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Hydroxylamine as an ammonia equivalent: access to NH-tetrahydroisoquinolonic derivatives from aldoximes by the Castagnoli–Cushman reaction followed by reduction

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1. **Experimental section. General information**.

NMR spectra were recorded with Bruker Avance 400 spectrometer (400.13 MHz for ^1H and 100.61 MHz for ^{13}C) and Bruker Avance 500 spectrometer (125 MHz for ^{13}C) in DMSO-d_6 and in $CDCl_3$ and were referenced to residual solvent proton signals (δ_H = 2.50 and 7.26 ppm, respectively) and solvent carbon signals (δ_C = 39.5 and 77.0 ppm, respectively). Melting points were determined with a Stuart SMP50 instrument in open capillary tubes and are uncorrected. Mass spectra were recorded with a Bruker Maxis HRMS-ESI-qTOF spectrometer (electrospray ionization mode). Single crystal X-ray data were obtained from Xcalibur, Eos (monochromated Mo*Kα* radiation, λ = 0.71073 Å) diffractometer. Merck silica gel 60 mesh was used for column chromatography. TLC was performed with Macherey-Nagel «Alugram Sil G/UV254» plates. Homophthalic anhydride (HPA) and 15% aqueous solution $TiCl_3$ were obtained from commercial sources. Oximes were synthesized according to known procedure[S1] as *E/Z* isomeric mixtures. Synthesis of compounds **1a,d,e,j,k,m** was previously reported[S2].

2. General procedure for the preparation of acids 1a-h and the corresponding analytical data. A mixture of homophthalic anhydride (HPA, 1 mmol) and the corresponding oxime (1 mmol) was suspended in dry toluene (2 ml per 1 mmol) in a screw-cap vial and was placed in a pre-heated oil bath at 110 °C. After 24 h of vigorous stirring, the reaction mixture was cooled to room temperature. Acids 1 precipitated from the reaction mixture and were purified by filtration and washing with small amount of cold diethyl ether.

*trans-3-(2,4-Dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid (**1b**)* was prepared from HPA (162 mg, 1 mmol) and 2,4-dimethoxybenzaldehyde oxime (181 mg, 1 mmol). Yield 284 mg, 83%. White solid, m.p. 215-217 °C. ^1H NMR (400 MHz, DMSO-d_6) δ 10.13 (s, 1H), 7.95 (dt, *J* = 7.0, 3.0 Hz, 1H), 7.45 – 7.37 (m, 2H), 7.29 – 7.22 (m, 1H), 6.59 (d, *J* = 2.3 Hz, 1H), 6.50 (d, *J* = 8.5 Hz, 1H), 6.33 (dd, *J* = 8.5, 2.3 Hz, 1H), 5.66 (d, *J* = 1.0 Hz, 1H), 4.04 (d, *J* = 1.0 Hz, 1H), 3.86 (s, 3H), 3.68 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.5, 161.1, 160.6, 157.6, 133.6, 132.1, 130.5, 128.9, 128.2, 126.9, 126.8, 118.1, 104.7, 99.3, 60.8, 56.2, 55.6, 50.1. HRMS (ESI), m/z calcd for $C_{18}H_{18}NO_6$ $[M+H]^+$ 344.1129, found 344.1143.

*trans-3-(3,4-Dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid (**1c**)* was prepared from HPA (162 mg, 1 mmol) and 3,4-dimethoxybenzaldehyde oxime (181 mg, 1 mmol). Yield 284 mg, 83%. White solid, m.p. 217-219 °C. ^1H NMR (400 MHz, DMSO-d_6) δ 13.03 (s, 1H), 10.18 (s, 1H), 7.94 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.48 – 7.38 (m, 2H), 7.29 (d, *J* = 6.9 Hz, 1H), 6.83 – 6.76 (m, 2H), 6.54 (dd, *J* = 8.3, 1.7 Hz, 1H), 5.42 (d, *J* = 1.6 Hz, 1H), 4.28 (d, *J* = 1.6 Hz, 1H), 3.66 (s, 3H), 3.65 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.4, 160.7, 149.1, 148.6, 133.7, 132.2, 131.4, 130.2, 129.1, 128.3, 126.9, 118.3, 112.0, 110.7, 65.3, 55.9, 55.8, 51.9. HRMS (ESI), m/z calcd for $C_{18}H_{17}NNaO_6$ [M+Na]$^+$ 366.0948, found 366.0955.

trans-3-(4-tert-Butylphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid ***(1f)*** was prepared from HPA (162 mg, 1 mmol) and 4-*tert*-butylbenzaldehyde oxime (177 mg, 1 mmol). Yield 240 mg, 71 %. White solid, m.p. 234-236 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.06 (s, 1H), 10.18 (s, 1H), 7.95 (dd, *J* = 7.5, 1.3 Hz, 1H), 7.50 – 7.38 (m, 2H), 7.33 – 7.25 (m, 3H), 7.05 (d, *J* = 8.3 Hz, 2H), 5.45 (d, *J* = 1.3 Hz, 1H), 4.27 (d, *J* = 1.3 Hz, 1H), 1.21 (s, 9H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.4, 160.7, 150.4, 136.2, 133.5, 132.2, 130.4, 129.1, 128.3, 127.0, 126.3, 125.8, 65.4, 51.8, 34.6, 31.5. HRMS (ESI), m/z calcd for $C_{20}H_{22}NO_4$ [M+H]$^+$ 340.1543, found 340.1553.

trans-2-Hydroxy-3-(4-methylthiophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid ***(1g)*** was prepared from HPA (162 mg, 1 mmol) and 4-methylthiobenzaldehyde oxime (167 mg, 1 mmol). Yield 225 mg, 68%. White solid, m.p. 198-201 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.08 (s, 1H), 10.24 (s, 1H), 7.93 (m, 1H), 7.51 – 7.37 (m, 2H), 7.29 (d, *J* = 6.8 Hz, 1H), 7.16 (d, *J* = 8.4 Hz, 2H), 7.07 (d, *J* = 8.4 Hz, 2H), 5.45 (d, *J* = 1.6 Hz, 1H), 4.26 (d, *J* = 1.6 Hz, 1H), 2.41 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.3, 160.8, 138.0, 135.7, 133.4, 132.3, 130.2, 129.0, 128.4, 127.1, 127.0, 126.4, 65.3, 51.8, 15.0. HRMS (ESI), m/z calcd for $C_{17}H_{15}NO_4SNa$ [M+Na]$^+$ 352.0614, found 352.0605.

trans-3-(3,5-Dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid ***(1h)*** was prepared from HPA (162 mg, 1 mmol) and 3,4-dimethoxybenzaldehyde oxime (181 mg, 1 mmol). Yield 172 mg, 50%. White solid, m.p. 217-219 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.07 (s, 1H), 10.23 (s, 1H), 7.94 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.50 – 7.37 (m, 2H), 7.30 (d, *J* = 7.5 Hz, 1H), 6.34 (t, *J* = 2.0 Hz, 1H), 6.28 (d, *J* = 2.0 Hz, 2H), 5.42 (d, *J* = 1.4 Hz, 1H), 4.30 (d, *J* = 1.4 Hz, 1H), 3.65 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.3, 160.9, 160.8, 141.6, 133.5, 132.2, 130.3, 128.9, 128.3, 126.9, 104.9, 99.2, 65.5, 55.6, 51.7. HRMS (ESI), m/z calcd for $C_{18}H_{18}NO_6$ [M+H]$^+$ 344.1129, found 344.1139.

3. General procedure for the preparation of acids 1i-m and the corresponding analytical data. A mixture of homophthalic anhydride (1 mmol) and the corresponding oxime (1 mmol) was placed in a screw-cap vial and was thoroughly ground with a spatula. The vial was placed in a pre-heated oil bath at 110 °C. After 24 h the reaction mixture was cooled to room temperature. A small amount of diethyl ether (5 ml per 1 mmol) was added, and the reaction mixture was sonicated in ultrasonic bath for 15 minutes. The resulting suspension was cooled to –20 °C, filtered and dried in air to give essentially pure compounds **1i-m**.

*trans-3-(3-Bromophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid (**1i**)* was prepared from HPA (162 mg, 1 mmol) and 3-bromobenzaldehyde oxime (200 mg, 1 mmol). Yield 271 mg, 75%. White semi-solid. ^{1}H NMR (400 MHz, DMSO-*d₆*) δ 13.09 (s, 1H), 10.35 (s, 1H), 7.95 (dd, *J* = 7.5, 1.7 Hz, 1H), 7.48 (m, 1H), 7.43 (m, 2H), 7.35 (m, 1H), 7.31 (dd, *J* = 7.4, 1.5 Hz, 1H), 7.25 (t, *J* = 7.8 Hz, 1H), 7.15 (d, *J* = 7.8 Hz, 1H). 5.51 (d, *J* = 1.6 Hz, 1H), 4.34 (d, *J* = 1.6 Hz, 1H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 172.0, 160.8, 141.9, 133.2, 132.4, 131.2, 131.0, 130.3, 129.4, 128.8, 128.5, 127.1, 125.7, 122.2, 65.0, 51.5. HRMS (ESI), m/z calcd for $C_{16}H_{12}BrNO_4Na$ [M+Na]$^+$ 383.9842, found 383.9845.

*trans-3-(3,4-Dichlorophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylic acid (**1l**)* was prepared from HPA (162 mg, 1 mmol) and 3,4-dichlorobenzaldehyde oxime (189 mg, 1 mmol). Yield 202 mg, 58%. White solid, m.p. 205-207 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.12 (s, 1H), 10.39 (s, 1H), 7.95 (d, *J* = 7.5 Hz, 1H), 7.56 (d, *J* = 8.4 Hz, 1H), 7.53 – 7.39 (m, 3H), 7.31 (d, *J* = 7.4 Hz, 1H), 7.12 (dd, *J* = 8.4, 1.9 Hz, 1H), 5.52 (d, *J* = 1.6 Hz,, 1H), 4.37 (d, *J* = 1.6 Hz, 1H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 171.9, 160.8, 140.3, 133.1, 132.5, 131.6, 131.7, 130.8, 130.3, 128.9, 128.7, 128.6, 127.1, 126.9, 64.6, 51.3. HRMS (ESI), m/z calcd for $C_{16}H_{12}Cl_2NO_4$ [M+H]$^+$ 352.0138, found 352.0128.

4. General procedure for the preparation of esters 2a-m and the corresponding analytical data. To a stirred solution of compounds **1a-m** (0.5-0.8 mmol) in MeOH (5 ml) concentrated sulfuric acid (40 µl) was quickly added. The reaction mixture was left to stand at room temperature overnight. After evaporation of solvent, distilled water (10 ml) was added to the residue and the mixture was cooled to 4-5 °C. After 12 hours the suspension was sonicated in ultrasonic bath for 15 minutes, filtered and washed with a small amount of water. The precipitate was dried in air to give essentially pure esters **2a-m.**

*Methyl trans-2-hydroxy-3-(4-methoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2a**)* was prepared from acid **1a** (250 mg, 0.8 mmol). Yield 200 mg, 77%. Pale pink semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (m, 1H), 7.56 – 7.40 (m, 2H), 7.26 – 7.15 (m, 1H), 7.07 (d, *J* = 8.7 Hz, 2H), 6.81 (d, *J* = 8.7 Hz, 2H), 5.63 (d, *J* = 2.4 Hz, 1H), 4.12 (d, *J* = 2.5 Hz, 1H), 3.76 (s, 3H), 3.74 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 160.3, 159.6, 132.5, 131.7, 129.3, 129.2, 128.6, 127.6, 127.5, 126.8, 114.3, 63.4, 55.3, 53.1, 52.1. HRMS (ESI), m/z calcd for $C_{18}H_{18}NO_5$ $[M+H]^+$ 328.1179, found 328.1186.

*Methyl trans-3-(2,4-dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2b**)* was prepared from acid **1b** (250 mg, 0.7 mmol). Yield 243 mg, 97%. White solid, m.p. 142-144°C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 5.6, 3.5 Hz, 1H), 7.51 – 7.40 (m, 2H), 7.26 – 7.09 (m, 1H), 6.66 (d, *J* = 8.5 Hz, 1H), 6.48 (d, *J* = 2.2 Hz, 1H), 6.29 (dd, *J* = 8.5, 2.2 Hz, 1H), 5.99 (d, *J* = 1.0 Hz, 1H), 4.15 (d, *J* = 1.0 Hz, 1H), 3.89 (s, 3H), 3.74 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.9, 160.8, 160.6, 157.3, 132.3, 132.1, 129.8, 128.3, 127.4, 126.8, 126.8, 116.9, 104.0, 99.0, 58.4, 55.6, 55.3, 52.9, 49.8. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_6$ $[M+H]^+$ 358.1285, found 358.1299.

*Methyl trans-3-(3,4-dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2c**)* was prepared from acid **1c** (250 mg, 0.7 mmol). Yield 180 mg, 72%. White solid, m.p. 161-163 °C. ^{1}H NMR (400 MHz, DMSO-*d6* +$CDCl_3$) δ 8.05 (dt, *J* = 7.2, 3.2 Hz, 1H), 7.36 (m, 2H), 7.14 (dd, *J* = 8.0, 5.6 Hz, 1H), 6.66 (d, *J* = 8.2 Hz, 1H), 6.61 (d, *J* = 2.0 Hz, 1H), 6.58 (t, *J* = 2.7 Hz, 1H), 5.43 (d, *J* = 2.2 Hz, 1H), 4.03 (d, *J* = 2.2 Hz, 1H), 3.72 (s, 3H), 3.66 (s, 3H), 3.64 (s, 3H). ^{13}C NMR (101 MHz, DMSO-*d6*+$CDCl_3$) δ 170.8, 160.7, 149.0, 148.8, 132.1, 131.8, 130.4, 129.2, 128.4, 128.3, 127.4, 118.6, 111.2, 109.5, 64.6, 55.8, 55.7, 52.9, 52.1. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_6$ $[M+H]^+$ 358.1285, found 358.1268.

*Methyl trans-3-(3-benzyloxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2d**)* was prepared from acid **1d** (197 mg, 0.5 mmol). Yield 180 mg, 89%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.14 (d, *J* = 6.7 Hz, 1H), 7.54 – 7.42 (m, 2H), 7.35 (m, 5H), 7.21 (m, 3H), 6.96 – 6.84 (m, 1H), 6.82 – 6.64 (m, 2H), 5.67 (d, *J* = 1.3 Hz, H), 5.01 – 4.91 (m, 2H), 4.14 (d, *J* = 1.3 Hz, 1H), 3.75 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 160.3, 159.2, 138.7, 136.6, 132.7, 131.5, 130.1, 129.4, 128.7, 128.6, 128.0, 127.6, 127.5, 126.5, 118.6, 114.8, 112.8, 70.0, 63.6, 53.2, 51.8. HRMS (ESI), m/z calcd for $C_{24}H_{21}NO_5Na$ $[M+Na]^+$ 426.1312, found 426.1329.

*Methyl trans-3-(2,6-dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2e**)* was prepared from acid **1e** (140 mg, 0.4 mmol). Yield 106 mg, 74%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 – 8.12 (m, 1H), 7.49 – 7.39 (m, 2H), 7.27 – 7.23 (m, 1H), 7.23 – 7.17 (m, 1H), 6.52 (d, *J* = 8.4 Hz, 2H), 6.28 (d, *J* = 3.0 Hz, 1H), 4.24 (d, *J* = 2.9

Hz, 1H), 3.73 (s, 3H), 3.64 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.4, 160.4, 158.7, 133.5, 131.5, 129.8, 128.4, 127.8, 127.4, 126.9, 113.1, 104.2, 55.7, 55.2, 52.8, 49.6. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_6$ [M+H]$^+$ 358.1285, found 358.1292.

*Methyl trans-3-(4-tert-butylphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2f**)* was prepared from acid **1f** (213 mg, 0.6 mmol). Yield 198 mg, 94%. Amorphous white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 – 8.09 (m, 1H), 7.59 – 7.45 (m, 2H), 7.30 (m, 2H), 7.27 (d, *J* = 8.3 Hz, 2H), 7.07 (d, *J* = 8.3 Hz, 2H), 5.68 (d, *J* = 1.3 Hz, 1H), 4.15 (d, *J* = 1.3 Hz, 1H), 3.76 (s, 3H), 1.27 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 160.3, 151.6, 133.8, 132.8, 131.7, 129.6, 128.7, 127.7, 126.3, 125.9, 125.9, 63.6, 53.2, 51.7, 34.5, 31.2. HRMS (ESI), m/z calcd for $C_{21}H_{24}NO_4$ [M+H]$^+$ 354.1700, found 354.1716.

*Methyl trans-2-hydroxy-3-(4-methylthiophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2g**)* was prepared from acid **1g** (190 mg, 0.6 mmol). Yield 150 mg, 73%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 6.0, 3.0 Hz, 1H), 7.55 – 7.45 (m, 2H), 7.27 – 7.21 (m, 1H), 7.16 (d, *J* = 8.4 Hz, 2H), 7.06 (d, *J* = 8.4 Hz, 2H), 5.66 (d, *J* = 2.2 Hz, 1H), 4.11 (d, *J* = 2.3 Hz, 1H), 3.75 (s, 3H), 2.44 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.4, 160.3, 139.2, 133.7, 132.7, 131.5, 129.4, 128.7, 127.7, 126.7, 126.5, 63.3, 53.1, 51.9, 15.5. HRMS (ESI), m/z calcd for $C_{18}H_{17}NO_4SNa$ [M+Na]$^+$ 366.0770, found 366.0786.

*Methyl trans-3-(3,5-dimethoxyphenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2h**)* was prepared from acid **1h** (140 mg, 0.4 mmol). Yield 130 mg, 91%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 6.0, 3.0 Hz, 1H), 7.53 – 7.43 (m, 2H), 7.26 – 7.21 (m, 1H), 6.36 (t, *J* = 2.0 Hz, 1H), 6.28 (d, *J* = 2.1 Hz, 2H), 5.62 (d, *J* = 2.1 Hz, 1H), 4.13 (d, *J* = 2.1 Hz, 1H), 3.75 (s, 3H), 3.70 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 161.1, 160.2, 139.6, 132.5, 131.6, 129.4, 128.6, 127.5, 126.7, 104.3, 100.1, 63.6, 55.3, 53.1, 51.8. HRMS (ESI), m/z calcd for $C_{19}H_{19}NO_6Na$ [M+Na]$^+$ 380.1105, found 380.1102.

*Methyl trans-3-(3-bromophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**2i**)* was prepared from acid **1i** (240 mg, 0.6 mmol). Yield 213 mg, 95%. Pink semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 5.5 Hz, 1H), 7.51 (m, 2H), 7.42 (d, *J* = 7.8 Hz, 1H), 7.36 (s, 1H), 7.27 – 7.21 (m, 1H), 7.17 (m, 1H), 7.07 – 6.99 (m, 1H), 5.67 (d, J = 1.6 Hz, 1H), 4.12 (d, *J* = 1.6 Hz, 1H), 3.76 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 170.2, 160.4, 139.6, 132.8, 131.7, 131.2, 130.5, 129.5, 129.4, 128.9, 127.8, 126.5, 124.7, 123.0, 63.1, 53.2, 51.8. HRMS (ESI), m/z calcd for $C_{17}H_{15}BrNO_4$ [M+H]$^+$ 376.0184, found 376.0179.

Methyl trans-2-hydroxy-3-(4-methoxycarbonylphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate ***(2j)*** was prepared from acid **1j** (250 mg, 0.7 mmol). Yield 240 mg, 97%. White solid, m.p. 88-90 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 5.8, 3.3 Hz, 1H), 7.96 (d, *J* = 8.3 Hz, 2H), 7.54 – 7.43 (m, 2H), 7.24 (d, *J* = 8.3 Hz, 2H), 7.23 – 7.18 (m, 1H), 5.76 (d, *J* = 2.1 Hz, 1H), 4.13 (d, *J* = 2.2 Hz, 1H), 3.90 (s, 3H), 3.75 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 166.4, 160.5, 142.2, 132.7, 131.2, 130.4, 130.2, 129.4, 128.8, 127.7, 126.6, 126.2, 63.4, 53.2, 52.2, 51.8. HRMS (ESI), m/z calcd for $C_{19}H_{17}NO_6Na$ $[M+Na]^+$ 378.0948, found 378.0933.

Methyl trans-3-(2-fluorophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate ***(2k)*** was prepared from acid **1k** (260 mg, 0.8 mmol). Yield 230 mg, 91%. White solid, m.p. 122-125 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (dd, *J* = 5.8, 3.3 Hz, 1H), 7.55 – 7.42 (m, 2H), 7.28 – 7.20 (m, 2H), 7.15 – 7.05 (m, 1H), 6.99 (t, *J* = 7.6 Hz, 1H), 6.87 (t, *J* = 7.7 Hz, 1H), 6.08 (d, *J* = 1.5 Hz, H), 4.17 (d, *J* = 1.5 Hz, 1H), 3.77 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 160.8, 159.7 (d, *J* = 246.5 Hz), 132.6, 131.4, 130.0 (d, *J* = 8.2 Hz), 129.7, 128.7, 127.6, 127.0 (d, *J* = 3.2 Hz), 126.6, 124.4 (d, *J* = 3.5 Hz), 124.2 (d, *J* = 12.8 Hz), 115.9 (d, *J* = 21.0 Hz), 58.0 (d, *J* = 3.5 Hz), 53.1 (d, *J* = 2.4 Hz), 50.2. HRMS (ESI), m/z calcd for $C_{17}H_{14}FNO_4Na$ $[M+Na]^+$ 338.0799, found 338.0813.

Methyl trans-3-(3,4-dichlorophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate ***(2l)*** was prepared from acid **1l** (210 mg, 0.6 mmol). Yield 202 mg, 92%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 6.7 Hz, 1H), 7.52 (m, 2H), 7.36 (d, *J* = 8.3 Hz, 1H), 7.29 (d, *J* = 5.6 Hz, 1H), 7.25 (d, *J* = 7.7 Hz, 1H), 6.98 (d, *J* = 8.3 Hz, 1H), 5.66 (d, *J* = 1.8 Hz, 1H), 4.10 (d, *J* = 1.8 Hz, 1H), 3.76 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.0, 160.5, 137.4, 133.2, 133.0, 132.8, 131.0, 130.9, 129.3, 129.0, 128.5, 127.9, 126.3, 125.5, 62.8, 53.3, 51.6. HRMS (ESI), m/z calcd for $C_{17}H_{14}Cl_2NO_4$ $[M+H]^+$ 366.0300, found 366.0294.

Methyl trans-3-(4-fluorophenyl)-2-hydroxy-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate ***(2m)*** was prepared from acid **1m** (250 mg, 0.8 mmol). Yield 241 mg, 96%. Pale pink solid, m.p. 115-117 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 – 8.10 (m, 1H), 7.54 – 7.46 (m, 2H), 7.27 – 7.21 (m, 1H), 7.14 (dd, *J* = 8.6, 5.2 Hz, 2H), 7.04 – 6.93 (m, 2H), 5.67 (d, *J* = 2.4 Hz, 1H), 4.11 (d, *J* = 2.5 Hz, 1H), 3.75 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.4, 162.6 (d, *J* = 247.3 Hz), 160.6, 133.1, 132.7, 131.4, 129.3, 128.7, 128.0 (d, *J* = 8.3 Hz), 127.7, 126.9, 115.9 (d, *J* = 21.7 Hz), 63.5, 53.1, 52.0. HRMS (ESI), m/z calcd for $C_{17}H_{15}FNO_4$ $[M+H]^+$ 316.0980, found 316.0994.

5. General procedure for the preparation of *NH*-tetrahydroisoquinolinic deruvatives 3a-m and the corresponding analytical data. To a vial fitted with a septum and N_2 inlet hydroxamic acid **2** (0.25-0.63 mmol) and NaOAc (12 equiv.) were added. The vial was flushed with N_2 and MeOH-H_2O mixture (1:1, 10 ml) was added. Then a 15% solution of $TiCl_3$ (5 ml) was added dropwise to the solution within 10 min. The mixture was stirred at room temperature and (TLC control) until completion of the reaction (12 h). The mixture was diluted with water, extracted with ethyl acetate (3 x 25 ml). The combined organic layers were dried over $MgSO_4$, filtered and concentrated to give pure lactams **3a-c,e,g**. Products **3d,f,h-m** were additionally purified by column chromatography on silica (eluting with 0→0.2% MeOH in CH_2Cl_2).

*Methyl trans-3-(4-methoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3a**)* was prepared from compound **2a** (165 mg, 0.5 mmol). Yield 105 mg, 68%. White solid, m.p. 139-141 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 (dd, *J* = 7.5, 1.3 Hz, 1H), 7.54 – 7.43 (m, 2H), 7.24 (d, *J* = 8.7 Hz, 2H), 7.14 (d, *J* = 7.4 Hz, 1H), 6.86 (d, *J* = 8.7 Hz, 2H), 6.20 (s, 1H), 5.18 (dd, *J* = 7.5, 2.4 Hz, 1H), 4.14 (d, *J* = 7.5 Hz, 1H), 3.80 (s, 3H), 3.70 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.2, 165.2, 159.7, 134.5, 132.8, 131.1, 128.3, 128.2, 128.1, 127.9, 127.3, 114.3, 56.9, 55.3, 52.6, 52.5. HRMS (ESI), m/z calcd for $C_{18}H_{17}NO_4Na$ $[M+Na]^+$ 334.1050, found 334.1059.

*Methyl trans-3-(2,4-dimethoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3b**)* was prepared from compound **2b** (190 mg, 0.5 mmol). Yield 130 mg, 76%. White solid, m.p. 188-190 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 – 8.11 (m, 1H), 7.46 (m, 2H), 7.22 (d, *J* = 7.4 Hz, 1H), 6.94 (d, *J* = 8.5 Hz, 1H), 6.46 (d, *J* = 2.3 Hz, 1H), 6.32 (dd, *J* = 8.5, 2.3 Hz, 1H), 6.17 (d, *J* = 3.3 Hz, 1H), 5.55 (t, J = 3.8 Hz, 1H), 4.20 (d, *J* = 3.4 Hz, 1H), 3.88 (s, 3H), 3.76 (s, 3H), 3.72 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.4, 165.2, 160.7, 157.3, 134.4, 132.5, 128.9, 128.3, 128.2, 128.0, 127.8, 120.0, 103.9, 98.8, 55.5, 55.3, 52.6, 50.9, 48.8. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_5$ $[M+H]^+$ 342.1336, found 342.1345.

*Methyl trans-3-(3,4-dimethoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3c**)* was prepared from compound **2c** (170 mg, 0.47 mmol). Yield 44 mg, 28%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (d, *J* = 7.4 Hz, 1H), 7.60 – 7.39 (m, 2H), 7.15 (d, *J* = 7.6 Hz, 1H), 6.87 (dd, *J* = 8.3, 1.7 Hz, 1H), 6.82 (d, *J* = 8.2 Hz, 2H), 6.09 (s, 1H), 5.18 (dd, *J* = 7.6, 2.2 Hz, 1H), 4.16 (d, *J* = 7.6 Hz, 1H), 3.87 (s, 3H), 3.84 (s, 3H), 3.72 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.2, 165.1, 149.3, 149.2, 134.5, 132.7, 131.5, 128.4, 128.2, 128.1, 127.3, 119.2, 111.2, 109.5, 57.2, 55.9, 55.9, 52.7, 52.5. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_5$ $[M+H]^+$ 342.1336, found 342.1346.

*Methyl trans-3-(3-benzyloxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3d**)* was prepared from **2d** (150 mg, 0.37 mmol). Yield 74 mg, 52%. Analytical pure sample was obtained after column chromatography. Amorphous solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 (d, *J* = 7.2 Hz, 1H), 7.48 (m, 2H), 7.42 – 7.32 (m, 5H), 7.25 (t, *J* = 7.9 Hz, 1H), 7.15 (d, *J* = 7.3 Hz, 1H), 6.99 – 6.84 (m, 3H), 6.16 (s, 1H), 5.29 – 5.19 (m, 1H), 5.07 – 4.98 (m, 2H), 4.15 (d, *J* = 6.5 Hz, 1H), 3.71 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.1, 165.0, 159.1, 141.0, 136.6, 134.1, 132.8, 130.1, 128.6, 128.4, 128.2, 128.1, 128.1, 127.7, 127.5, 119.1, 114.9, 113.2, 70.0, 57.1, 52.6, 52.3. HRMS (ESI), m/z calcd for $C_{24}H_{22}NO_4$ [M+H]$^+$ 388.1543, found 388.1555.

*Methyl trans-3-(2,6-dimethoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3e**)* was prepared from compound **2e** (88 mg, 0.25 mmol). Yield 70 mg, 82%. White semi-solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (d, *J* = 7.5 Hz, 1H), 7.57 – 7.45 (m, 1H), 7.41 (m, 1H), 7.31 – 7.23 (m, 2H), 7.16 (t, *J* = 8.9 Hz, 1H), 6.57 (d, *J* = 8.4 Hz, 1H), 5.94 (s, 1H), 5.87 (dd, *J* = 9.4, 1.8 Hz, 1H), 4.83 (d, *J* = 9.4 Hz, 1H), 3.76 (s, 6H), 3.65 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.9, 165.4, 159.0, 137.0, 132.2, 130.3, 128.5, 128.1, 127.6, 126.3, 113.5, 104.3, 55.8, 52.1, 48.6, 48.5. HRMS (ESI), m/z calcd for $C_{19}H_{20}NO_5$ [M+H]$^+$ 342.1336, found 342.1347.

*Methyl trans-3-(4-tert-butylphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3f**)* was prepared from **2f** (200 mg, 0.57 mmol). Yield 46 mg, 37% after column chromatography. Amorphous solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.55 – 7.41 (m, 2H), 7.35 (d, *J* = 8.4 Hz, 2H), 7.23 (d, *J* = 8.3 Hz, 2H), 7.16 (d, *J* = 7.3 Hz, 1H), 6.15 (s, 1H), 5.23 (dd, *J* = 6.6, 2.4 Hz, 1H), 4.16 (d, *J* = 6.6 Hz, 1H), 3.71 (s, 3H), 1.30 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.2, 165.0, 151.6, 136.3, 134.3, 132.7, 128.3, 128.2, 128.2, 127.7, 126.3, 125.9, 56.9, 52.6, 52.2, 34.6, 31.2. HRMS (ESI), m/z calcd for $C_{21}H_{24}NONa$ [M+Na]$^+$ 360.1570, found 360.1570.

*Methyl trans-3-(4-methylthiophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3g**)* was prepared from compound **2g** (120 mg, 0.35 mmol). Yield 50 mg, 44%**.** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 (dd, *J* = 7.5, 1.4 Hz, 1H), 7.57 – 7.39 (m, 2H), 7.26 – 7.17 (m, 4H), 7.15 (d, *J* = 7.3 Hz, 1H), 6.08 (s, 1H), 5.22 (dd, *J* = 6.8, 2.6 Hz, 1H), 4.13 (d, *J* = 6.8 Hz, 1H), 3.72 (s, 3H), 2.48 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.0, 165.0, 139.2, 135.9, 134.1, 132.8, 128.4, 128.2, 128.1, 127.6, 127.1, 126.6, 56.8, 52.6, 52.3, 15.5. HRMS (ESI), m/z calcd for $C_{18}H_{18}NO_3S$ [M+H]$^+$ 328.1002, found 328.1014.

*Methyl trans-3-(3,5-dimethoxyphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3h**)* was prepared from compound **2h** (103 mg, 0.29 mmol). Yield 52 mg, 53%. Analytical pure sample was obtained after column chromatography Amorphous solid. ^{1}H NMR (400 MHz,

$CDCl_3$) δ 8.18 (d, *J* = 7.4 Hz, 1H), 7.48 (dt, *J* = 20.3, 7.4 Hz, 2H), 7.16 (d, *J* = 7.3 Hz, 1H), 6.43 (t, *J* = 8.4 Hz, 2H), 6.39 (s, 1H), 6.09 (s, 1H), 5.32 (s, 1H), 5.18 (dd, *J* = 6.5, 2.4 Hz, 1H), 4.15 (d, *J* = 6.6 Hz, 1H), 3.75 (s, 6H), 3.73 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.1, 164.9, 161.2, 141.7, 134.2, 132.8, 128.4, 128.2, 128.1, 127.6, 104.6, 100.3, 57.3, 55.4, 52.6, 52.3. HRMS (ESI), m/z calcd for $C_{19}H_{19}NO_5Na$ $[M+Na]^+$ 364.1155, found 364.1173.

*Methyl trans-3-(3-bromophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3i**)* was prepared from compound **2i** (200 mg, 0.53 mmol). Yield 92 mg, 48% after column chromatography. Amorphous solid. ^1H NMR (400 MHz, $CDCl_3$) δ 8.22 – 8.15 (m, 1H), 7.55 – 7.42 (m, 4H), 7.25 – 7.21 (m, 1H), 7.21 – 7.13 (m, 2H), 6.19 (s, 1H), 5.26 (dd, *J* = 5.8, 2.7 Hz, 1H), 4.11 (d, *J* = 6.0 Hz, 1H), 3.73 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.8, 164.9, 141.8, 133.6, 133.0, 131.7, 130.5, 129.7, 128.6, 128.3, 128.0, 127.9, 125.2, 123.0, 56.6, 52.8, 52.0. HRMS (ESI), m/z calcd for $C_{17}H_{14}BrNO_3Na$ $[M+Na]^+$ 382.0049, found 382.0042.

*Methyl trans-3-(4-methoxycarbonylphenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3j**)* was prepared from compound **2j** (200 mg, 0.56 mmol). Yield 75 mg, yield 40% after column chromatography. Amorphous solid. ^1H NMR (400 MHz, $CDCl_3$) δ 8.14 (s, 1H), 7.97 (d, *J* = 6.2 Hz, 2H), 7.58 – 7.40 (m, 2H), 7.15 (d, *J* = 7.1 Hz, 2H), 7.11 – 6.77 (m, 1H), 7.02 (s, 1H), 5.38 (s, 1H), 4.12 (d, *J* = 3.9 Hz, 1H), 3.90 (s, 3H), 3.70 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.7, 166.1, 164.5, 145.2, 133.5, 132.5, 129.6, 129.5, 128.5, 128.3, 128.2, 127.4, 126.4, 55.8, 52.4, 51.8, 50.9. HRMS (ESI), m/z calcd for $C_{19}H_{18}NO_5$ $[M+H]^+$ 340.1179, found 340.1188.

