Supporting Information

Transition metal free regio-selective C-H hydroxylation of chromanones towards the synthesis of hydroxyl-chromanones using $PhI(OAc)_2$ as the oxidant

N. Viswanadh,[ac] Ganesh S. Ghotekar,[ac] Mahesh B. Thoke,[a] R.Velayudham,[a] Aslam C. Shaikh[ac] M. Karthikeyan,[bc] and M. Muthukrishnan[ac]*

[a]*Division of Organic Chemistry, CSIR-National Chemical Laboratory, Pune 411 008, India.*
[b] *Chemical Engineering and Process Development, CSIR-National Chemical Laboratory, Dr. Homi-Bhabha Road, Pune - 411008, India.*
[c]*Academy of Scientific & Innovative Research (ACSIR), CSIR-NCL Campus, Pune, India*

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1. General information

Practical considerations

Unless otherwise specified, all reactions were carried out in oven dried vials or reaction vessels with magnetic stirring. Screens were performed in 5 mL/10.0 mL round-bottom flasks with rubber septa. All experiments were monitored by analytical thin layer chromatography (TLC). TLC was performed on pre-coated silica gel plates. After elution, plate was visualized under UV illumination at 254 nm for UV active materials. Further visualization was achieved by staining iodine, potassium permanganate solution and charring on a hot plate. Solvents were removed in vacuo and heated with a water bath at 35 °C. Silica gel finer than 100-200 mesh was used for flash column chromatography. Columns were packed as slurry of silica gel in petroleum ether and equilibrated with the appropriate solvent mixture prior to use. The compounds were loaded neat or as a concentrated solution using the appropriate solvent system. The elution was assisted by applying pressure with an air pump.

Materials

Unless otherwise noted, materials obtained from commercial suppliers were used without further purification. Tetrahydrofuran was distilled from Na/benzophenone under an atmosphere of dry nitrogen. Anhydrous methanol, dichloromethane, dimethylformamide, diethyl ether, acetonitrile, and petroleum ether were dried by using standard protocol under nitrogen. $PhI(OAc)_2$ was purchased from Sigma–Aldrich Chemical Company. Deuterated solvents were used as supplied.

Instrumentation

Melting points are uncorrected and recorded using digital Buchi melting point apparatus B-540. ^{1}H NMR spectra and ^{13}C NMR spectra were recorded on Bruker AV, 200/400/500 MHz spectrometers in appropriate solvents using TMS as internal standard or the solvent signals as secondary standards and the chemical shifts are shown in δ scales. Multiplicities of ^{1}H NMR signals are designated as s (singlet), d (doublet), dd (doublet of doublet), dt (doublet of triplet), t (triplet), quin (quintet), br.s. (broad signal), m (multiplet)… etc. HRMS (ESI) data were recorded on a Thermo Scientific Q-Exactive, Accela 1250 pump. X-ray intensity data measurements of compounds were carried out on a Bruker SMART APEX II CCD diffractometer with graphite-monochromatized (MoK_α= 0.71073Å) radiation.

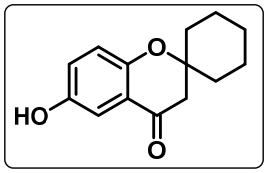
2. Experimental procedure

2a. Representative procedure for C-H hydroxylation of 2-spiro chromanones:

To a clean glass round bottom flask equipped with a stir bar and reflux condenser was added iodobenzene diacetate (143 mg, 0.44 mmol), spiro[chromane-2,1'-cyclohexan]-4-one **5a** (80 mg, 0.37 mmol) followed by slow addition of trifluoroaceticacid (TFA, 0.5 mL) at 0 °C and stirred the reaction mixture for 30 min at room temperature. Then H_2O (0.5 mL) was added into a reaction mixture and heated the content to 120 °C. The reaction was monitored by TLC. After the reaction was completed (12 h), aqueous $NaHCO_3$ (5 mL) was added and the mixture was extracted with ethylacetate (10 mL X 4). The combined organic layer was washed with water (10 mL X 4), brine (10 mL X 2), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by flash column chromatography on silica gel to afford the desired product **6a** in 70% yield.

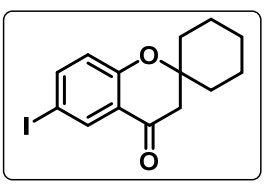
2b. Characterization data

6-hydroxyspiro[chromane-2,1'-cyclohexan]-4-one (6a):



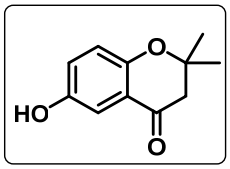
Off white solid, 75mg; Yield 70%; mp = 112-114 °C; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 1.26-1.34 (m, 1H), 1.43-1.54 (m, 4 H),1.60-1.73 (m, 3 H),1.98 (d, *J* = 13.0 Hz, 2H),2.69 (s, 2H),6.88 (d, *J* = 9.1 Hz, 1H),7.07 (dd, *J* = 9.1, 3.2 Hz, 1H),7.35 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.6, 154.0, 149.8, 125.0, 120.6, 119.6, 110.7, 79.7, 48.1, 34.6, 25.2, 21.4; **HRMS (ESI)** calcd for $C_{14}H_{16}O_3$ $[M+H]^+$ 233.1172, found 233.1171.

6-iodospiro[chromane-2,1'-cyclohexan]-4-one (6a'):



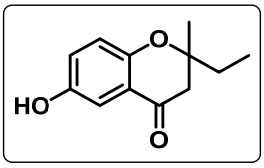
Thick liquid, 14 mg; Yield 16%; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 1.45-1.52 (m, 5H), 1.64-1.70 (m, 3H), 1.96-2.00 (m, 2H), 2.69 (s, 2H), 6.77 (d, *J* = 9.2 Hz, 1H), 7.72 (dd, *J* = 8.5, 1.8 Hz, 1H), 8.13 (d, *J* = 1.8 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ** = 191.3, 159.2, 144.3, 135.1, 122.6, 120.8, 82.7, 80.5, 47.8, 34.6, 25.0, 21.3; **HRMS (ESI)** calcd for $C_{14}H_{16}IO_2$ $[M+H]^+$343.0178, found 343.0203.

6-hydroxy-2,2-dimethylchroman-4-one (6b):



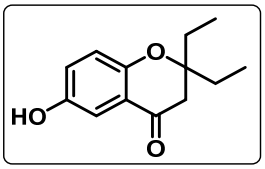
Thick liquid, 78mg; Yield 72%; **^{1}H NMR (400 MHz, $CDCl_3$) *δ***=1.44 (s, 6H), 2.71 (s, 2H), 6.83 (d, *J* = 9.1 Hz, 1H),7.07 (dd, *J* = 8.8, 3.0 Hz, 1H),7.35 (d, *J* = 2.9 Hz, 1H);**^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.5, 154.4, 149.8, 125.1, 119.6, 110.7, 78.9, 48.8, 26.5; **HRMS (ESI)** calcd for $C_{11}H_{12}O_3$ $[M+H]^+$193.0859, found 193.0856.

2-ethyl-6-hydroxy-2-methylchroman-4-one (6c):



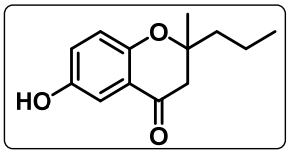
Thick liquid, 84mg; Yield 78%; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 0.98 (t, *J* = 7.6 Hz, 3H), 1.38 (s, 3H),1.70 (dd, *J* = 14.2, 7.3 Hz, 1H),1.83 (dd, *J* = 14.2, 7.3Hz, 1H),2.64 (d, *J* = 16.5 Hz, 1H),2.76 (d, *J* = 16.5 Hz, 1H),5.33 (bs, 1H),6.85 (d, *J* = 8.24 Hz, 1H),7.06 (dd, *J* = 9.16, 3.21 1H),7.32 (d, *J* = 2.3 Hz, 1H);**^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.2, 154.3, 149.5, 124.8, 120.3, 119.6, 110.6, 81.2, 47.0, 31.9, 23.3, 7.9; **HRMS (ESI)** calcd for $C_{12}H_{14}O_3$ $[M+H]^+$207.1016, found 207.1011.

2,2-diethyl-6-hydroxychroman-4-one (6d):



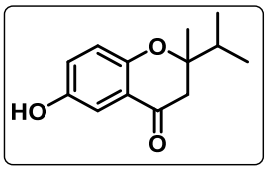
Thick liquid, 93mg; Yield 87%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.92 (t, *J* = 7.56 Hz, 6H), 1.70 (dd, *J* = 14.6, 7.3Hz, 2H),1.80 (dd, *J* = 14.6, 7.3 Hz, 2H),2.70 (s, 2H),5.52 (bs, 1H),6.86 (d, *J* = 8.7 Hz, 1H),7.06 (dd, *J* = 8.7, 3.2 Hz, 1H),7.33 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.5, 154.3, 149.5, 124.8, 120.5, 119.6, 110.6, 83.4, 44.8, 28.1, 7.7; **HRMS (ESI)** calcd for $C_{13}H_{16}O_3$ $[M+H]^+$ 221.1172, found 221.1167.

6-hydroxy-2-methyl-2-propylchroman-4-one (6e):



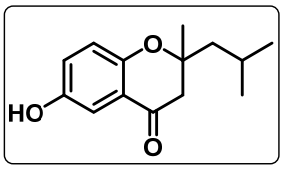
Thick liquid, 72mg; Yield 67%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.93 (t, *J* = 7.3 Hz, 3H), 1.38 (s, 3H),1.41-1.51 (m, 2H), 1.60-1.66 (m, 1H), 1.70-1.76 (m, 1H), 2.63 (d, *J* = 16.94 Hz, 1H), 2.76 (d, *J* = 16.49 Hz, 1H),5.37 (bs, 1H),6.84 (d, *J* = 8.70 Hz, 1H),7.06 (dd, *J* = 3.21, 9.16 Hz, 1H),7.32 (d, *J* = 3.21 Hz, 1H);**^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.2, 154.3, 149.5, 124.8, 120.3, 119.6, 110.6, 81.0, 47.4, 41.5, 23.8, 16.9, 14.3; **HRMS (ESI)** calcd for $C_{13}H_{16}O_3$ $[M+H]^+$221.1172, found 221.1166.

6-hydroxy-2-isopropyl-2-methylchroman-4-one (6f):



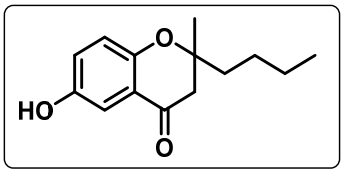
Thick liquid, 73mg; Yield 68%;**^{1}H NMR (400 MHz, $CDCl_3$) δ** = 0.99 (t, *J* = 6.36 Hz, 6H), 1.29 (s, 3H),2.11 (quin, *J* = 6.85 Hz, 1H),2.60 (d, *J* = 16.63 Hz, 1H),2.83 (d, *J* = 16.63 Hz, 1H),5.21 (bs, 1H),6.85 (d, *J* = 8.80 Hz, 1H),7.05 (dd, *J* = 3.06, 8.93 Hz, 1H),7.30 (d, *J* = 3.18 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.2, 154.3, 149.4, 124.7, 120.4, 119.6, 110.6, 83.7, 45.1, 35.3, 19.4, 17.2, 16.7; **HRMS (ESI)** calcd for $C_{13}H_{16}O_3$ $[M+H]^+$221.1172, found 221.1168.

6-hydroxy-2-isobutyl-2-methylchroman-4-one (6g):



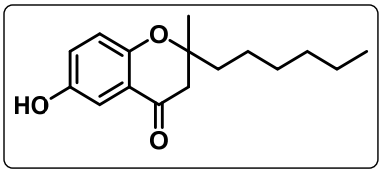
Thick liquid, 55mg; Yield 52%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.96 (d, *J* = 6.87 Hz, 6H), 1.43 (s, 3H),1.53 (dd, *J* = 5.50, 14.65 Hz, 1H),1.72 (dd, *J* = 7.10, 14.43 Hz, 1H),1.85 - 1.96 (m, 1H),2.64 (d, *J* = 16.5 Hz, 1H),2.76 (d, *J* = 16.5 Hz, 1H),5.14 (bs, 1H),6.82 (d, *J* = 9.2 Hz, 1H),7.05 (dd, *J* = 8.5, 2.5 Hz, 1H),7.29 (d, *J* = 3.21 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.1, 154.2, 149.4, 124.7, 120.2, 119.7, 110.5, 81.5, 48.3, 47.1, 24.6, 24.2, 23.8; **HRMS (ESI)** calcd for $C_{14}H_{18}O_3$ $[M+H]^+$ 235.1329, found 235.1323.

2-butyl-6-hydroxy-2-methylchroman-4-one (6h):



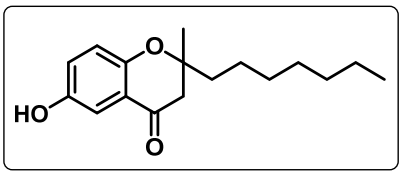
Thick liquid, 68mg; Yield 64%; **^{1}H NMR (200 MHz, $CDCl_3$) δ**= 0.85-0.95 (m, 3H), 1.21-1.37 (m, 4H),1.38 (s, 3H),1.64-1.79 (m, 2H),2.58-2.83 (m, 2H),5.94 (bs, 1H),6.84 (d, *J* = 8.97 Hz, 1H),7.07 (dd, *J* = 3.09, 8.91 Hz, 1H),7.35-7.39 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.8, 154.3, 149.8, 125.1, 120.2, 119.6, 110.6, 81.0, 47.4, 39.0, 25.7, 23.8, 22.9, 14.0; **HRMS (ESI)** calcd for $C_{14}H_{18}O_3$ $[M+H]^+$ 235.1329, found 235.1324.

2-hexyl-6-hydroxy-2-methylchroman-4-one (6i):



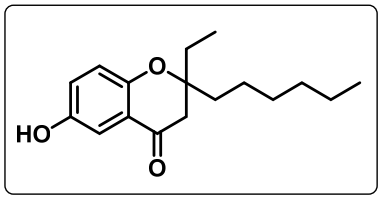
Thick liquid, 82 mg; Yield 78%; **^{1}H NMR (500 MHz, $CDCl_3$) δ**= 0.85-0.89 (m, 3H), 1.22-1.32 (m, 8H), 1.38 (s, 3H), 1.62-1.68 (m, 1H), 1.72-1.78 (m, 1H),2.64 (d, *J* = 16.7 Hz, 1H), 2.77 (d, *J* = 16.5 Hz, 1H), 6.37 (bs, 1H), 6.83 (d, *J* = 8.9 Hz, 1H),7.08 (dd, *J* = 8.9, 3.2 Hz, 1H),7.39 (d, *J* = 3.2 Hz, 1H);**^{13}C NMR (125 MHz, $CDCl_3$) δ**= 193.9, 154.3, 149.8, 125.2, 120.2, 119.6, 110.7, 81.1, 47.4, 39.3, 31.6, 29.4, 23.8, 23.5, 22.5, 14.0; **HRMS (ESI)** calcd for $C_{16}H_{22}O_3$ $[M+H]^+$263.1642, found 263.1635.

2-heptyl-6-hydroxy-2-methylchroman-4-one (6j):



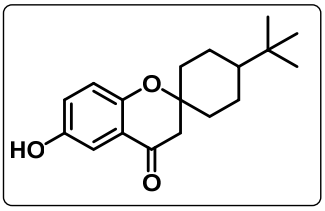
Thick liquid, 55mg; Yield 52%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.88 (t, *J* = 6.7 Hz, 3H), 1.25-1.32 (m, 8H),1.36-1.44 (m, 5H),1.60-1.70 (m, 1H),1.71-1.80 (m, 1H),2.64 (d, *J* = 16.6 Hz, 1H),2.77 (d, *J* = 16.6 Hz, 1H),6.13 (bs, 1H),6.83 (d, *J* = 9.1 Hz, 1H),7.07 (dd, *J* = 8.9, 3.1 Hz, 1H),7.35 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.6, 154.3, 149.7, 125.0, 120.2, 119.6, 110.6, 81.1, 47.4, 39.3, 31.7, 29.7, 29.1, 23.8, 23.5, 22.6, 14.0; **HRMS (ESI)** calcd for $C_{17}H_{24}O_3$ $[M+H]^+$ 277.1798, found 277.1794.

2-ethyl-2-hexyl-6-hydroxychroman-4-one (6k):



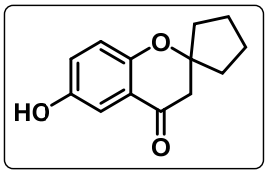
Thick liquid, 58mg; Yield 55%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.87 (t, *J* = 6.7 Hz, 3H), 0.91 (t, *J* = 7.5 Hz, 3H),1.25-1.37 (m, 8H),1.64-1.84 (m, 4H),2.71 (s, 2H),6.22 (bs, 1H),6.84 (d, *J* = 9.1 Hz, 1H),7.07 (dd, *J* = 8.8, 3.2 Hz, 1H),7.36 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.9, 154.2, 149.7, 125.1, 120.4, 119.5, 110.6, 83.3, 45.2, 35.5, 31.6, 29.5, 28.7, 23.2, 22.5, 14.0, 7.7; **HRMS (ESI)** calcd for $C_{17}H_{24}O_3$ $[M+H]^+$277.1798, found 277.1795.

4'-(tert-butyl)-6-hydroxyspiro[chromane-2,1'-cyclohexan]-4-one (6l):



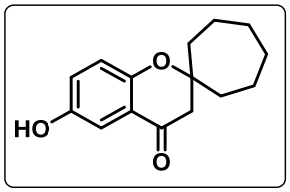
Thick liquid, 48mg; Yield 48%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 0.89 (s, 9H), 1.02-1.08 (m, 1H), 1.26-1.37 (m, 4H),1.39-1.50 (m, 2H), 1.56-1.61 (m, 2H),2.63 (s, 2H),6.89 (d, *J* = 8.7 Hz, 1H),7.06 (dd, *J* = 9.2, 3.2 Hz, 1H),7.32 (d, *J* = 2.3 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.3, 153.9, 149.6, 124.7, 120.8, 119.6, 110.7, 79.0, 49.0, 47.0, 34.8, 32.4, 27.5, 21.9; **HRMS (ESI)** calcd for $C_{18}H_{24}O_3$ $[M+H]^+$ 289.1798, found 289.1791.

6-hydroxyspiro[chromane-2,1'-cyclopentan]-4-one (6m):



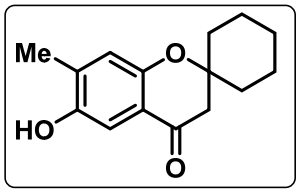
Thick liquid, 74mg; Yield 69%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 1.61-1.68 (m, 2H), 1.69-1.74 (m, 2H),1.84-1.90 (m, 2H),2.08 (m, 2H),2.82 (s, 2 H),5.46 (bs, 1H),6.84 (d, *J* = 8.80 Hz, 1H),7.05 (dd, *J* = 8.93, 3.06 Hz, 1H),7.34 (d, *J* = 3.18 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.2, 154.8, 149.6, 124.6, 120.9, 119.8, 110.9, 89.8, 47.0, 37.3, 23.8; **HRMS (ESI)** calcd for $C_{13}H_{14}O_3$ $[M+H]^+$ 219.1016, found 219.1012.

6-hydroxyspiro[chromane-2,1'-cycloheptan]-4-one (6n):



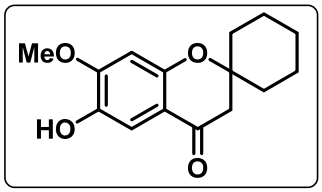
Thick liquid, 76mg; Yield 72%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 1.36-1.47 (m, 2H), 1.49-1.59 (m, 2H),1.63-1.78 (m, 6H),2.04-2.11 (m, 2H),2.73 (s, 2H),6.46 (bs, 1H),6.85 (d, *J* = 8.70 Hz, 1H),7.08 (dd, *J* = 8.93, 2.06 Hz, 1H),7.38 (d, *J* = 2.75 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.9, 154.2, 149.8, 125.1, 120.5, 119.7, 110.6, 84.0, 48.8, 38.0, 29.2, 21.9; **HRMS (ESI)** calcd for $C_{15}H_{18}O_3$ $[M+H]^+$ 247.1329, found 247.1322.

6-hydroxy-7-methylspiro[chromane-2,1'-cyclohexan]-4-one (6o):



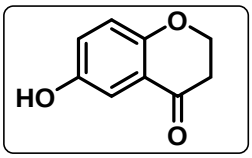
Off white solid, 58 mg; Yield 56%; mp = 186-188 °C; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 7.32 (s, 1 H), 6.77 (s, 1 H), 5.87 (br. s., 1 H), 2.66 (s, 2 H), 2.28 (s, 3 H), 1.99 (d, *J* = 13.4 Hz, 2 H), 1.72 - 1.60 (m, 3 H), 1.55 - 1.42 (m, 5 H), 1.31 (d, *J* = 11.6 Hz, 1 H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 193.2, 153.9, 148.4, 135.9, 120.2, 118.8, 110.0, 79.7, 48.1, 34.7, 25.2, 21.4, 16.8; **HRMS (ESI)**calcd for $C_{15}H_{19}O_3$ $[M+H]^+$ 247.1329, found 247.1326.

6-hydroxy-7-methoxyspiro[chromane-2,1'-cyclohexan]-4-one (6p):



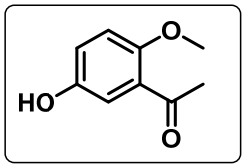
Off white solid, 68 mg; Yield 62%; mp = 135-137 °C; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 7.34 (s, 1 H), 6.44 (s, 1 H), 5.27 (br. s., 1 H), 3.94 (s, 3 H), 2.64 (s, 2 H), 1.99 (d, *J* = 12.8 Hz, 2 H), 1.73 - 1.63 (m, 4 H), 1.52 (d, *J* = 4.3 Hz, 3 H), 1.35 (br. s., 1 H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 191.3, 155.1, 153.6, 140.1, 113.9, 109.9, 99.9, 80.3, 56.2, 47.8, 34.7, 25.2, 21.5; **HRMS (ESI)** calcd for $C_{15}H_{19}O_4$ $[M+H]^+$ 263.1278 found 263.1275.

6-hydroxychroman-4-one (6q):



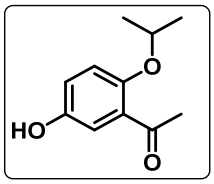
Thick liquid, 38 mg; Yield 42%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 7.36 (d, *J* = 3.0 Hz, 1 H), 7.13 - 6.99 (m, 1 H), 6.90 (d, *J* = 9.0 Hz, 1 H), 4.61 - 4.36 (m, 2 H), 2.91 - 2.68 (m, 2 H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 192.3, 156.4, 150.1, 124.7, 121.3, 119.2, 111.2, 67.0, 37.7; **HRMS (ESI)**calcd for $C_9H_9O_3$ $[M+H]^+$ 165.0546, found 165.0546.

1-(5-hydroxy-2-methoxyphenyl)ethan-1-one (8a):



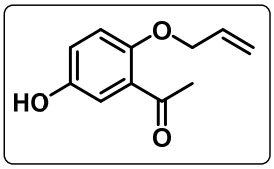
Thick liquid, 44mg; Yield 40%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 2.64 (s, 3H), 3.87 (s, 3H), 6.55 (bs, 1H),6.88 (d, *J* = 9.0 Hz, 1H), 7.04 (dd, *J* = 3.2, 9.0 Hz, 1H),7.39 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 200.6, 153.5, 149.8, 128.0, 121.2, 116.4, 113.3, 56.0, 32.0; **HRMS (ESI)** calcd for $C_9H_{10}O_3$ $[M+H]^+$167.0703, found 167.0703.

1-(5-hydroxy-2-isopropoxyphenyl)ethan-1-one (8b):



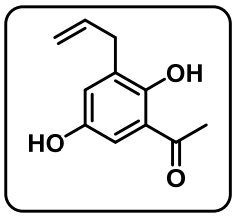
Thick liquid, 25mg; Yield 23%; **^{1}H NMR (400 MHz, $CDCl_3$) δ**= 1.36 (d, *J* = 6.1 Hz, 6H), 2.65 (s, 3H), 4.58 (spt, *J* = 6.1 Hz, 1H), 6.86 (dd, *J* = 8.8 Hz, 1H), 6.87 (d, *J* = 8.8 Hz, 1H), 7.01 (dd, *J* = 8.8, 3.2 Hz, 1H), 7.35 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ** = 201.0, 151.6, 149.6, 129.4, 121.2, 116.2, 115.8, 71.3, 32.2, 22.1; **HRMS (ESI)** calcd for $C_{11}H_{14}O_3$ $[M+H]^+$ 195.1016, found 195.1016.

1-(2-(allyloxy)-5-hydroxyphenyl)ethan-1-one (8c):



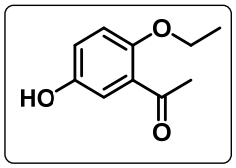
Thick liquid, 16mg; Yield 15%; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 2.68 (s, 3H), 4.60 (d, *J* = 5.4 Hz, 2H), 5.31 (dd, *J* = 10.5, 1.2 Hz, 1H), 5.42 (dd, *J* = 17.4, 1.5 Hz, 1H), 5.95 (bs, 1H),6.03-6.12 (m, 1H), 6.87 (d, *J* = 8.8 Hz, 1H), 7.0 (dd, *J* = 9.0, 3.2 Hz, 1H),7.34 (d, *J* = 3.0 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 200.2, 152.4, 149.8, 132.9, 128.6, 121.0, 118.1, 116.3, 114.8, 70.1, 32.1; **HRMS (ESI)** calcd for $C_{11}H_{12}O_3$ $[M+H]^+$ 193.0859, found 193.0855.

1-(3-allyl-2,5-dihydroxyphenyl)ethan-1-one (8c'):



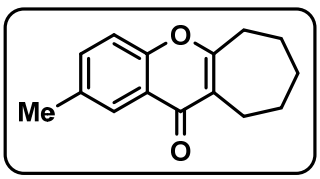
Thick liquid, 16 mg; Yield 20%; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 2.60 (s, 3H), 3.40 (d, *J* = 6.6 Hz, 2H), 4.72 (bs, 1H), 5.09-5.13 (m, 2H), 5.93-6.03 (m, 1H), 6.94 (d, *J* = 2.9 Hz, 1H), 7.1 (d, *J* = 2.9 Hz, 1H), 12.18 (s, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ** = 204.2, 154.7, 146.8, 135.7, 130.8, 125.0, 118.9, 116.4, 113.3, 33.4, 26.9; **HRMS (ESI)** calcd for $C_{11}H_{12}O_3$ $[M+H]^+$ 193.0859, found 193.0855.

1-(2-ethoxy-5-hydroxyphenyl)ethan-1-one (8d):



Off white solid, 60mg; Yield 55%; mp = 93-95 °C; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 1.46 (t, *J* = 7.0, 3H), 2.66 (s, 3H), 4.08 (q, *J* = 7.1, 2H), 6.44 (bs, 1H), 6.85 (d, *J* = 8.8 Hz, 1H), 7.02 (dd, *J* = 8.8, 3.2Hz, 1H), 7.41 (d, *J* = 3.2 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$) δ**= 200.6, 153.0, 149.7, 128.1, 121.3, 116.3, 114.2, 64.6, 32.1, 14.9; **HRMS (ESI)** calcd for $C_{10}H_{12}O_3$ $[M+H]^+$ 181.0859, found 181.0859.

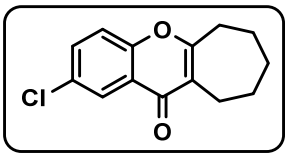
2-methyl-7,8,9,10-tetrahydrocyclohepta[b]chromen-11(6H)-one (10a):



Off white solid, 77 mg; Yield 78%; mp = 66-68 °C; **^{1}H NMR (500 MHz, $CDCl_3$) δ** = 7.98 (s, 1 H), 7.39 (d, *J* = 8.4 Hz, 1 H), 7.25 (s, 1 H), 2.89 - 2.81 (m, 2 H), 2.81 - 2.72 (m, 2 H),

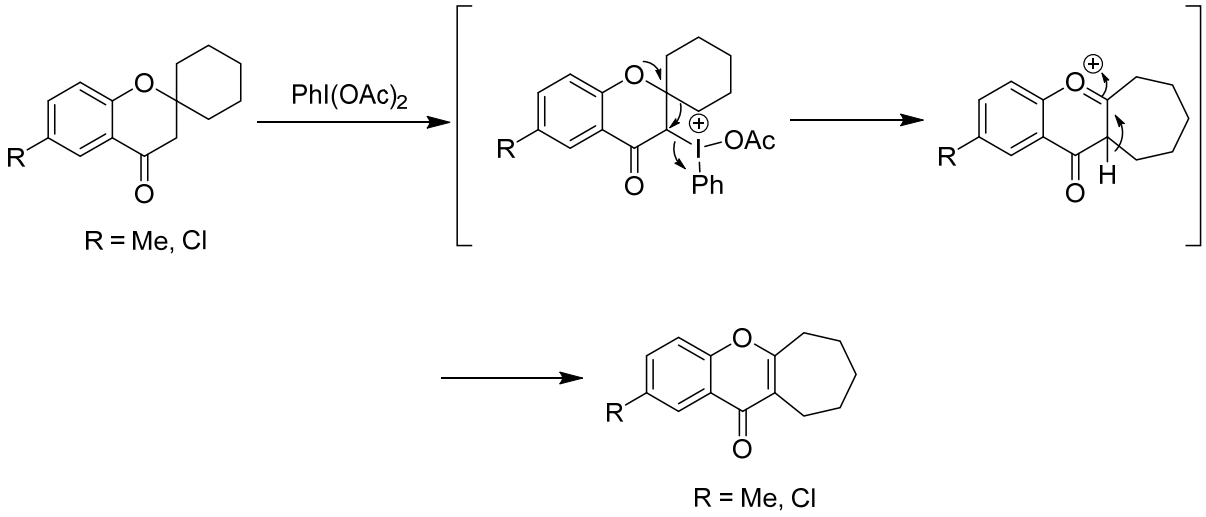
2.42 (s, 3 H), 1.88 - 1.81 (m, 2 H), 1.73 (td, *J* = 5.6, 10.6 Hz, 2 H), 1.63 - 1.55 (m, 2 H) ; **^{13}C NMR (125 MHz, $CDCl_3$) δ** = 177.3, 169.1, 154.2, 134.6, 134.2, 125.5, 122.9, 122.6, 117.7, 35.0, 32.2, 26.7, 25.2, 22.5, 21.1; **HRMS (ESI)** calcd for $C_{15}H_{17}O_2$ $[M+H]^+$229.1223, found 229.1223.

2-chloro-7,8,9,10-tetrahydrocyclohepta[b]chromen-11(6*H*)-one (10b):



Thick liquid, 61mg; Yield 62%; **^{1}H NMR (400 MHz, $CDCl_3$) δ** = 1.60-1.64 (m, 2H), 1.73-1.79 (m, 2H), 1.84-1.90 (m, 2H), 2.79 (t, *J* = 5.6 Hz, 2H), 2.86 (t, *J* = 5.6 Hz, 2H), 7.35 (d, *J* = 9.0, 1H), 7.54 (dd, *J* = 8.9, 2.5 Hz, 1H), 8.16 (d, *J* = 2.7 Hz, 1H) ; **^{13}C NMR (100 MHz, $CDCl_3$) δ** = 175.9, 169.3, 154.0, 133.0, 130.4, 125.5, 123.7, 123.3, 119.5, 34.7, 31.9, 26.3, 24.9, 22.3; **HRMS (ESI)** calcd for $C_{14}H_{13}ClO_2$ $[M+H]^+$ 249.0677, found 249.0679.

3. Plausible mechanism for the formation of migration product 10

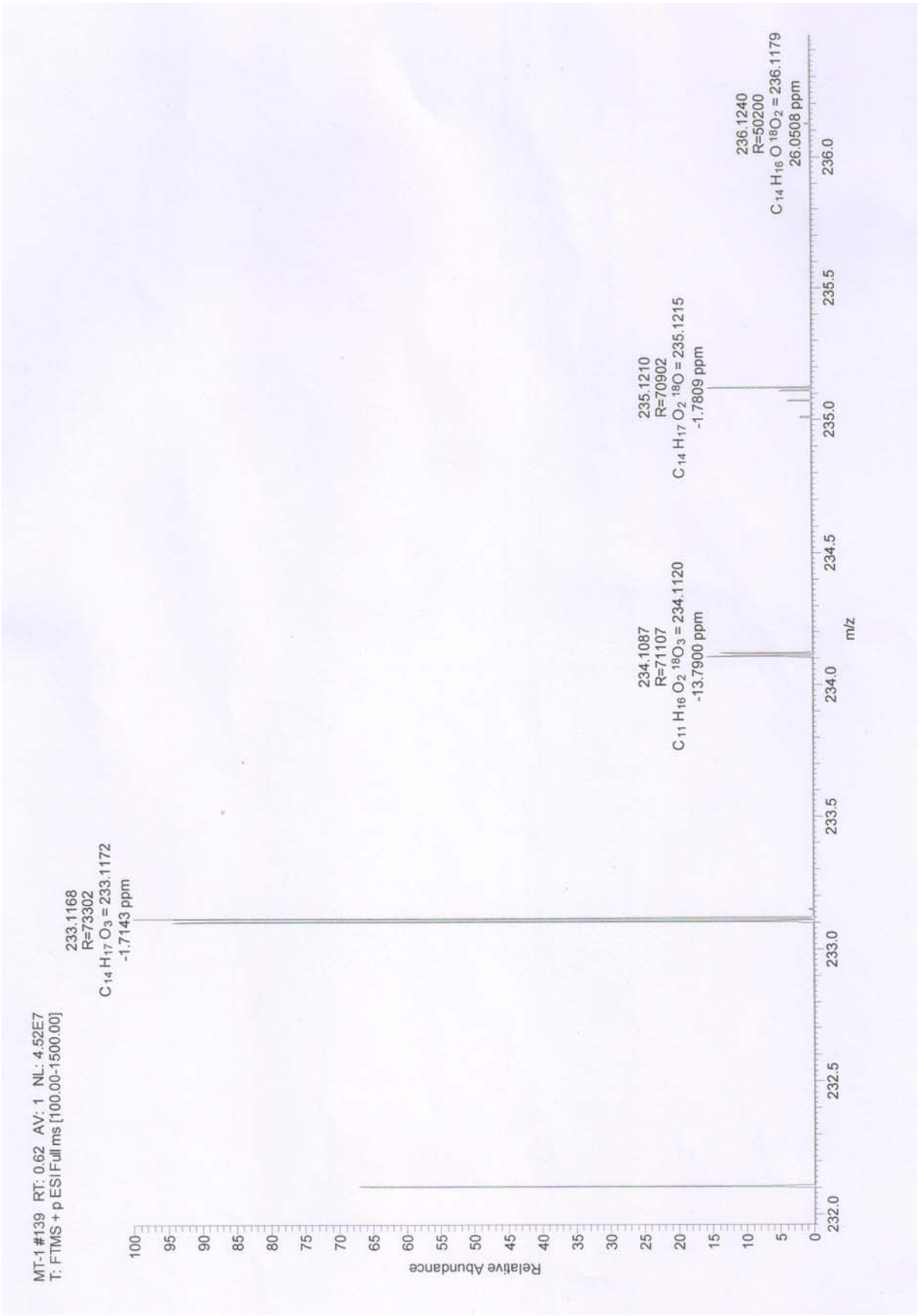


4. Controlled experiments using H_2O^{18}

To a flame-dried sealed tube equipped with a magnetic stir bar and Teflon cap was added $PhI(OAc)_2$ (72 mg, 0.22 mmol) and spiro[chromane-2,1'-cyclohexan]-4-one **5a** (40 mg, 0.19 mmol). TFA (0.5 mL) and H_2O^{18} (0.5 mL) was added under argon atmosphere. The sealed tube was then placed into a preheated oil bath (80 °C) and increases the temperature to 120 °C and stirred for 12 h. The reaction was monitored by TLC. After the reaction was completed (12 h), aqueous $NaHCO_3$ (5 mL) was added and the mixture was extracted with ethylacetate (10 mL X 4). The combined organic layer was washed with water (10 mL X 4), brine (10 mL X 2), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by flash column chromatography on silica gel to afford the desired product **6a** (mixture of O^{16} and O^{18} labelled products) in the ratio 6.4:1.

The product incorporating O^{16} and O^{18} were formed in 6.4:1 ratio, indicating C-6 oxygen is predominantly derived from TFA over labelled H_2O^{18}.

Partial HRMS spectrum of reaction using H_2O^{18}



D:\Data\MT-1 03/18/16 10:57:56

MT-1#139 RT: 0.62
T: FTMS + p ESI Full ms [100.00-1500.00]
m/z= 231.9588-236.4577

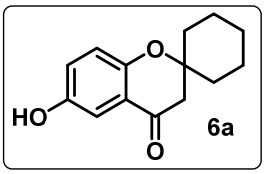
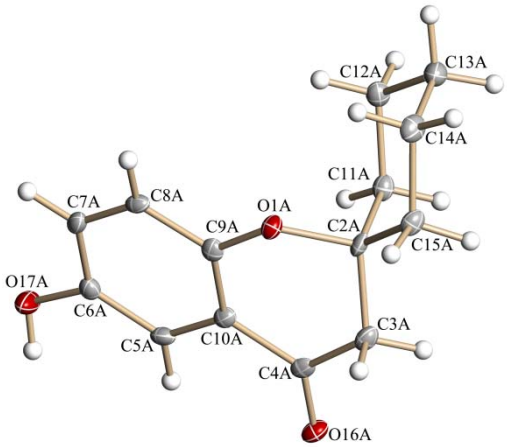
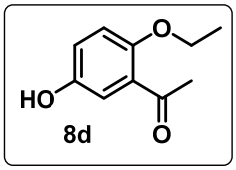
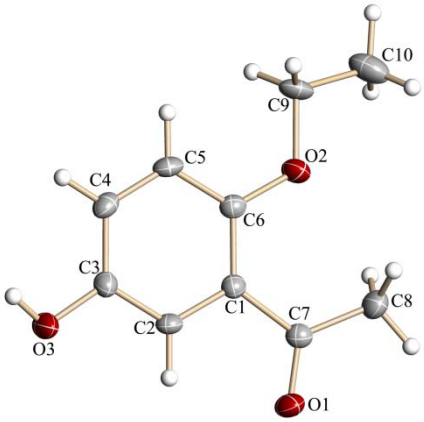
m/z	Intensity	Relative	Resolution	Theo. Mass	Delta (mmu)	Composition
232.1046	31798988.0	69.43	74202.00	232.1077	-13.56	$C_{11}H_{16}O_3{}^{18}O_2$
233.1055	44393832.0	96.93	72702.00	233.1058	-1.49	$C_{14}H_{15}O_2{}^{18}O$
233.1168	45800132.0	100.00	73302.00	233.1172	-1.71	$C_{14}H_{17}O_3$
233.1507	356492.7	0.78	51500.00			
234.1087	7434893.0	16.23	71107.00	234.1120	-13.79	$C_{11}H_{16}O_2{}^{18}O_3$
234.1203	6194896.0	13.53	69902.00			
235.0098	783579.1	1.71	53100.00			
235.0724	1698047.8	3.71	61100.00	235.0737	-5.29	$C_{13}H_{11}O_2{}^{18}O_2$
235.1099	2214064.5	4.83	62500.00	235.1101	-0.72	$C_{14}H_{15}O{}^{18}O_2$
235.1210	7140909.5	15.59	70902.00	235.1215	-1.78	$C_{14}H_{17}O_2{}^{18}O$
236.1240	410203.5	0.90	50200.00			

5. Single crystal analysis data

X-ray intensity data measurements of compounds **6a and 8d** were carried out on a Bruker SMART APEX II CCD diffractometer with graphite-monochromatized (MoK_α= 0.71073Å) radiation. The X-ray generator was operated at 50 kV and 30 mA. A preliminary set of cell constants and an orientation matrix were calculated from three sets of 36 frames.Data were collected with ωscan width of 0.5° at different settings of φ and 2θkeeping the sample-to-detector distance fixed at 5.00 cm. The X-ray data collection was monitored by APEX2 program (Bruker, 2006).[1]All the data were corrected for Lorentzian, polarization and absorption effects using SAINT and SADABS programs (Bruker, 2006). SHELX-97 was used for structure solution and full matrix least-squares refinement on F^2.[2]All the hydrogen atoms were placed in geometrically idealized positionand constrained to ride on their parent.An *ORTEP* III[3] view of both compounds were drawn with 50% probability displacement ellipsoids and H atoms are shown as small spheres of arbitrary radii.

Crystal data of **6a** $C_{14}H_{16}O_3$, Mw =232.27, colorless block, 0.55 x 0.49 x 0.42 mm^3, monoclinic, space group $P2_1/c$, a =21.1661(9)Å, b=6.9223(3)Å, c=23.4838(9)Å, β=91.652(2)°, V = 3439.4(2)$Å^3$, Z = 12, T = 100(2) K, $2\theta_{max}$=50.00°, D_{calc} (g cm^{-3}) = 1.346, $F(000)$ = 1488, μ (mm^{-1}) = 0.094, 46855 reflections collected, 6049 unique reflections (R_{int}=0.0257), 5207 observed ($I > 2\sigma(I)$) reflections, multi-scan absorption correction, T_{min} = 0.950, T_{max} = 0.962, 463 refined parameters, S = 1.164, $R1$=0.0528, $wR2$=0.1050 (all data R = 0.0641, $wR2$ = 0.1099), maximum and minimum residual electron densities; $\Delta\rho_{max}$ = 0.252, $\Delta\rho_{min}$= -0.247 ($eÅ^{-3}$).

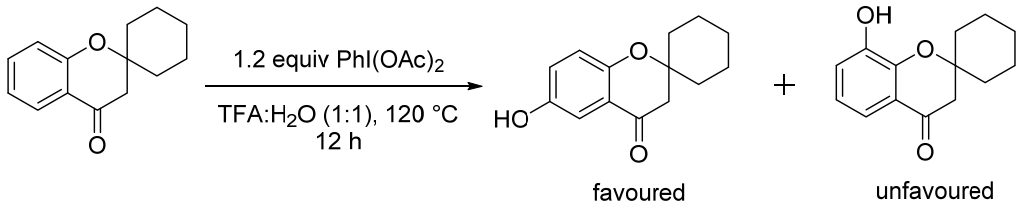
Crystal data of **8d** $C_{10}H_{12}O_3$, Mw =180.20, colorless prismatic, 0.44 x 0.29 x 0.12 mm^3, monoclinic, space group $P2_1/n$, a =7.9634(4) Å, b=10.2991(5) Å, c=11.6563(6) Å, β=91.605(4)°, V = 955.63(8) $Å^3$, Z = 4, T = 150(2) K, $2\theta_{max}$=50.00°, D_{calc} (g cm^{-3}) = 1.252, $F(000)$ = 384, μ (mm^{-1}) = 0.092, 6803 reflections collected, 1679 unique reflections (R_{int}=0.0303), 1406 observed ($I > 2\sigma(I)$) reflections, multi-scan absorption correction, T_{min} = 0.960, T_{max} = 0.989, 463 refined parameters, S = 1.176, $R1$=0.0594, $wR2$=0.1163 (all data R = 0.0740, $wR2$ = 0.1218), maximum and minimum residual electron densities; $\Delta\rho_{max}$ = 0.156, $\Delta\rho_{min}$= -0.372 ($eÅ^{-3}$).

Sr. No	Compound Structure	ORTEP Diagram
1	 **CCDC 1457371**	
2	 **CCDC-1572104**	

6. Computational studies

The geometry optimizations were conducted employing density functional theory (DFT) with Schrödinger. The triple-ζ basis set augmented by a polarization function (Schrödinger basis set MO6_2X) was used for all the atoms. The resolutions of identity (RI) along with the multiple accelerated resolutions of identity (marij) approximations were employed for an accurate and efficient treatment of the electronic Coulomb term. Solvent effects were accounted for as follows: we have done full geometry optimizations of all intermediates and transition states calculations using the COSMO model. To improve the calculation of the energy values, a further correction was made through single-point B3-LYP calculations for the DFT (PBE)-optimized structures. The contributions of internal energy

and entropy were obtained from frequency calculations done on the DFT structures: thus, the energies reported in the figures are the ΔG values.



The above reaction was favoured -para product over the -ortho product. To gain insight into the mechanism, we performed two different reaction pathways based on substitution effect at ortho and para positions using quantum chemical calculations by density functional theory (DFT), employing the MO6-2X/ 6-31G**/3-21G* with Schrödinger 17.

ΔG at 120°C in Kcal/mol

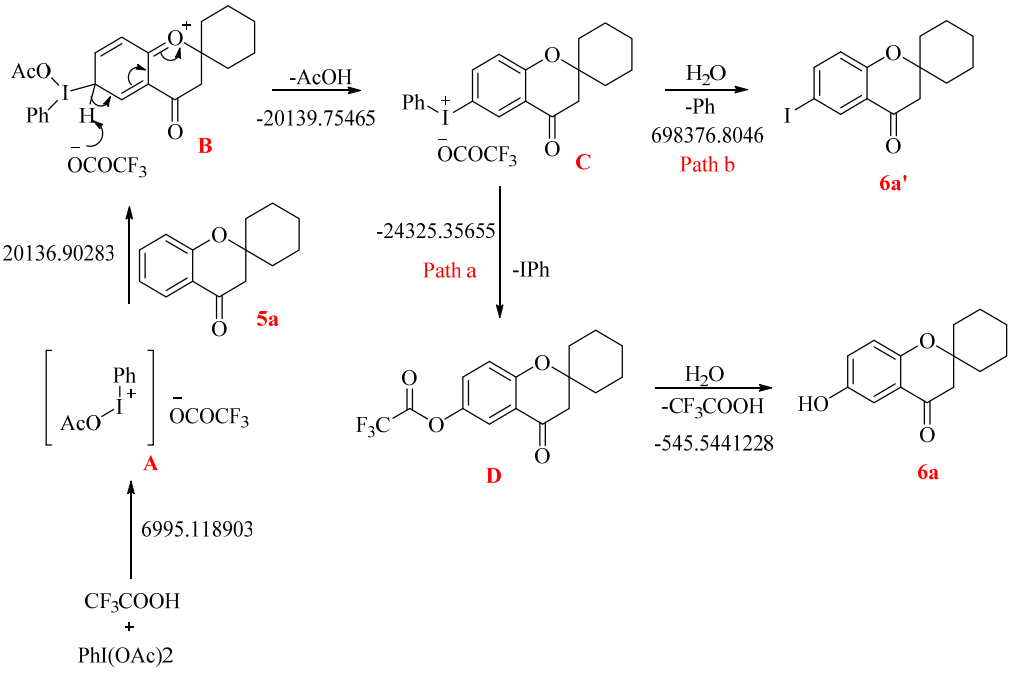


Figure CS1: Formation of para-product **6a** and **6a′**

The mechanism for the formation of product **6a** and **6a′** proceeded by the pathways **a** and **b** at 120˚C. The product **6a** is more favoured than **6a′** with the ΔG difference of -698922.34872 kcal/mol. Similarly the computational investigation of ortho- pathway was performed and the details are depicted below.

