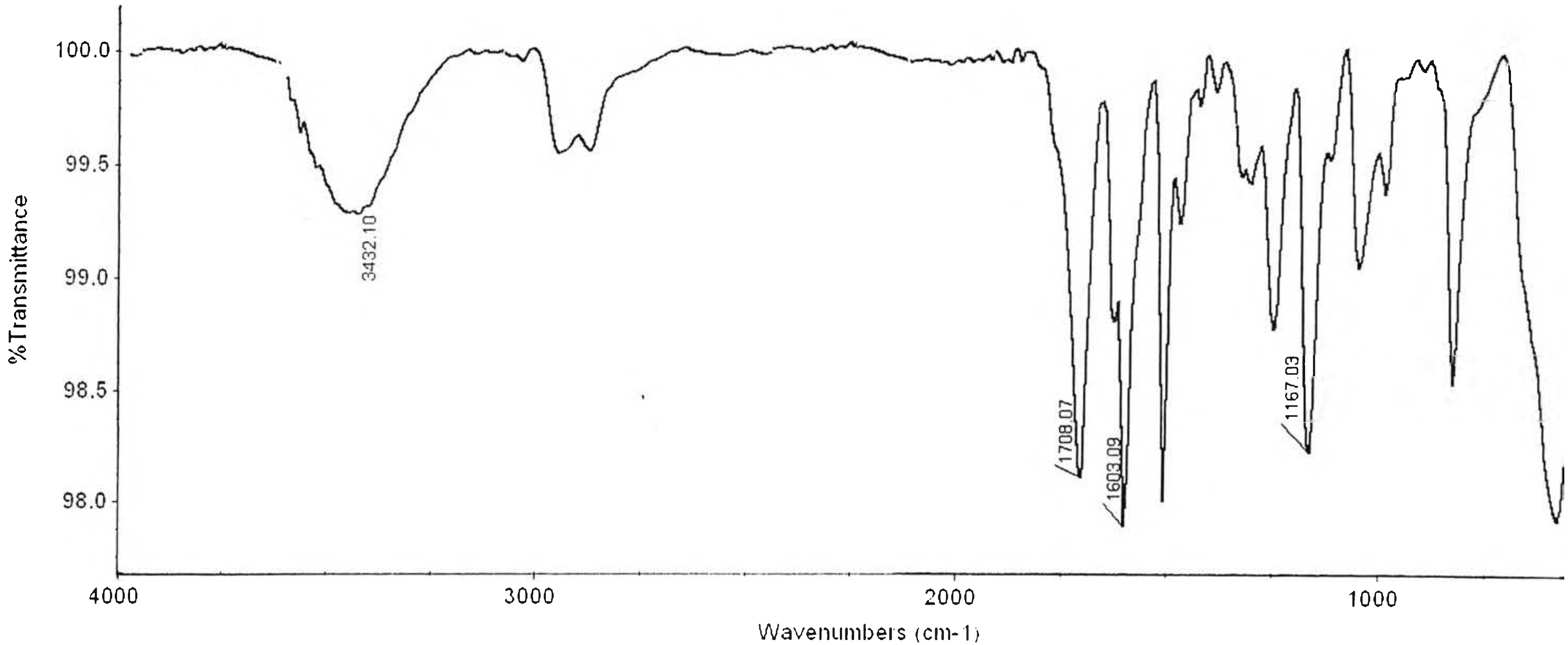

Figure B.25 IR spectrum of poly(*p*-propoxy cinnamate), P-3 (insoluble part)

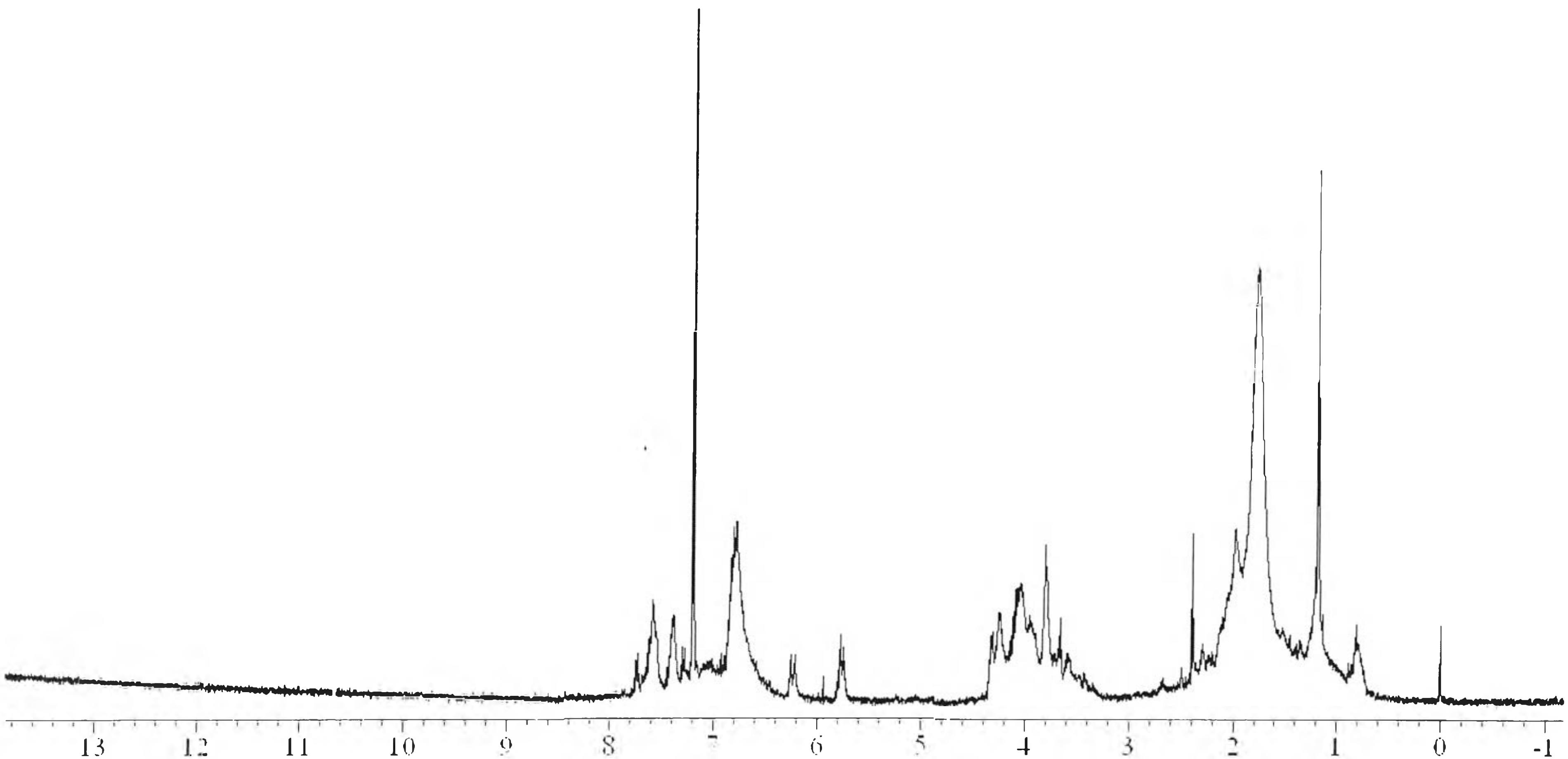

Figure B.26 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-propoxy cinnamate), P-3 irradiated

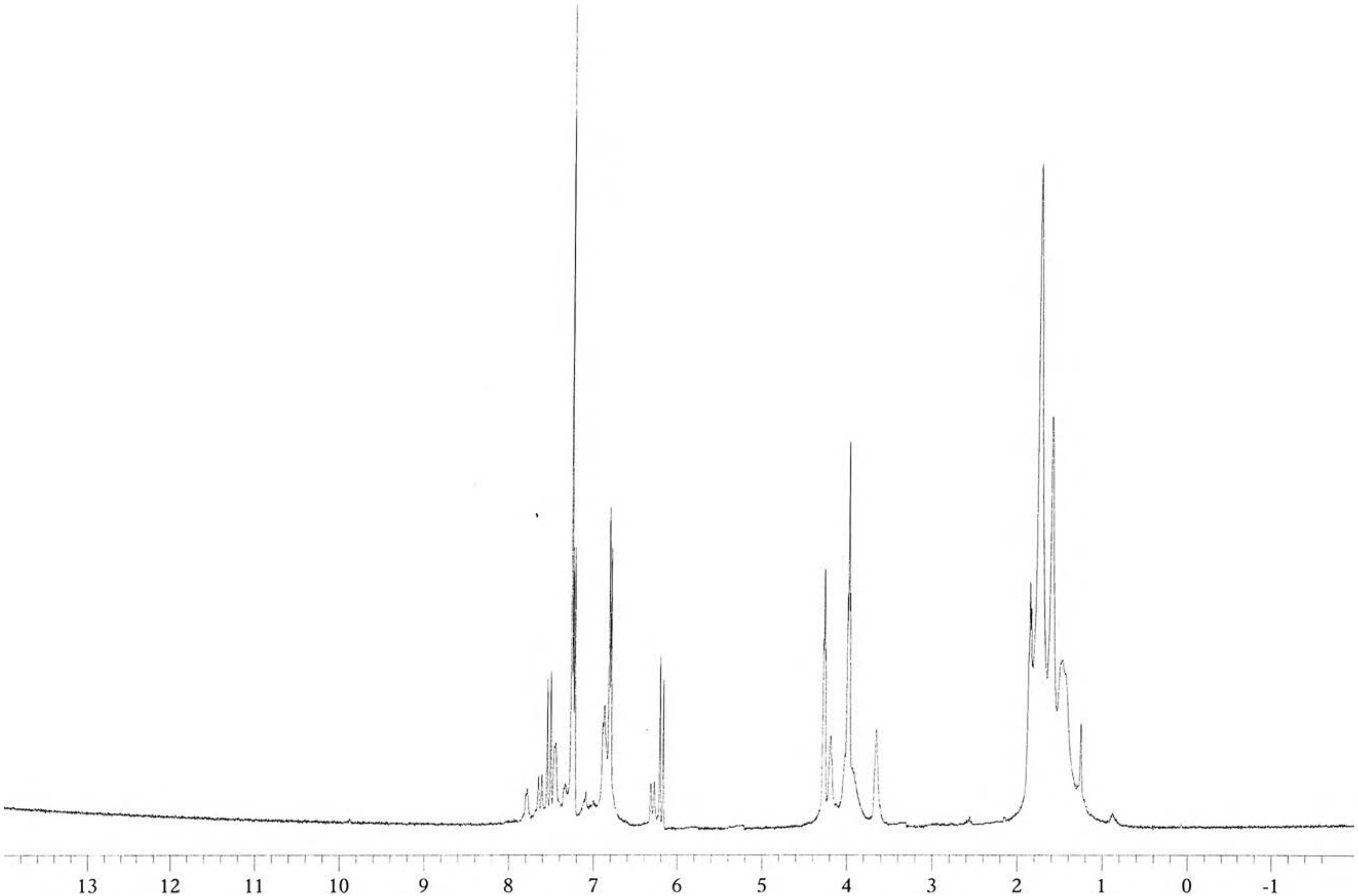

Figure B.27 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-hexyloxy cinnamate), P-6

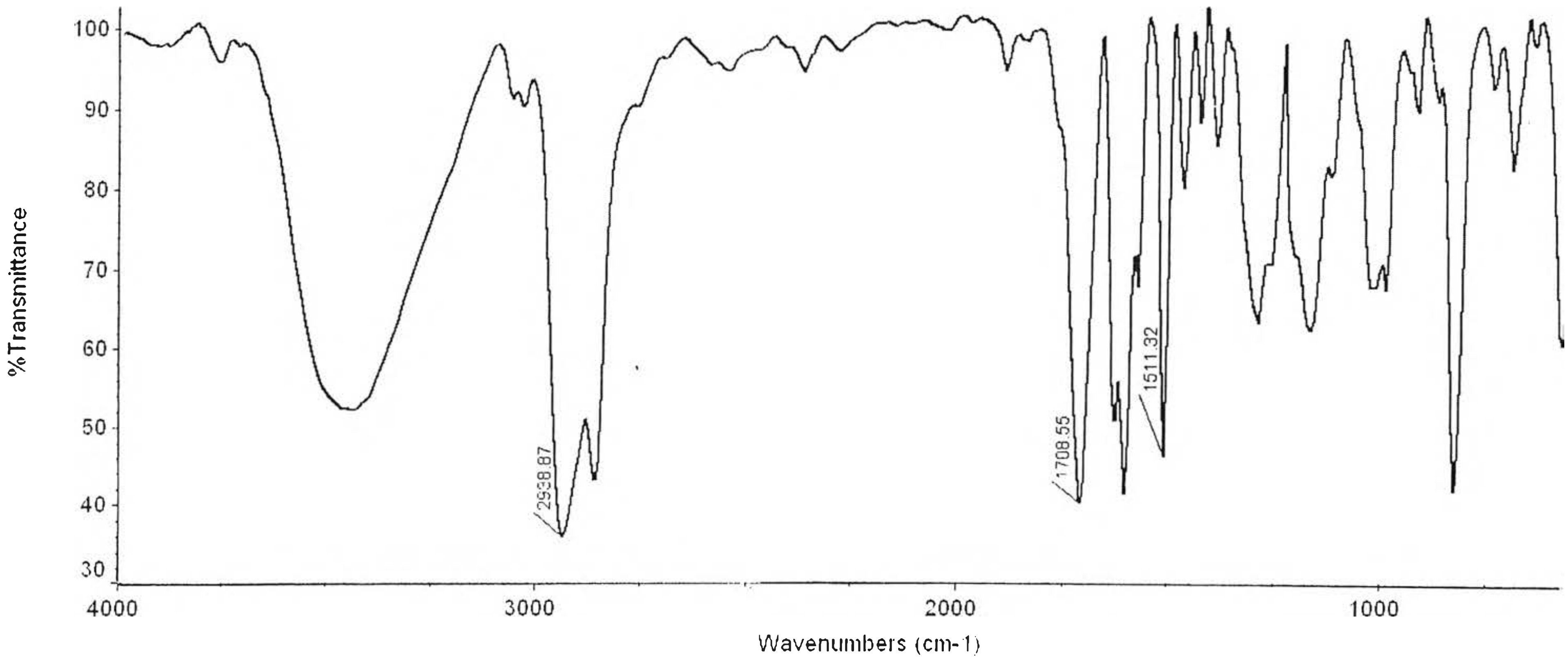

Figure B.28 IR spectrum of poly(*p*-hexyloxy cinnamate), P-6

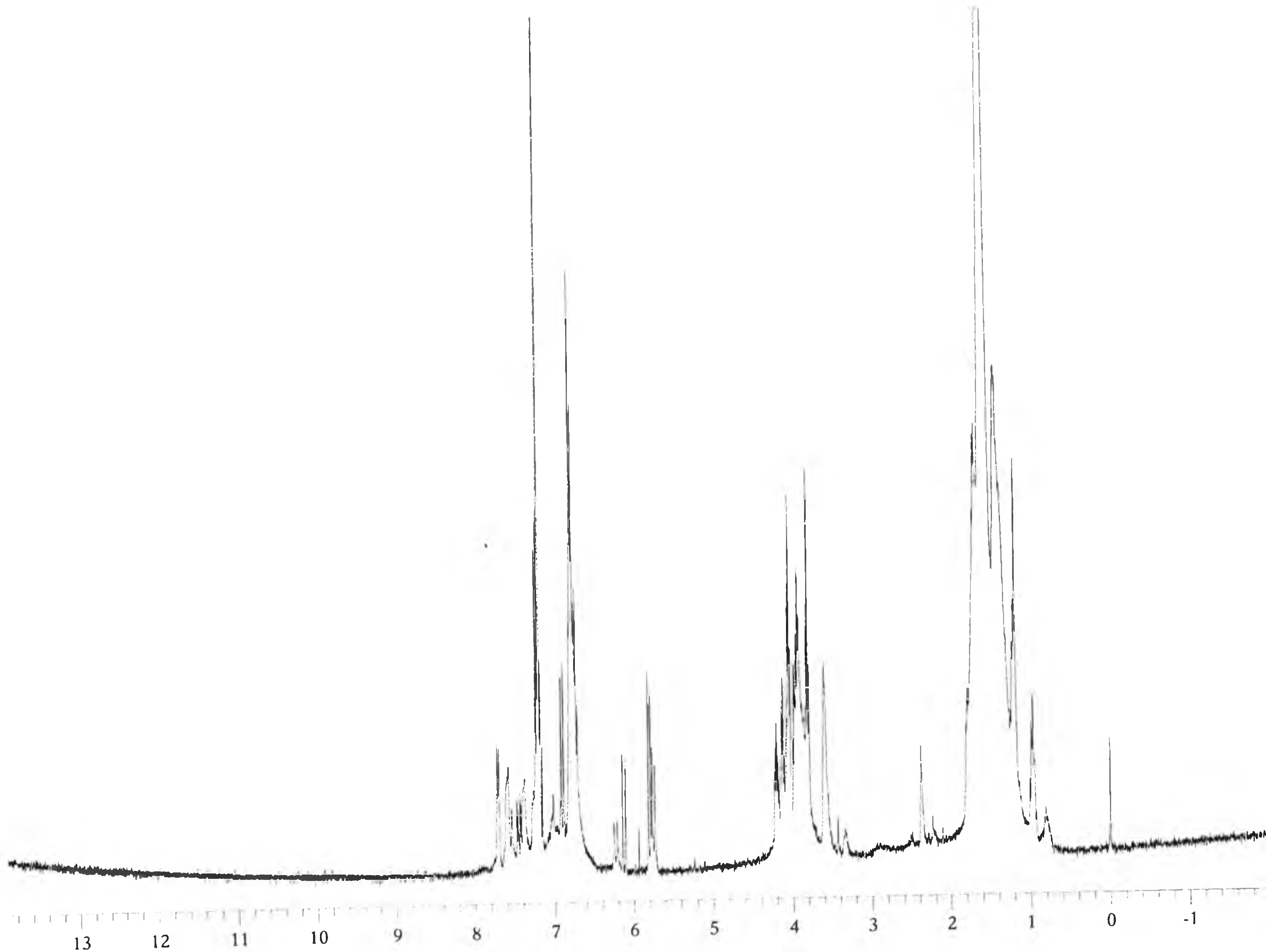

Figure B.29 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-hexyloxy cinnamate), P-6 irradiated

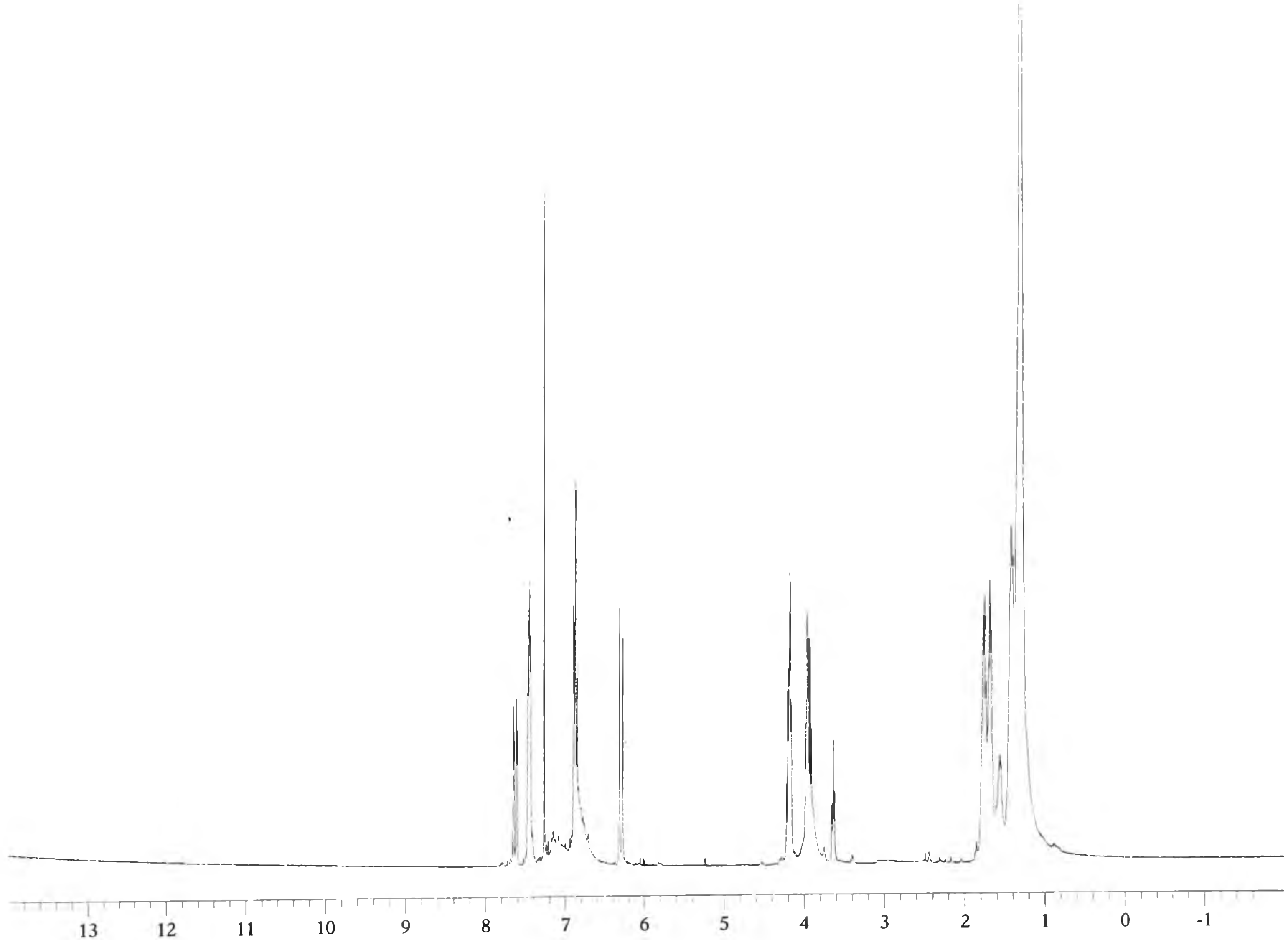

Figure B.30 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-undecyloxy cinnamate), P-11

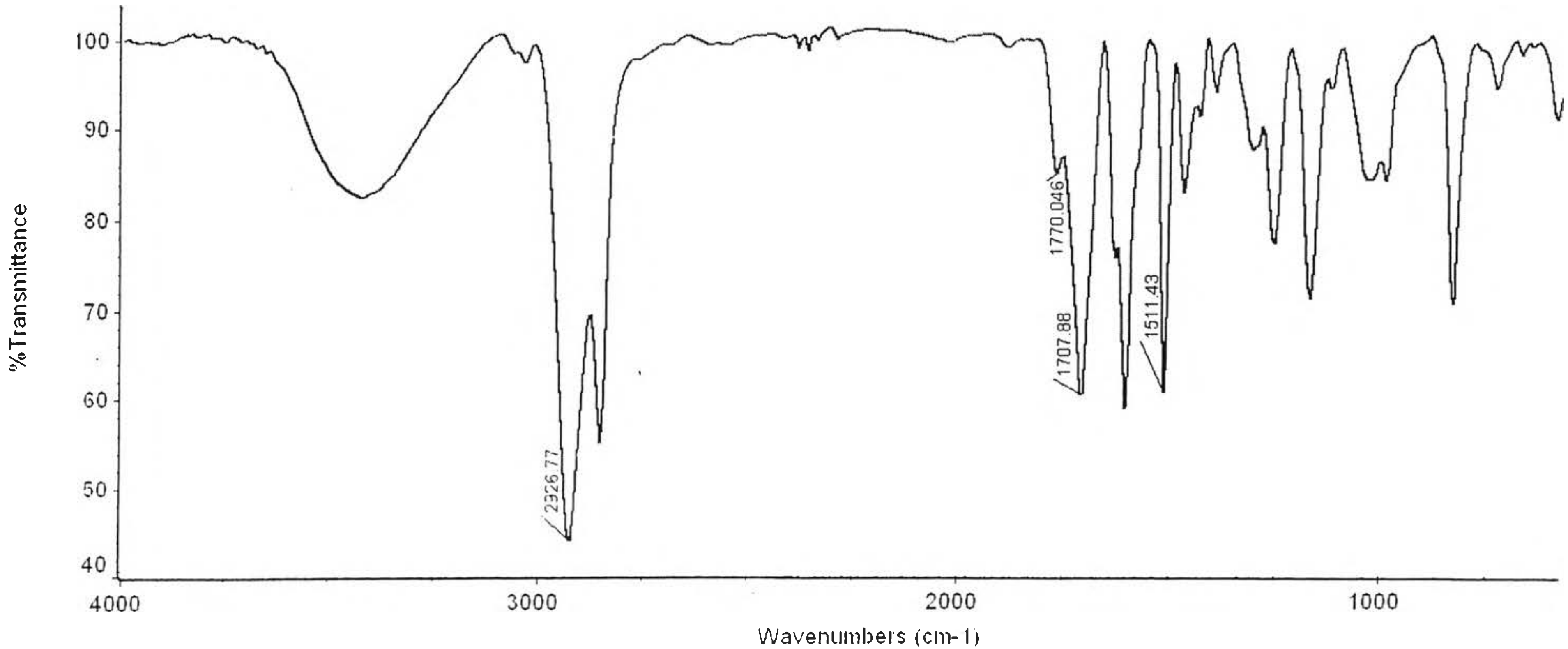

Figure B.31 IR spectrum of poly(*p*-undecyloxy cinnamate), P-11

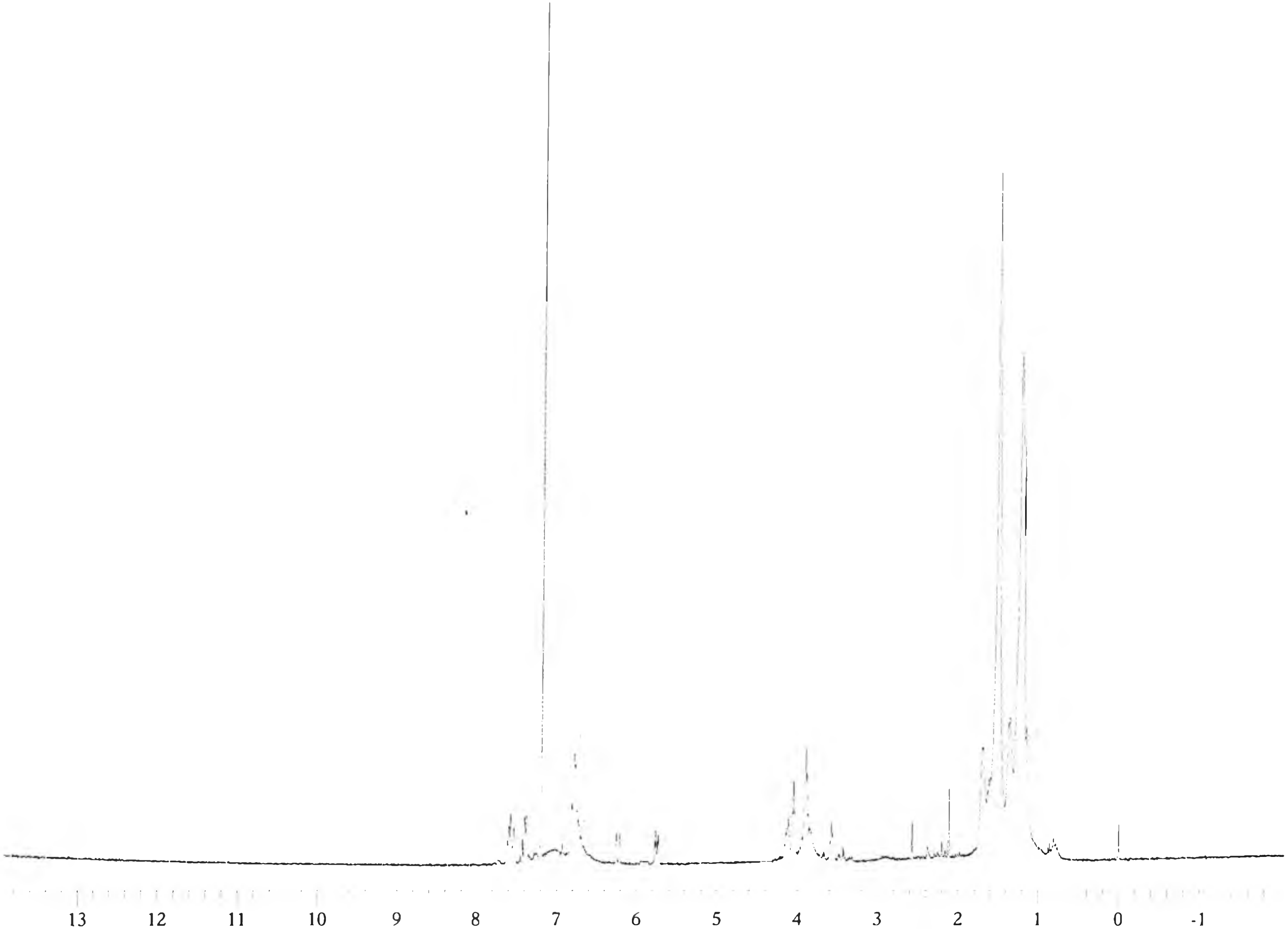

Figure B.32 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-undecyloxy cinnamate), P-11 irradiated