*Methyl trans-3-(2-fluorophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3k**)* was prepared from compound **2k** (200 mg, 0.63 mmol). Yield 150 mg, 80% after column chromatography. Amorphous solid. ^1H NMR (400 MHz, $CDCl_3$) δ 8.19 – 8.13 (m, 1H), 7.53 – 7.41 (m, 2H), 7.29 – 7.24 (m, 1H), 7.22 (d, *J* = 7.5 Hz, 1H), 7.18 – 6.96 (m, 3H), 6.25 (s, 1H), 5.67 (t, *J* = 3.7 Hz, 1H), 4.16 (d, *J* = 3.5 Hz, 1H), 3.74 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 160.8, 160.0 (d, *J* = 246.5 Hz), 132.6, 131.4, 130.0 (d, *J* = 8.2 Hz), 129.7, 128.7, 127.6, 127.0 (d, *J* = 3.2 Hz), 126.6, 124.4 (d, *J* = 3.5 Hz), 124.2 (d, *J* = 12.8 Hz), 115.9 (d, *J* = 21.0 Hz), 58.0 (d, *J* = 3.5 Hz), 53.1 (d, *J* = 2.4 Hz), 50.2. HRMS (ESI), m/z calcd for $C_{17}H_{14}FNO_3Na$ $[M+Na]^+$ 322.0855, found 322.0850.

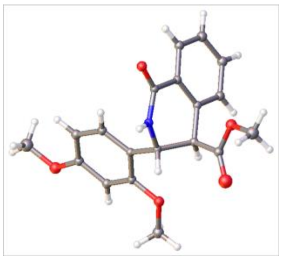
*Methyl trans-3-(3,4-dichlorophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate (**3l**)* was prepared from compound **2l** (125 mg, 0.34 mmol). Yield 82 mg, 70% after column chromatography. Amorphous solid. ^1H NMR (400 MHz, $CDCl_3$) δ 8.27 – 8.11 (m, 1H), 7.63 – 7.44 (m, 2H), 7.41 (m, 2H), 7.22 – 7.09 (m, 2H), 6.07 (s, 1H), 5.26 (dd, *J* = 5.7, 3.3 Hz, 1H), 4.08 (d, *J* = 5.7 Hz, 1H), 3.74 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 164.7, 139.8, 133.3, 133.2, 133.1, 132.7, 130.9, 128.7, 128.6, 128.3, 128.0, 127.9, 125.8, 56.1, 52.9, 51.9. HRMS (ESI), m/z calcd for $C_{17}H_{13}Cl_2NO_3Na$ [M+Na]$^+$ 372.0165, found 372.0180.

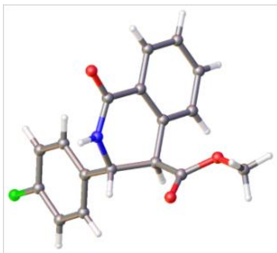
4.5.13. Methyl trans-3-(4-fluorophenyl)-1-oxo-1,2,3,4-tetrahydroisoquinoline-4-carboxylate ***(3m)*** was prepared from compound **2m** (171 mg, 0.5 mmol). Yield 64 mg, 43%. Analytical pure sample was obtained after column chromatography. Amorphous solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (dd, *J* = 7.5, 1.4 Hz, 1H), 7.50 (m, 2H), 7.36 – 7.27 (m, 3H), 7.15 (d, *J* = 7.3 Hz, 1H), 7.04 (t, *J* = 8.6 Hz, 2H), 6.07 (s, 1H), 5.25 (dd, *J* = 6.9, 2.6 Hz, 1H), 4.12 (d, *J* = 6.9 Hz, 1H), 3.71 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.0, 165.0, 162.7 (d, *J* = 247.9 Hz), 135.1 (d, *J* = 3.2 Hz), 134.0, 133.0, 128.5 (d, *J* = 6.3 Hz), 128.4, 128.3, 128.0, 127.5, 116.0 (d, *J* = 21.7 Hz), 56.7, 52.7, 52.5. HRMS (ESI), m/z calcd for $C_{17}H_{15}FNO_3$ [M+H]$^+$ 300.1030, found 300.1024.

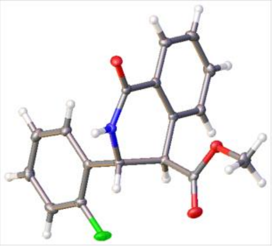
6. Crystallographic data for compounds 3b, 3k, 3m.

Suitable crystals of **3k** and **3m** were studied using Xcalibur, Eos diffractometer (monochromated Mo*Kα* radiation, λ = 0.71073 Å). Suitable crystals of **3b** were studied using a SuperNova, Single source at offset/far, HyPix3000 diffractometer. Temperature was kept at 100(10), 293.23 (10) and 293(2) K. Using Olex2,[S3] the structure was solved with the ShelXS[S4] structure solution program using Direct Methods and refined with the ShelXL[S5] refinement package using Least Squares minimisation.

Table S1. Crystal data and structure refinement for compounds **3b, 3k, 3m.**



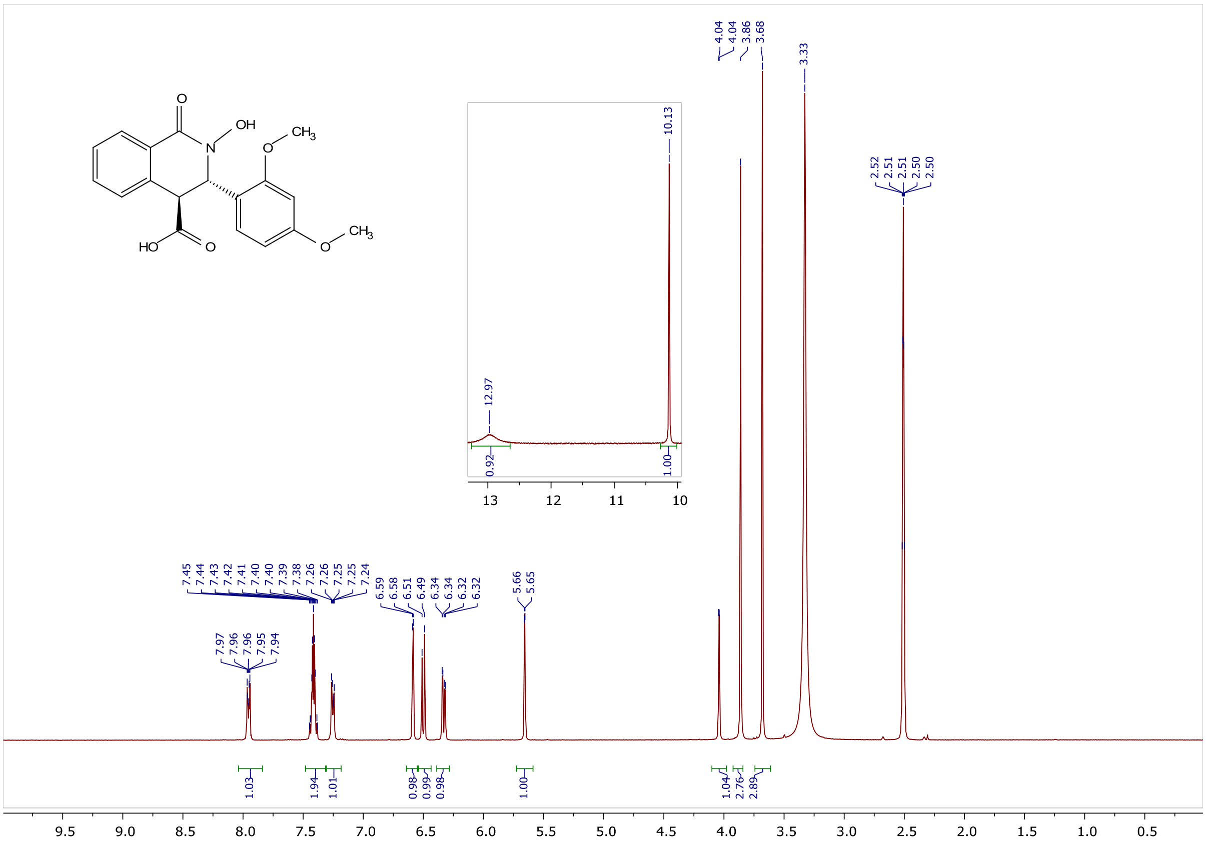


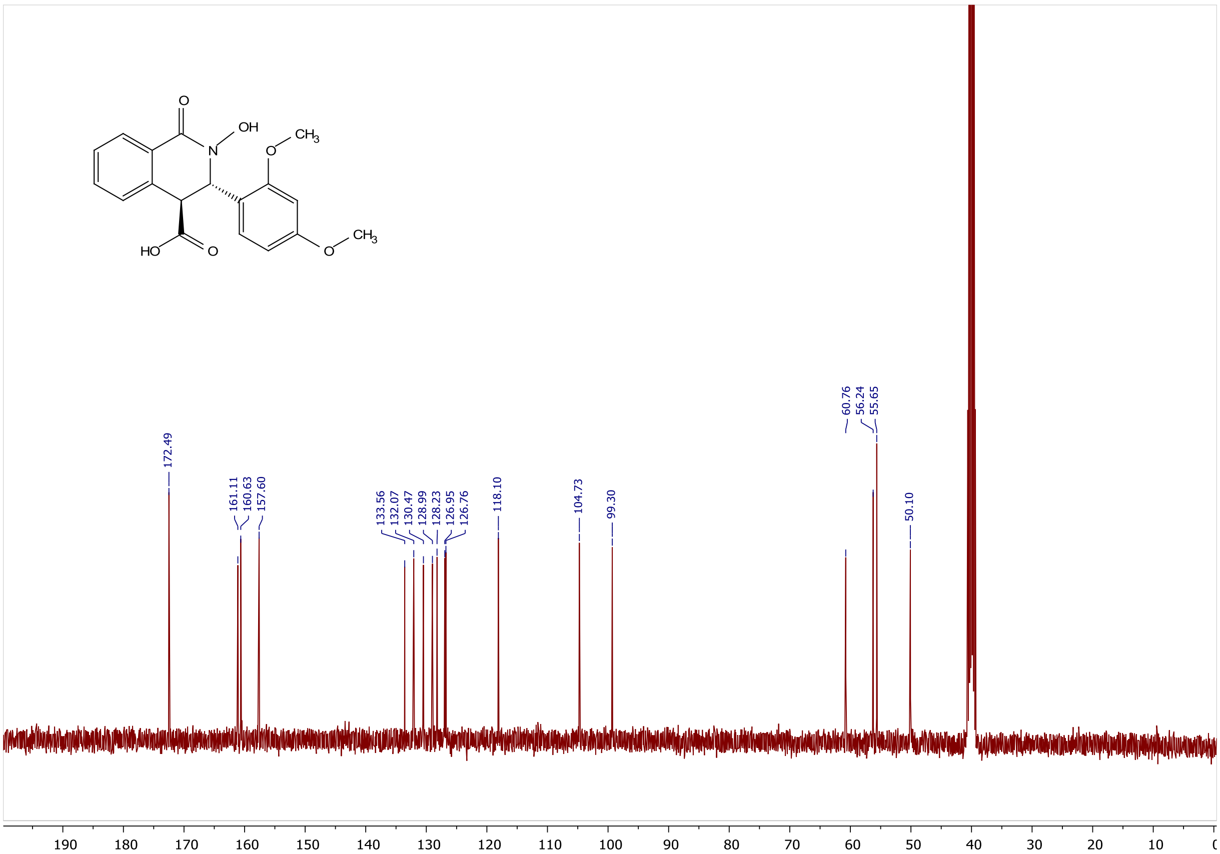


Identification code	**3b**	**3m**	**3k**
Empirical formula	$C_{19}H_{19}NO_5$	$C_{17}H_{14}FNO_3$	$C_{17}H_{14}FNO_3{\cdot}CHCl_3$
Formula weight	341.35	299.29	418.67
Temperature/K	293(2)	100(10)	293.23(10)
Crystal system	triclinic	Monoclinic	Triclinic
Space group	P-1	$P2_1/c$	P-1
a/Å	9.0077(4)	8.6881(4)	7.9446(2)
b/Å	9.6470(5)	13.7850(4)	10.2448(3)
c/Å	10.7733(5)	12.8469(7)	12.3622(3)
α/°	100.470(4)	90	68.059(3)
β/°	103.983(4)	108.733(5)	77.131(3)
γ/°	108.854(5)	90	83.226(3)
Volume/$Å^3$	824.56(7)	1457.11(12)	909.18(5)
Z	2	4	2
ρ_{calc} g cm^{-3}	1.375	1.364	1.529
μ/mm^{-1}	0.100	0.102	0.532
F(000)	360.0	624.0	428.0
Crystal size/mm^3	0.6 × 0.5 × 0.4	0.7 × 0.4 × 0.3	0.6 × 0.5 × 0.3
Radiation	MoKα (λ = 0.71073)	MoKα (λ = 0.71073)	MoKα (λ = 0.71073)
2Θ range for data collection/°	5.24 to 61.858	5.766 to 55	5.782 to 54.994
Index ranges	$-12 \le h \le 12$, $-13 \le k \le 13$, $-15 \le l \le 14$	$-11 \le h \le 9$, $-17 \le k \le 17$, $-15 \le l \le 16$	$-10 \le h \le 10$, $-13 \le k \le 13$, $-16 \le l \le 16$
Reflections collected	15259	12811	15222
Independent reflections	4740 [Rint = 0.0329, Rsigma = 0.0373]	3357 [Rint = 0.0301, Rsigma = 0.0263]	4157 [Rint = 0.0237, Rsigma = 0.0219]
Data/restraints/parameters	4740/0/104	3357/0/200	4157/0/236
Goodness-of-fit on F^2	1.038	1.036	1.027
Final R indexes [I ≥ 2σ (I)]	R1 = 0.0818, wR2 = 0.2066	R1 = 0.0393, wR2 = 0.0965	R1 = 0.0636, wR2 = 0.1397
Final R indexes [all data]	R1 = 0.0970, wR2 = 0.2218	R1 = 0.0491, wR2 = 0.1044	R1 = 0.0689, wR2 = 0.1433
Largest diff. peak/hole / e $Å^{-3}$	1.54/-1.00	0.28/-0.20	1.35/-1.41
CCDC	**1854033**	**1854031**	**1854032**

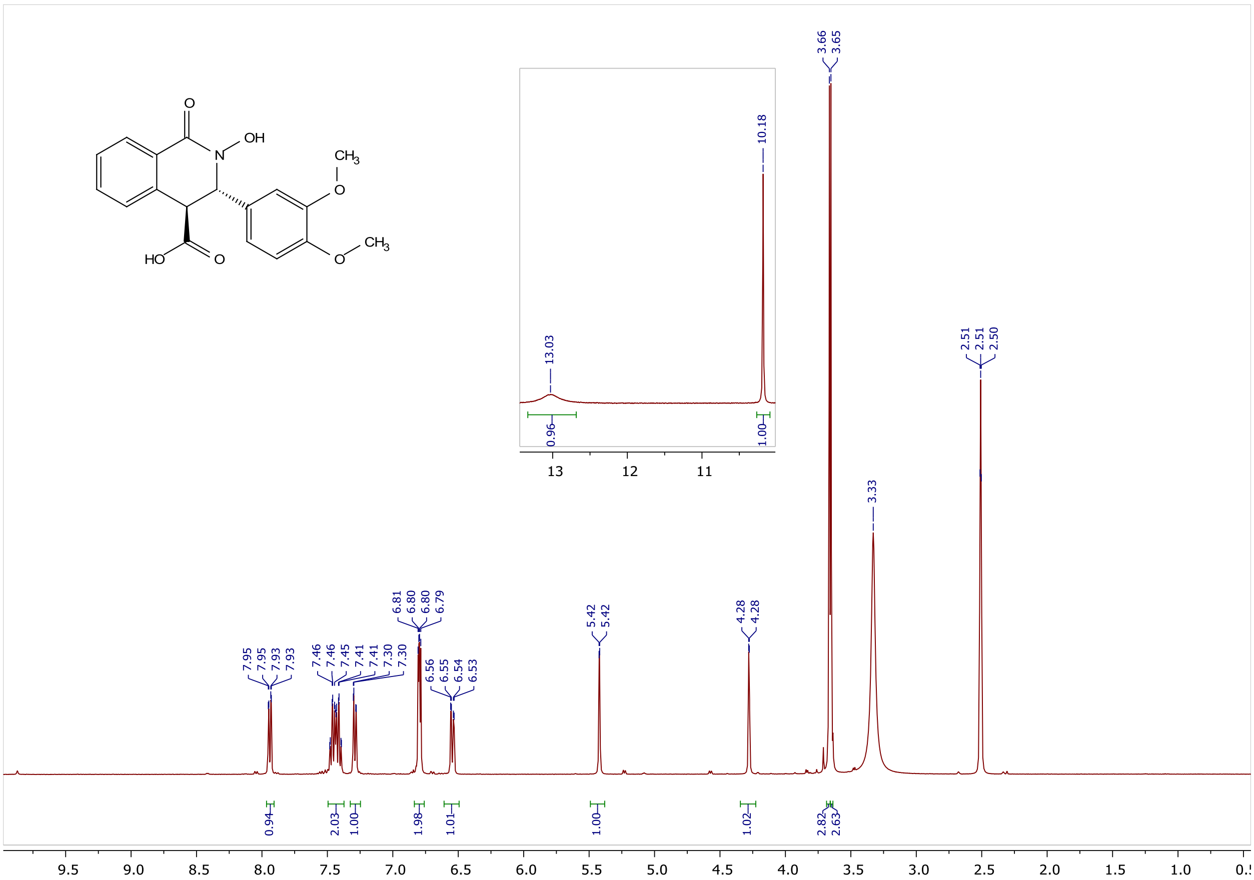
7. Copies of ^{1}H and ^{13}C spectra for compounds 1b, c, f-i, l, 2a-m, 3a-m.

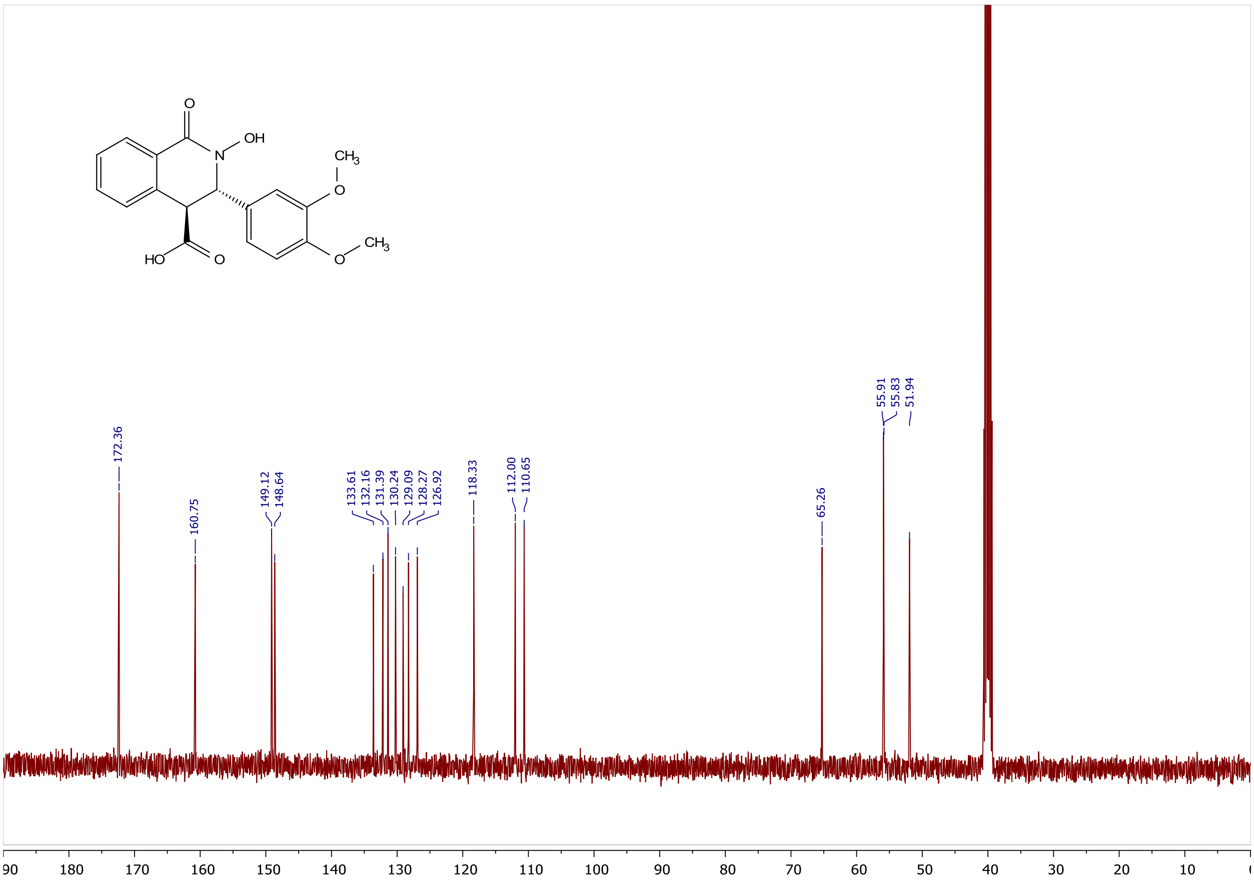
^{1}H and ^{13}C NMR of compound **1b**





^{1}H and ^{13}C NMR of compound **1c**





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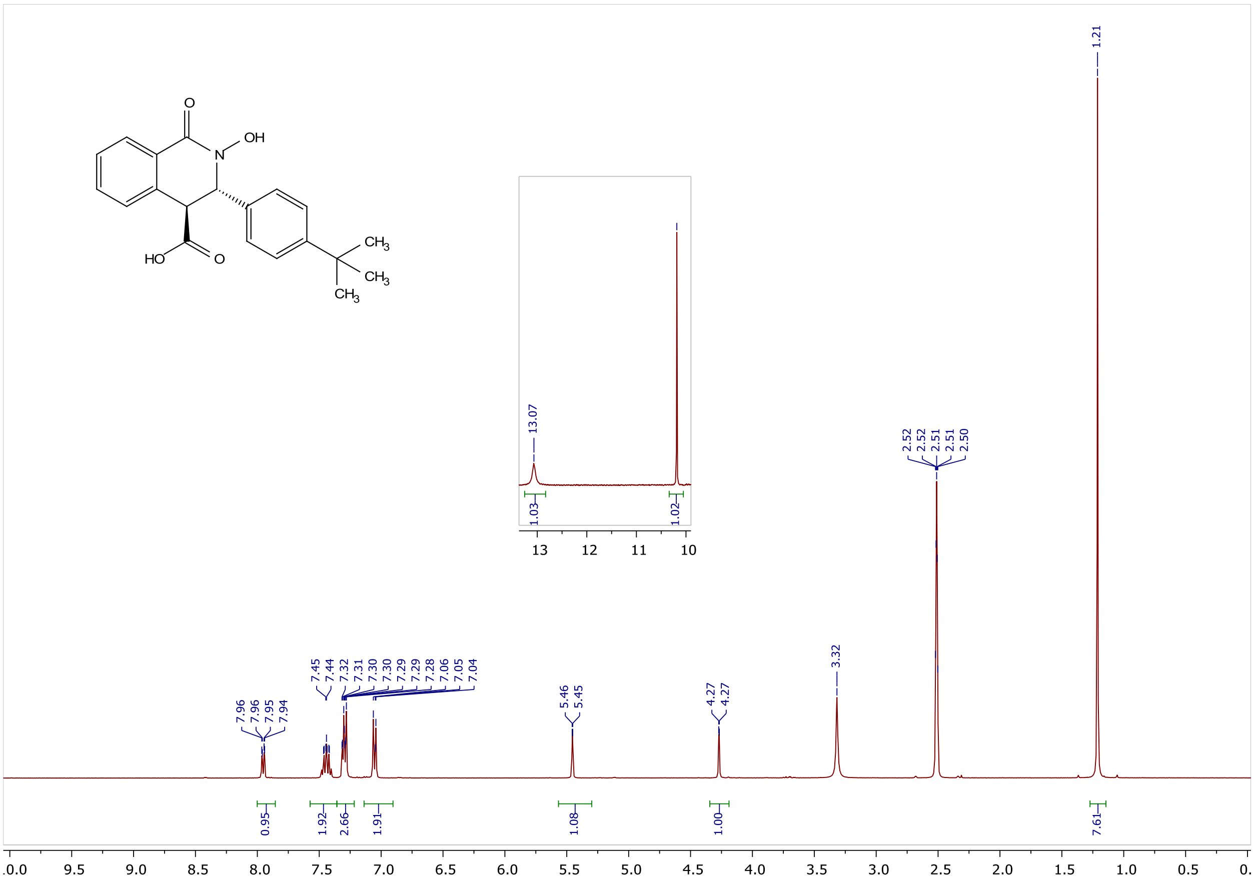