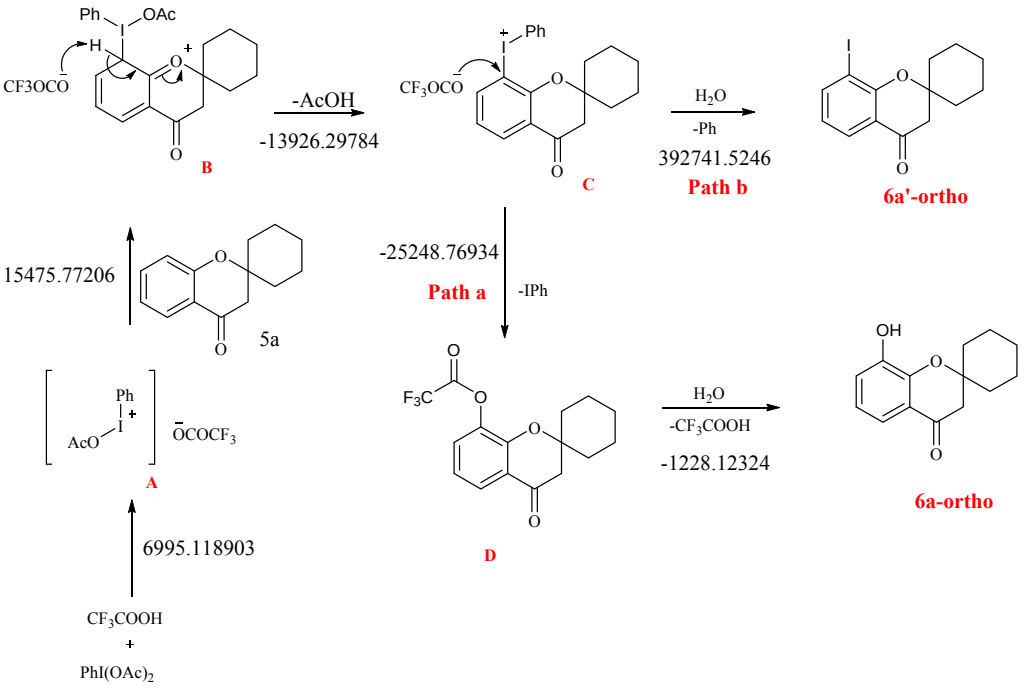


Figure CS2: Formation of ortho-product **6a** and **6a′**

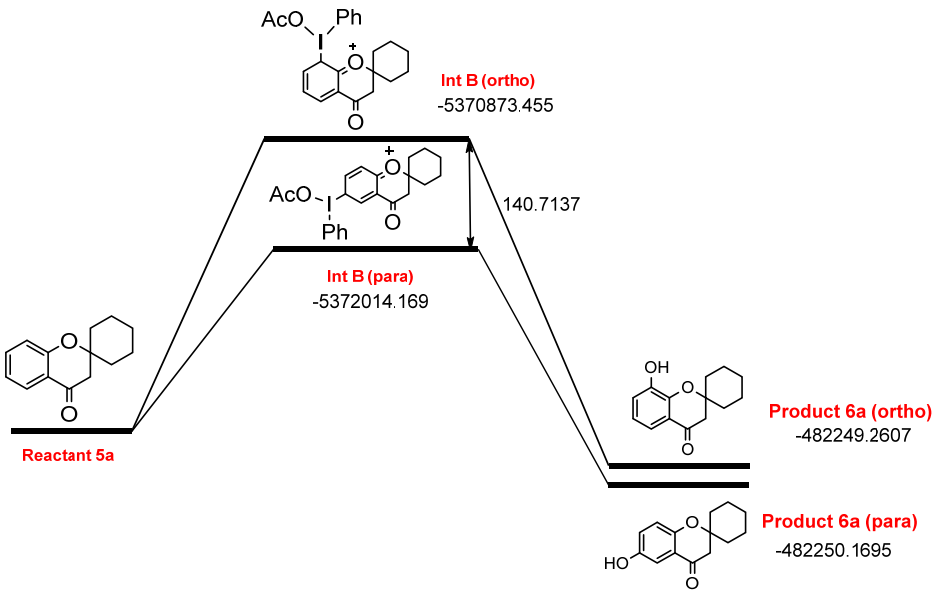


Figure CS3: Free Energy Profile for the formation of product 6a (in kcal/mol)

The energy profile of reaction pathways depicted above shows the formation of the para- product favoured over ortho- by about 140.7137 kcal/mol complementing the experimental observation.

The optimized geometries of the 3D structures are given below (the atomic symbol followed by the Cartesian coordinates in Å):

$PhI(OAc)_2$

I1	0.3393	0.6433	0.042
O2	1.9554	-0.765	-0.056
C3	-0.348	-0.7	1.559
O4	-1.435	1.7226	0.436
C5	2.8229	-0.45	-1.036
O6	2.6506	0.5292	-1.767
C7	3.9878	-1.412	-1.115
C8	-1.381	2.617	1.467
O9	-0.398	2.7463	2.187
C10	-2.683	3.3781	1.59
C11	-1.283	-2.408	3.521
C12	-2.144	-1.48	2.934
C13	-1.678	-0.615	1.944
C14	0.5269	-1.624	2.113
C15	0.0466	-2.478	3.108
H16	3.6095	-2.426	-1.265
H17	4.6398	-1.121	-1.937
H18	4.5357	-1.391	-0.169
H19	-2.94	3.8121	0.622
H20	-3.481	2.683	1.869
H21	-2.581	4.1529	2.348
H22	-1.649	-3.074	4.292
H23	-3.182	-1.426	3.24
H24	-2.324	0.1129	1.475
H25	1.543	-1.682	1.755
H26	0.7202	-3.199	3.555

CF_3COOH

C1	0.0103	-0.003	0.005
C2	1.5477	0.0108	-0.019
O3	2.2301	-0.48	0.831
O4	1.9775	0.6413	-1.11
F5	-0.459	1.2454	0.006
F6	-0.459	-0.628	-1.075
F7	-0.424	-0.628	1.088
H8	2.9474	0.6318	-1.094

A

O1	-0.419	0.384	-0.537
I2	1.565	-0.041	-0.027
C3	-0.810	1.671	-0.366
C4	2.134	1.058	-1.737
O5	-0.044	2.552	0.024
C6	-2.270	1.876	-0.714
C7	2.904	2.487	-3.968
C8	2.663	1.116	-4.072
C9	2.756	3.135	-2.742
C10	2.274	0.389	-2.947
H36	-1.269	1.214	-1.71
C11	2.366	2.422	-1.607
O12	3.684	-0.398	0.135
C13	4.426	0.644	0.471
C14	5.894	0.238	0.566
O15	4.044	1.789	0.692
F16	6.067	-0.726	1.514
F17	6.336	-0.265	-0.620
F18	6.655	1.313	0.895
H19	-2.723	0.927	-0.991
H20	-2.784	2.312	0.146
H21	-2.339	2.587	-1.542
H22	3.209	3.048	-4.842
H23	2.779	0.608	-5.021
H24	2.946	4.198	-2.658
H25	2.094	-0.676	-3.018
H26	2.248	2.908	-0.651

5a

C1	-2.24	0.763	0.552
C2	-2.97	1.7083	-0.147
C3	-2.6	2.1059	-1.435
C4	-1.48	1.5362	-2.022
C5	-0.73	0.5719	-1.34
C6	-1.11	0.1932	-0.043
O7	-0.42	-0.733	0.676
C8	0.435	-0.075	-1.987
C9	1.04	-1.215	-1.192
C10	0.955	-0.964	0.313
C11	1.295	-1.958	2.621
C12	1.365	-2.201	1.111
C13	1.795	0.2513	0.736
C14	1.713	0.4978	2.243
C15	2.138	-0.747	3.025
O16	0.845	0.254	-3.081
H17	-2.5	0.4546	1.555
H18	-3.85	2.1496	0.32
H19	-3.18	2.8511	-1.966
H20	-1.16	1.8073	-3.022
H21	2.074	-1.368	-1.514
H22	0.471	-2.122	-1.436
H23	1.628	-2.855	3.153
H24	0.25	-1.786	2.901
H25	2.391	-2.462	0.82
C8	-3.337	2.741	-1.583
H26	0.718	-3.034	0.819
H27	1.475	1.1399	0.18
H28	2.835	0.054	0.444
H29	0.68	0.7597	2.504
H30	2.338	1.3546	2.511
H31	3.197	-0.957	2.818
H32	2.055	-0.568	4.101

Structure B (para)

C1	-0.363	2.95	-2.49
C2	-0.483	1.953	-1.6
C3	0.5557	4.054	-2.2
C4	0.4173	1.869	-0.4
O5	0.283	5.221	-2.85
C6	1.519	3.919	-1.26
C7	1.7389	2.573	-0.66
I8	0.7446	-0.195	0.463
C9	0.0875	-1.147	-1.34
O10	1.4765	-1.542	3.019
C11	2.3106	5.057	-0.79
C12	2.1973	6.28	-1.69
O13	3.0205	5.001	0.217
C14	0.7616	6.474	-2.18
C15	-0.208	6.765	-1.03
C16	0.6609	7.536	-3.28
C17	-1.655	6.875	-1.54
C18	-0.787	7.648	-3.79
C19	-1.752	7.964	-2.63
C20	-0.741	-2.256	-1.23
C21	0.5103	-0.652	-2.56
C22	1.1437	-2.512	2.318
C23	-1.196	-2.855	-2.41
C24	0.0496	-1.263	-3.73
O25	0.7594	-2.394	1.051
C26	1.1381	-3.949	2.821
C27	-0.809	-2.357	-3.65
O28	2.4463	1.63	-1.63
C29	2.7608	2.051	-2.88
O30	2.3462	1.524	-3.89
C31	3.8056	3.151	-2.95
F32	4.2283	3.485	-1.71
F33	4.8711	2.733	-3.68
F34	3.3008	4.266	-3.57
H35	-1.012	3.049	-3.35

Structure D (para)

H37	-0.078	2.362	0.454
H38	2.387	2.662	0.216
H39	2.8548	6.105	-2.54
H40	2.526	7.168	-1.14
H41	0.1024	7.712	-0.57
H42	-0.124	5.978	-0.27
H43	1.3412	7.263	-4.09
H44	0.988	8.493	-2.85
H45	-2.328	7.103	-0.71
H46	-1.95	5.91	-1.97
H47	-1.064	6.691	-4.25
H48	-0.847	8.425	-4.56
H49	-1.489	8.936	-2.19
H50	-2.78	8.032	-3
H51	-0.965	-2.664	-0.26
H52	1.1896	0.182	-2.63
H53	-1.844	-3.721	-2.34
H54	0.3848	-0.876	-4.68
H55	1.4542	-3.97	3.863
H56	0.1327	-4.366	2.717
H57	1.8138	-4.547	2.204
H58	-1.165	-2.833	-4.56

AcOH

C1	-0.12	1.455	0
C2	-0.09	-0.051	0
O3	-1.06	-0.764	0
O4	1.169	-0.539	0
H5	0.886	1.8778	0
H6	-0.67	1.7915	-0.881
H7	-0.67	1.7915	0.881
H8	1.086	-1.505	0

Structure C (para)

C1	-0.480	0.263	-1.975
C2	-1.704	0.826	-1.616
C3	-2.518	0.193	-0.666
C4	-2.085	-0.994	-0.071
C5	-0.859	-1.550	-0.415
C6	-0.067	-0.913	-1.375
C7	-2.098	2.123	-2.214

H_2O

O1	0	0	-0.07
H2	0	0.76	0.523
H3	0	-0.76	0.523

C9	-4.369	1.668	-1.219
O10	-3.742	0.702	-0.284
C11	-5.544	2.241	-0.424
C12	-6.515	1.117	-0.014
C13	-7.020	0.361	-1.260
C14	-5.830	-0.218	-2.052
C15	-4.860	0.905	-2.460
O16	-1.436	2.679	-3.094
I17	2.375	0.072	1.202
C18	2.105	1.338	-0.486
C19	1.229	2.418	-0.395
C20	0.997	3.204	-1.522
C21	1.636	2.912	-2.728
C22	2.526	1.842	-2.797
C23	2.766	1.047	-1.672
O24	1.201	-1.380	-1.797
C25	1.818	-2.486	-1.331
O26	1.389	-3.328	-0.569
C27	3.220	-2.513	-1.937
F28	3.225	-1.991	-3.188
F29	4.085	-1.759	-1.183
F30	3.686	-3.784	-1.963
H31	0.153	0.771	-2.693
H32	-2.724	-1.465	0.662
H33	-0.516	-2.462	0.047
H34	-3.767	3.476	-2.267
H35	-3.022	3.250	-0.660
H36	-6.059	2.977	-1.054
H37	-5.149	2.750	0.463
H38	-7.356	1.539	0.546
H39	-5.975	0.424	0.639
H40	-7.580	1.053	-1.903
H41	-7.700	-0.444	-0.962
H42	-6.184	-0.745	-2.944
H43	-5.291	-0.935	-1.423
H44	-5.368	1.624	-3.115
H45	-4.004	0.493	-3.008
H46	0.717	2.627	0.535
H47	0.292	4.024	-1.472
H48	1.418	3.503	-3.608
H49	3.028	1.606	-3.728
H50	3.433	0.201	-1.731

Iodo-Product (6a′)

C1	-0.074	2.466	-2.527
C2	0.2705	1.92	-1.287
C3	-0.613	2.01	-0.207

C1	-2.134	1.097	0.299
C2	-0.751	1.053	0.335
C3	-0.103	-0.183	0.327
C4	-0.809	-1.364	0.265
C5	-2.205	-1.323	0.211
C6	-2.871	-0.09	0.241
O7	-4.219	0.017	0.2
C8	-2.984	-2.577	0.075
C9	-4.461	-2.363	-0.18
C10	-4.996	-1.144	0.576
C11	-5.912	-2.36	2.615
C12	-4.912	-1.32	2.1
C13	-6.427	-0.803	0.165
C14	-7.434	-1.842	0.666
C15	-7.339	-2.01	2.184
O16	-2.472	-3.675	0.122
O17	1.2935	-0.276	0.303
C18	2.0049	0.39	1.219
C19	3.498	0.091	0.994
O20	1.5984	1.11	2.081
F21	3.7288	-1.218	1.089
F22	3.8691	0.496	-0.22
F23	4.2283	0.724	1.9
H24	-2.667	2.041	0.32
H25	-0.173	1.968	0.385
H26	-0.305	-2.324	0.24
H27	-4.998	-3.278	0.069
H28	-4.583	-2.186	-1.26
H29	-5.846	-2.416	3.705
H30	-5.646	-3.356	2.239
H31	-5.135	-0.343	2.546
H32	-3.892	-1.583	2.399
H33	-6.47	-0.695	-0.92
H34	-6.663	0.178	0.596
H35	-7.254	-2.807	0.177
H36	-8.444	-1.536	0.377
H37	-7.636	-1.069	2.666
H38	-8.039	-2.777	2.527

Structure B (ortho)

C1	4.847	-3.804	-2.616
C2	4.825	-2.599	-3.308
C3	3.894	-1.623	-2.944

Para- Product (6a)

C1	-2.138	1.2036	0.002
C2	-0.751	1.201	-0.01
C3	-0.036	-0.001	0.002
C4	-0.725	-1.204	0.021
C5	-2.121	-1.209	0.019
C6	-2.835	-0.003	0.02
O7	-4.196	0.0527	0.022
C8	-2.862	-2.494	-0.02
C9	-4.36	-2.348	-0.2
C10	-4.9	-1.105	0.515
C11	-5.66	-2.221	2.675
C12	-4.729	-1.184	2.04
C13	-6.366	-0.843	0.169
C14	-7.305	-1.88	0.791
C15	-7.12	-1.946	2.309
O16	1.3269	-0.044	-0
O17	-2.312	-3.573	0.057
H18	-2.699	2.1313	0.004
H19	-0.214	2.1464	-0.03
H20	-0.193	-2.149	0.025
H21	-4.844	-3.267	0.135
H22	-4.548	-2.241	-1.28
H23	-5.53	-2.208	3.762
H24	-5.38	-3.229	2.345
H25	-4.961	-0.188	2.438
H26	-3.684	-1.394	2.296
H27	-6.473	-0.807	-0.92
H28	-6.614	0.1551	0.551
H29	-7.113	-2.869	0.355
H30	-8.34	-1.63	0.541
H31	-7.424	-0.986	2.747
H32	-7.773	-2.712	2.739
H33	1.6765	0.8528	-0.02
H42	0.590	-2.444	1.508
H43	0.162	-4.717	0.588
H44	0.925	-5.453	2.019
H45	4.388	-4.180	1.302
H46	3.389	-5.108	2.409
H47	3.101	-2.104	1.906
H48	3.891	-2.817	3.315
H49	1.717	-3.903	3.965
C4	-1.833	2.671	-0.371
C5	-2.163	3.226	-1.6
C6	-1.283	3.118	-2.684
C7	1.5975	1.274	-1.142
C8	1.9428	0.897	0.289
C9	0.7055	0.4	1.044
O10	-0.328	1.465	1.027
C11	0.9807	0.186	2.534
C12	-0.309	-0.236	3.264
C13	-0.894	-1.515	2.632
C14	-1.174	-1.289	1.132
C15	0.1151	-0.866	0.403
I16	-1.814	3.958	-4.562
O17	2.3623	1.122	-2.096
H18	0.6406	2.364	-3.335
H19	-2.505	2.732	0.474
H20	-3.109	3.738	-1.721
H21	2.3209	1.799	0.79
H22	2.7262	0.135	0.288
H23	1.371	1.12	2.952
H24	1.7471	-0.593	2.633
H25	-1.033	0.579	3.172
H26	-0.098	-0.395	4.327
H27	-1.816	-1.803	3.148
H28	-0.175	-2.338	2.745
H29	-1.916	-0.492	1.019
H30	-1.576	-2.199	0.675
H31	0.8695	-1.66	0.477
H32	-0.085	-0.688	-0.66

Phenol

C1	-6.266	1.113	-0.086
C2	-5.556	2.312	-0.086
C3	-4.166	2.316	-0.086
C4	-3.475	1.104	-0.087
C5	-4.177	-0.102	-0.086
C6	-5.569	-0.091	-0.086
O7	-2.114	1.158	-0.087
H8	-7.351	1.118	-0.086
C26	-8.741	-1.782	0.502
O27	-10.024	0.285	0.511
F28	-8.719	-2.758	-0.443
F29	-7.456	-1.603	0.939
F30	-9.494	-2.184	1.555
H31	-3.667	-2.035	-0.347
H32	-1.221	-1.643	-0.353
H33	-0.115	-0.721	-2.379
C4	3.011	-1.868	-1.900
C5	3.019	-3.074	-1.196
C6	3.940	-4.051	-1.586
C7	3.930	-5.355	-0.899
C8	2.628	-5.665	-0.201
O9	2.160	-3.235	-0.155
O10	4.935	-6.084	-0.897
C11	0.621	-3.302	2.191
C12	0.919	-4.572	1.365
C13	2.294	-4.462	0.705
C14	3.392	-4.226	1.754
C15	3.098	-2.963	2.578
C16	1.717	-3.069	3.251
O17	-1.116	3.183	0.854
I18	1.695	-0.380	-1.216
C19	-0.048	2.859	0.095
O20	0.309	1.688	-0.052
C21	0.573	4.098	-0.510
C22	4.401	0.202	2.824
C23	4.990	-0.225	1.633
C24	4.218	-0.369	0.479
C25	2.868	-0.070	0.566
C26	2.239	0.335	1.731
C27	3.033	0.472	2.875
O28	6.600	-4.631	0.481
C29	6.638	-3.298	0.489
C30	7.174	-2.883	1.858
O31	6.271	-2.507	-0.364
F32	6.134	-2.857	2.753
F33	8.121	-3.722	2.319
F34	7.689	-1.616	1.794
H35	5.551	-4.587	-2.879
H36	5.519	-2.409	-4.114
H37	3.871	-0.674	-3.466
H38	6.189	-5.124	-0.305
H39	2.733	-6.566	0.406
H40	1.830	-5.801	-0.943
H41	-0.361	-3.398	2.665
O16	-3.080	0.965	1.447
O17	-1.867	-1.431	1.566
C18	-1.218	-1.088	0.447
C19	0.289	-1.015	0.741
O20	-1.694	-0.860	-0.623
F21	0.535	-0.018	1.595
F22	0.719	-2.152	1.287
F23	0.962	-0.793	-0.378

H50	1.506	-2.151	3.811
H51	0.213	5.002	-0.017
H52	1.659	4.022	-0.411
H53	0.313	4.140	-1.572
H54	5.005	0.304	3.717
H55	6.039	-0.472	1.579
H56	4.682	-0.755	-0.420
H57	1.175	0.522	1.772
H58	2.569	0.779	3.804

Structure C (ortho)

I1	-6.035	-1.674	-2.339
C2	-3.936	-1.348	-2.367
C3	-3.182	-1.639	-1.230
C4	-1.805	-1.411	-1.236
C5	-1.184	-0.896	-2.375
C6	-1.945	-0.606	-3.507
C7	-3.323	-0.831	-3.506
C8	-7.308	3.245	-2.746
C9	-7.011	2.790	-1.457
C10	-8.174	2.529	-3.561
C11	-7.572	1.605	-0.992
C12	-6.099	3.566	-0.582
C13	-8.742	1.334	-3.093
C14	-8.428	0.884	-1.828
O15	-7.333	1.070	0.249
C16	-6.036	3.060	0.853
O17	-5.502	4.567	-0.980
C18	-6.094	1.528	0.939
C19	-6.272	1.024	2.373
C20	-4.909	0.831	0.261
C21	-4.976	1.204	3.190
C22	-3.609	1.033	1.061
C23	-3.790	0.501	2.498
O24	-8.854	-0.382	-1.370
C25	-9.305	-0.487	-0.067
O17	-1.255	-1.357	0.221
H18	-6.496	-1.515	0.194
H19	-2.722	-3.598	0.272
H20	-5.202	-3.665	0.266
H21	-5.188	3.083	0.241
H22	-4.473	2.330	-1.197
H23	-2.812	4.160	0.500
H24	-2.224	3.232	-0.886
H25	-0.338	3.920	0.623
H26	-0.489	2.166	0.514
H34	-1.471	-0.203	-4.394
H35	-3.913	-0.605	-4.385
H36	-6.842	4.167	-3.071
H37	-8.412	2.881	-4.555
H38	-9.401	0.738	-3.711
H39	-6.914	3.463	1.378
H40	-5.135	3.449	1.329
H41	-6.538	-0.035	2.299
H42	-7.112	1.554	2.834
H43	-4.799	1.174	-0.776
H44	-5.161	-0.235	0.233
H45	-5.124	0.798	4.196
H46	-4.750	2.273	3.300
H47	-3.341	2.097	1.091
H48	-2.796	0.506	0.551
H49	-3.990	-0.578	2.454
H50	-2.873	0.650	3.078

Structure D (ortho)

C1	-6.020	-1.251	1.611
C2	-5.274	-0.069	1.587
C3	-3.878	-0.118	1.510
C4	-3.261	-1.375	1.523
C5	-3.995	-2.540	1.560
C6	-5.392	-2.483	1.591
C7	-5.938	1.251	1.735
C8	-4.973	2.391	1.990
C9	-3.703	2.247	1.151
O10	-7.142	1.386	1.717
C11	-2.653	3.281	1.546
C12	-1.395	3.186	0.680
C13	-1.746	3.333	-0.801
C14	-2.765	2.273	-1.224

Iodo-ortho-Product

C1	-4.994	1.787	-1.416
C2	-4.346	0.914	-2.299
C3	-3.822	1.388	-3.503
C4	-3.954	2.727	-3.845
C5	-4.611	3.599	-2.968
C6	-5.120	3.134	-1.762
C7	-4.220	-0.532	-1.981
C8	-4.964	-0.969	-0.728
C9	-4.924	0.120	0.348
O10	-5.511	1.361	-0.216
H24	-7.100	-1.159	1.664
H25	-3.465	-3.487	1.565
H26	-5.969	-3.399	1.613
H27	-4.706	2.366	3.055
H28	-5.472	3.341	1.786
H29	-2.414	3.146	2.607
H30	-3.107	4.274	1.434
H31	-0.913	2.216	0.853
H32	-0.681	3.956	0.988
H33	-0.844	3.256	-1.415
H34	-2.166	4.334	-0.974
H35	-2.316	1.278	-1.146
H36	-3.050	2.410	-2.271
H37	-4.548	3.275	-0.513
H38	-4.716	1.527	-0.627

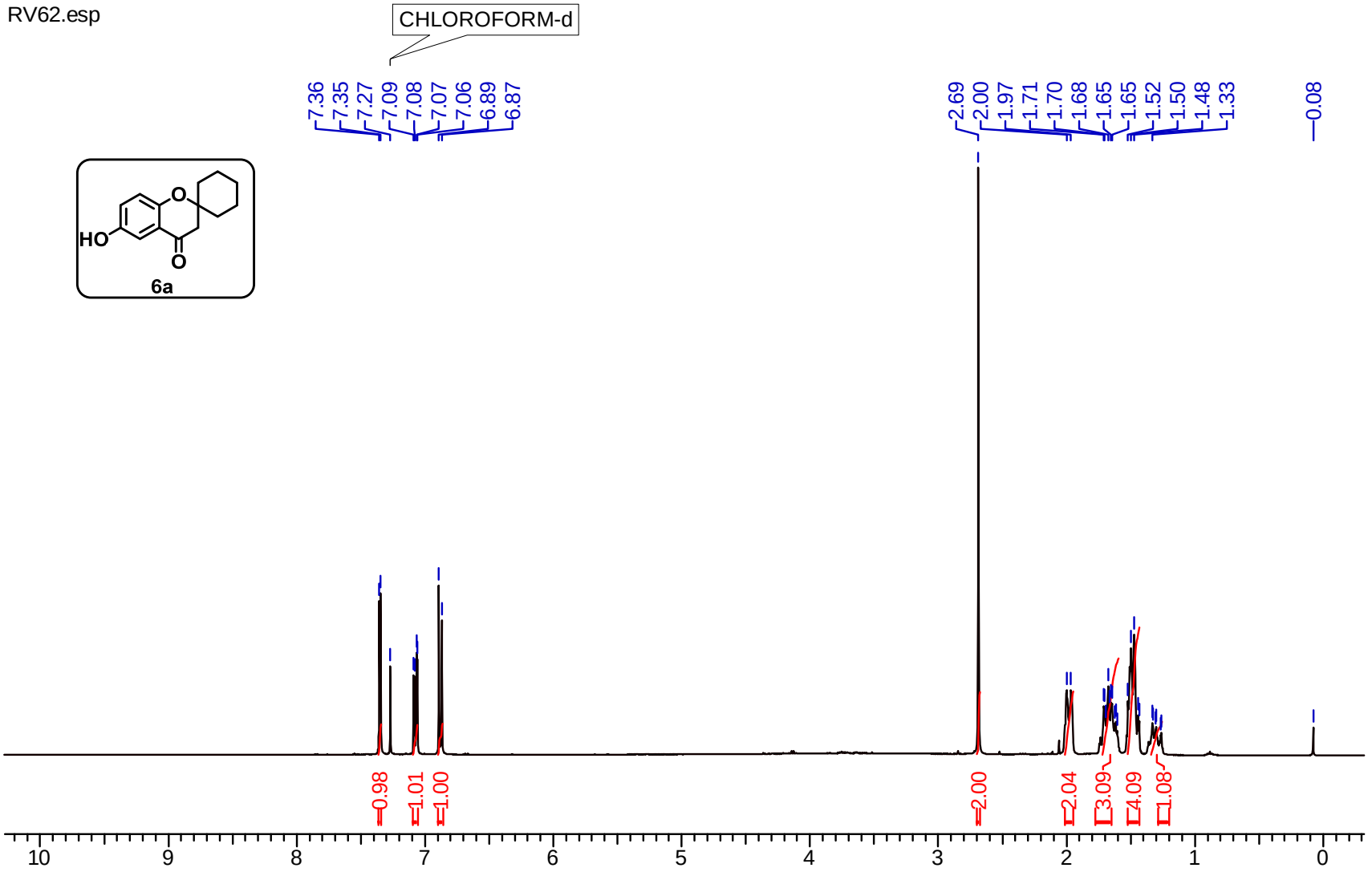
Ortho-product

C1	-5.411	-1.530	0.195
C2	-4.736	-0.304	0.146
C3	-3.340	-0.264	0.150
C4	-2.610	-1.466	0.198
C5	-3.293	-2.672	0.234
C6	-4.692	-2.709	0.234
C7	-5.494	0.973	0.073
C8	-4.637	2.210	-0.117
C9	-3.283	2.077	0.579
O10	-6.705	1.016	0.126
C11	-2.337	3.217	0.204
C12	-0.976	3.072	0.890
C13	-1.132	2.972	2.409
C14	-2.068	1.820	2.785
C15	-3.429	1.983	2.106
H18	-3.324	0.673	-4.148
H19	-3.556	3.102	-4.778
H20	-4.718	4.646	-3.220
H21	-4.531	-1.900	-0.354
H22	-6.012	-1.148	-1.009
H23	-3.088	-0.477	1.277
H24	-2.861	0.655	-0.071
H25	-3.861	2.496	1.291
H26	-2.453	1.805	2.122

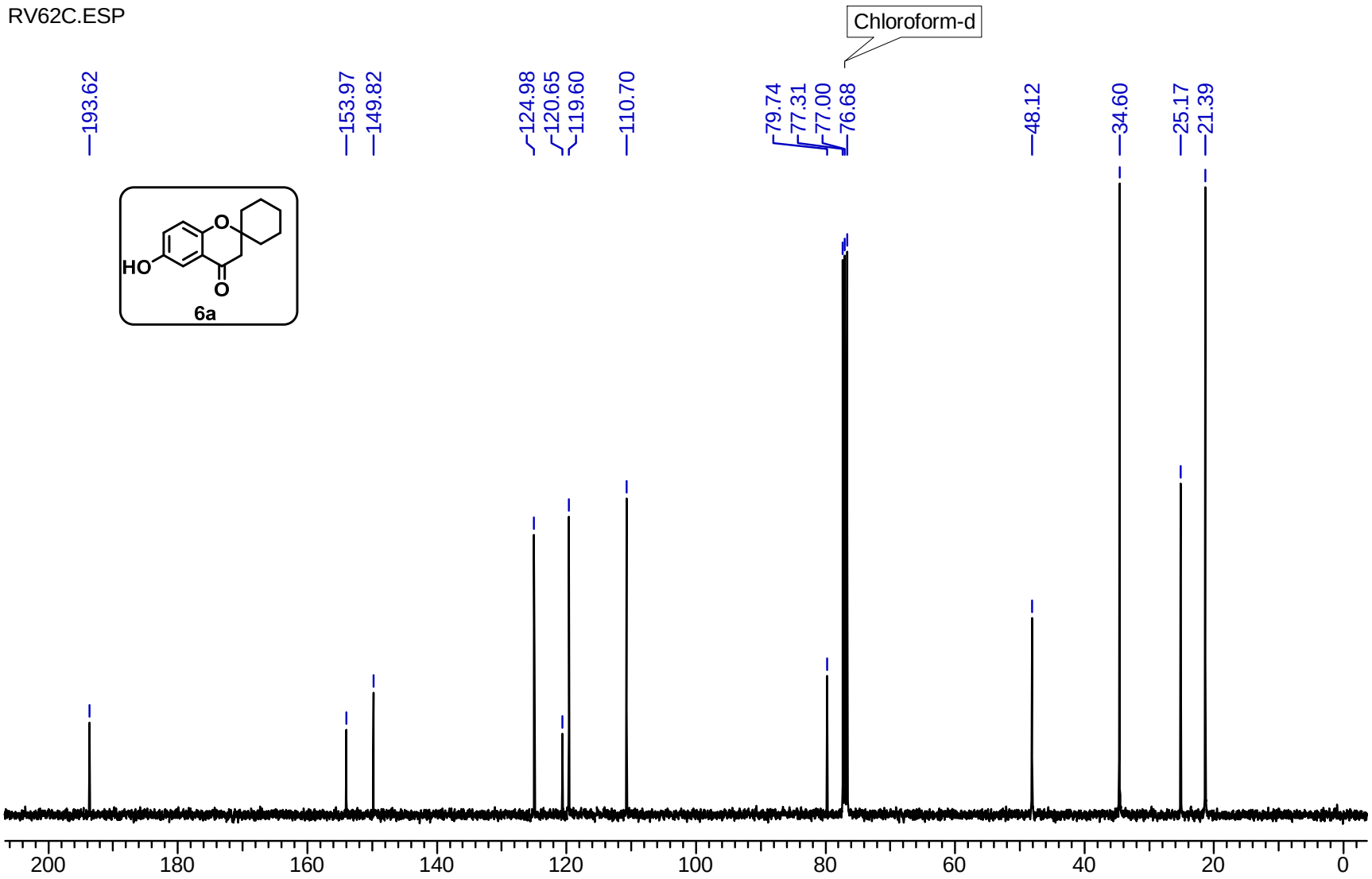
H27	-1.546	3.914	2.796
H28	-0.154	2.837	2.882
H29	-2.199	1.767	3.870
H30	-1.623	0.870	2.463
H31	-4.094	1.152	2.370
H32	-3.918	2.903	2.452
H33	-0.869	-2.240	0.255
C15	-4.019	2.327	-0.350
O11	-3.605	-1.309	-2.714
C12	-3.487	0.427	0.801
C13	-3.479	1.602	1.797
C14	-4.378	1.281	3.009
C15	-5.817	0.979	2.543
C16	-5.826	-0.195	1.544
O16	-2.626	0.884	0.101
I17	-6.074	4.442	-0.400
H27	-4.380	2.124	3.708
H28	-3.975	0.407	3.537
H29	-6.227	1.860	2.038
H30	-6.455	0.741	3.401
H31	-6.840	-0.378	1.175
H32	-5.452	-1.109	2.023

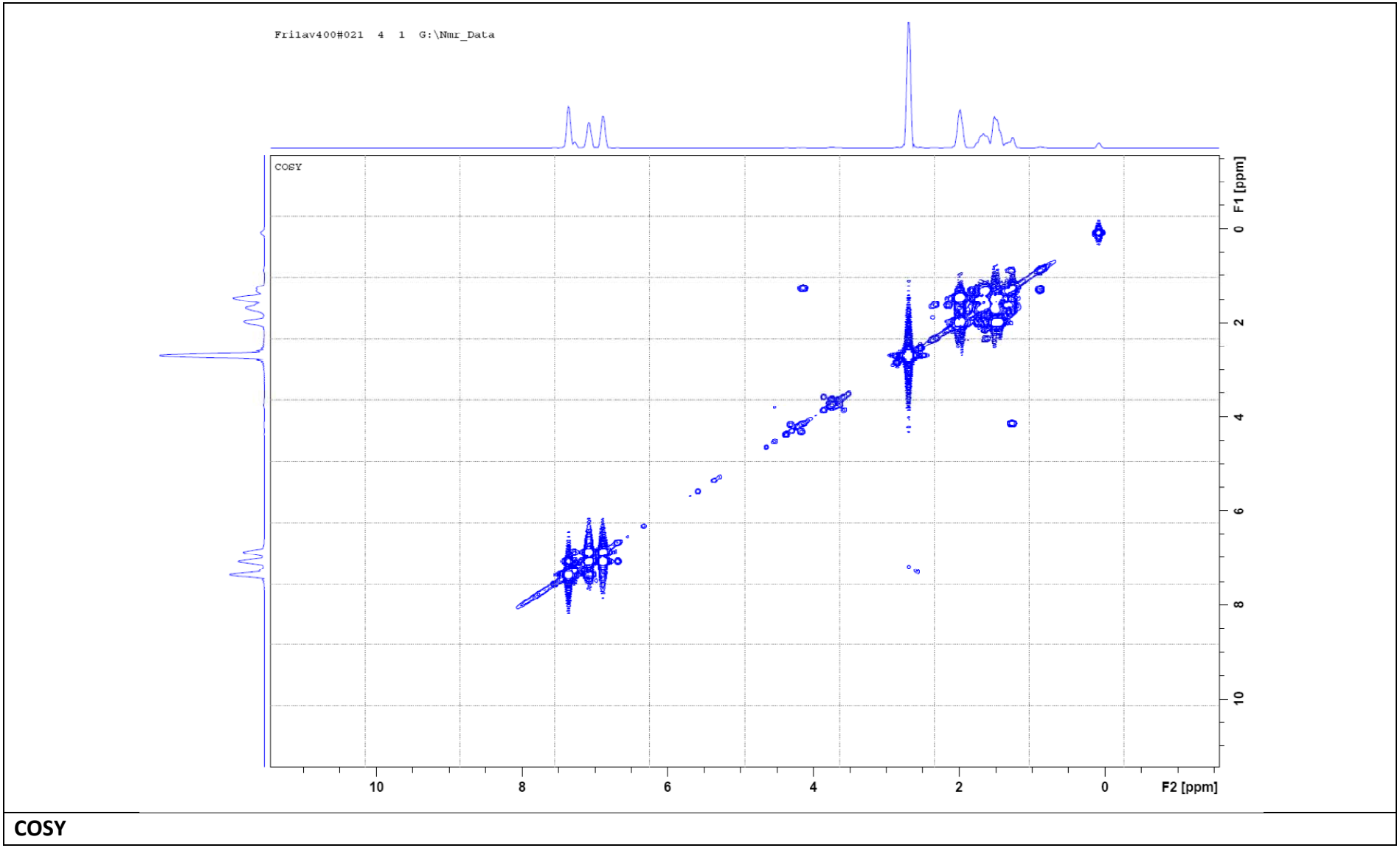
7. Spectral data

^{1}H NMR (400 MHz, $CDCl_3$) of compound *6a*:



^{13}C NMR (100 MHz, $CDCl_3$) of compound *6a*:

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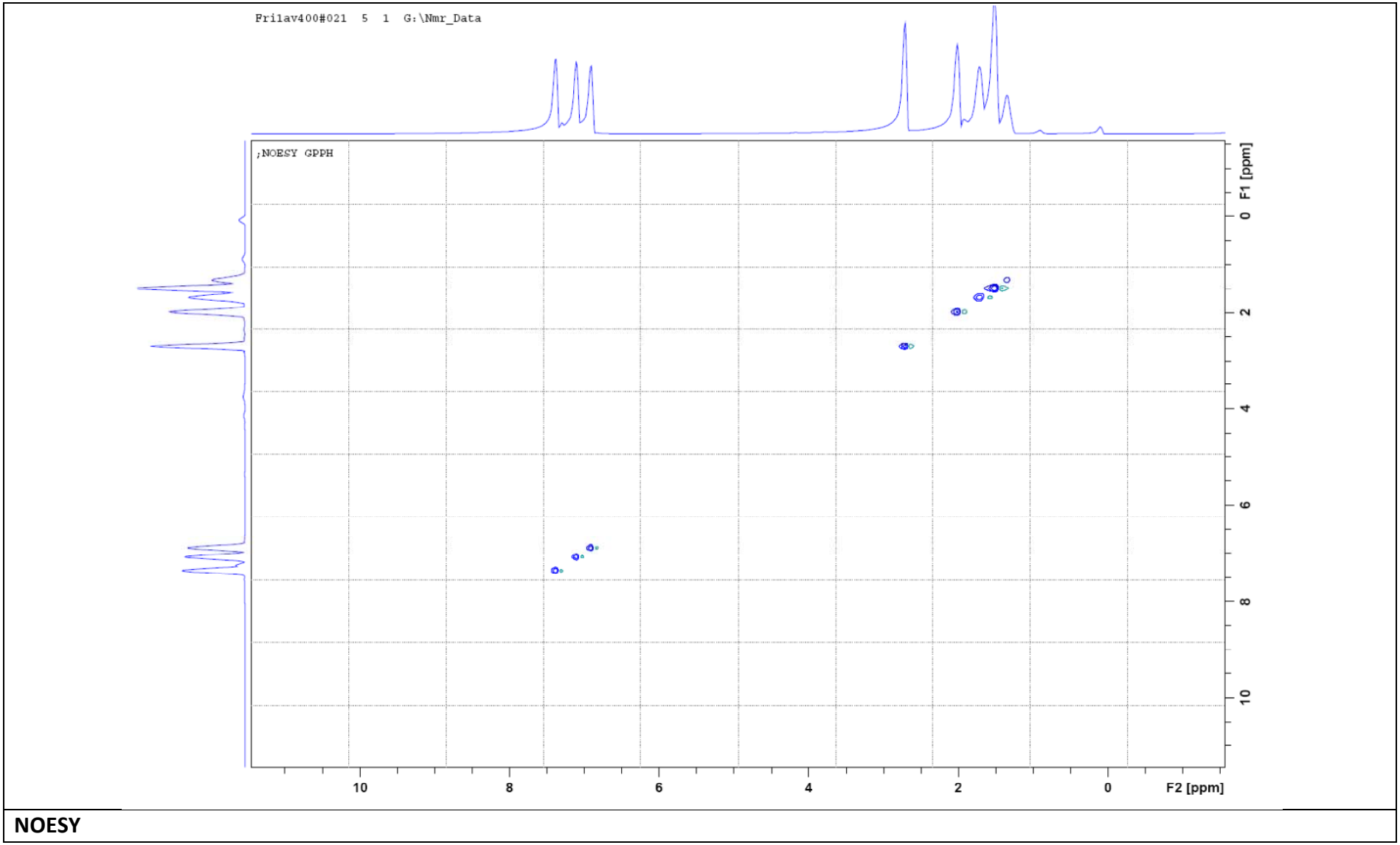
2
4
6
8
10
F2 [ppm]
10
8
6
4
2
0

COSY


Prilav400#021 5 1 G:\Nmr_Data
;NOESY GPPH
F1 [ppm]
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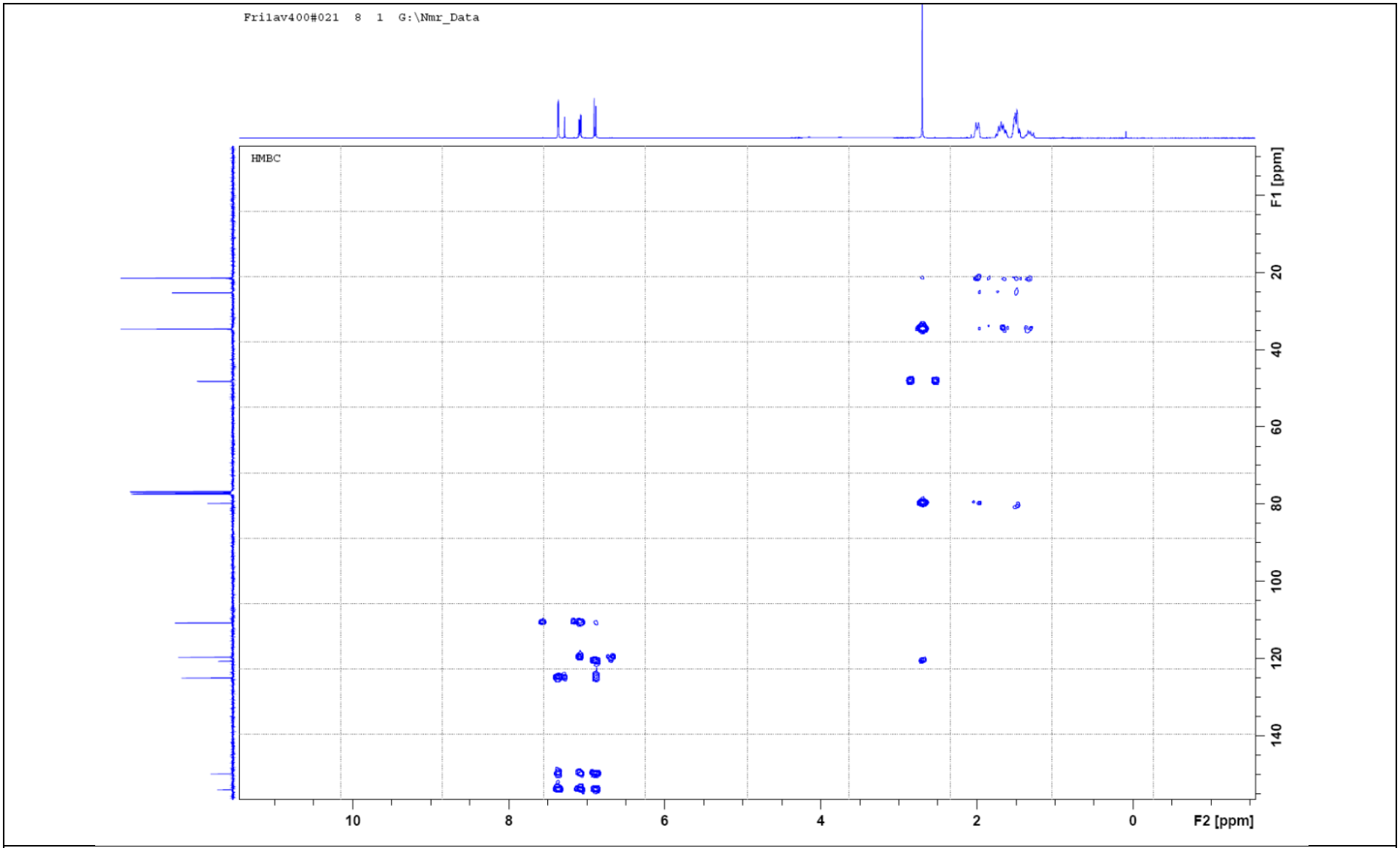
2
4
6
8
10
F2 [ppm]
10
8
6
4
2
0