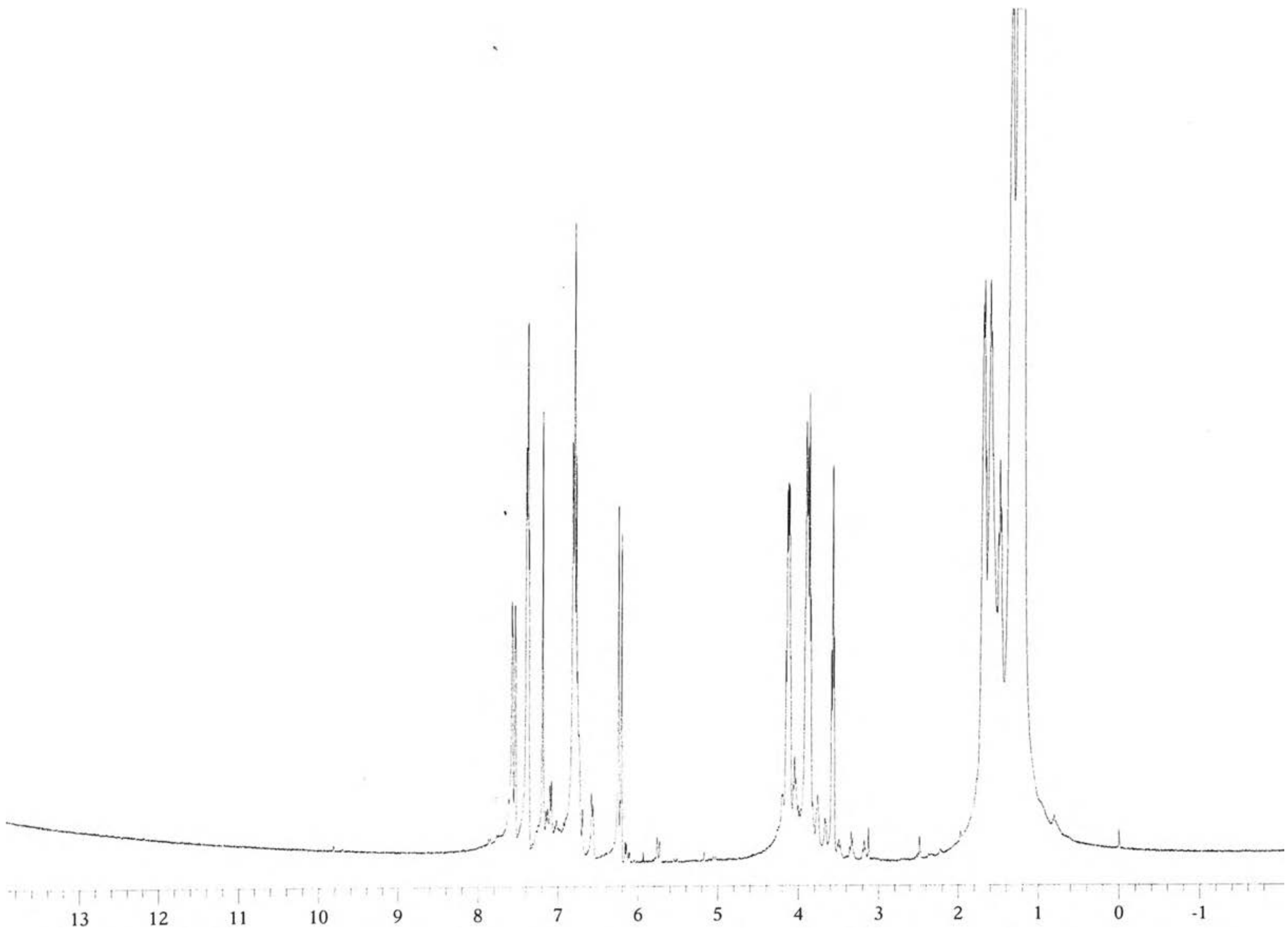

Figure B.33 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-undecyloxy cinnamate), P-11dil

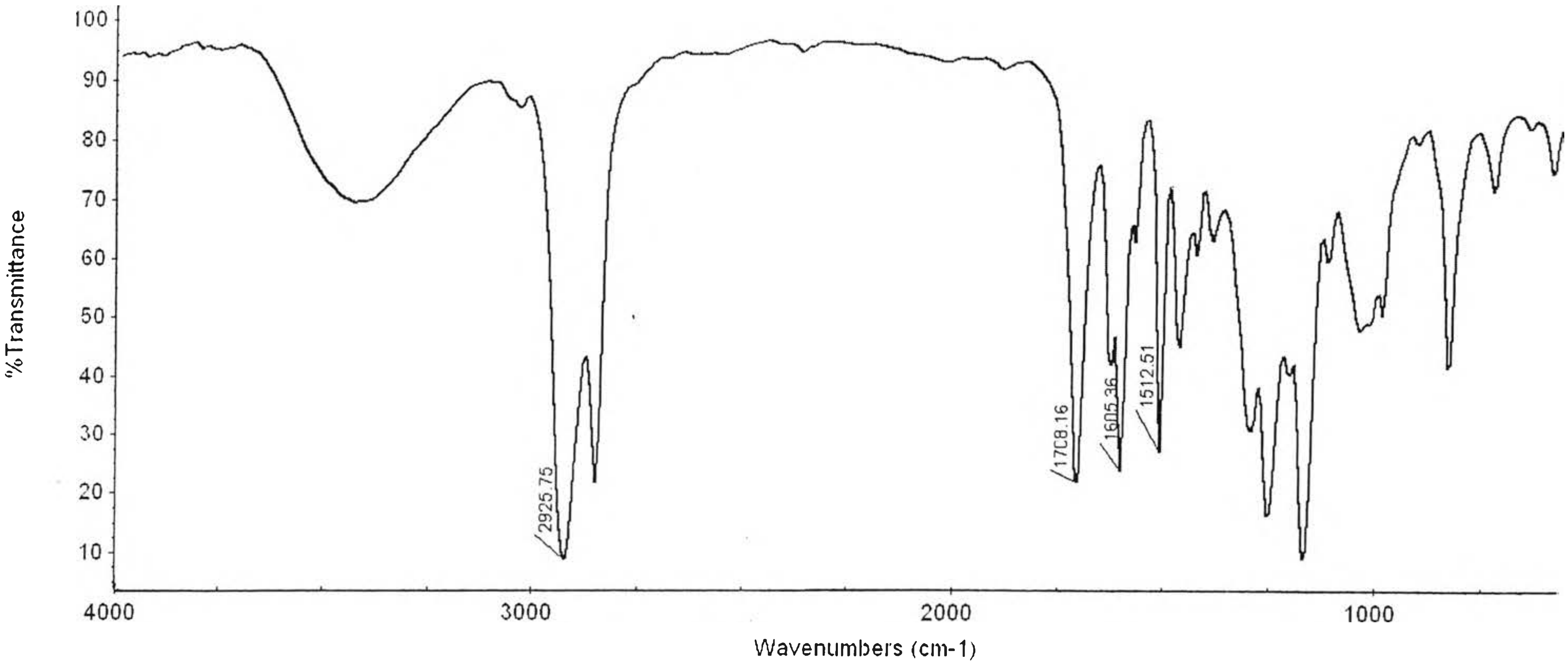

Figure B.34 IR spectrum of poly(p-undecyloxy cinnamate), P-11dil

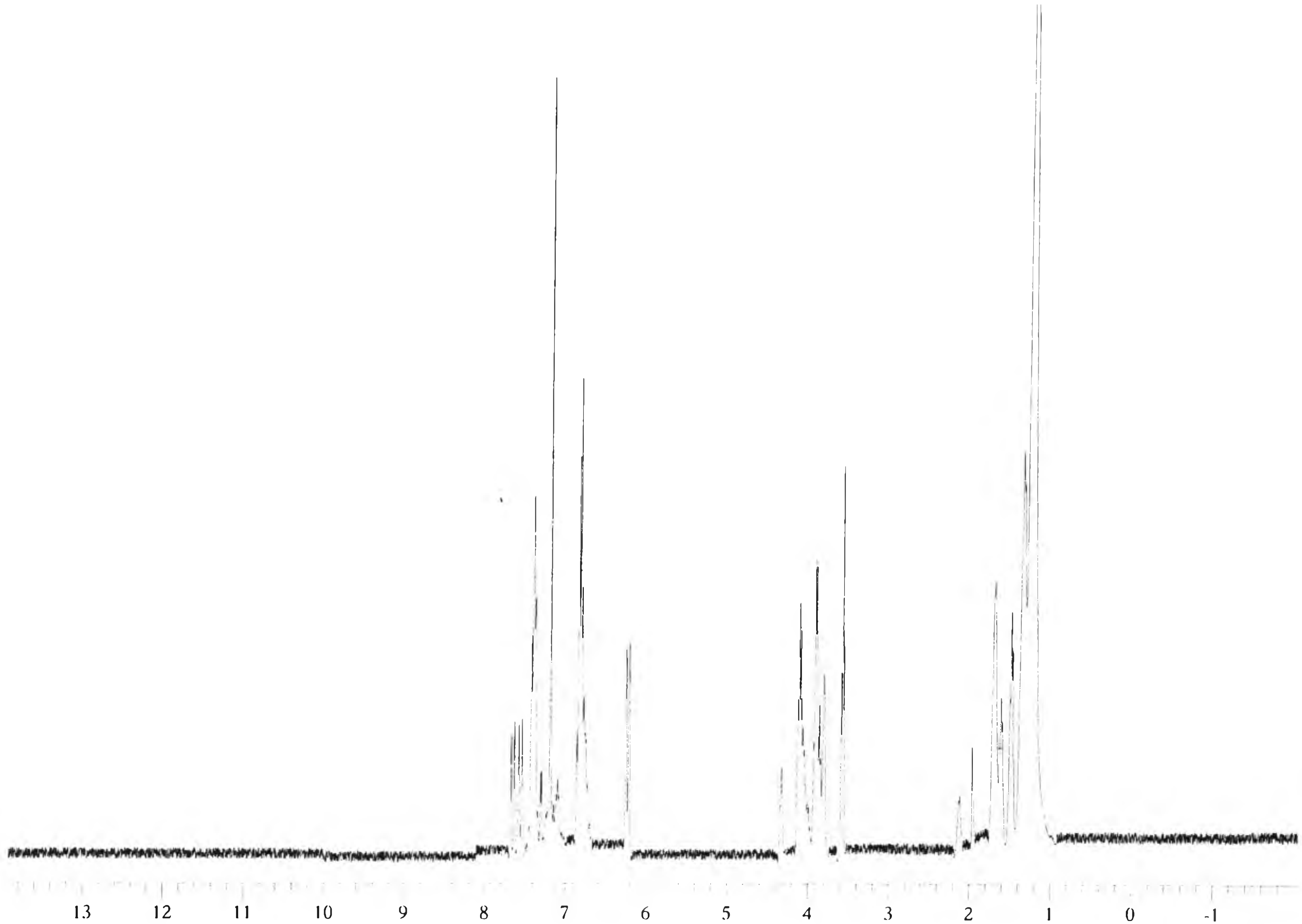

Figure B.35 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-propoxy cinnamate)-*co*-(*p*-undecyloxy cinnamate), P-3/11

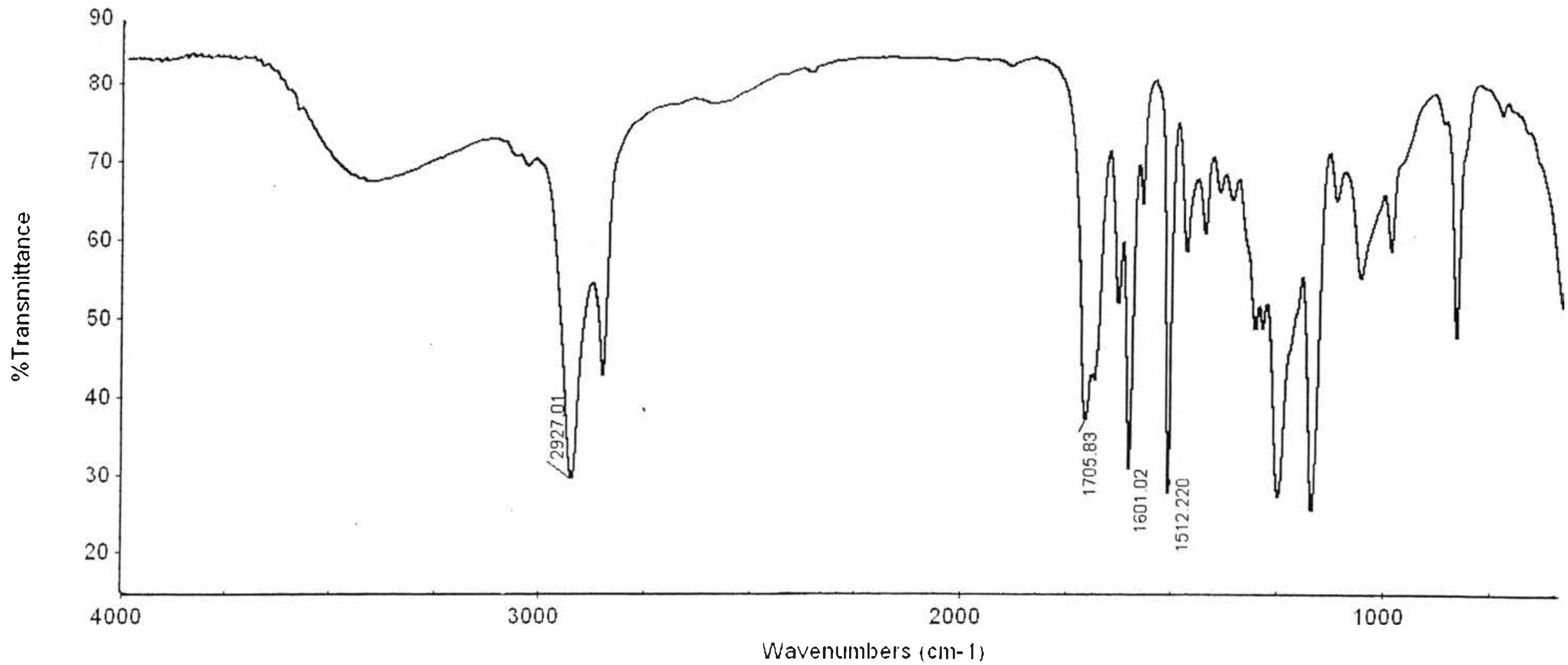

Figure B.36 IR spectrum of poly(*p*-propoxy cinnamate)-*co*-(*p*-undecyloxy cinnamate), P-3/11

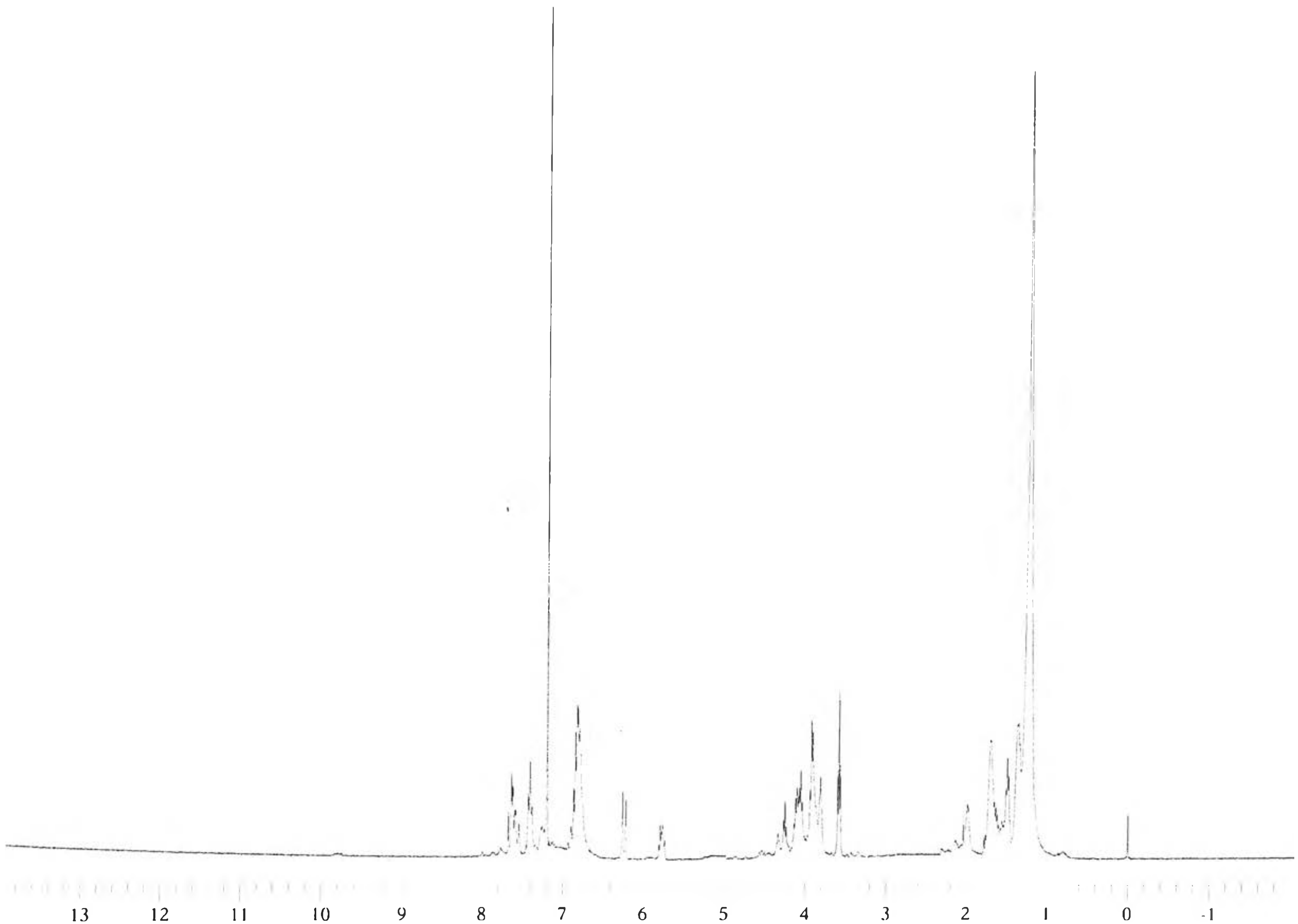

Figure B.37 ^{1}H-NMR ($CDCl_3$) spectrum of poly(*p*-propoxy cinnamate)-*co*-(*p*-undecyloxy cinnamate), P-3/11irradiated

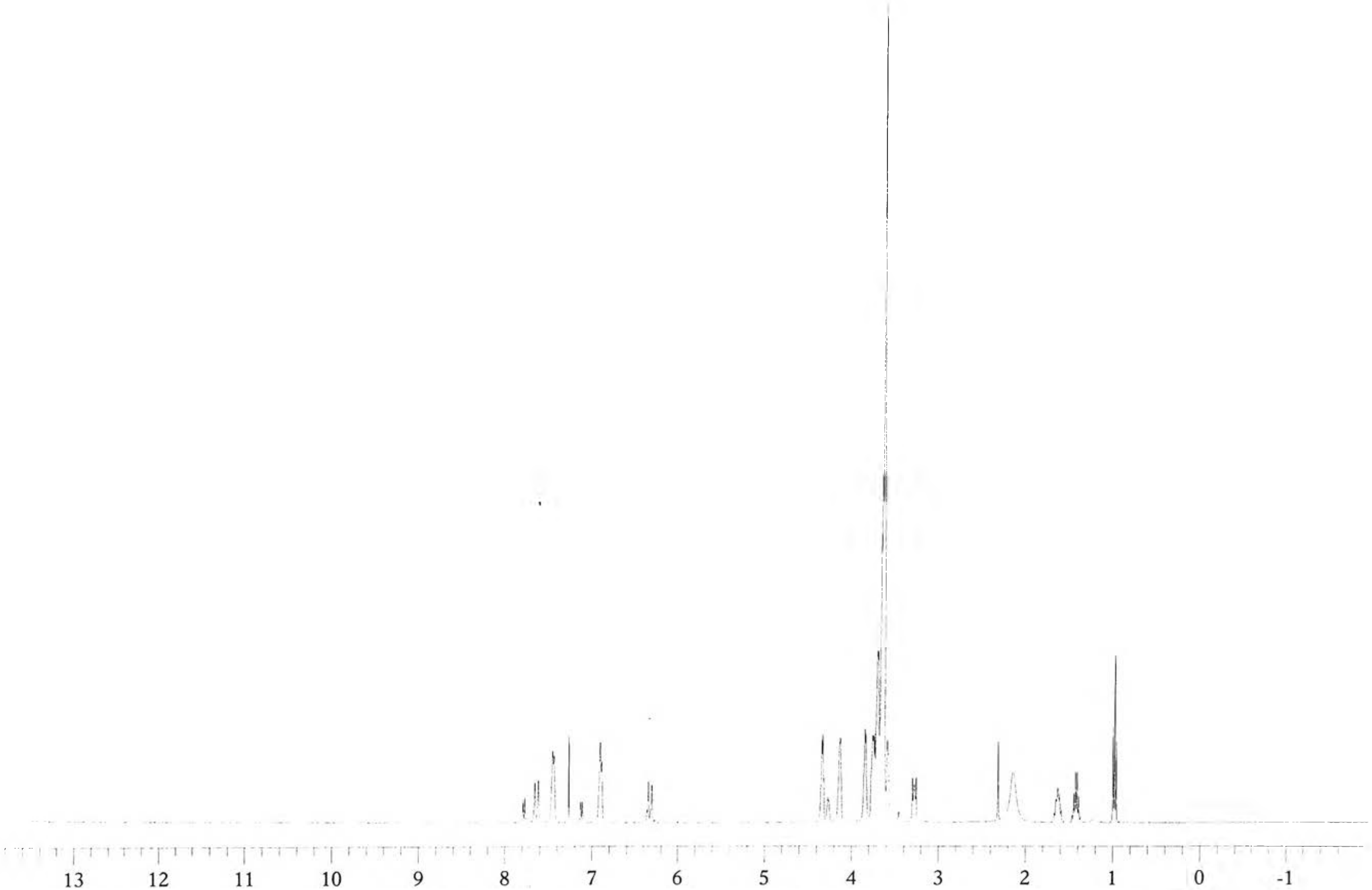

Figure B.38 ^{1}H-NMR ($CDCl_3$) spectrum of poly(pentaethylene glycol cinnamate), PPGC

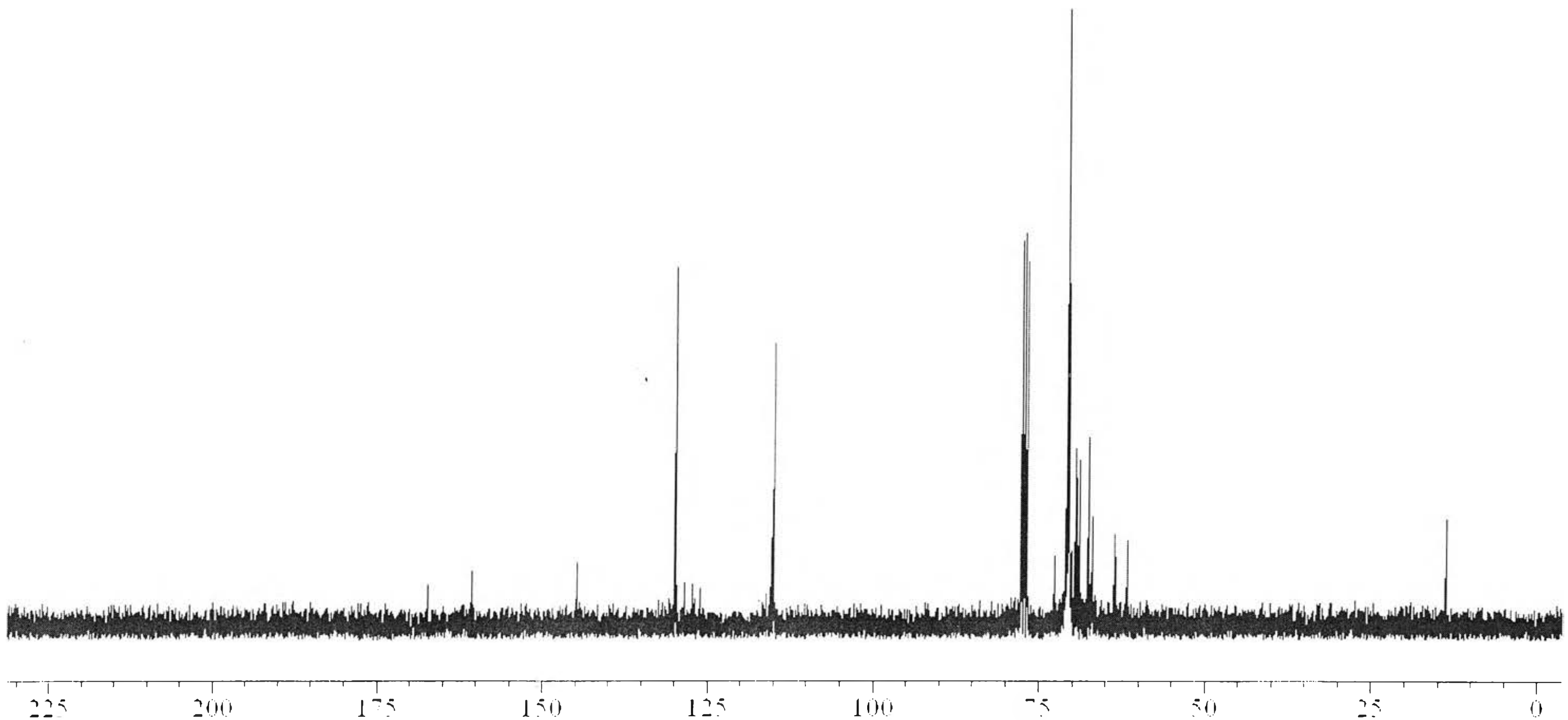

Figure B.39 ^{13}C-NMR ($CDCl_3$) spectrum of poly(pentaethylene glycol cinnamate), PPGC

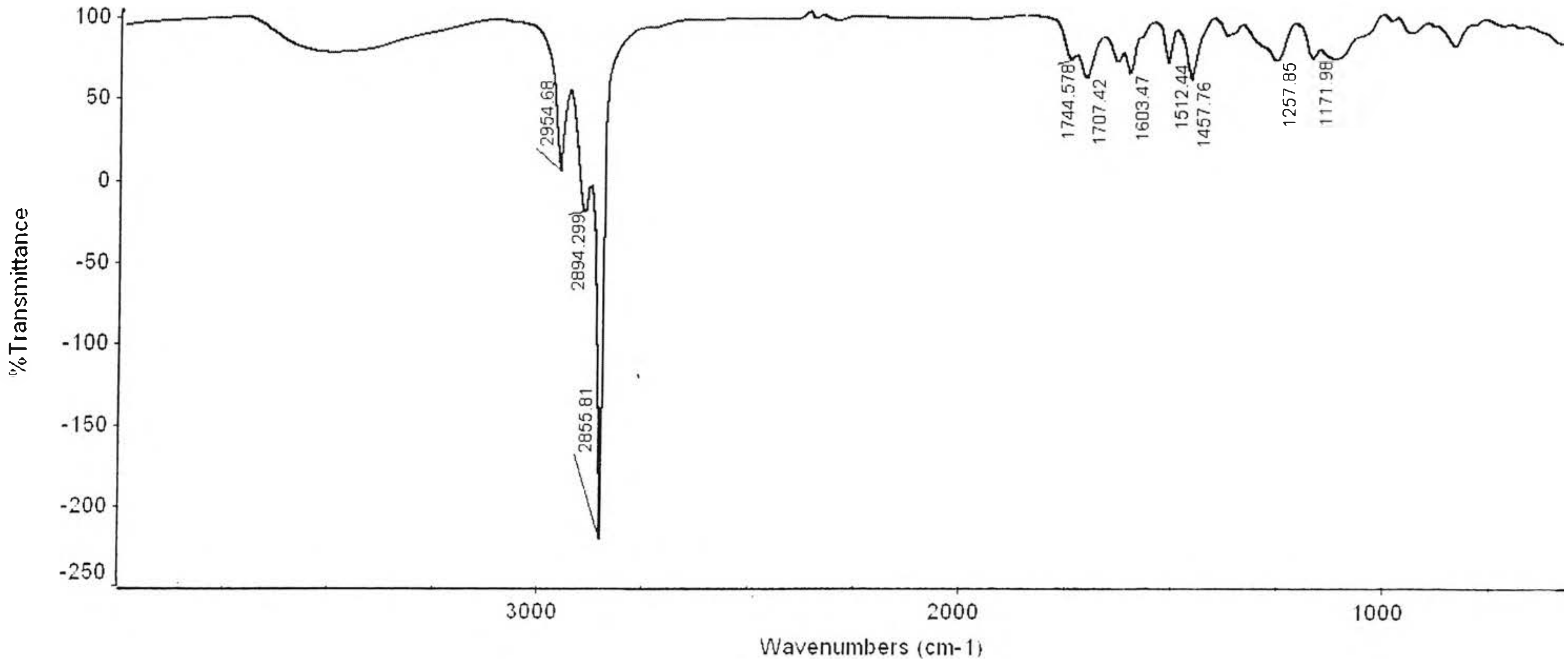

Figure B.40 IR spectrum of poly(pentaethylene glycol cinnamate), PPGC

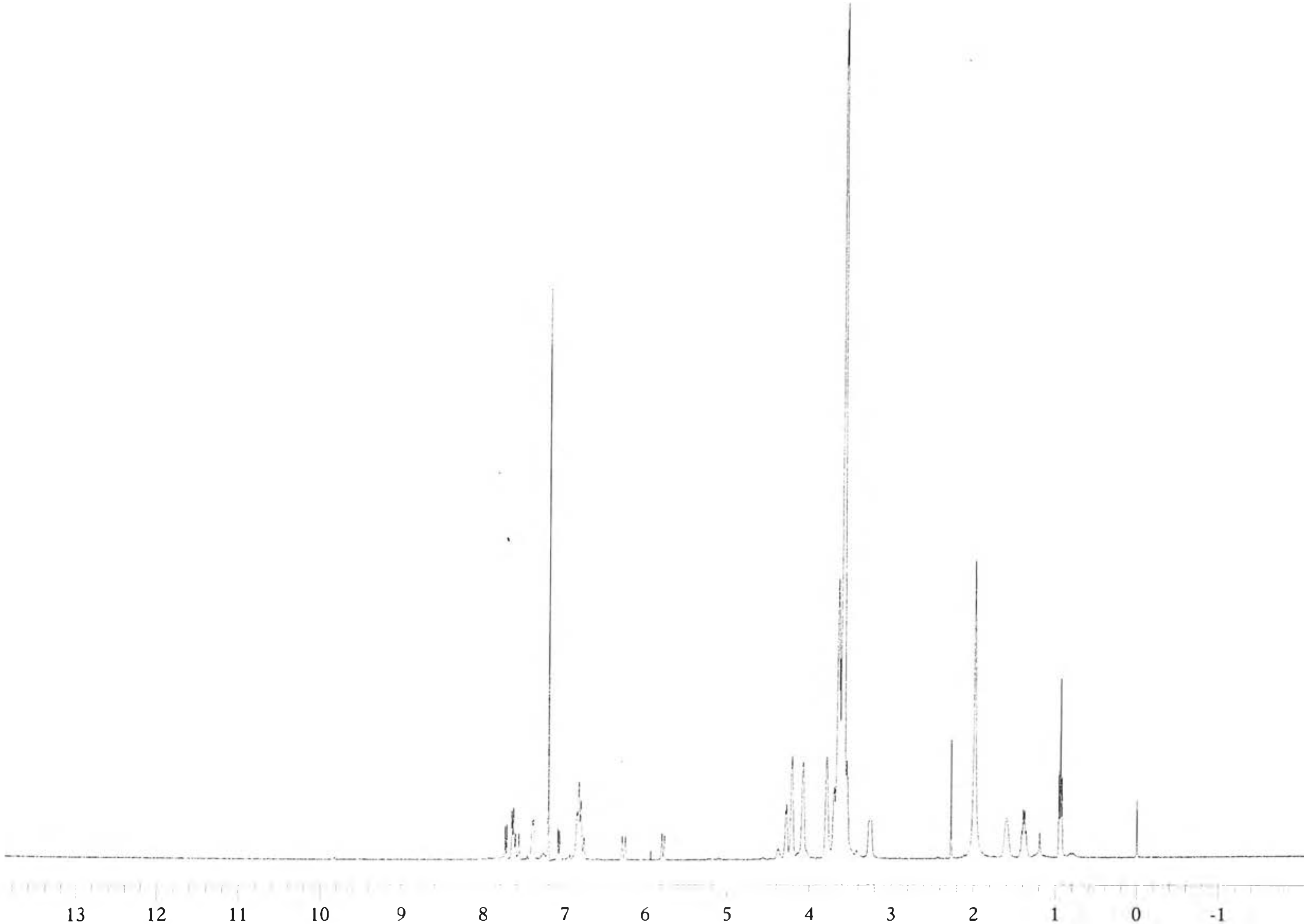

Figure B.41 ^{1}H-NMR ($CDCl_3$) spectrum of poly(pentaethylene glycol cinnamate), PPGC irradiated

VITA

Miss Sasiprapa Sasiwilaskorn was born in 1977 in Nong Khai, Thailand. She is now working at Khon Kaen University (Nong Khai Campus) and her home address is 633 Prachuk Road, Muang, Nong Khai 43000. Her e-mail address is ssasip@kku.ac.th.

Experience

2001-present	Nong Khai Campus, Khon Kaen University
1999-2001	International Laboratory, Co. (ILC)

Education

1995-1998	B. Sc. (Chemistry) Chulalongkorn University
2003-2005	M.S. (Petrochemistry and Polymer Science) Chulalongkorn University