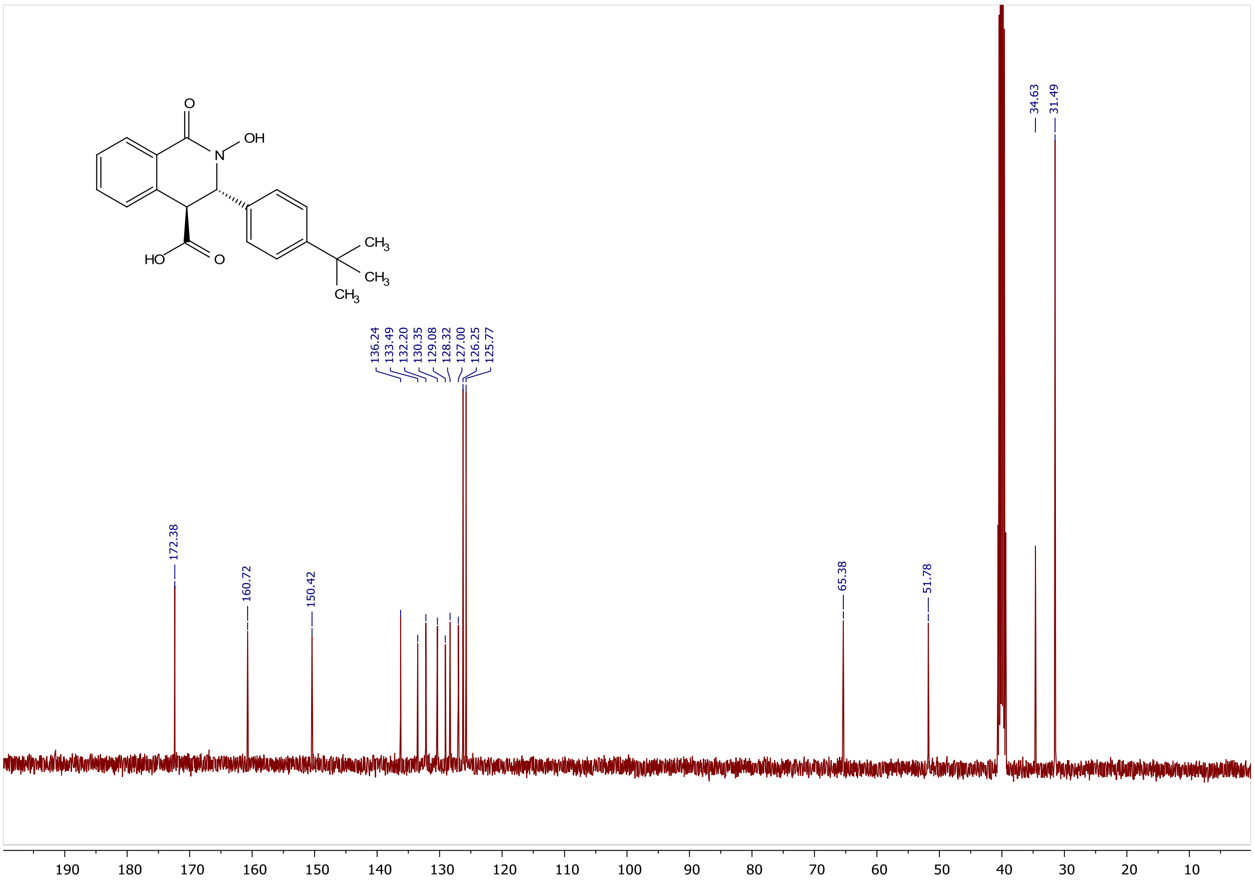

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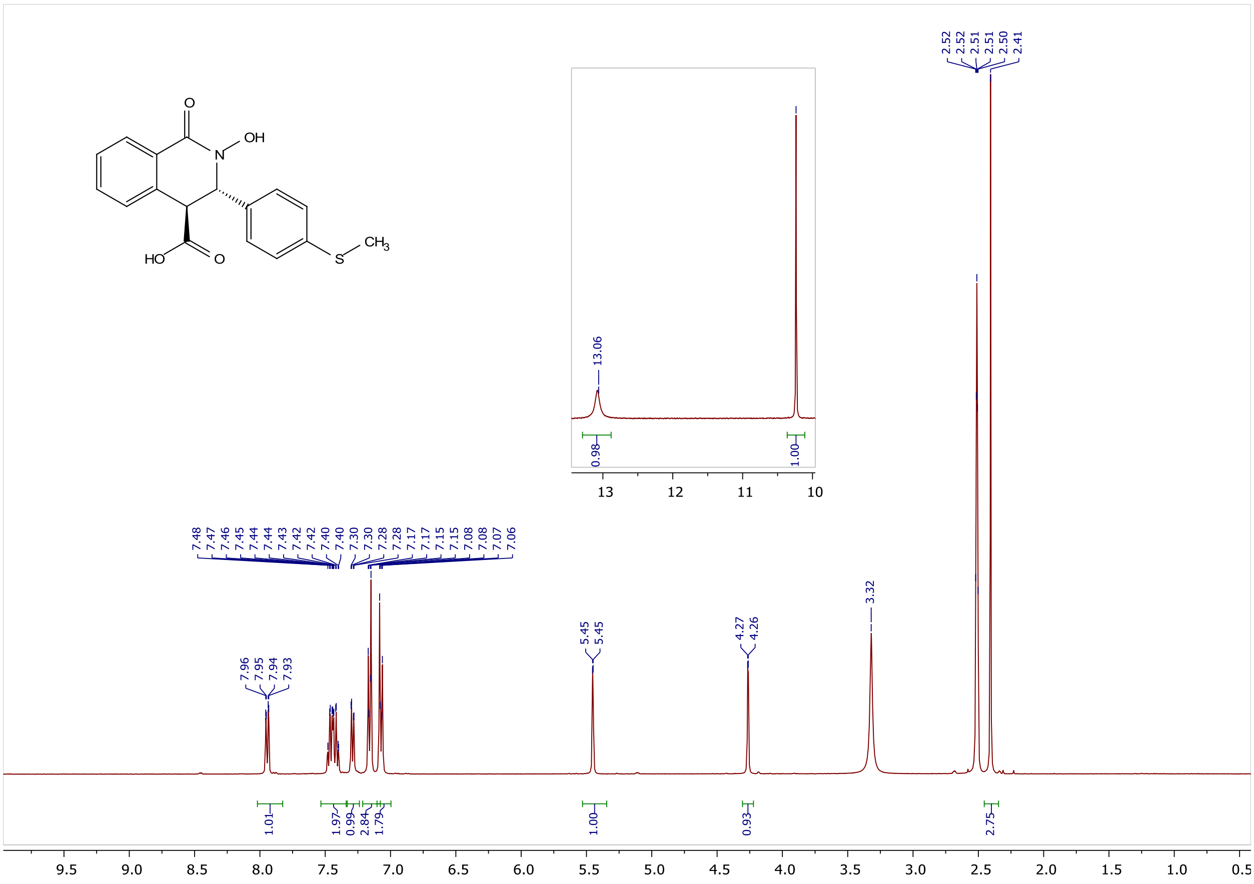
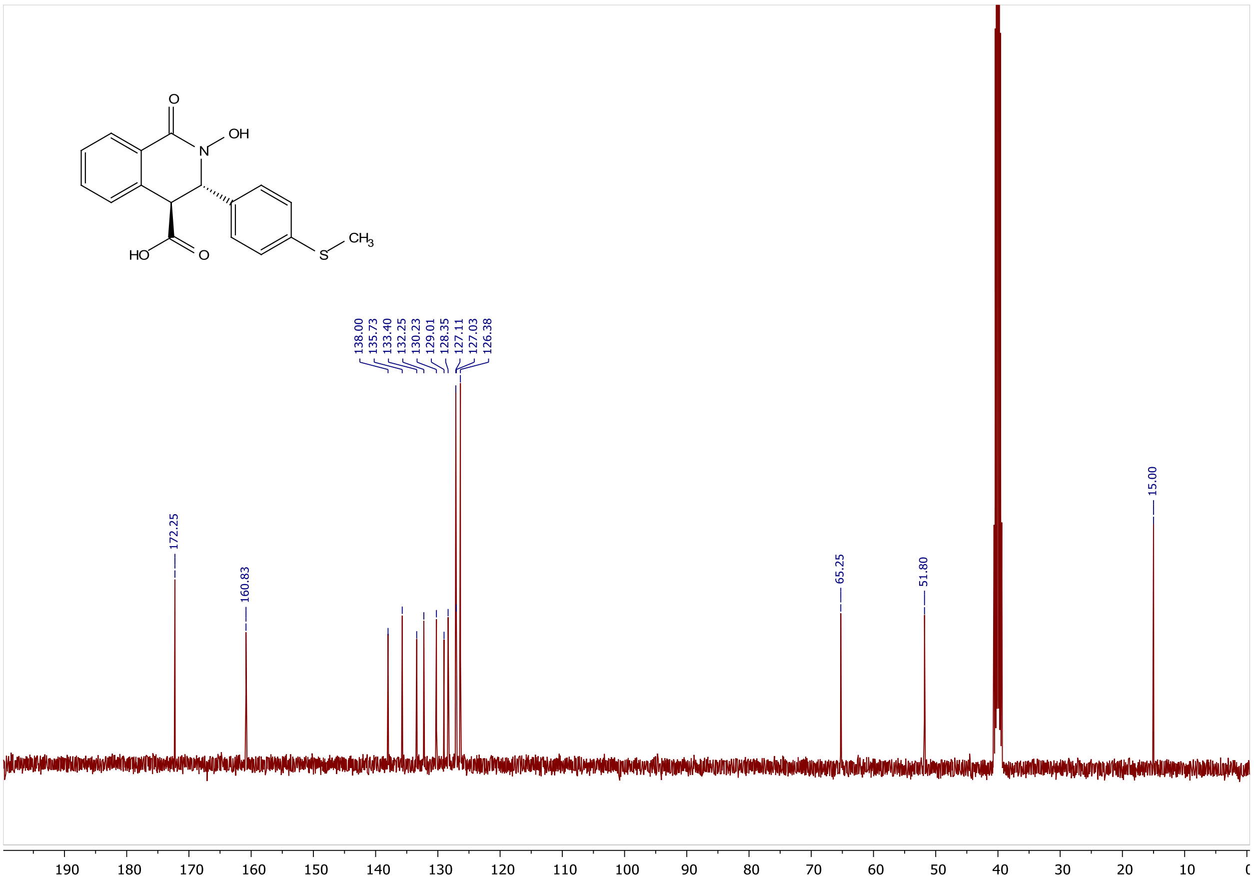
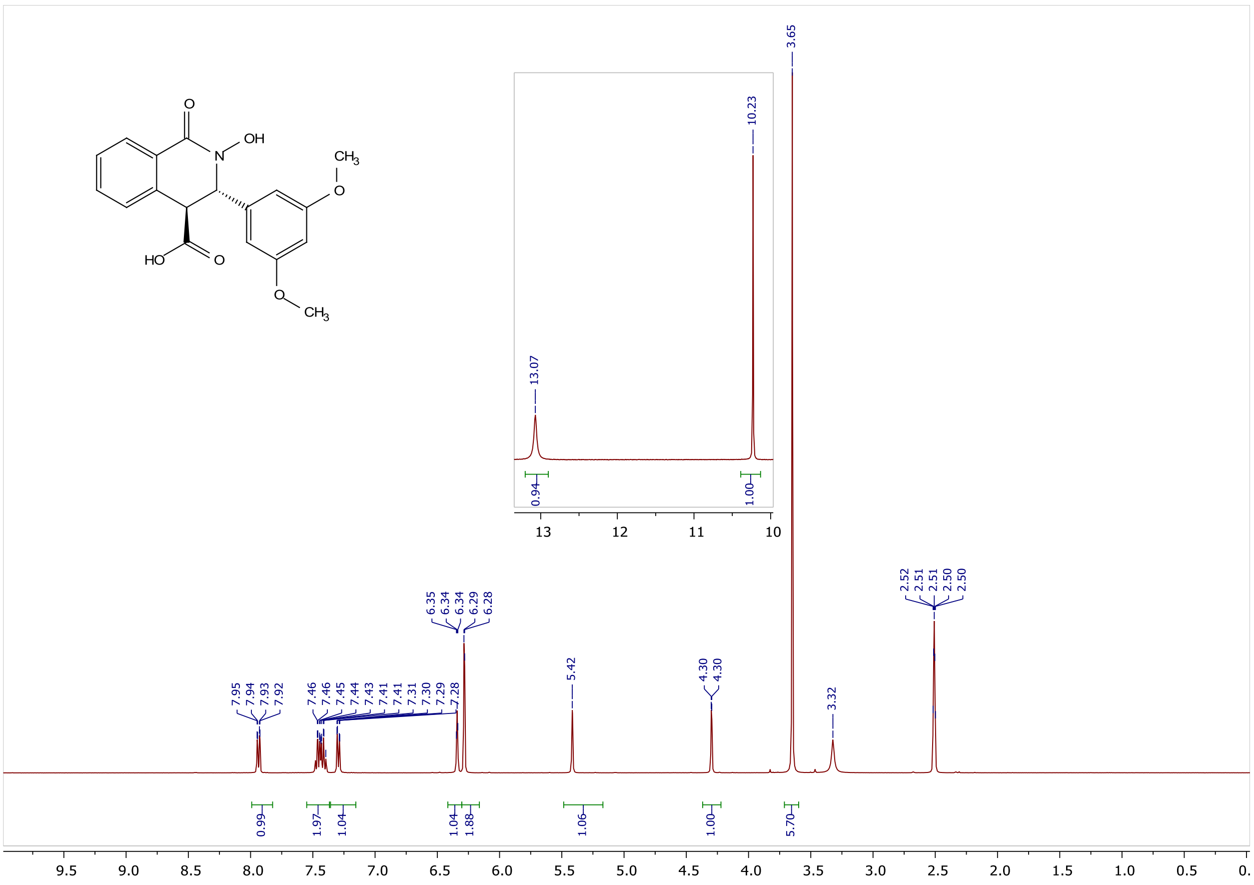
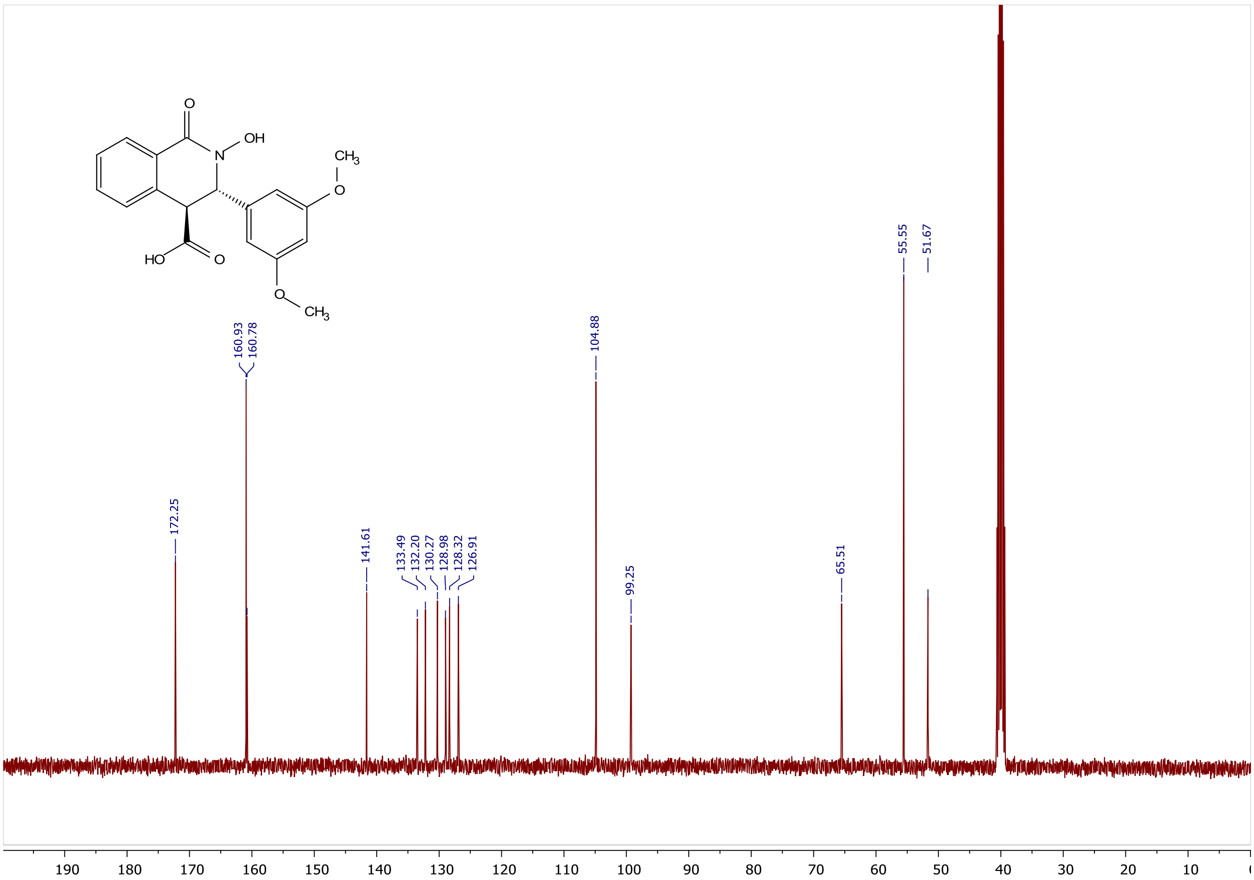


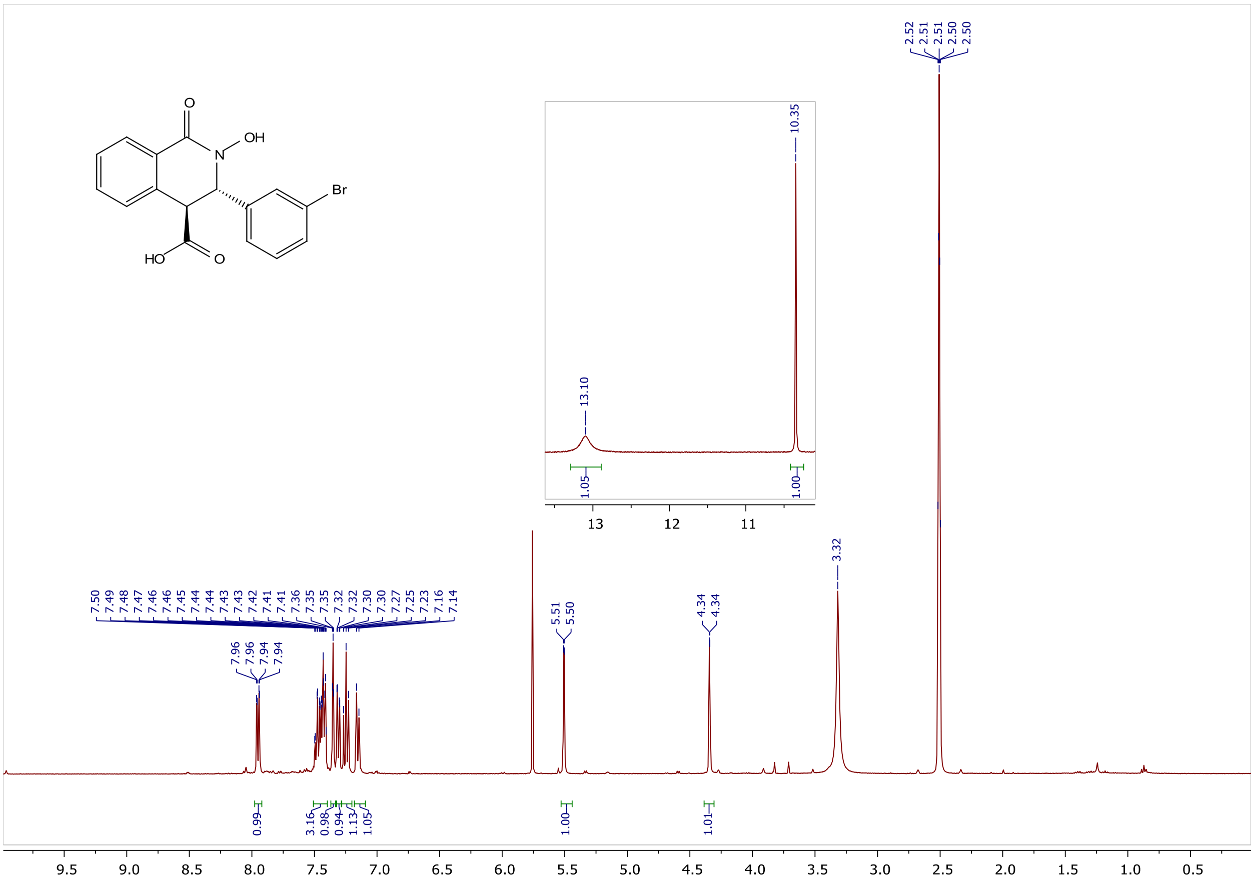


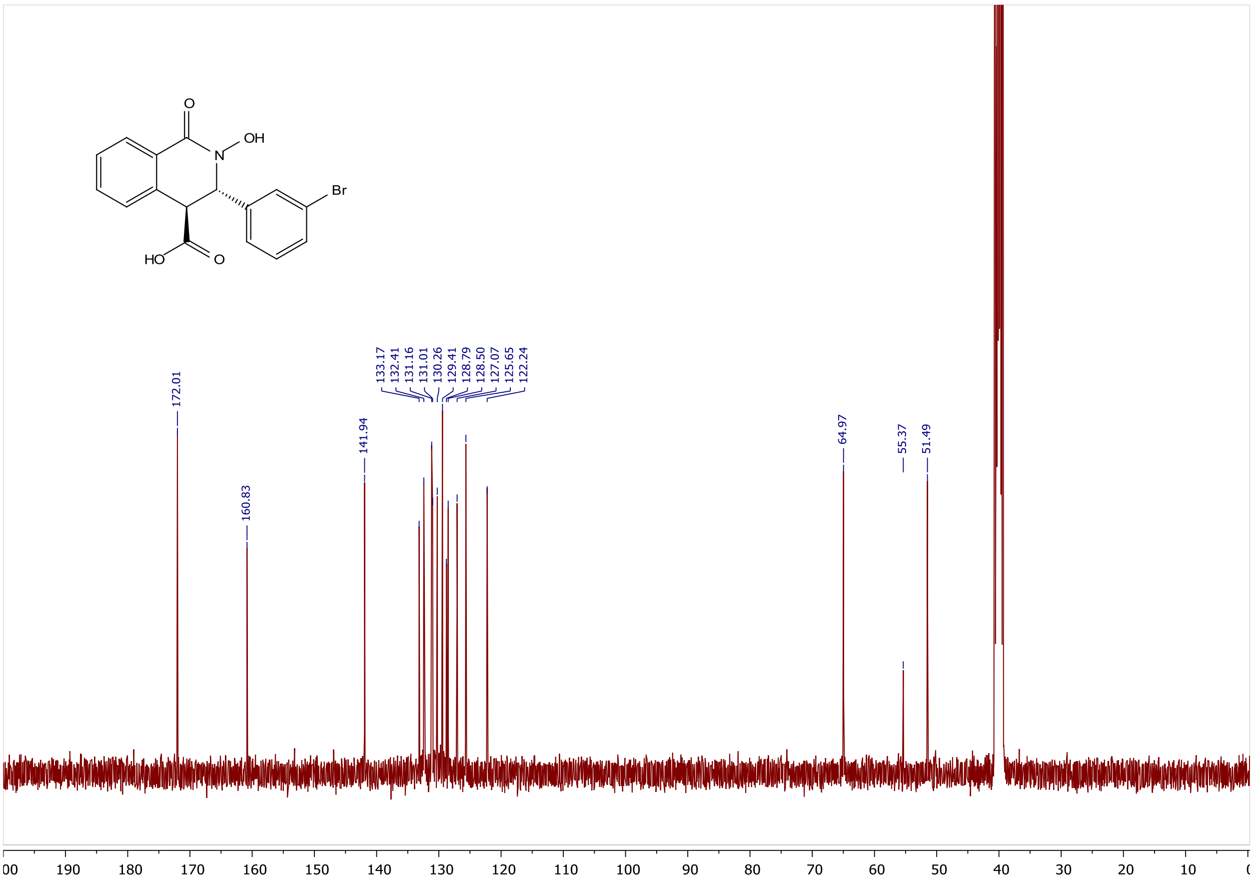
^{1}H and ^{13}C NMR of compound **1h**



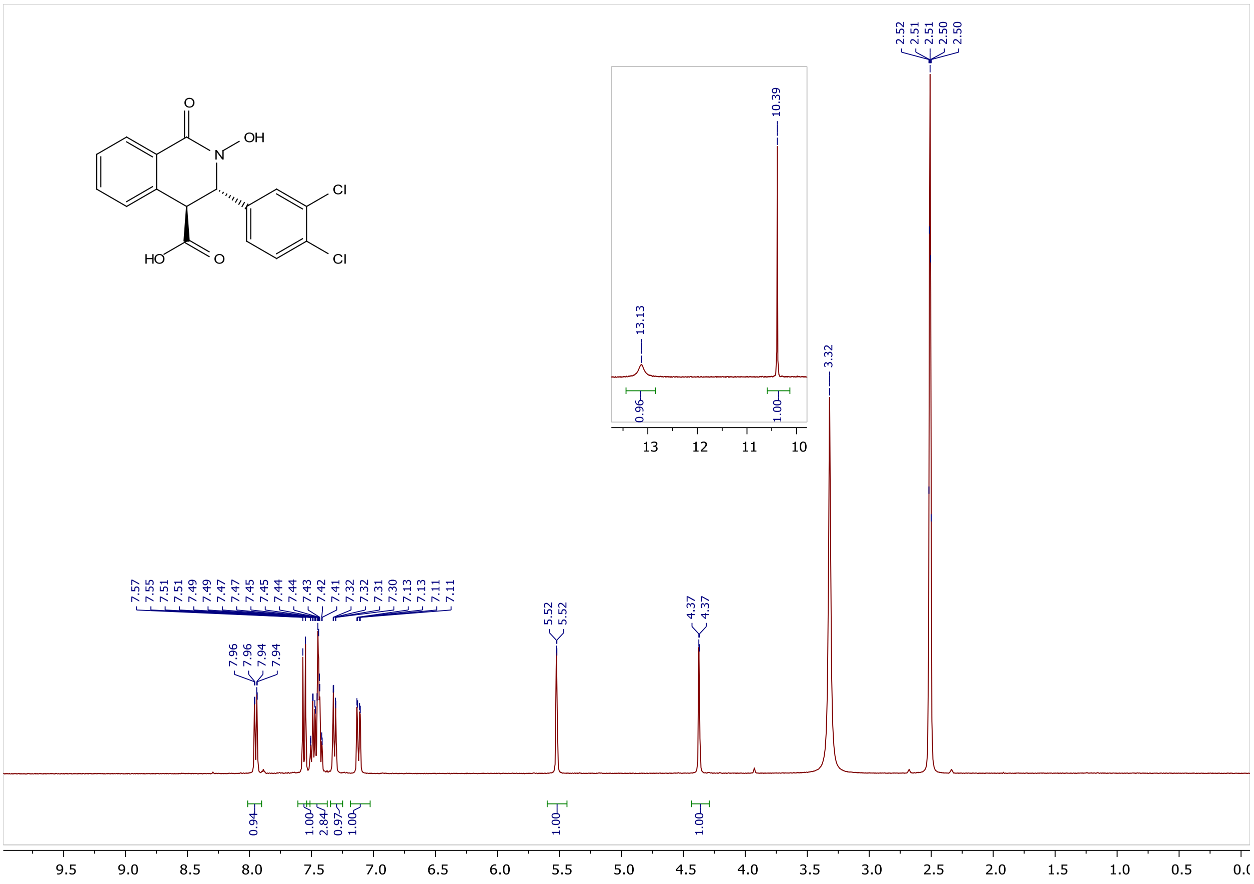


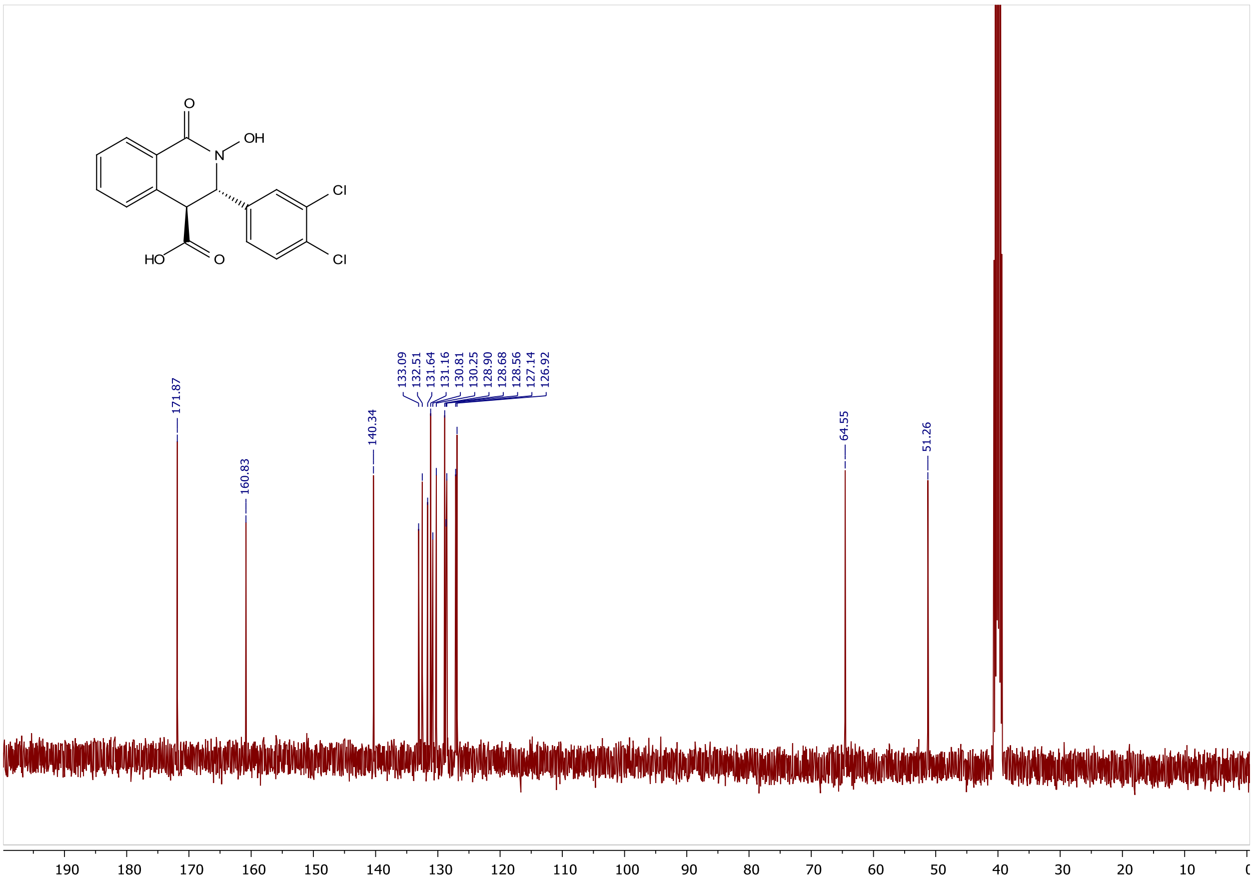
^{1}H and ^{13}C NMR of compound **1i**



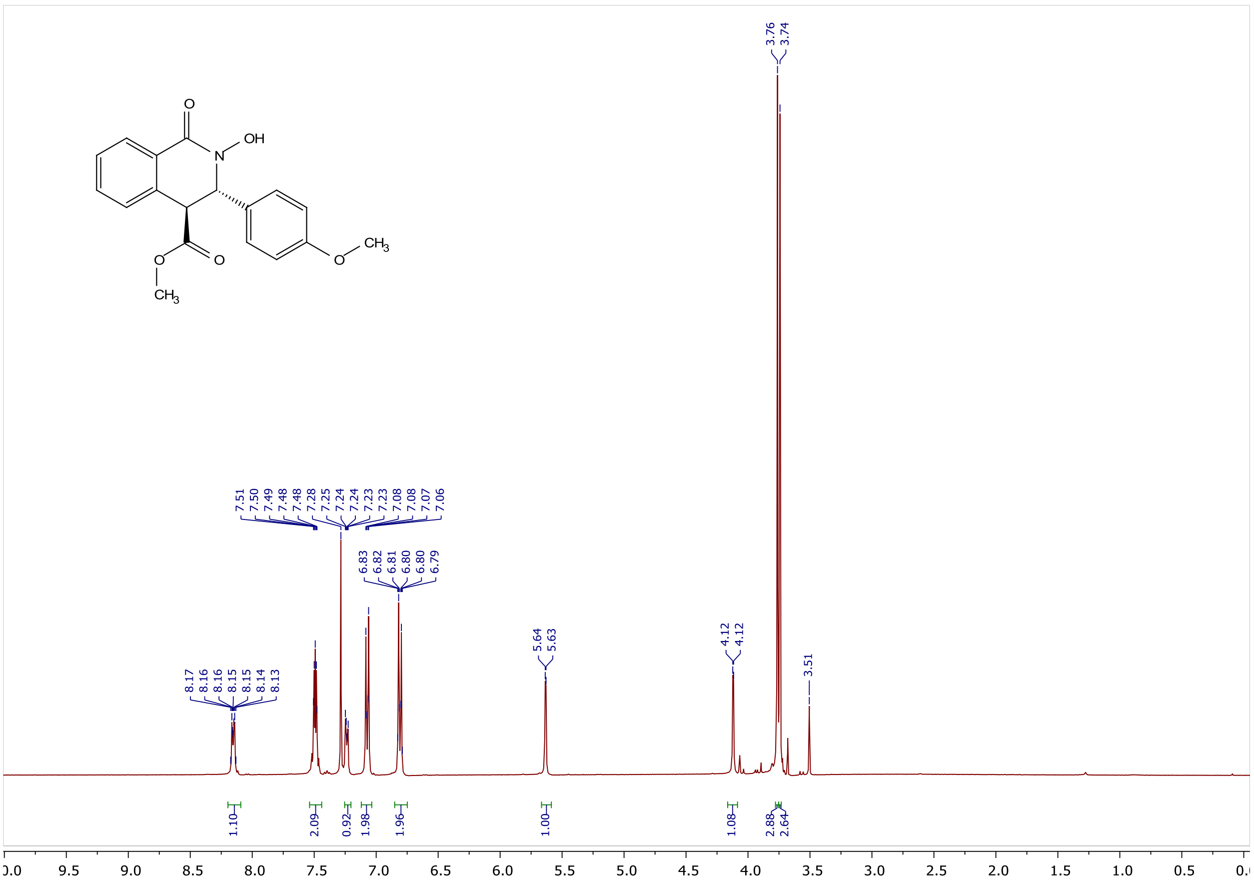


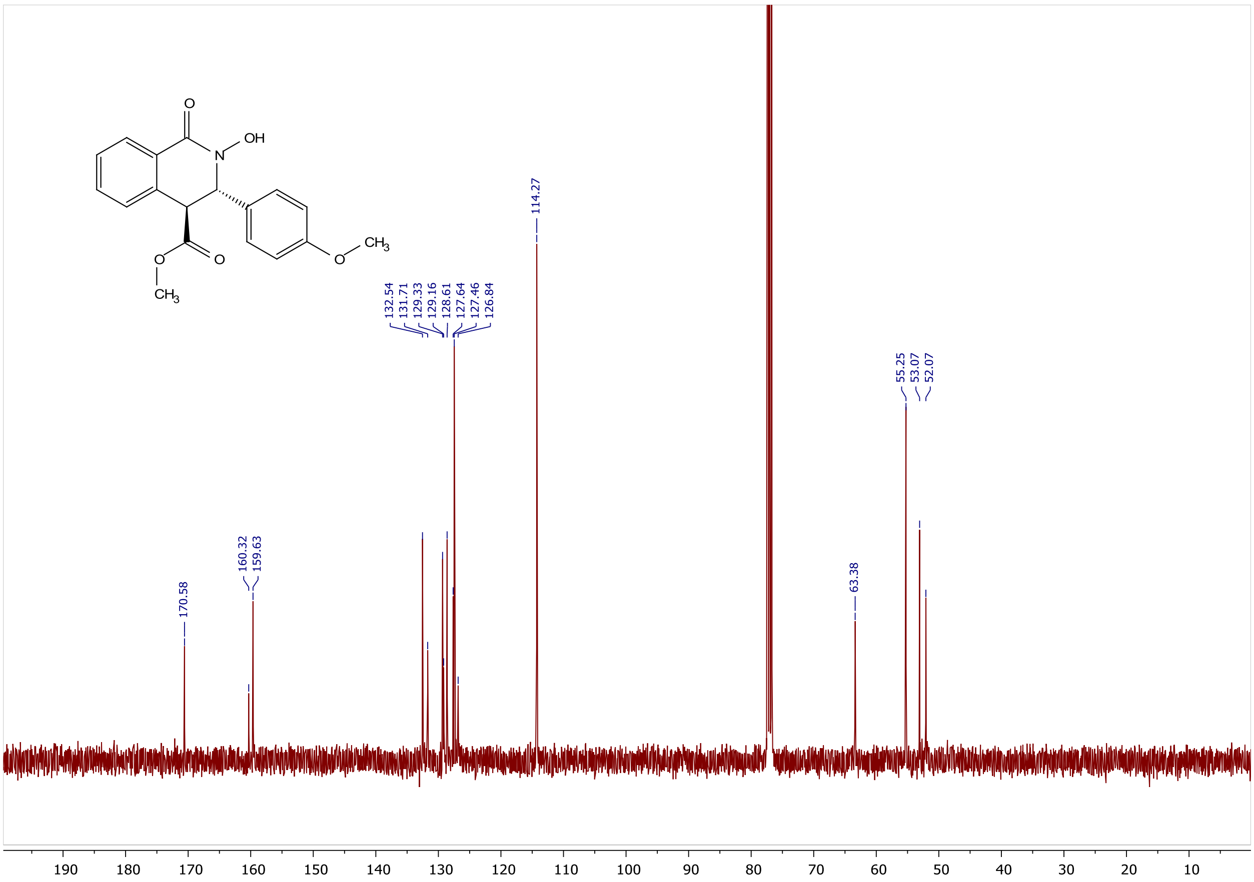
^{1}H and ^{13}C NMR of compound **1l**



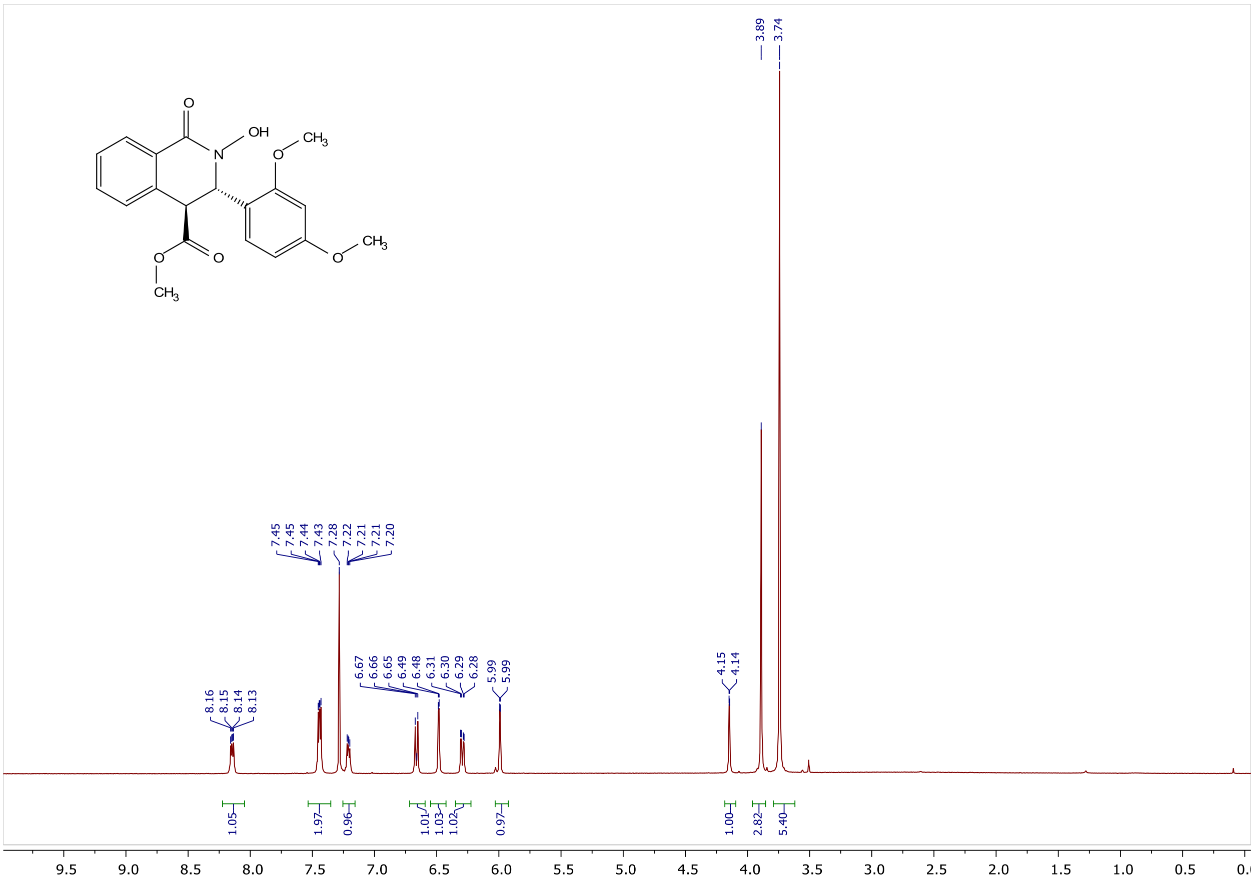


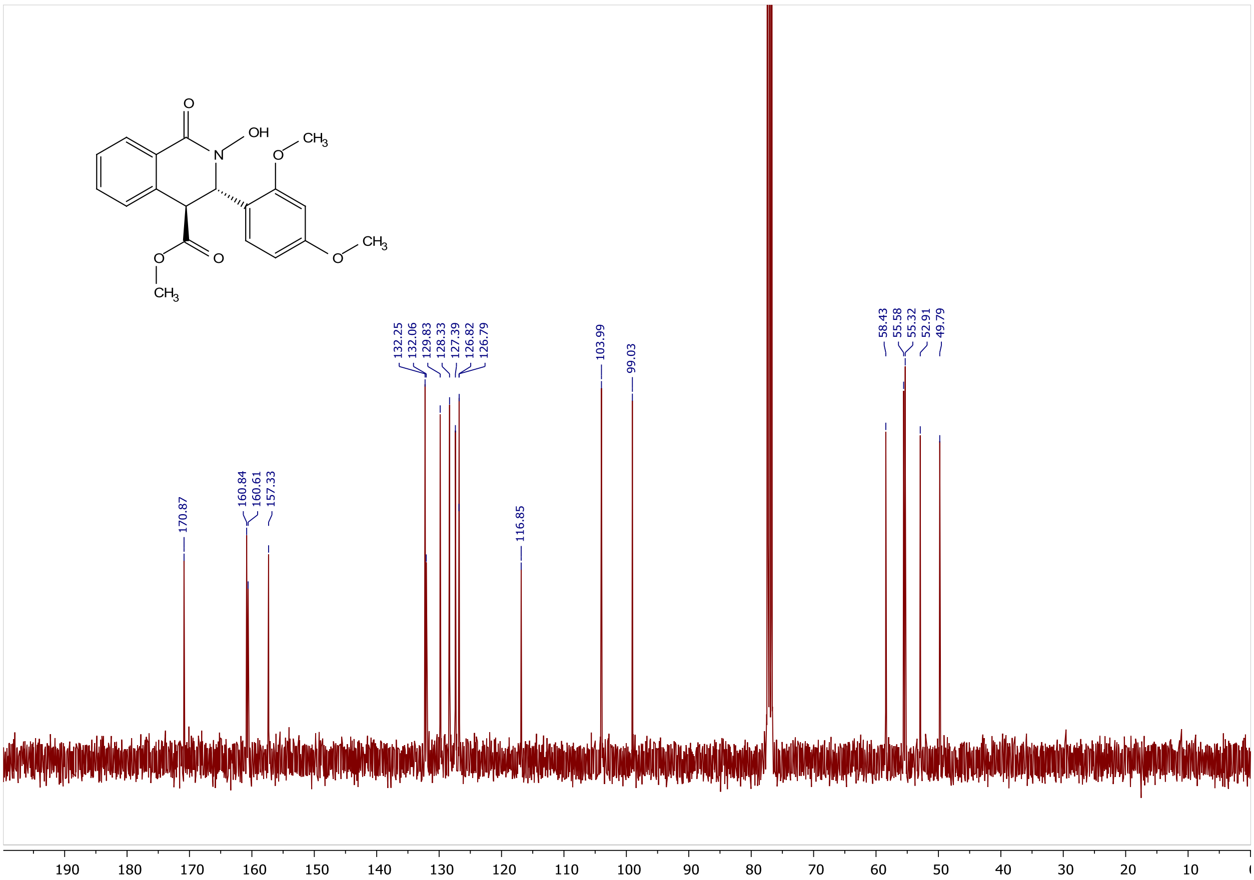
^{1}H and ^{13}C NMR of compound 2a





^{1}H and ^{13}C NMR of compound 2b





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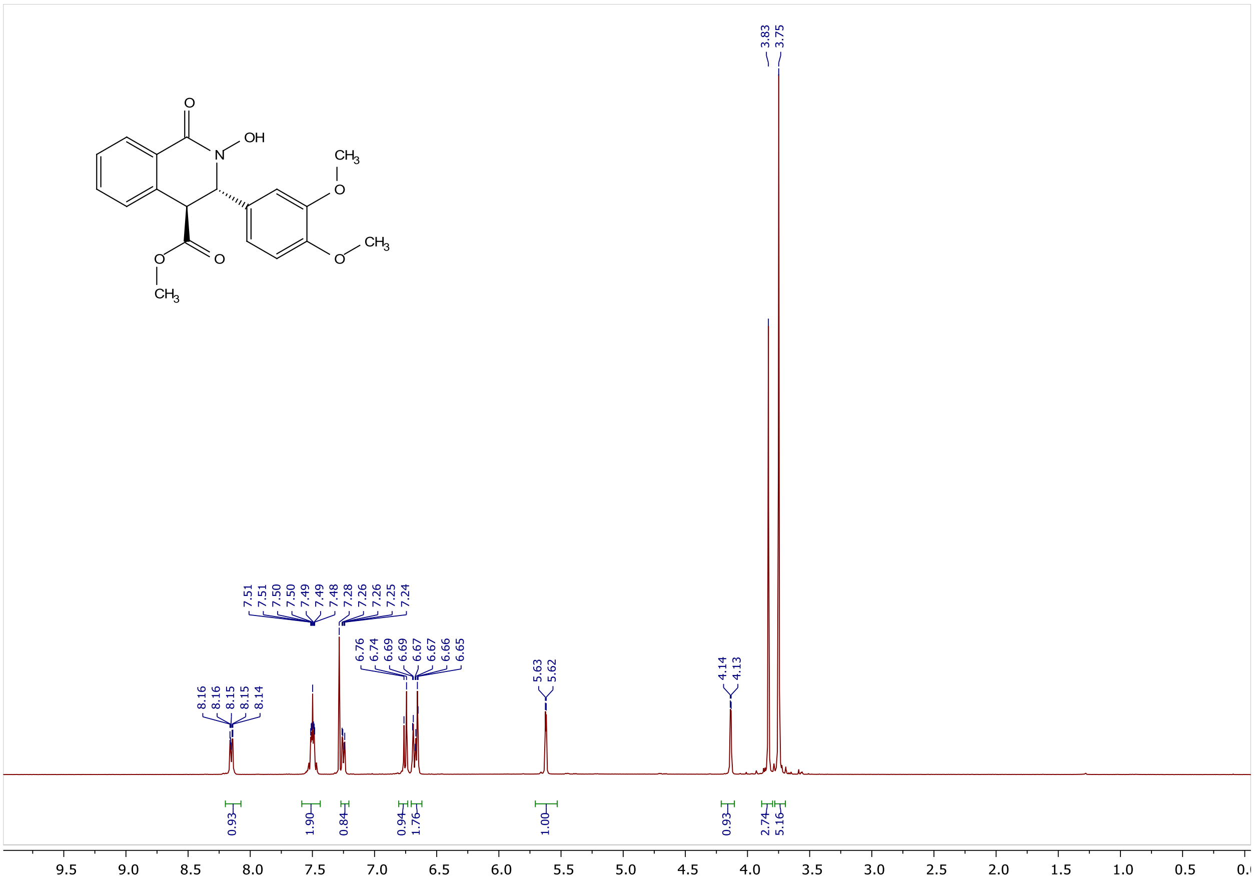
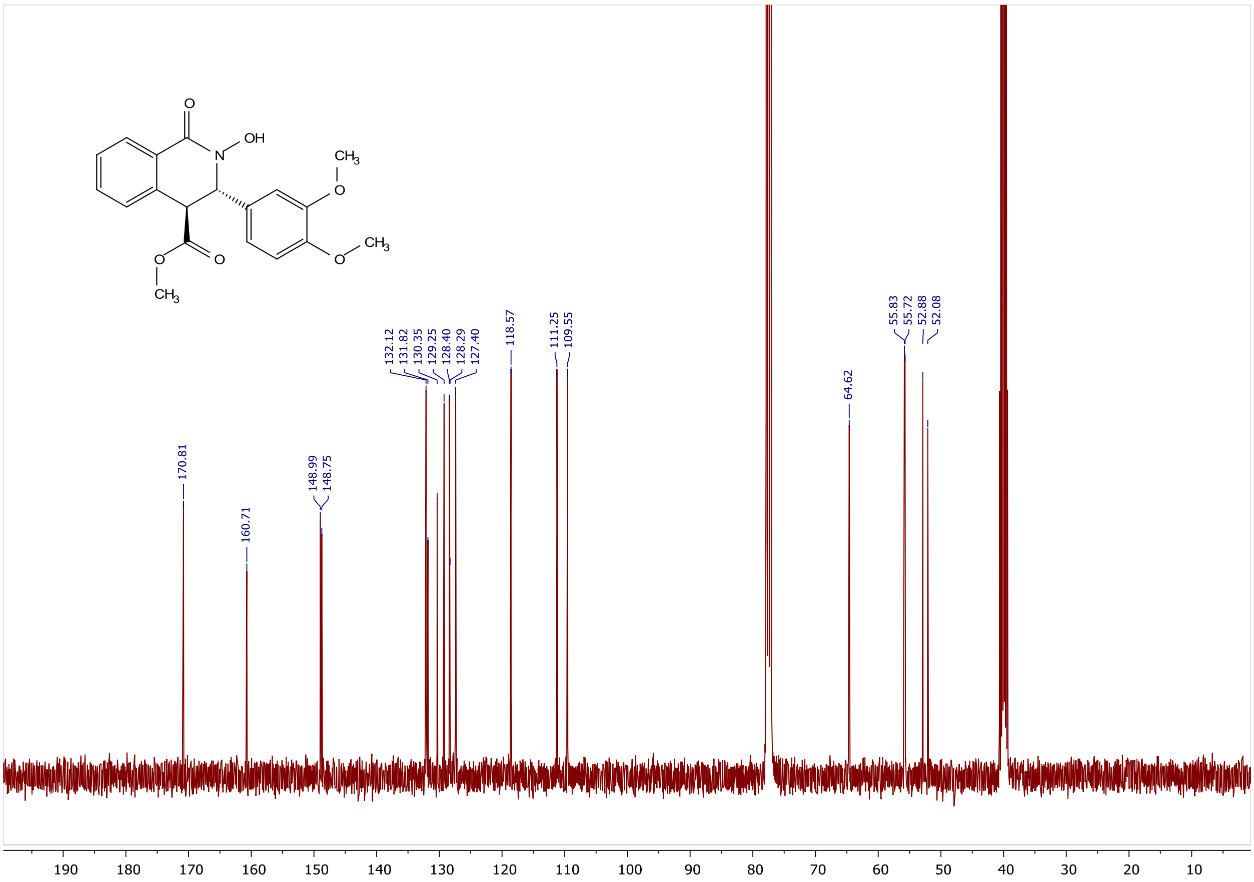
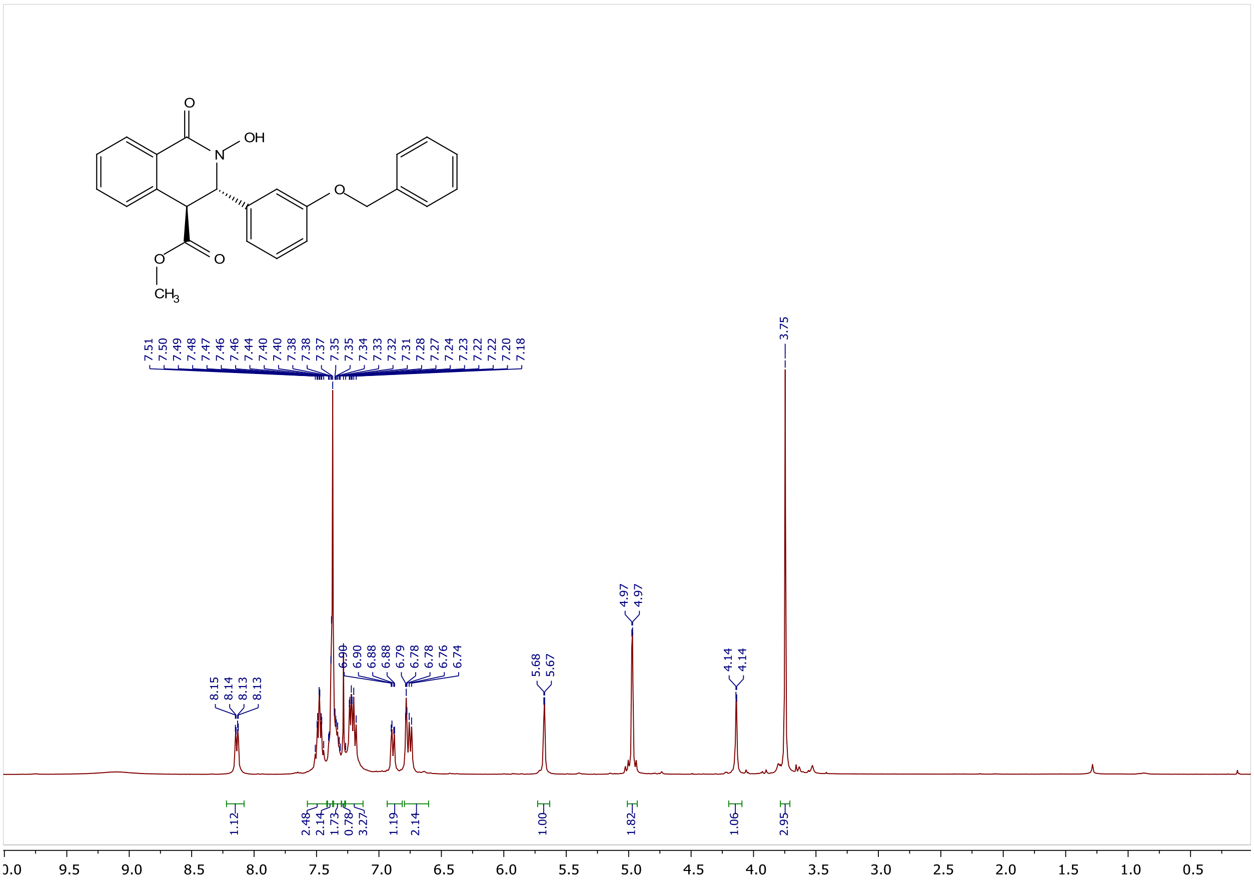
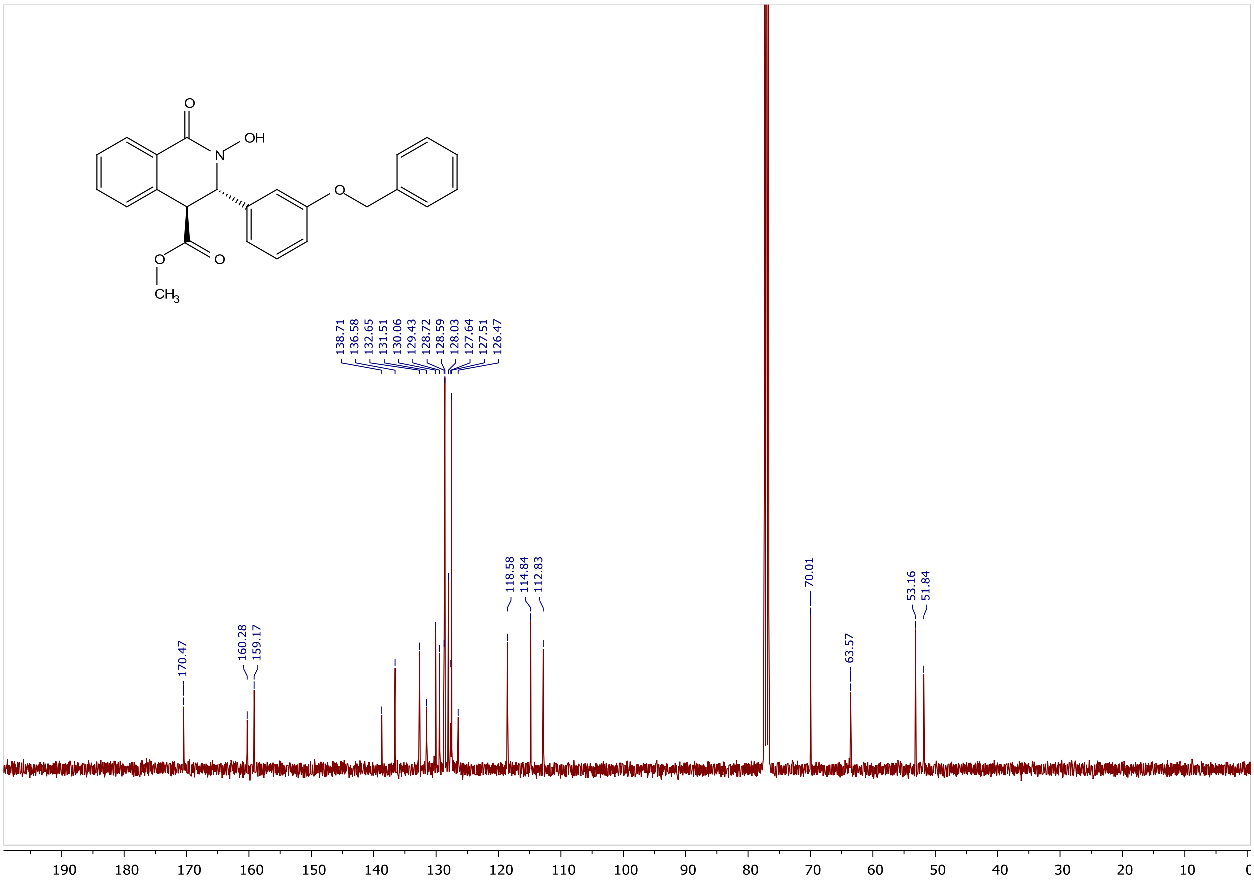


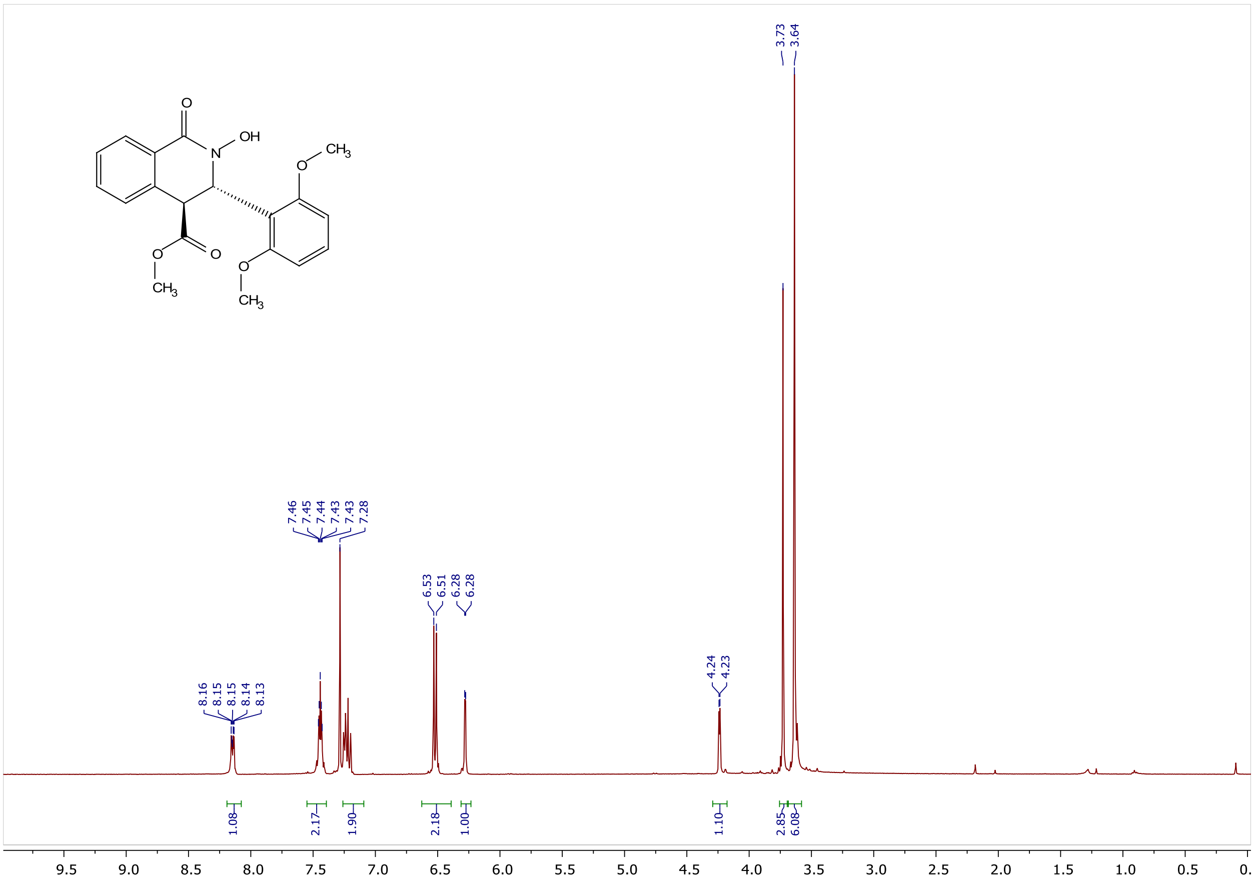


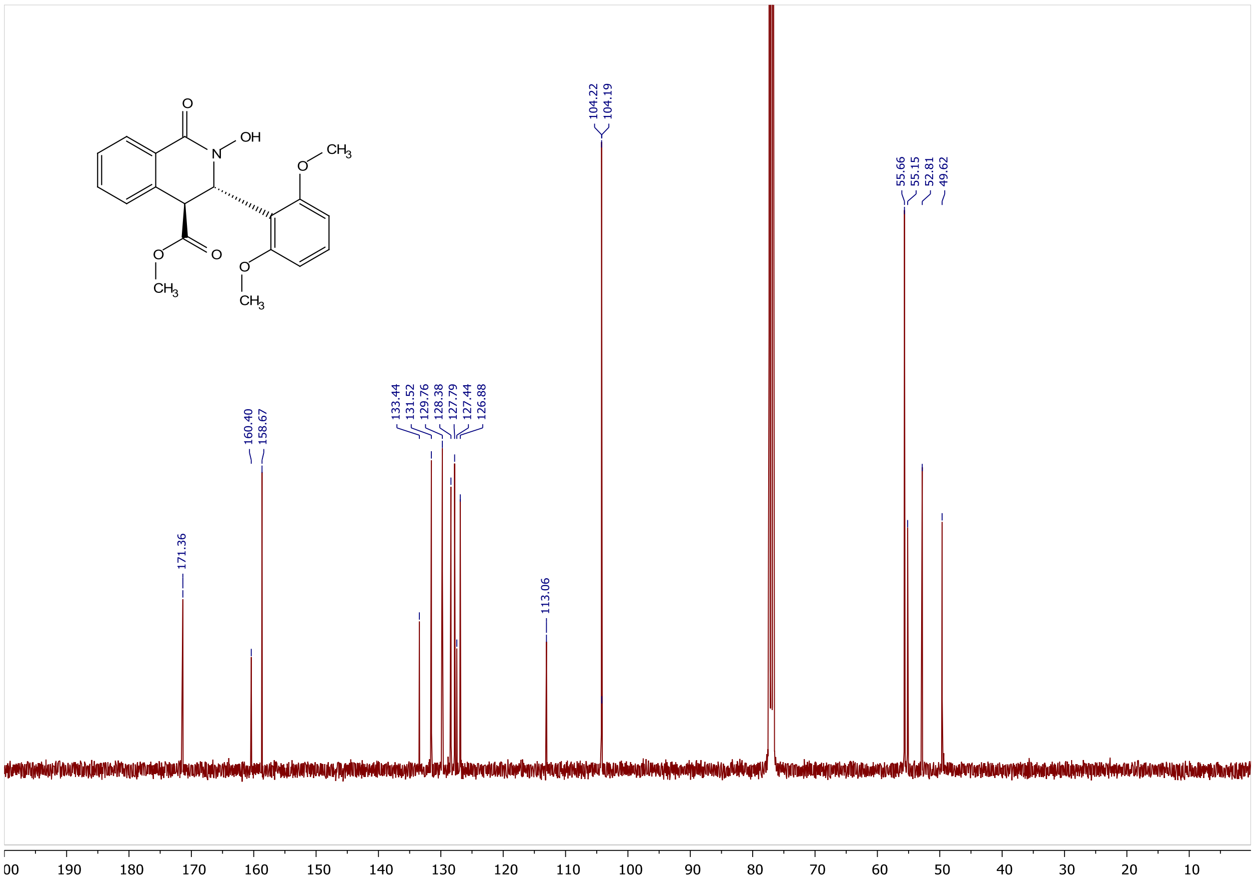
^{1}H and ^{13}C NMR of compound 2d





^{1}H and ^{13}C NMR of compound 2e





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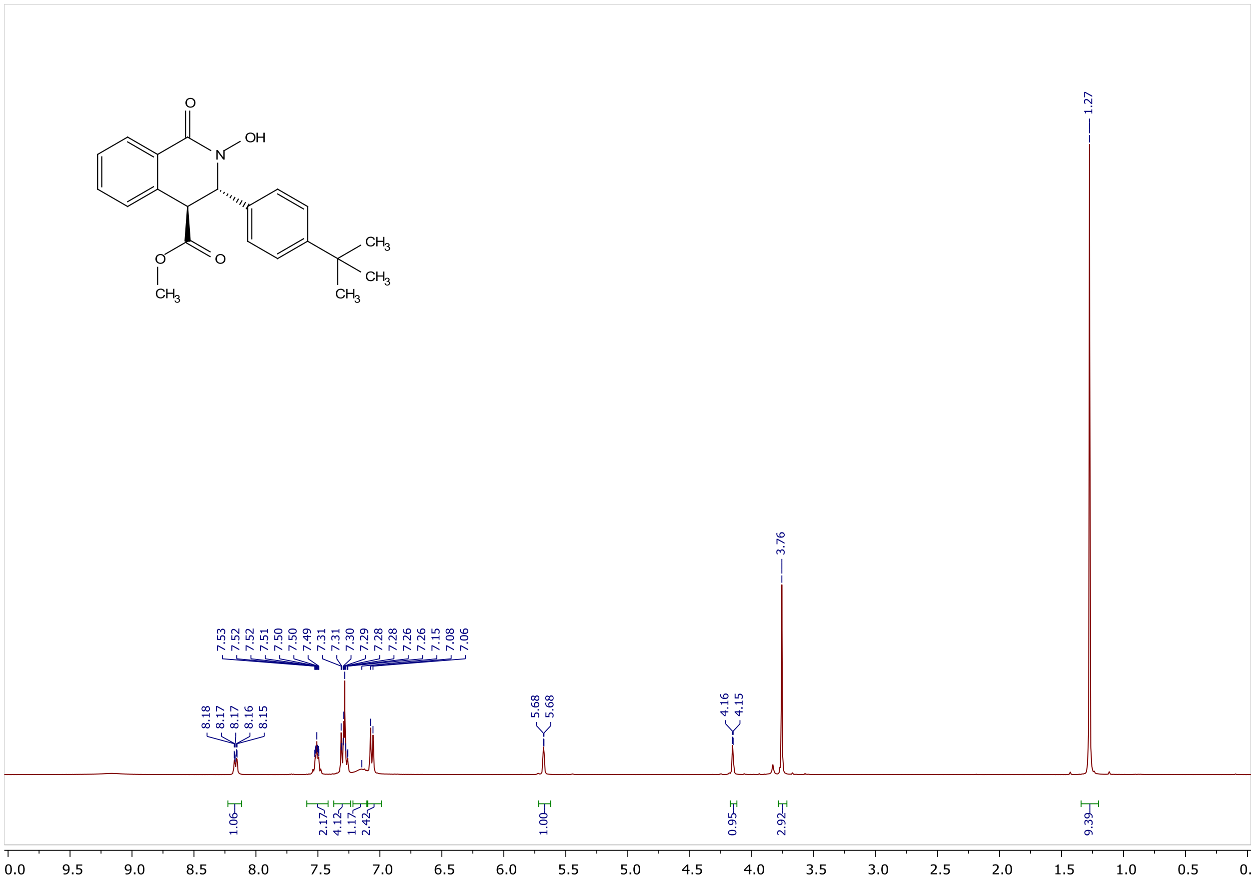
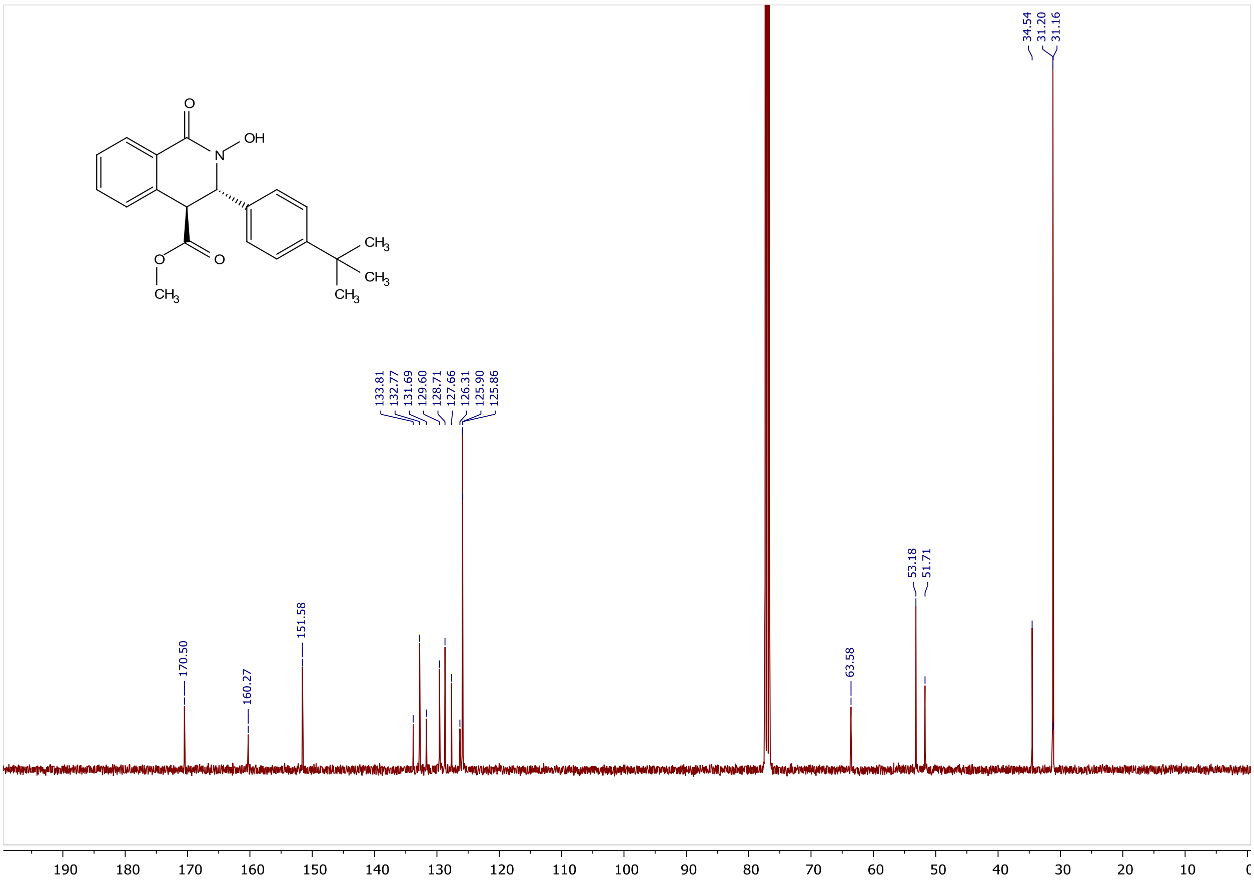
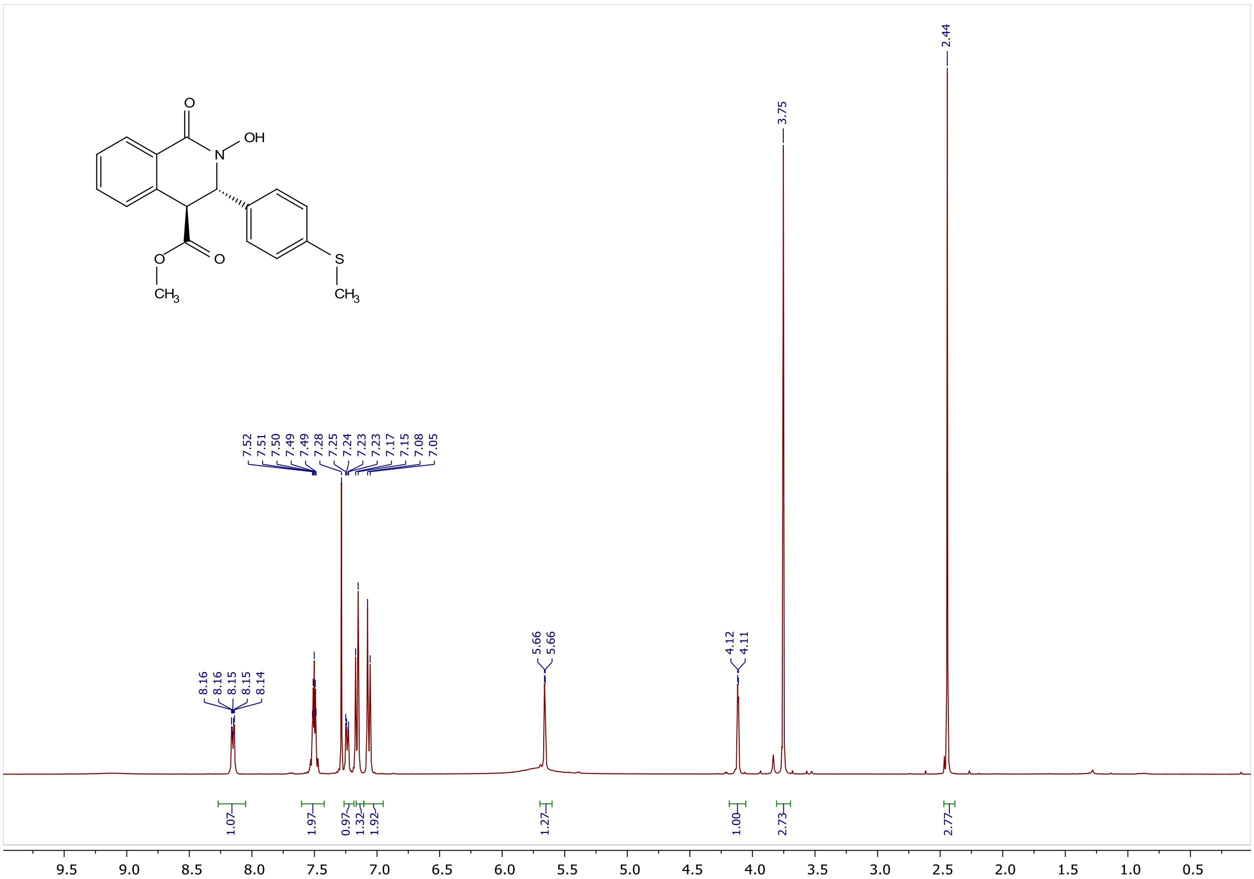
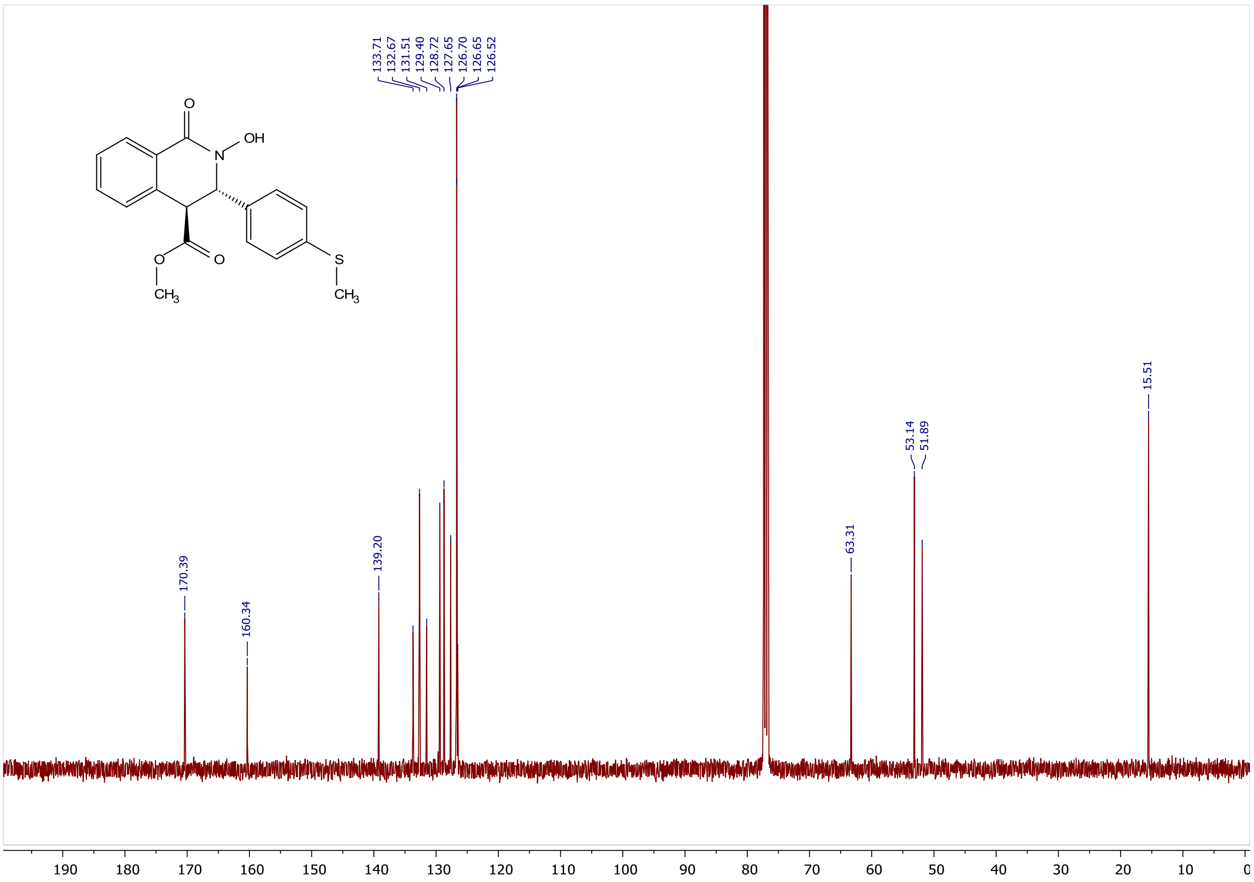


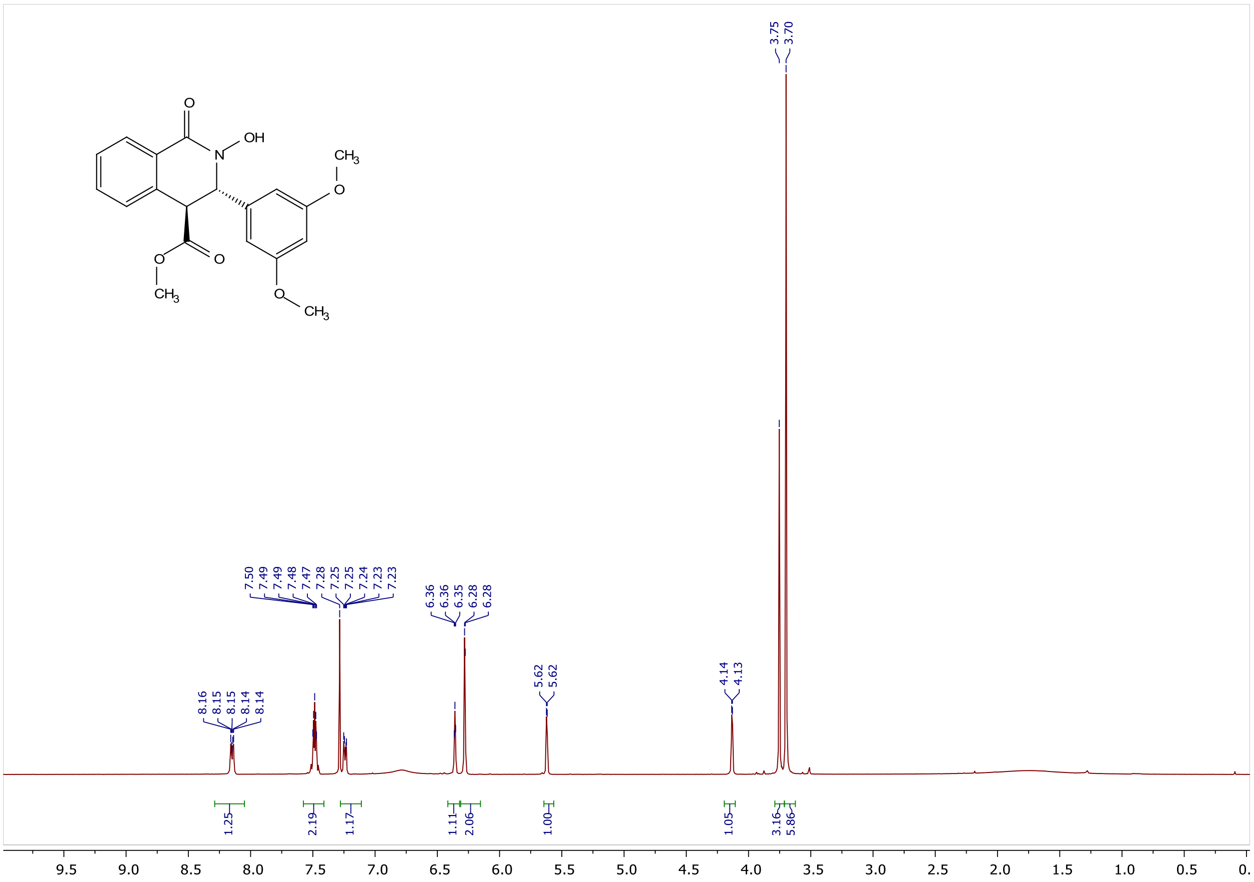


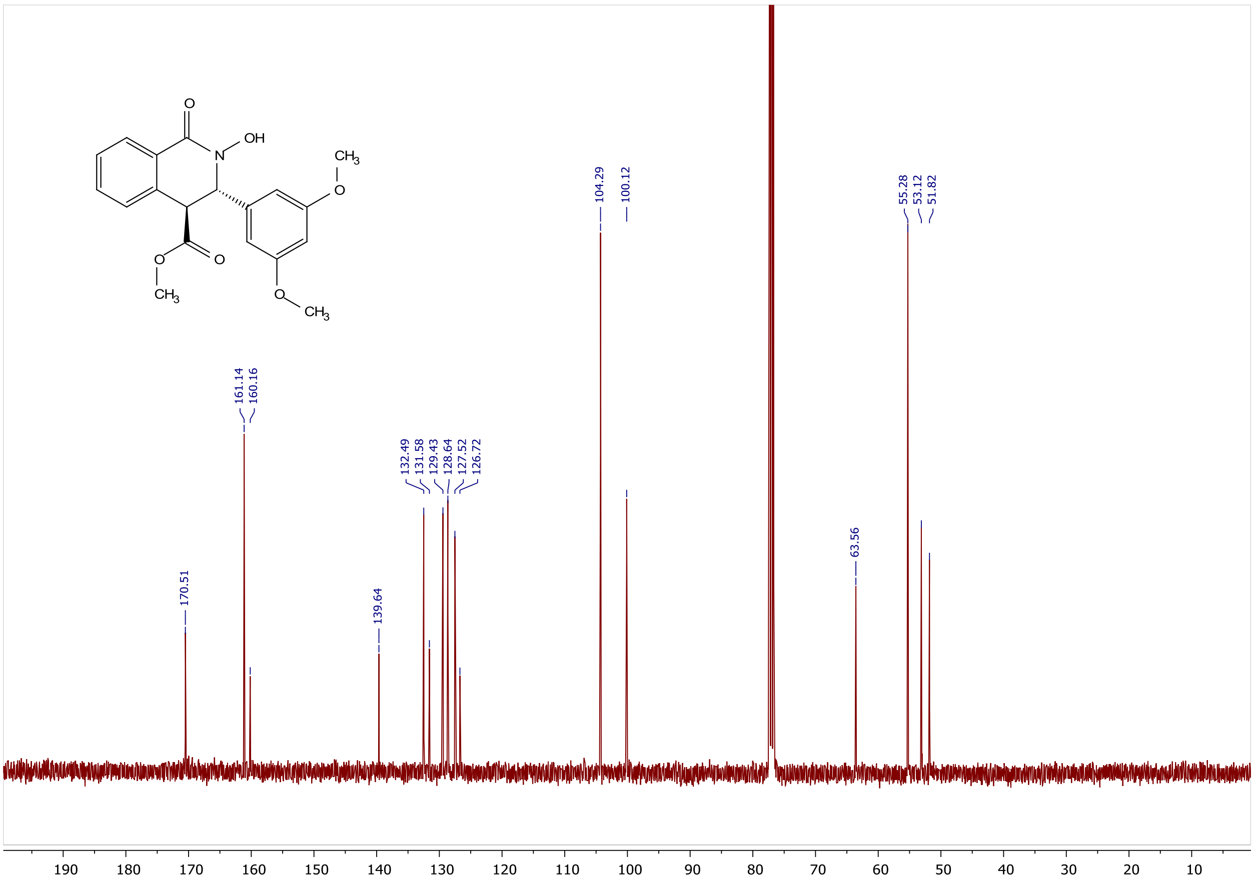
^1H and ^{13}C NMR of compound 2g



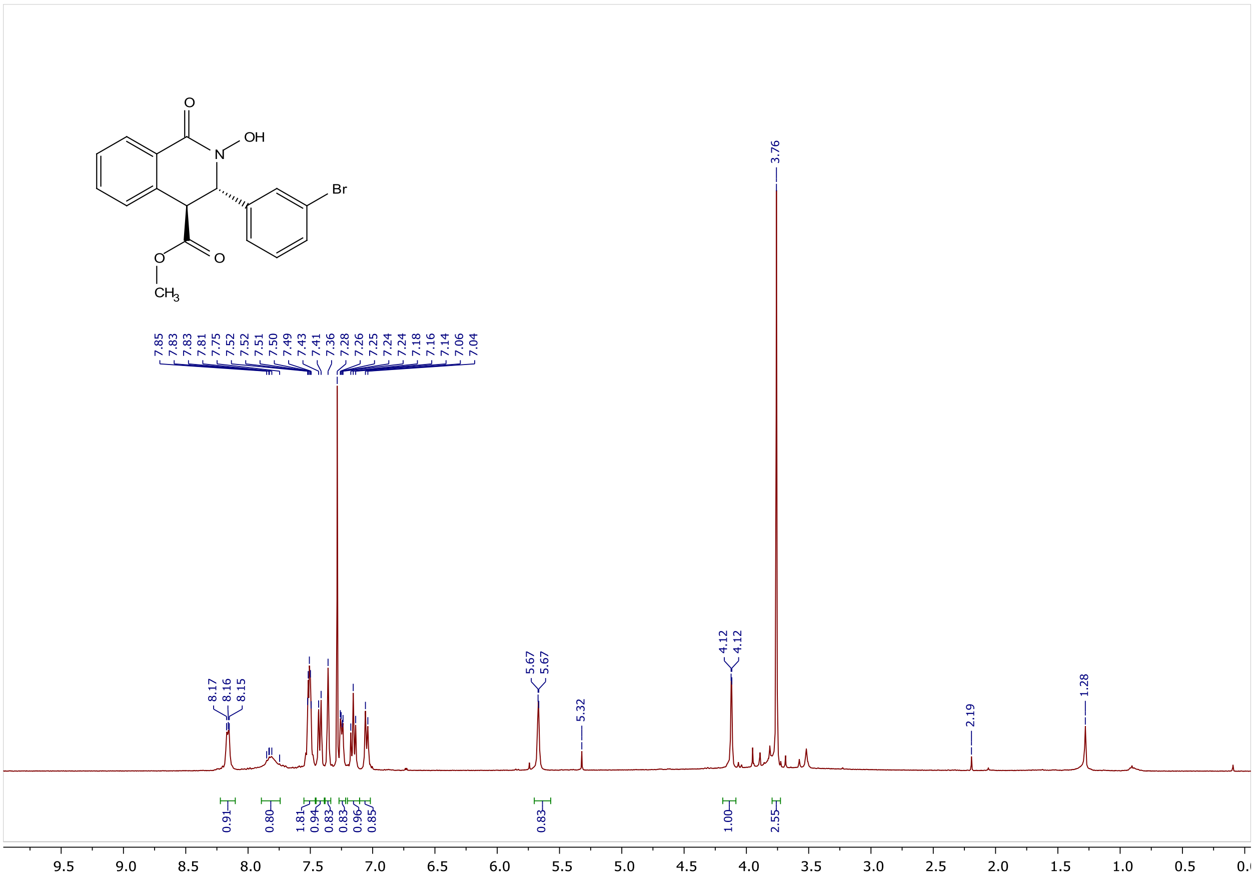


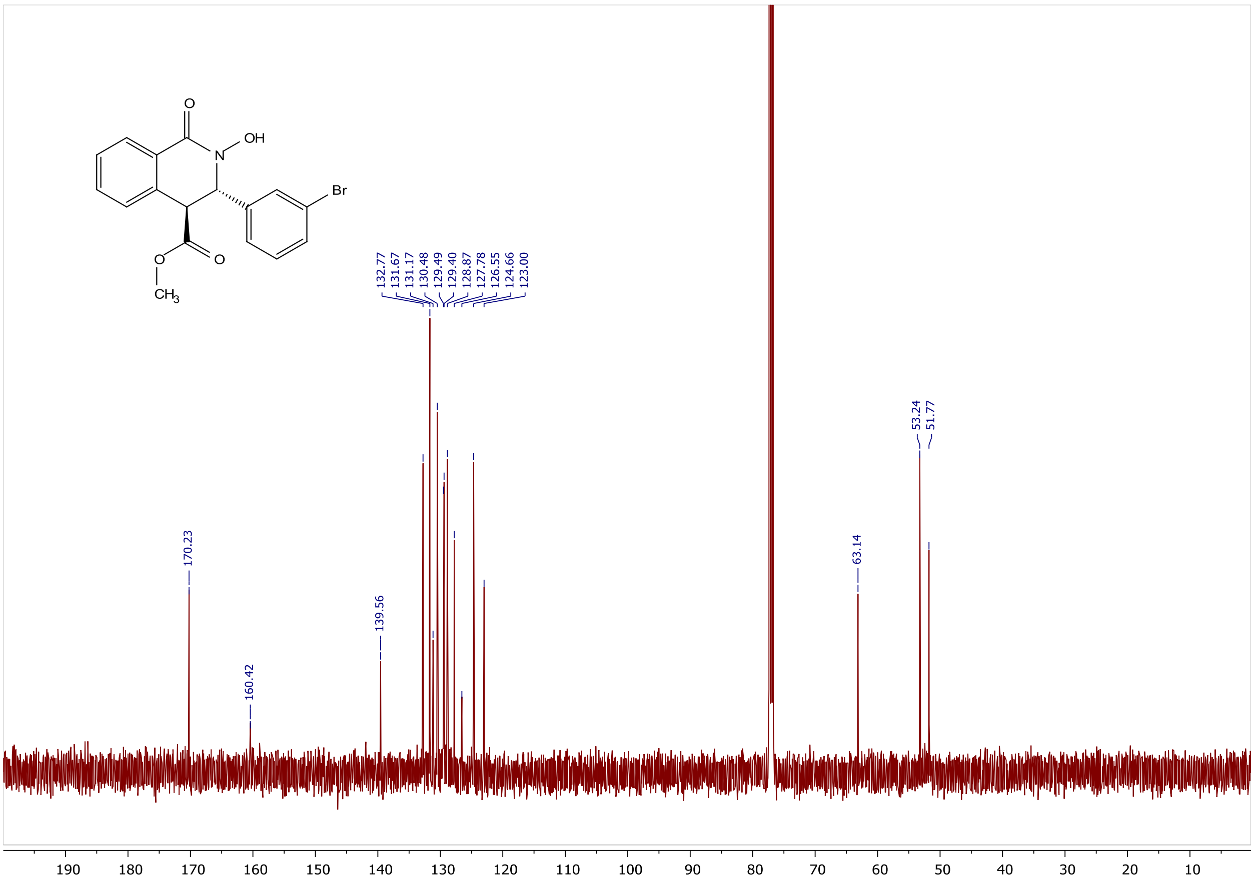
^{1}H and ^{13}C NMR of compound 2h





^{1}H and ^{13}C NMR of compound 2i





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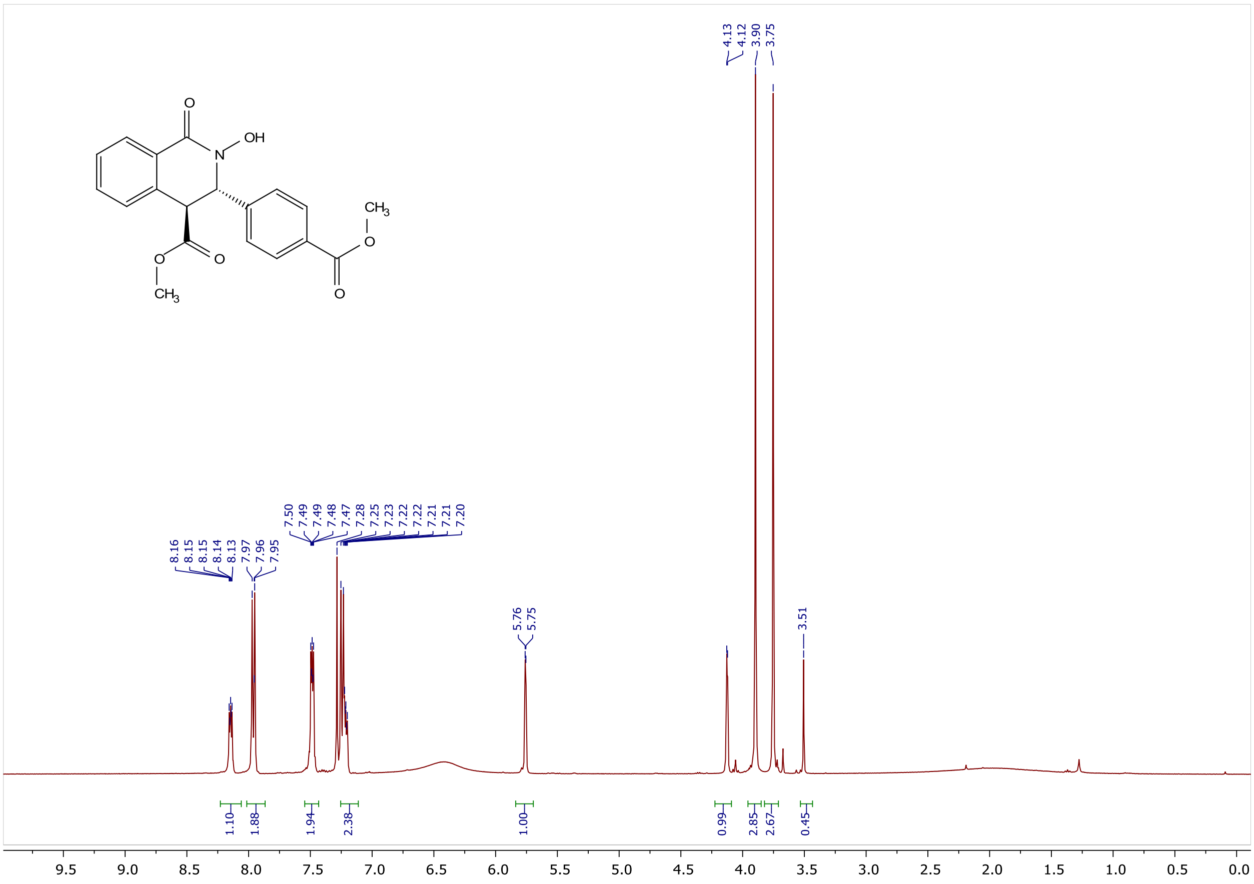
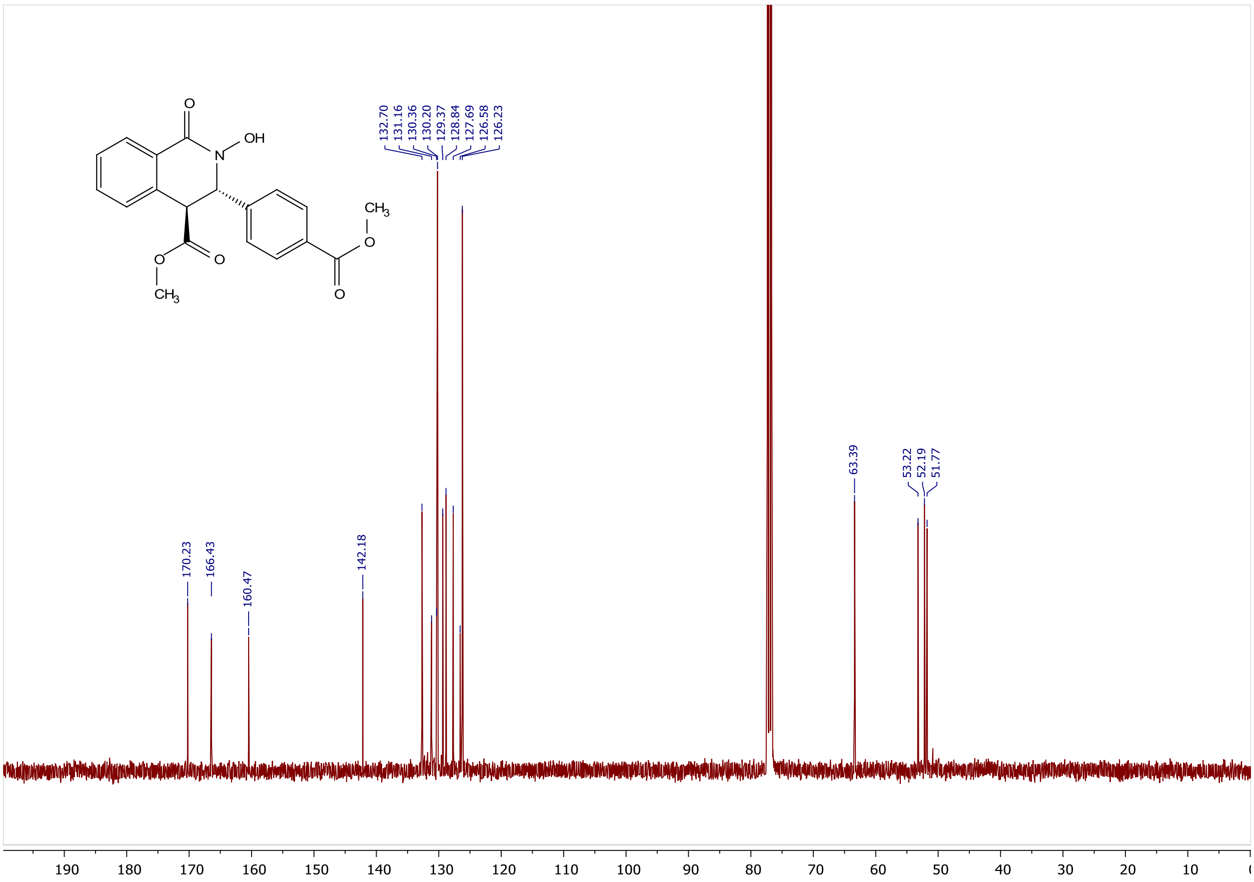
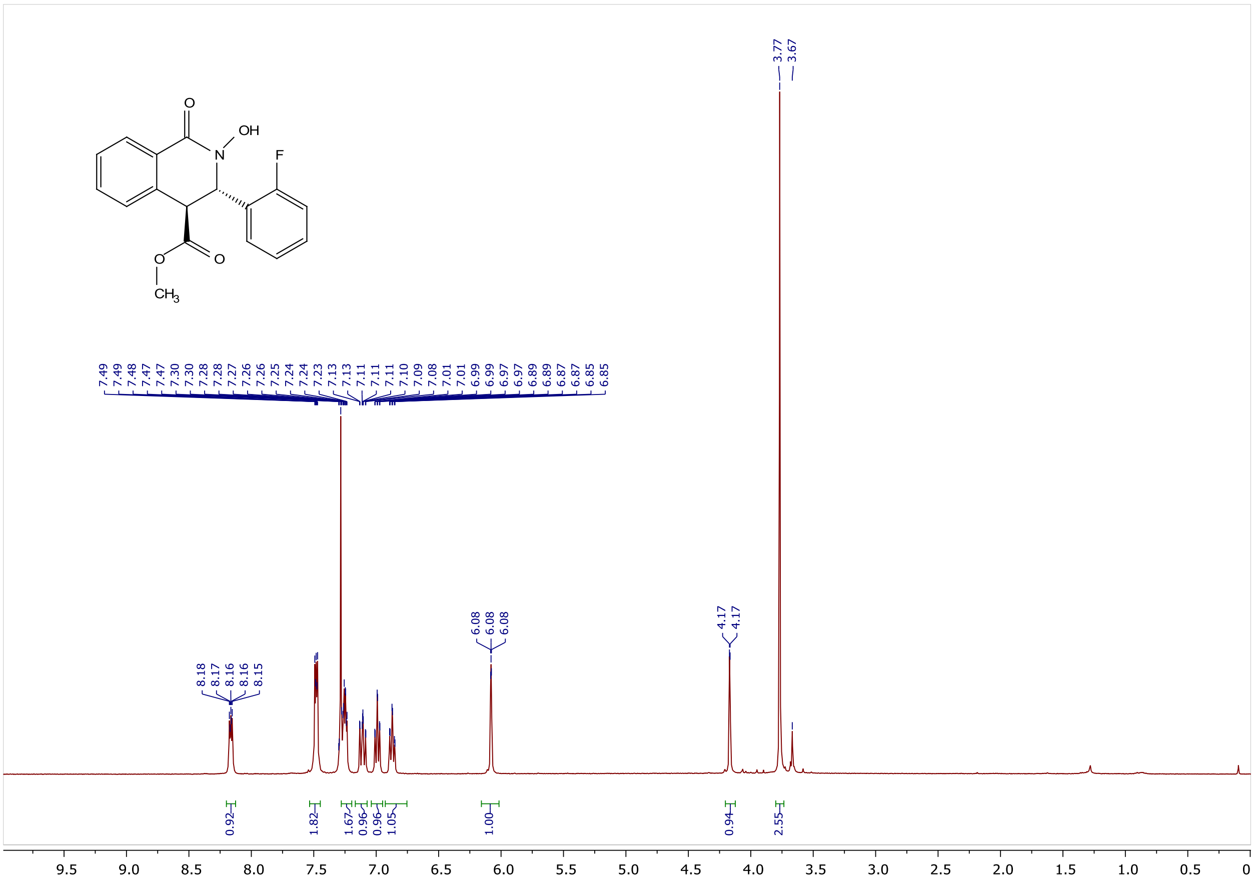
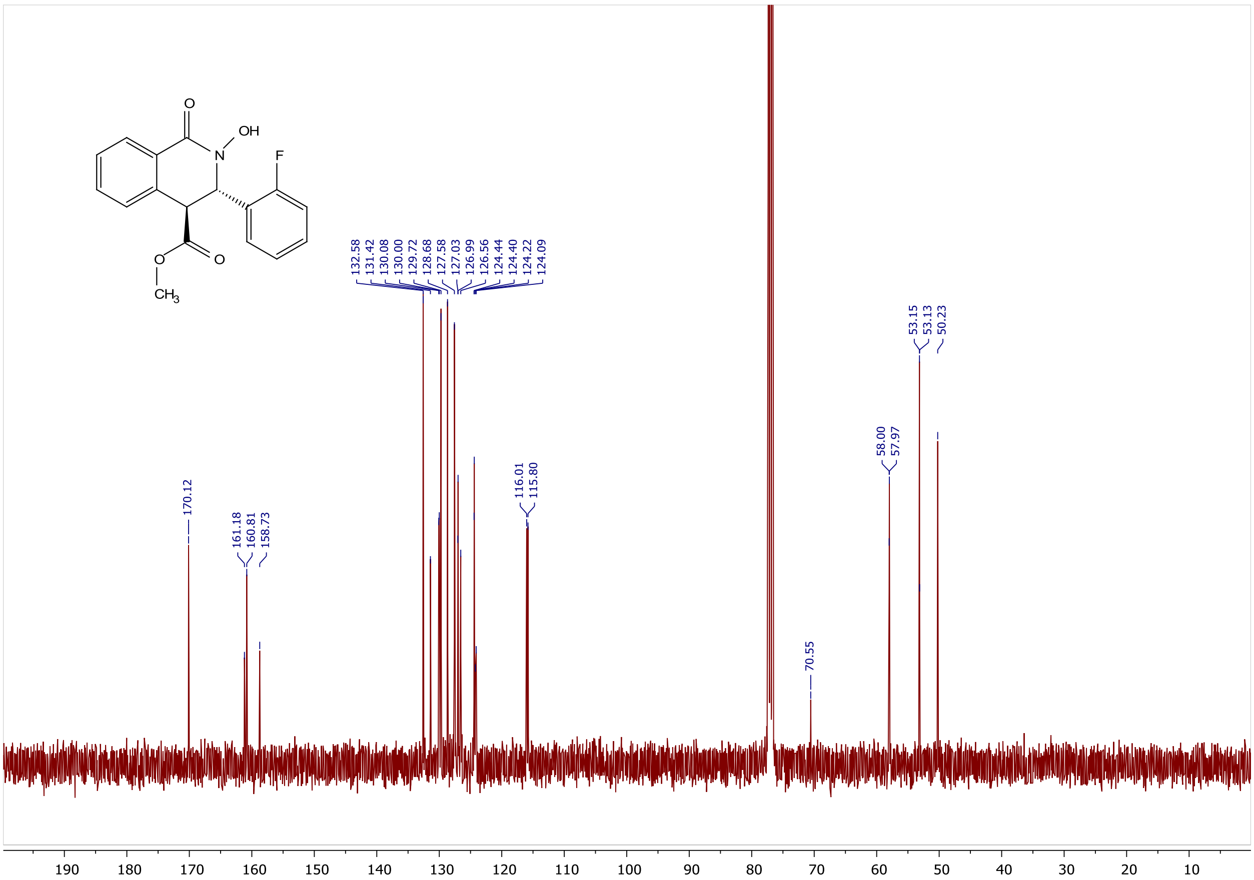




^{1}H and ^{13}C NMR of compound 2k





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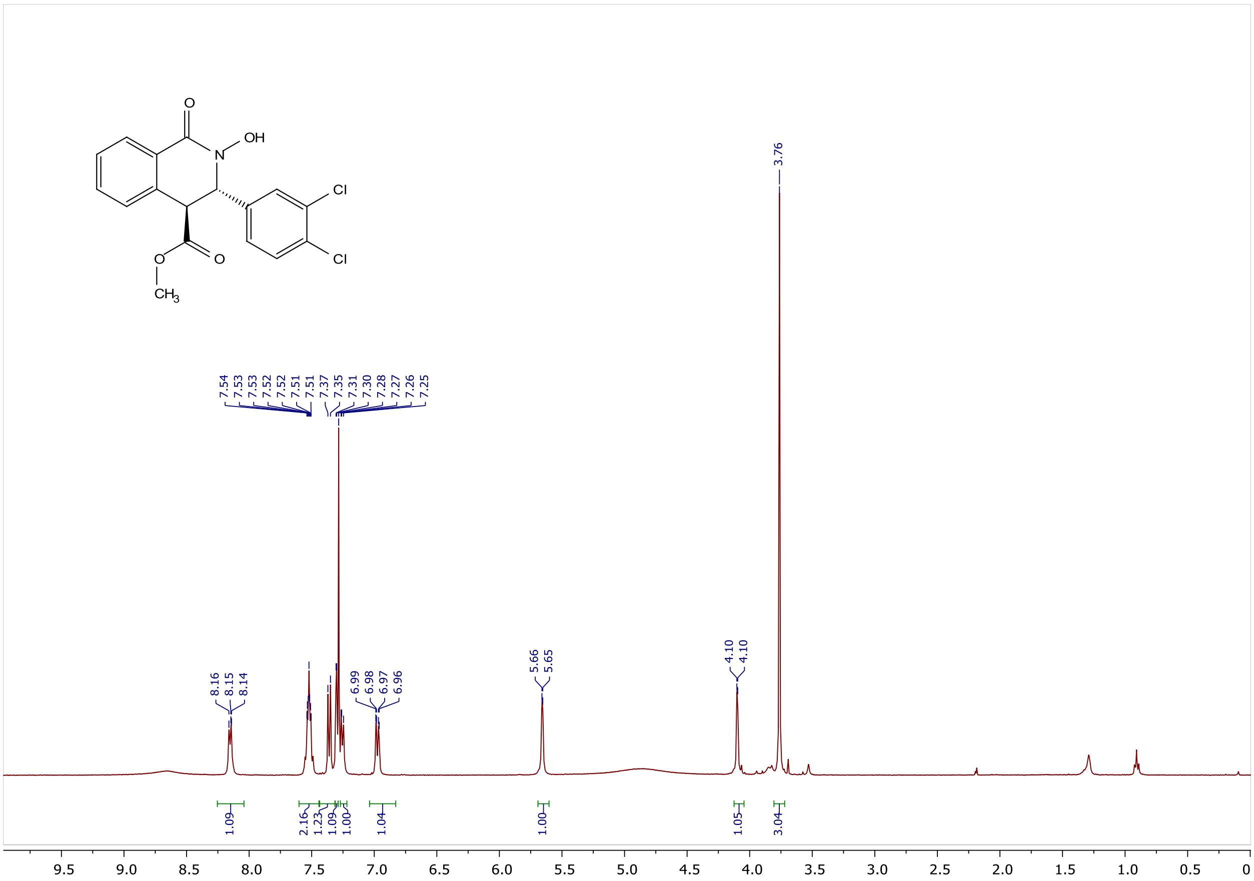

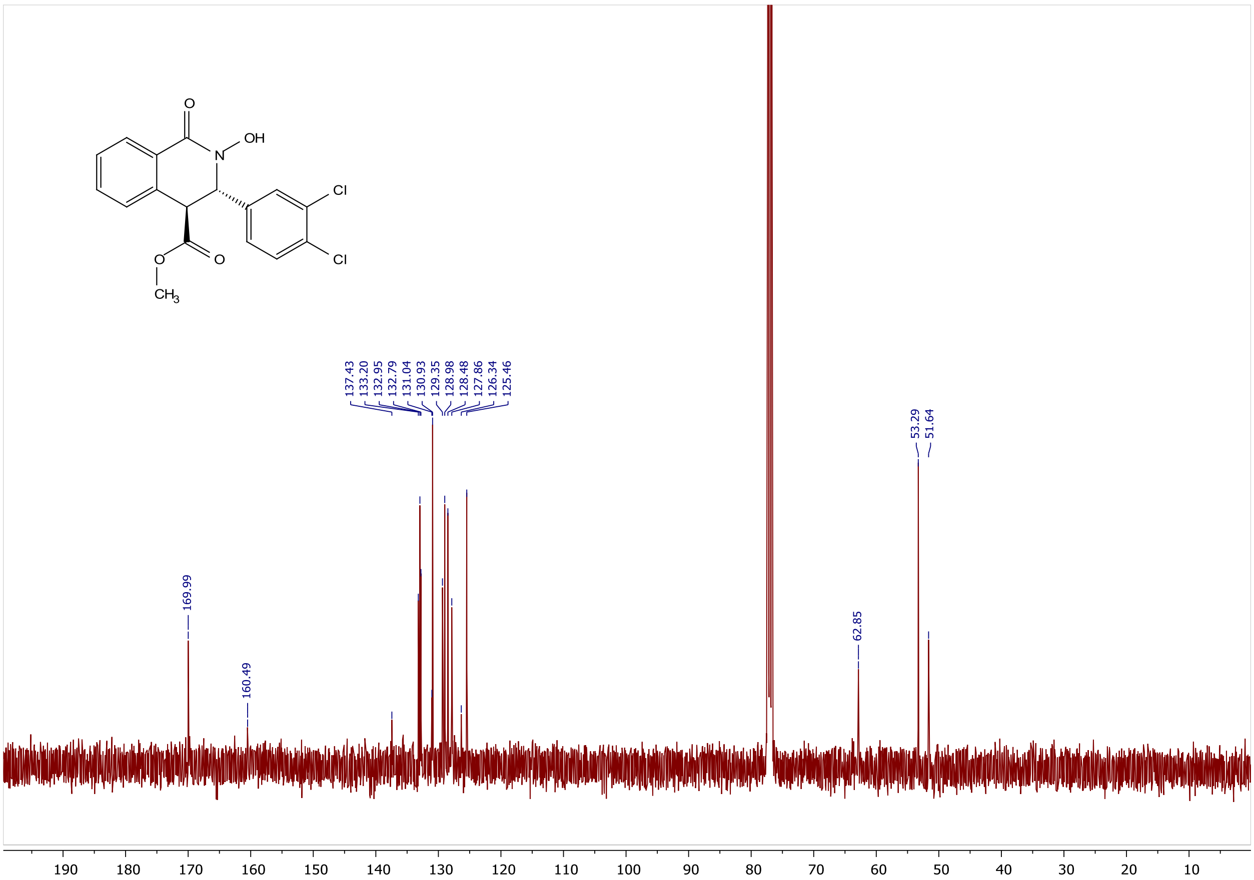

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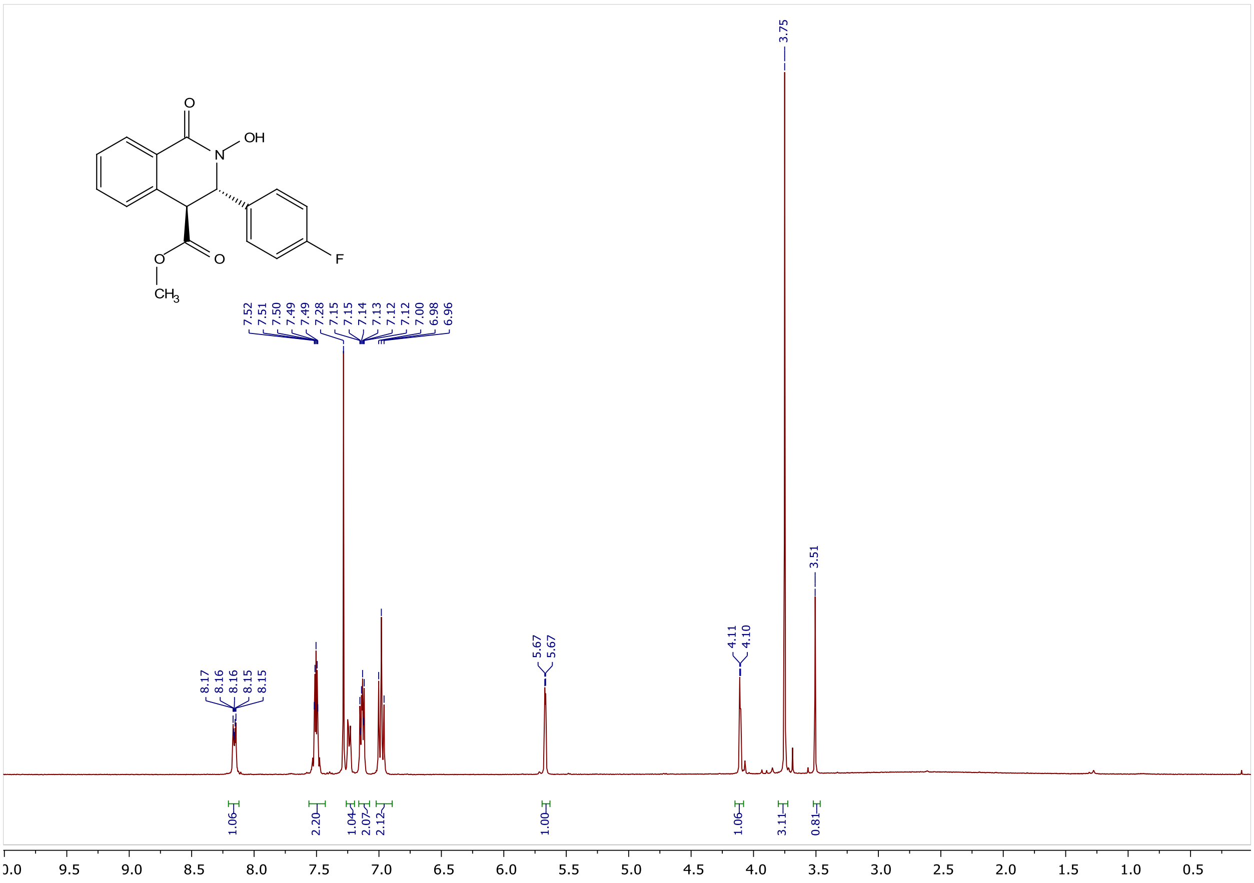
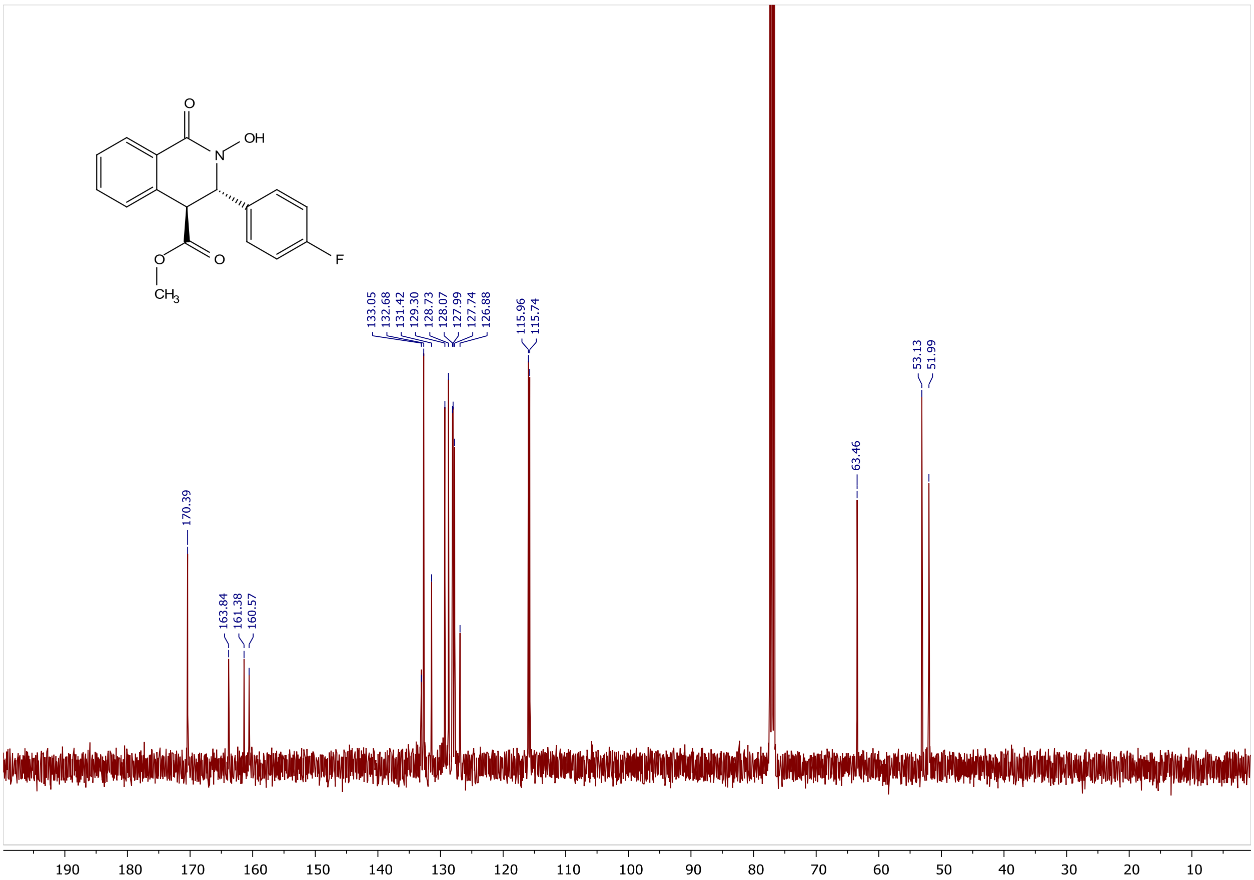
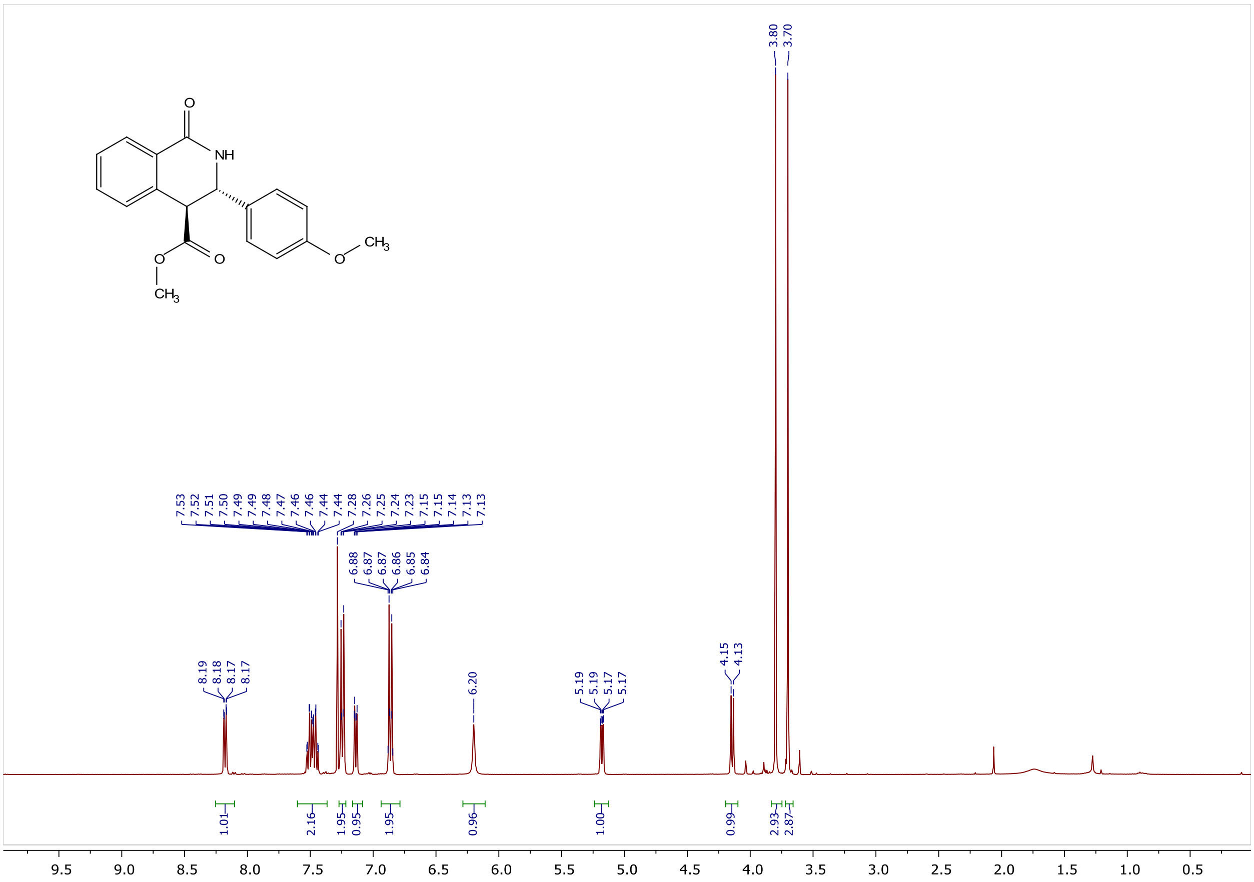
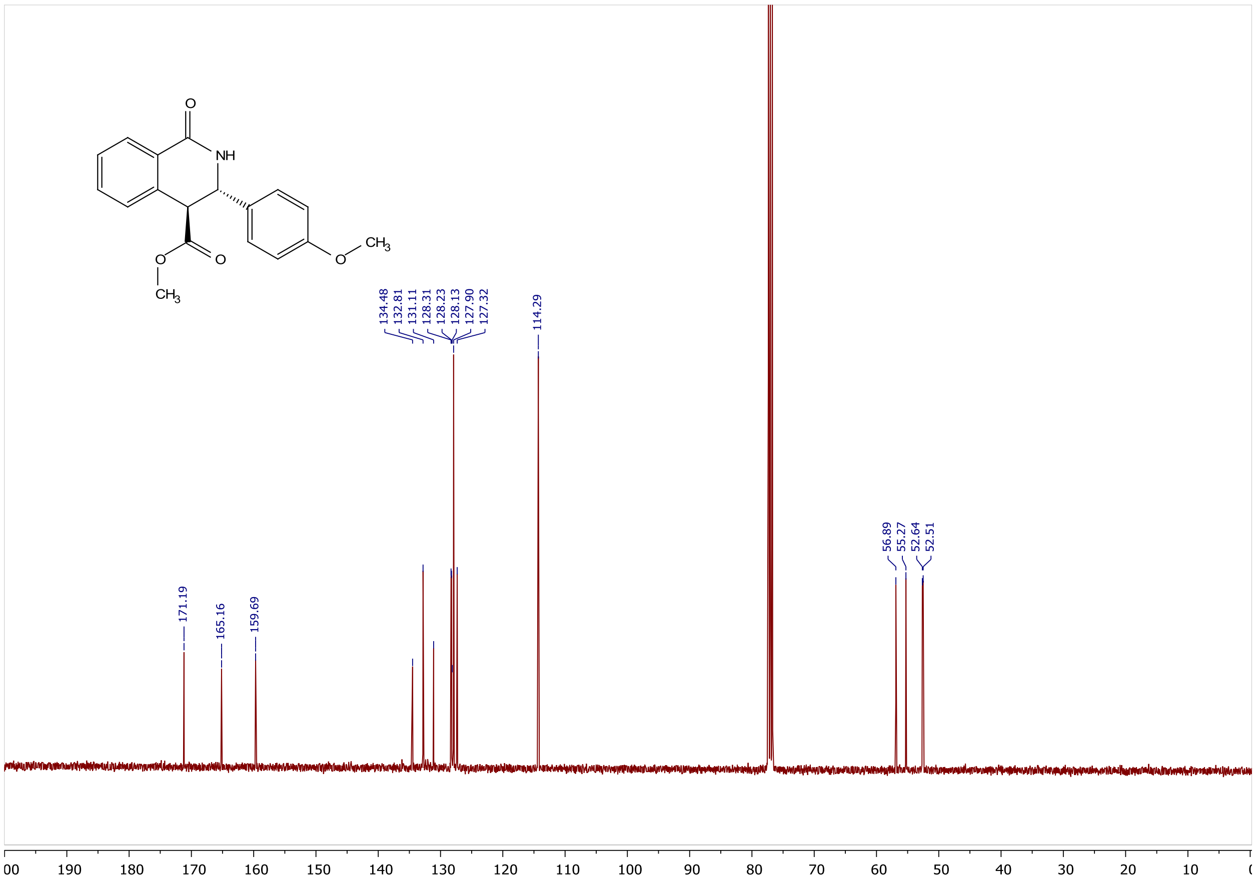




^{1}H and ^{13}C NMR of compound 3a





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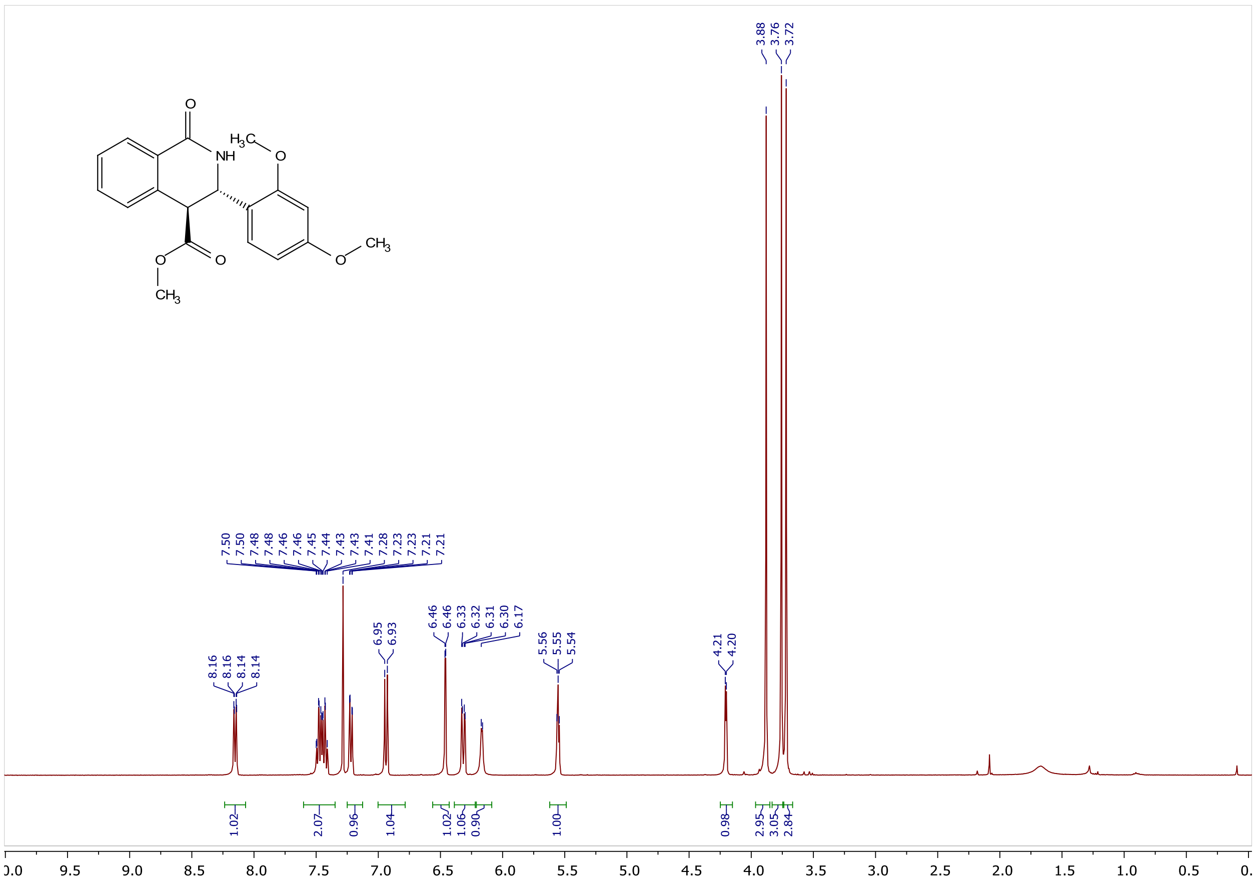

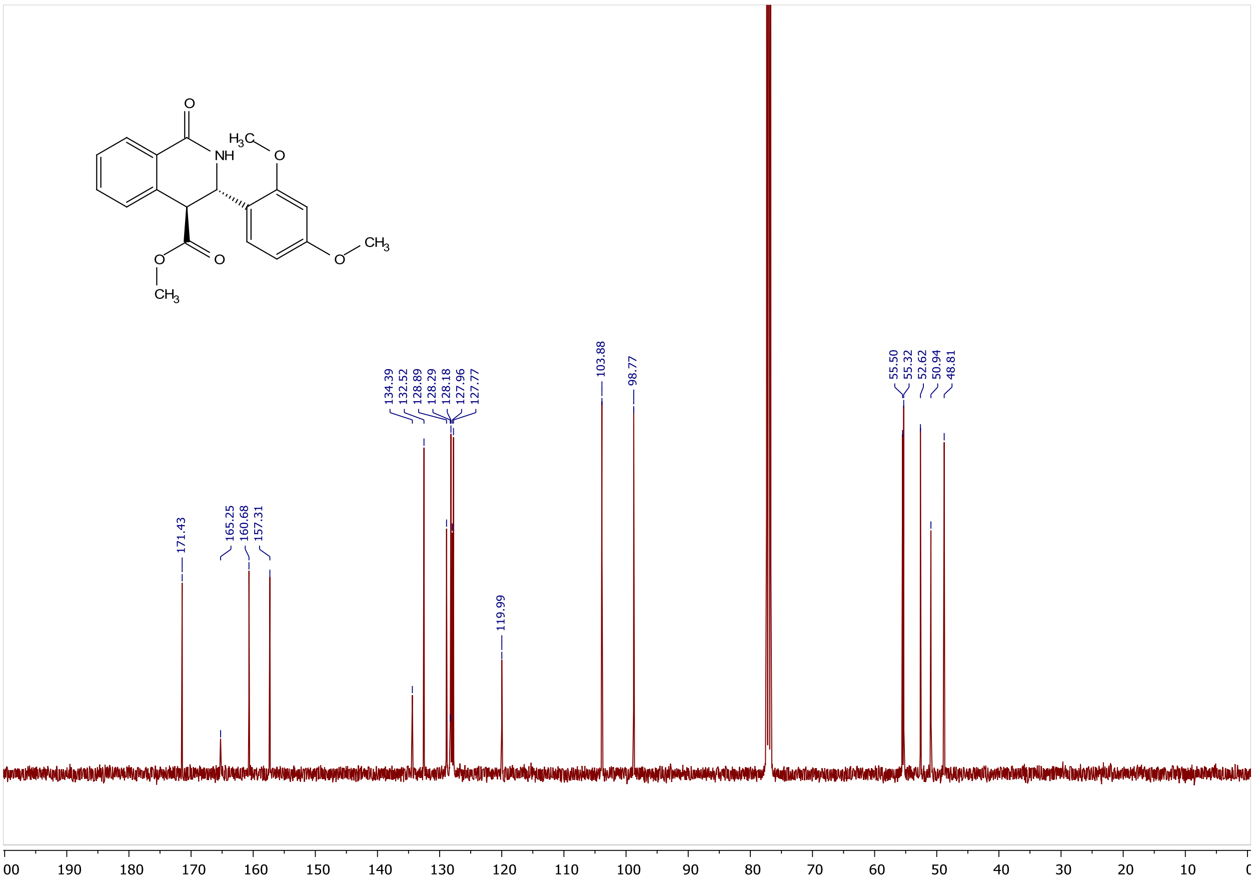

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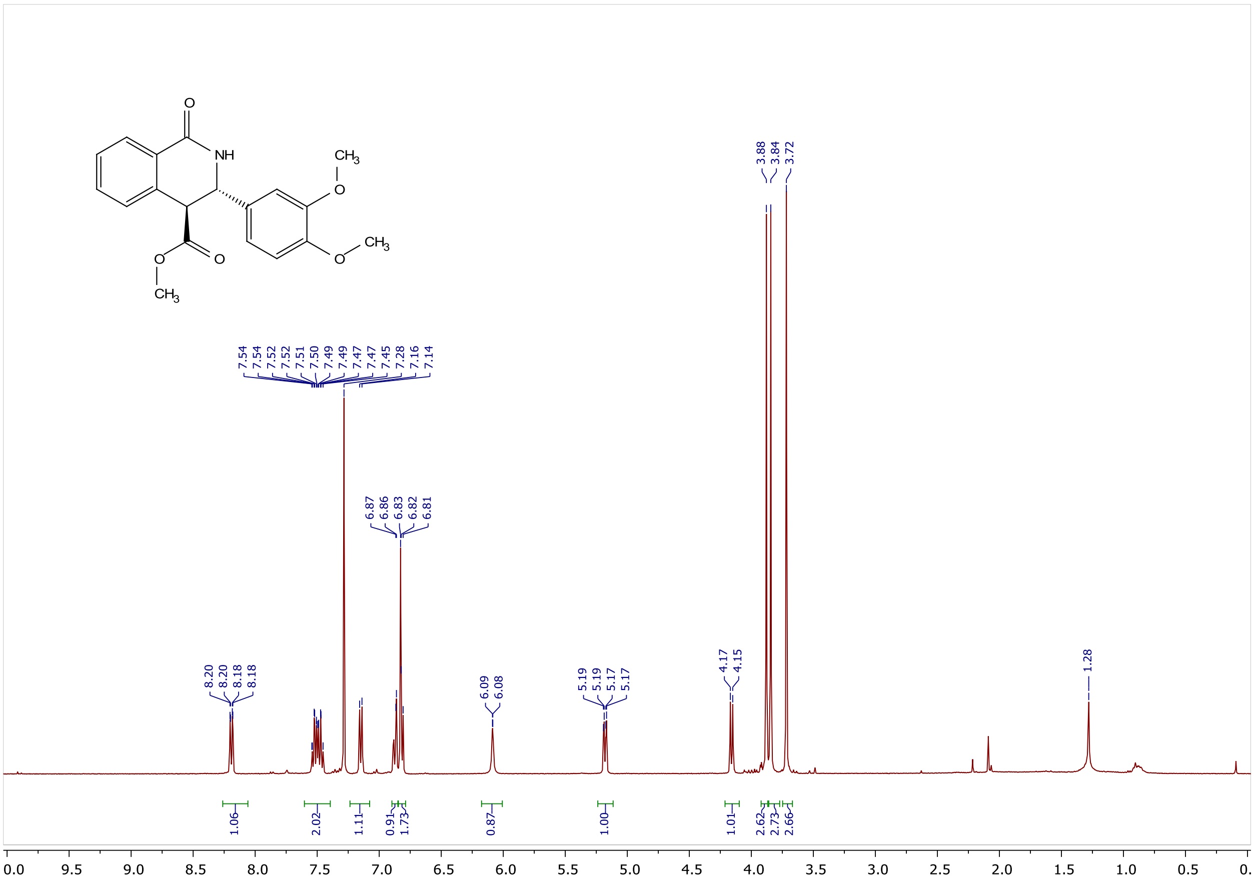

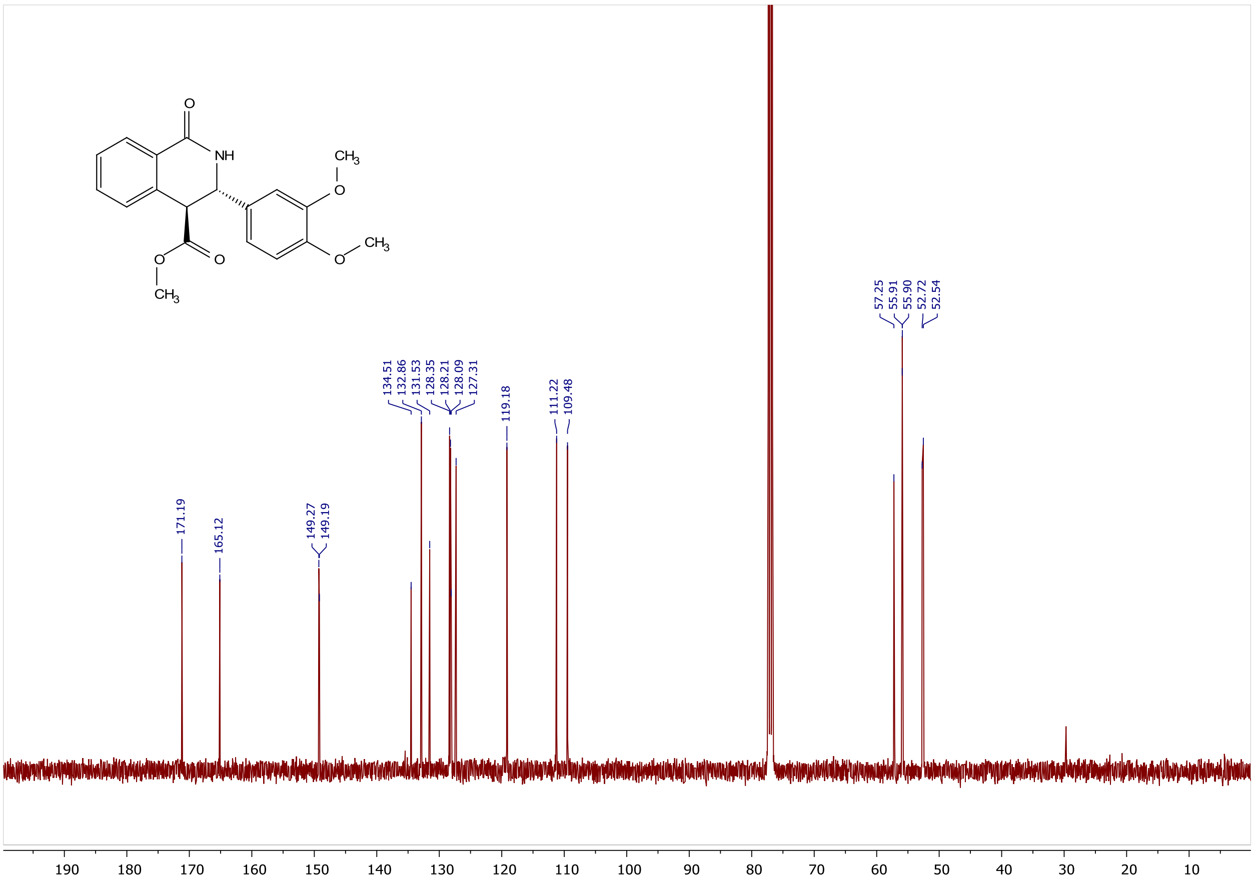

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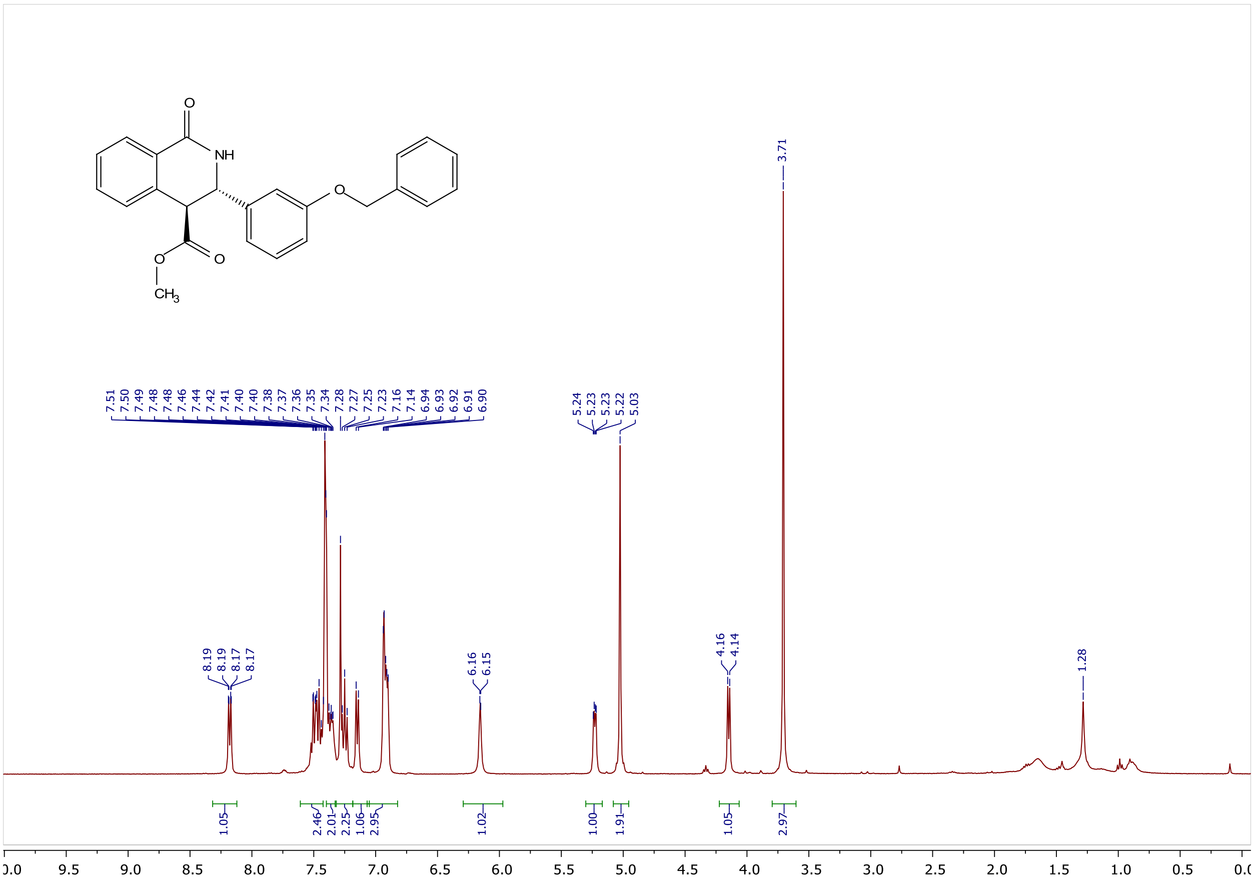

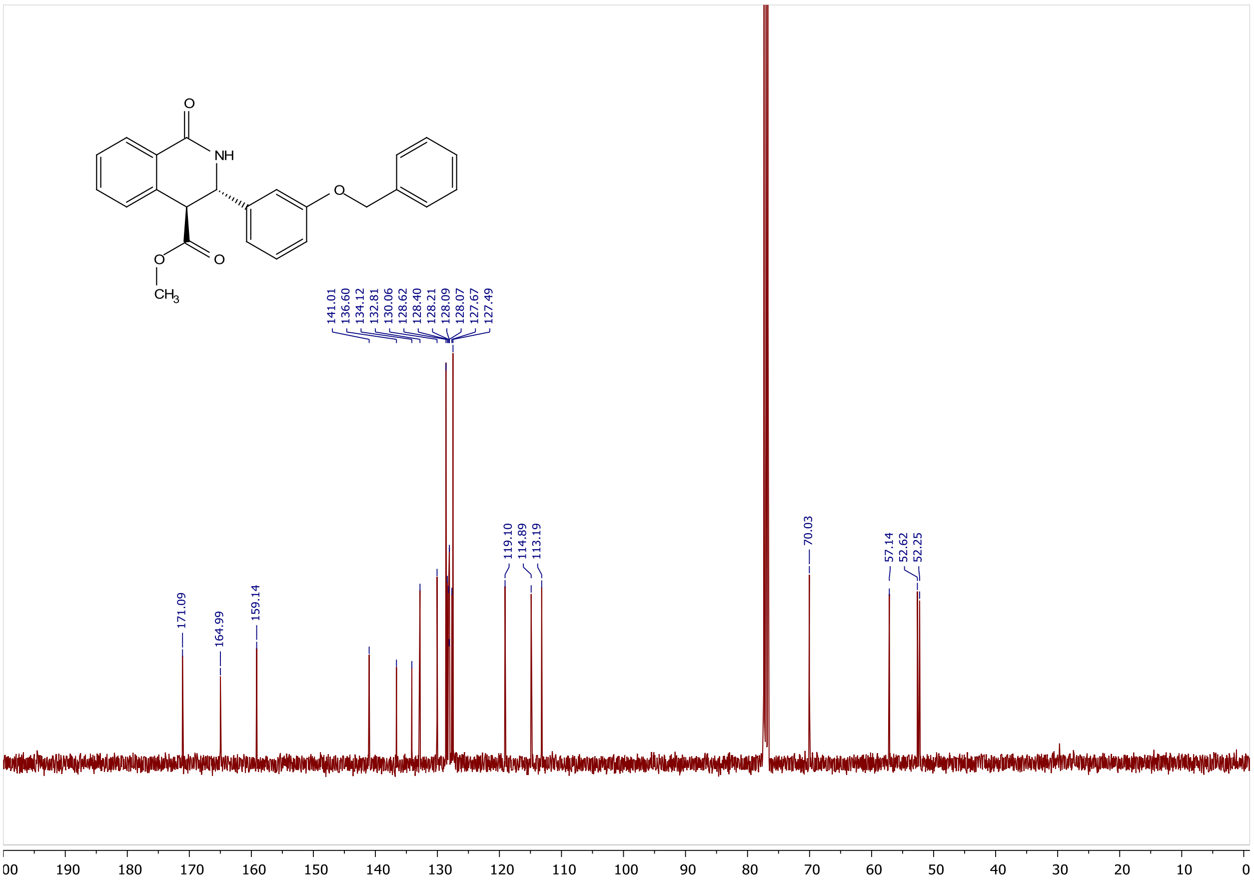

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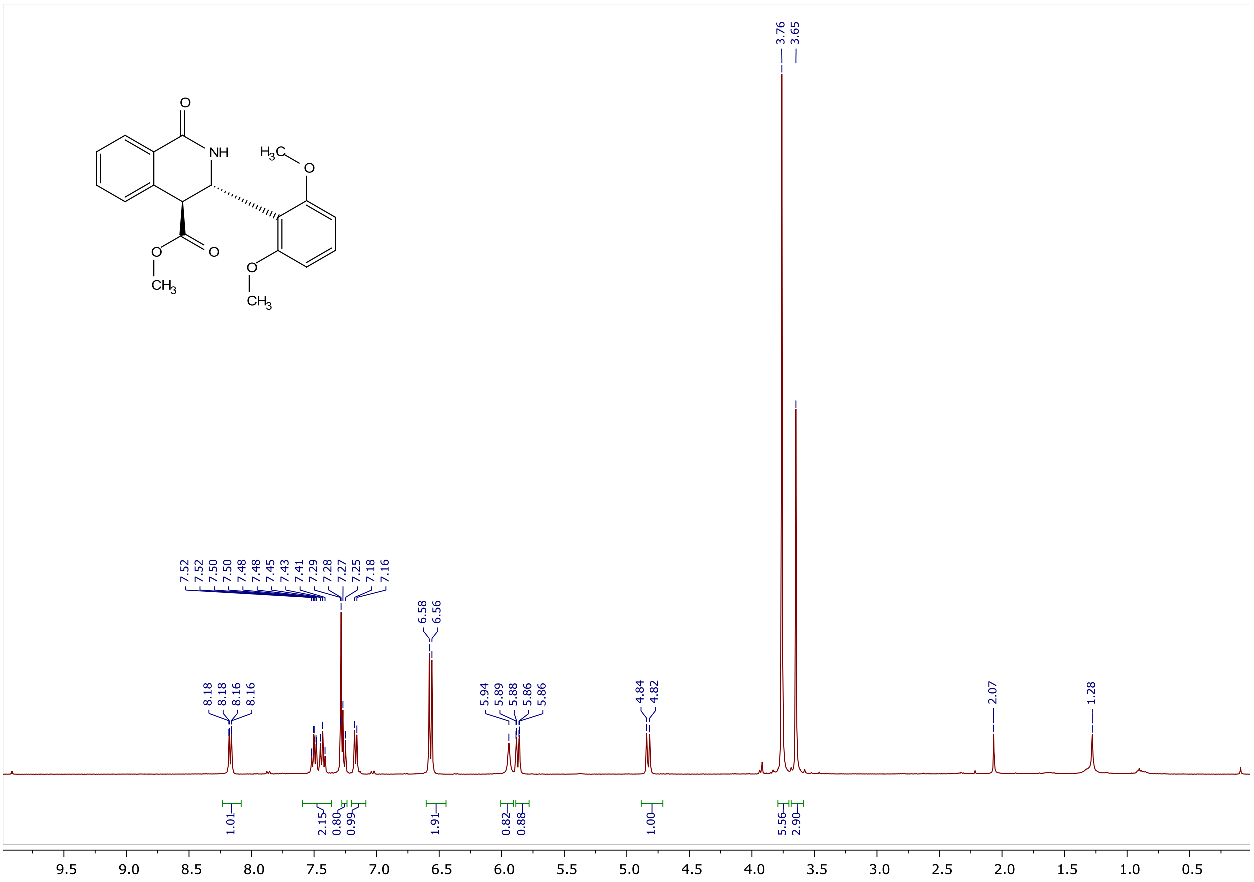

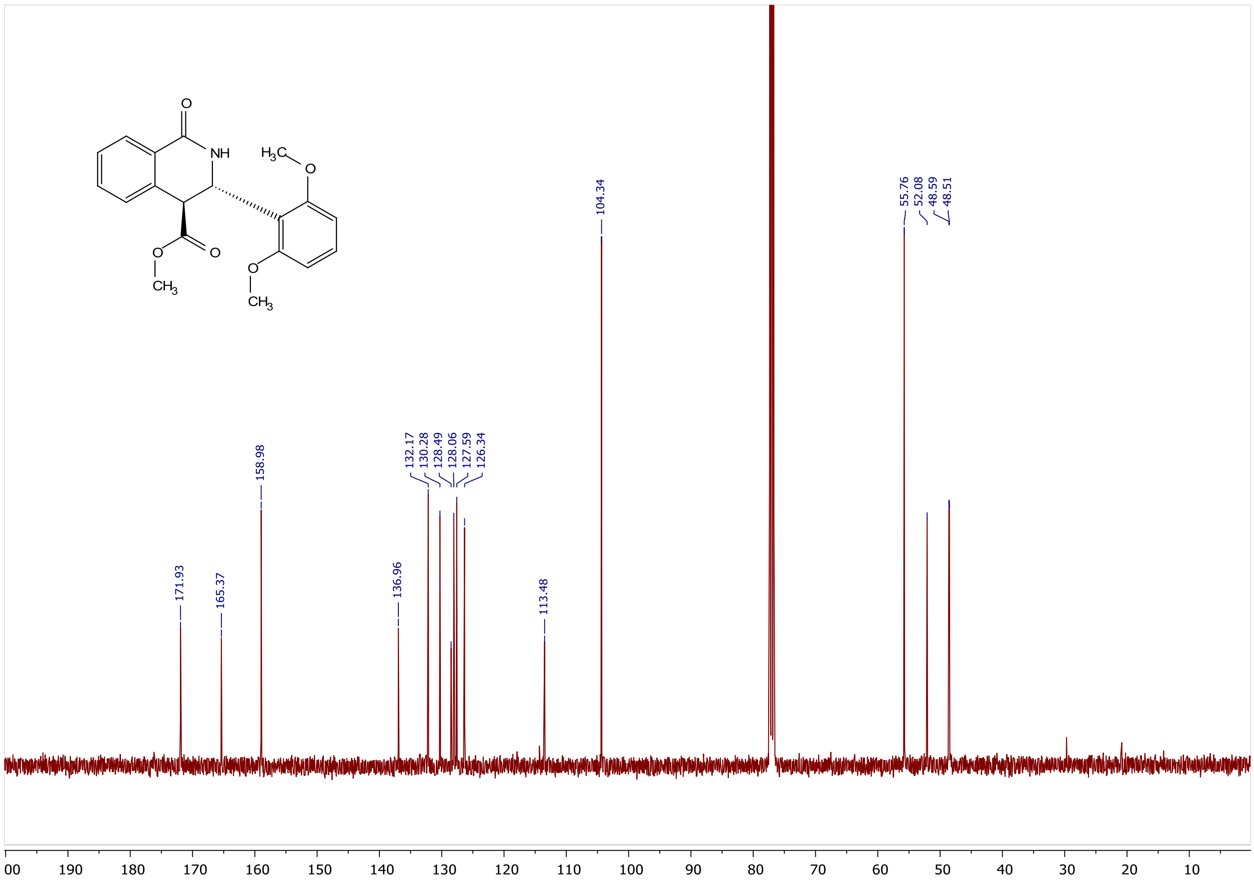

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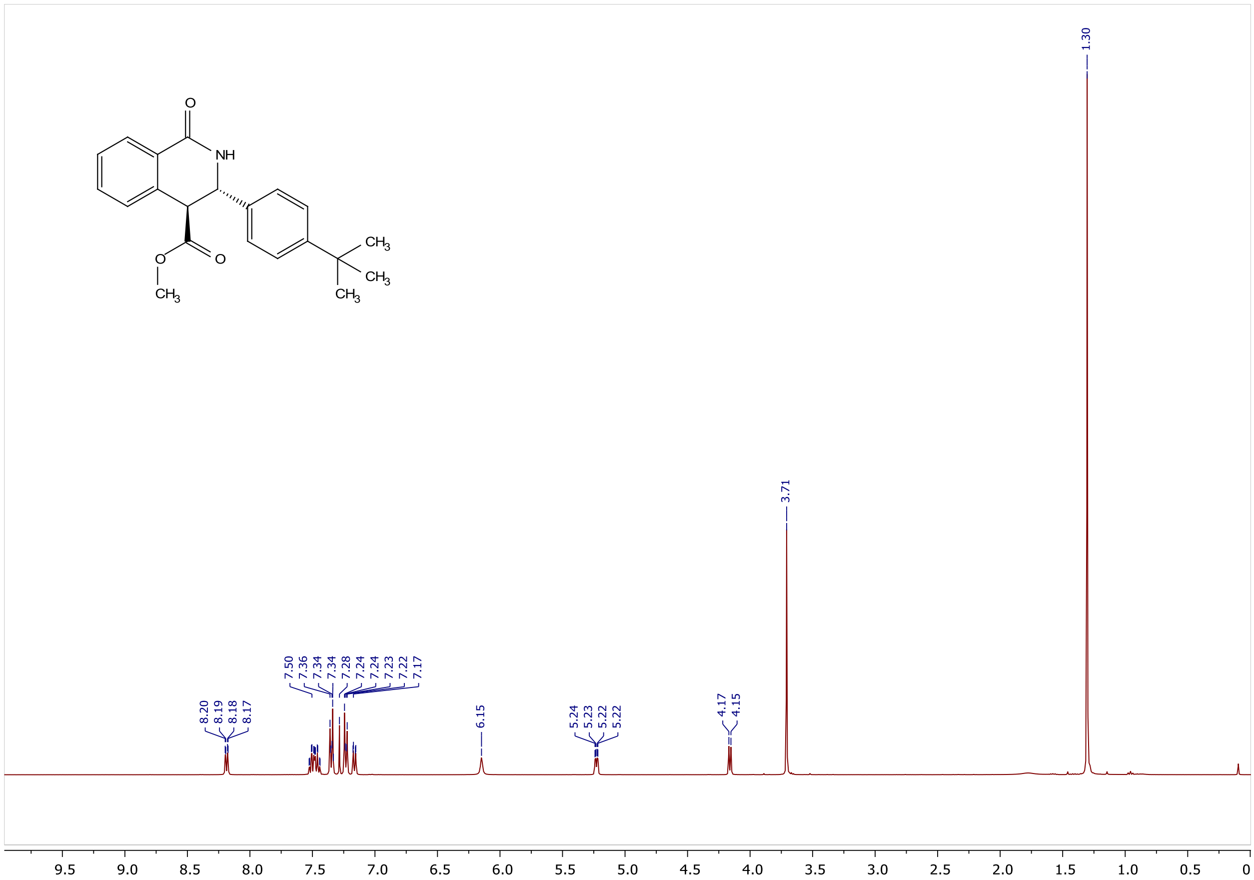

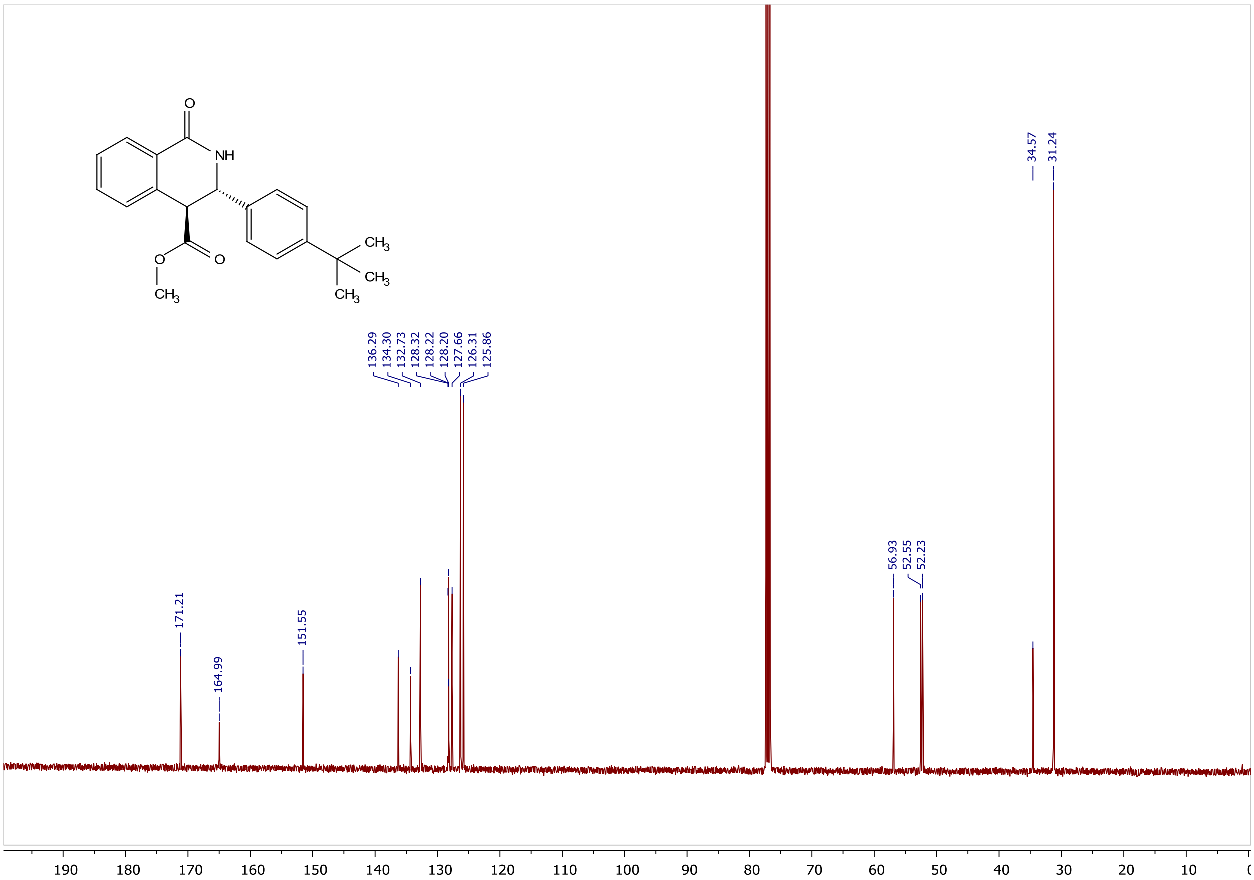

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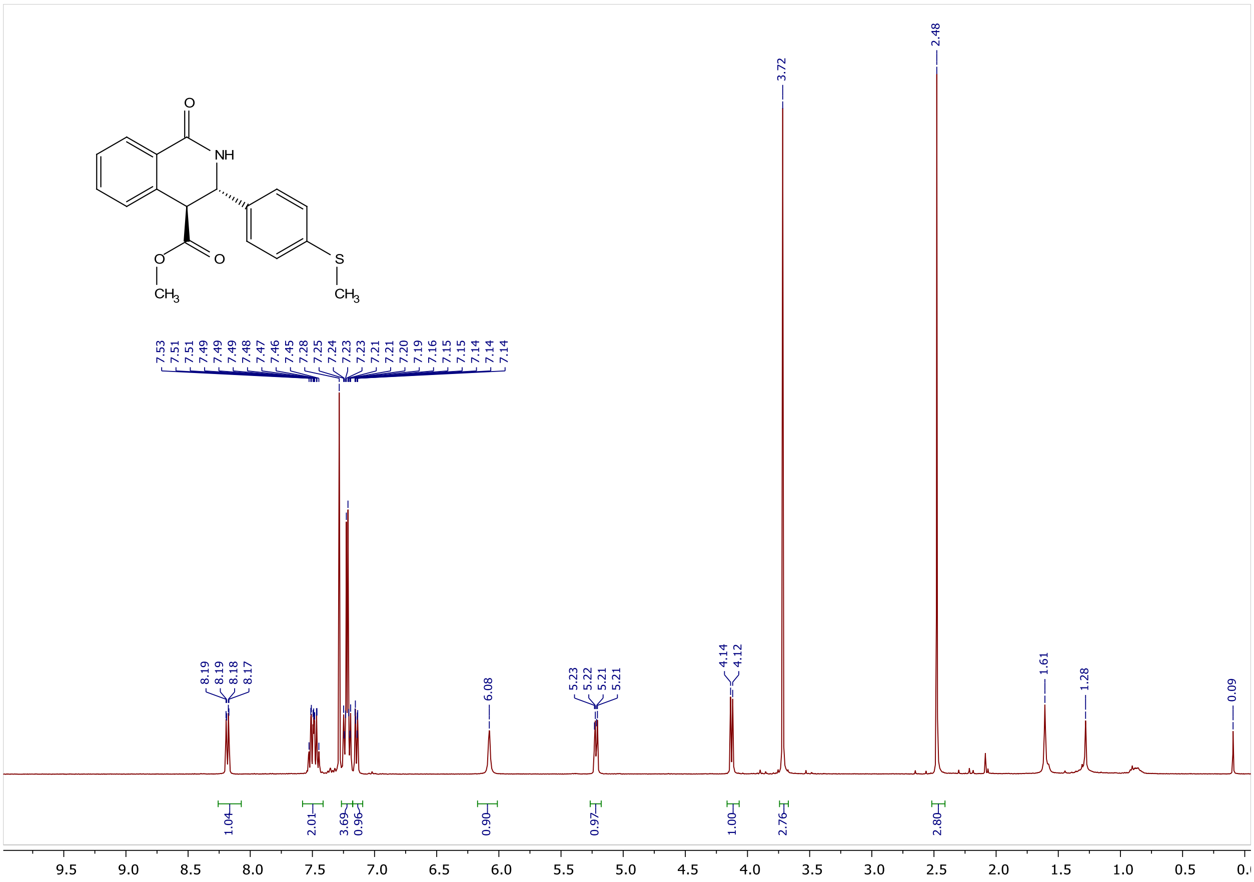
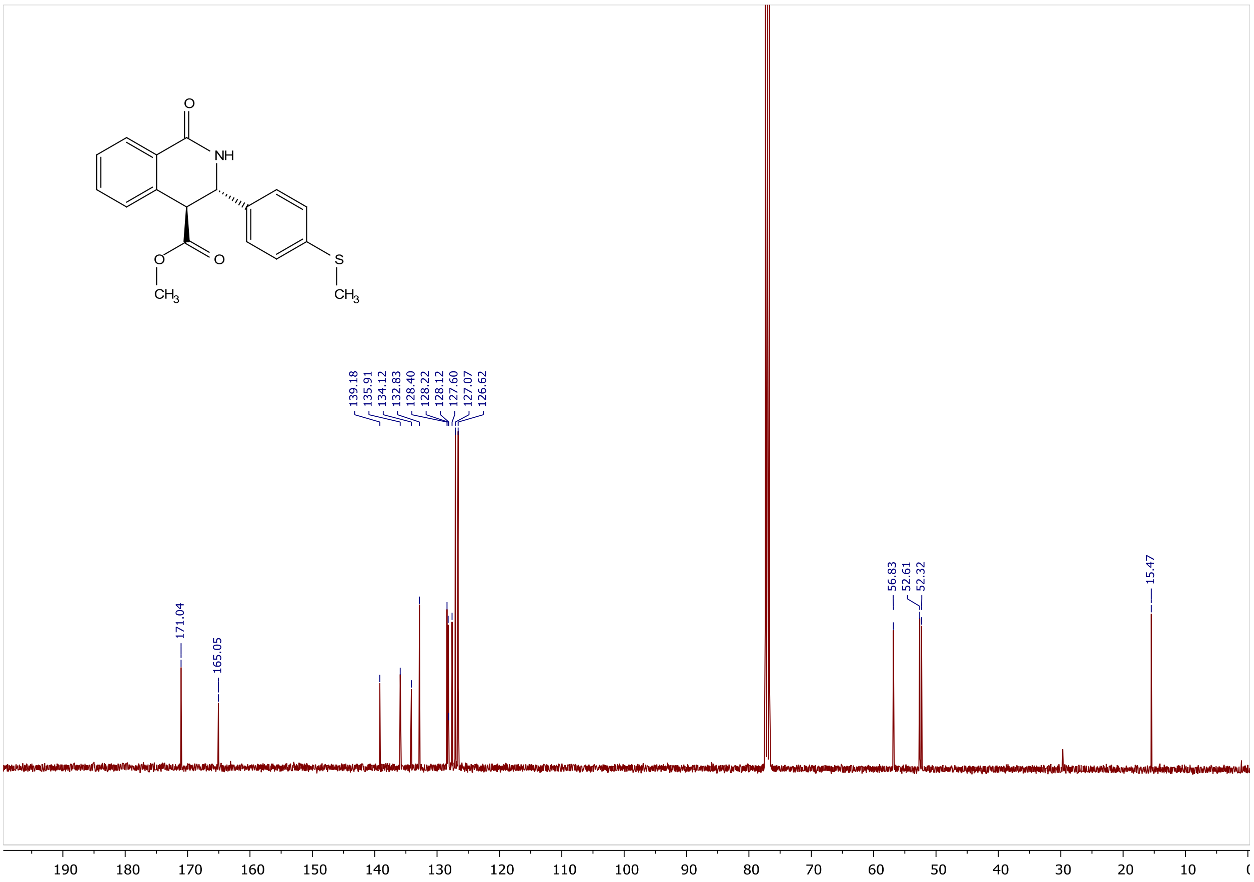
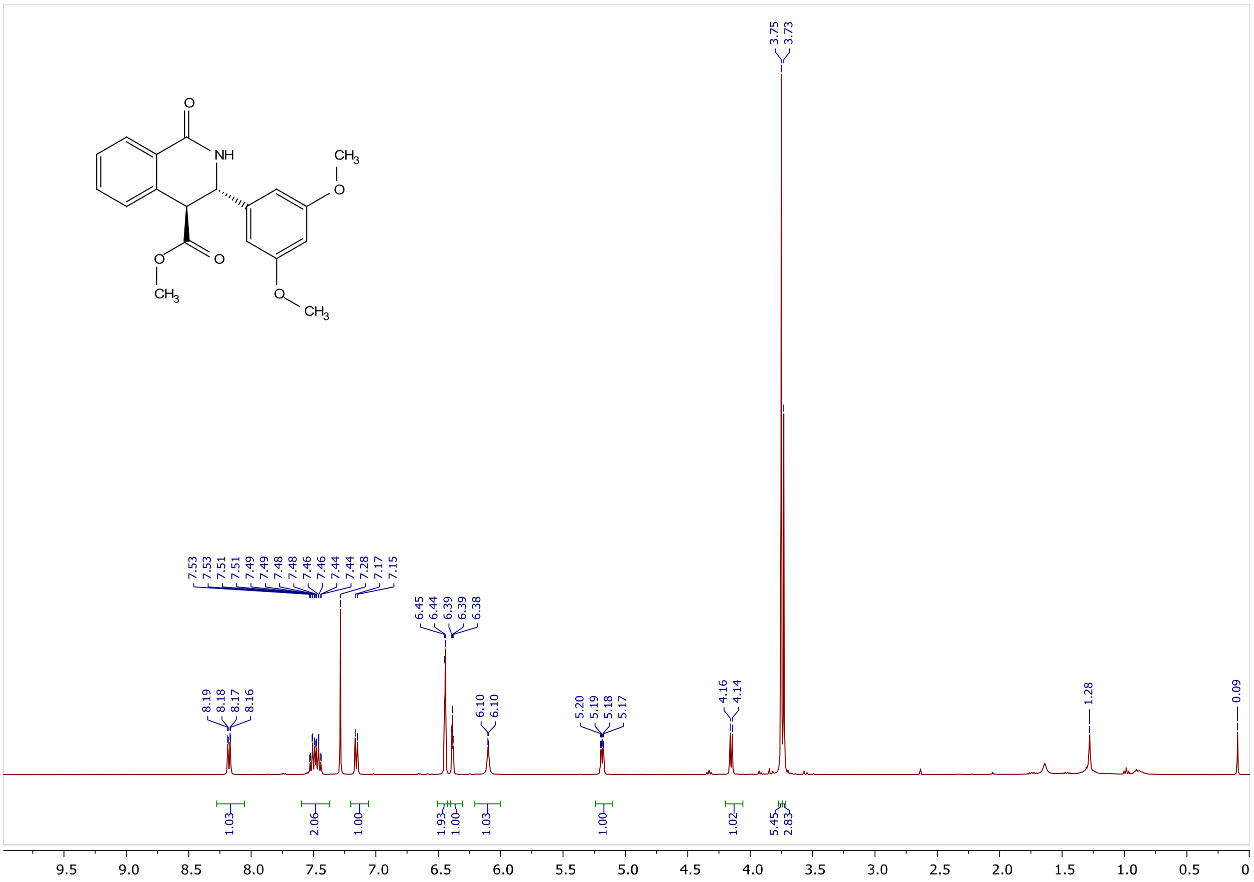
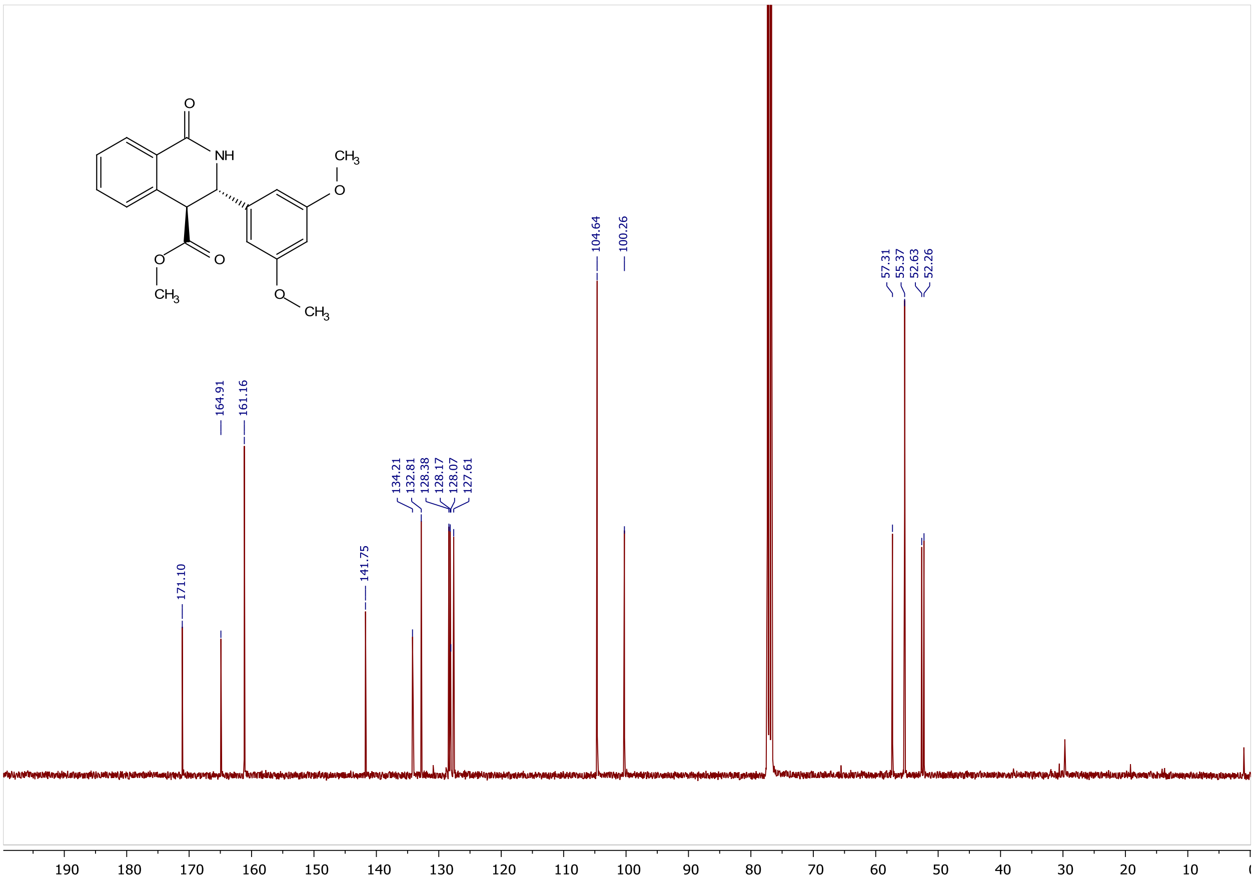


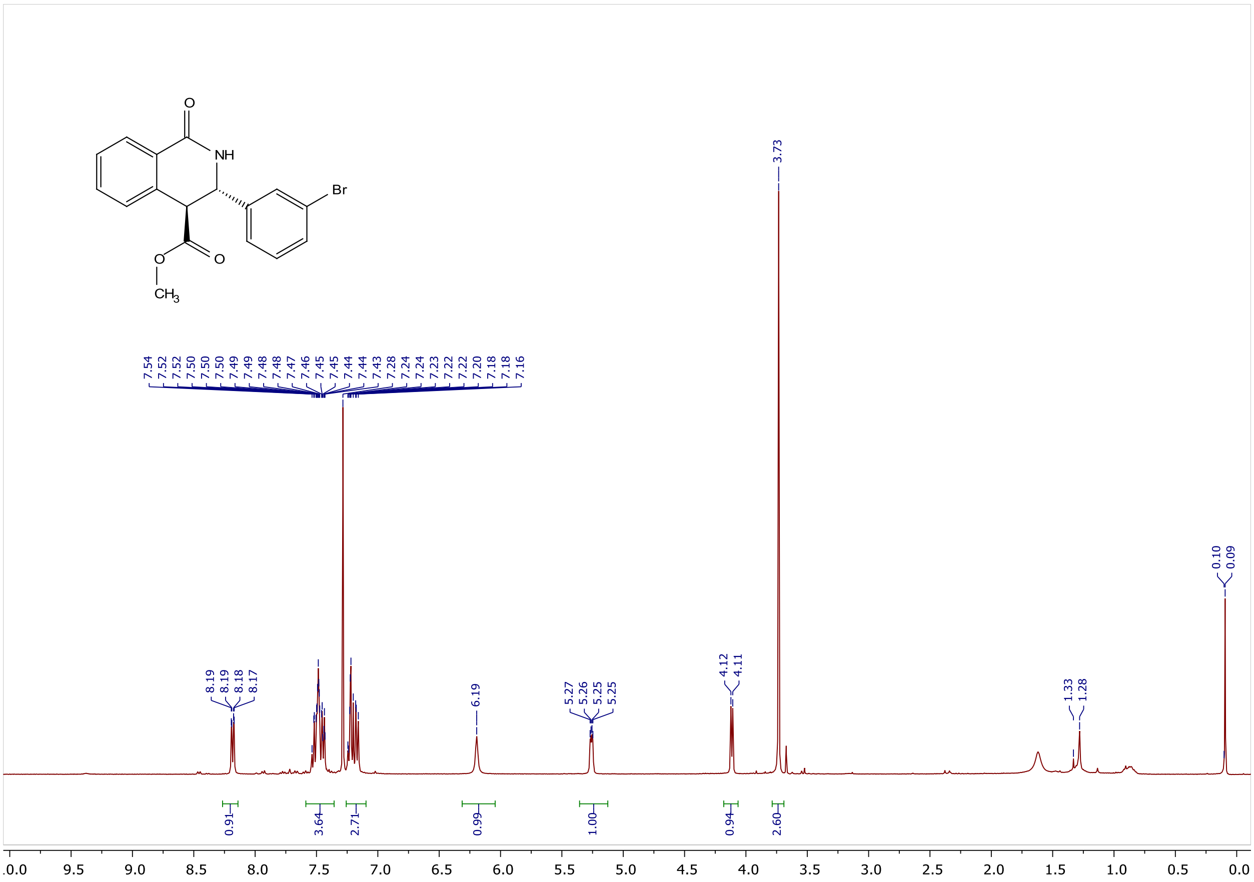


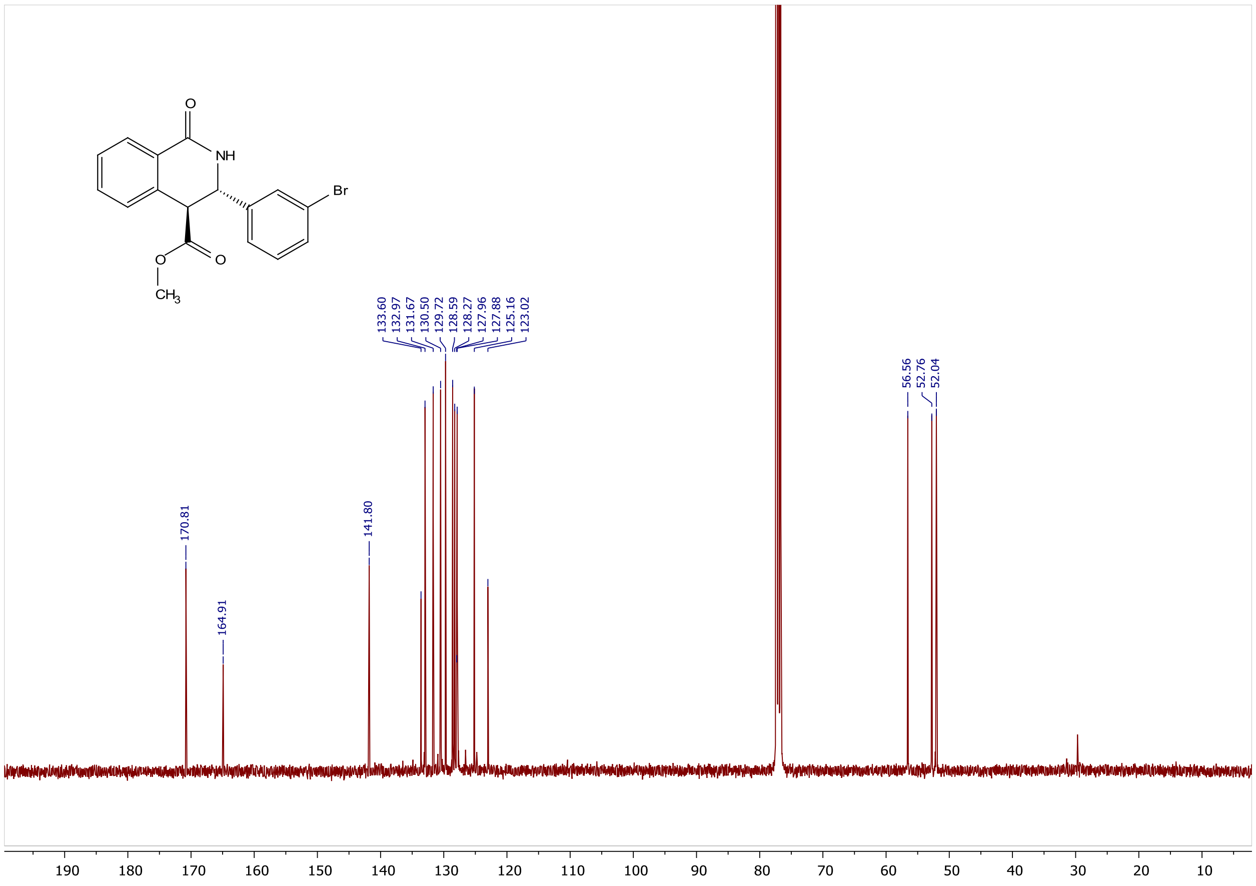
^{1}H and ^{13}C NMR of compound 3h





^{1}H and ^{13}C NMR of compound 3i





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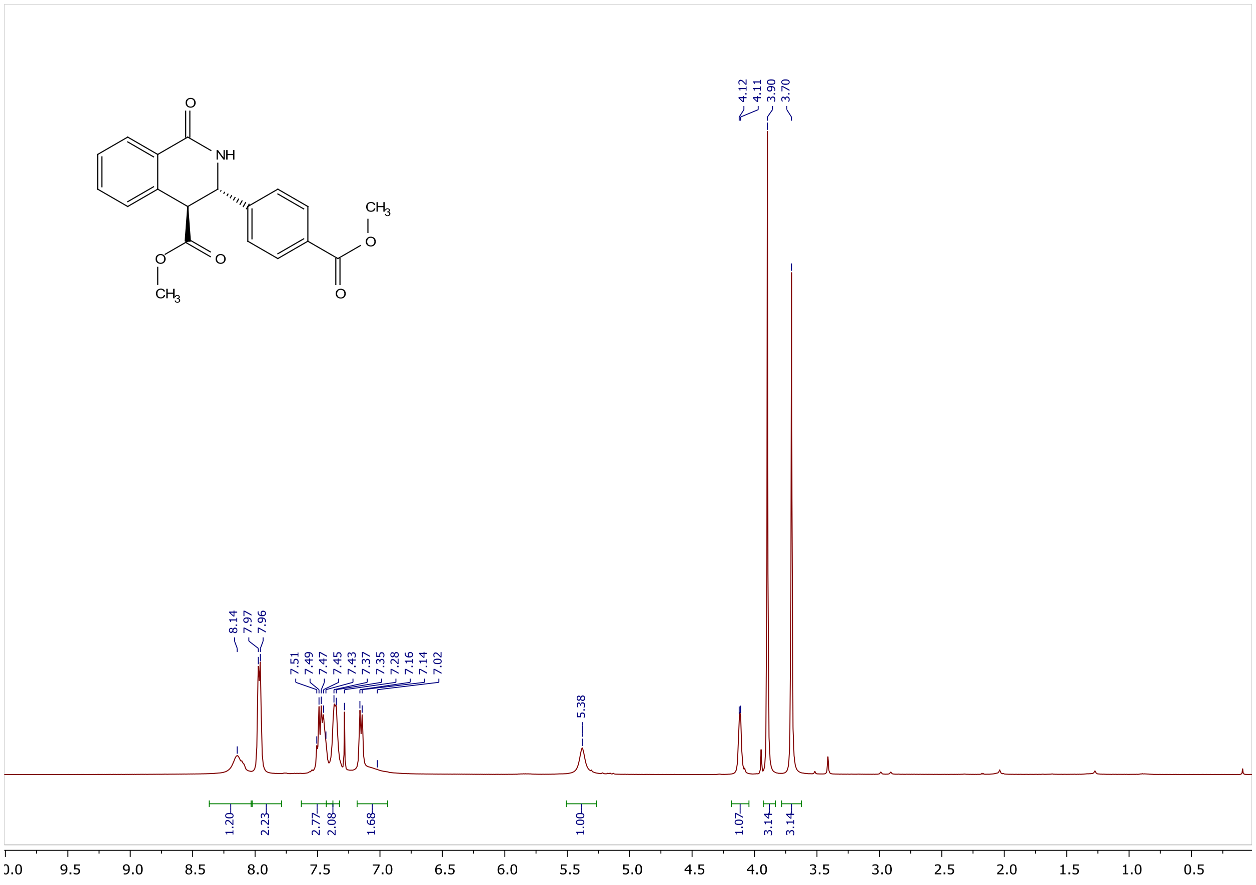
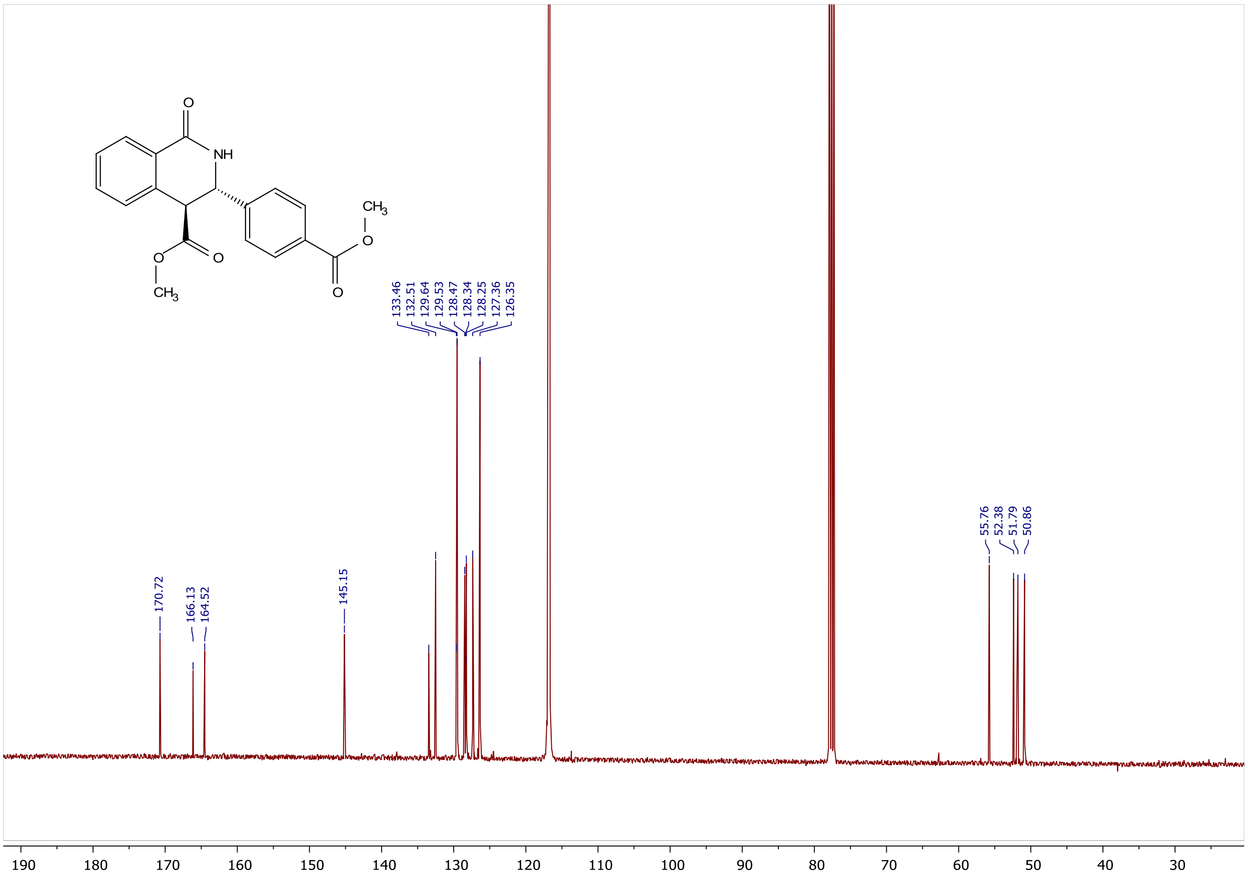
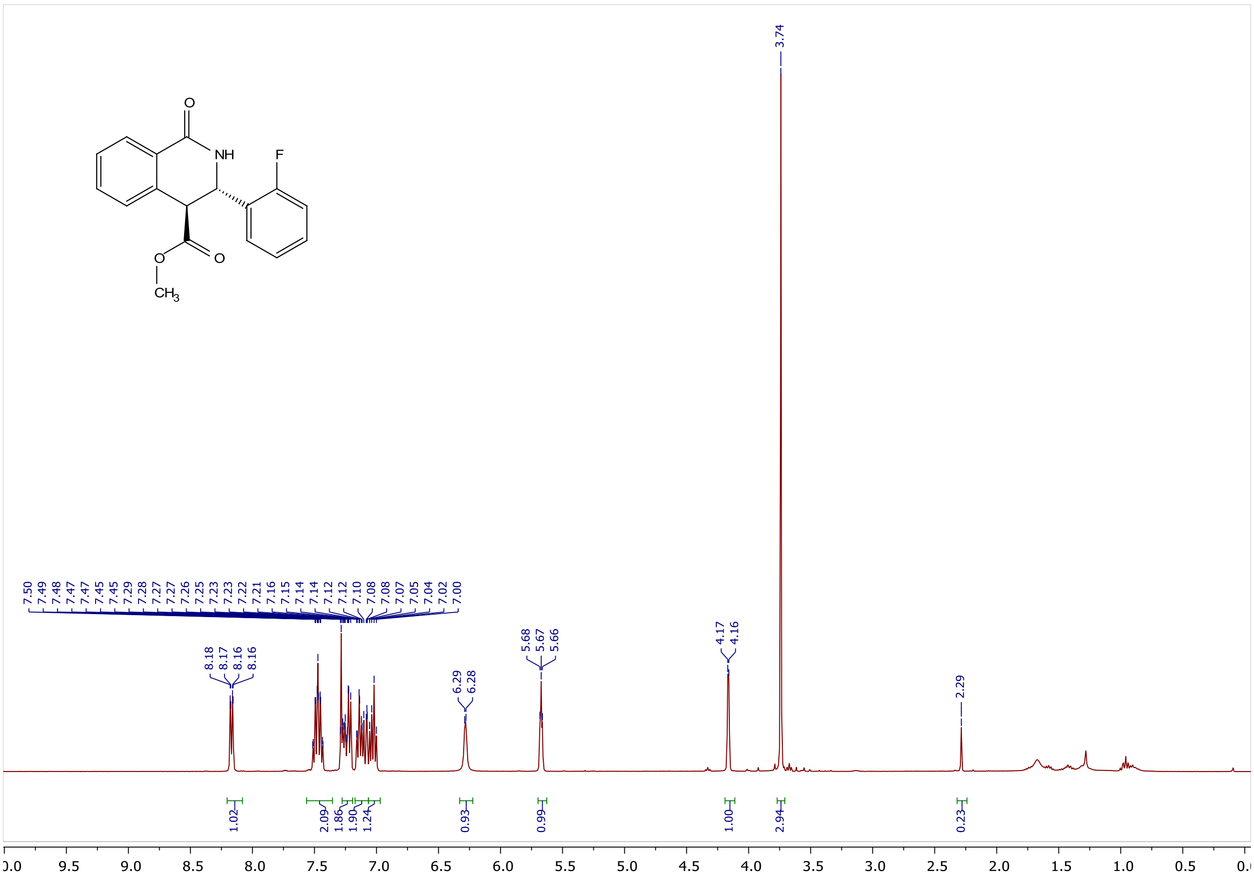
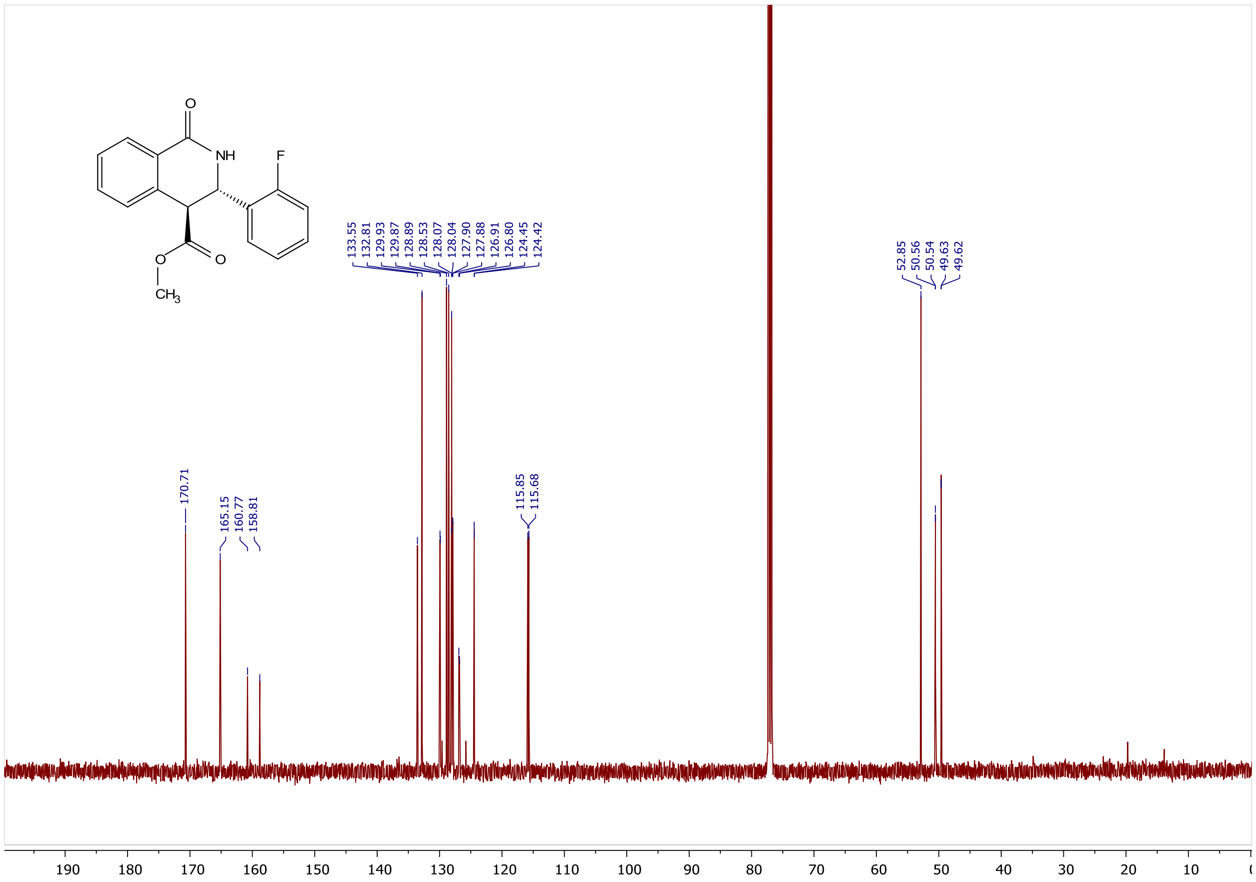




^{1}H and ^{13}C NMR of compound 3k





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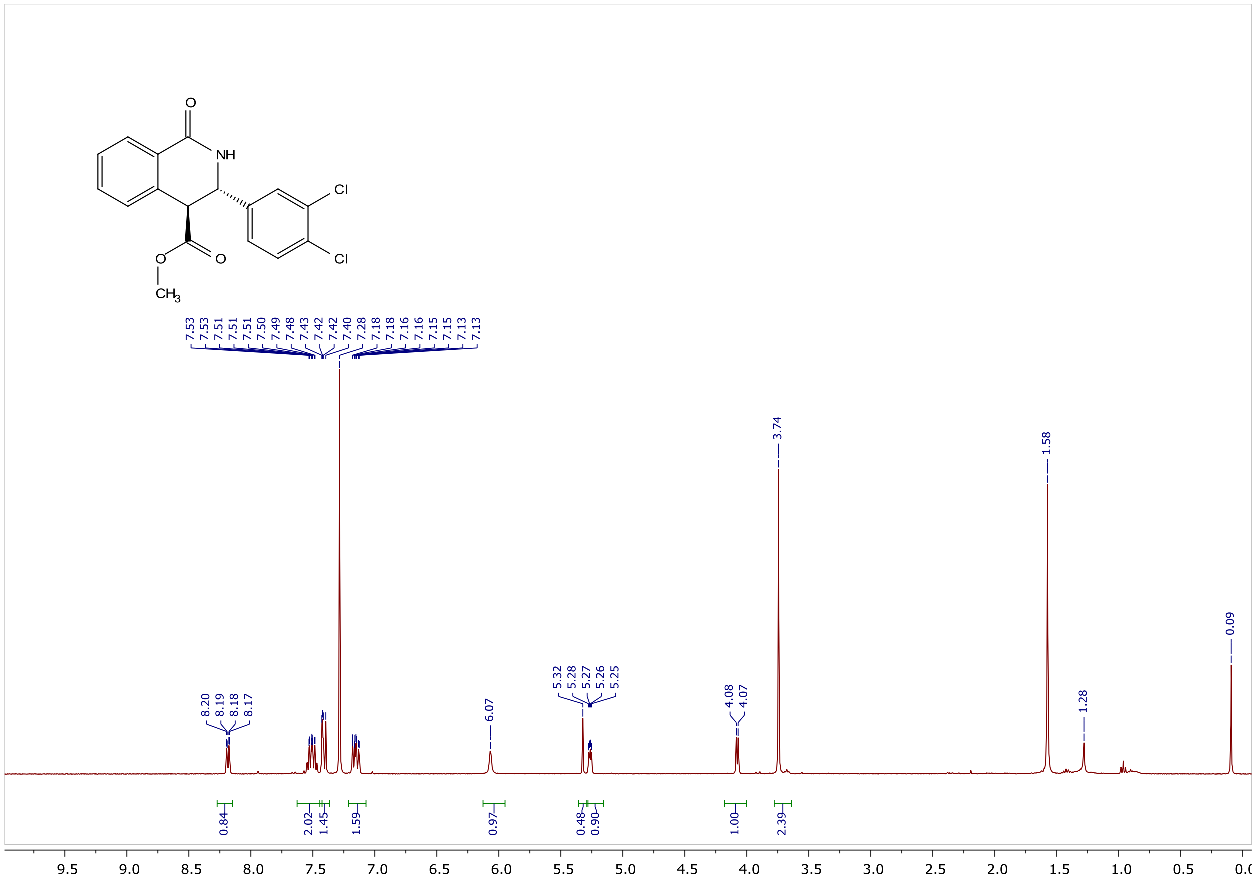

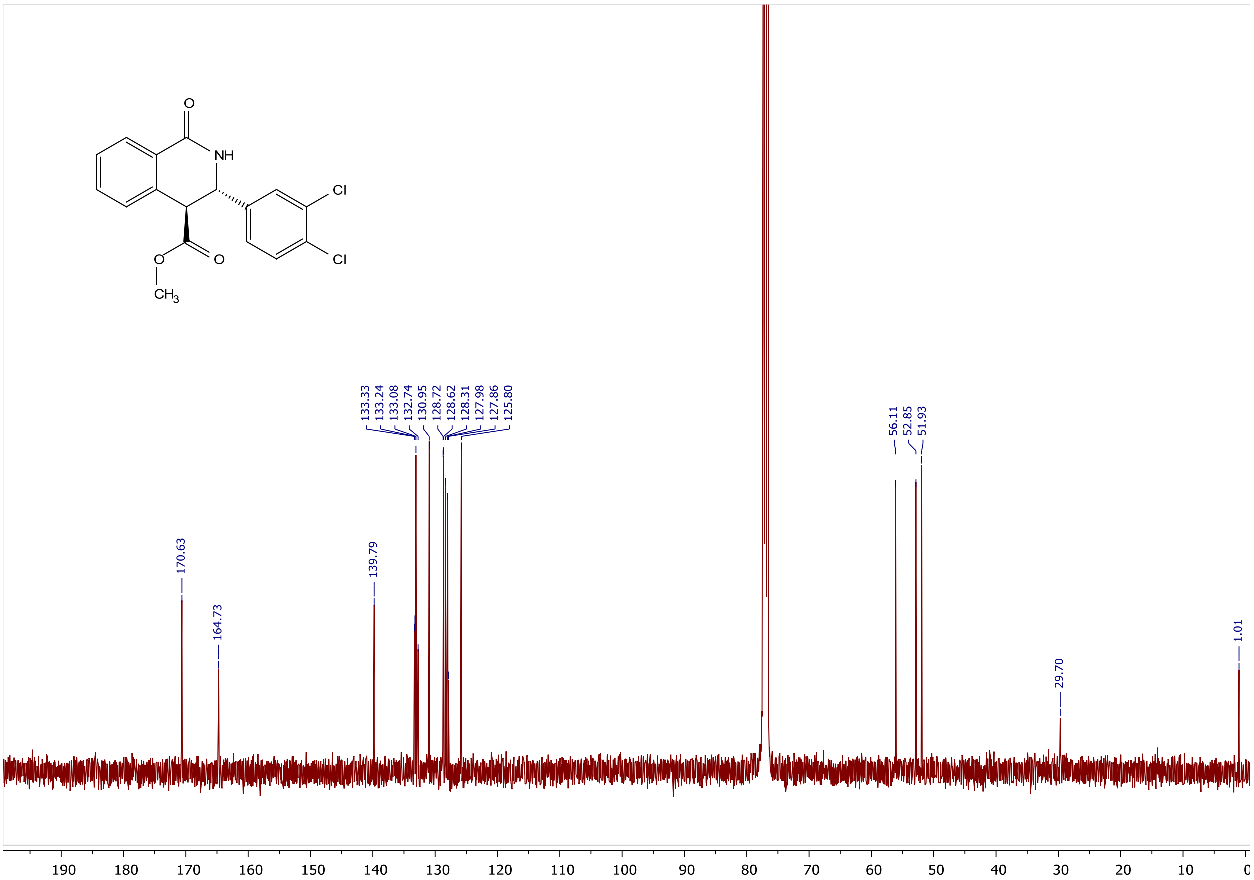

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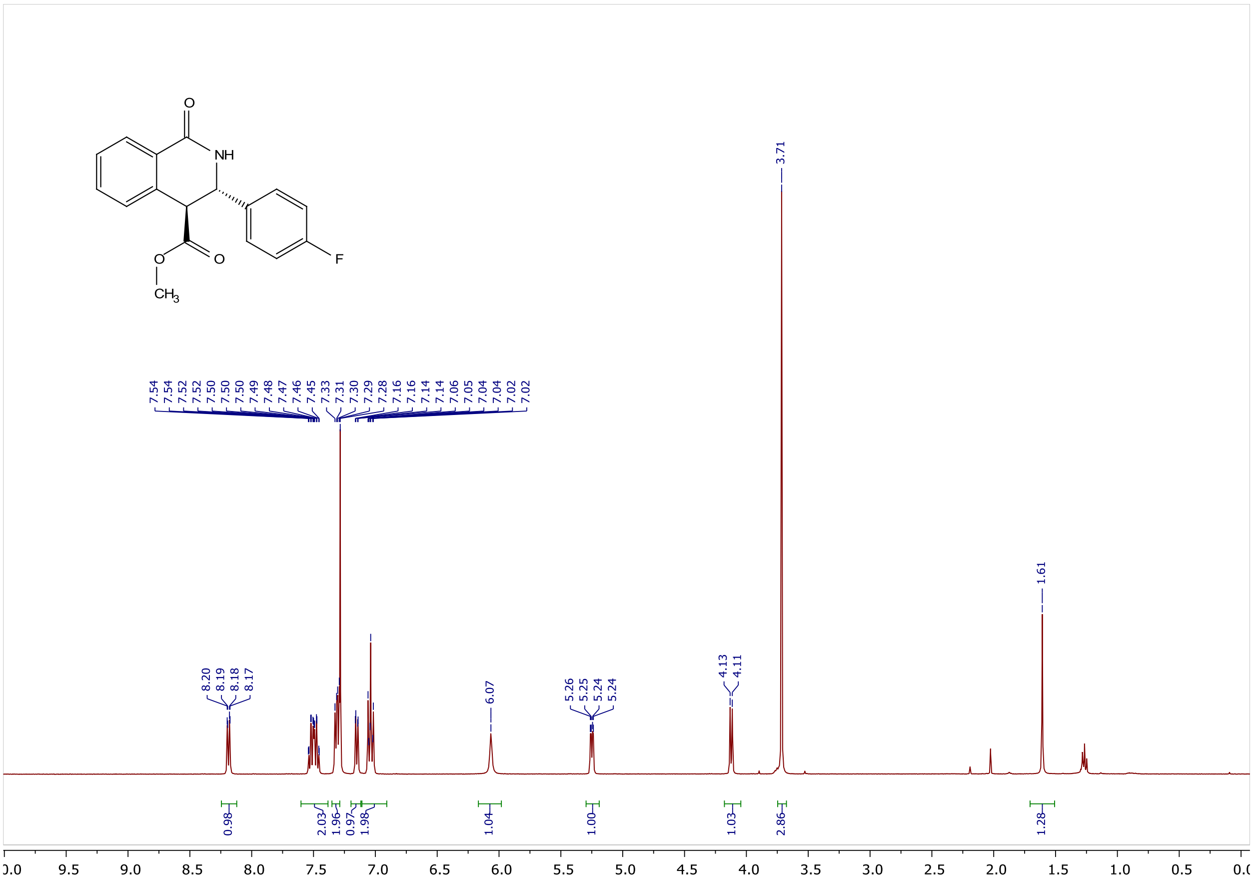

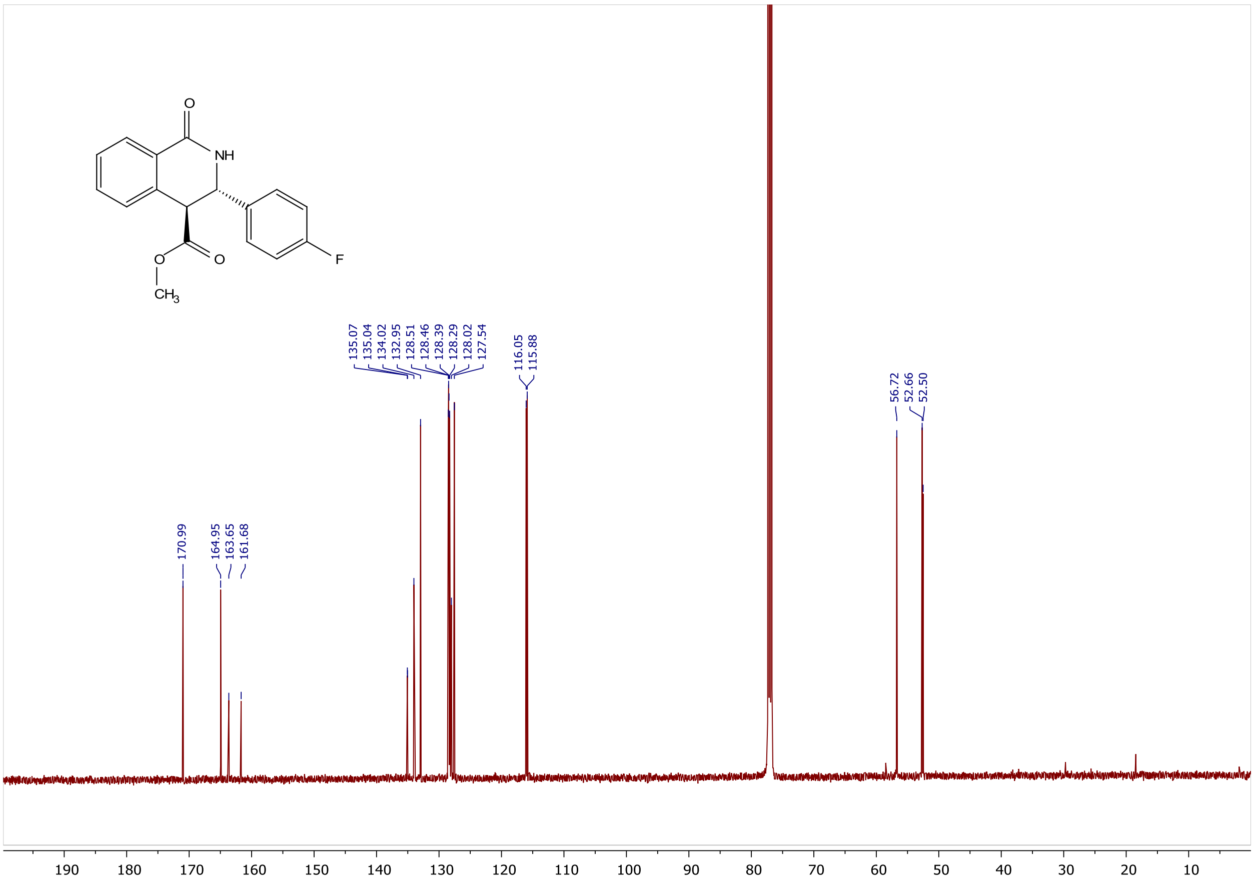

8. References

[S1]. J. S. Meek and J. R. Dann, *J. Am. Chem. Soc.*, 1955, **77**, 6677.

[S2]. O. Yu. Bakulina, A. V. Bannykh, D. V. Dar'in and M. Yu. Krasavin, *Chem. Eur. J.*, 2017, **23**, 17667.

[S3]. O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Crystallogr.*, 2009, **42**, 339.

[S4]. G. M. Sheldrick, *Acta Crystallogr.*, 2015, **A71**, 3.

[S5]. G. M. Sheldrick, *Acta Crystallogr.*, 2015**, C71**, 3.