NOESY


Frilav400#021 8 1 G:\Nmr_Data
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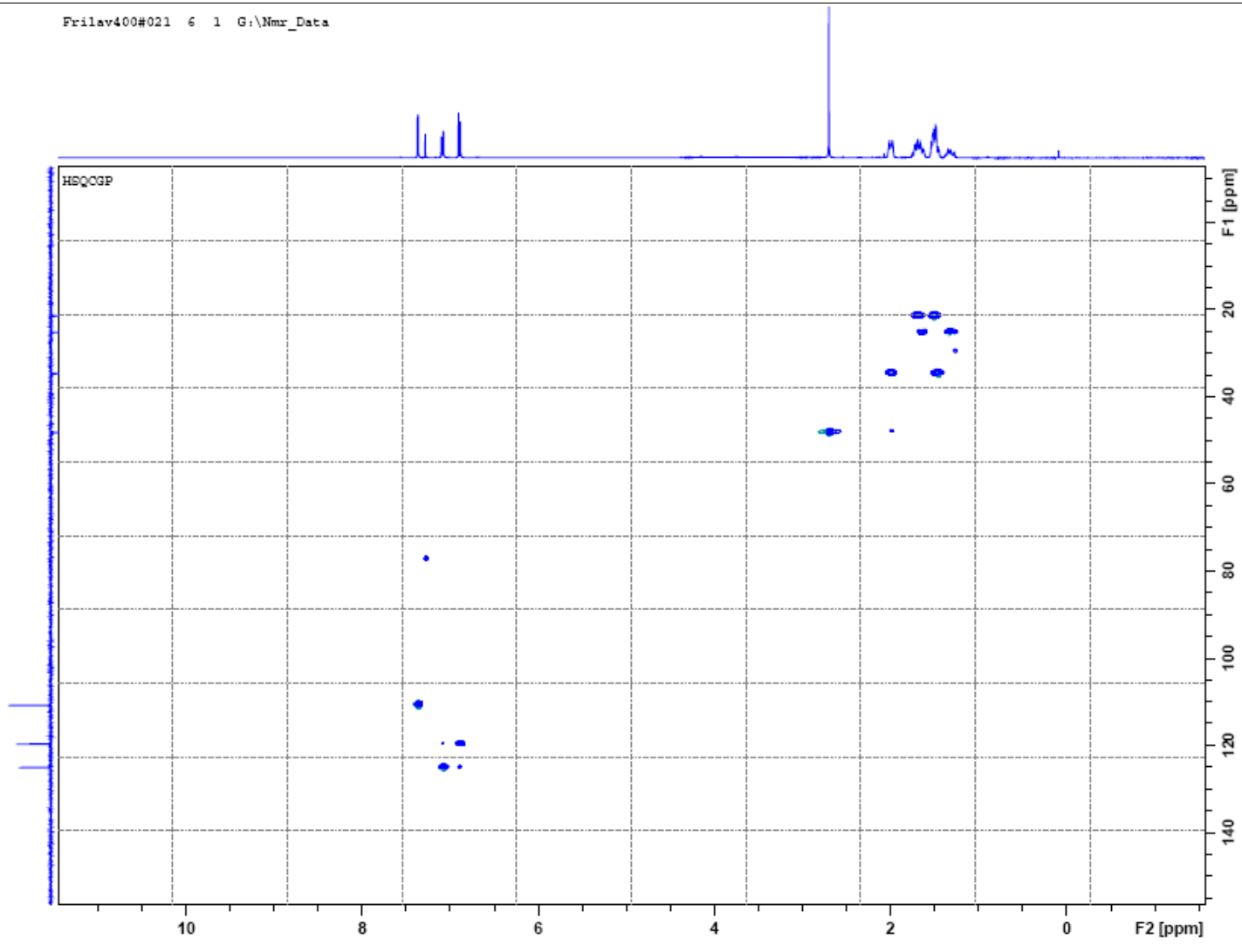
0
F2 [ppm]

HMBC


Frilav400#021 6 1 G:\Nmr_Data
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40
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4
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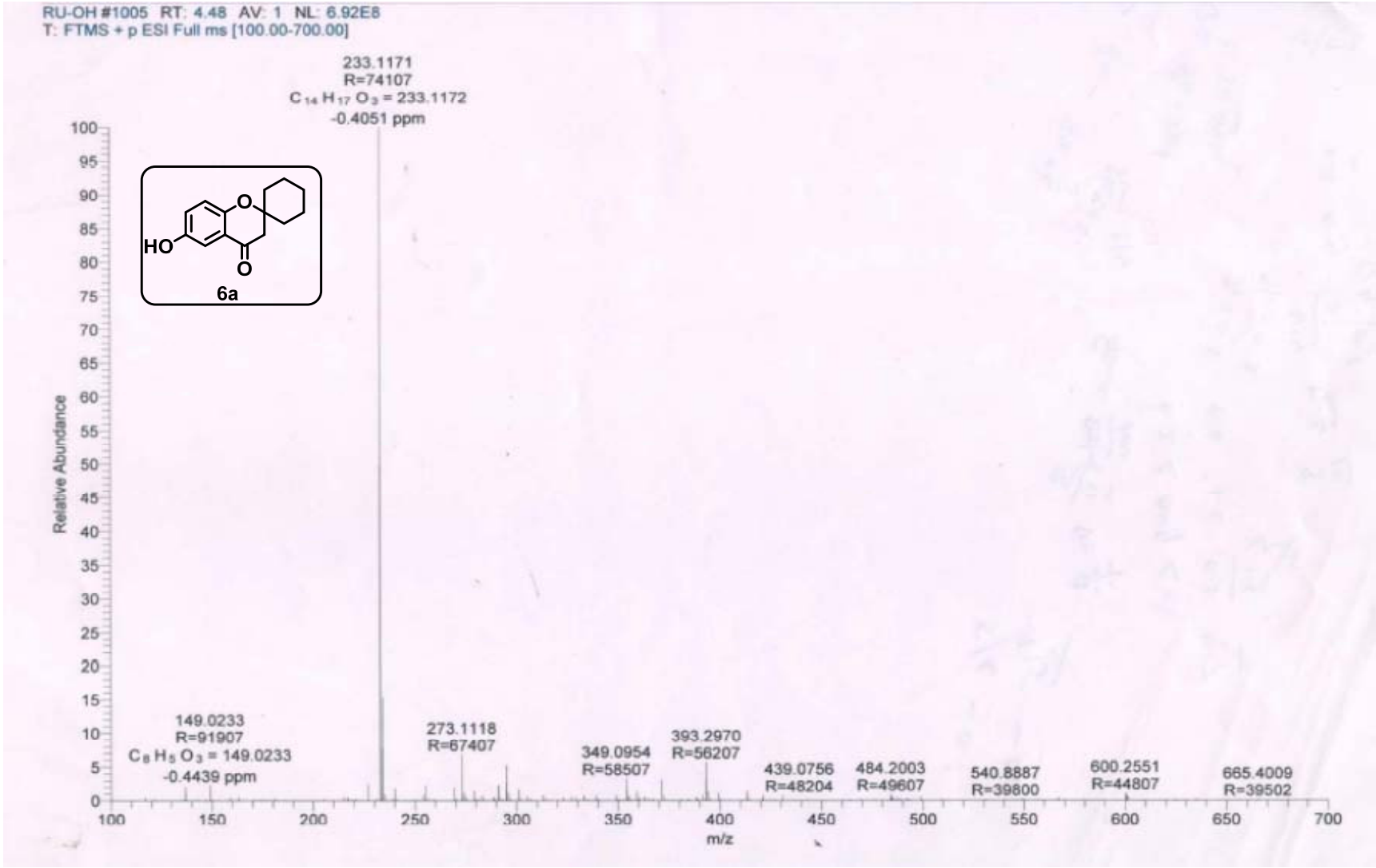
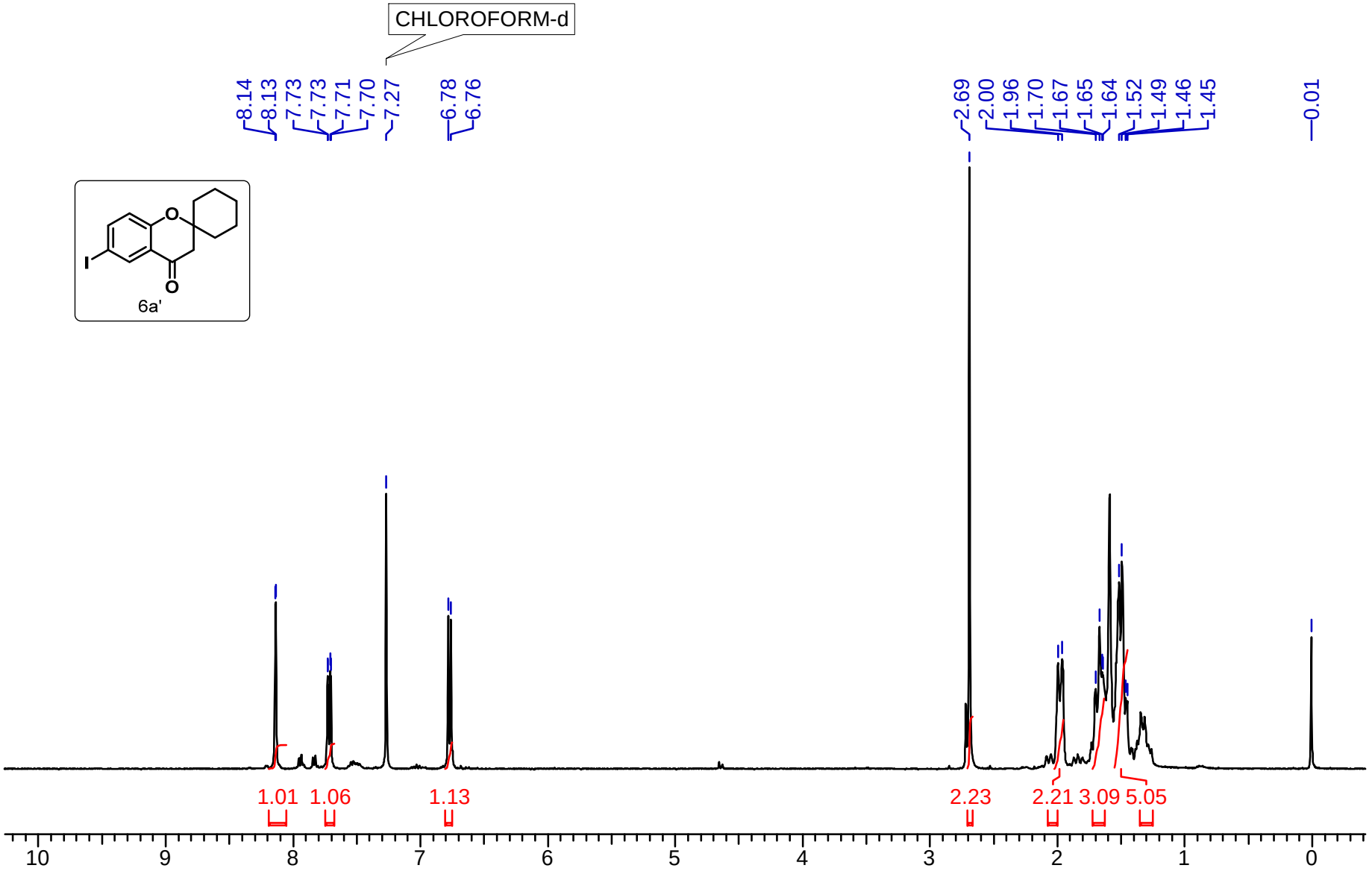
0
F2 [ppm]

HSQC

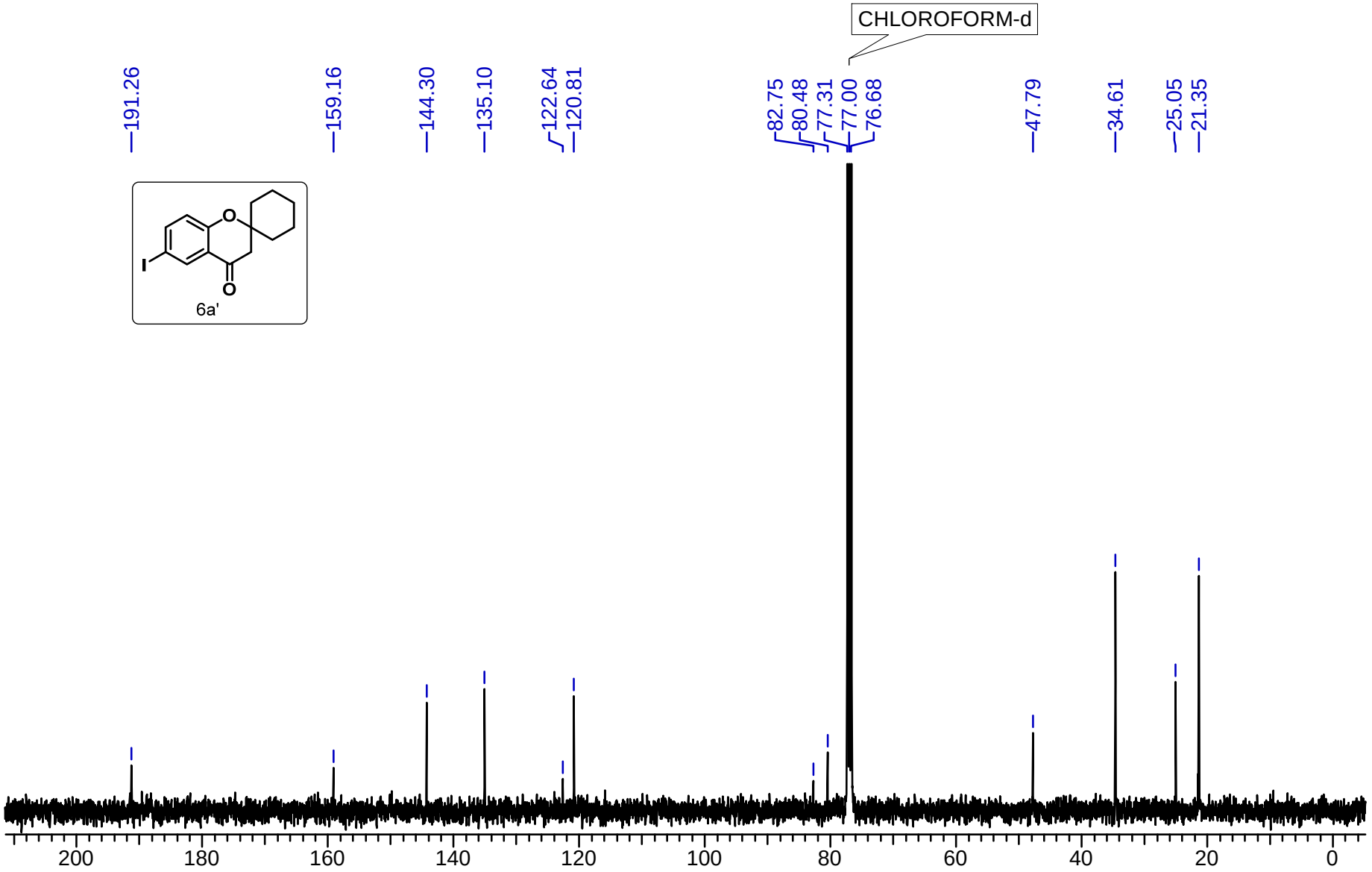
HRMS of compound *6a*:



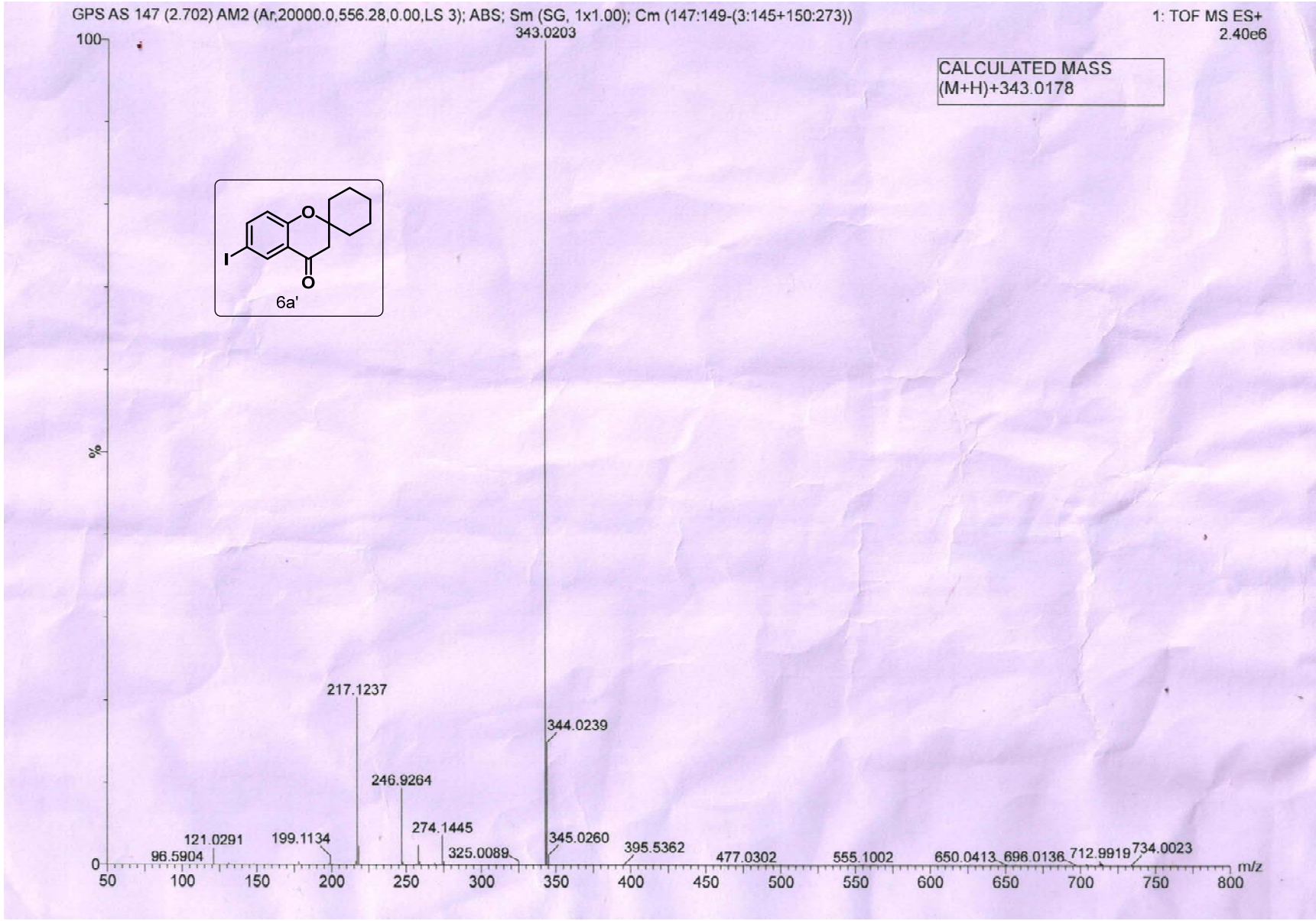
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6a'*:



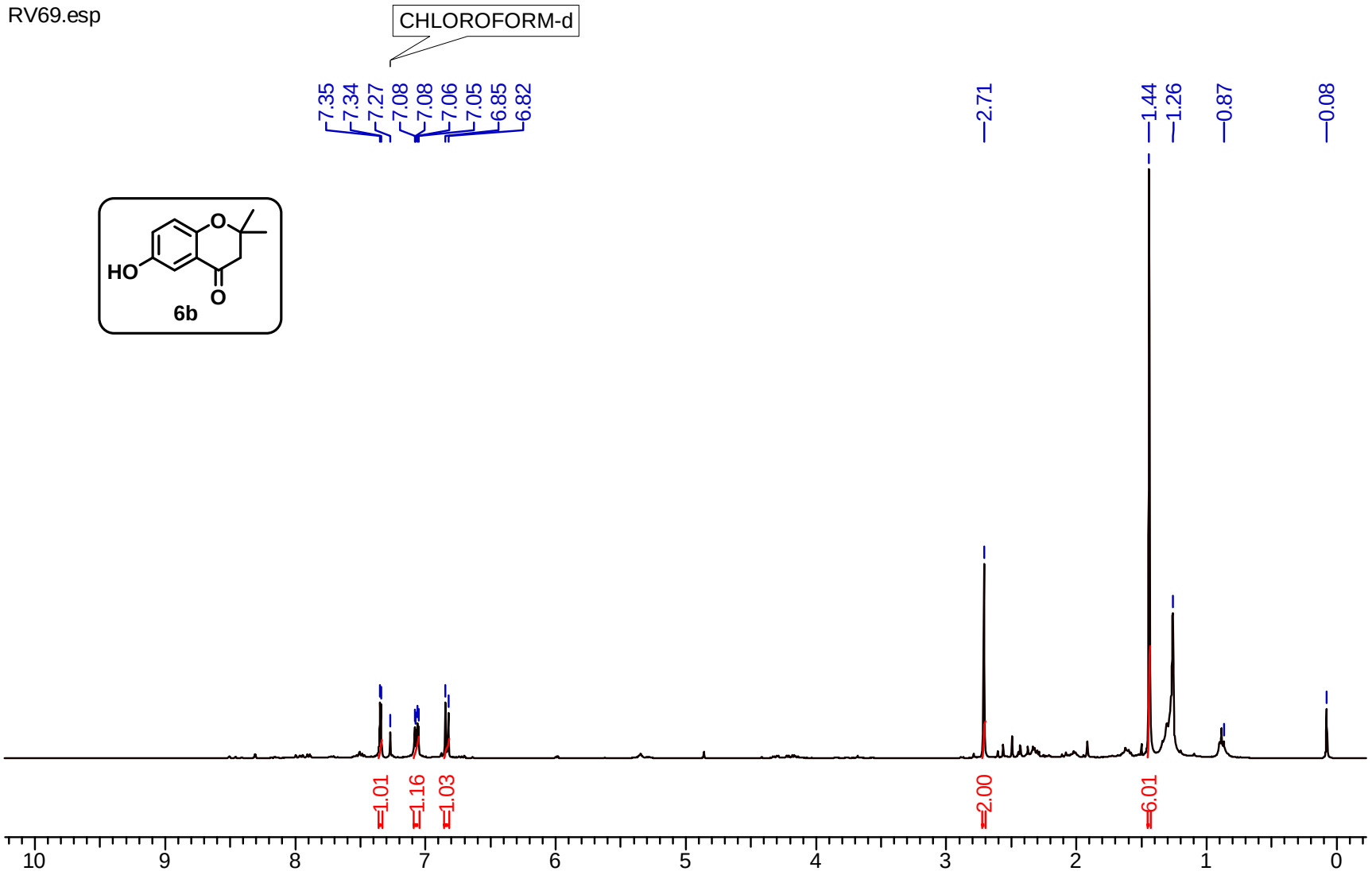
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6a'*:



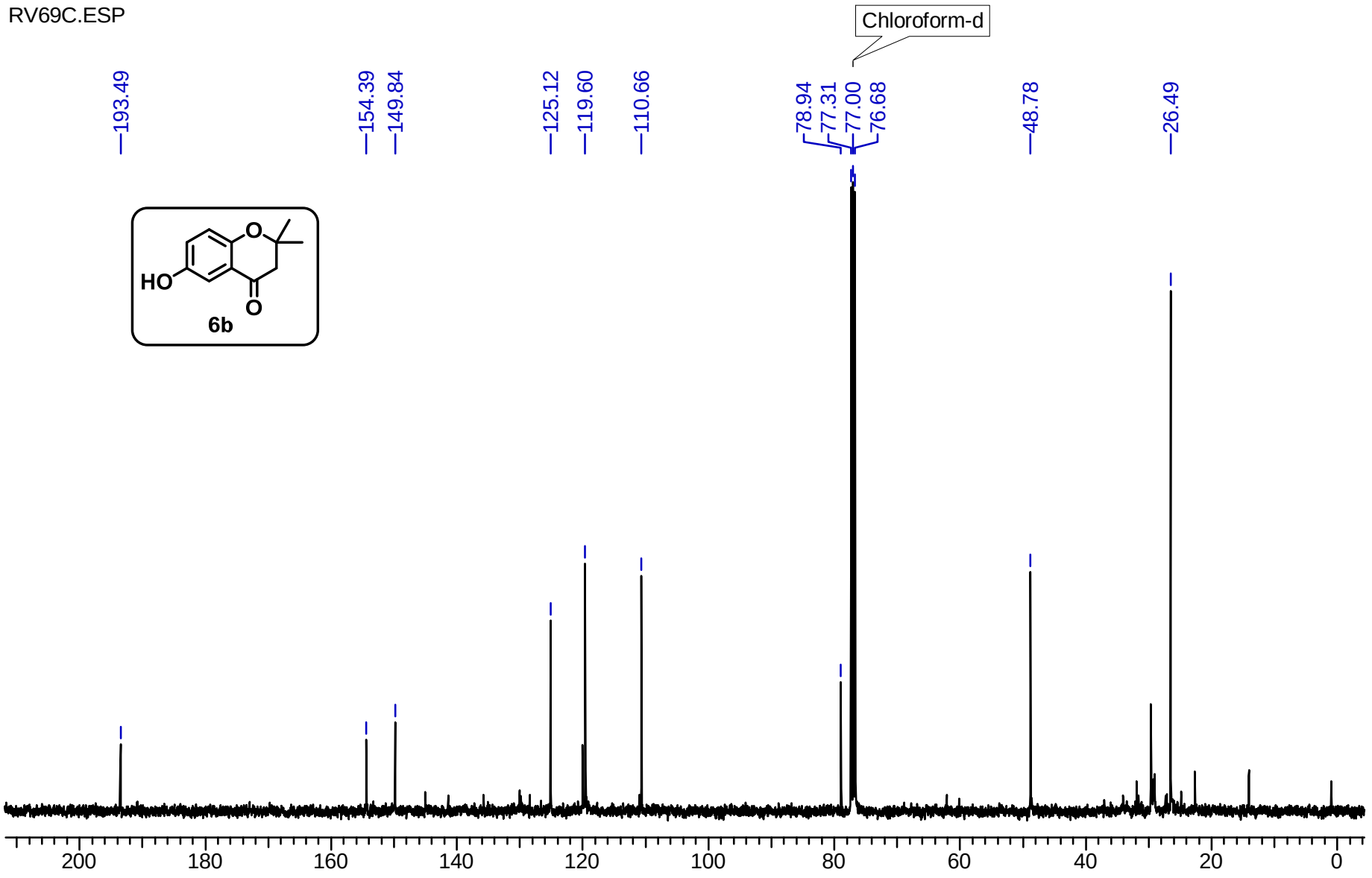
HRMS of compound *6a'*:



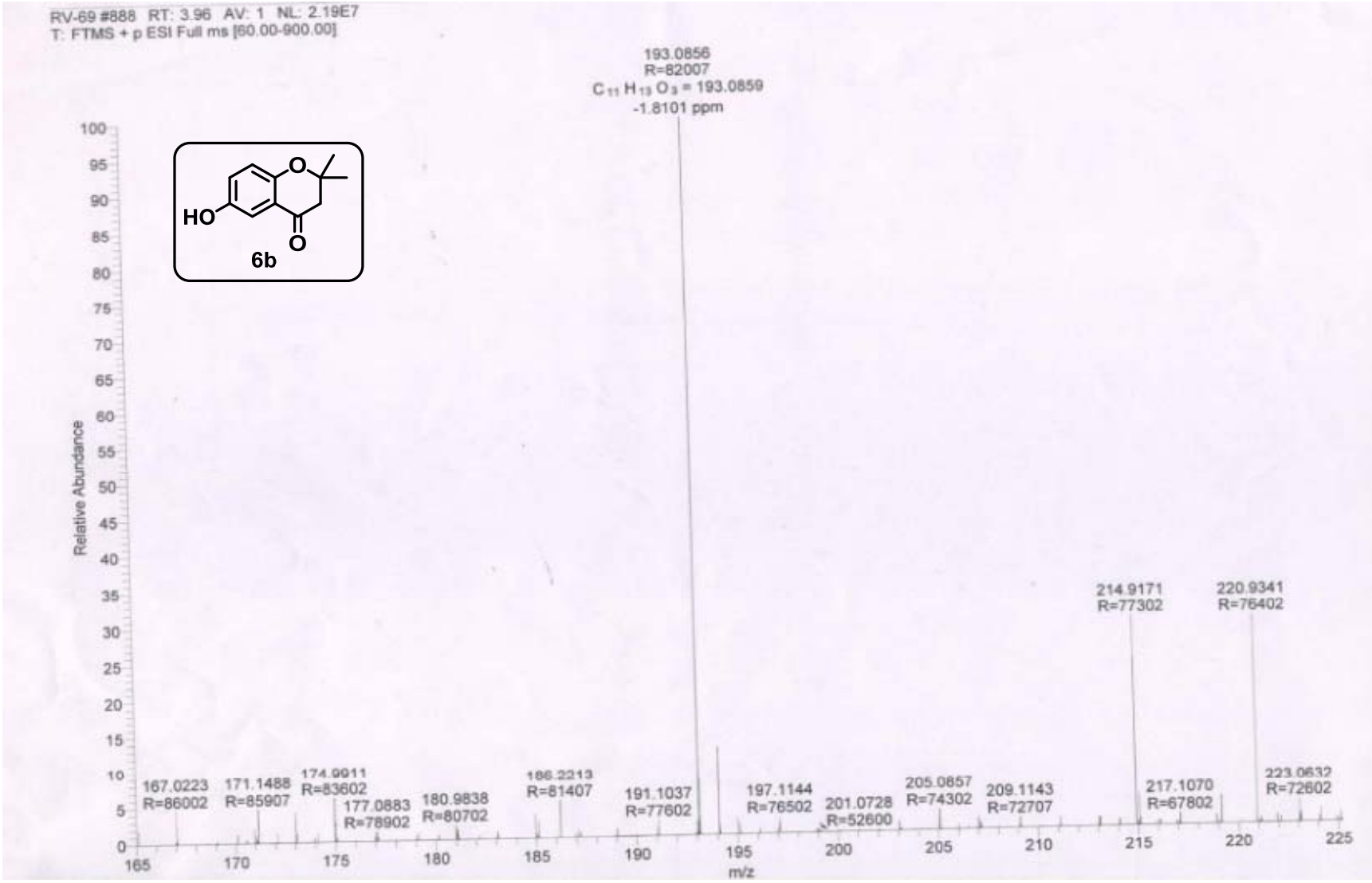
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6b*:



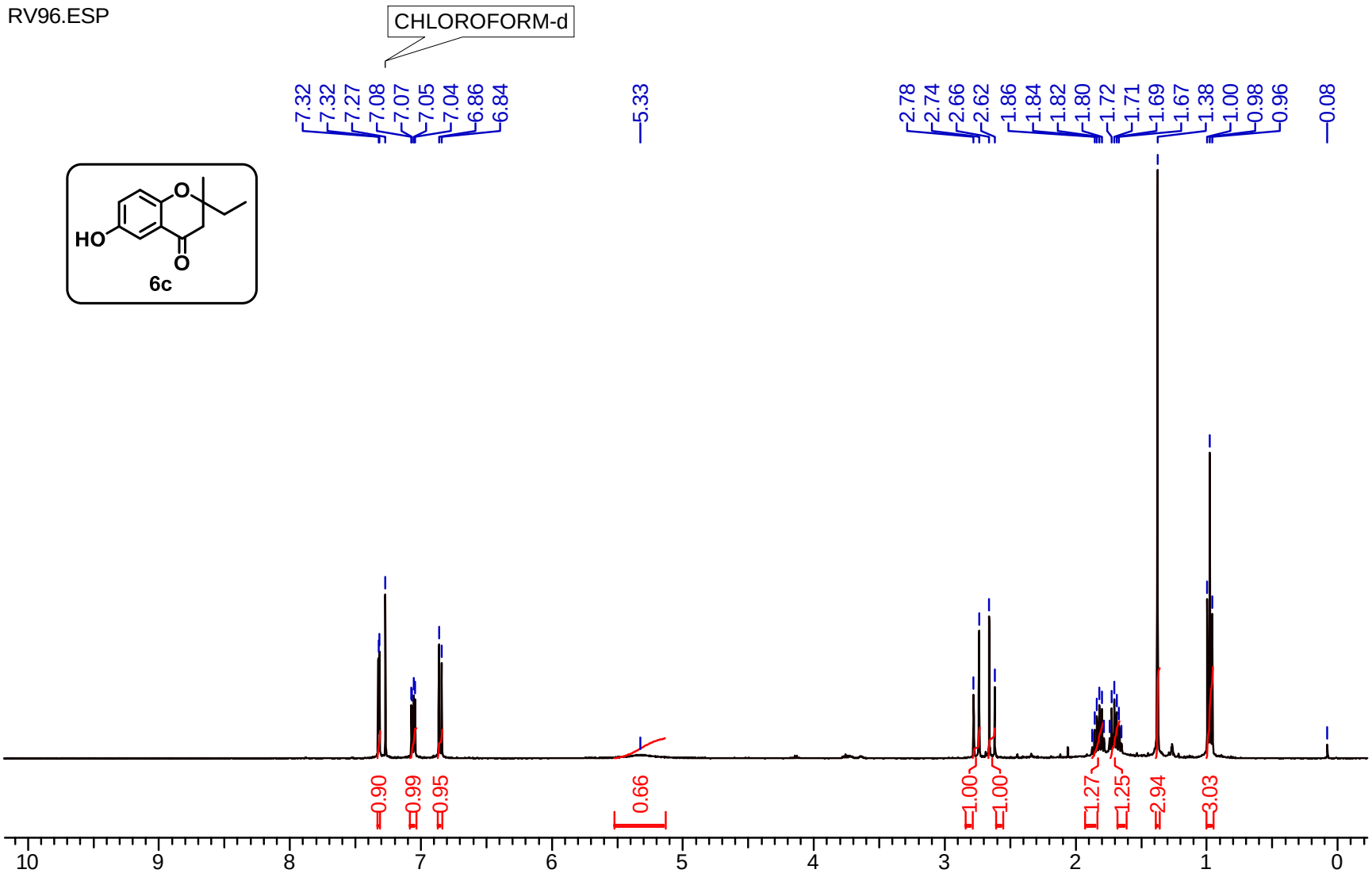
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6b*:



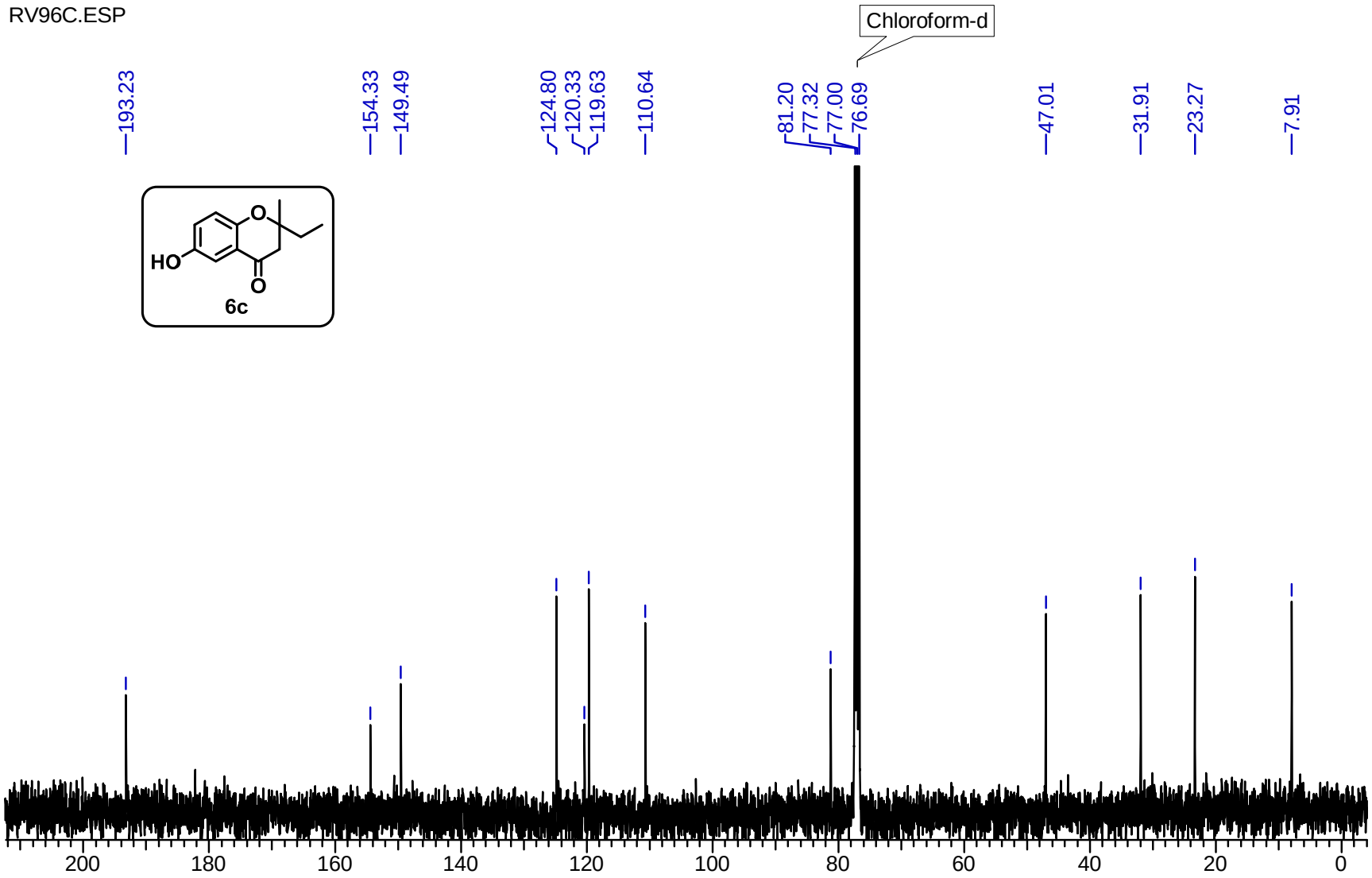
HRMS of compound *6b*:



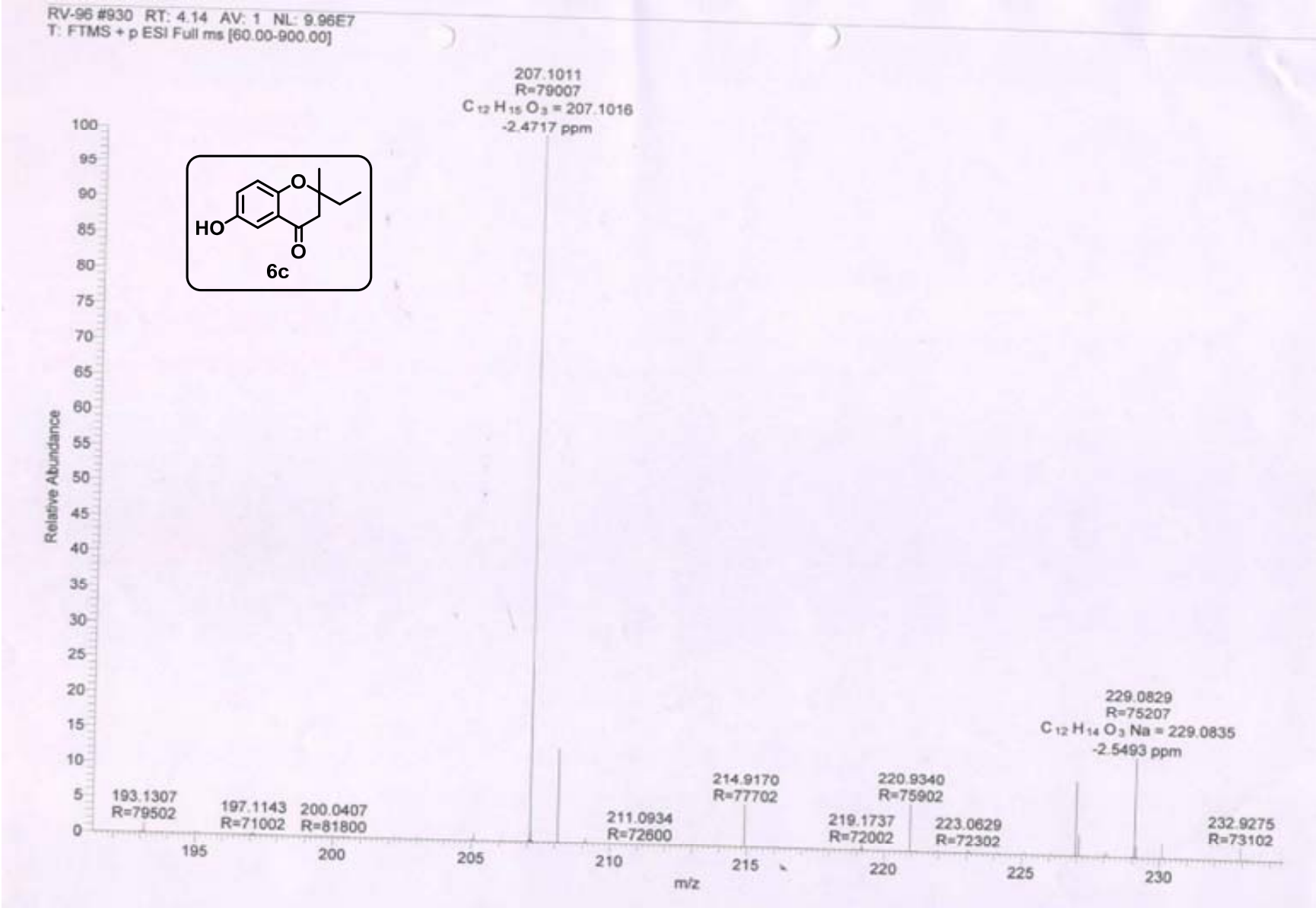
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6c*:



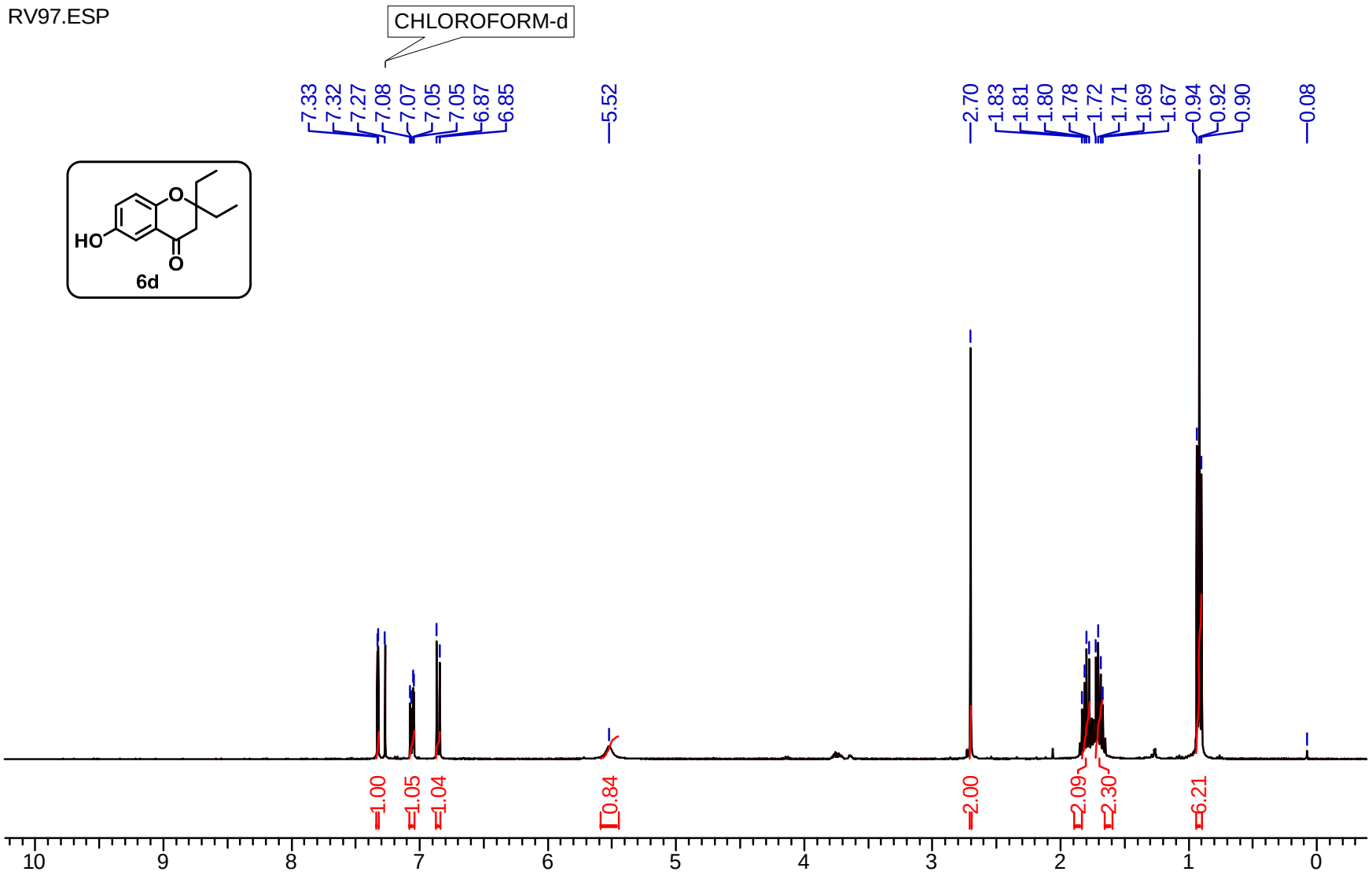
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6c*:



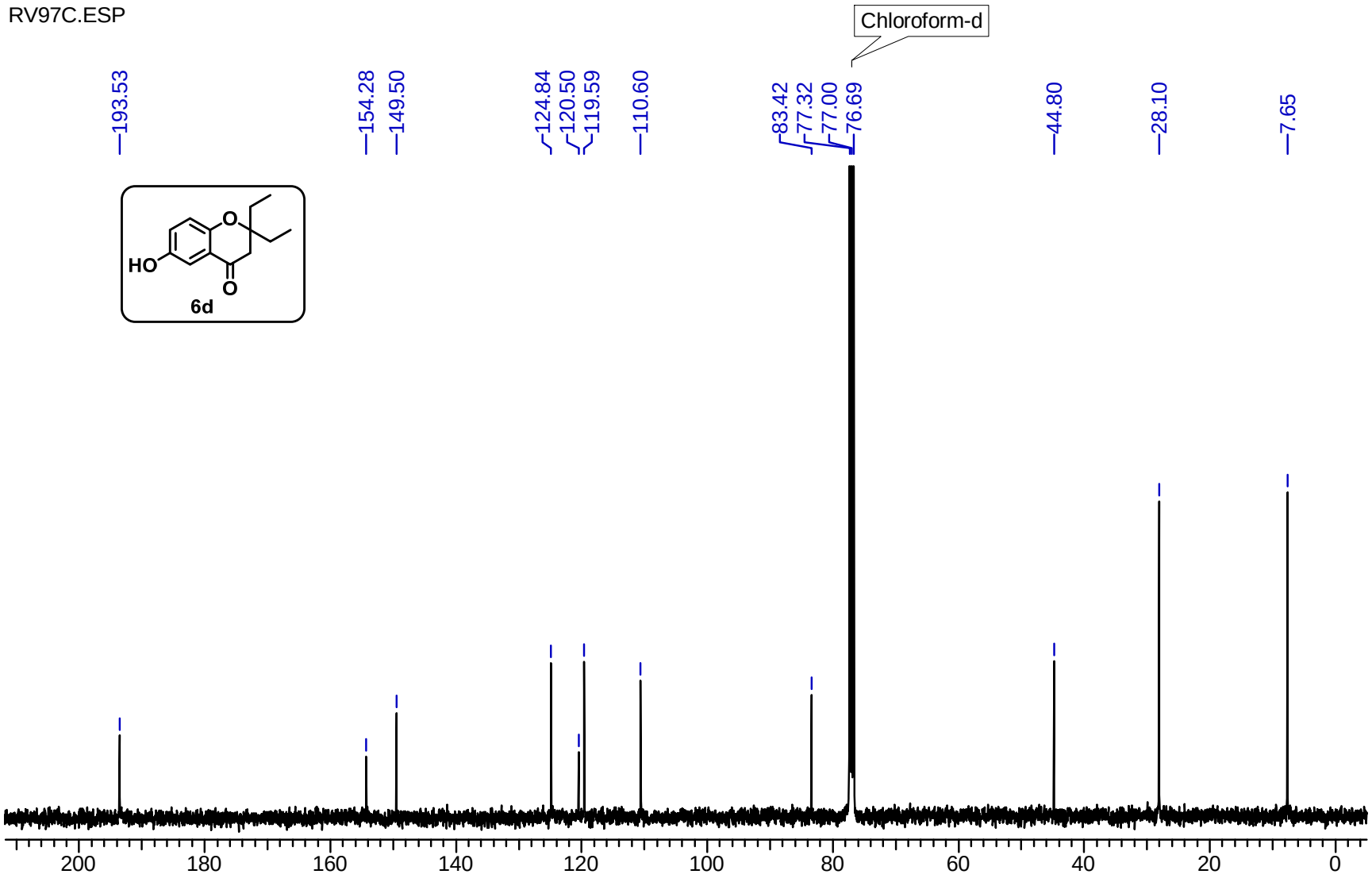
HRMS of compound *6c*:



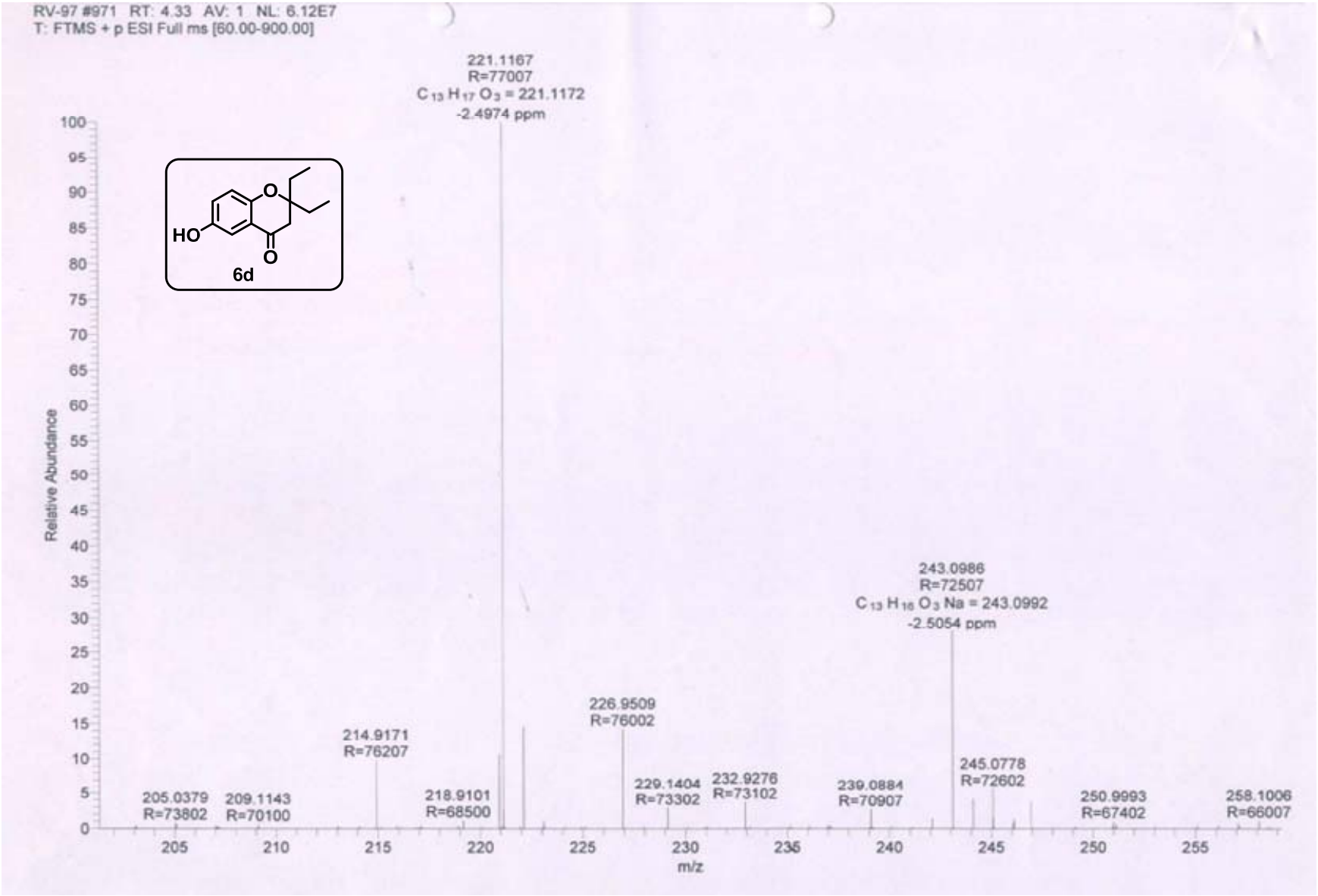
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6d*:



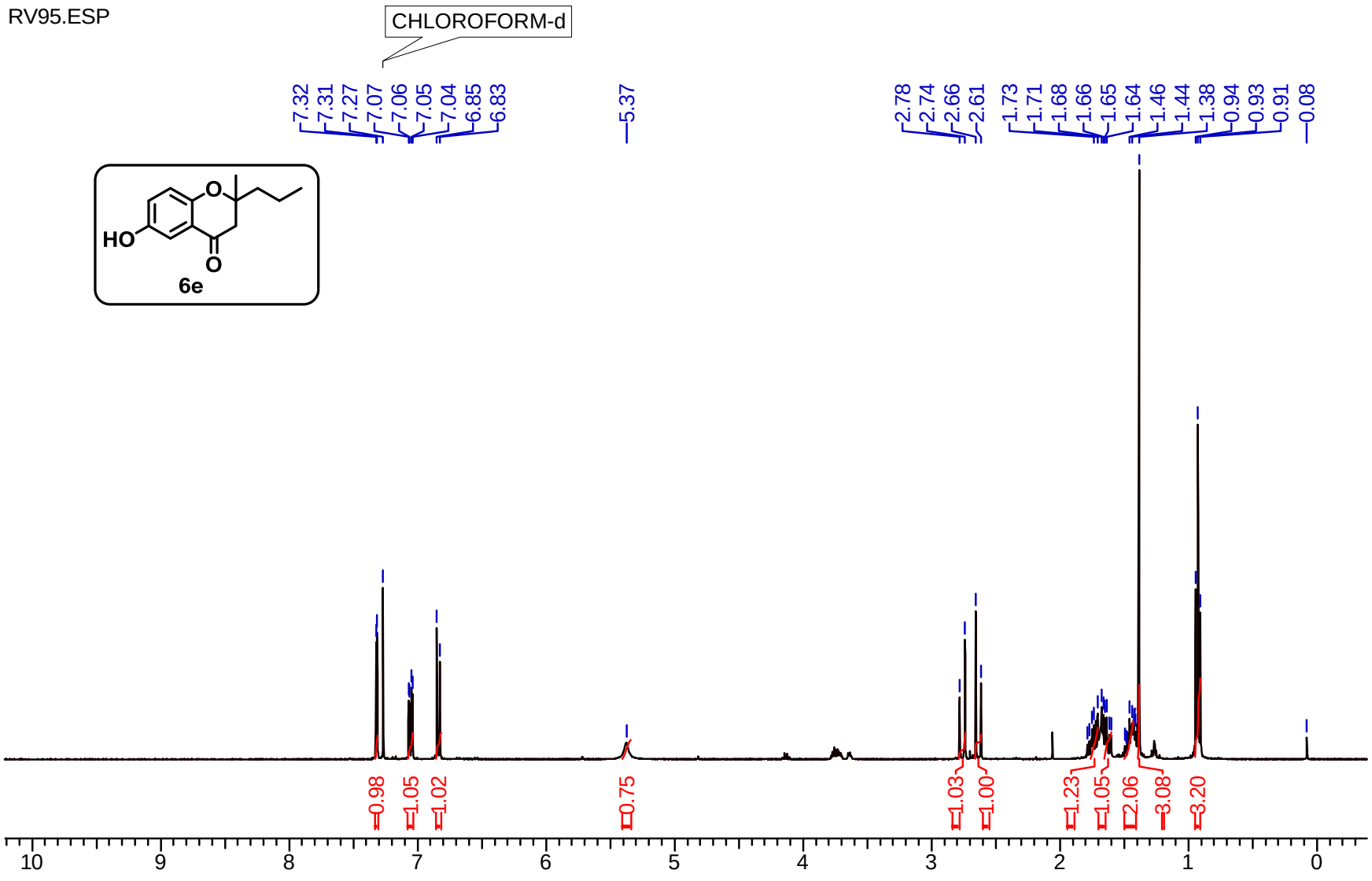
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6d*:



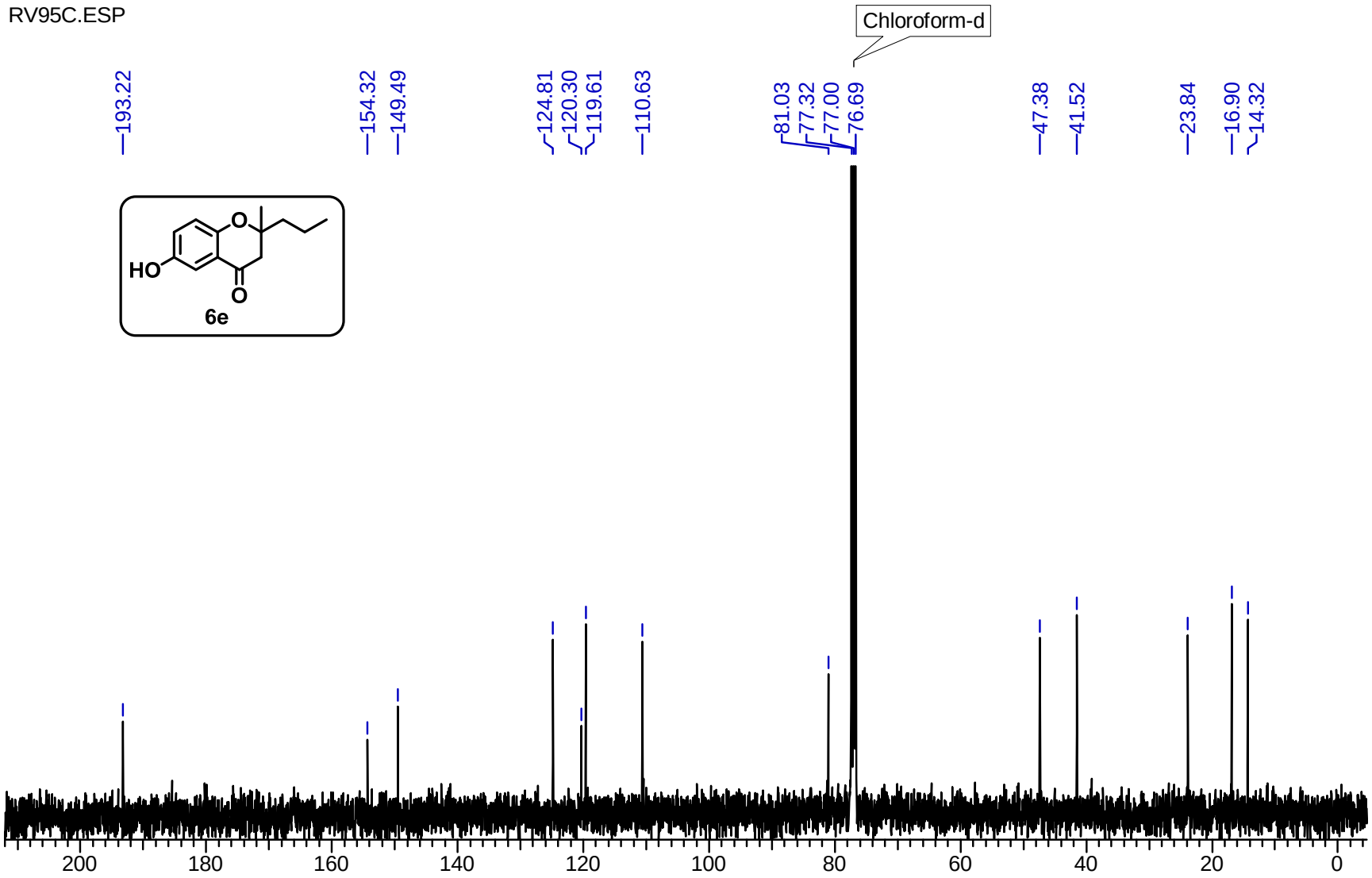
HRMS of compound *6d*:



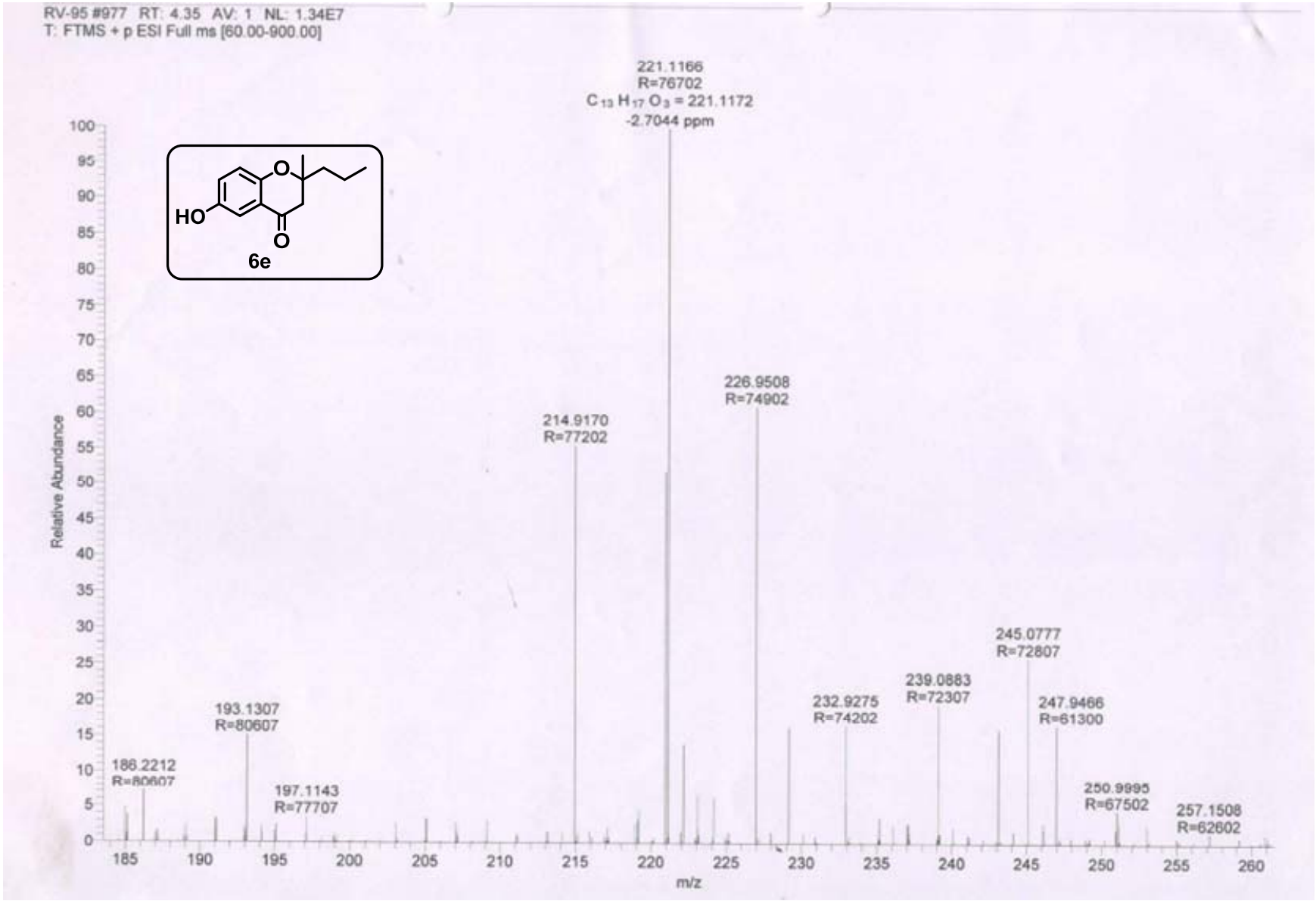
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6e*:



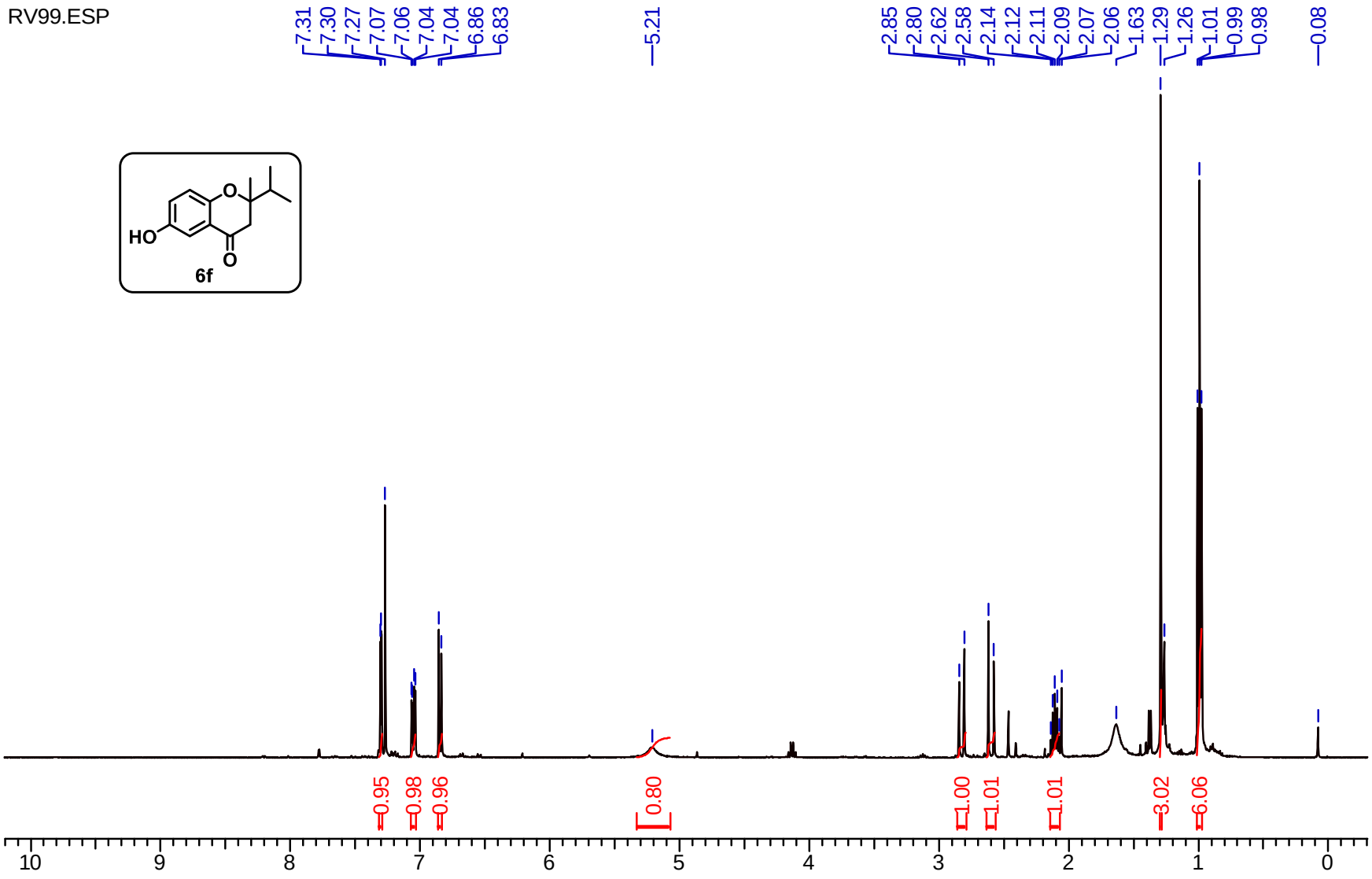
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6e*:



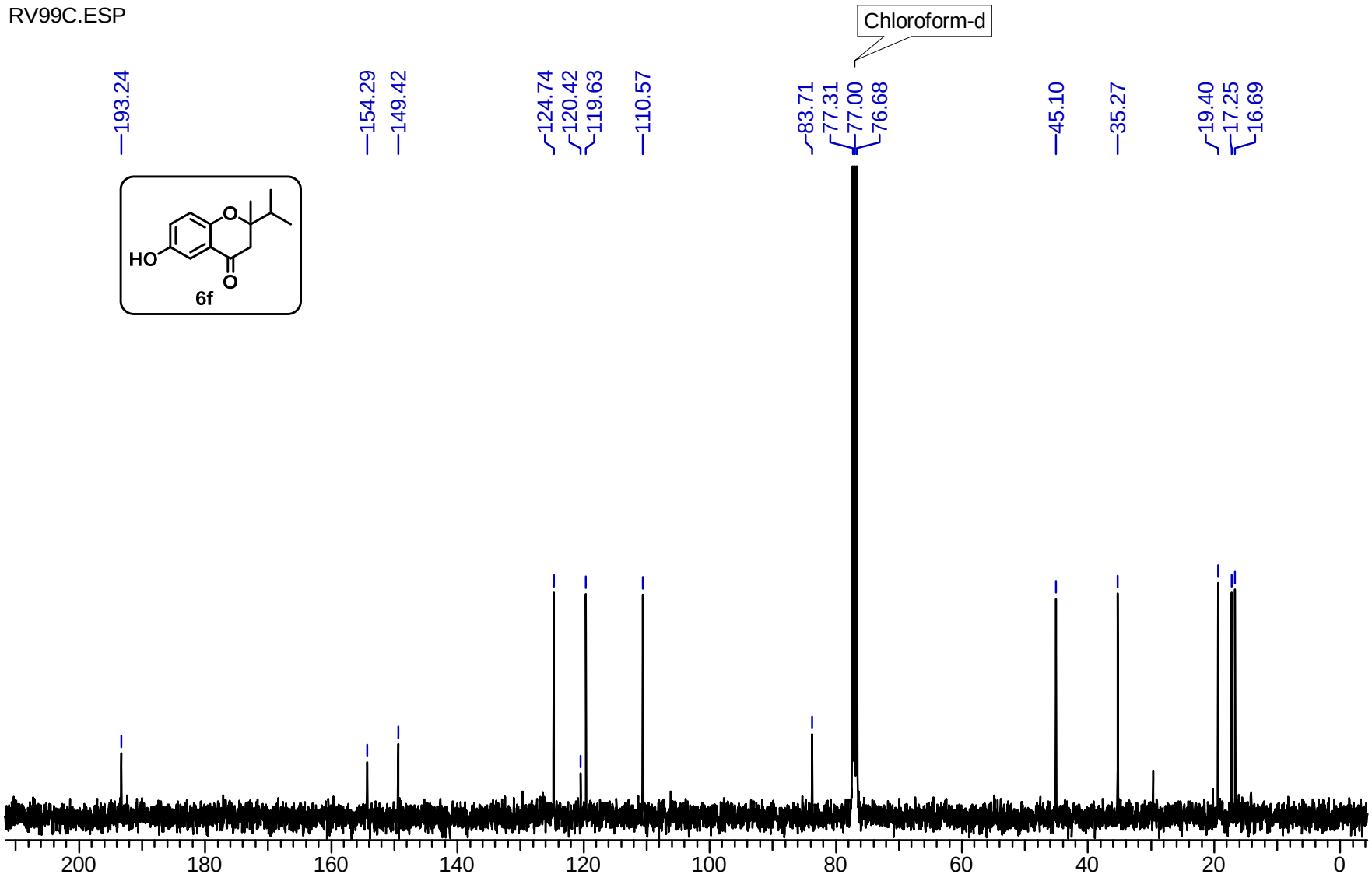
HRMS of compound *6e*:



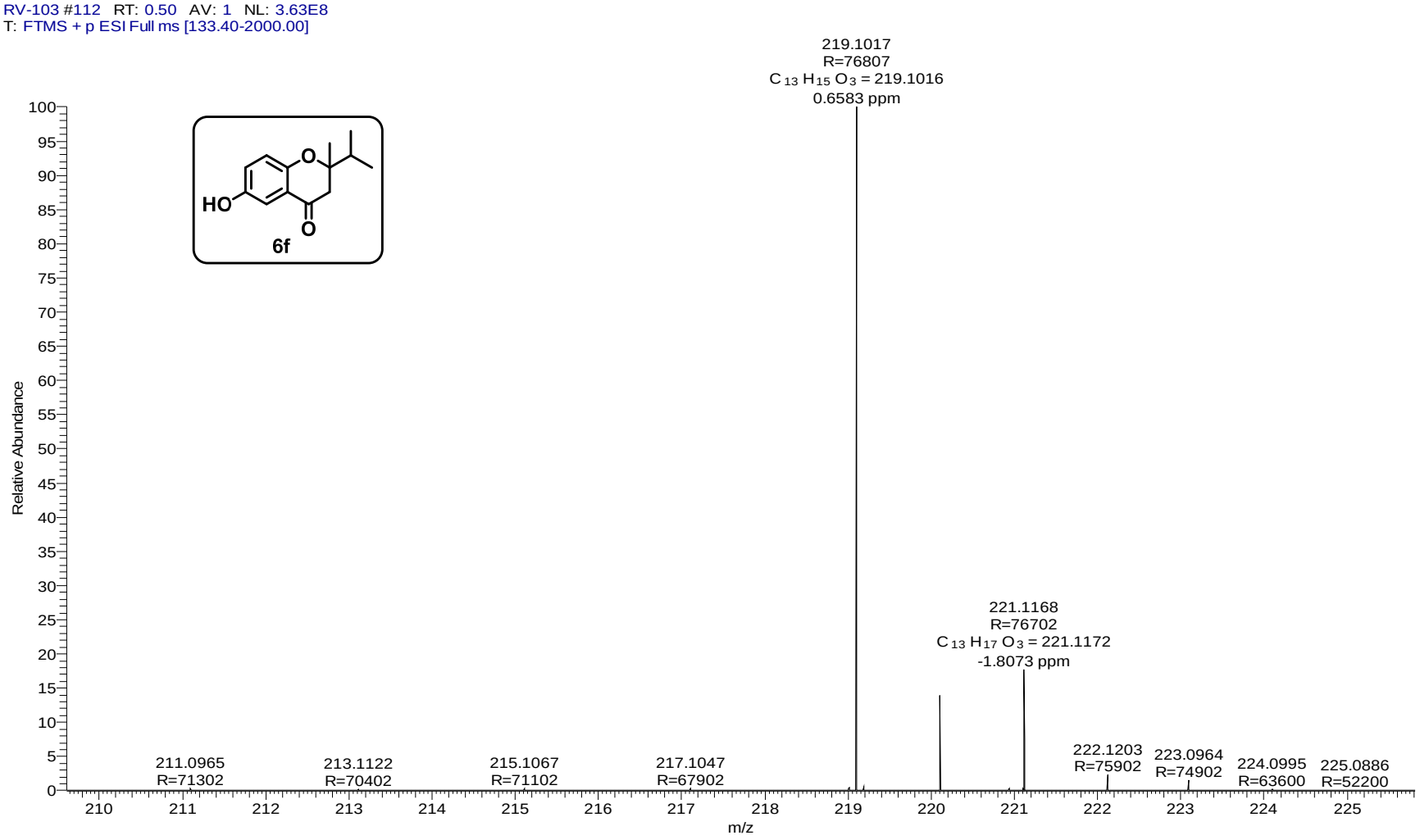
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6f*:



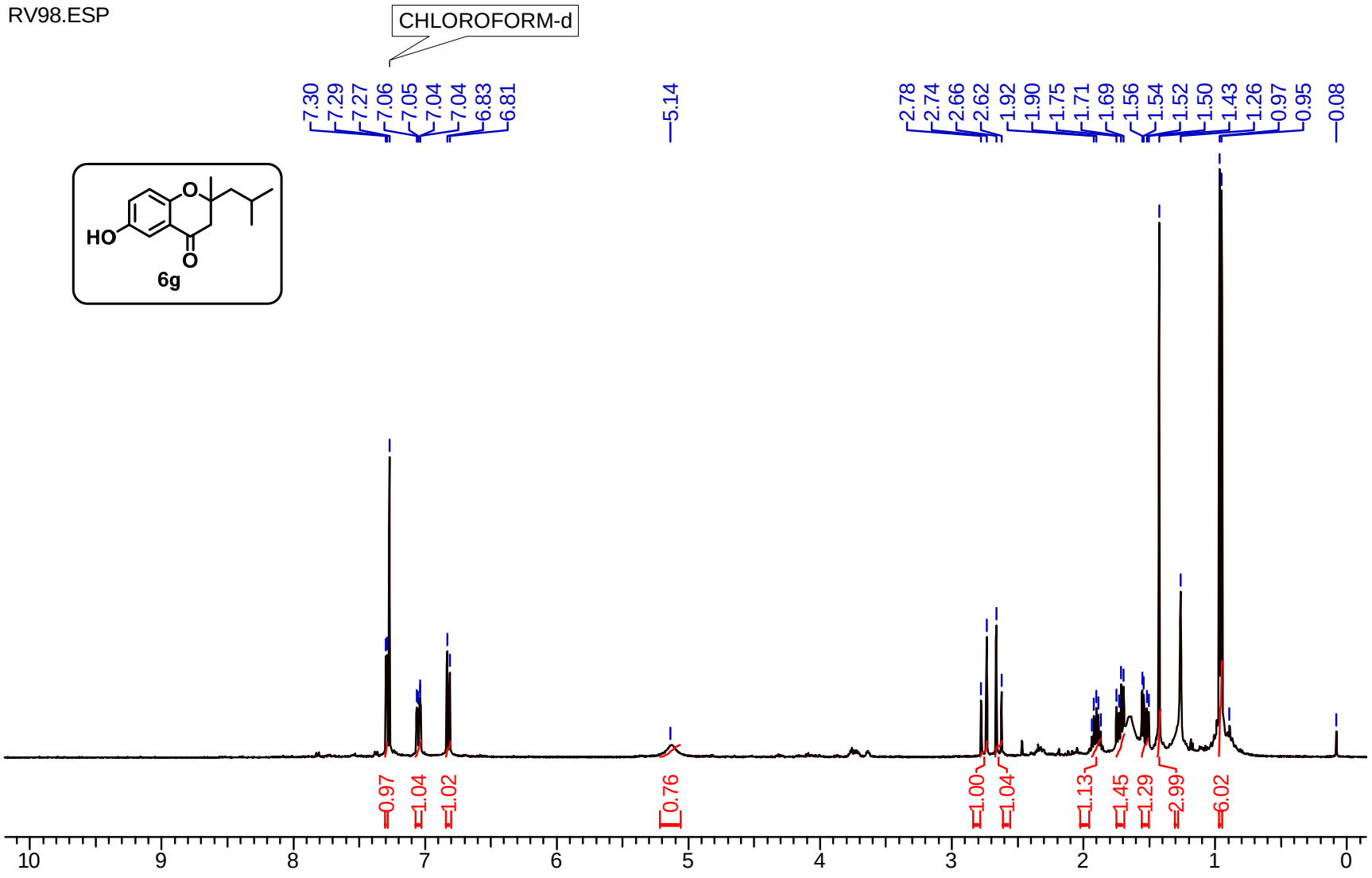
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6f*:



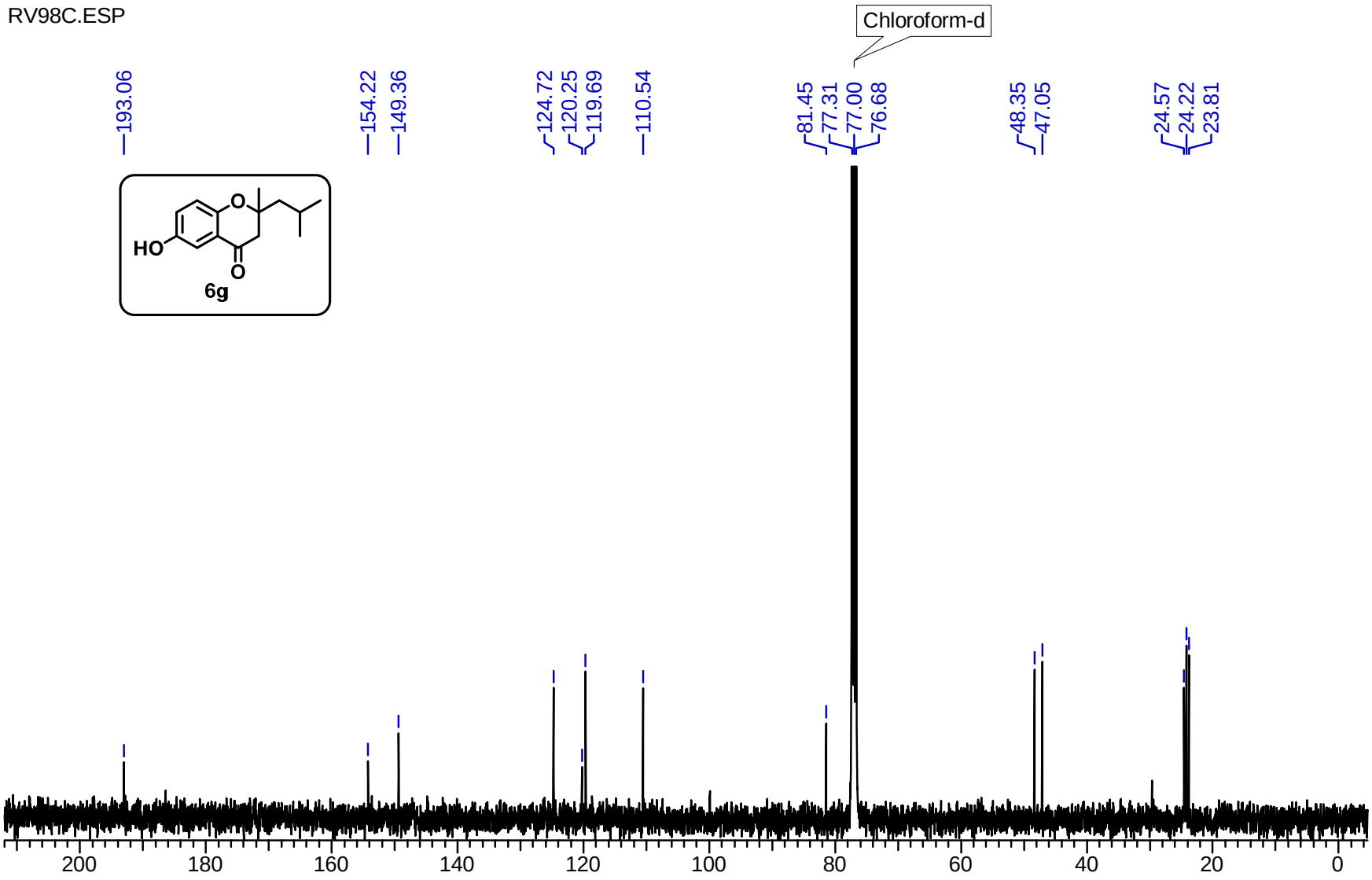
HRMS of compound *6f*:



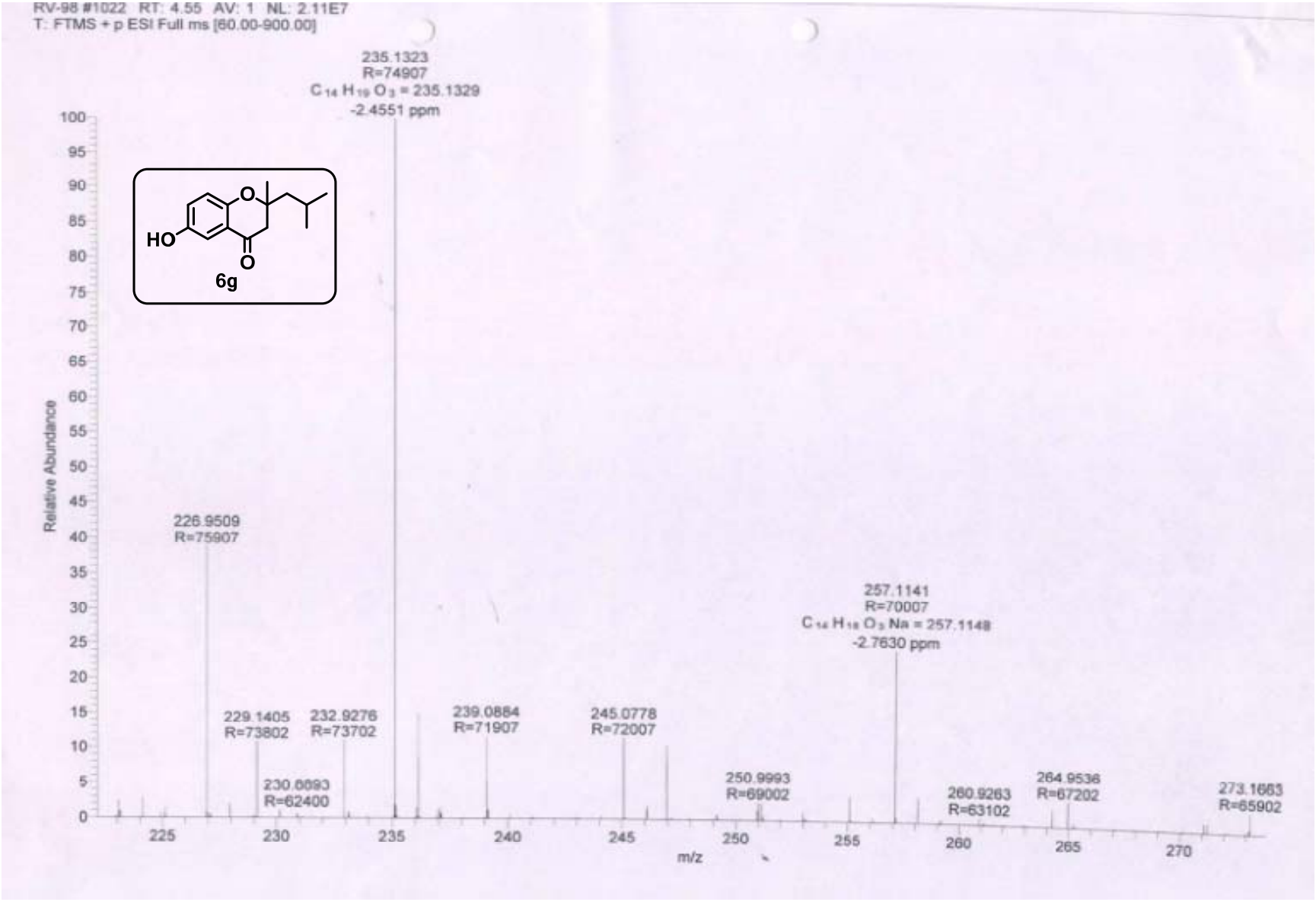
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6g*:



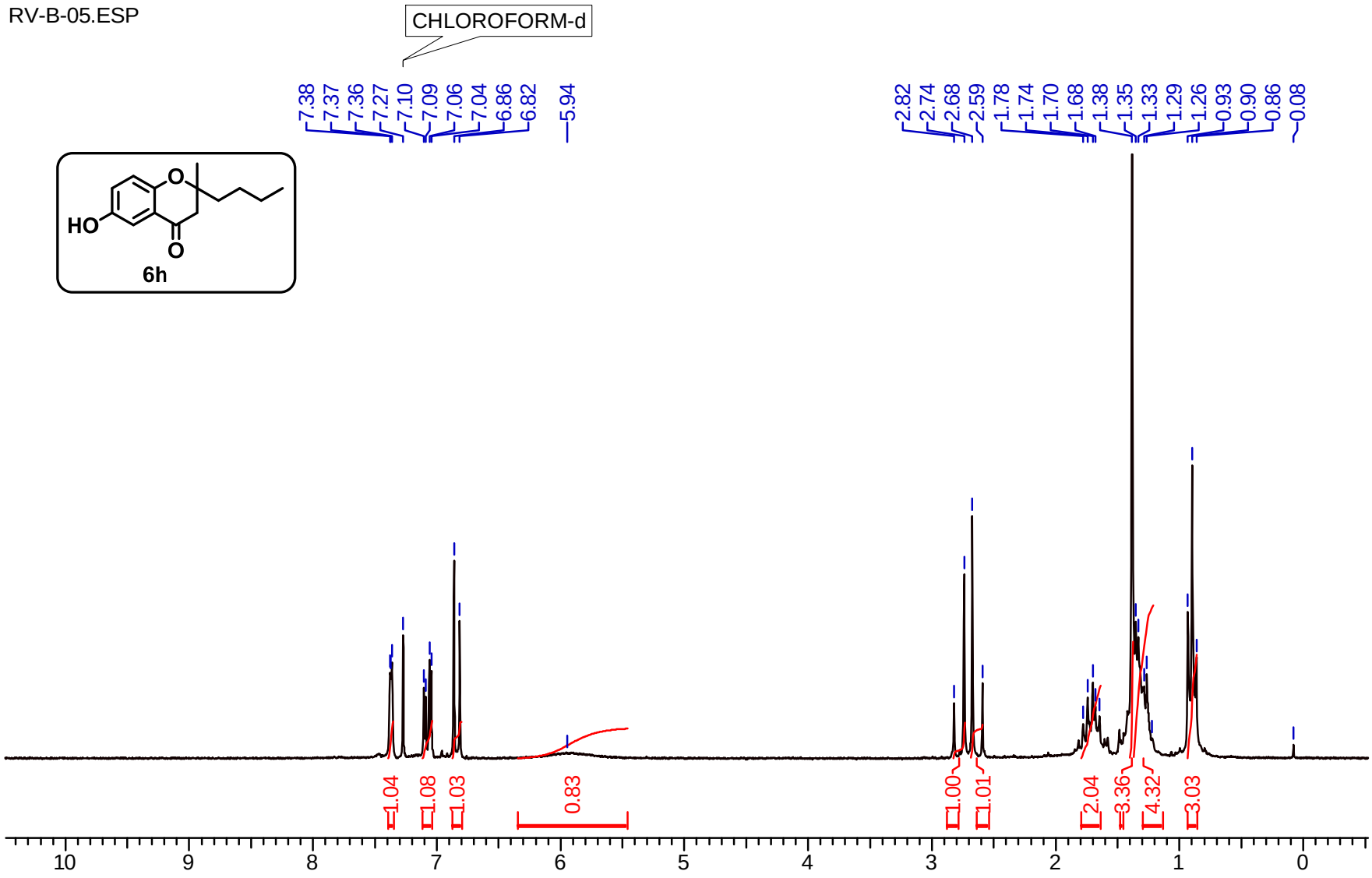
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6g*:



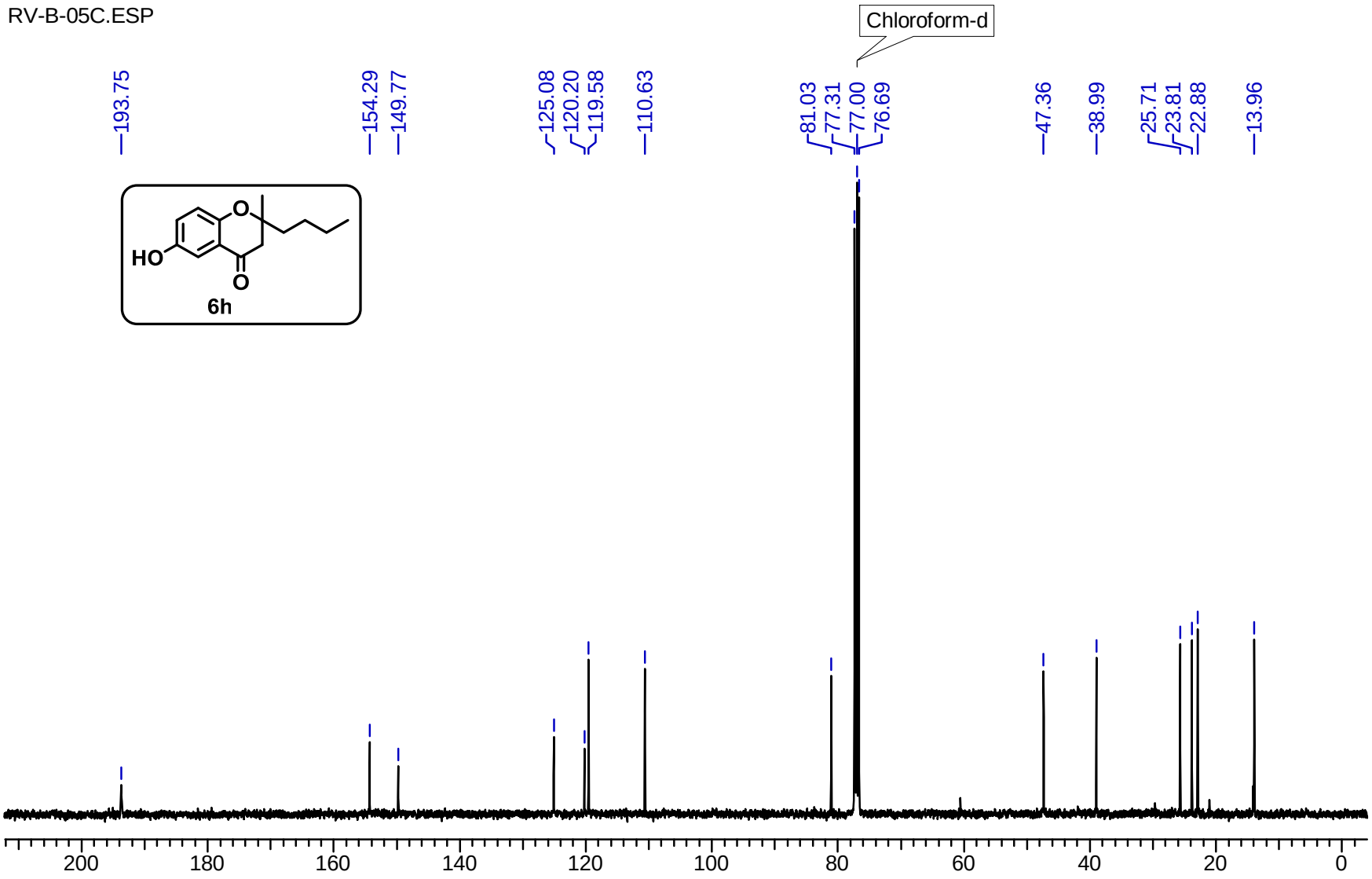
HRMS of compound *6g*:



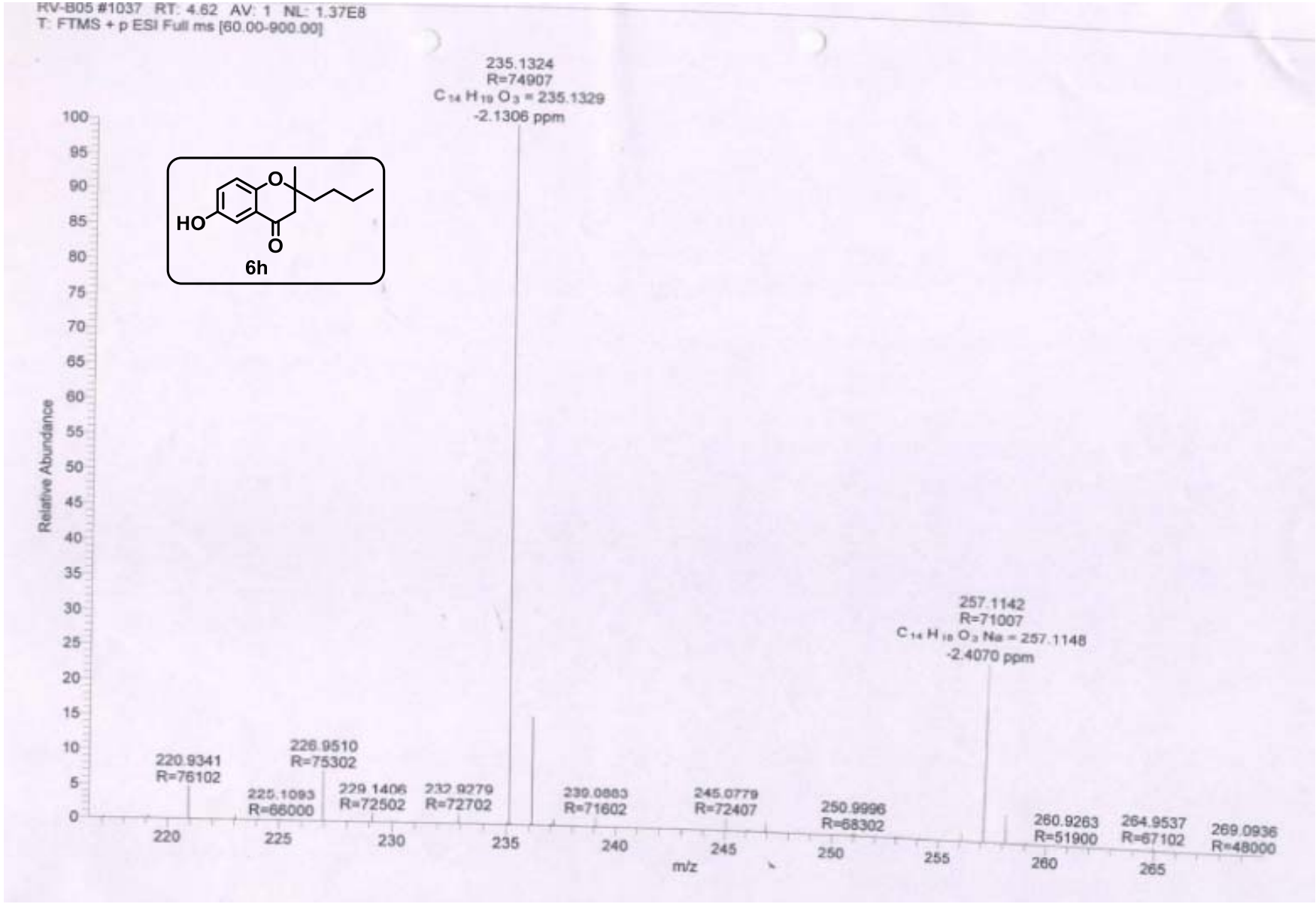
^{1}H NMR (200 MHz, $CDCl_3$) of compound *6h*:



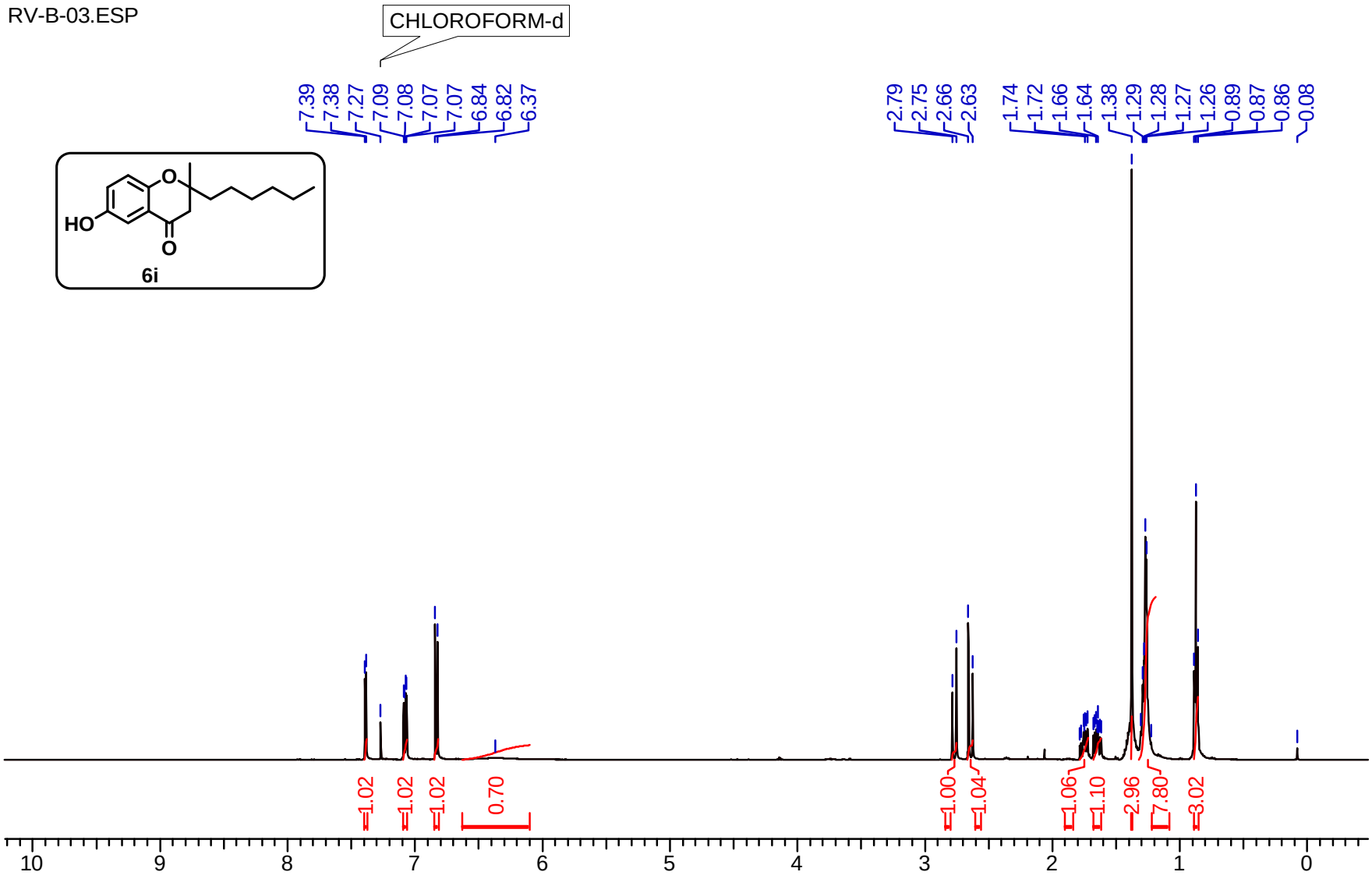
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6h*:



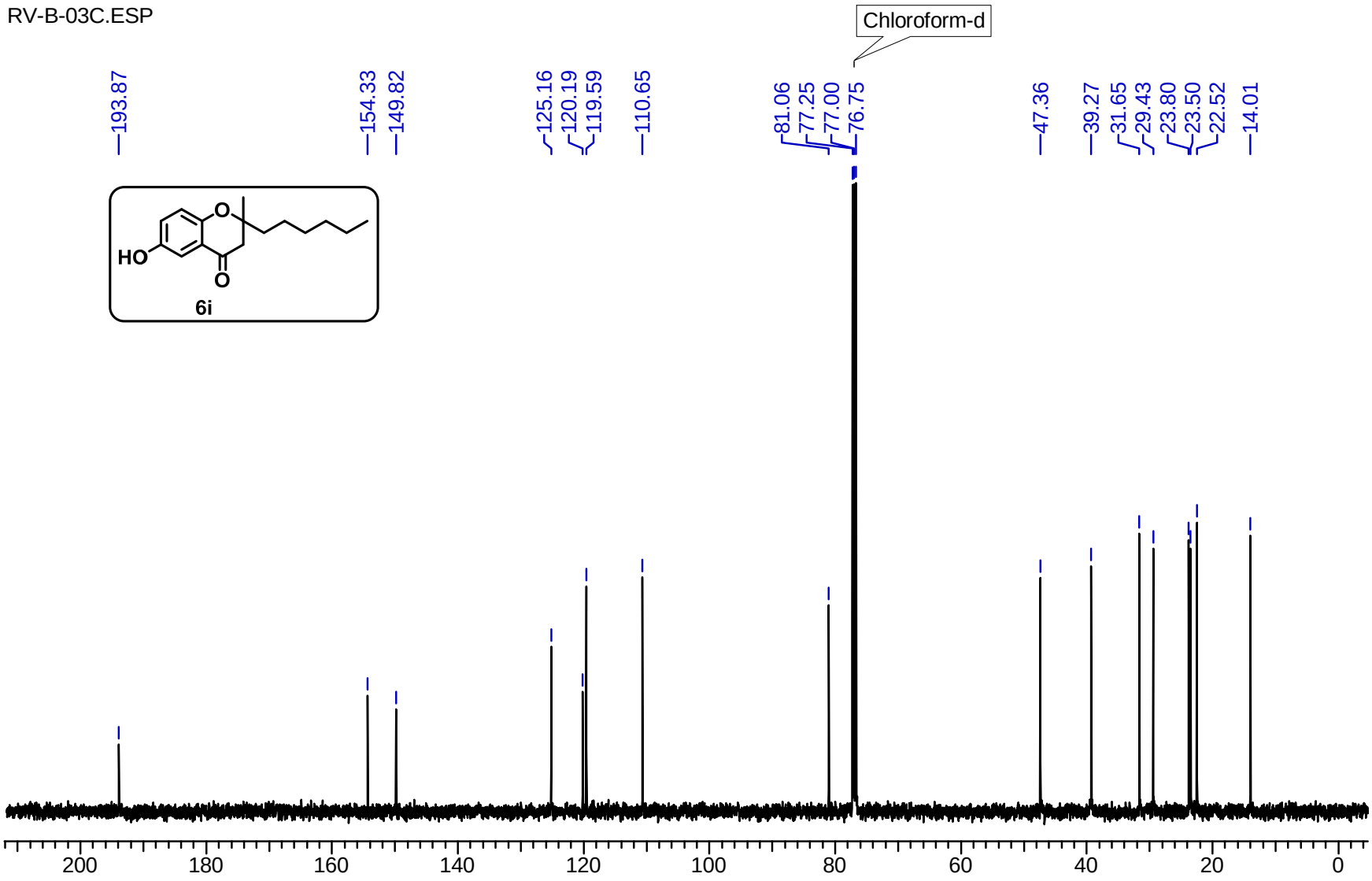
HRMS of compound *6h*:



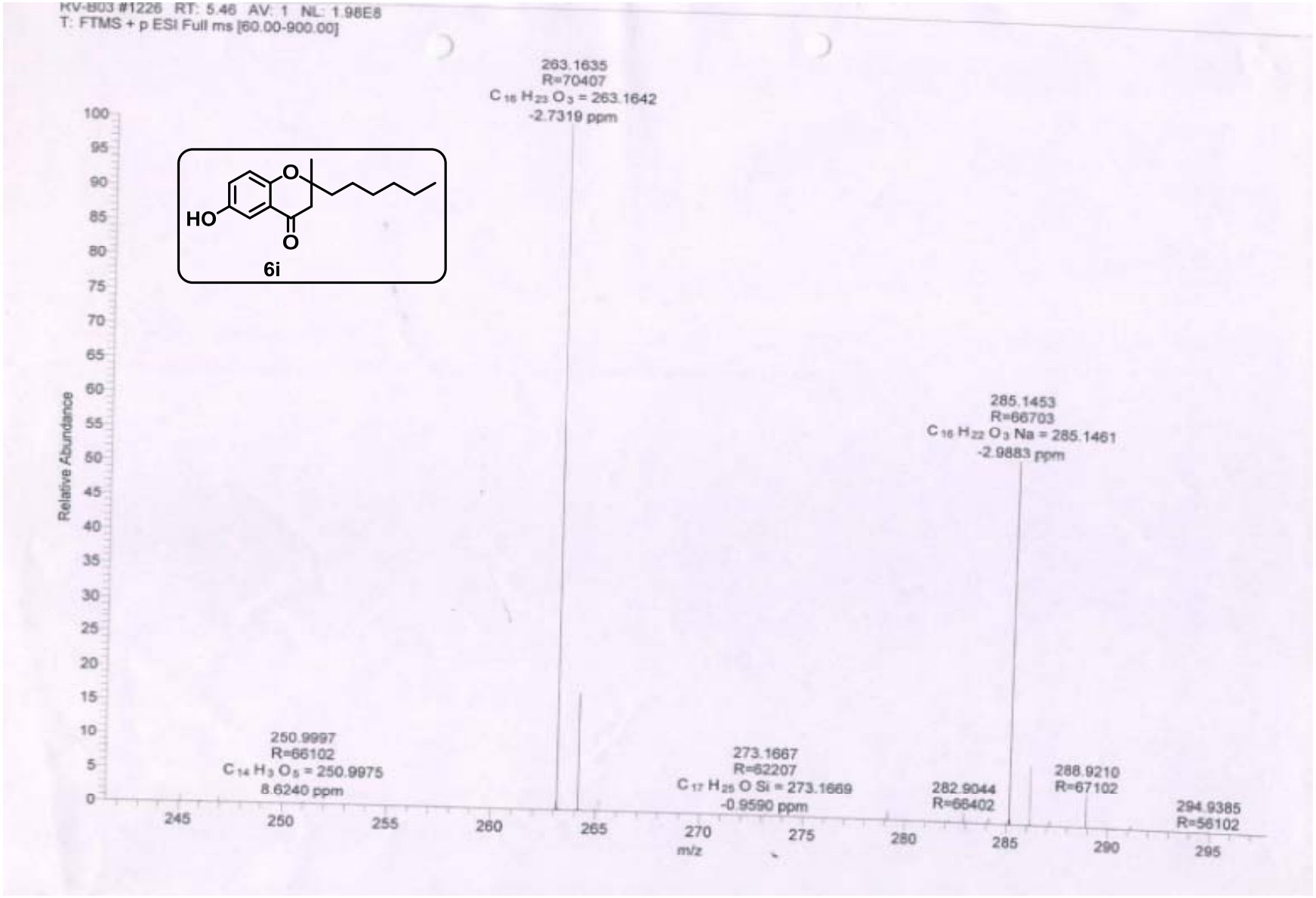
^{1}H NMR (500 MHz, $CDCl_3$) of compound *6i*:



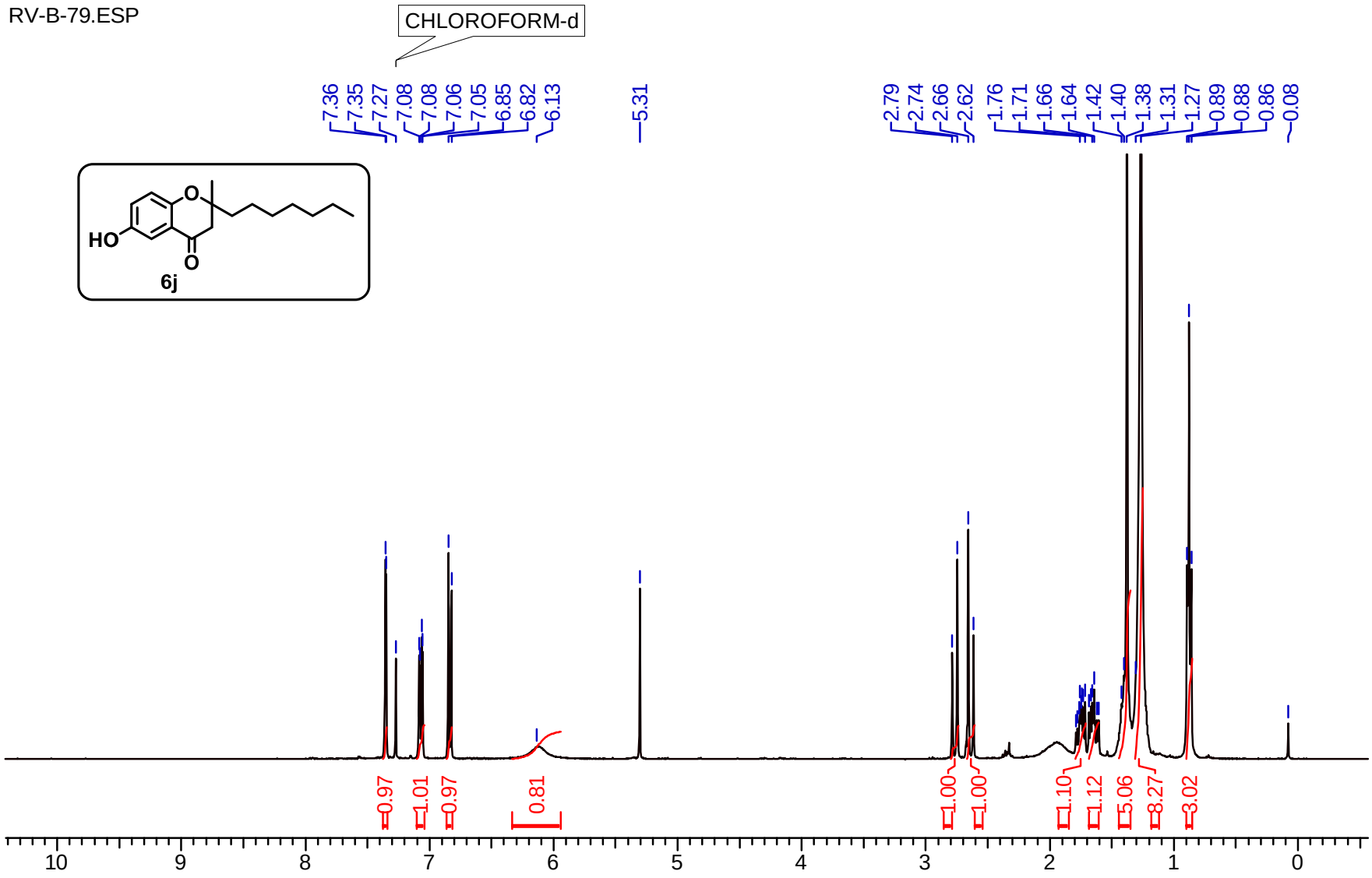
^{13}C NMR (125 MHz, $CDCl_3$) of compound *6i*:



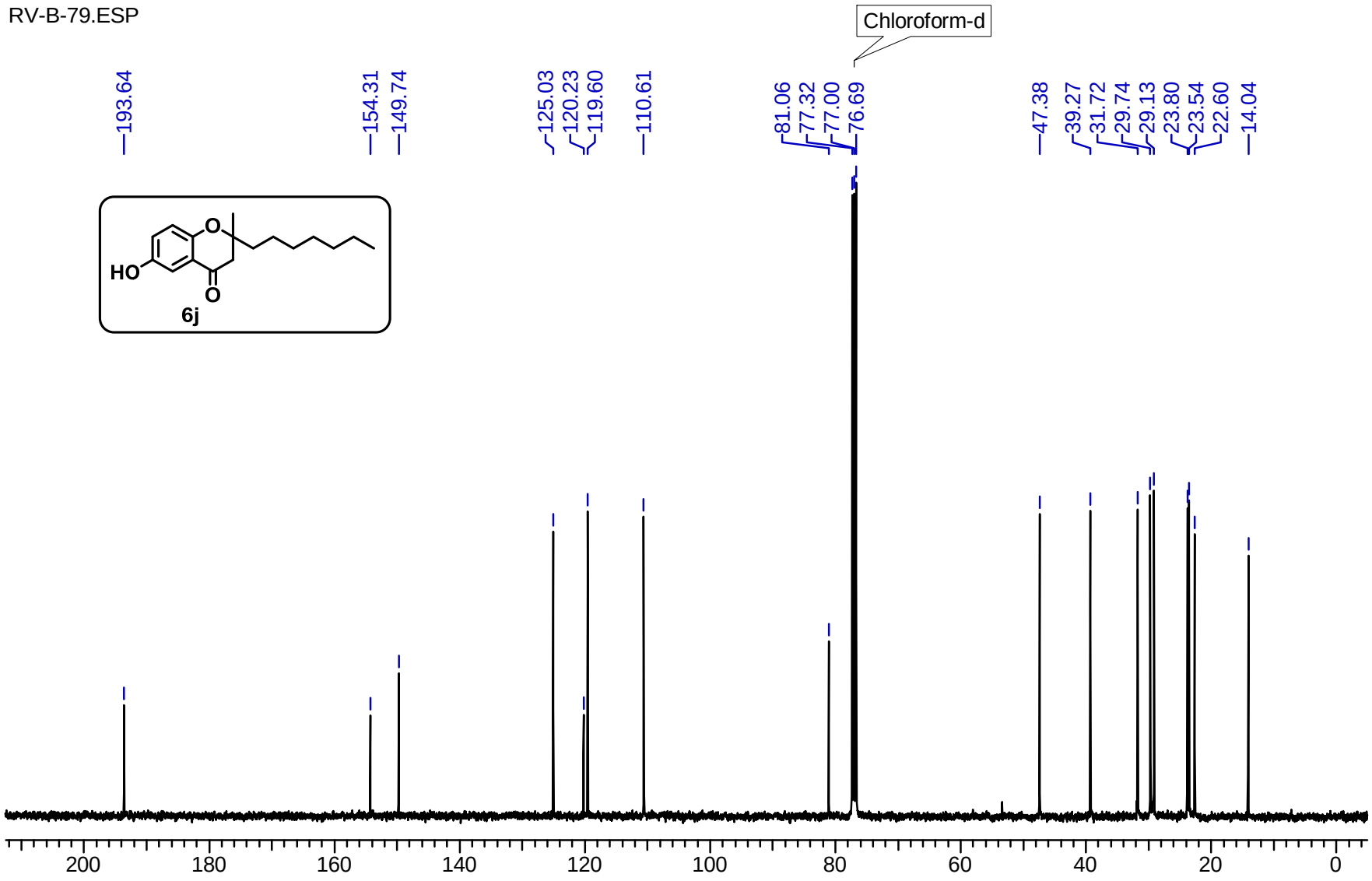
HRMS of compound *6i*:



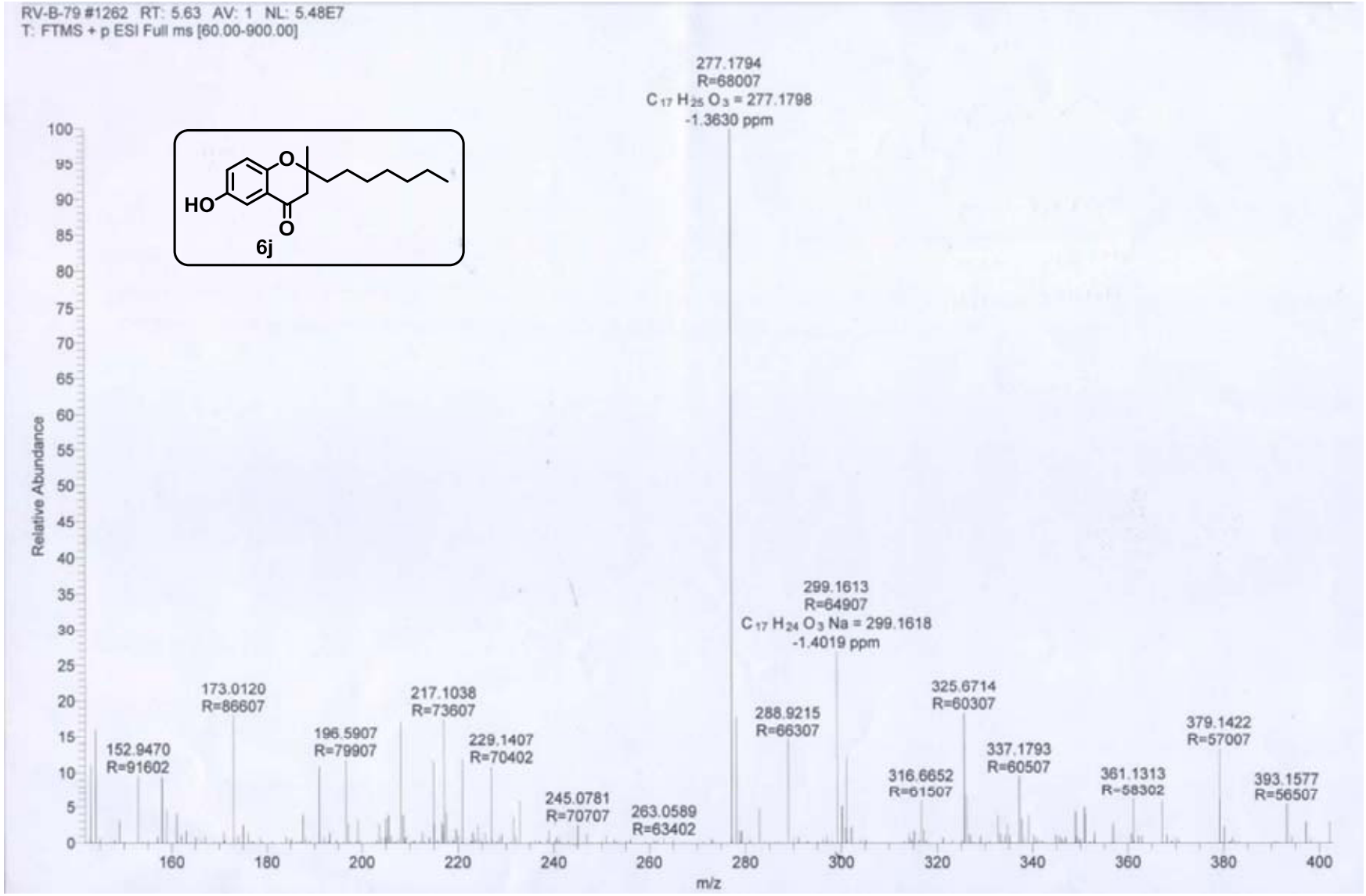
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6j*:



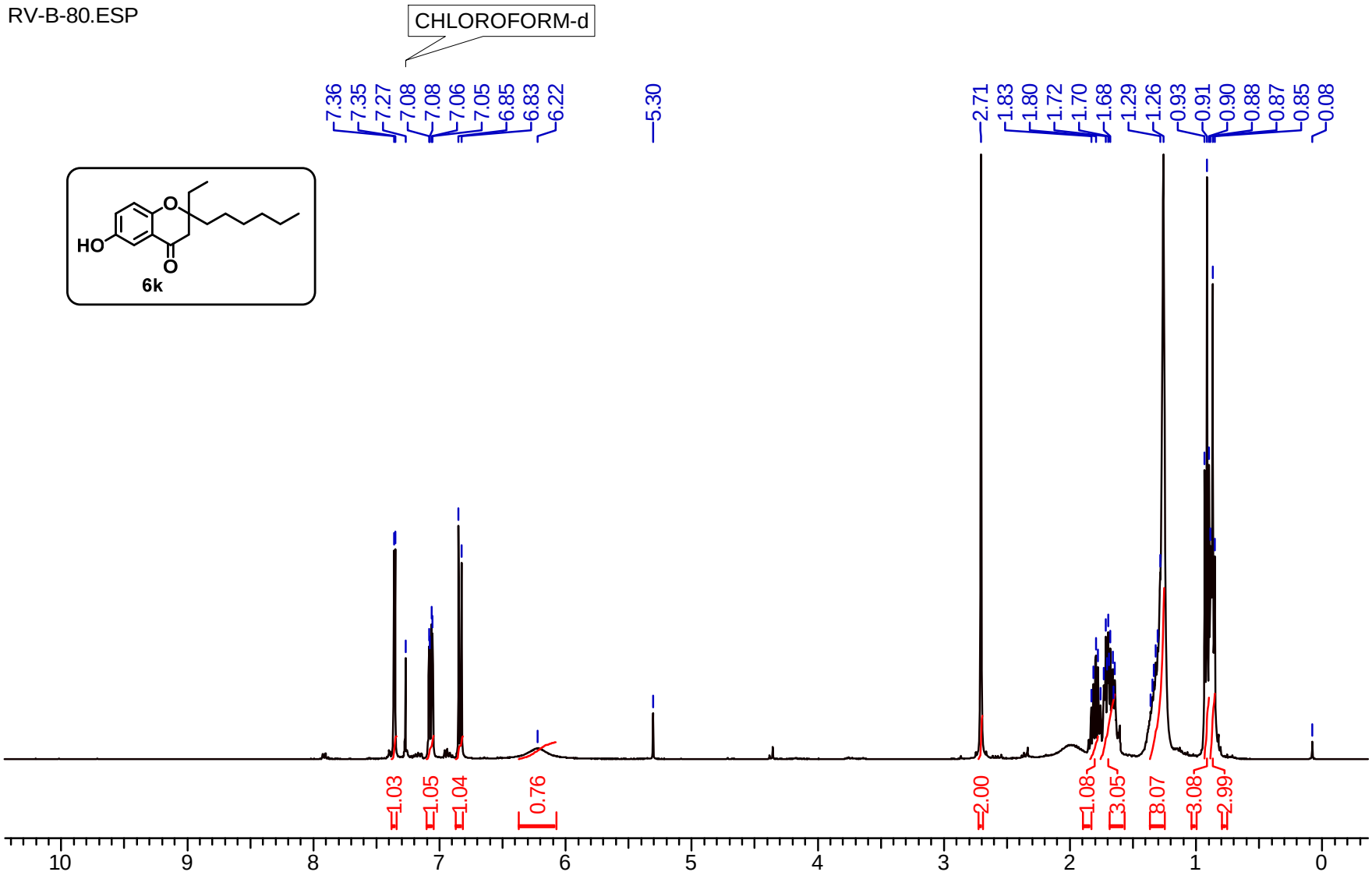
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6j*:



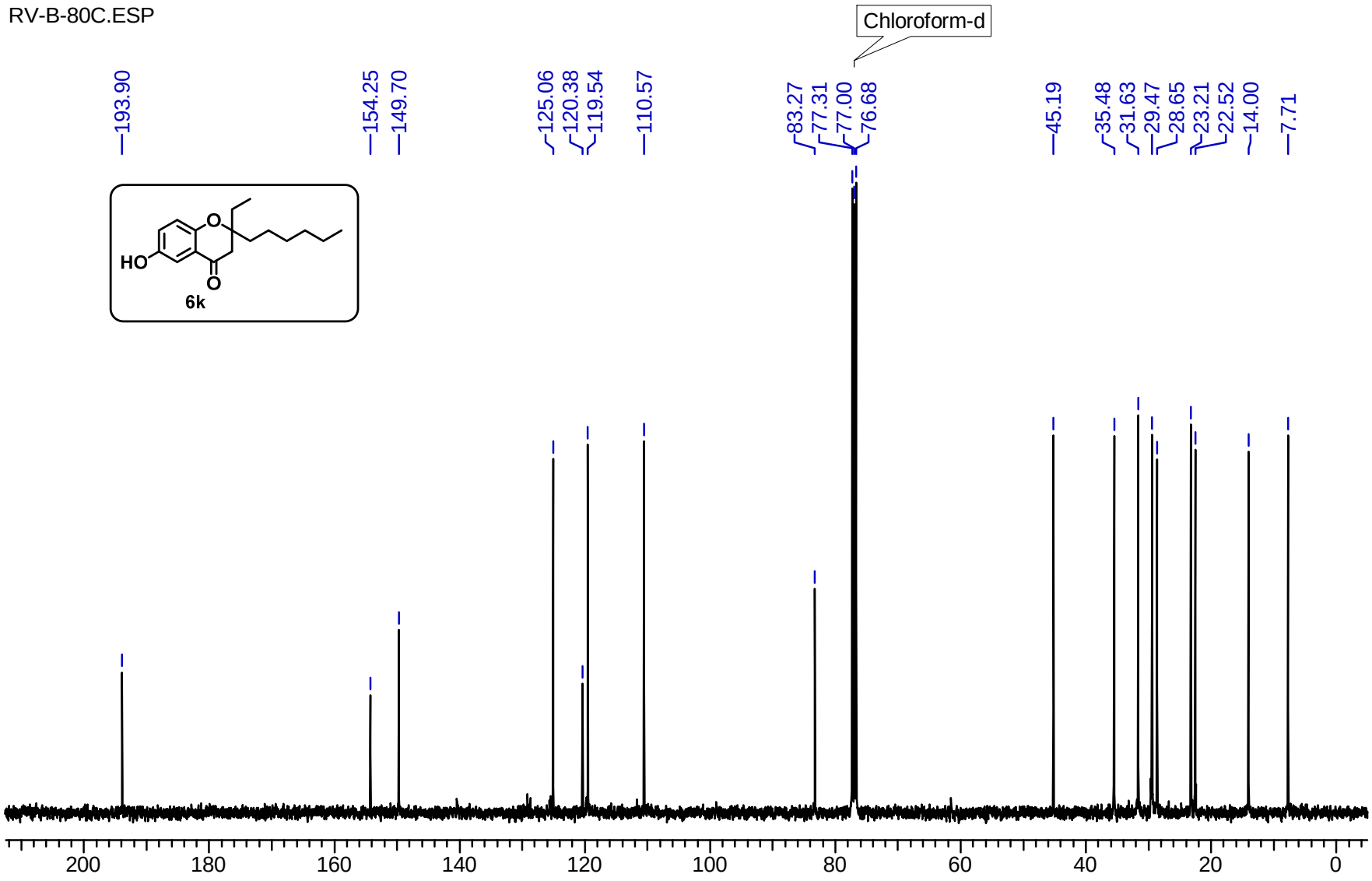
HRMS of compound *6j*:



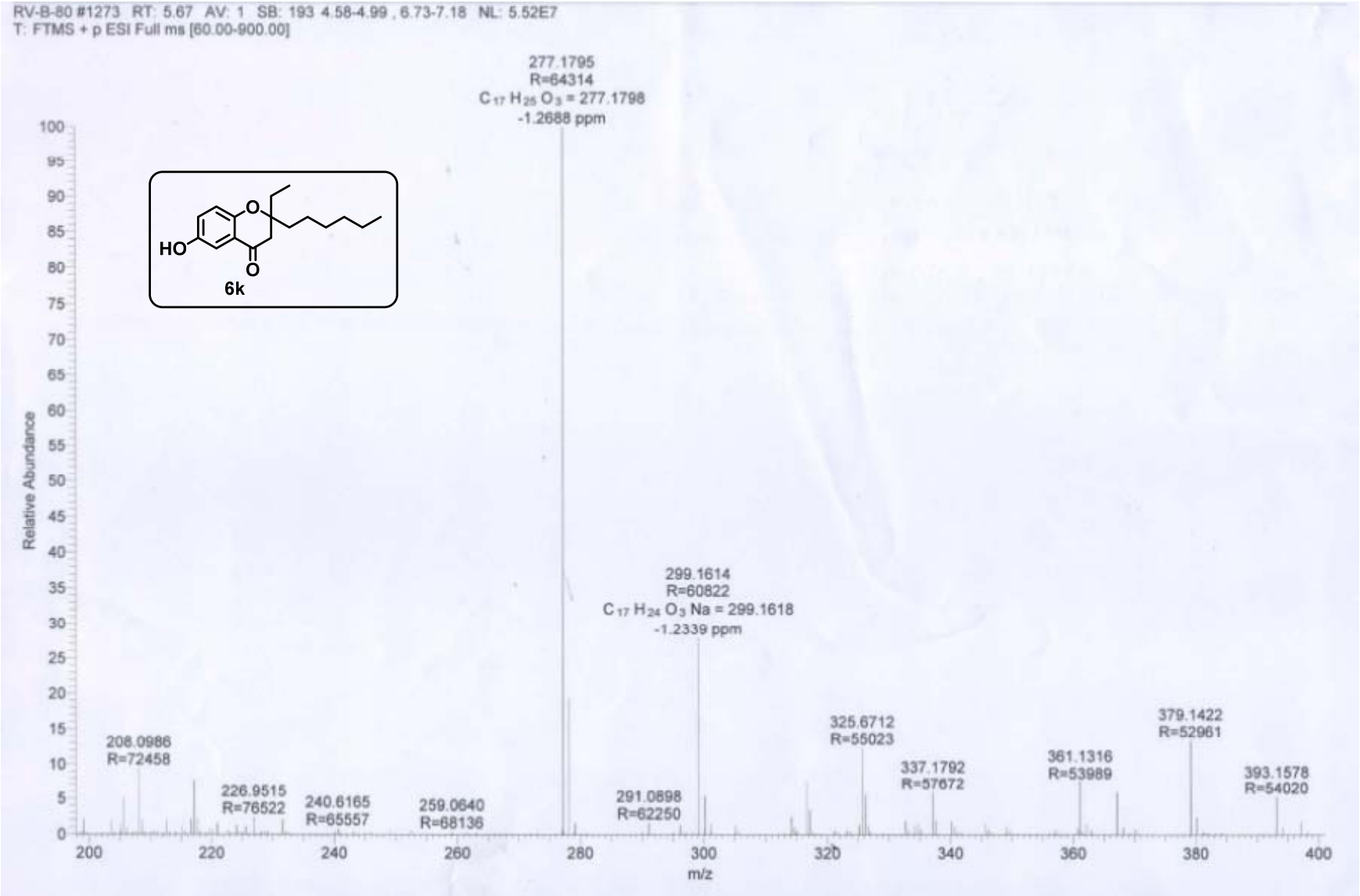
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6k*:



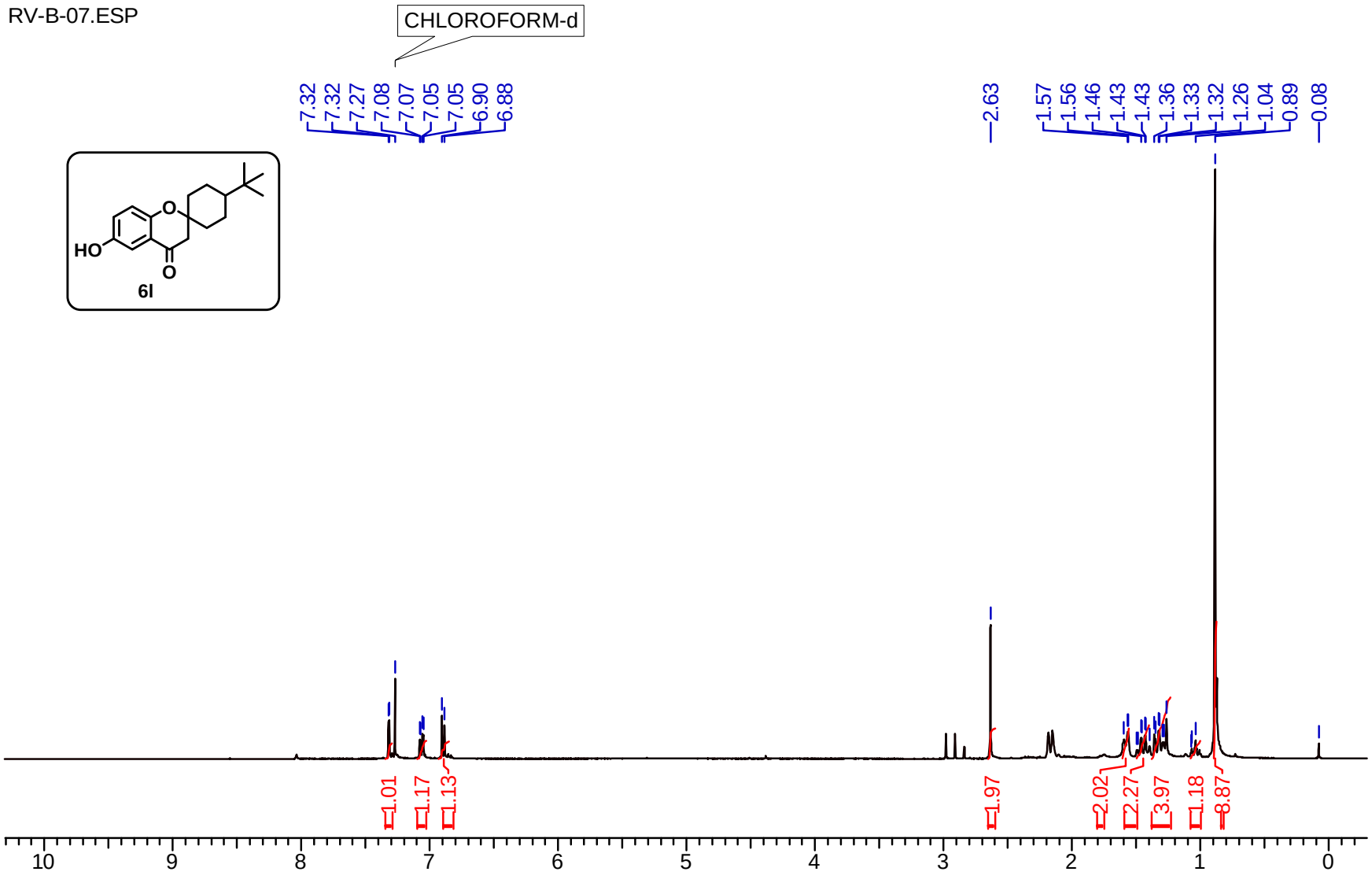
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6k*:



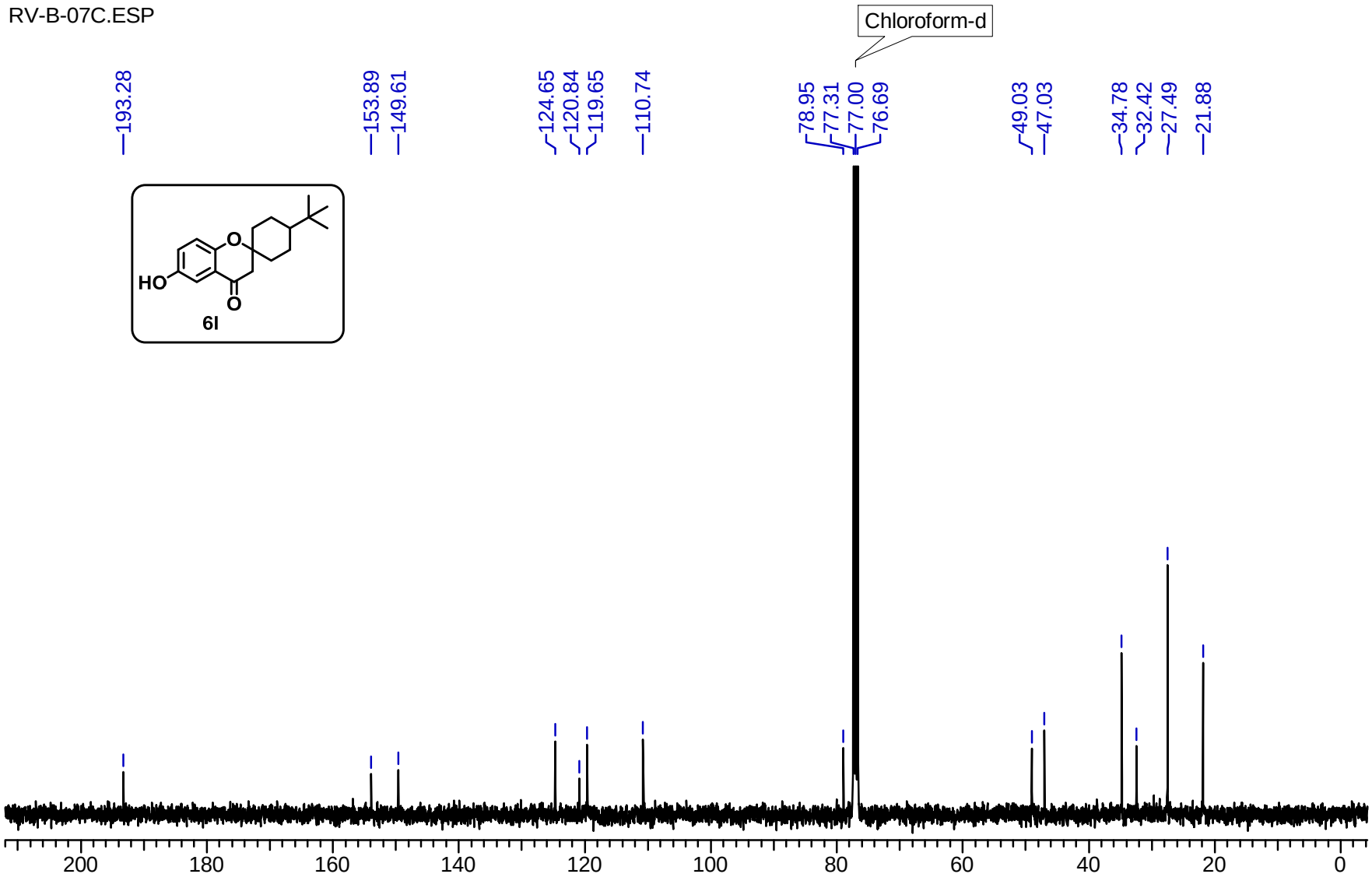
HRMS of compound *6k*:



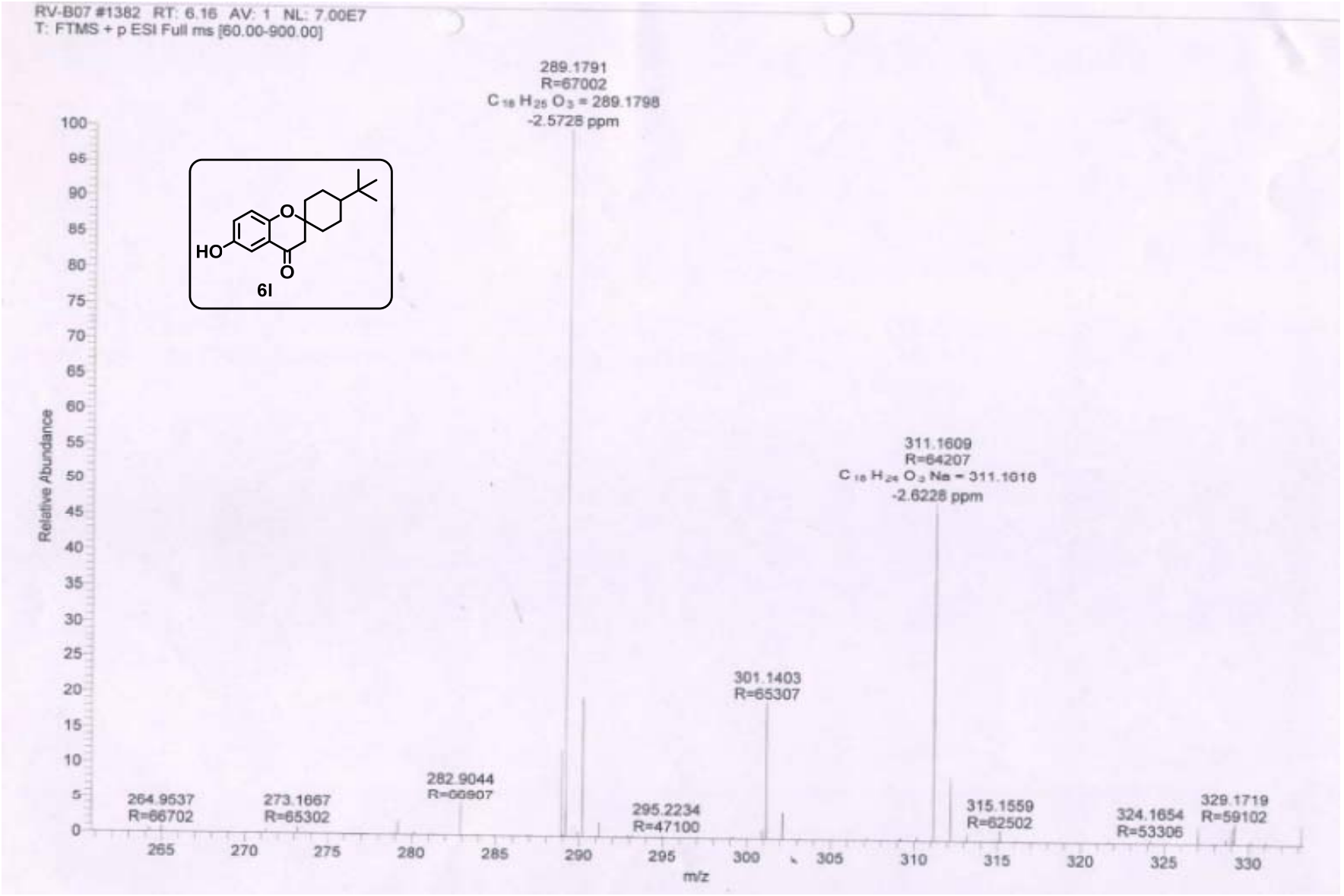
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6l*:



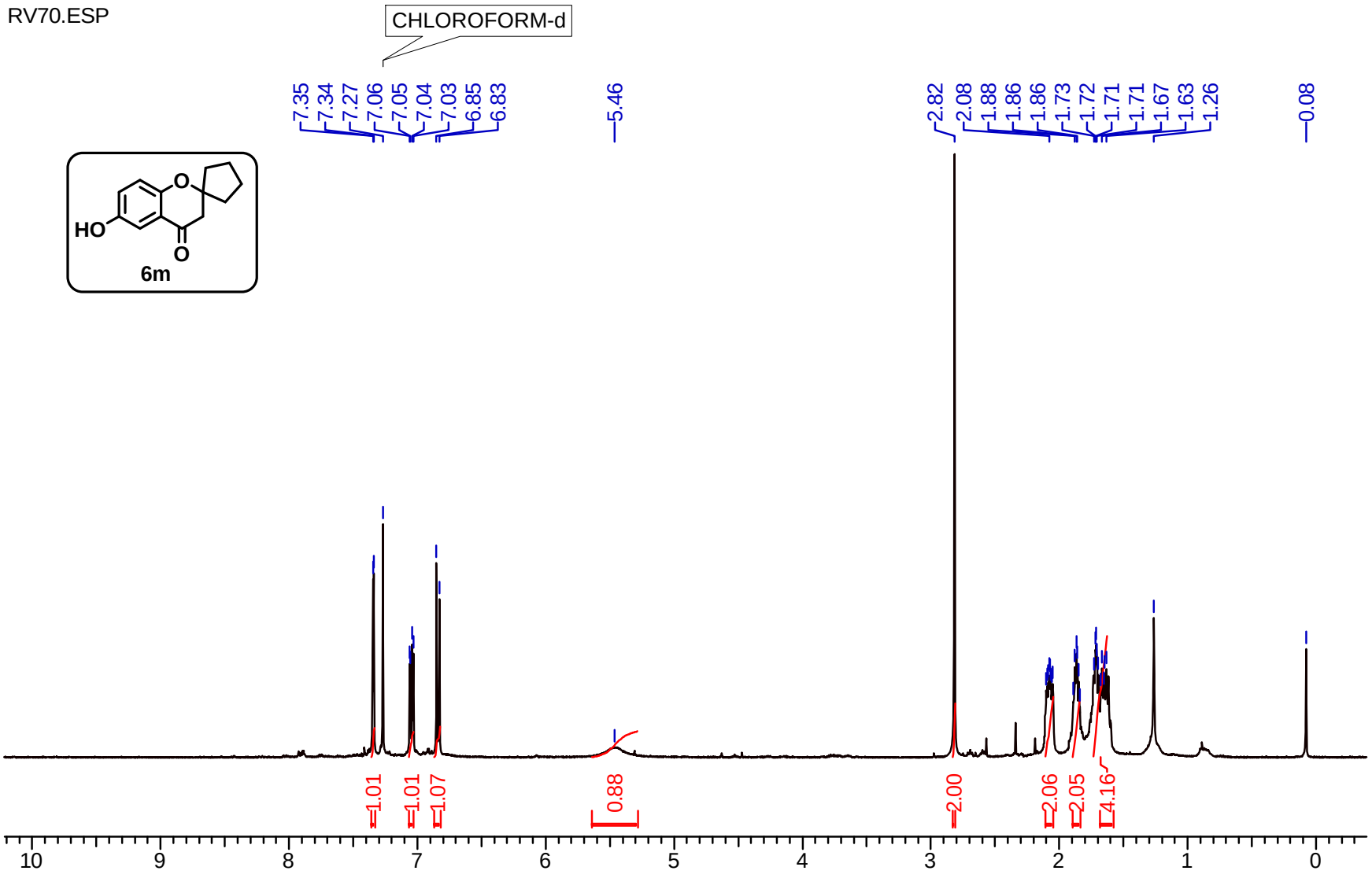
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6l*:



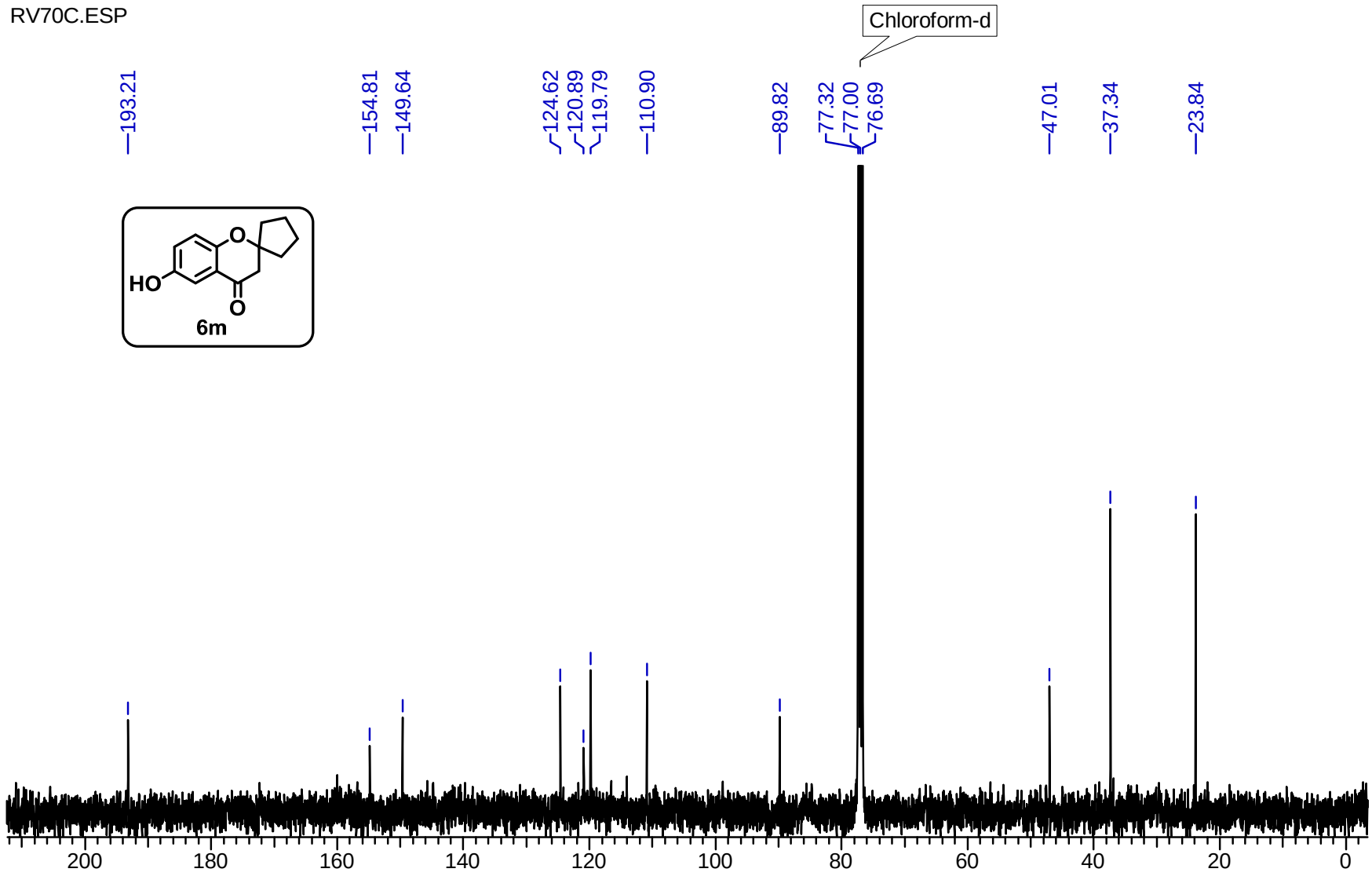
HRMS of compound *6l*:



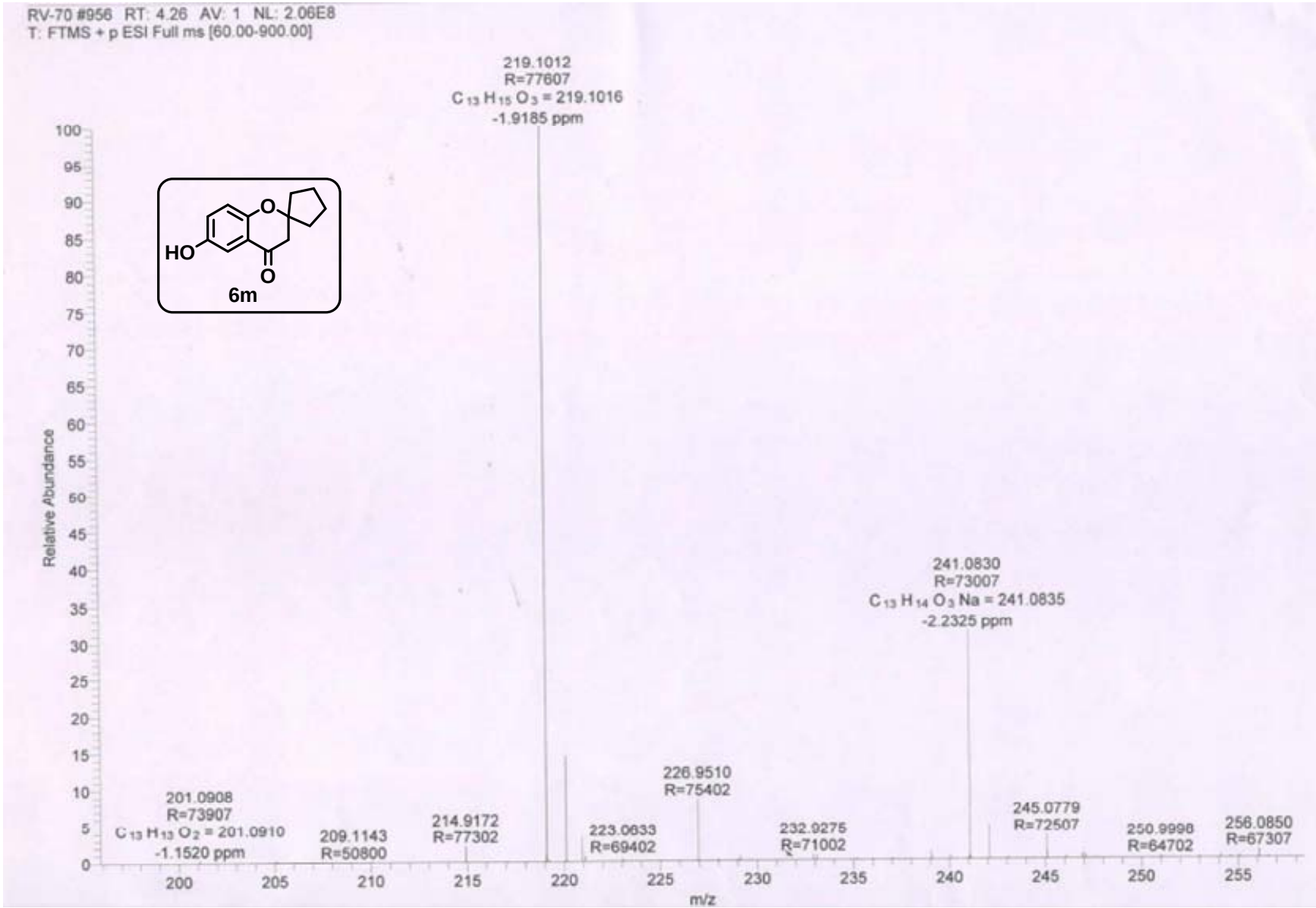
^{1}H NMR (400 MHz, CDCl3) of compound *6m*:



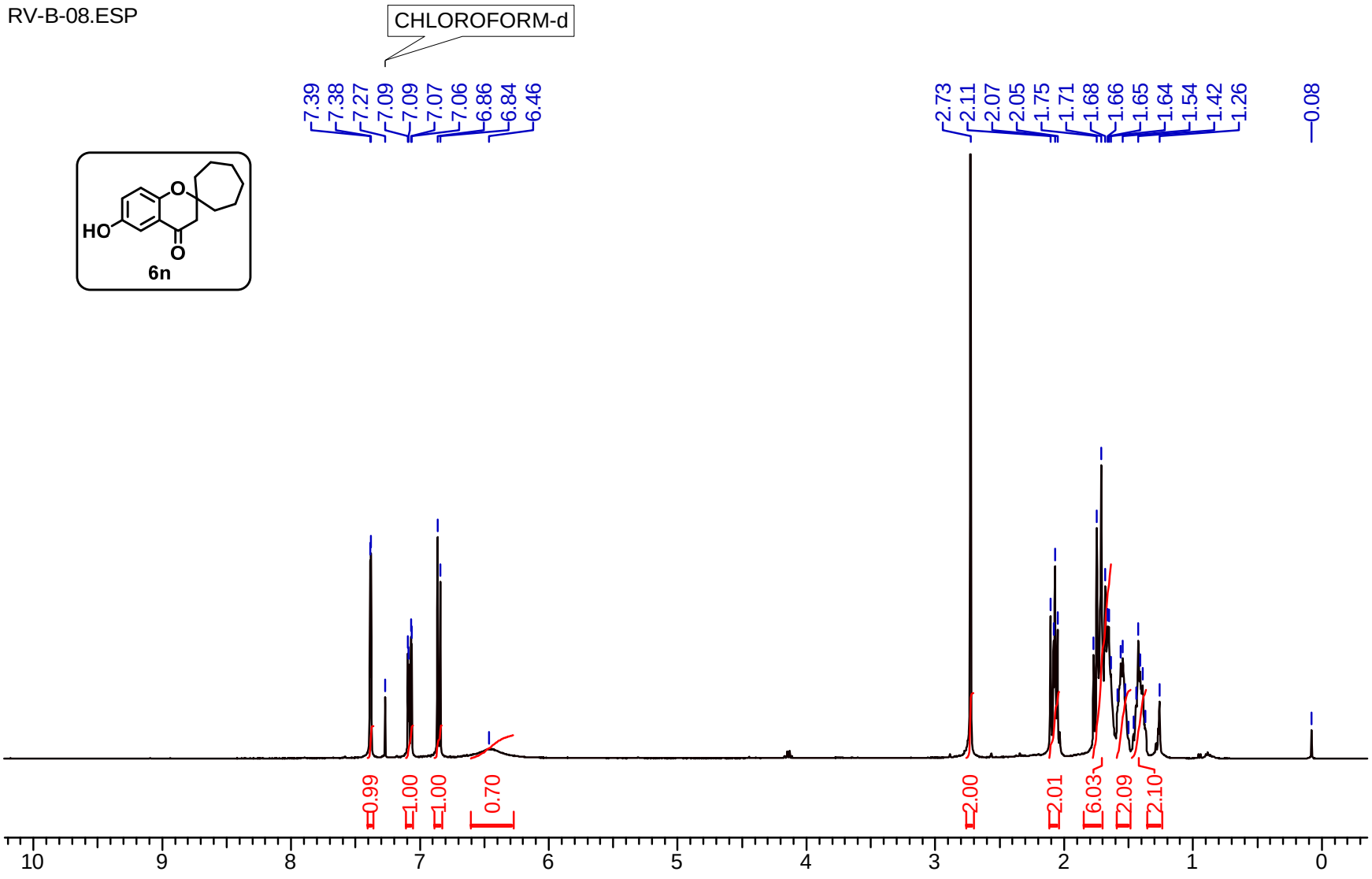
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6m*:



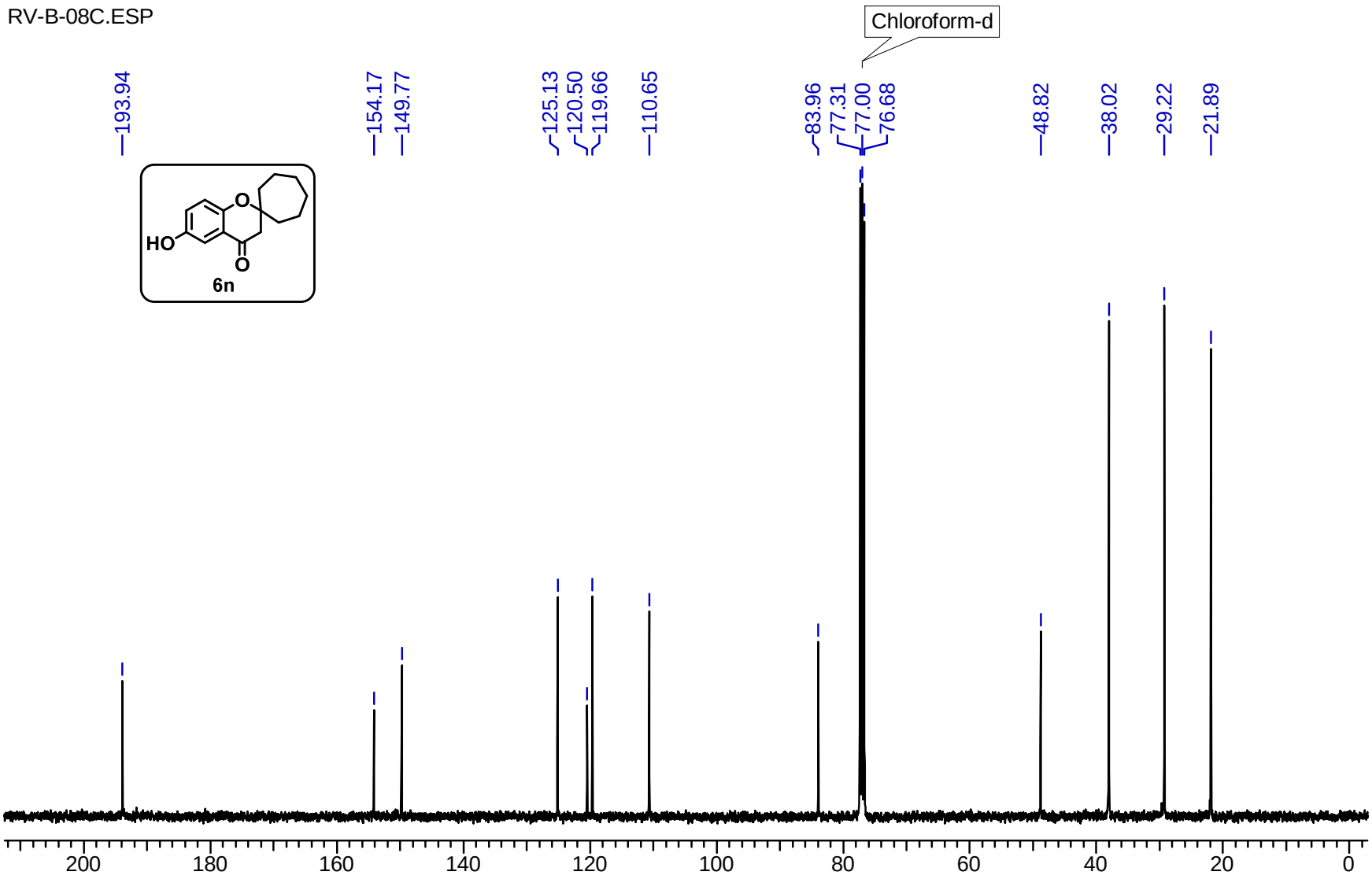
HRMS of compound *6m*:



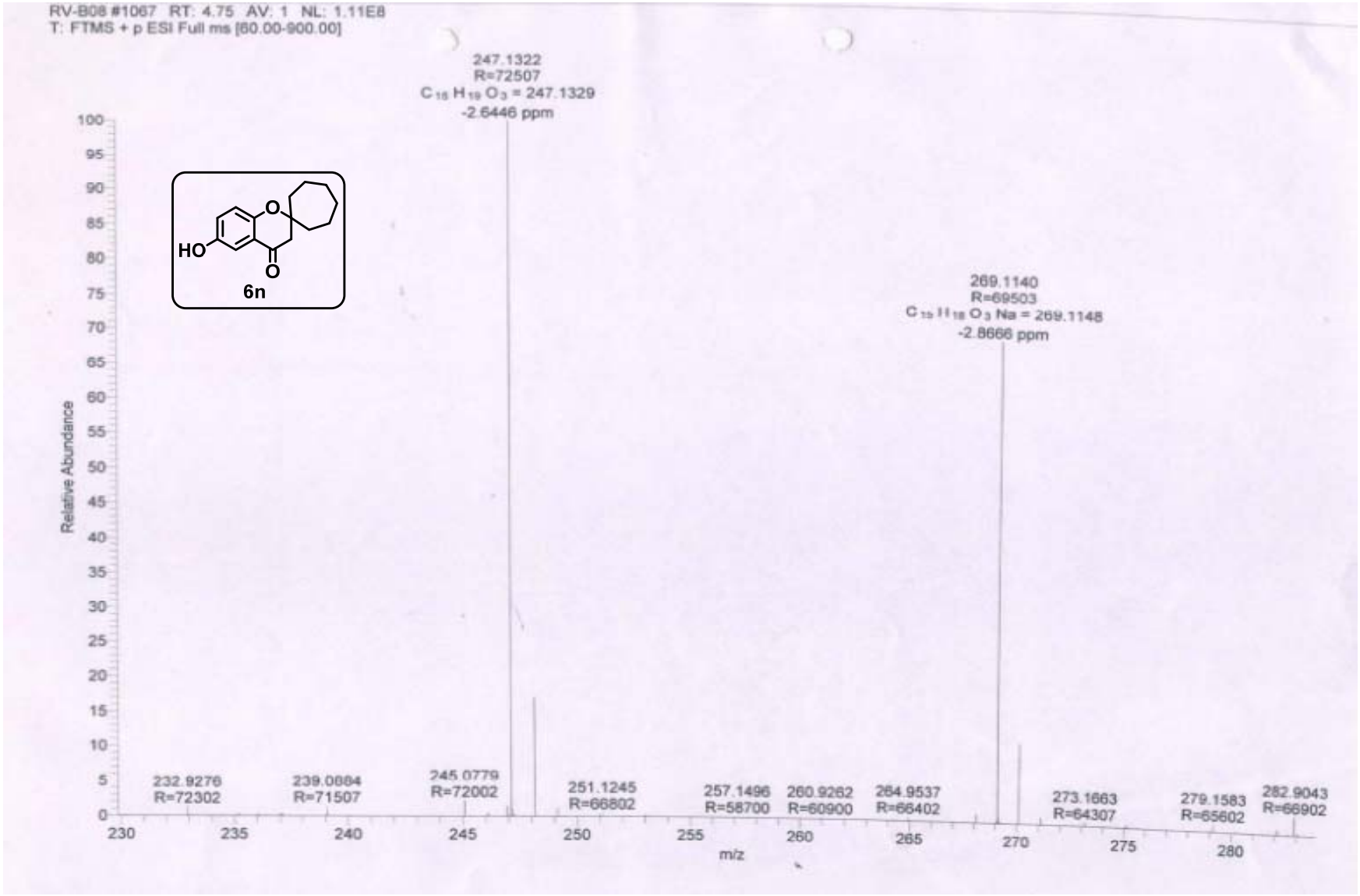
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6n*:



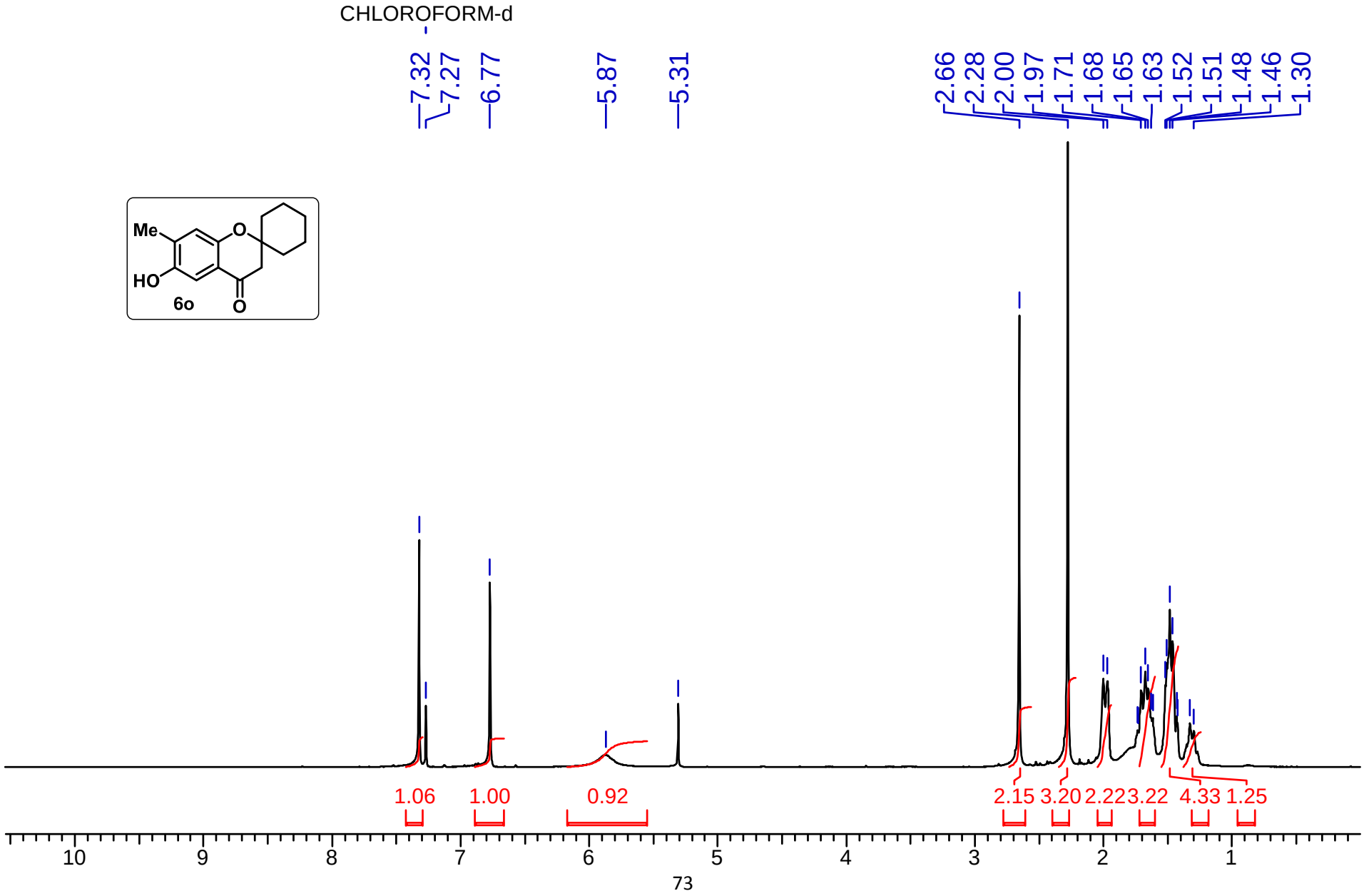
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6n*:



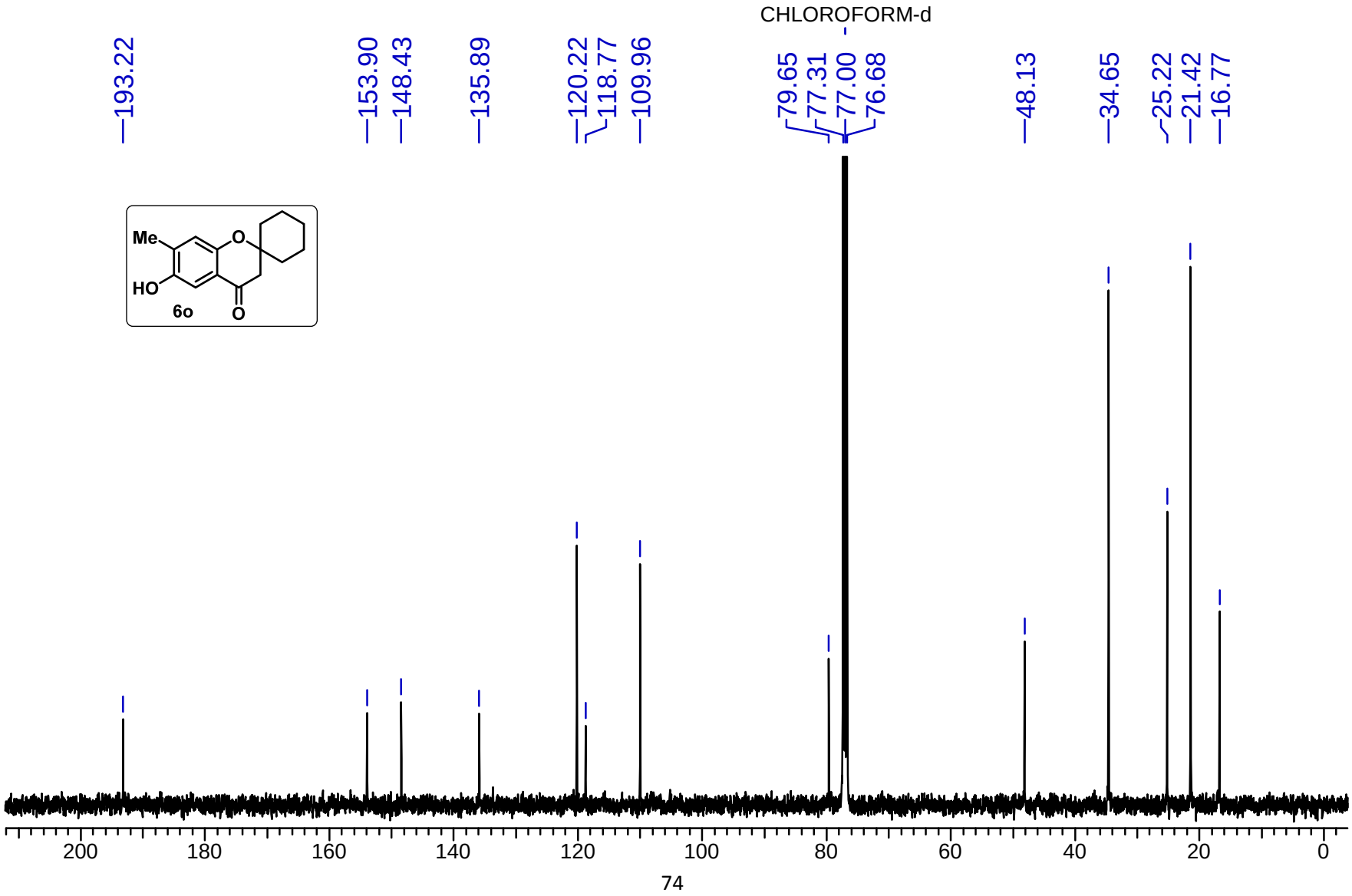
HRMS of compound *6n*:



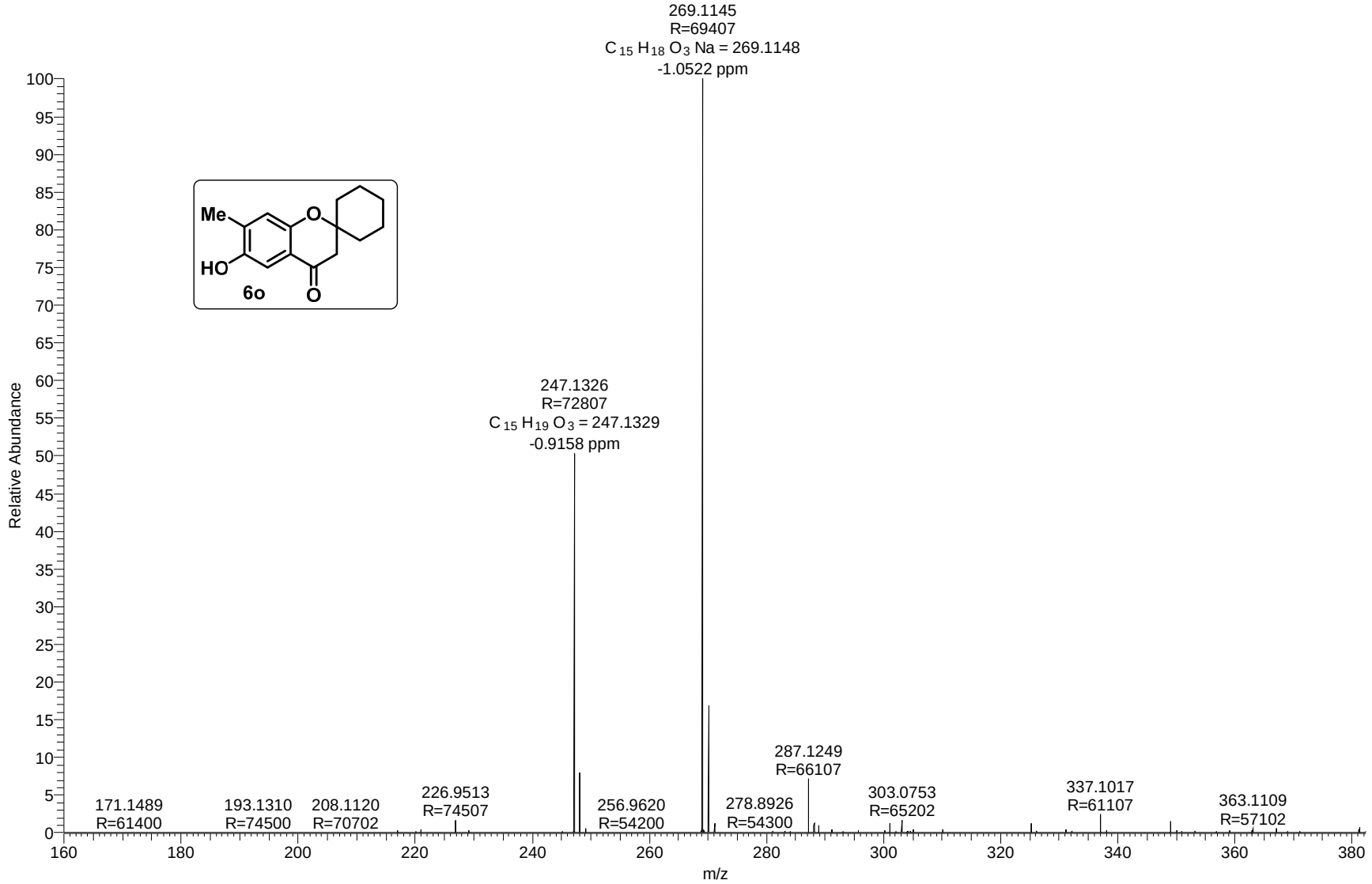
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6o*:



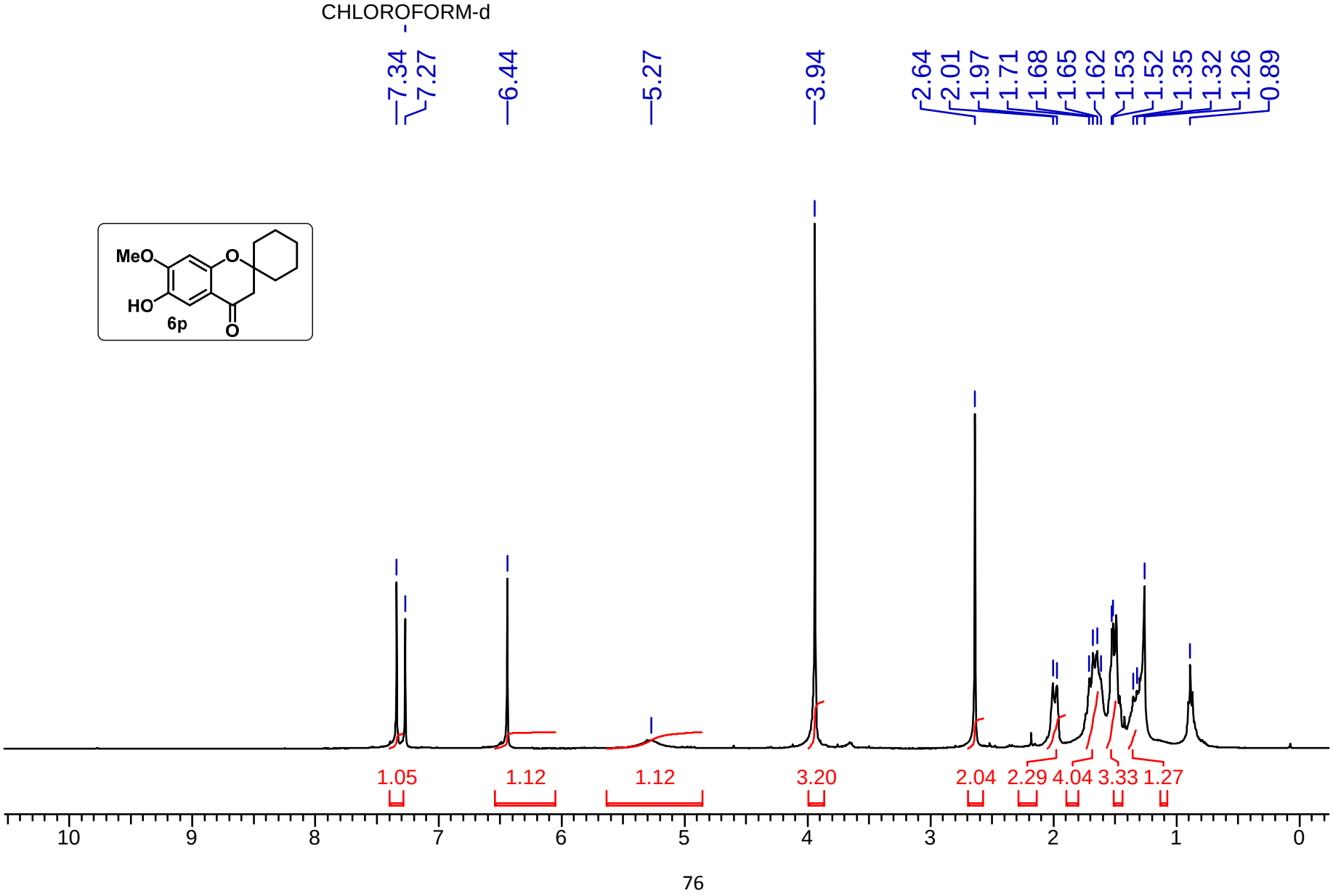
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6o*



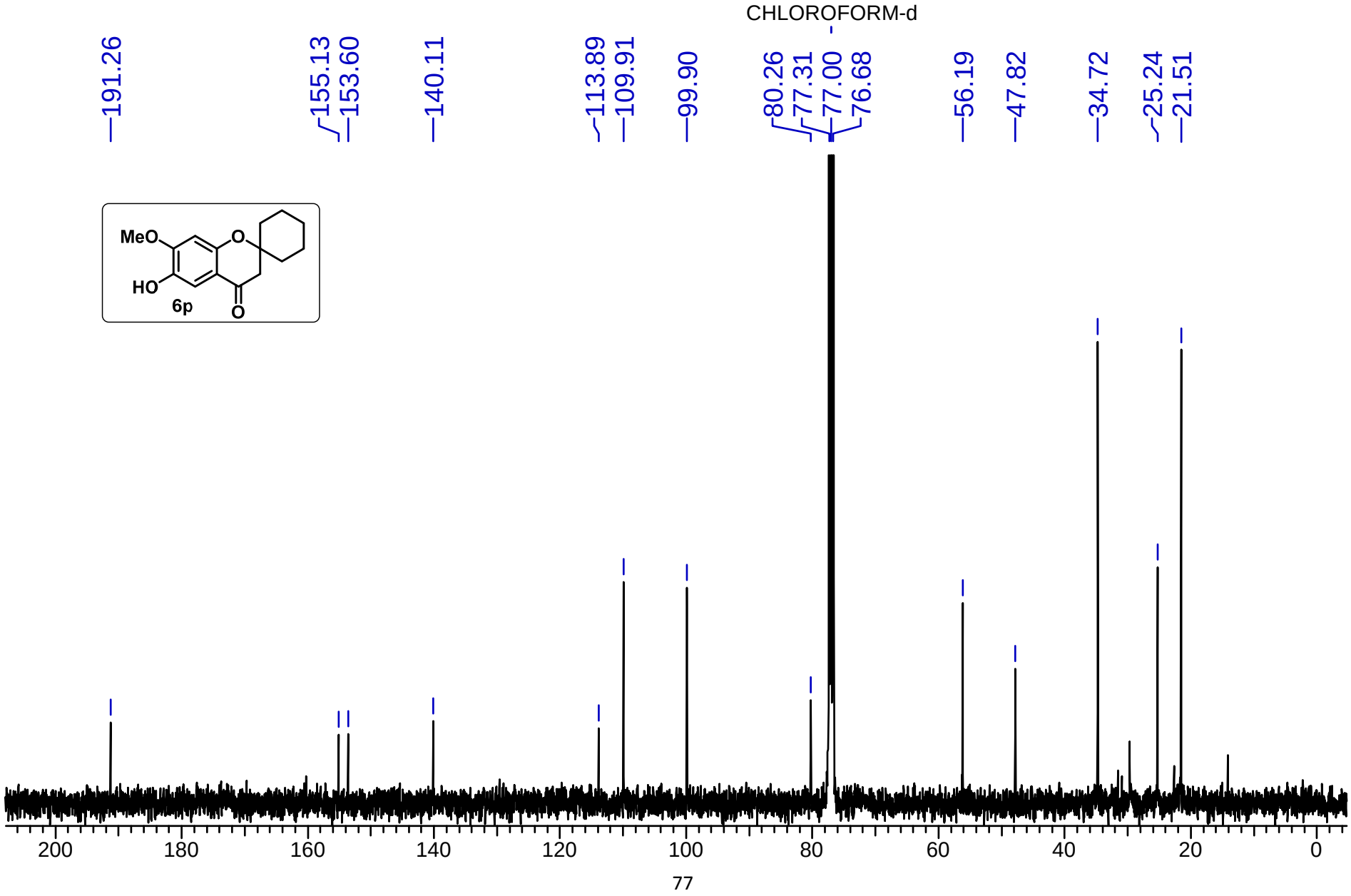
HRMS of compound *6o*:



