References

1. Krishnaswamy, N.R. in Recent Trends in Coumarin Chemistry, Advancing Frontiers in the Chemistry of Natural Product, (Professor Sir Robert Robinson, ed.) pp. 124-137, Hindustan Publishing Corporation, India, 1965.

2. Steck, W. and Mazurek, M. "Identification of Natural Coumarins by NMR Spectroscopy." Lloydia 35(4), (1972) : 418-439.

3. Seshadri, T.R. and Vishwapaul "Recent Advances in Naturally Occurring Coumarins." J. Scient. Ind. Res. 32(May), (1973) : 227-255.

4. Tandon, A. and Rastogi, R.P. "Recent Advances in Naturally Occurring Coumarins." J. Scient. Ind. Res. 38(August), (1979) : 428-441.

5. Gray, A.I. and Waterman, P.G. "Review Coumarins in the Rutaceae." Phytochemistry 17(1978) : 845-864.

6. Brown, S.A. "Biosysthetic Studies on Coumarins." Planta medica 36(4), (1979) : 299-310.

7. Rakash, D., Raj, K., Kapil, R.S. and Popli, S.P. "Coumarins from *Clausena indica*." Phytochemistry 17(1978) : 1194-1195.

8. Joshi, B.S., Kamat, V.N. and Gawad, D.H. "Structure of Clausindine, a New Coumarin from *Clausena indica* Oliv." Experientia 30(3), (1974) : 223.

9. Joshi, B.S., Gawad, D.H. and Kamat, V.N. "6-Methoxyheptaphylline, a New Carbazole Alkaloid from *Clausena indica* Oliv." Indian J. Chem. *10* (December), (1972) : 1123-1124.

10. Joshi, B.S. and Gawad, D.H. "Isolation of Some Furanocoumarins from *Clausena indica* and Identity of Chalepensin with Xylotenin." Phytochemistry *10* (1971) : 480-481.

11. Joshi, B.S., Gawad, D.H. and Williams, D.J. "The Structure of Clausantalene, a New Sesquiterpene from *Clausena indica* Oliv." Experientia *31* (2), (1975) : 138-139.

12. Okorie, D.A. "A New Carbazole Alkaloid and Coumarins from Roots of *Clausena anisata*." Phytochemistry *14* (1975) : 2720-2721.

13. Mester, I., Szendrei, K. and Reisch, J. "Constituents of *Clausena anisata* (Willd.) Oliv. (Rutaceae) I. Coumarins from the root bark." Planta medica *32* (1977) : 81-85.

14. Tian-Shung Wu and Hiroshi Furukawa "Biological and Phytochemical Investigation of *Clausena excavata*." Lloydia *45* (6), (1982) : 718-720.

15. Subba Rao, G.S.R., Srinivasa Rao, K. and Ravindranath, B. "Structure of Diclausenan A and B." Tetrahedron Letters *13* (1976) : 1019-1020.

16. Subba Rao, G.S.R., Raj, K. and Kumar, V.P.S. "Chemical Examination of *Clausena willdenovii* W & A : Isolation of 3-(1,1-Dimethylallyl) xanthyletin from the Root & Bark." Indian J. Chem. *20B* (January), (1981) : 88-89.

17. Manandhar, M.D., Shoeb, A., Kapil, R.S. and Popli, S.P. "*o*-Methylclausenol-a C_{33} terpenoid from *Clausena pentaphylla*." Experientia *33*(2), (1977) : 153.

18. Anwer, F., Shoeb, A., Kapil, R.S. and and Popli, S.P. "Clausarin - a novel coumarin from *Clausena pentaphylla* (Roxb.) DC." Experientia *33*(4), (1977) : 412-413.

19. Shoeb, A., Manandhar, M.D., Kapil, R.S. and Popli, S.P. "Clausmarins A and B : Two Novel Spasmolytic Terpenoid Coumarins from *Clausena pentaphylla* (Roxb.) DC." J.C.S. Chem. Comm. *7*(1978) : 281-282.

20. Govindachari, T.R., Pai, B.R., Subramaniam, P.S. and Muthukumaraswamy, N." Coumarins of *Clausena dentata* (Willd.) R. and S." Tetrehedron *24*(1968) : 753-757.

21. Joshi, B.S., Kamat, A.K., Saksena, A.K. and Govindachari, T.R. "Structure of Heptaphylline, a Carbazole Alkaloid from *Clausena heptaphylla* Wt. & Arn." Tetrahedron Letters *41*(1967) : 4019-4022.

22. Ganguly, A.K., Joshi, B.S., Kamat, V.N. and Manmade, A.H. "Systhesis of Clausenin, Xanthoxyletin, Alloxanthoxyletin, Xanthyletin and Nor-Dalbergin" Tetrahedron *23*(1967) : 4777-4784.

23. Joshi, B.S., Kamat, V.N. and Saksena, A.K. "Structures of Clausenin and Clausenidin Two New Pyranocoumarins from the Roots of *Clausena heptaphylla* Wt. & Arn." Tetrahedron *23*(1967) : 4785-4789.

24. Joshi, B.S. and Kamat, V.N. "Structures of Clausenin, Clausenidin and a Synthesis of Clausenin and Xanthoxyletin." Tetrahedron Letters 46(1966) : 5767-5773.

25. Joshi, B.S., Kamat, V.N., Gawad, D.H. and Govindachari, T.R. "Structure and Synthesis of Heptaphylline." Phytochemistry 11(1972) : 2065-2071.

26. Chakraborty, D.P., Bhattacharyya, P. and Bhattacharyya, S.P. "Clausenolide : a Novel Pentanortriterpenoid Furanolactone; X-Ray Crystal Structure." J.C.S. Chem. Comm. (1979) : 246-248.

27. Roy, S., Bhattachryya, P. and Chakraborty, D.P. "3-Methyl-carbazole from *Clausena heptaphylla*." Phytochemistry 13(1974) : 1017.

28. Chakraborty, D.P., Islam, A. and Roy, S. "2-Methylanthraquinone from *Clausena heptaphylla*." Phytochemistry 17(1978) : 2043.

29. Ray, S. and Chakrabotry, D.P. "Murrayacine from *Clausena heptaphylla*." Phytochemistry 15(1976) : 356.

30. Dean, F.M. "Naturally Occurring Oxygen Ring Compounds." Butterworths, (Butterworth Scientific Publishers, London), (1963) : Chapters 6 and 16.

31. Mendez, J. and Lojo, M.I. Microchem. J. 13(1968) : 506.

32. Lee, K. and Soine, T.O. "Spectral Studies on Some Linear Furanocoumarins." J. Pharm. Sci. 58(1969) : 681.

33. Bukreeva, T.V. and Pigulevskii, G.V. Zh. Prikl. Khim. 39(1966) : 1541.

34. Barnes, C.S. and Occolowits, J.L. "The Mass Spectra of Some Naturally Occuring Oxygen Heterocycles and Related Compounds." Aust. J. Chem. 17 (1964) : 975.

35. Reisch, J., Novak, I., Szendrei, K. and Minker, E. "The Application of NMR Spectroscopy in Structure Determination of Coumarin Derivatives." Pharmazie 22 (1967) : 205.

36. Jarvis, M.W. and Moritz, A.D. "Long-range Coupling in Substituted Coumarins." Aust. J. Chem. 21 (1968) : 2445.

37. Lassek, E.V. and Pinhey, J.T. "The Proton Magnetic Resonance of Some Coumarins and 2,2-dimithylchromens : Further Examples of Inter-ring Spin-spin Coupling." J. Chem. Soc. C (1967) : 2000.

38. Neish, A.C. in Biochemistry of Phenolic Compounds, (Harborne, J.B., ed.) pp. 295, Academic Press, London, 1964.

39. Camm, E.L. and Towers, G.H.N. "Review Article Phenylalanine Ammonia Lyase." Phytochemistry 12 (1973) : 961.

40. Weygand, F. and Wendt, H. Z. Naturforsch. 14b (1959) : 421.

41. Kosuge, T. and Conn, E.E. "The Metabolism of Aromatic Compounds in Higher Plants I. Coumarin and *o*-Coumaric acid." J. Biol. Chem. 234 (1959) : 2133.

42. Brown, S.A., Towers, G.H.N. and Wright, D. "Biosynthesis of the *Hierochloe odorata* and *Melitotus officinalis*." Can. J. Biochem. Physiol. 38 (1960) : 143.

43. Brown, S.A. Z. Naturforsch. 15b (1960) : 768.

44. Brown, S.A. "Biosynthesis of the Coumarins IV. the Formation of Coumarin and Herniarin in Lavender." Phytochemistry 2 (1963) : 137.

45. Haskins, F.A., Williams, L.G. and Gorz, H.J. Plant Physiol. 39 (1964) : 777.

46. Edwards, K.G. and Stoker, J.R. "Biosynthesis of Coumarin. The Isomerization Stage." Phytochemistry 6 (1967) : 655.

47. Chambers, K., Kenner, G.W., Robinson, M.J.T. and Webster, B.R. "The Biosynthesis of Certain Coumarins, Particularly of Novobiocin." Proc. Chem. Soc. 1960 : 291.

48. Bunton, C.A., Kenner, G.W., Robinson, M.J.T. and Webster, B.R. "Experiments Related to the Biosynthesis of Novobiocin and Other Coumarins." Tetrahedron 19 (1963) : 1001.

49. Kindl, H. "Zur Frage der *Ortho*-Hydroxylierung aromatischer Carbonsäuren in höheren Pflanzen." Hoppe-Seylers Z. Physiol. Chem. 352 (1971) : 78.

50. Gestetner, B. and Conn, E.E. "The 2-Hydroxylation of *trans*-Cinnamic Acid by Chloroplasts from *Melitotus alba* Desr." Arch. Biochem. Biophys. 163 (1974) : 617.

51. Haskins, F.A. and Gorz, H.J. Crop Sci 1 (1961) : 320.

52. Brown, S.A. "Biosynthesis of the Coumarins VI. Further Studies on Herniarin Formation in Lavender." Can. J. Biochem. 43 (1965) : 199.

53. Austin, D.J. and Meyers, M.B. "The Formation of 7-Oxygenated Coumarins in Hydrangea and Lavender." Phytochemistry (1965) : 245.

54. Kosuge, T. and Conn, E.E. "The Metabolism of Aromatic Compounds in Higher Plants III. The β-Glucosides of *o*-Coumaric,

Coumarinic, and Melilotic acids." J. Biol. Chem. 236 (1961) : 1617.

55. Brown, S.A., El-Dakhakhny, M. and Steck, W. "Biosynthesis of Linear Furanocoumarins." Can. J. Biochem. 48 (1970) : 863.

56. Ellis, B.E. and Brown, S.A. "Isolation of Dimethylallylpyrophosphate : Umbelliferone Dimethylallyltransferase from *Ruta graveolens*." Can. J. Biochem. 52 (1974) : 734.

57. Dhillon, D.S. and Brown, S.A. "Localization, Purification and Characterization of Dimethylallylpyrophosphate : Umbelliferone Dimethylallyltransferase from *Ruta graveolens*." Arch. Biochem. Biophys. 177 (1976) : 74.

58. Games, D.E. and James, D.H. "The Biosynthesis of the Coumarins of *Angelica archengelica*." Phytochemistry 11 (1972) : 868.

59. Brown, S.A. and Steck, W. "7-Demethylsuberosin and Osthenol as Intermediates in Furanocoumarin Biosynthesis." Phytochemistry 12 (1973) : 1315.

60. Innocenti, G., Dall 'Acqua, F., Guiotto, A. and Caporale, G. Atti Ist. Veneto Sci., Lett. Arti. Cl. Sci. Mat. Nat. 135 (1977) : 37.

61. Birch, A.J., Maung, M. and Pelter, A. "Studies in Relation to Biosynthesis." Aust. J. Chem. 22 (1969) : 1923.

62. Murray, R.D.H., Sutcliffe, M. and McCabe, P.H. "Claisen Rearrangements IV. Oxidative Cyclisation of two Coumarin *o*-isoprenylphenols." Tetrahedron 27 (1971) : 4901.

63. Yanagisawa, H. and Kondo, H. J. Pharm. Soc. Japan, (1921) : 498.

64. May, P. Perf. essent. Oil. Rec. Feb. 1925 : 45.

65. Kaufman, K.D. and Kelly, R.C. "A New Synthesis of Coumarins." J. Heterocyclic Chem. 2 (1965) : 91.

66. Austin, P.W., Seshadri, T.R., Sood, M.S. and Vishwapaul. "Components of *Seseli sibiricum* Constitution and Synthesis of Sibiricin, A New Coumarin." Tetrahedron 24 (1968) : 3247.

67. Dreyer, D.L. "Chemotaxonomy of the Rutaceae IV. Constituents of *Murraya paniculata* (Linn.) Jack." J. Org. Chem. 33 (1968) : 3574.

68. Murray, R.D.H., Ballantyne, M.M. and Mathai, K.P. "A Method to Introduce a 3,3-dimethylallyl Unit Ortho to a Phenol." Tetrahedron Lett. 1970 : 243.

69. Seshadri, T.R. and Sood, M.S. Indian J. Chem. 1 (1963) : 291.

70. Chatterjee, D.K. and Sen, K. "New Syntheses of Xanthotoxol and Xanthotoxin." Tetrahedron Lett. 1969 : 5223.

71. Ahluwalia, V.K., Seshadri,T.R. and Venkateshwarlu, P. Indian J. Chem. 9 (1971) : 194.

72. Das Gupta, A.K. and Das, K.R. "Coumarins and Related Compounds Part VI. A New Approach to Xanthyletin." J. Chem. Soc. C (1969) : 33.

73. Krebs, K.G., Heusser, D. and Wimmer, H. in Spray Reagents, Thin-layer Chromatography, (Egon Stahl, ed.) 2nd. ed., pp. 854-909, Springer International Student Edition, Springer-Verlag Berlin, Heidelberg,New York, 1969, Toppan Company Limited, Tokyo, Japan.

74. Lecomte, M.H. in in *Clausena harmandiana* Pierre., Flore Generale De L'Indo Chine, Vol.I. pp. 662-663, Masson et C^{ic}, Edituers, Paris, 1911.

75. Floss, H.G. in Biosynthesis of Furanocoumarins, Recent Advances in Phytochemistry, (Runeckles, V.C. and Watkin, J.E. eds.) Vol. 4. pp. 143-164, Appleton-Century-Crofts, Educational Division Meredith Corporation, New York,1972.

76. Grundon, M.F. and McColl, I.S. "Stereochemical Aspects of the Biological Oxidation of Aryl Isoprenoids. The Asymmetric Synthesis and Absolute Configuration of Meranzin and of Meranzin Hydrate." Phytochemistry *14*(1975) : 143.

APPENDIX

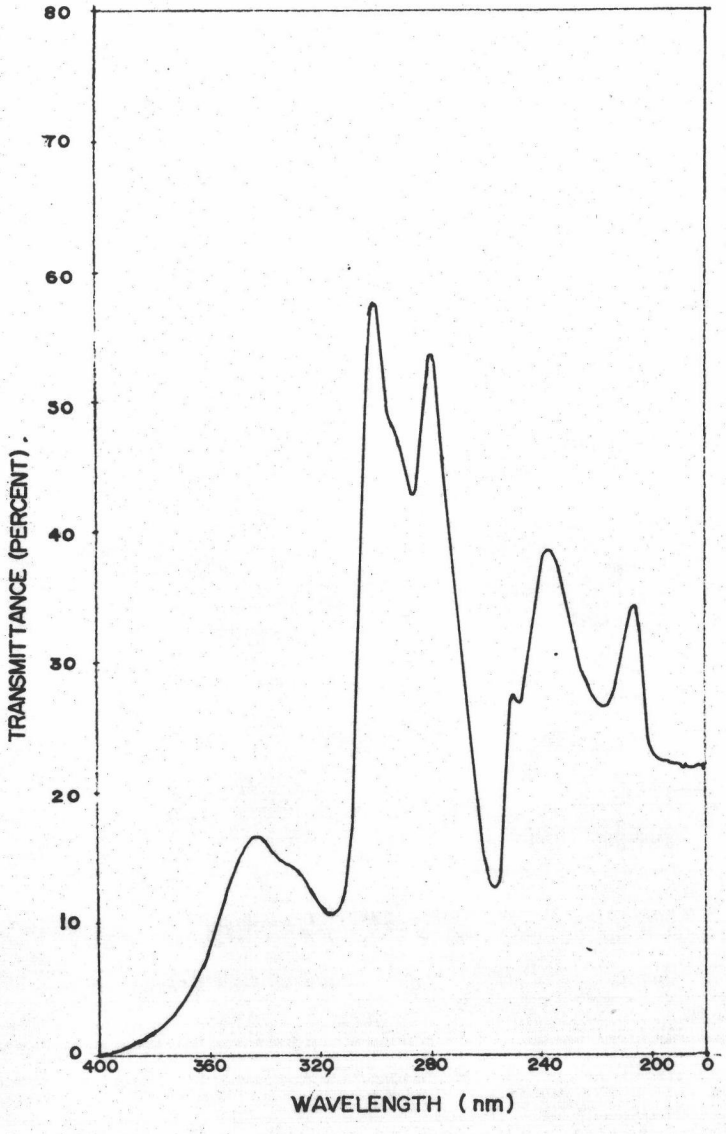

Fig. 9 Ultraviolet absorption spectrum of compound I (heptaphylline) in methanol.

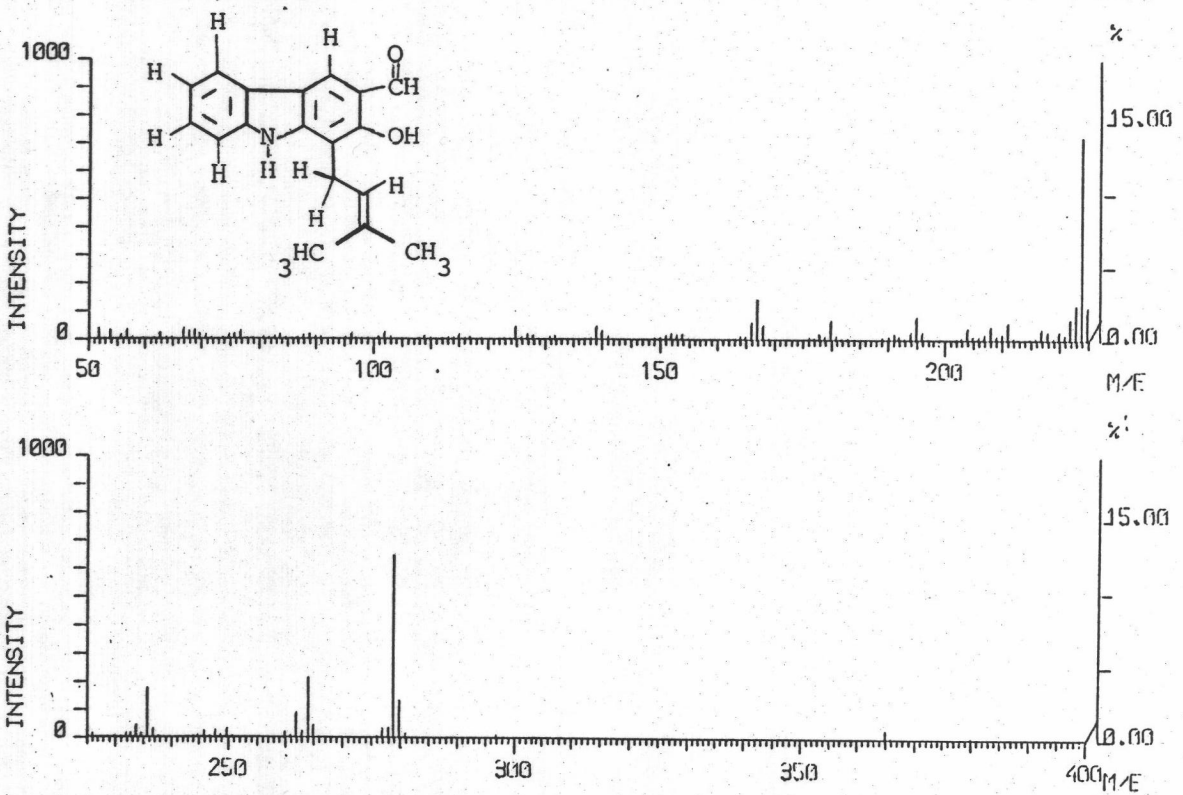

Fig. 10 Electron impact mass spectrum (EIMS) of compound I (heptaphylline).

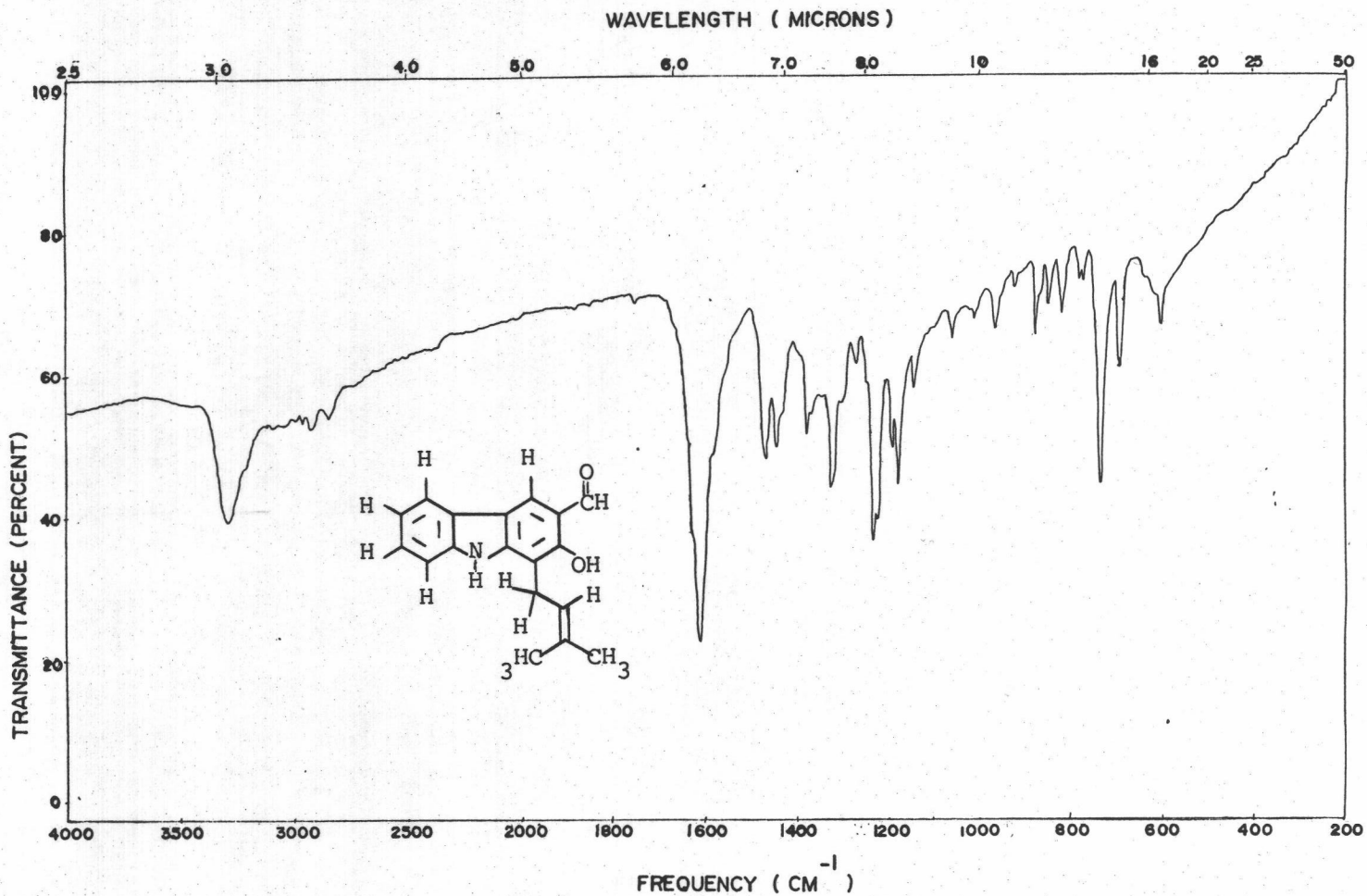

Fig. 11 Infrared absorption spectrum of compound I (heptaphylline)(KBr).

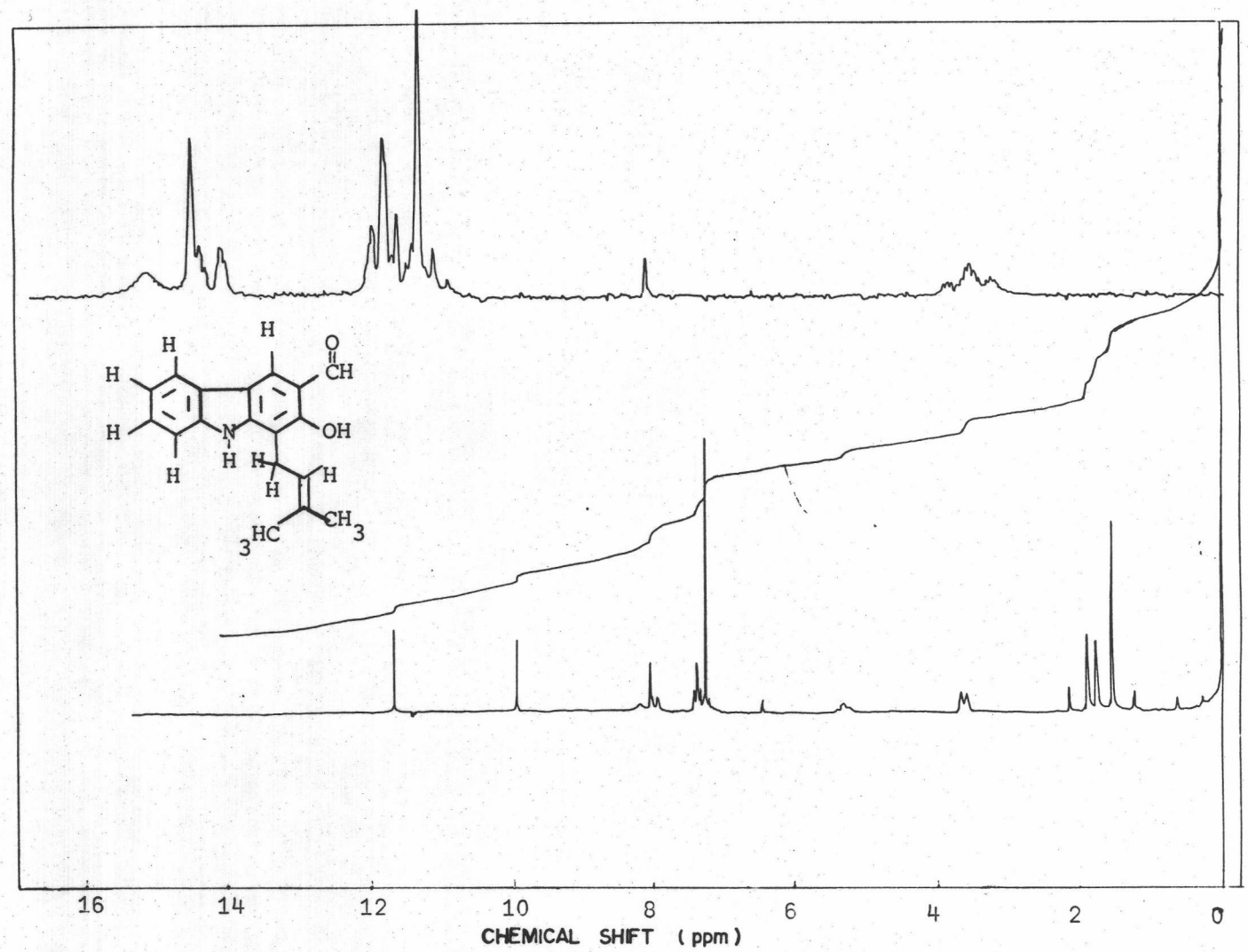

Fig. 12 90 MHz ^{1}H-NMR spectrum of compound I (heptaphylline) in $CDCl_3$.

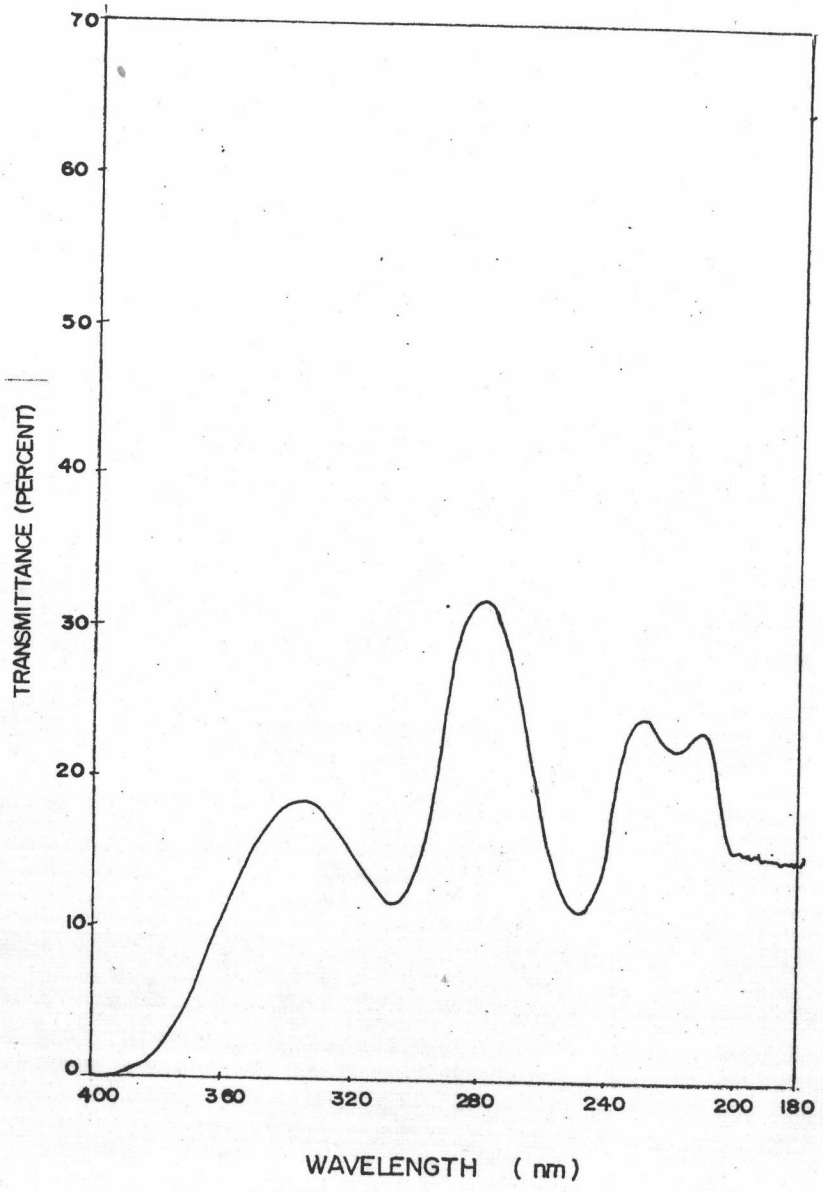

Fig. 13 Ultraviolet absorption spectrum of compound II (clausarin) in methanol.

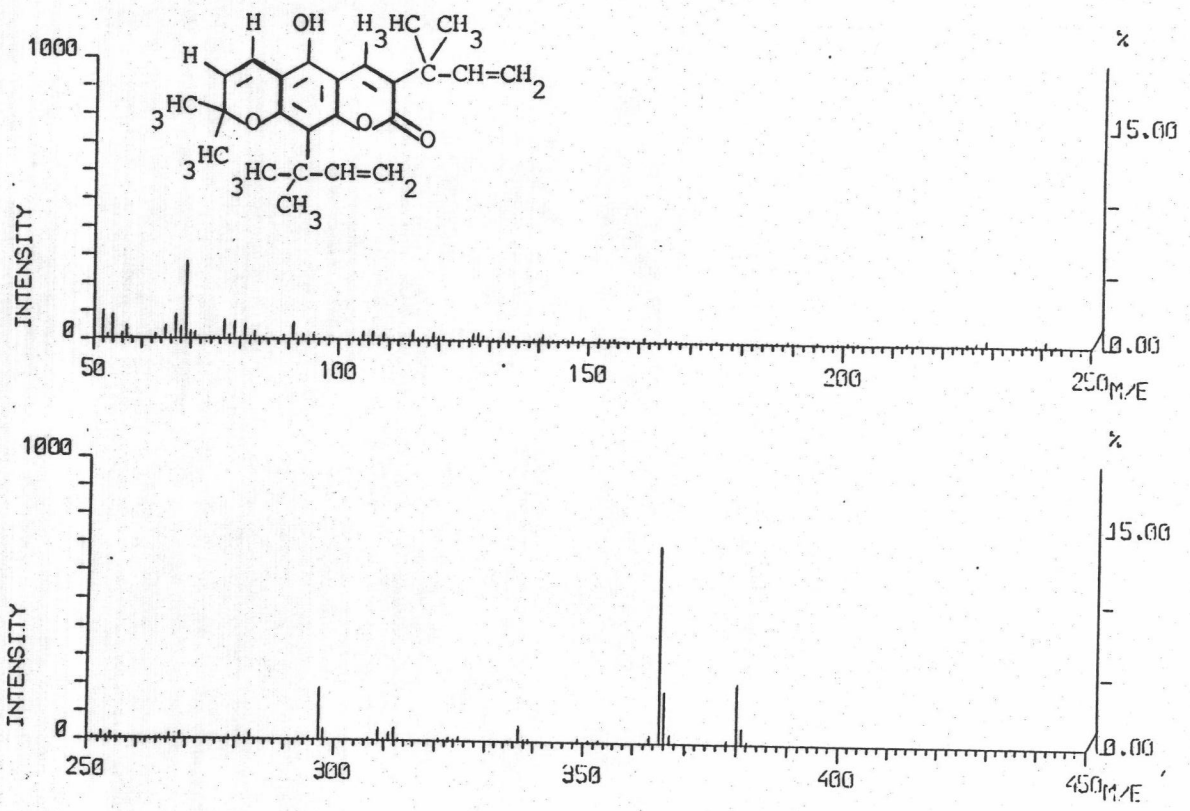

Fig. 14 Electron impact mass spectrum (EIMS) of compound II (clausarin).

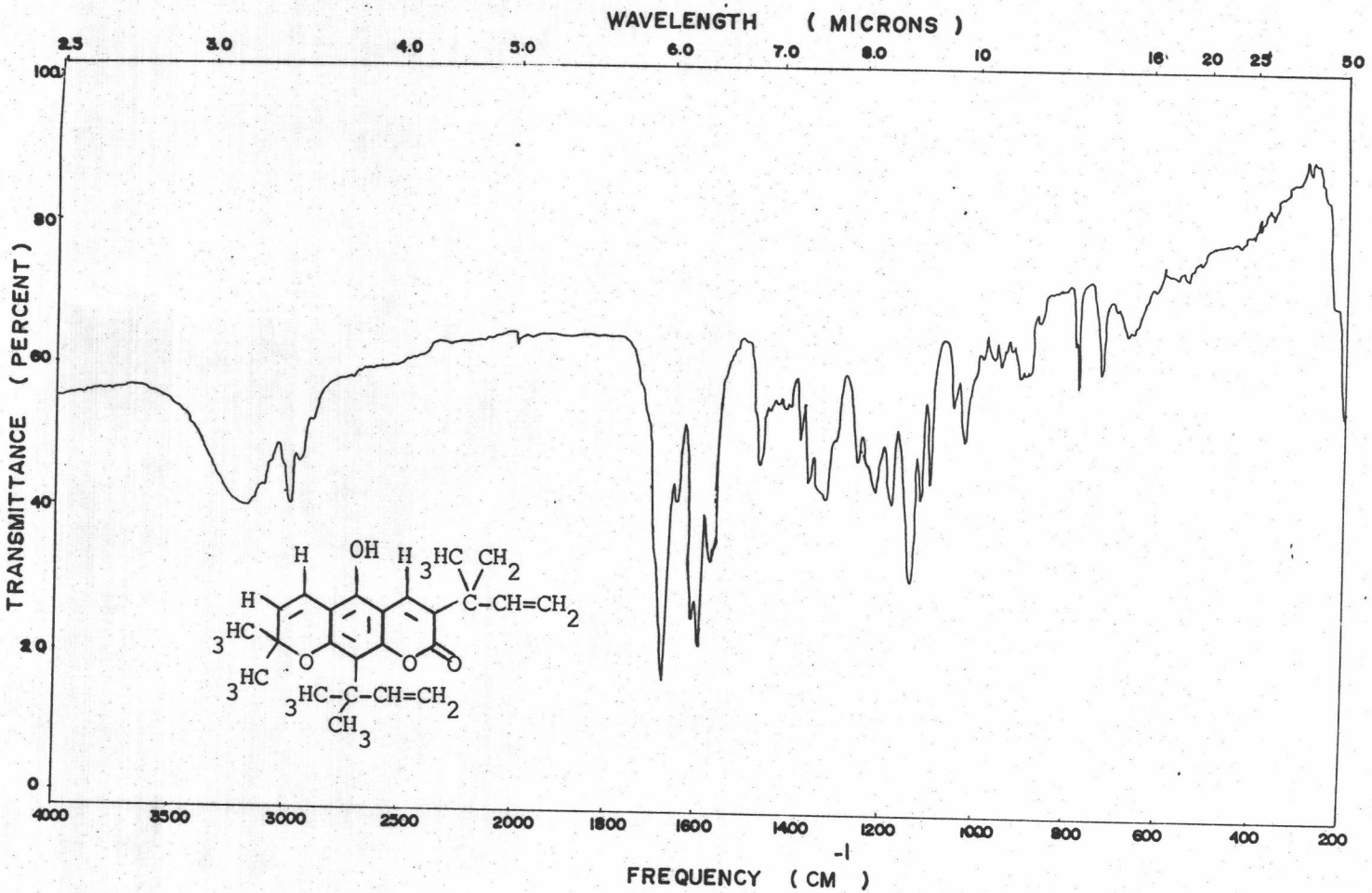

Fig. 15 Infrared absorption spectrum of compound II (clausarin)(KBr).

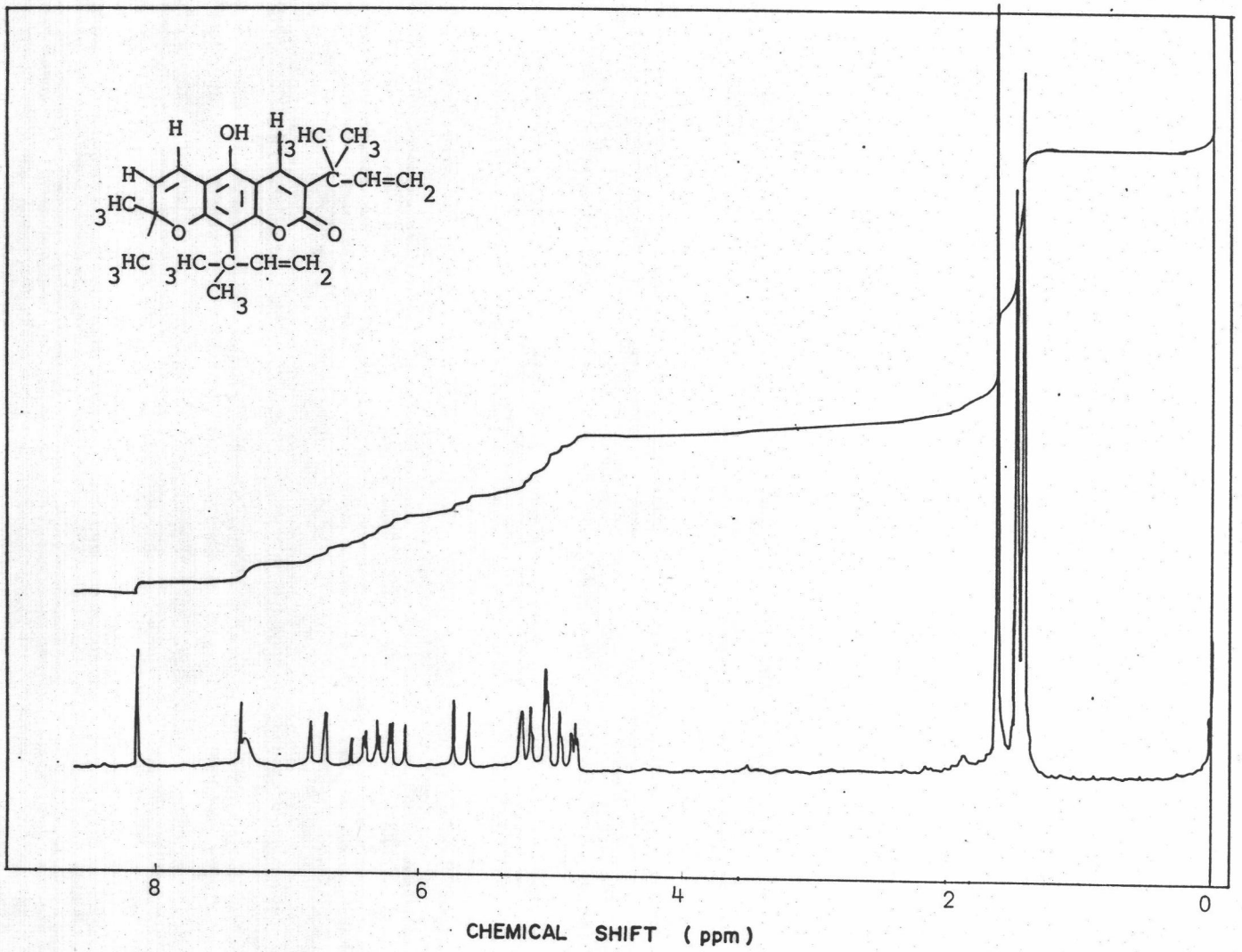

Fig. 16 90 MHz ^{1}H-NMR spectrum of compound II (clausarin) in $CDCl_3$.

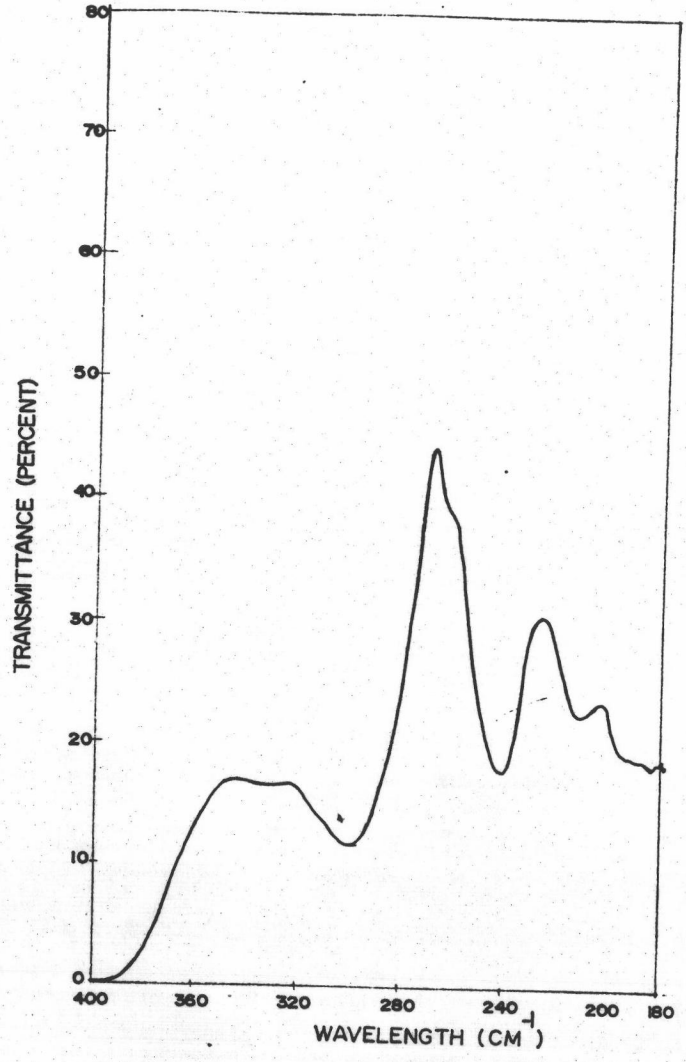

Fig. 17 Ultraviolet absorption spectrum of compound III (dentatin) in methanol.

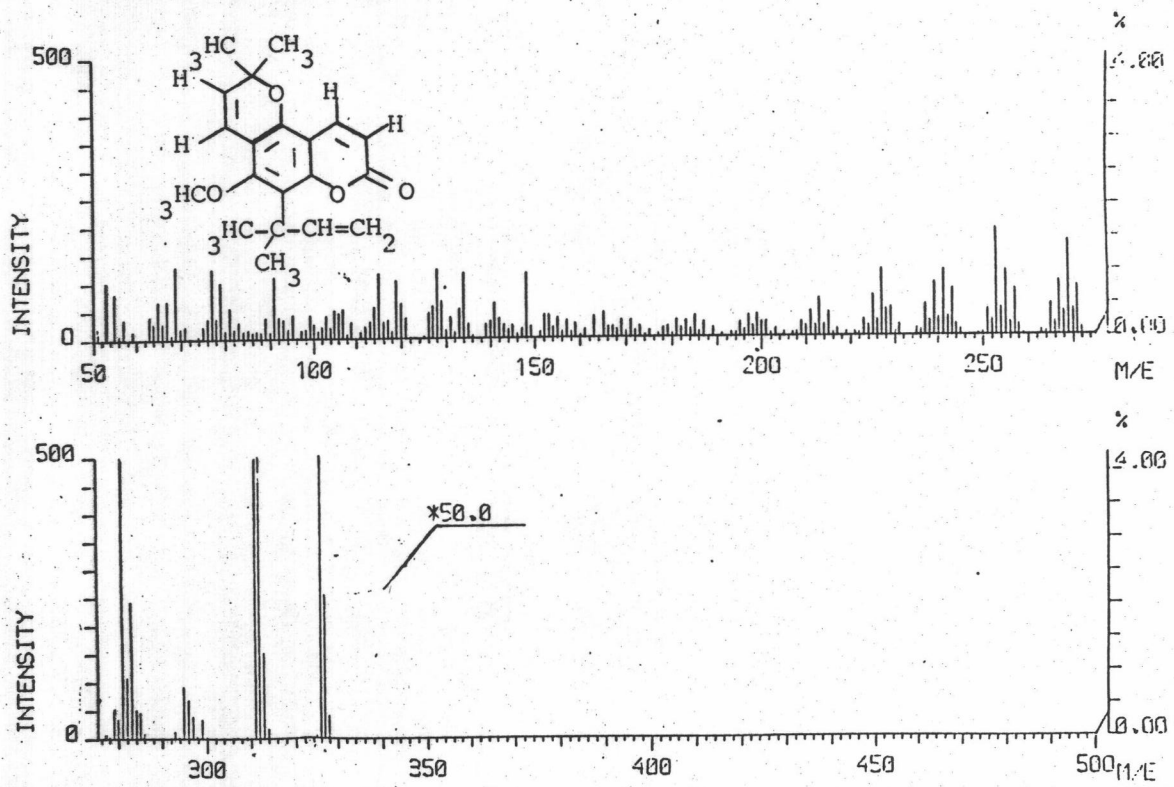

Fig. 18 Electron impact mass spectrum (EIMS) of compound III (dentatin).

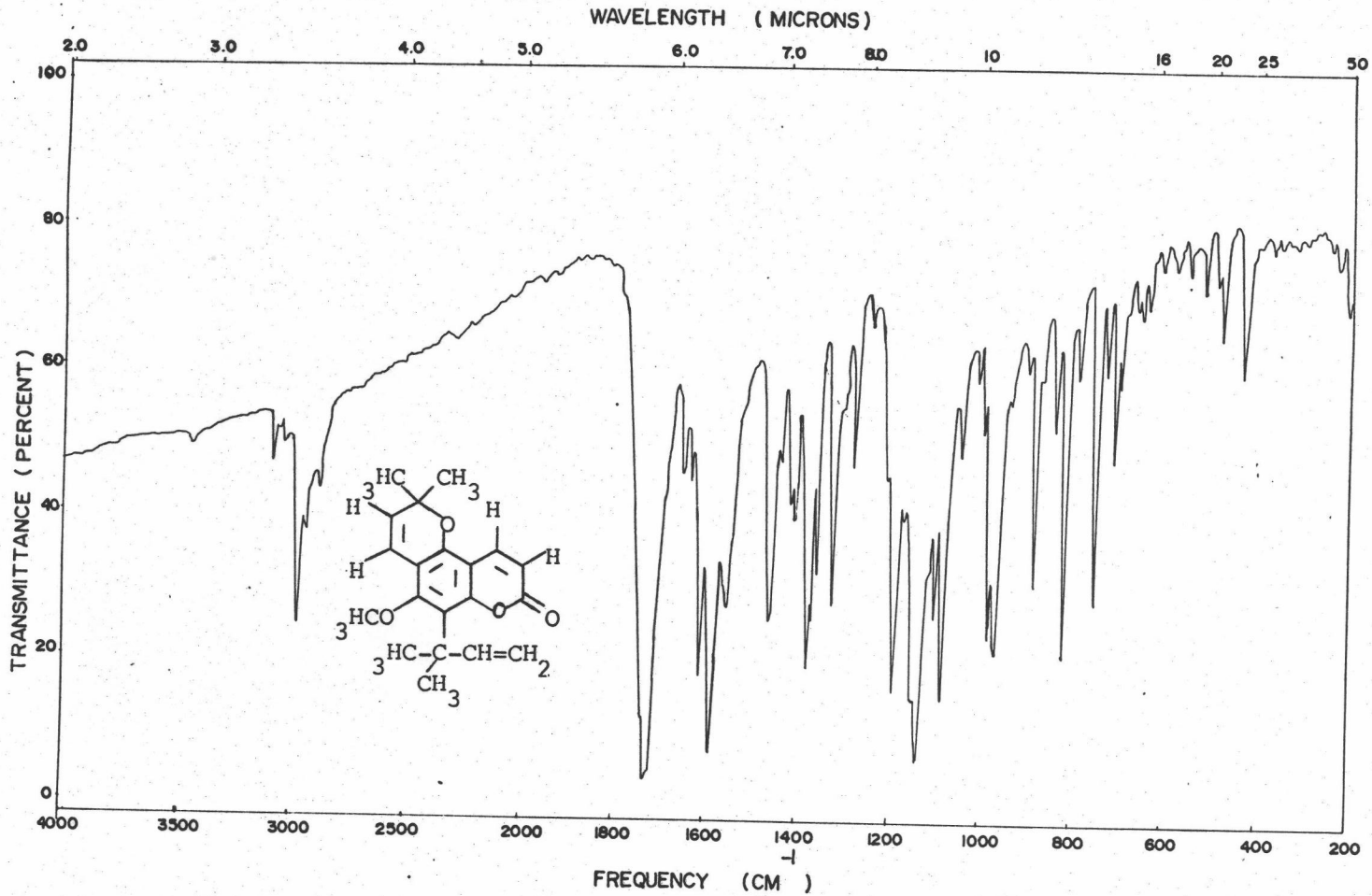

Fig. 19 Infrared absorption spectrum of compound III (dentatin) (KBr).

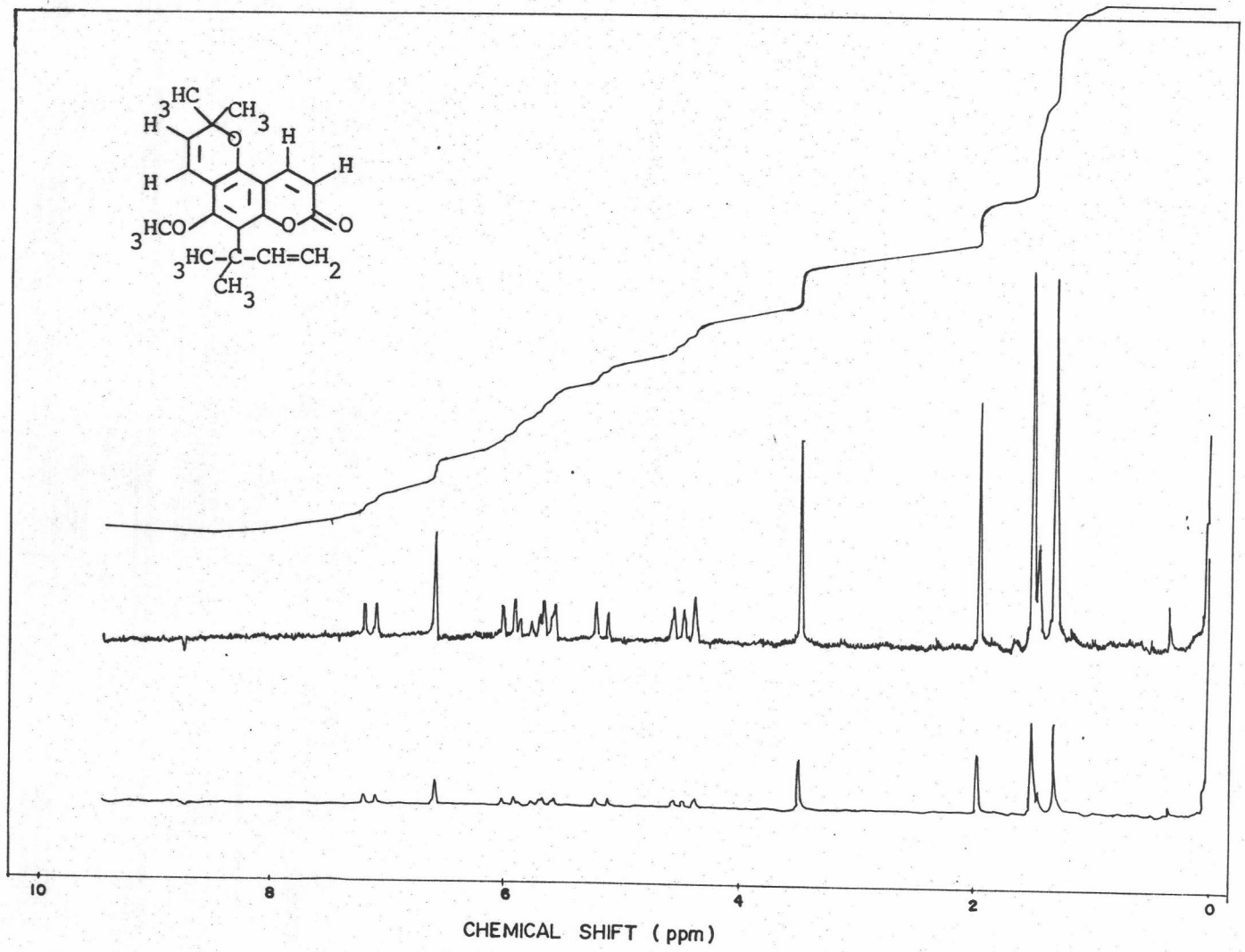

Fig. 20 90 MHz ^{1}H-NMR spectrum of compound III (dentatin) in $CDCl_3$.

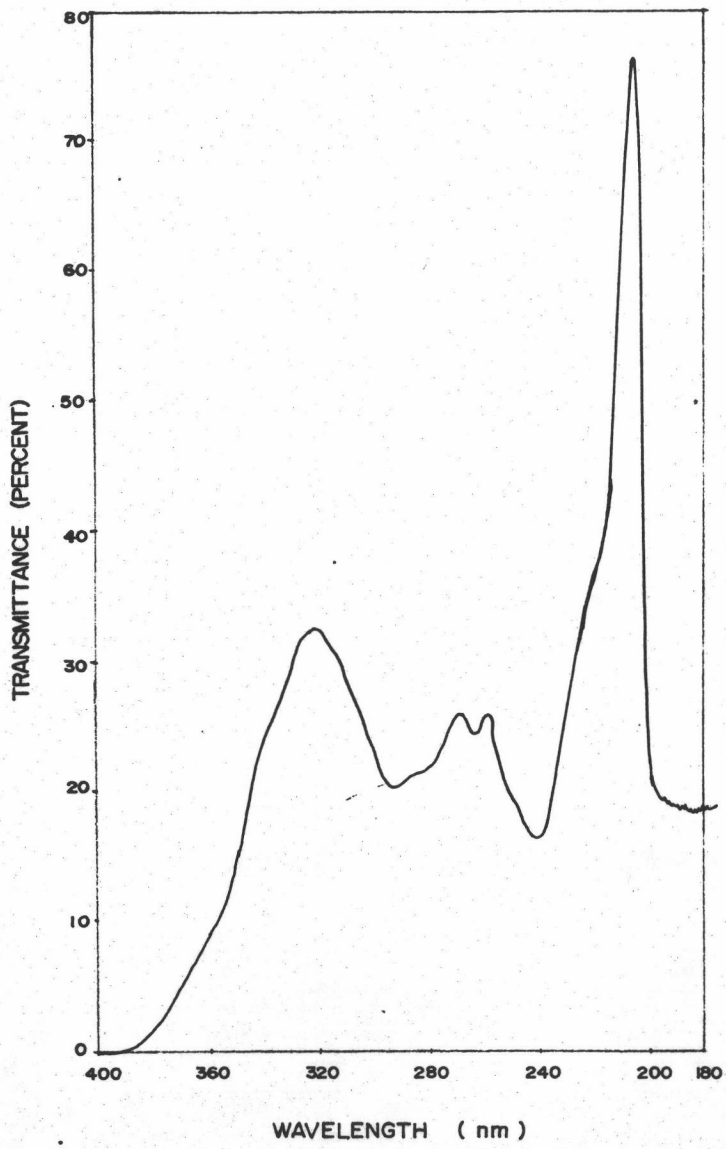

Fig. 21 Ultraviolet absorption spectrum of compound IV (osthol) in methanol.

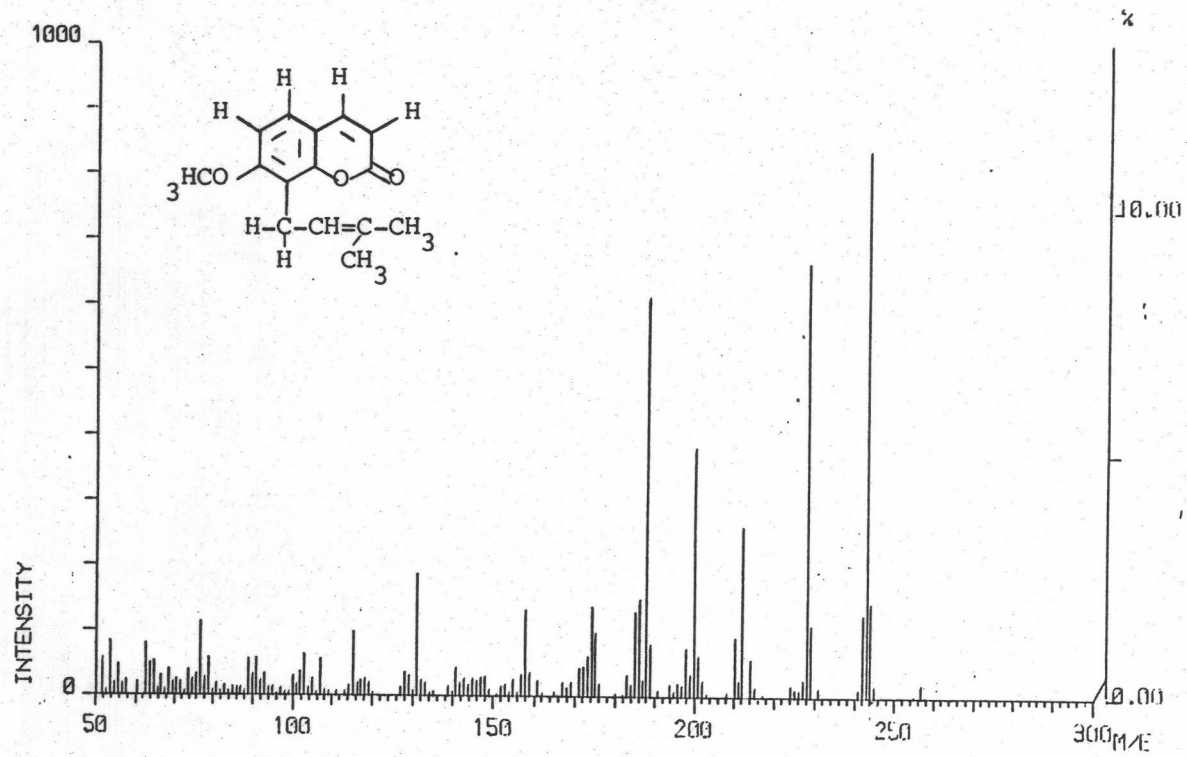

Fig. 22 Electron impact mass spectrum (EIMS) of compound IV (osthol).

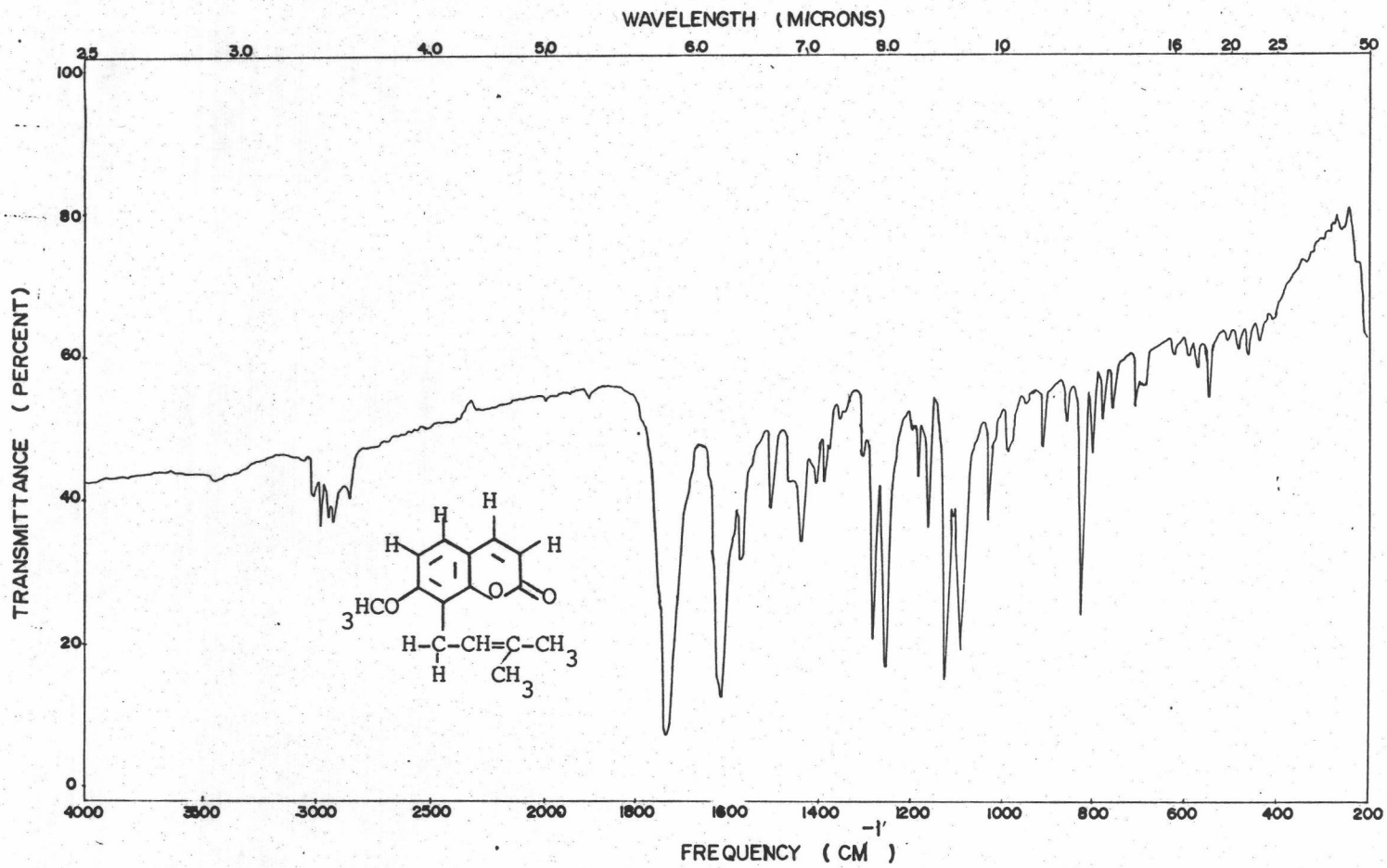

Fig. 23 Infrared absorption spectrum of compound IV (osthol)(KBr).

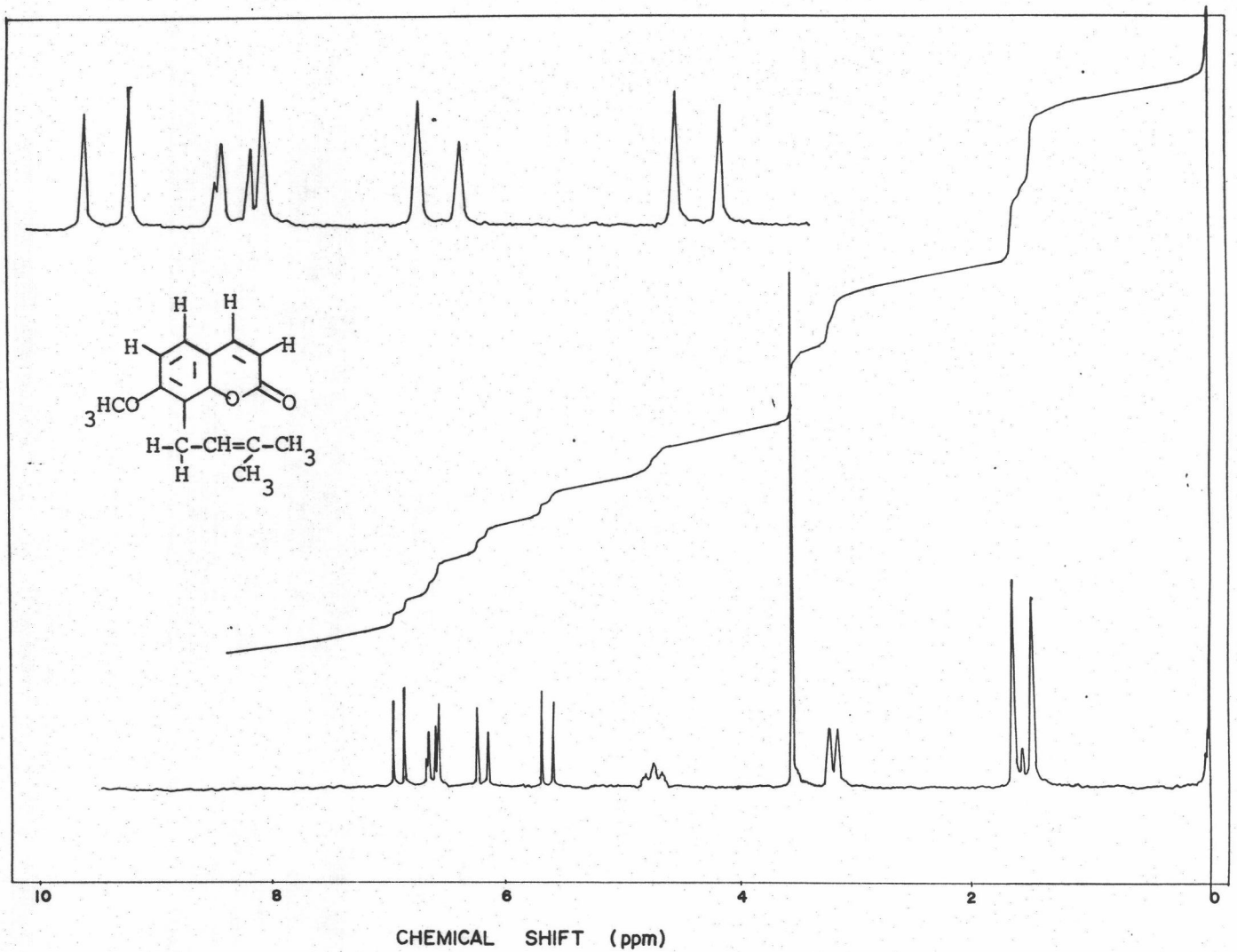

Fig. 24 90 MHz ^{1}H-NMR spectrum of compound IV (osthol) in $CDCl_3$.

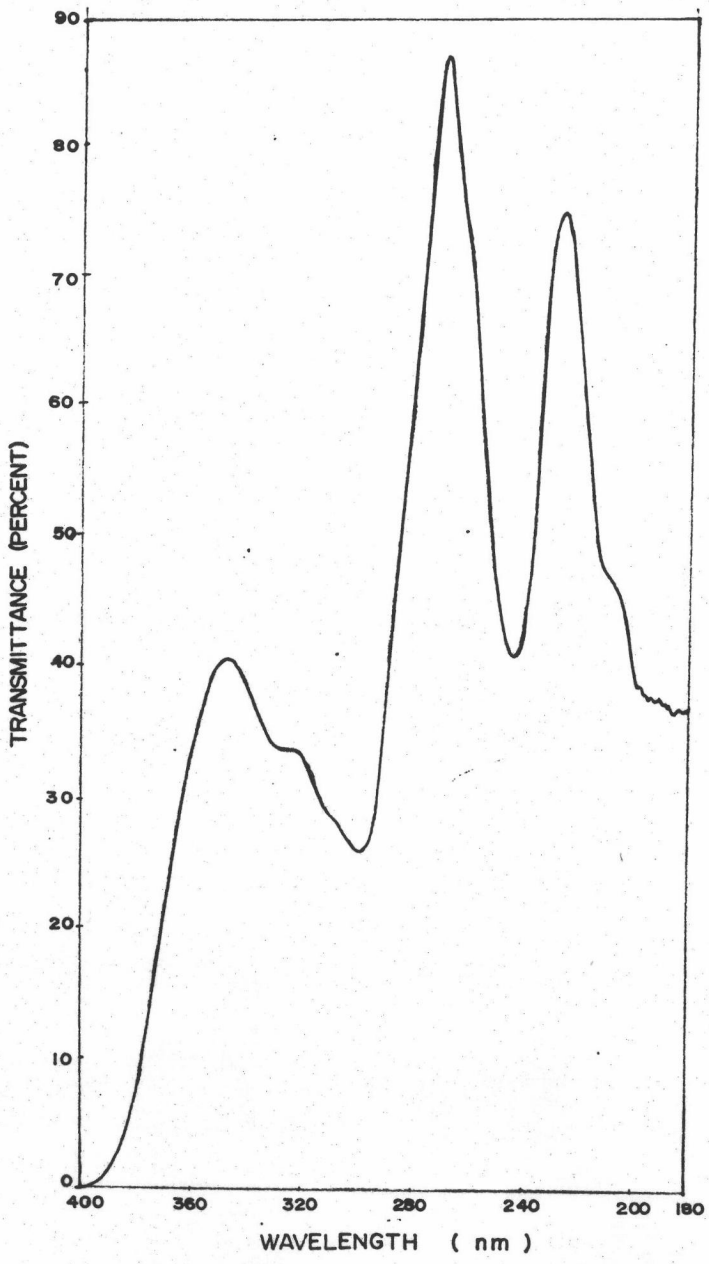

Fig. 25 Ultraviolet absorption spectrum of compound V (xanthoxyletin) in methanol.

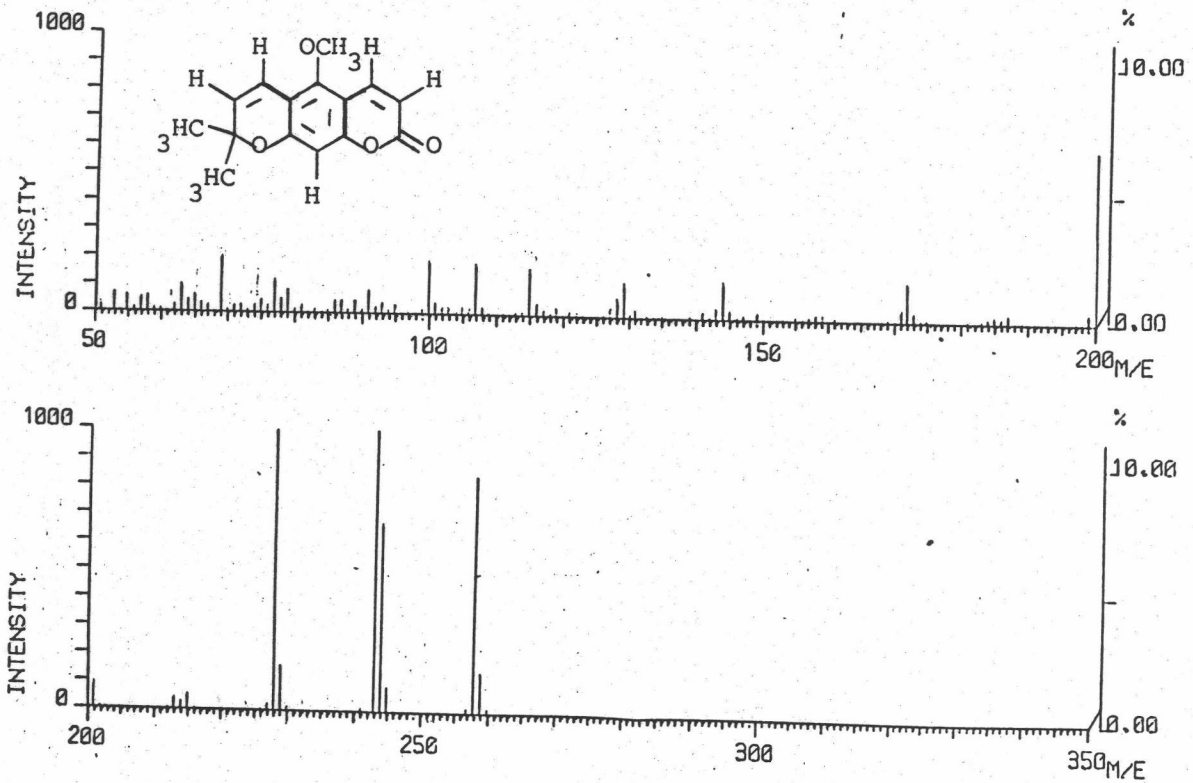

Fig. 26 Electron impact mass spectrum (EIMS) of compound V (xanthoxyletin).

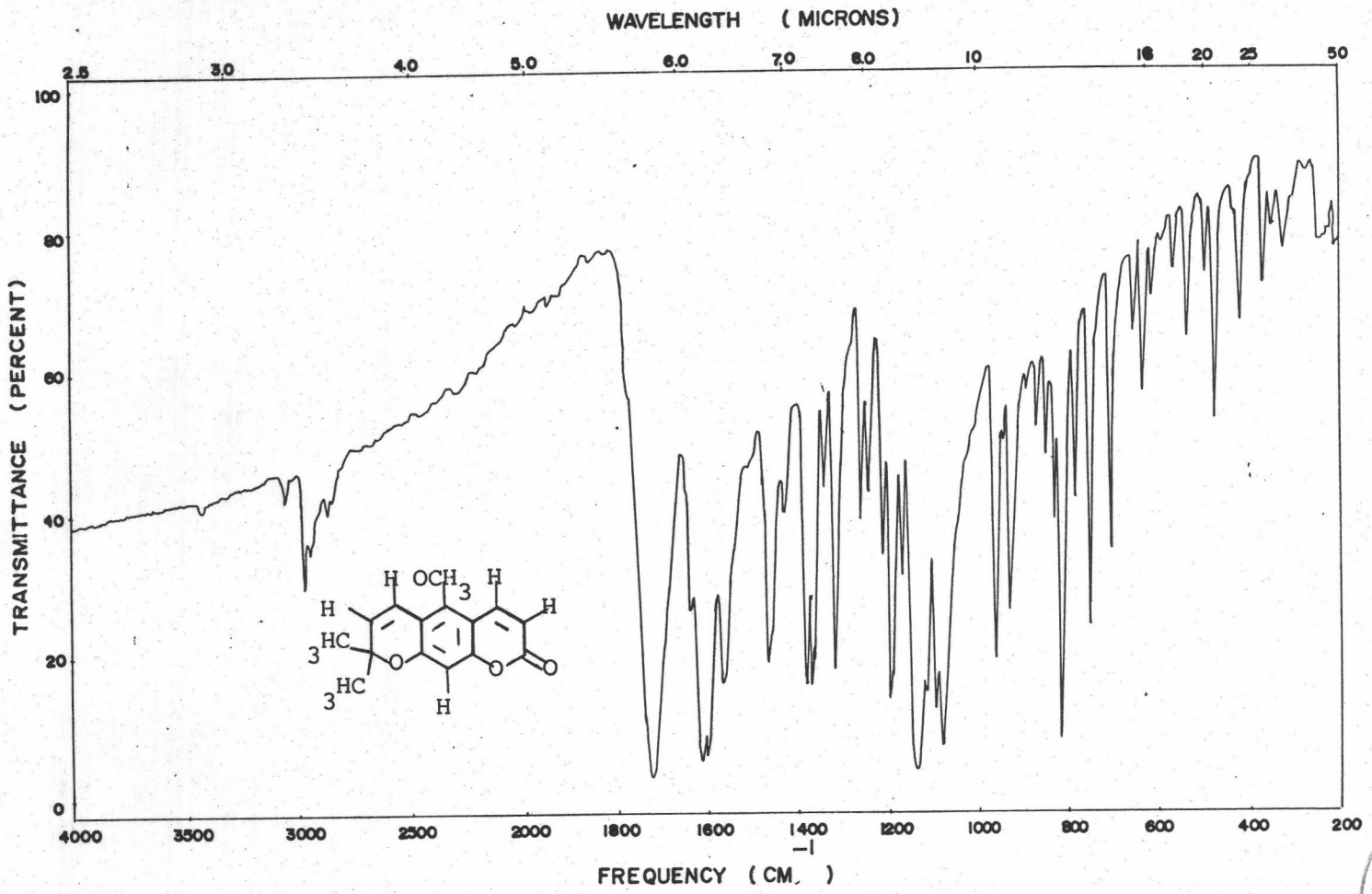

Fig. 27 Infrared absorption spectrum of compound V (xanthoxyletin)(KBr).

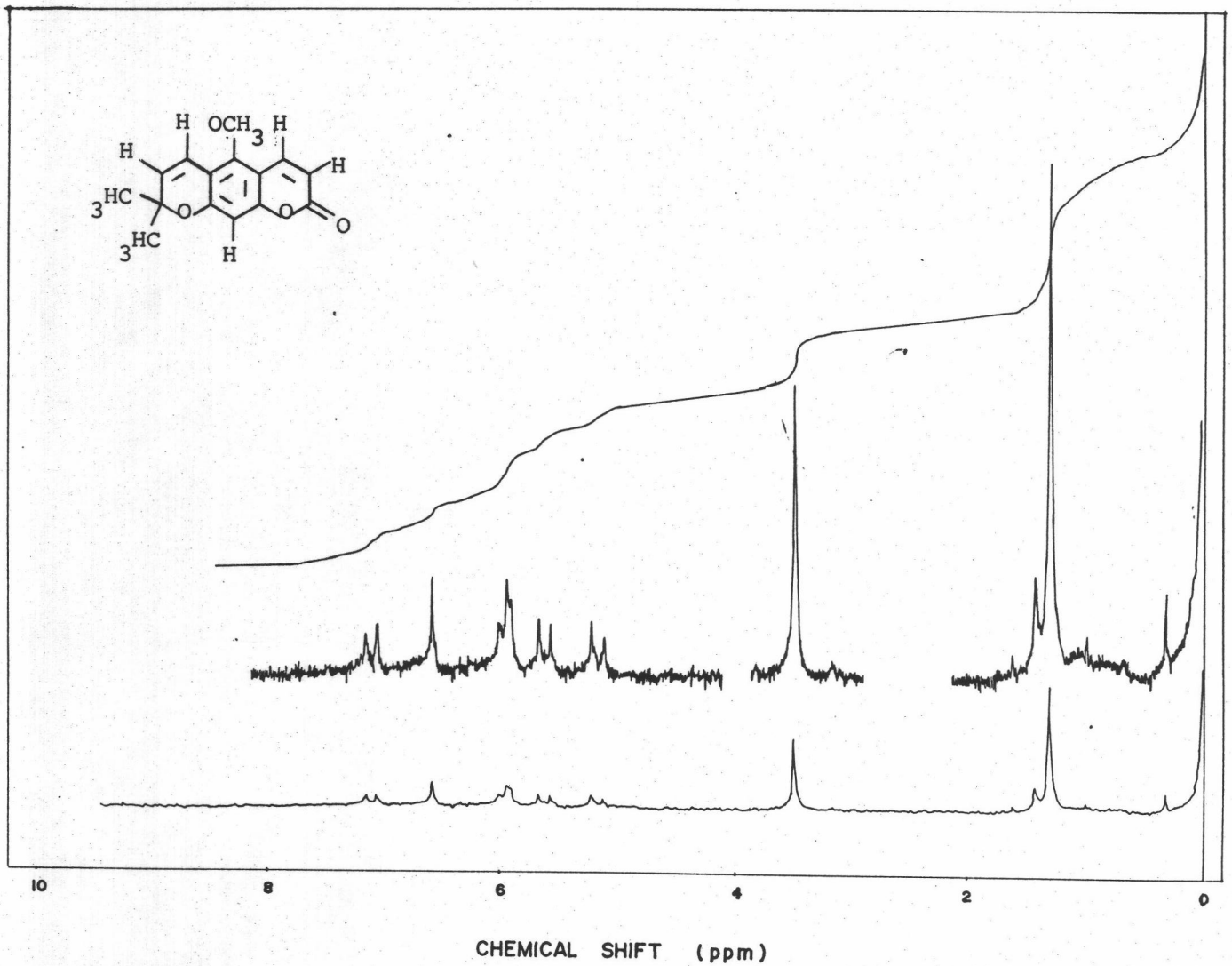

fig. 28 90 MHz ^{1}H-NMR spectrum of compound V (xanthoxyletin) in $CDCl_3$.

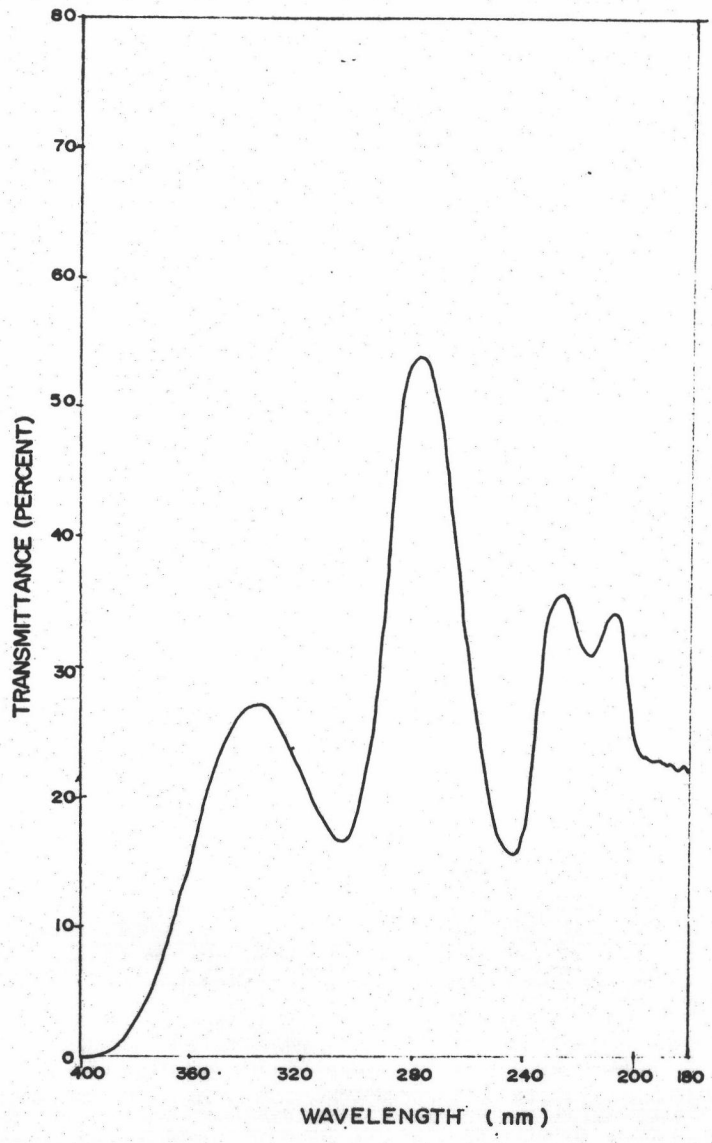

Fig. 29 Ultraviolet absorption spectrum of compound VI (nordentatin) in methanol.

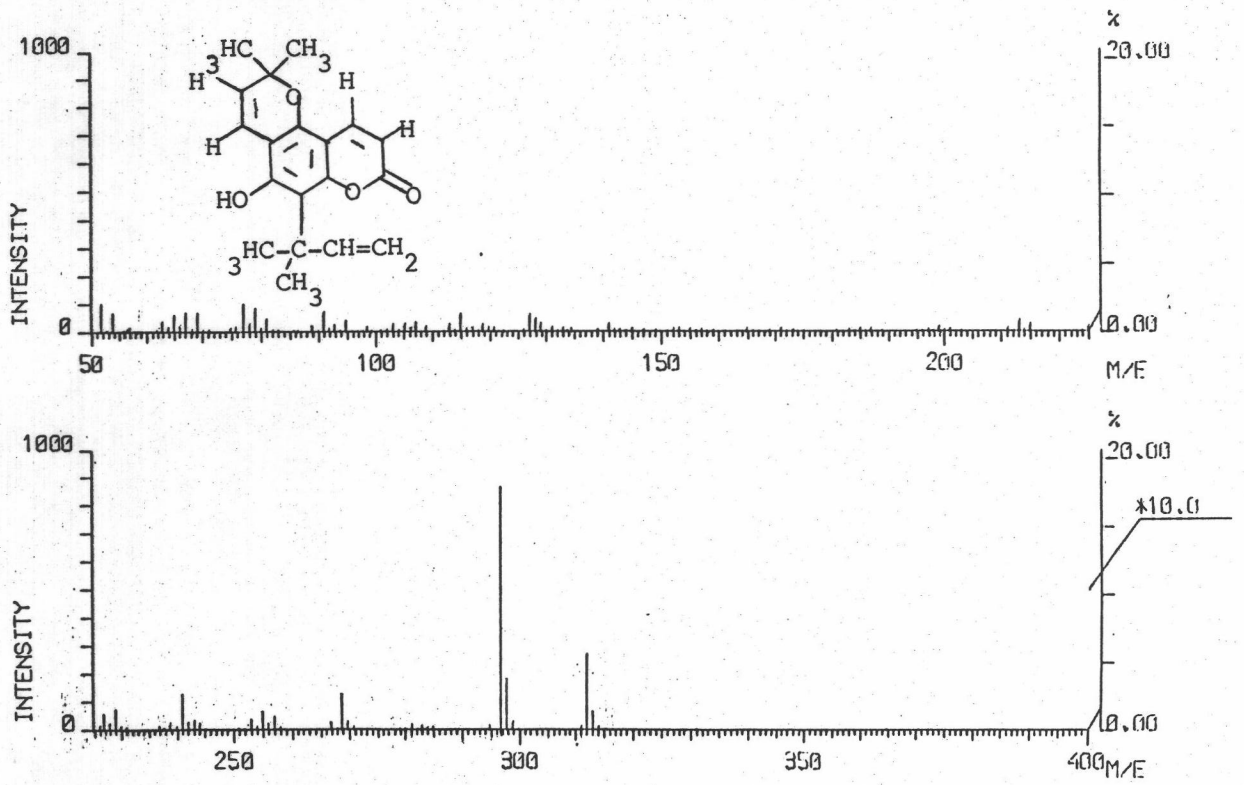

Fig. 30 Electron impact mass spectrum (EIMS) of compound VI (nordentatin).

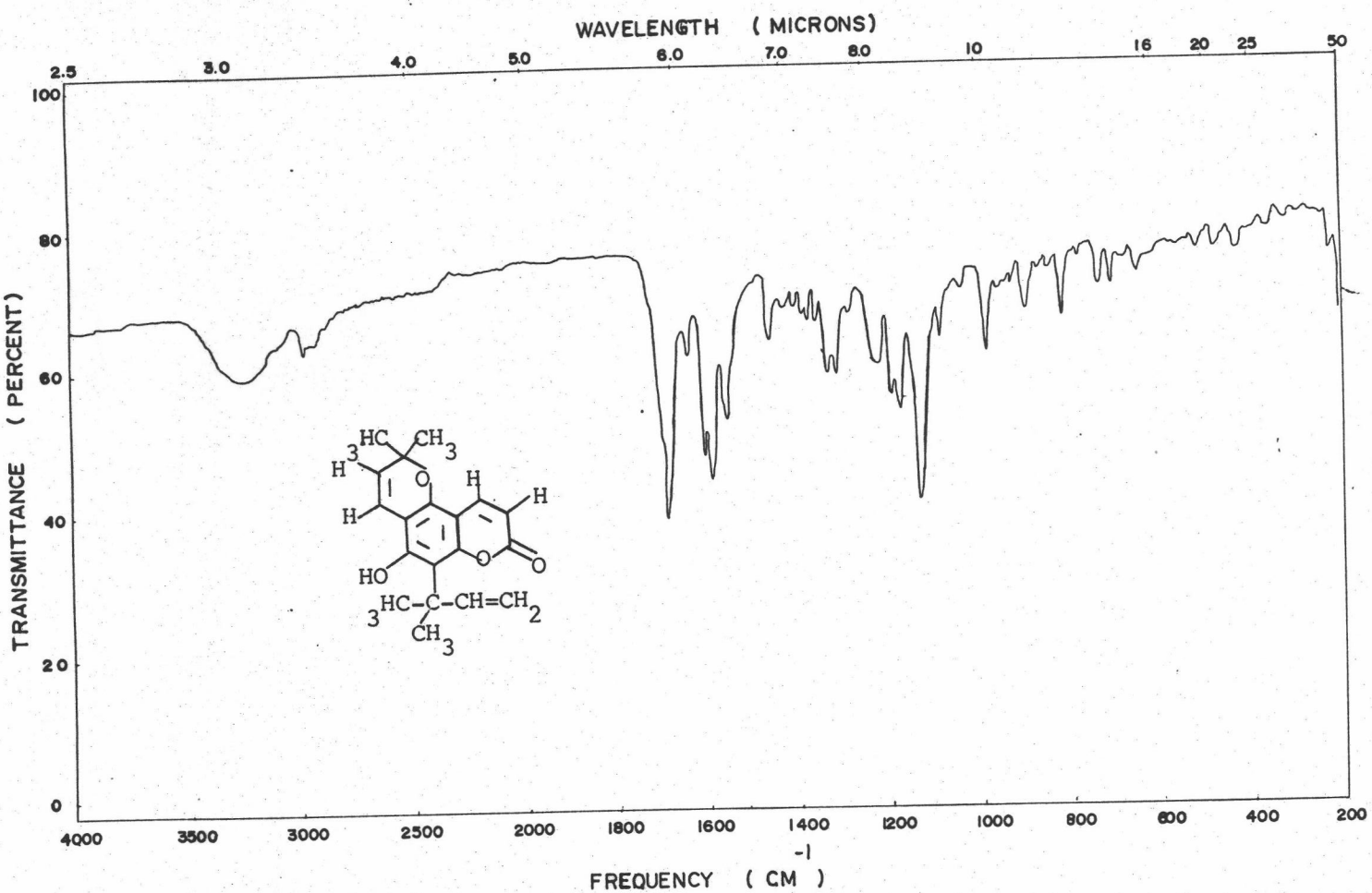

Fig. 31 Infrared absorption spectrum of compound VI (nordentatin)(KBr).

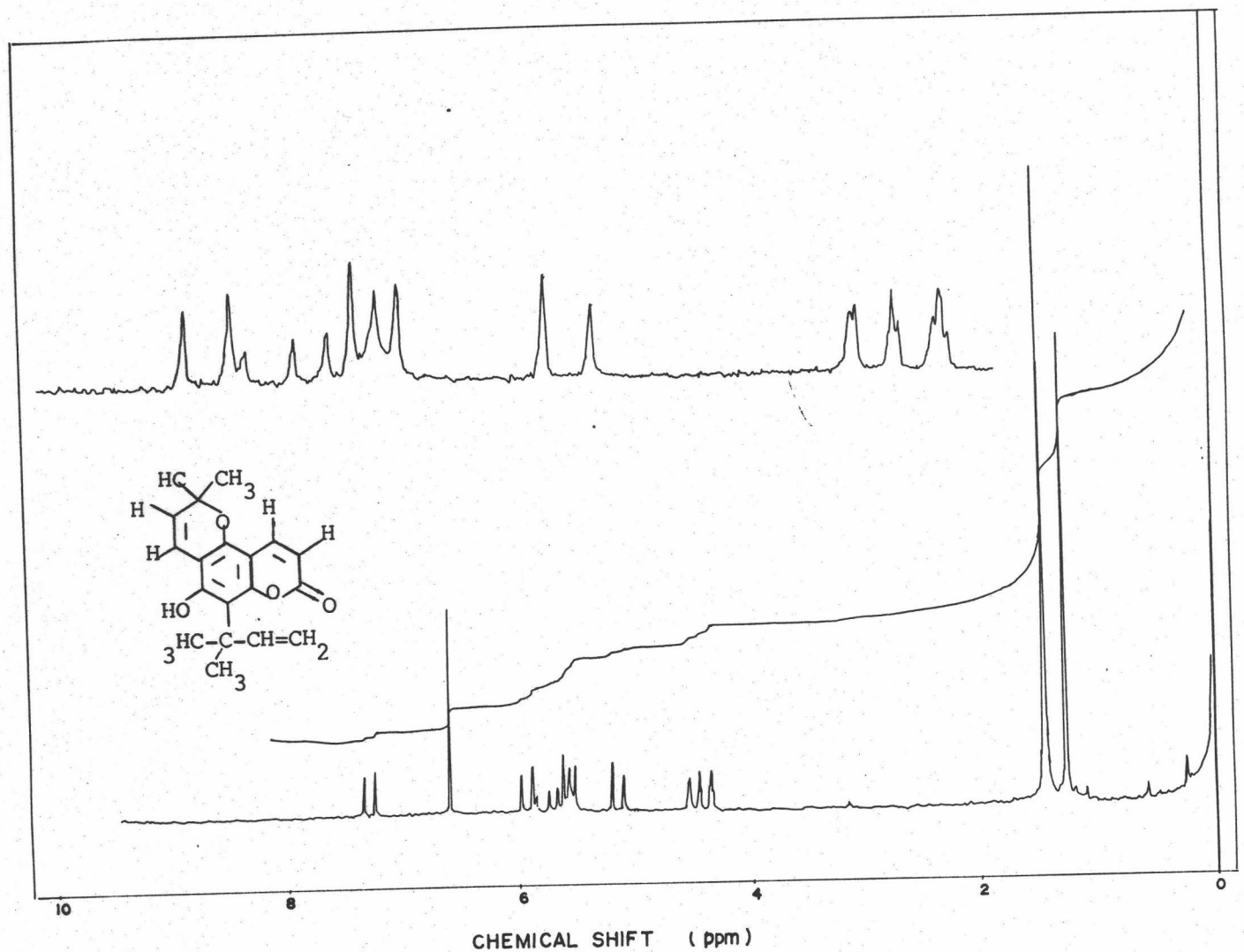

Fig. 32 90 MHz ^{1}H-NMR spectrum of compound VI (nordentatin) in $CDCl_3$.

VITA

Name Miss Jinda Wangboonskul

Education B.Sc. in Pharmacy, Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok 5, Thailand, 1978.

Position and site of the Employer's Office

Pharmacist in Medic-Pharma Co, Ltd. 59 Chareon-nekorn road, Klongson, Bangkok 6, Thailand.