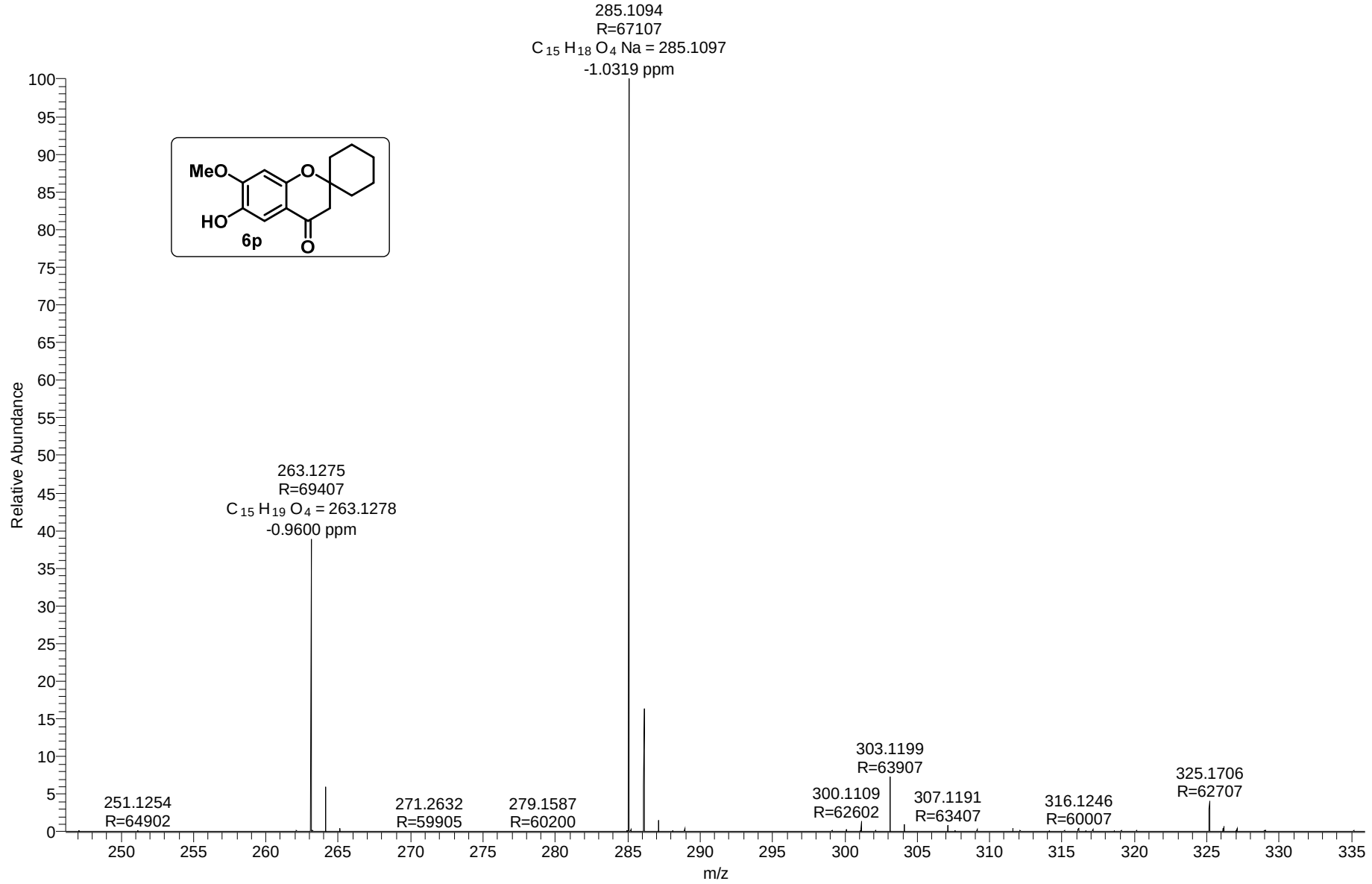
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6p*:



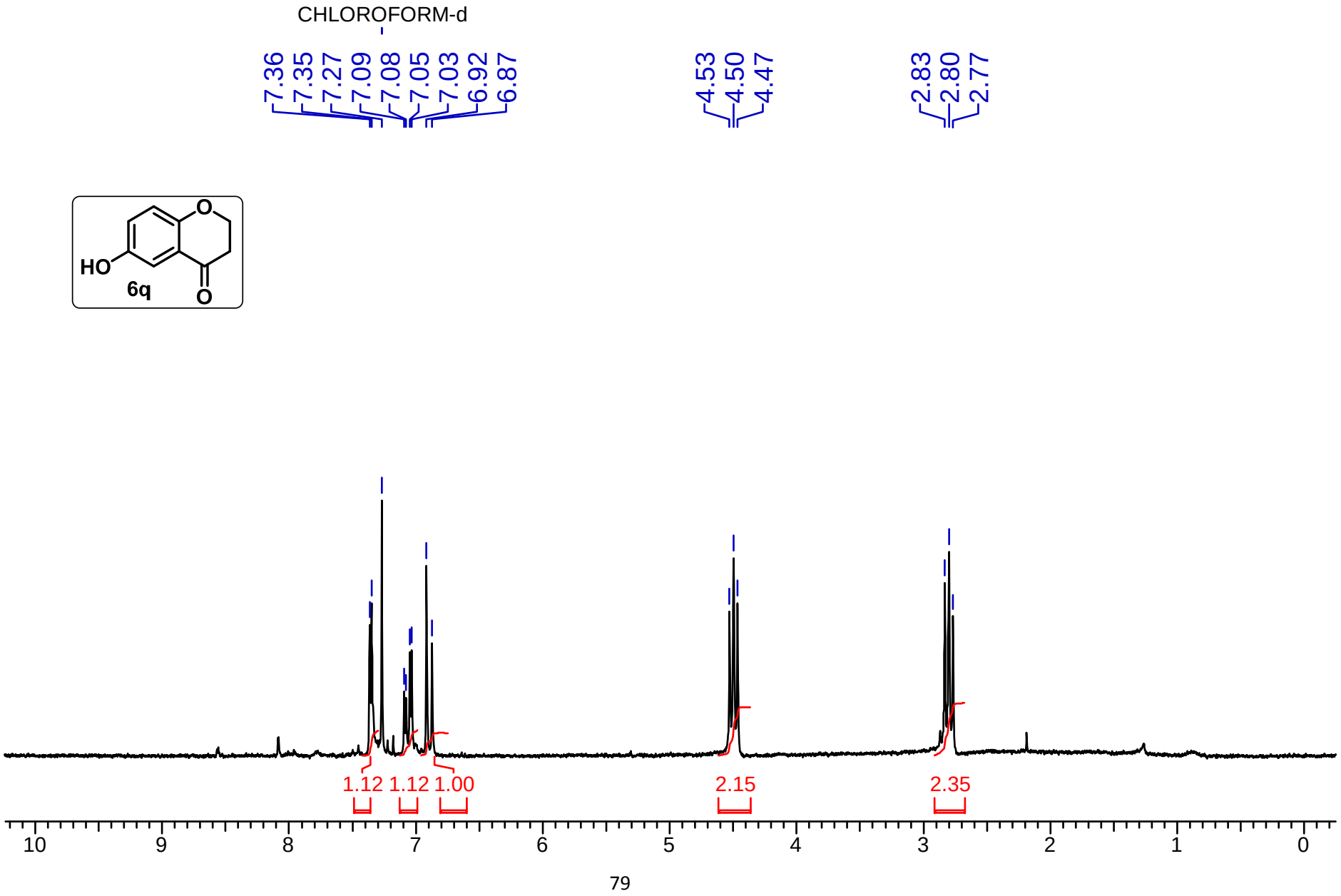
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6p:*



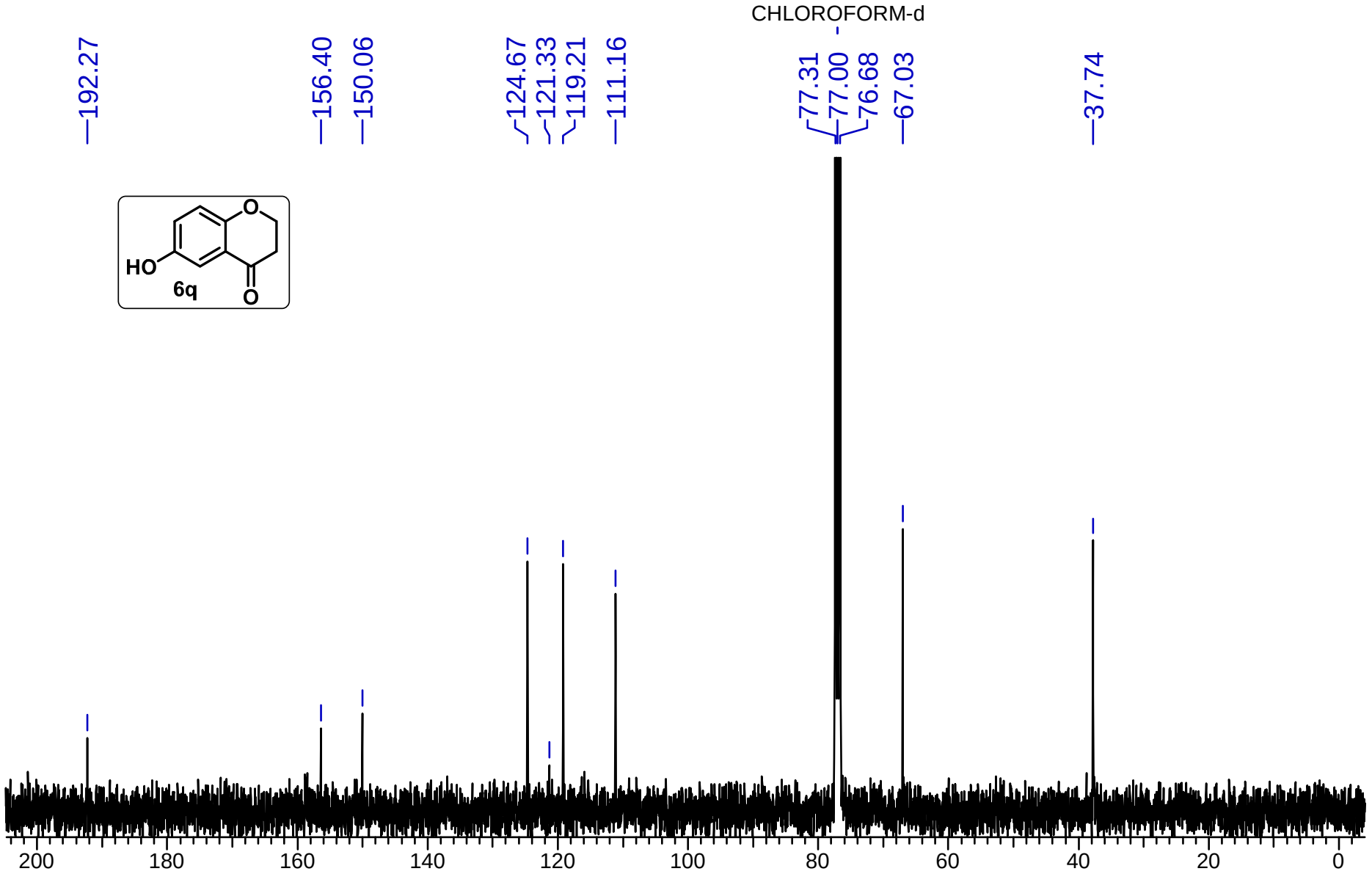
HRMS of compound *6p*:



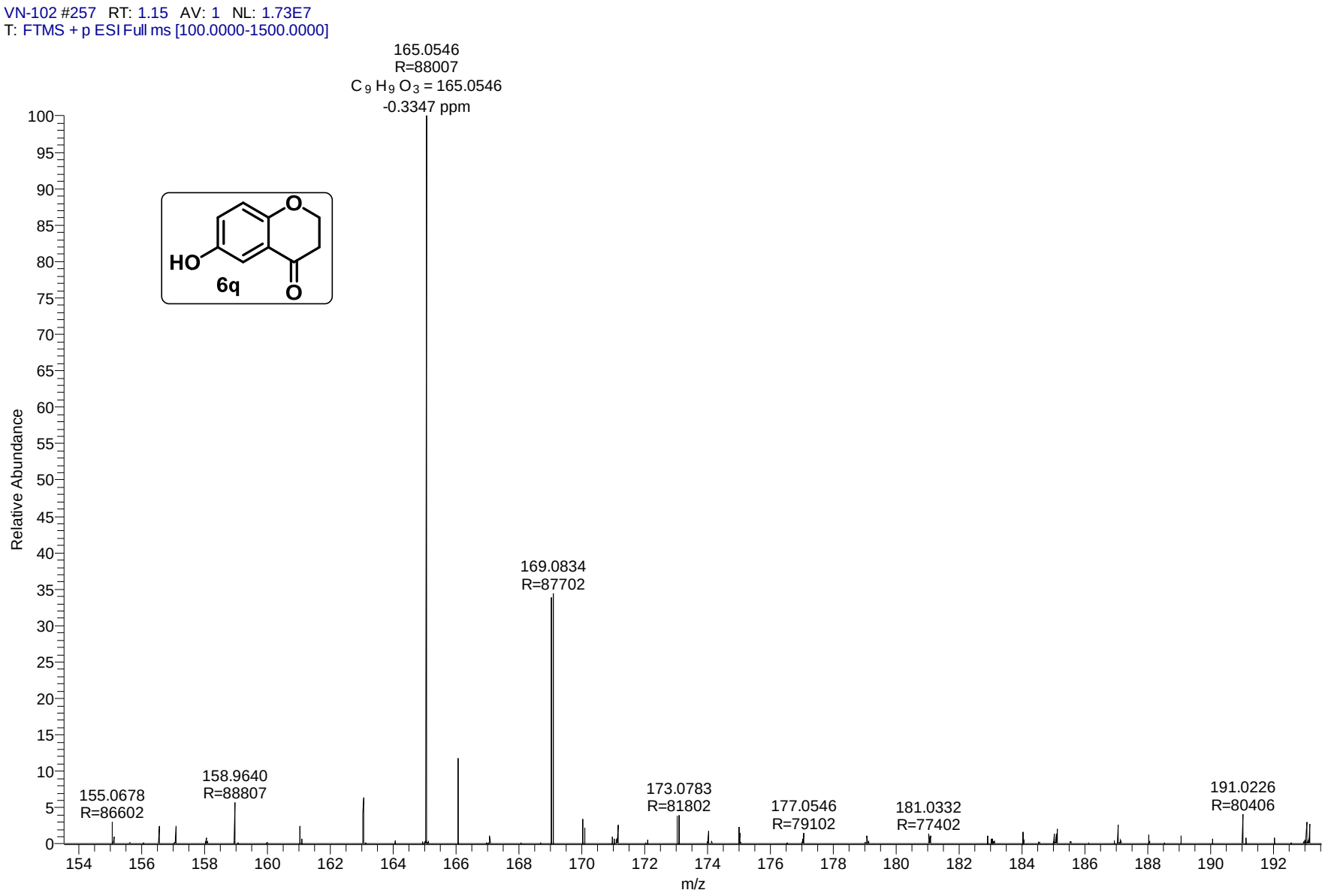
^{1}H NMR (400 MHz, $CDCl_3$) of compound *6q*:



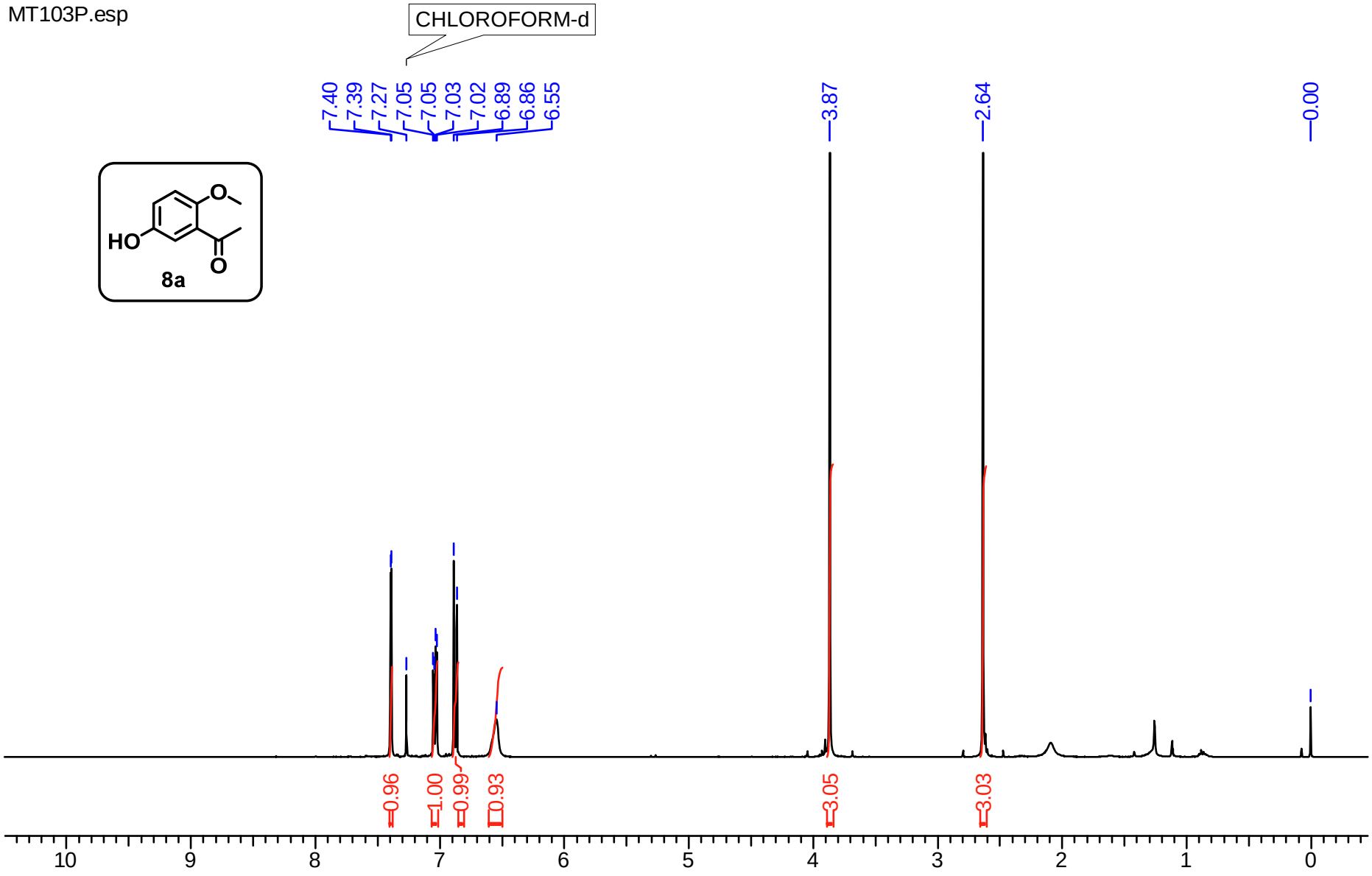
^{13}C NMR (100 MHz, $CDCl_3$) of compound *6q:*



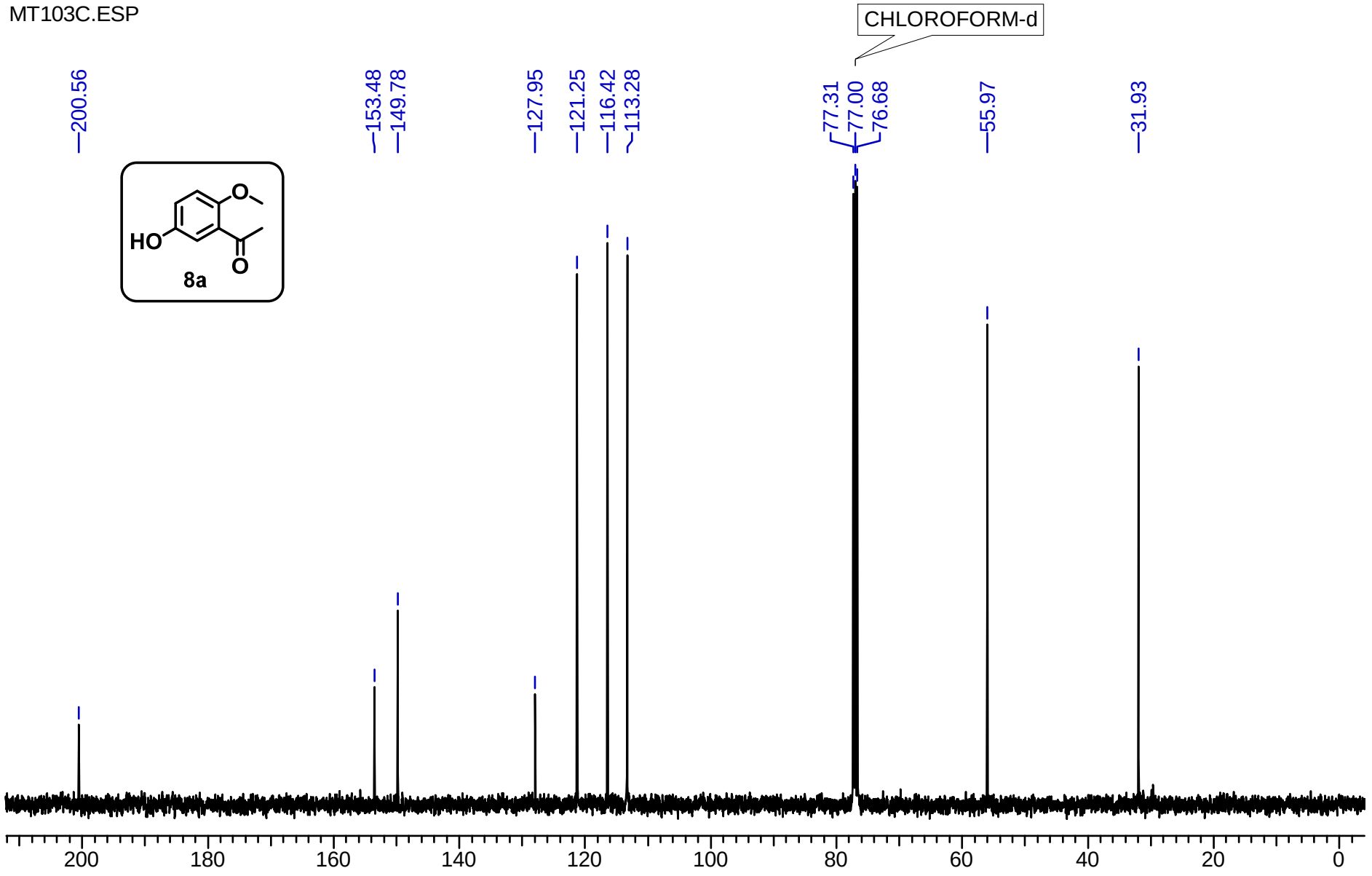
HRMS of compound *6q*:



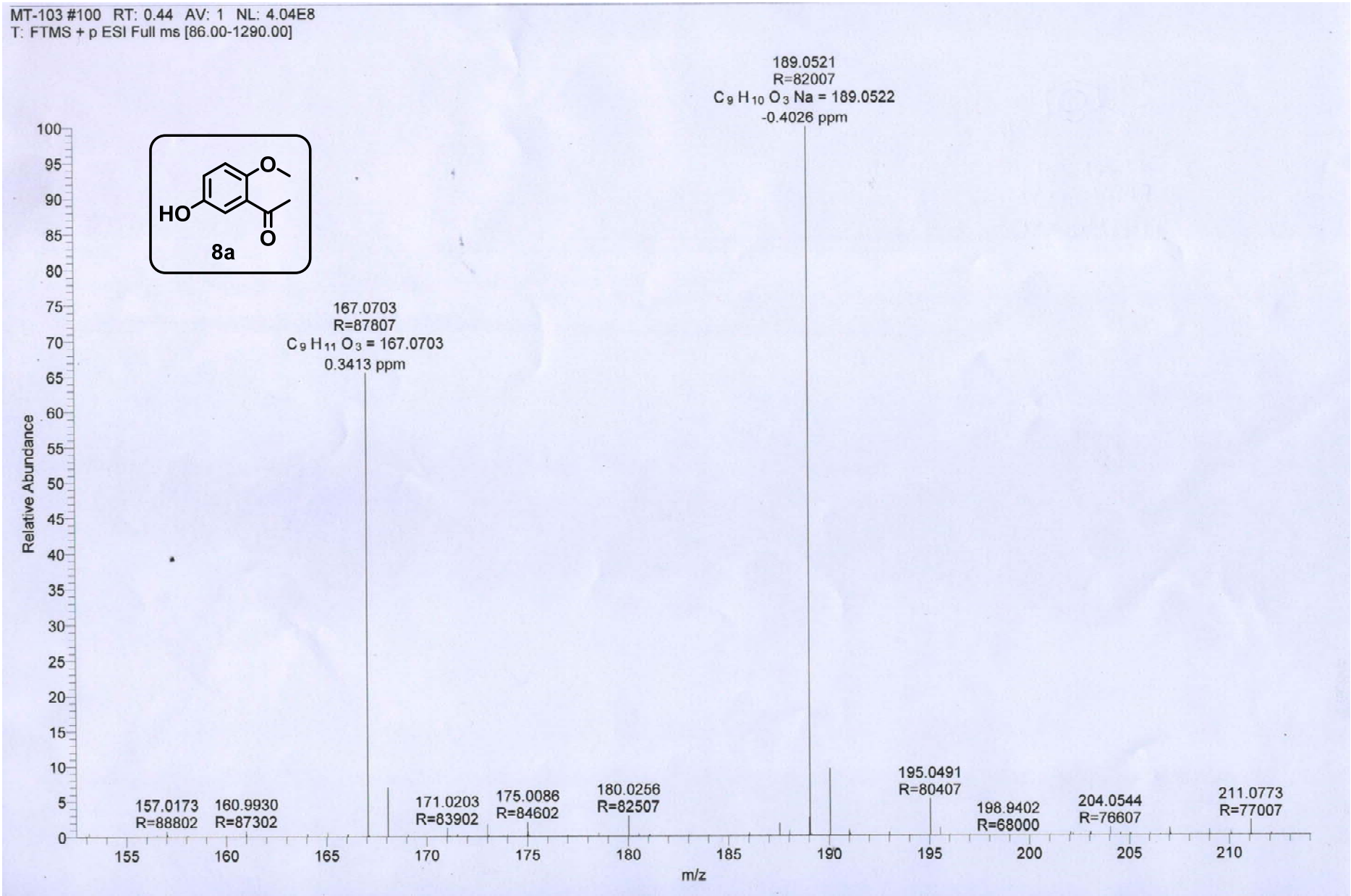
^{1}H NMR (400 MHz, $CDCl_3$) of compound *8a*:



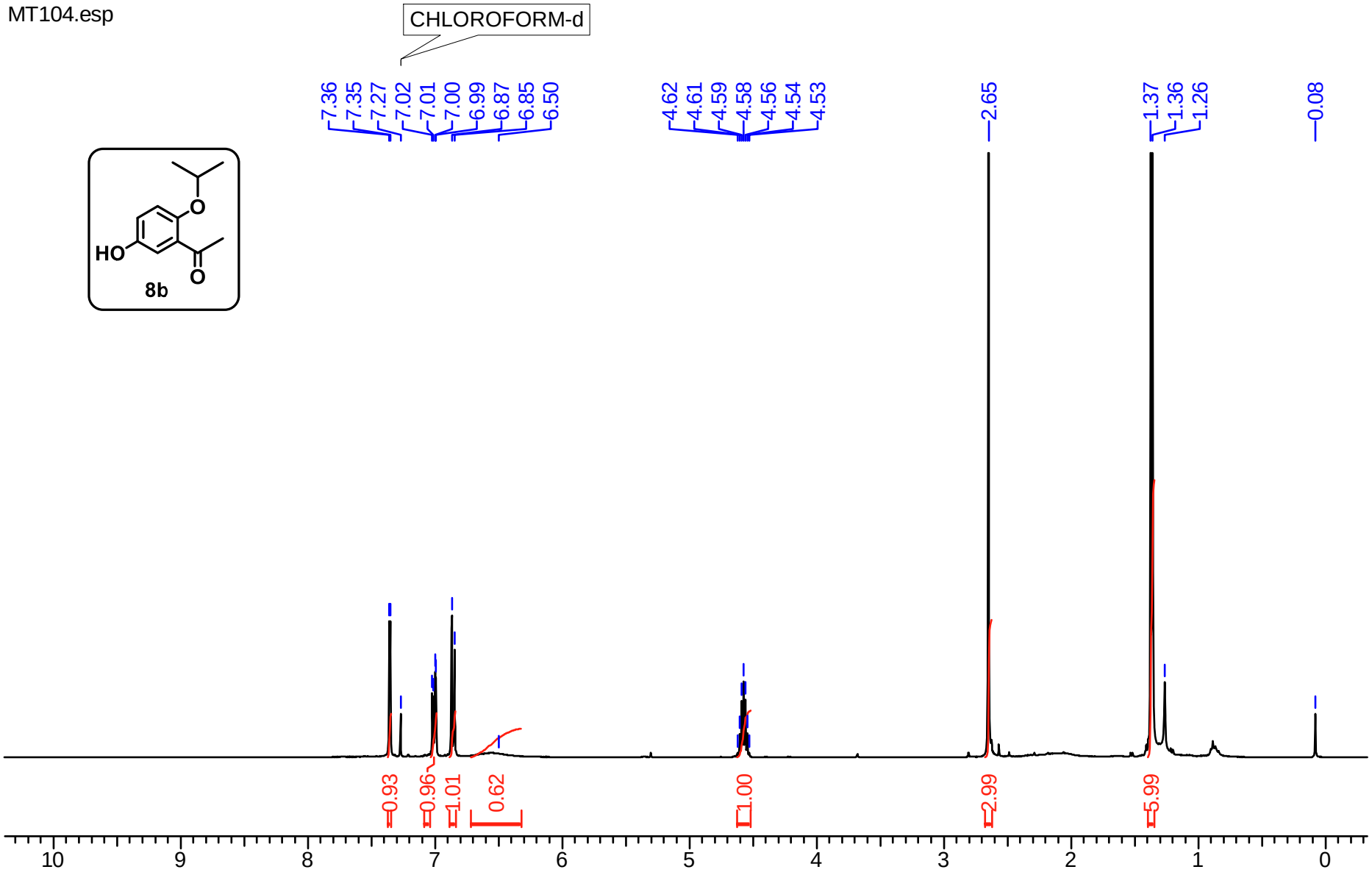
^{13}C NMR (100 MHz, $CDCl_3$) of compound *8a*:



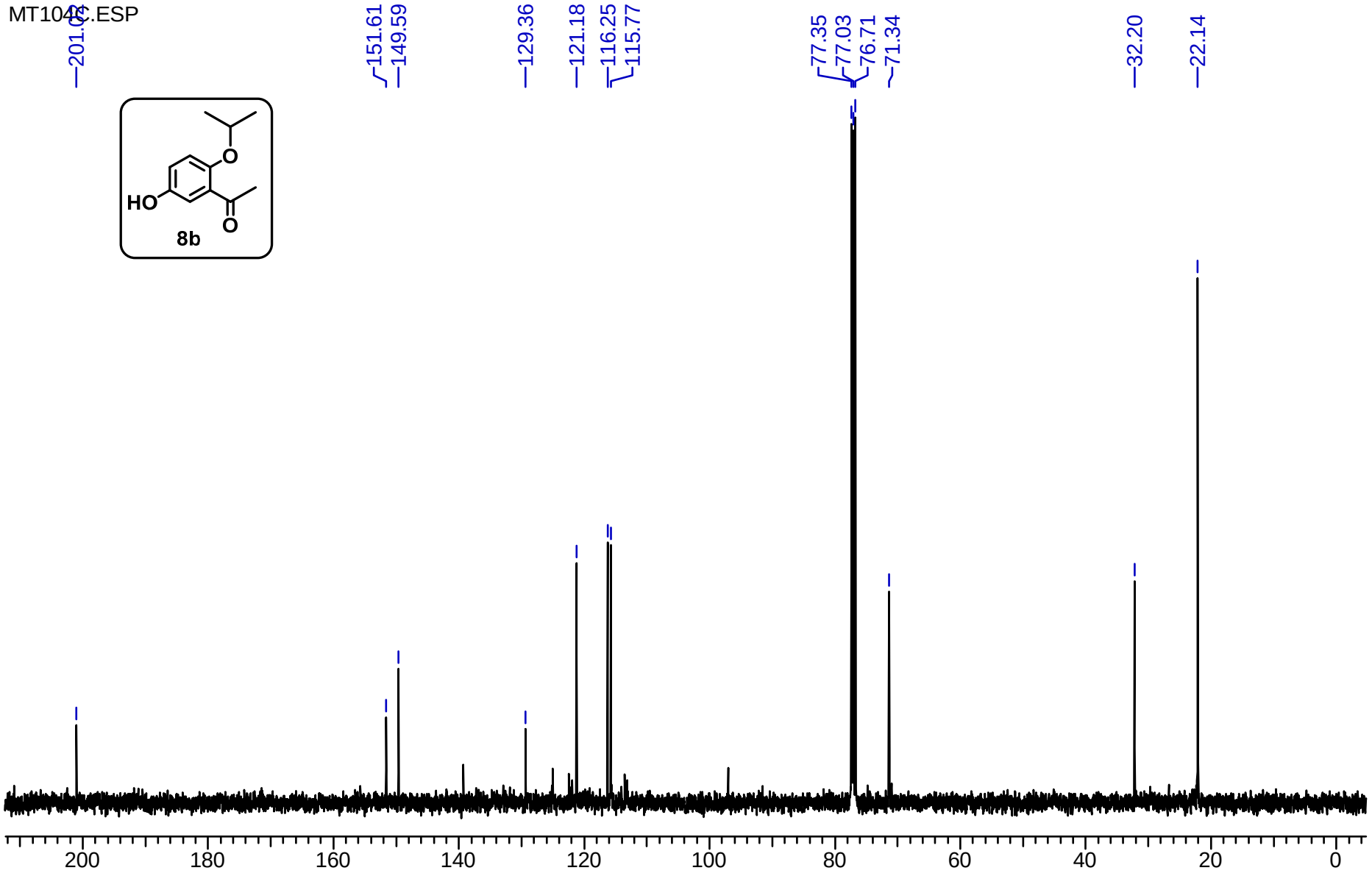
HRMS of compound *8a*:



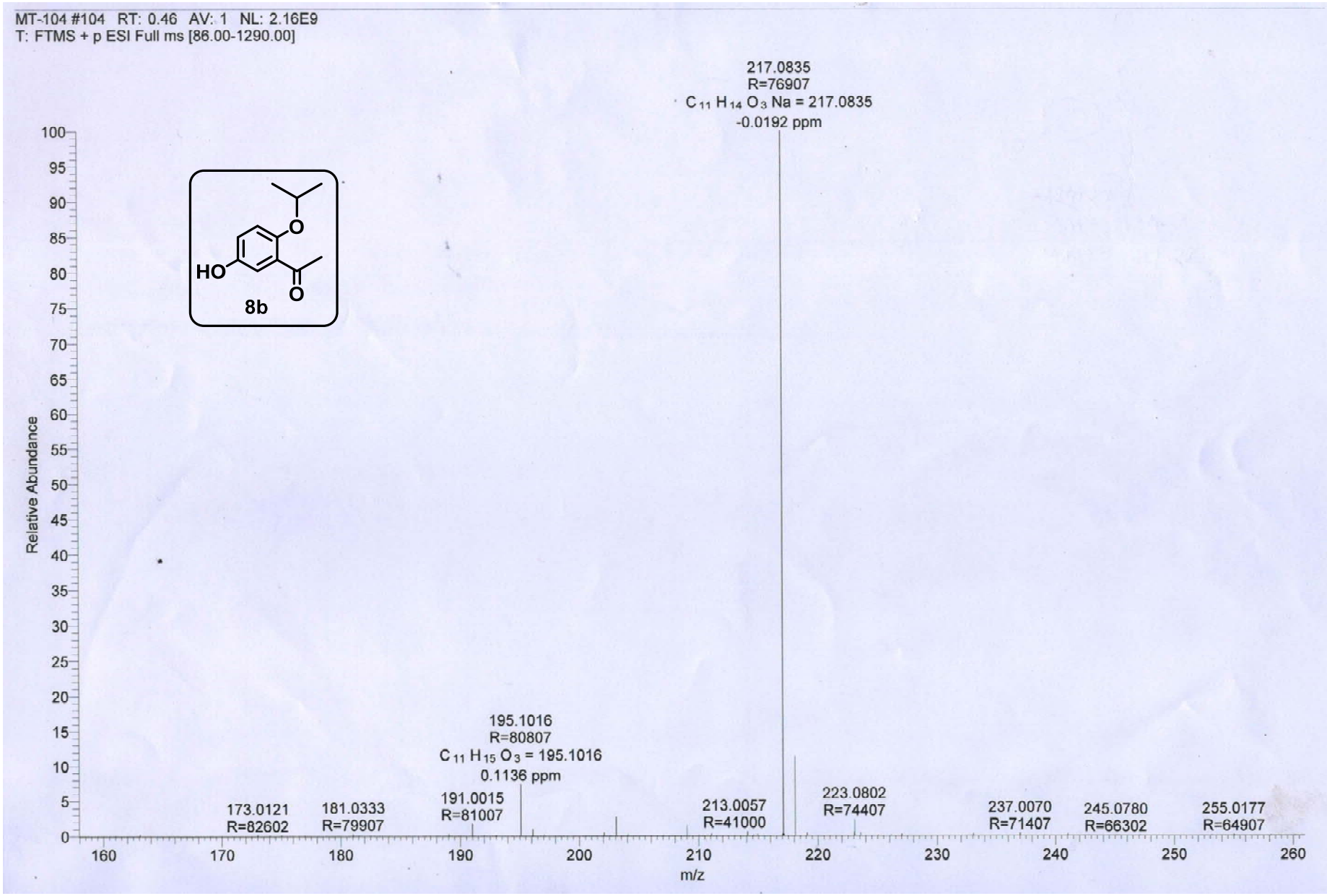
^{1}H NMR (400 MHz, $CDCl_3$) of compound *8b*:



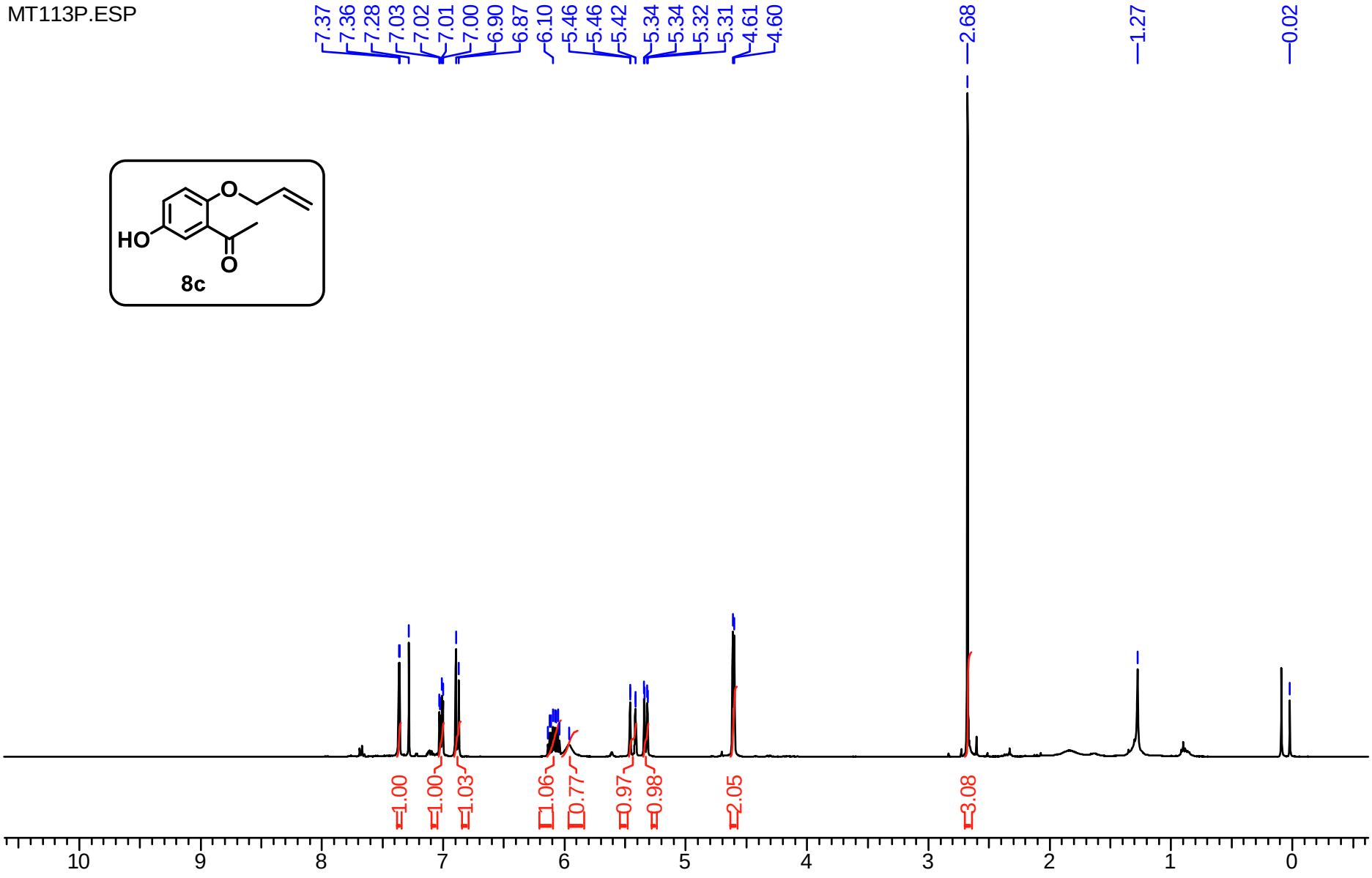
^{13}C NMR (100 MHz, $CDCl_3$) of compound *8b*:



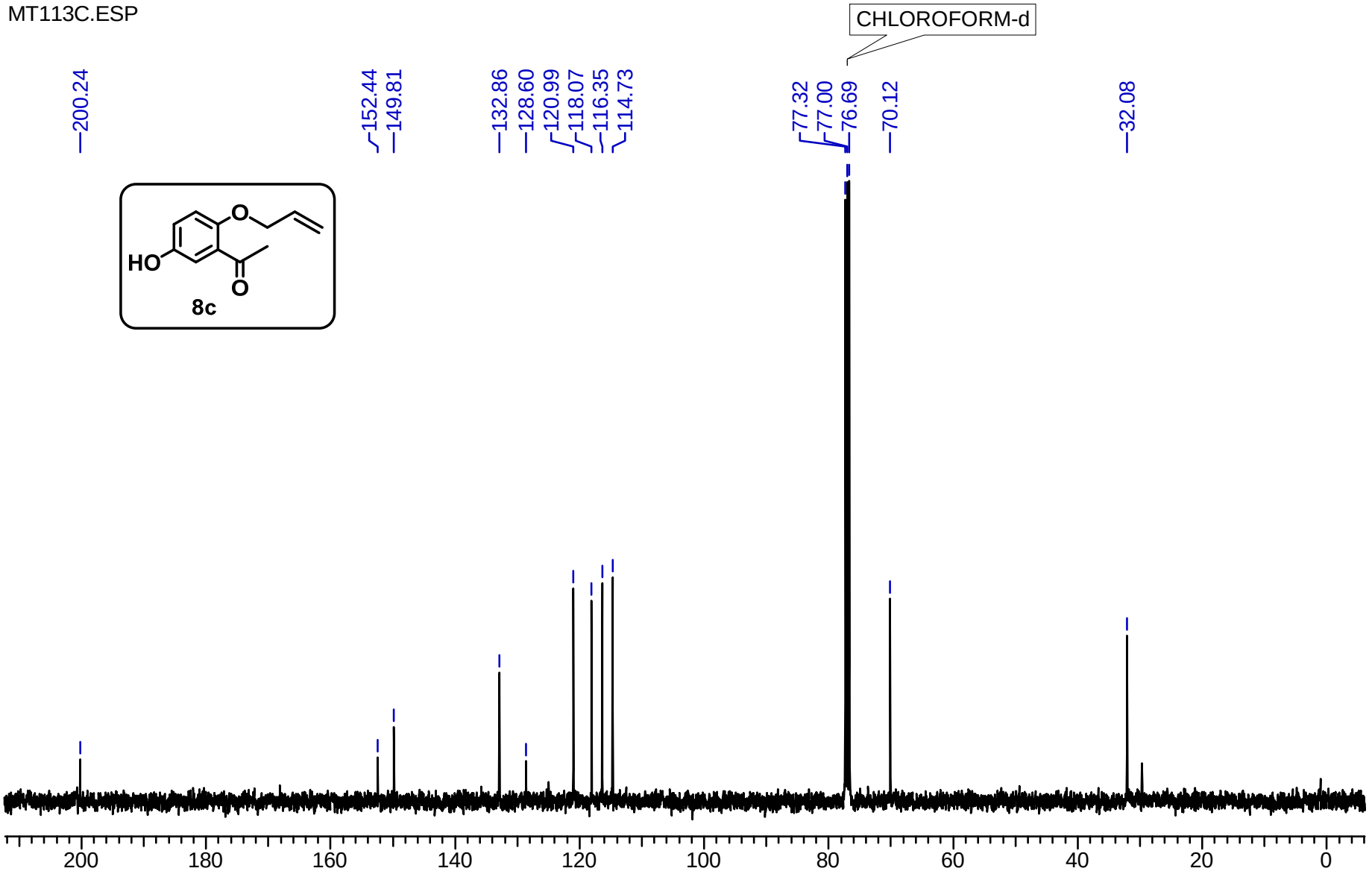
HRMS of compound *8b*:



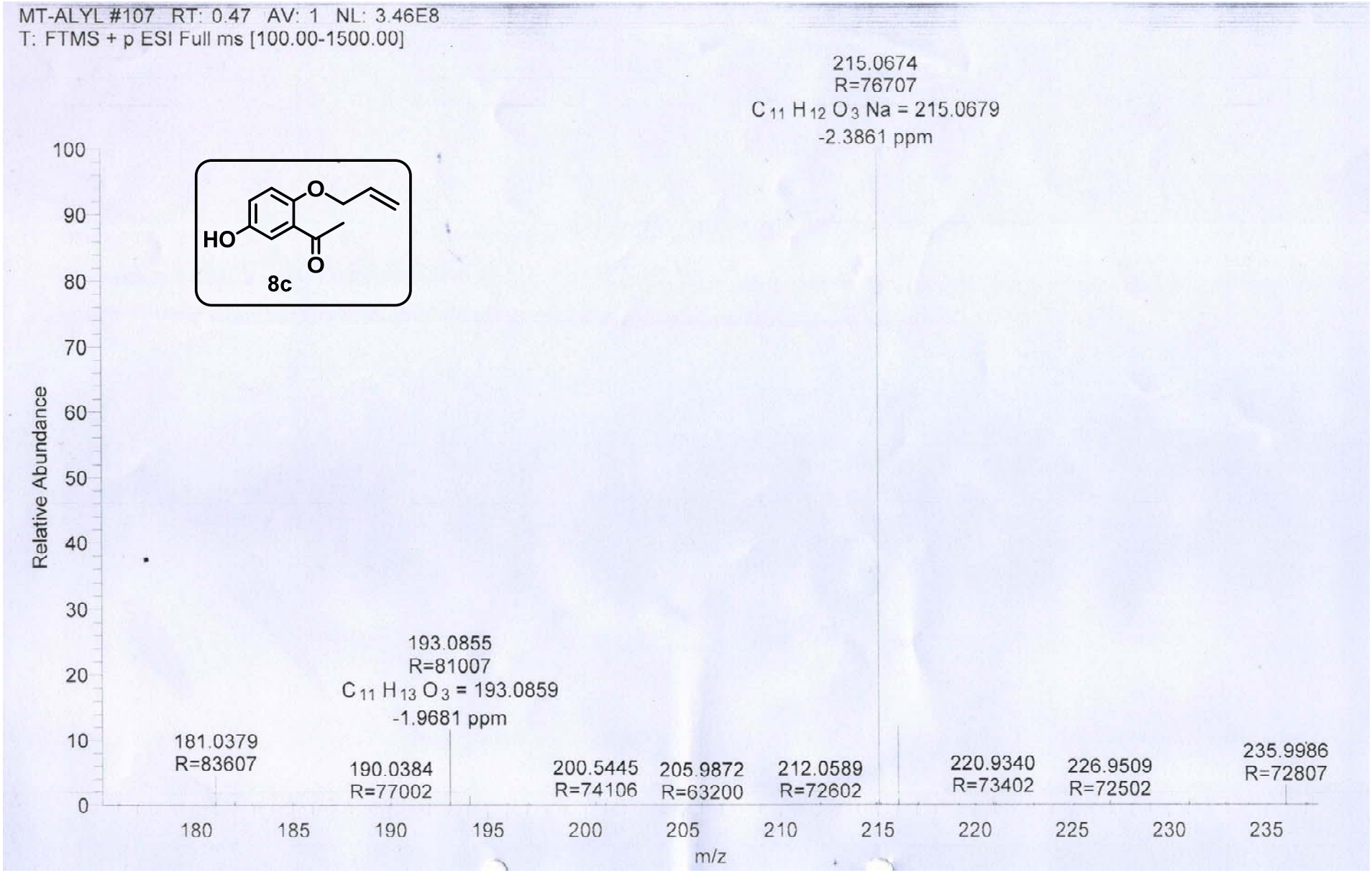
^{1}H NMR (400 MHz, $CDCl_3$) of compound *8c*:



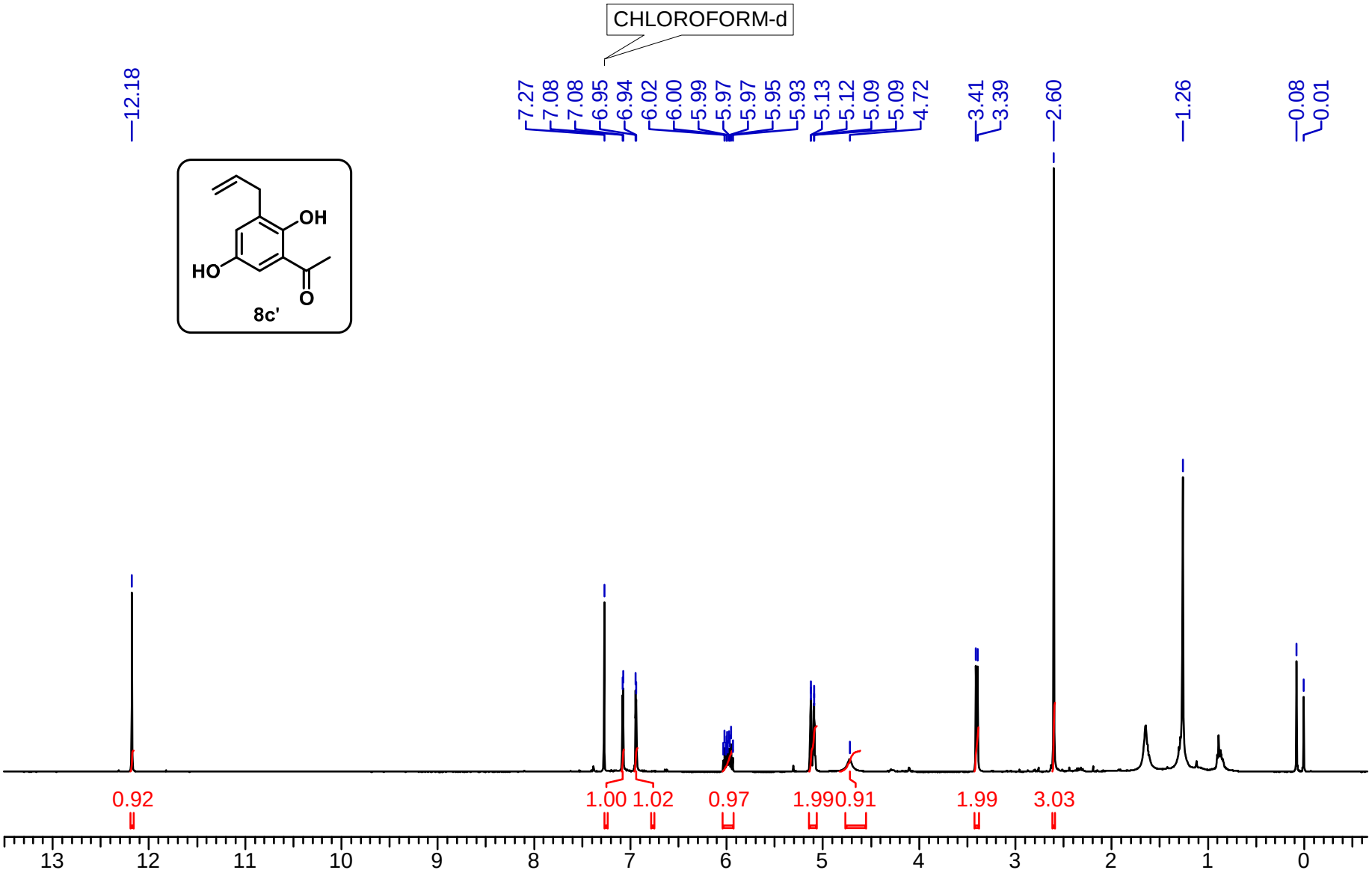
^{13}C NMR (100 MHz, $CDCl_3$) of compound *8c*:



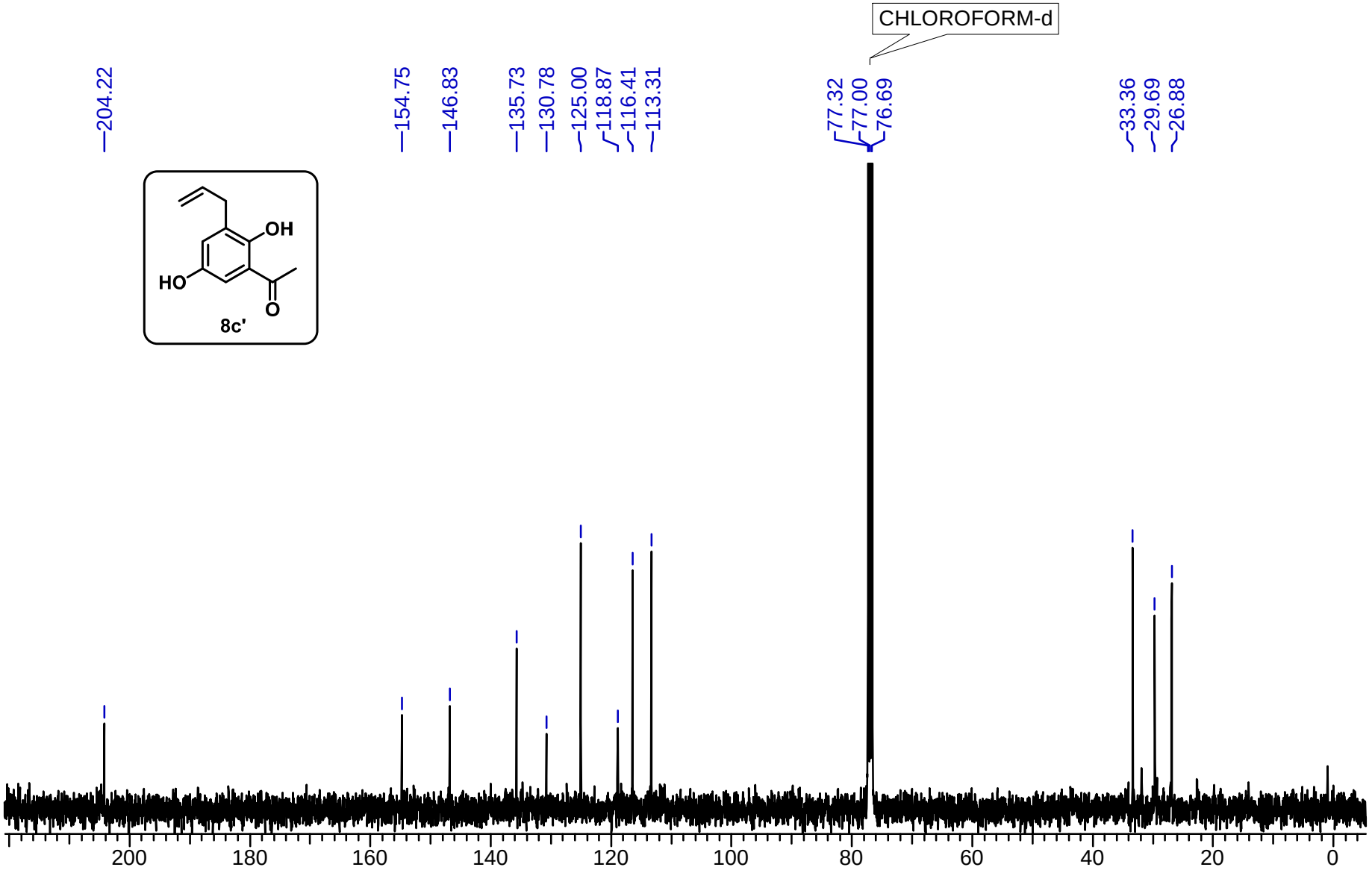
HRMS of compound *8c*:



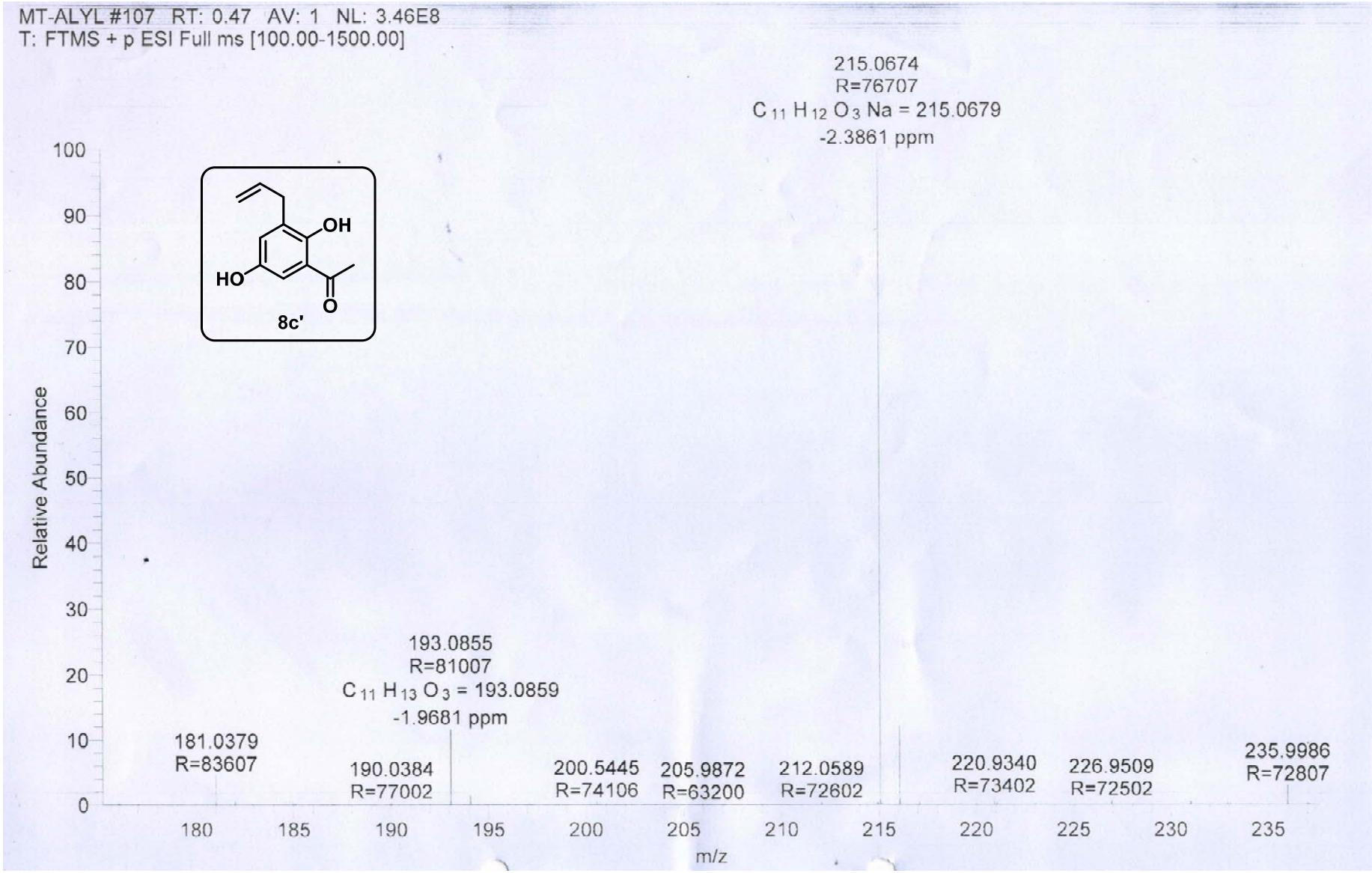
^{1}H NMR (400 MHz, $CDCl_3$) of compound *8c'*:



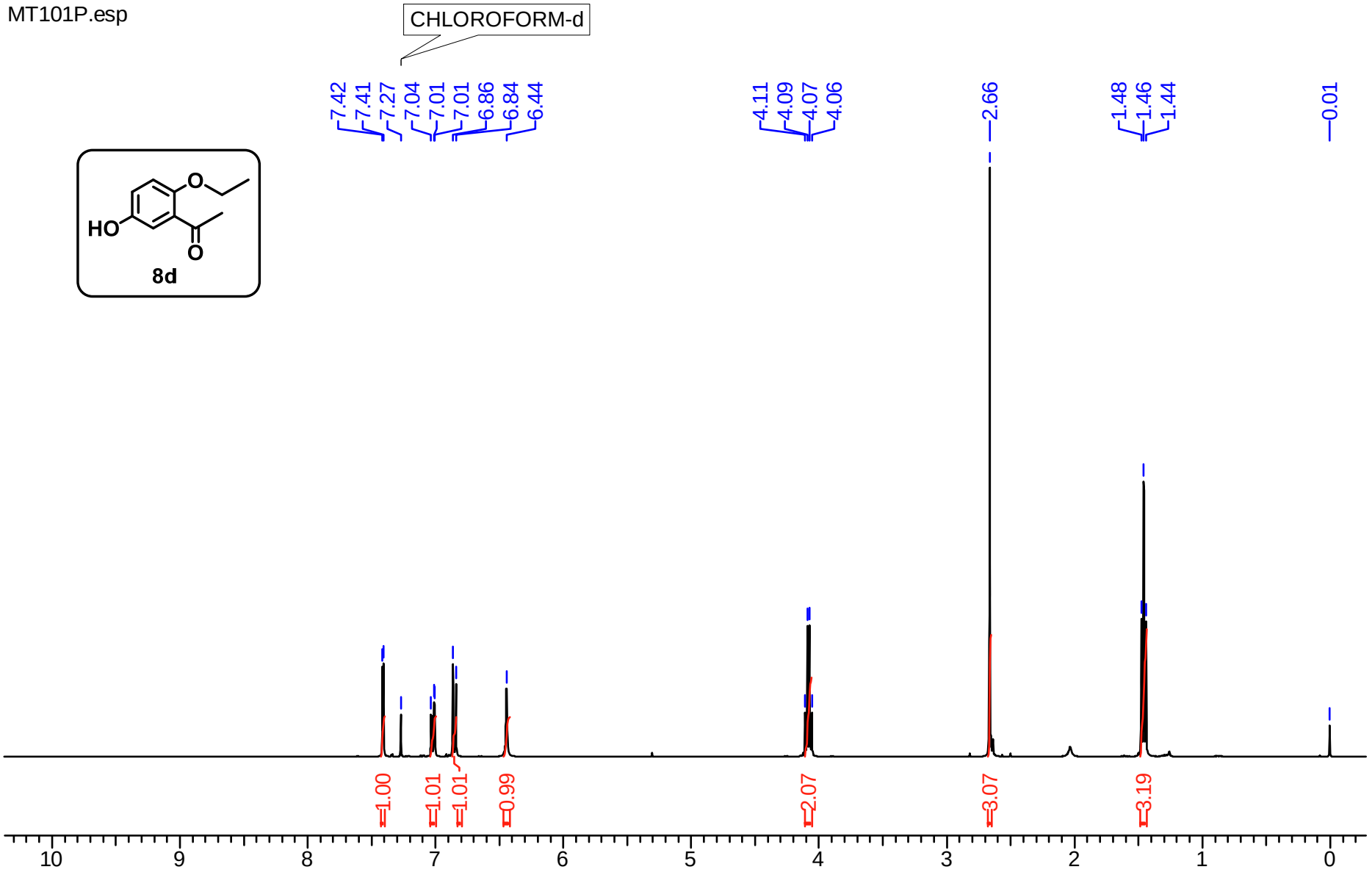
^{13}C NMR (100 MHz, $CDCl_3$) of compound *8c'*:



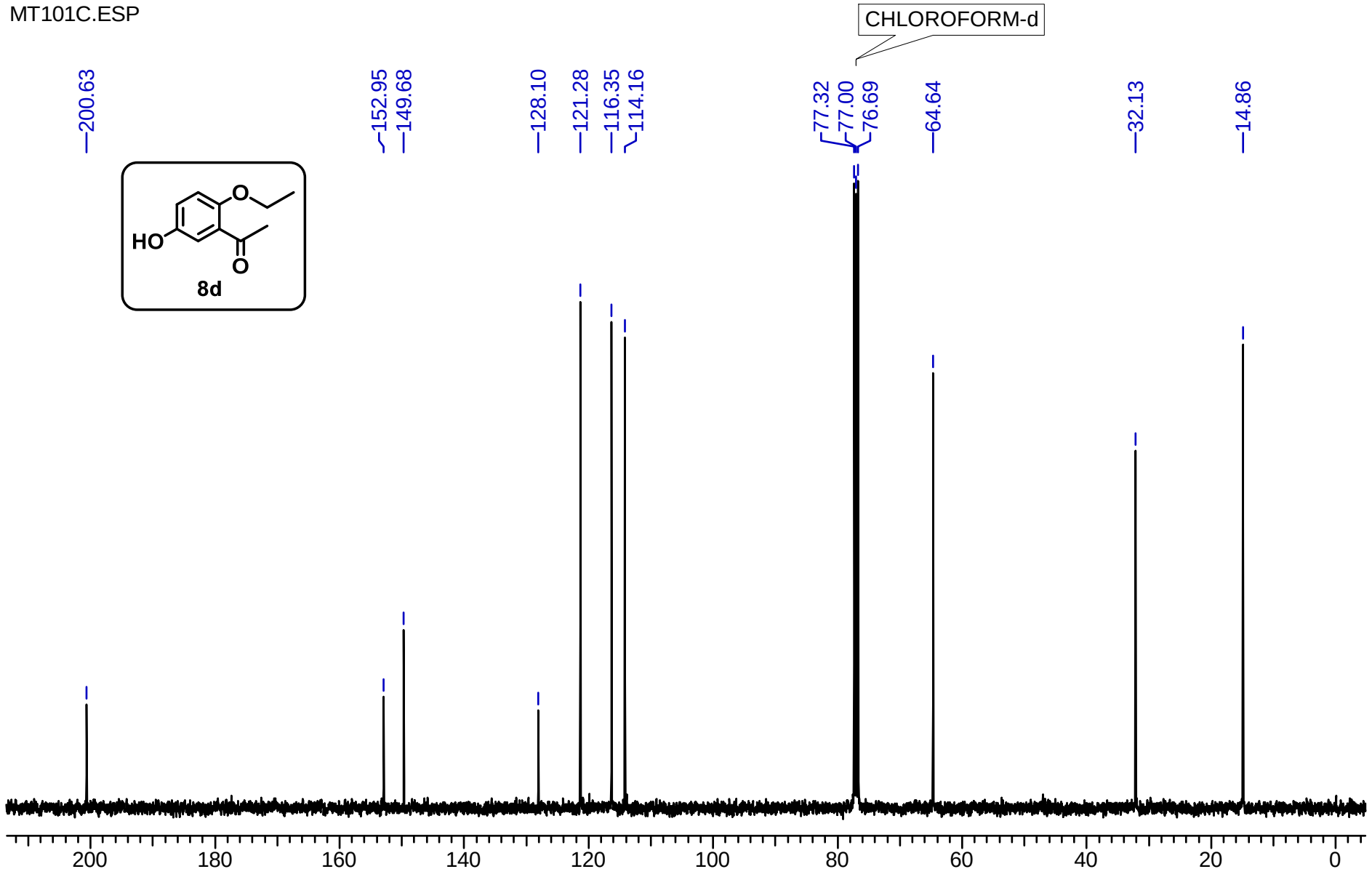
HRMS of compound *8c'*:



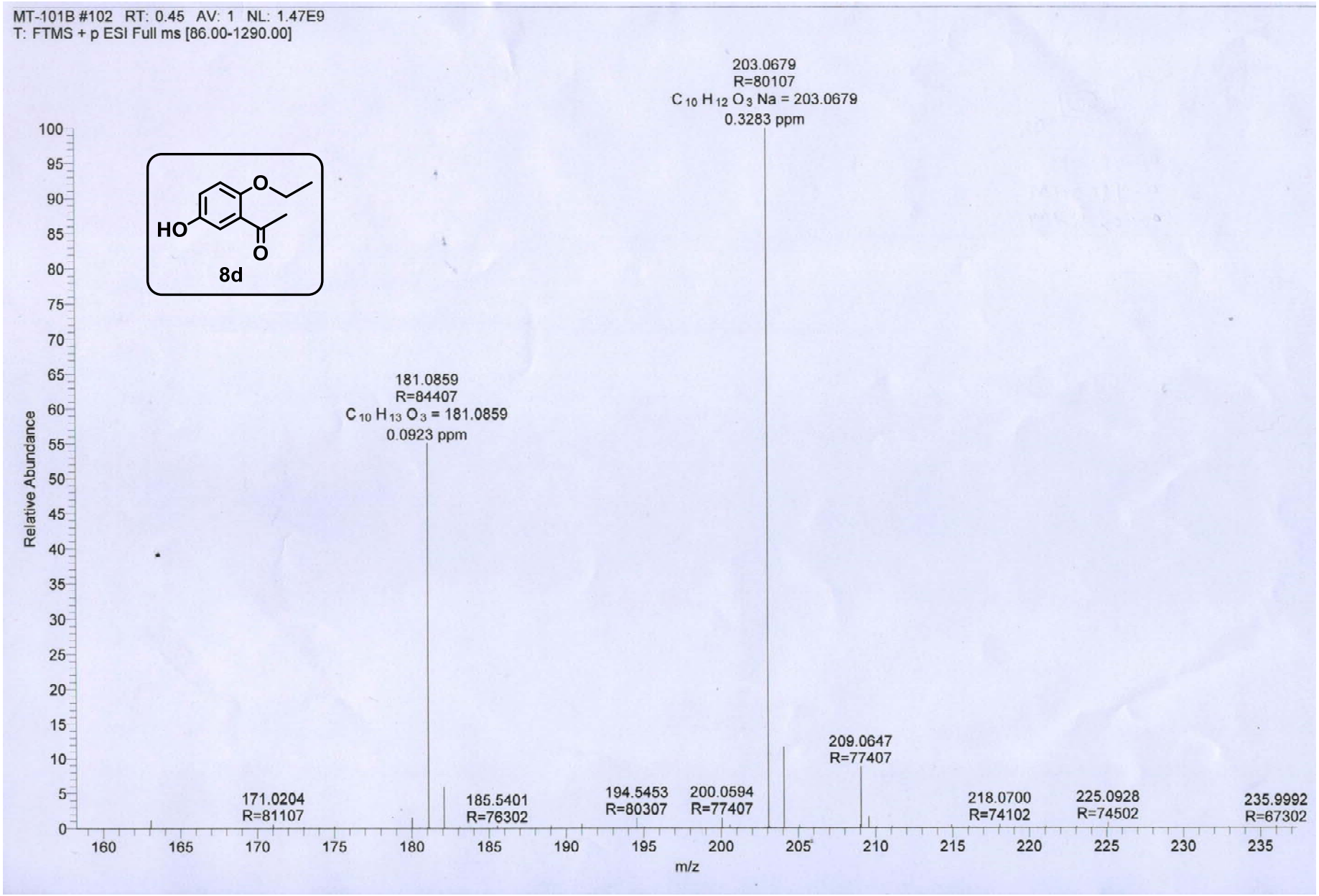
^{1}H NMR (400 MHz, $CDCl_3$) of compound *8d*:



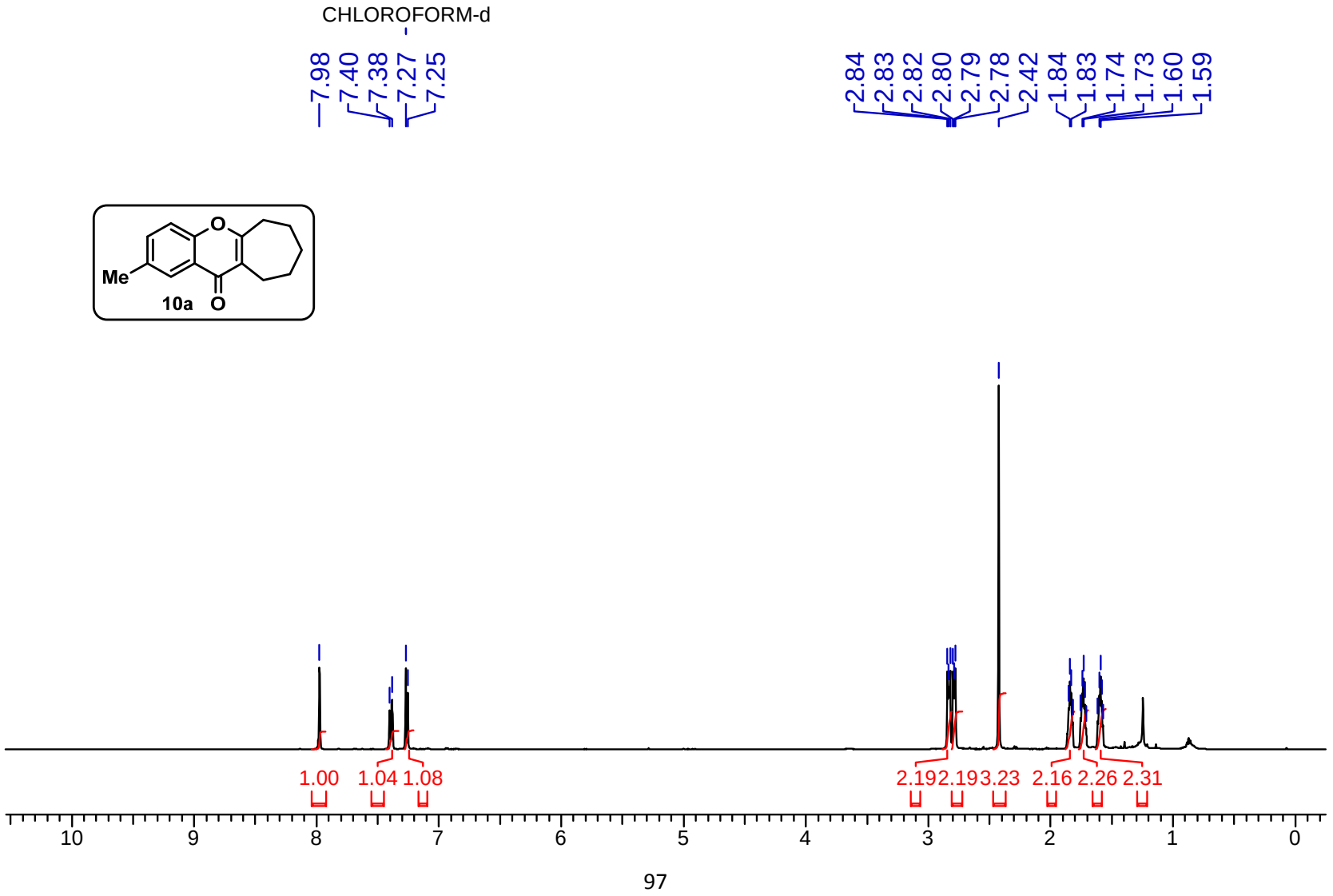
^{13}C NMR (100 MHz, $CDCl_3$) of compound *8d*:



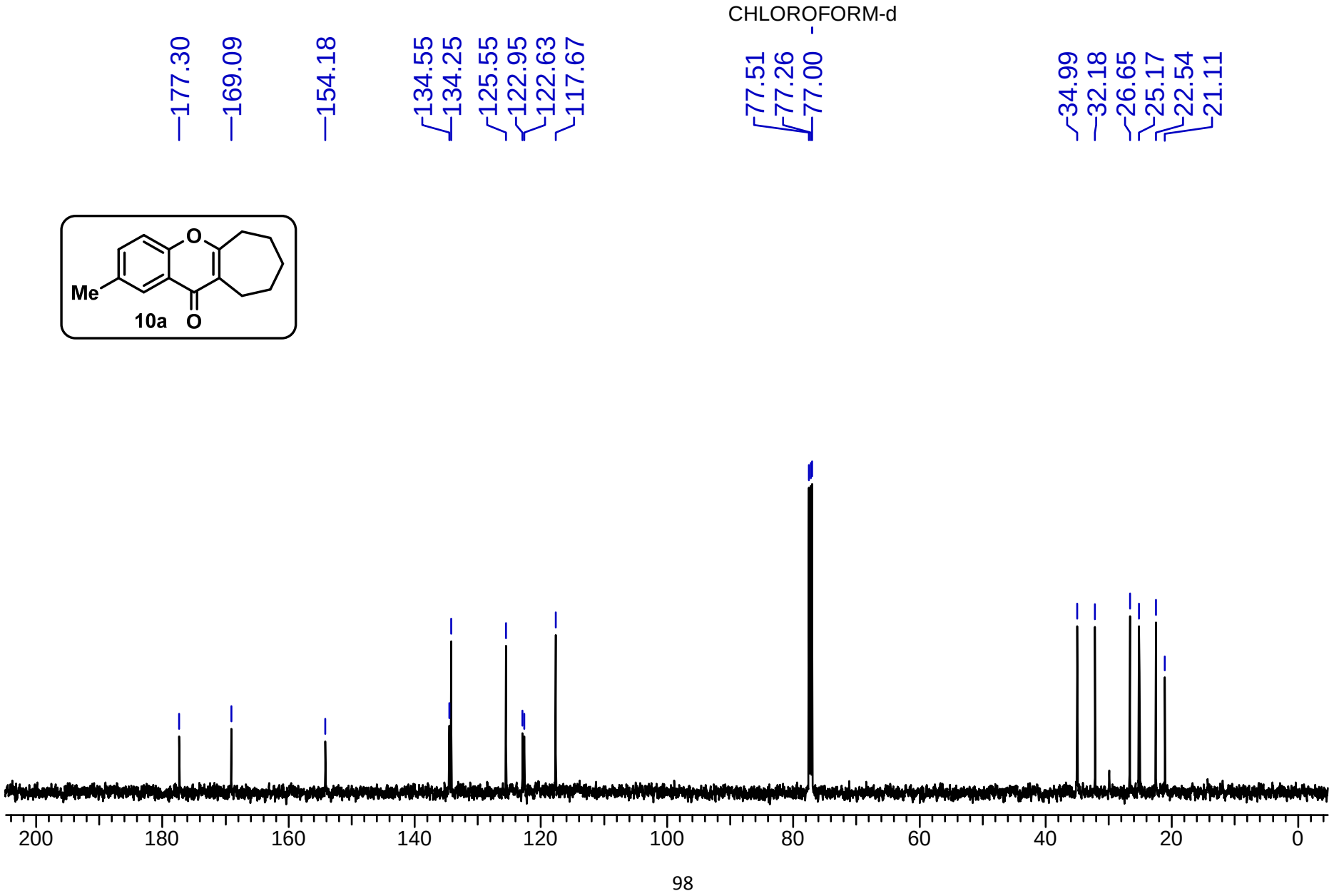
HRMS of compound *8d*:



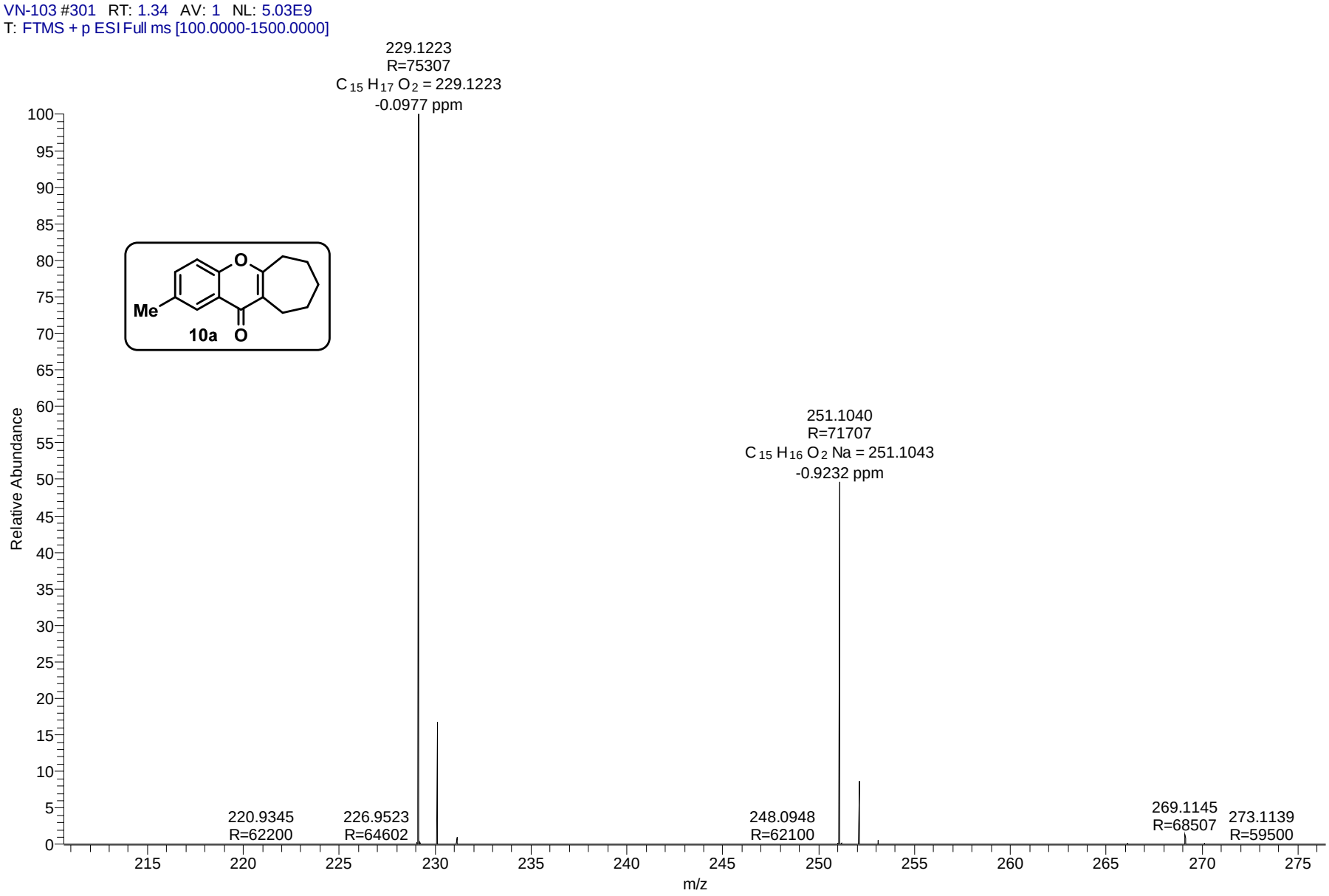
^{1}H NMR (500 MHz, $CDCl_3$) of compound *10a*:



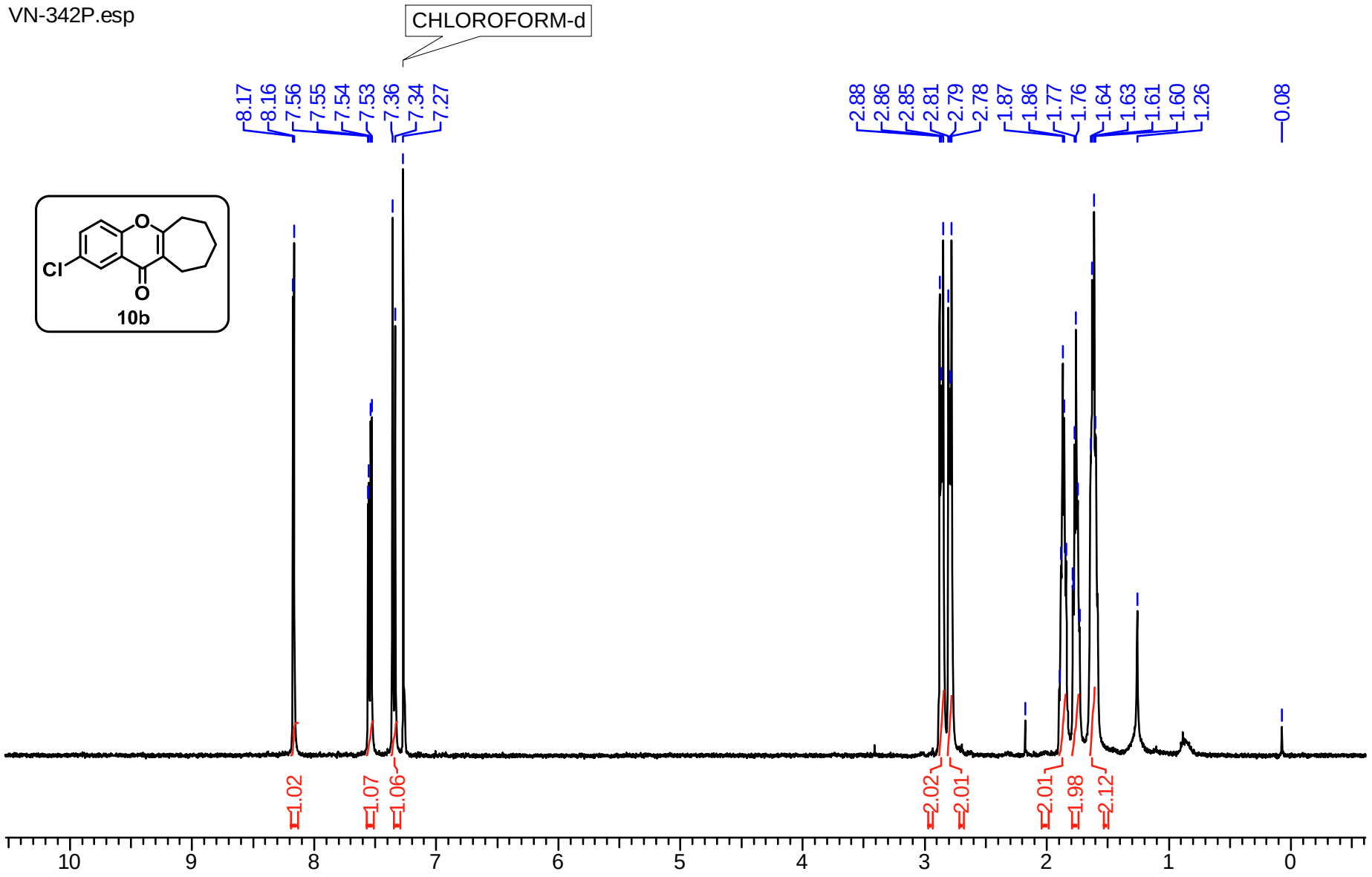
^{13}C NMR (125 MHz, $CDCl_3$) of compound *10a*:



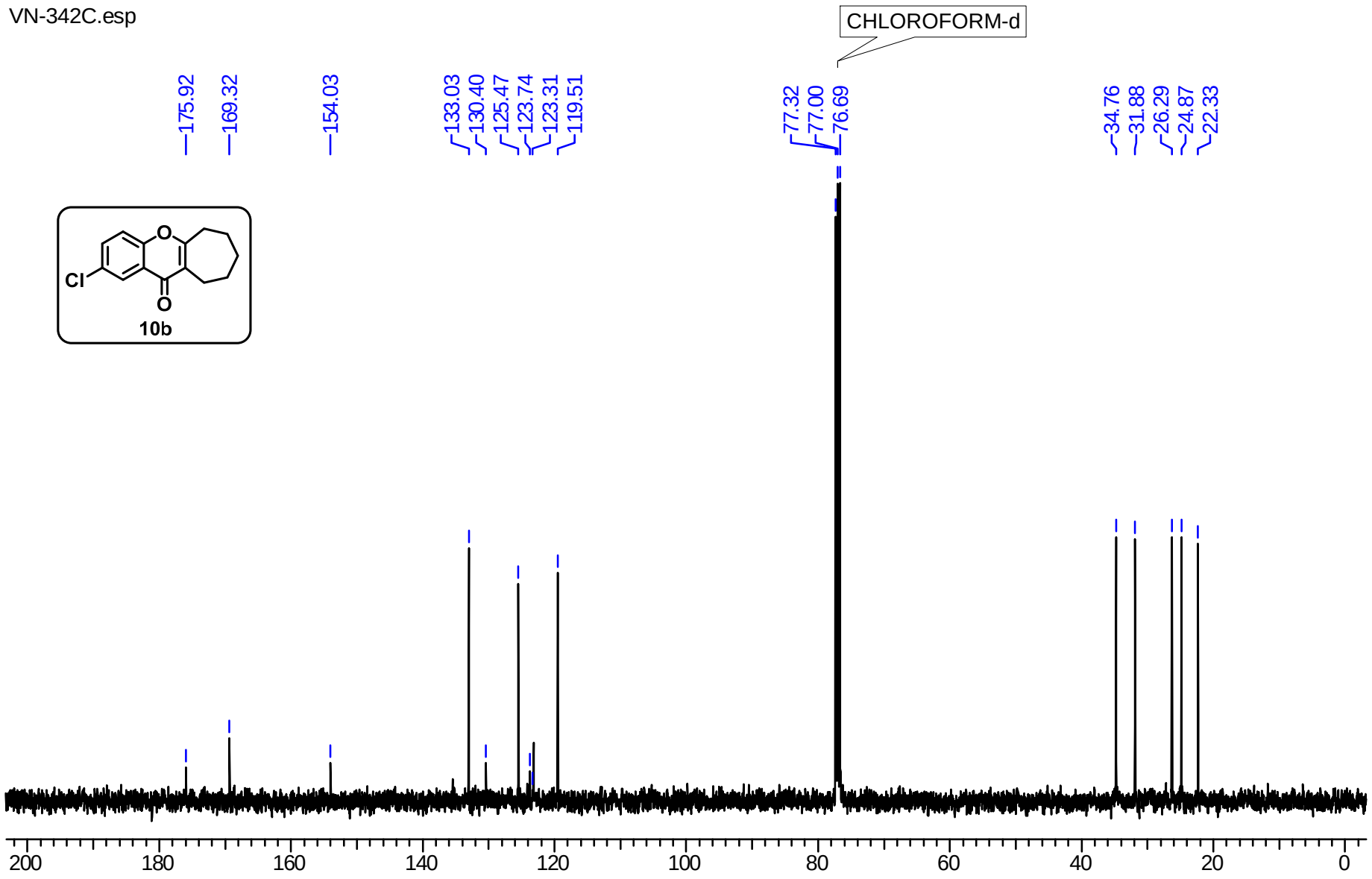
HRMS of compound *10a*:



^{1}H NMR (400 MHz, $CDCl_3$) of compound *10b*:



^{13}C NMR (100 MHz, $CDCl_3$) of compound *10b*:



HRMS of compound *10b*: