General Experimental Details:

General Methods

^{1}H, ^{13}C NMR spectra were recorded on a Bruker 400 instrument. Chemical shifts (δ) are reported in ppm relative to residual solvent signals for ^{1}H and ^{13}C NMR (^{1}H NMR: 7.26 ppm for $CDCl_3$, 3.34 ppm for CD_3OD; ^{13}C NMR: 77.0 ppm for $CDCl_3$, 49.00 ppm for CD_3OD). ^{13}C NMR spectra were acquired with ^{1}H broad band decoupled mode. Coupling constants (*J*) are in Hz. Multiplicities are reported as follows: s, singlet, d, doublet, dd, doublets of doublets, t, triplet, q, quartet, m, multiplet, c, complex, and br, broad. Mass spectra were recorded on a Micro mass LCT spectrometer using electrospray (ES) ionisation techniques. Melting points were determined using a Stuart scientific melting point apparatus. Optical rotations were measured on a Perkin-Elmer 241 polarimeter. The enantiomeric excess (*ee*) of the products was determined by chiral stationary phase CSP-HPLC (Daicel Chiralpak AD, Chiralcel OD and Chiralcel AS columns), using a UV detector operating at 254 nm and 210 nm. Infrared (IR) spectra were recorded as thin films between NaCl plates using a Bruker Tensor27 FT-IR instrument. Absorption maximum (νmax) was reported in wavenumbers (cm^{-1}) and only selected peaks are reported. The following abbreviations are used: w, weak, m, medium, s, strong and br, broad.

Materials

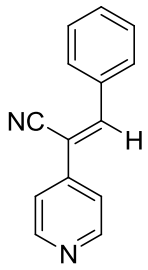
Analytical grade solvents and commercially available reagents were used as received, unless otherwise stated. Reactions were checked for completion by TLC (EM Science, silica gel 60 F254). Flash chromatography was performed using silica gel 60 (0.040-0.063 mm, 230-400 mesh).

Racemic samples were prepared using tetrabutylammonium bromide as a catalyst at room temperature.

General procedure for the synthesis of 3-substituted-2-(pyridin-4-yl)acrylonitrile 3a-m

In a two-neck round bottom flask equipped with a magnetic stirring bar, 4-pyridilacetonitrile hydrochloride (500 mg, 3.23 mmol, 1.0 eq) was weighted and the air was removed. After letting Ar° inside, dry DCM (15.5 mL) was added and the mixture reaction was cooled to 0 °C with an ice-bath. Then Et_3N (2.25 mL, 16.1 mmol, 5.0 eq for aromatic aldehyde; 450 μL, 3.23 mmol, 1.0 eq for aliphatic aldehyde) was added dropwise obtaining a brown/dark solution. After the addition, the ice-bath was removed, the aldehyde (6.46 mmol, 2.0 eq) was added in one portion and the reaction was left stirring at rt. After the stated time the solvent was removed *in vacuo* and the residue was purified by flash chromatography on silica gel eluting with DCM/Et_2O mixtures.

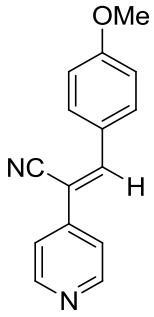
(*Z*)-3-phenyl-2-(pyridin-4-yl)acrylonitrile (1a)



Prepared following general procedure using benzaldehyde (658 μL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1a** as a pale yellow solid (599 mg, 90% yield).

mp = 113-115 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.71 (d, *J* = 6.0 Hz, 2H), 7.95-7.93 (m, 2H), 7.73 (s, 1H), 7.58 (d, *J* = 4.8 Hz, 2H), 7.51 (t, *J* = 3.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 162.5, 150.6, 144.7, 142.3, 132.1, 125.7, 119.8, 117.6, 114.7, 106.0; IR (NaCl) / cm^{-1}: 2239 s, 1650 s ; HRMS: *m/z* found $[M+H]^+$ 207.0863, $C_{14}H_{10}N_2$ requires 206.0844.

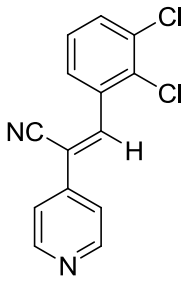
(*Z*)-3-(4-methoxyphenyl)-2-(pyridin-4-yl)acrylonitrile (1b)



Prepared following general procedure using p-anisaldehyde (786 μL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1b** as an orange-yellow solid (654 mg, 86% yield).

mp = 125-127 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.67 (d, *J* = 6.0 Hz, 2H), 7.95 (d, *J* = 8.8 Hz, 2H), 7.65 (s, 1H), 7.54 (d, *J* = 6.4 Hz, 2H), 7.01 (d, *J* = 8.8 Hz, 2H), 3.89 (s, 3H); ^{13}C-NMR (100.6 MHz): 162.5, 150.6, 144.7, 142.3, 132.1, 125.7, 119.8, 117.6, 114.7, 106.0, 55.6; IR (NaCl) / cm^{-1}: 2237 s, 1653 s; HRMS: *m/z* found $[M+H]^+$ 237.1029, $C_{15}H_{12}N_2O$ requires 236.0950.

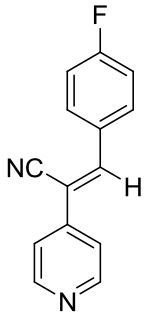
(*Z*)-3-(2,3-dichlorophenyl)-2-(pyridin-4-yl)acrylonitrile (1c)



Prepared following general procedure using 2,3-dichlorobenzaldehyde (1.13 g, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1c** as a pale yellow solid (825 mg, 93% yield).

mp = 188-190 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.75 (d, *J* = 6.4 Hz, 2H), 8.07 (s, 1H), 8.00 (dd, *J* = 7.9, 1.4 Hz, 1H), 7.61-7.59 (m, 3H), 7.38 (t, *J* = 8.0 Hz, 1H); ^{13}C-NMR (100.6 MHz): 151.0, 141.5, 140.8, 134.2, 133.6, 133.2, 132.8, 128.0, 127.9, 120.3, 115.9, 114.0; IR (NaCl) / cm^{-1}: 2249 s, 1652 s; HRMS: *m/z* found $[M+H]^+$ 275.0072, $C_{14}H_8Cl_2N_2$ requires 274.0065.

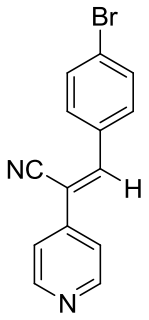
(*Z*)-3-(4-fluorophenyl)-2-(pyridin-4-yl)acrylonitrile (1d)



Prepared following general procedure using 4-fluorobenzaldehyde (693 µL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1d** as a bright yellow solid (629 mg, 87% yield).

mp = 167-169 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.71 (d, *J* = 6.4 Hz, 2H), 7.97 (dd, *J* = 8.9, 5.3 Hz, 2H), 7.68 (s, 1H), 7.56 (d, *J* = 6.4 Hz, 2H), 7.20 (t, *J* = 8.6 Hz, 2H); ^{13}C-NMR (100.6 MHz): 150.8, 143.8, 141.7, 132.2, 132.1, 129.3, 129.2, 120.0, 116.7, 116.5; IR (NaCl) / cm^{-1}: 2249 s, 1651 s; HRMS: *m/z* found $[M+H]^+$ 225.0825, $C_{14}H_9FN_2$ requires 224.0750.

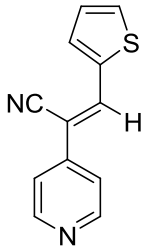
(*Z*)-3-(4-bromophenyl)-2-(pyridin-4-yl)acrylonitrile (1e)



Prepared following general procedure using 4-bromobenzaldehyde (1.19 g, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1e** as a bright yellow solid (817 mg, 89% yield).

mp = 114-116 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.72 (d, *J* = 6.0 Hz, 2H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.67-7.64 (m, 3H), 7.60 (d, *J* = 6.4 Hz, 2H); ^{13}C-NMR (100.6 MHz): 150.3, 144.1, 142.1, 132.6, 131.7, 131.2, 126.5, 120.2, 116.7, 109.9; IR (NaCl) / cm^{-1}: 2250 s, 1652 s; HRMS: *m/z* found $[M+H]^+$ 285.0031, $C_{14}H_9BrN_2$ requires 283.9949.

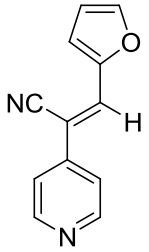
(*Z*)-2-(pyridin-4-yl)-3-(thiophen-2-yl)acrylonitrile (1f)



Prepared following general procedure using 3-thiophenecarboxaldehyde (566 μL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1f** as a yellow solid (609 mg, 89% yield).

mp = 134-136 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.69 (d, *J* = 5.2 Hz, 2H), 8.07-8.06 (m, 1H), 7.84 (dd, *J* = 5.2, 1.2 Hz, 1H), 7.75 (s, 1H), 7.56 (d, *J* = 6.0 Hz, 2H), 7.47 (dd, *J* = 5.1, 2.9 Hz, 1H); ^{13}C-NMR (100.6 MHz): 150.5, 142.0, 138.3, 135.5, 132.0, 127.5, 127.4, 119.9, 117.4, 107.4; IR (NaCl) / cm^{-1}: 2230 s, 1661 s; HRMS: *m/z* found $[M+H]^+$ 213.0448, $C_{12}H_8N_2S$ requires 212.0408.

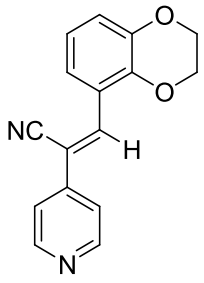
(*Z*)-3-(furan-2-yl)-2-(pyridin-4-yl)acrylonitrile (1g)



Prepared following general procedure using 2-furaldehyde (535 μL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1g** as a yellow solid (551 mg, 87% yield).

mp = 124-126 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.67 (d, *J* = 6.3 Hz, 2H), 7.68 (d, *J* = 1.7 Hz, 1H), 7.57 (s, 1H), 7.52 (d, *J* = 6.3 Hz, 2H), 7.31 (d, *J* = 3.6 Hz, 1H), 6.64 (dd, *J* = 3.6, 1.8 Hz, 1H); ^{13}C-NMR (100.6 MHz): 150.7, 149.6, 146.4, 141.2, 130.4, 119.5, 117.9, 116.8, 113.4, 105.0; IR (NaCl) / cm^{-1}: 2230 s, 1654 s; HRMS: *m/z* found $[M+H]^+$ 197.0715, $C_{12}H_8N_2O$ requires 196.0637.

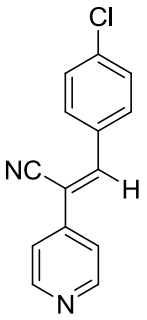
(*Z*)-3-(2,3-dihydrobenzo[b][1,4]dioxin-5-yl)-2-(pyridin-4-yl)acrylonitrile (1h)



Prepared following general procedure using 1,4-benzodioxan-6-carboxaldehyde (1.06 g, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1h** as a bright yellow solid (811.4 mg, 95% yield).

mp = 185-187 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.67 (d, *J* = 6.0 Hz, 2H), 7.58 (s, 1H), 7.55-7.53 (m, 3H), 7.48 (dd, *J* = 8.5, 2.2 Hz, 1H), 6.96 (d, *J* = 8.5 Hz, 1H), 4.34-4.29 (m, 4H).; ^{13}C-NMR (100.6 MHz): 150.5, 147.1, 144.7, 143.9, 142.4, 126.5, 124.4, 119.9, 118.9, 118.1, 117.4, 106.7, 64.9, 64.3; IR (NaCl) / cm^{-1}: 2237 s, 1652 s; HRMS: *m/z* found $[M+H]^+$ 265.0989, $C_{16}H_{12}N_2O_2$ requires 264.0899.

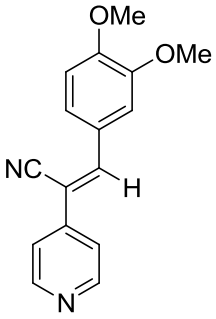
(*Z*)-3-(4-chlorophenyl)-2-(pyridin-4-yl)acrylonitrile (1i)



Prepared following general procedure using 4-chlorobenzaldehyde (0.91 g, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1i** as a bright yellow solid (682.1 mg, 88% yield).

mp = 124-126 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.71 (d, *J* = 6.4 Hz, 2H), 7.88 (d, *J* = 8.8 Hz, 2H), 7.67 (s, 1H), 7.56 (d, *J* = 6.4 Hz, 2H), 7.48 (d, *J* = 8.8 Hz, 2H); ^{13}C-NMR (100.6 MHz): 150.8, 143.7, 141.6, 137.9, 131.4, 131.1, 129.7, 120.1, 116.8, 110.0; IR (NaCl) / cm^{-1}: 2248 s, 1652 s; HRMS: *m/z* found $[M+H]^+$ 241.0548, $C_{14}H_9ClN_2$ requires 240.0454.

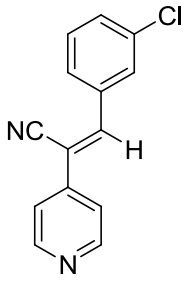
(*Z*)-3-(3,4-dimethoxyphenyl)-2-(pyridin-4-yl)acrylonitrile (1j)



Prepared following general procedure using 3,4-dimethoxybenzaldehyde (1.07 g, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 8:2) afforded **1j** as a bright yellow solid (771.3 mg, 90% yield).

mp = 148-150 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.67 (d, *J* = 6.4 Hz, 2H), 7.77 (d, *J* = 2.0 Hz, 1H), 7.63 (s, 1H), 7.54 (d, *J* = 6.4 Hz, 2H), 7.41 (dd, *J* = 8.4, 2.0 Hz, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 3.98 (s, 3H), 3.96 (s, 3H); ^{13}C-NMR (100.6 MHz): 152.4, 150.7, 149.4, 144.9, 142.3, 126.0, 125.7, 119.8, 117.7, 111.2, 111.1, 106.1, 56.2; IR (NaCl) / cm^{-1}: 2242 s, 1654 s; HRMS: *m/z* found $[M+H]^+$ 267.1098, $C_{16}H_{14}N_2O_2$ requires 266.1055.

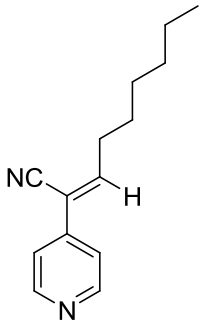
(*Z*)-3-(3-chlorophenyl)-2-(pyridin-4-yl)acrylonitrile (1k)



Prepared following general procedure using 3-chlorobenzaldehyde (732 µL, 6.46 mmol). Reaction time: 120 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1k** as a yellow solid (679.7 mg, 87% yield).

mp = 176-178 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.72 (d, *J* = 6.4 Hz, 2H), 7.88-7.84 (m, 2H), 7.65 (s, 1H), 7.57 (d, *J* = 6.0 Hz, 2H), 7.47-7.45 (m, 2H); ^{13}C-NMR (100.6 MHz): 150.9, 143.5, 141.5, 135.4, 134.6, 131.6, 130.6, 129.9, 127.6, 120.2, 116.5, 111.2; IR (NaCl) / cm^{-1}: 2244 s, 1651 s; HRMS: *m/z* found $[M+H]^+$ 241.0499, $C_{14}H_9ClN_2$ requires 240.0454.

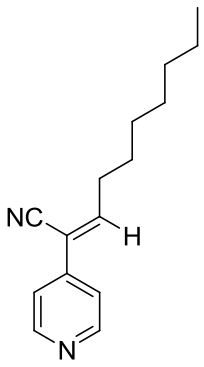
(*Z*)-2-(pyridin-4-yl)non-2-enenitrile (1l)



Prepared following general procedure using heptaldehyde (0.90 mL, 6.46 mmol). Reaction time: 144 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1l** as a colourless oil (484 mg, 70% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.64 (d, *J* = 5.6 Hz, 2H), 7.42 (d, *J* = 6.0 Hz, 2H), 7.08 (t, *J* = 7.8 Hz, 1H), 2.63 (q, *J* = 7.6 Hz, 2H), 1.58 (qui, *J* = 7.4 Hz, 2H), 1.38-1.26 (m, 6H), 0.90 (t, *J* = 6.8 Hz, 3H); ^{13}C-NMR (100.6 MHz): 151.3, 150.6, 140.7, 119.9, 115.5, 114.4, 32.6, 31.6, 29.0, 28.5, 22.6, 14.1; IR (NaCl) / cm^{-1}: 2244 s, 1660 s; HRMS: *m/z* found $[M+H]^+$ 215.1550, $C_{14}H_{18}N_2$ requires 214.1470.

(*Z*)-2-(pyridin-4-yl)dec-2-enenitrile (1m)



Prepared following general procedure using octanal (1.01 mL, 6.46 mmol). Reaction time: 144 h. Column chromatography (Solvents DCM:Et_2O 7:3) afforded **1m** as a yellow oil (551 mg, 75% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.64 (d, *J* = 6.4 Hz, 2H), 7.42 (d, *J* = 6.4 Hz, 2H), 7.08 (t, *J* = 7.8 Hz, 1H), 2.63 (q, *J* = 7.6 Hz, 2H), 1.41-1.28 (m, 10H), 0.88 (t, *J* = 6.8 Hz, 3H); ^{13}C-NMR (100.6 MHz): 151.3, 150.6, 140.7, 119.9, 115.5, 114.3, 32.6, 31.8, 29.3, 29.1, 28.5, 22.7,

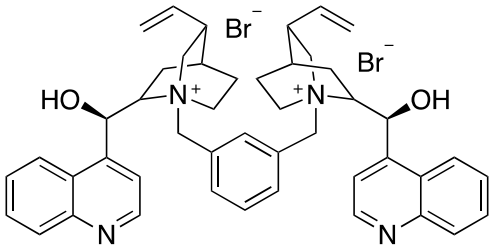
14.2; IR (NaCl) / cm^{-1}: 2245 s, 1661 s; HRMS: *m/z* found $[M+H]^+$ 229.1700, $C_{15}H_{20}N_2$ requires 228.1626.

The following catalyst was commercially available: **7**

The following catalyst was prepared using literature procedure: **9**[1]

Experimental procedure for the preparation of catalyst α,α'-Biscinchonidinium-*m*-xylene dibromide (8)

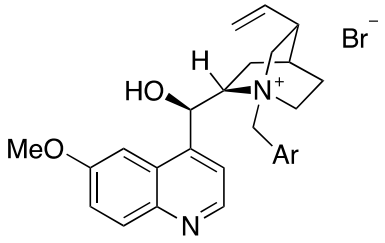
A mixture of cinchonidine (2.0 g, 6.79 mmol) with α,α'-dibromo-*m*-xylene (0.88 g, 3.33 mmol) in a mixture of ethanol (5 mL), DMF (6 mL), and chloroform (2 mL) was stirred at 100 °C for 6 h. After cooling the reaction mixture to room temperature, the reaction mixture was diluted with methanol (40 mL) and then added to ether (200 mL) dropwise with stirring. The solid precipitated was filtered, washed with ether (500 mL). The crude solid was recrystallized from methanol-ether to afford 2.7 g (96% yield) of desired product as a pink solid.



$[\alpha]_D^{25}$ = –171 (c = 0.276 in CH_3OH); ^{1}H-NMR (400 MHz, DMSO-d_6): 9.00 (d, *J* = 4.5 Hz, 2H), 8.37 (d, *J* = 8.3 Hz, 2H), 8.16-8.11 (m, 3H), 7.98 (d, *J* = 7.5 Hz, 2H), 7.88-7.84 (m, 4H), 7.80-7.74 (m, 3H), 6.77 (d, *J* = 4.3 Hz, 2H), 6.61 (s, 2H), 5.73-5.67 (m, 2H), 5.33 (d, *J* = 12.3 Hz, 2H), 5.24-5.18 (m, 4H), 4.97 (d, *J* = 10.5 Hz, 2H), 4.40-4.25 (m, 2H), 4.01-3.97 (m, 2H), 3.89-3.79 (m, 2H), 3.63-3.57 (m, 2H), 3.45-3.38 (m, 2H), 2.72-2.81 (m, 2H), 2.16-2.11 (m, 2H), 2.06-2.02 (m, 4H), 1.91-1.76 (m, 2H), 1.34-1.29 (m, 2H); ^{13}C-NMR (100.6 MHz, DMSO-d_6) 150.6, 148.1, 145.6, 139.3, 138.6, 135.7, 130.3, 129.9, 129.8, 129.0, 127.7, 124.7, 124.1, 120.6, 116.7, 68.1, 64.6, 62.6, 59.6, 51.0, 37.3, 26.3, 24.6, 21.5; m.p. 205 °C (decomp.); HRMS: *m/z* found $[M-2Br]^{2+}$ 692.4097, $C_{46}H_{52}N_4O_2$ requires 692.4090.

Experimental procedure for the preparation of catalyst N-benzyl quininium bromide (10)

Quinine (1.00 g, 3.08 mmol) was dissolved in MeOH (10 mL) and benzyl bromide (0.513 g, 3.00 mmol) was added dropwise at rt. The reaction mixture was stirred for 18 h at rt and then poured in Diethylether (400 mL). The crude product was filtered and recrystallized from MeOH to give the title compound (1.05 g, 71% yield) as white solid.



mp = 168-170 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.71 (d, *J* = 4.6 Hz, 1H), 8.02-7.96 (m, 1H), 7.80-7.75 (m, 2H), 7.71 (d, *J* = 4.6 Hz, 1H), 7.45-7.39 (m, 1H), 7.37-7.29 (m, 4H), 6.68 (d, *J* = 6.4 Hz, 1H), 6.49 (d, *J* = 6.9 Hz, 1H), 6.07 (d, *J* = 12.0 Hz, 1H), 5.60 (ddd, *J* = 17.3 Hz, 10.4 Hz, 7.0 Hz, 1H), 5.09 (d, *J* = 17.1 Hz, 1H), 4.98 (d, *J* = 10.4 Hz, 1H), 4.92 (t, *J* = 11.6 Hz, 1H), 4.77 (d, *J* = 12.0 Hz, 1H), 3.97 (s, 3H), 3.96-3.89 (m, 1H), 3.56-3.43 (m, 2H), 3.14-3.04 (m, 1H), 2.65-2.50 (m, 1H), 2.38-2.22 (m, 2H), 2.01 (s, 1H), 1.80-1.65 (m, 1H), 1.61-1.50 (m, 1H); ^{13}C-NMR (100.6 MHz, $CDCl_3$): 158.2, 147.4, 144.2, 143.4, 136.4, 133.9, 131.9, 130.7, 129.3, 126.9, 126.2, 121.3, 120.6, 118.1, 102.0, 69.8, 63.9, 63.7, 60.9, 56.4, 51.2, 38.2, 26.9, 24.9, 21.6; HRMS: *m/z* found $[M\text{-}Br]^+$ 416.2247, $C_{27}H_{31}N_2O_2$ requires 415.2380.

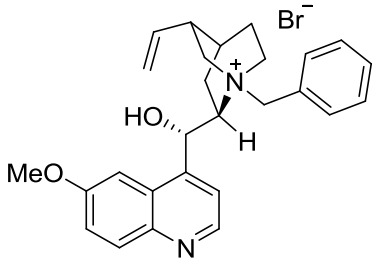
General procedure for the quaternization of the quinidine catalysts

To a stirred suspension of quinidine (2.00 g, 6.16 mmol, 1.00 eq) in acetone (35.0 mL), benzyl bromide (1.05 eq) was added. The resulting mixture was heated at 60 °C and stirred for 4 h at the same temperature. After cooling to r.t., the solvent was removed *in vacuo*. The residue was washed with EtO_2 affording the title compound.

Preparation of catalyst 11a

Following the general procedure using benzyl bromide.

White solid (2.99 g, 98% yield).

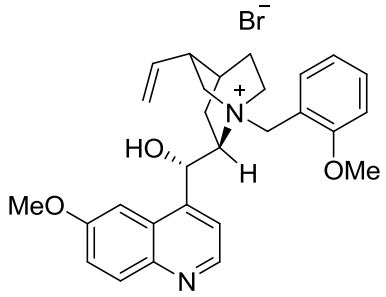


mp = 198-202 °C; $[\alpha]_D^{20}$ = +310 (c = 0.50 in CH_3Cl); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.77 (d, *J* = 4.4 Hz, 1H), 8.12 (d, *J* = 9.6 Hz, 1H), 7.96 (dd, *J*= 7.6 Hz, 1.6 Hz, 1H), 7.91 (d, *J* = 4.4 Hz, 1H), 7.49 (dt, J_d = 8.6 Hz, J_t = 1.4, 1H), 7.40 (dd, *J* = 9.2 Hz, 2.4 Hz, 1H), 7.18 (d, *J* = 2.4 Hz, 1H), 7.13 (dt, J_d = 6.5 Hz, J_t = 1.4, 1H), 7.02-7.00 (m, 2H), 6.96 (d, *J* = 6.4 Hz, 1H), 6.73 (d, *J* = 6.8 Hz, 1H), 6.27 (d, *J* = 12.0 Hz, 1H), 6.13-6.06 (m, 1H), 5.28-5.22 (m, 2H), 4.75 (d, *J* = 2.8 Hz, 1H), 4.73-4.69 (m, 1H), 3.93 (s, 3H), 3.74-3.67 (m, 2H), 3.61 (t, *J* = 12.4 Hz, 1H), 2.94-2.86 (m, 1H), 2.66-2.61 (m, 1H), 2.50-2.43 (m, 1H), 1.95-1.77 (m, 3H), 1.11-1.04 (m, 1H); ^{13}C-NMR (100.6 MHz): 158.6, 158.2, 148.0, 144.3, 143.3, 136.4, 135.8, 132.7, 132.5, 125.6, 122.0, 121.6, 120.6, 118.6, 115.5, 111.4, 100.6, 69.7, 64.1, 56.0, 55.6, 53.9, 53.6, 38.6, 24.1, 24.5, 21.3; HRMS: *m/z* found $[M\text{-}Br]^+$ 416.2247, $C_{27}H_{31}N_2O_2$ requires 415.2380.

Preparation of catalyst 11b

Following the general procedure using 2-(methoxy)benzyl bromide.

Purple solid (2.61 g, 95% yield).



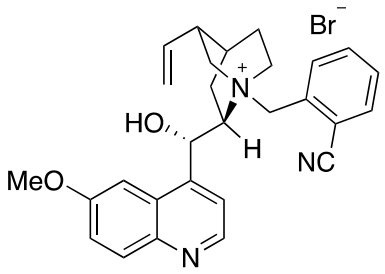
mp = 180-184 °C; $[\alpha]_D^{20}$ = +400 (c = 0.50 in CH_3Cl); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.77 (d, *J* = 4.4 Hz, 1H), 8.12 (d, *J* = 9.6 Hz, 1H), 7.96 (dd, *J*= 7.6 Hz, 1.6 Hz, 1H), 7.91 (d, *J* = 4.4 Hz, 1H), 7.49 (dt, J_d = 8.6 Hz, J_t = 1.4, 1H), 7.40 (dd, *J* = 9.2 Hz, 2.4 Hz, 1H), 7.18 (d, *J* = 2.4 Hz, 1H), 7.13 (dt, J_d = 6.5 Hz, J_t = 1.4, 1H), 7.01 (d, *J* = 8.4 Hz, 1H), 6.96 (d, *J* = 6.4 Hz, 1H), 6.73 (d, *J* = 6.8 Hz, 1H), 6.27 (d, *J* = 12.0 Hz, 1H), 6.13-6.06 (m, 1H), 5.28-5.22 (m, 2H), 4.75 (d, *J* = 2.8 Hz, 1H), 4.73-4.69 (m, 1H), 4.01 (s, 3H), 3.93 (s, 3H), 3.74-3.67 (m, 2H), 3.61 (t, *J* = 12.4 Hz, 1H), 2.94-2.86 (m, 1H), 2.66-2.61 (m, 1H), 2.50-2.43 (m, 1H), 1.95-1.77

(m, 3H), 1.11-1.04 (m, 1H); ^{13}C-NMR (100.6 MHz): 158.6, 158.2, 148.0, 144.3, 143.3, 136.4, 135.8, 132.7, 132.5, 125.6, 122.0, 121.6, 120.6, 118.6, 115.5, 111.4, 100.6, 69.7, 64.1, 58.6, 56.0, 55.6, 53.9, 53.6, 38.6, 24.1, 24.5, 21.3; HRMS: *m/z* found $[M\text{-}Br]^+$ 445.2482, $C_{28}H_{33}N_2O_3$ requires 445.2491.

Preparation of catalyst 11c

Following the general procedure using 2-(bromomethyl)benzonitrile.

White solid (3.08 g, 96% yield).

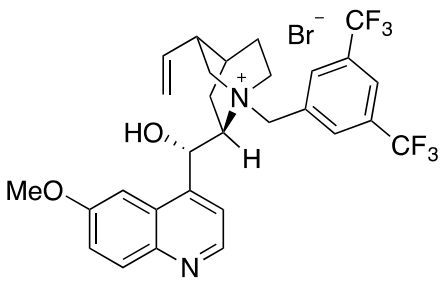


mp = 172-175 °C; ^{1}H-NMR (400 MHz, MeOD): 8.85-8.72 (m, 1H), 8.16 (t, *J* = 1.5 Hz, 1H), 8.09-7.96 (m, 3H), 7.91 (d, *J* = 4.8 Hz, 1H), 7.82-7.73 (m, 1H), 7.56 (dd, *J* = 9.3, 2.5 Hz, 1H), 7.48 (d, *J* = 2.5 Hz, 1H), 6.58 (d, *J* = 2.0 Hz, 1H), 6.20-6.00 (m, 1H), 5.50 (s, 1H), 5.35-5.24 (m, 2H), 5.14 (d, *J* = 12.5 Hz, 1H), 4.47 (s, 1H), 4.10 (s, 3H), 4.03-3.85 (m, 2H), 3.59 (s, 1H), 3.13 (d, *J* = 11.5 Hz, 1H), 2.00 (br. s., 1H), 1.96-1.83 (m, 2H), 1.23-1.06 (m, 1H); ^{13}C-NMR (100.6 MHz): 160.2, 148.3, 145.4, 144.8, 139.4, 138.3, 137.6, 135.4, 131.9, 131.6, 130.4, 127.4, 122.8, 114.8, 103.2, 69.6, 67.1, 64.1, 58.3, 56.5, 38.9, 30.7, 22.4; HRMS: *m/z* found $[M\text{-}Br]^+$ 519.1534, $C_{28}H_{30}BrN_3O_2$ requires 519.1521.

Preparation of catalyst 11d

Following the general procedure using 1-(bromomethyl)-3,5-bis(trifluoromethyl)benzene.

Light yellow powder (3.78 g, 97% yield).

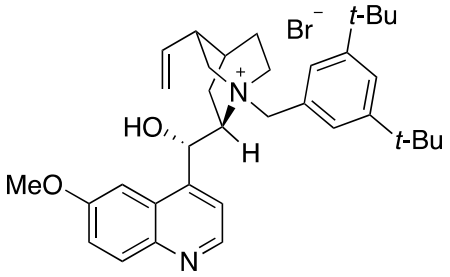


mp = 176-178 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.39-8.36 (m, 1H), 8.25-8.24 (m, 2H), 7.74 (s, 1H), 7.67 (d, *J* = 8.0 Hz, 1H), 7.61 (d, *J* = 4 Hz, 1H), 7.49 (d, *J* = 4 Hz, 1H), 6.95-6.92 (m, 1H), 6.48-6.47 (m, 1H), 6.12-6.09 (m, 1H), 6.10 (d, *J* = 8.0 Hz, 1H), 5.82 (d, *J* = 8.0 Hz, 1H), 5.80-5.74 (m, 1H), 5.16-5.10 (m, 2H), 4.56-4.50 (m, 1H), 4.34-4.29 (m, 1H), 4.15-4.10 (m, 1H), 3.68 (s, 3H), 3.08-3.02 (m, 1H), 2.64-2.59 (m, 1H), 2.39-2.19 (m, 2H), 1.77-1.73 (m, 1H), 0.85-0.82 (m, 1H); ^{13}C-NMR (100.6 MHz): 157.9, 147.0,144.0, 142.0, 134.9, 133.9, 132.6, 132.3, 131.6, 130.4, 126.0, 123.9, 121.2, 120.4, 120.0, 118.5, 103.2, 68.1, 67.1, 60.4, 60.2, 56.5, 56.3, 54.5, 37.9, 27.0, 23.8, 21.9.

Preparation of catalyst 11e

Following the general procedure using 1-(bromomethyl)-3,5-di-*tert*-butylbenzene.

Colorless powder (3.63 g, 97% yield).



mp = 197-198 °C; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.61-8.59 (m, 1H), 7.97-7.94 (m, 1H), 7.68-7.67 (m, 1H), 7.60-7.59 (m, 1H), 7.53-7.51 (m, 1H), 7.3-7.26 (m, 2H), 6.79-6.77 (m, 1H), 6.58-6.55 (m, 1H), 6.00-5.92 (m, 1H), 5.83-5.80 (m, 1H), 5.19-5.15 (m, 2H), 4.85-4.76 (m, 1H), 4.62-4.57 (m, 1H), 4.10-4.04 (m, 1H), 3.93 (s, 3H), 3.88-3.83 (m, 1H), 3.50-3.44 (m, 1H), 3.07-3.02 (m, 1H), 1.89-1.85 (m, 1H), 1.80-1.75 (m, 1H), 1.08-1.01 (m, 1H); ^{13}C-NMR (100.6 MHz): 157.9, 152.0, 147.4, 144.2, 143.0, 135.8, 131.8, 128.3, 126.2, 126.1, 124.4, 121.0, 120.5, 118.1, 102.2, 68.4, 65.3, 64.3, 56.8, 56.0, 54.2, 38.3, 35.0, 31.4, 30.9, 27.8, 24.2, 21.5.

General procedure for the organocatalytic, enantioselective Michael addition of ethylisocyanoacetate 2 to 3-substituted-2-(pyridin-4-yl)acrylonitrile 1a-m

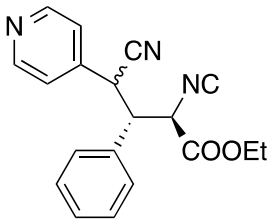
To a test tube equipped with a magnetic stirring bar were sequentially added the relevant substituted pyridine **1a-m** (0.10 mmol, 1.0 eq), catalyst **11a** (4.95 mg, 0.01 mmol, 0.10 eq), ethylisocyanoacetate **2** (55.0 μL, 0.50 mmol, 5.0 eq) and DCM (1.0 mL). Then K_2CO_3 50%

w/w (138 μL, 0.50 mmol, 5.0 eq) was added in one portion. The mixture was then vigorously stirred at room temperature, with no precautions to exclude moisture or air. After the stated reaction time, the reaction was filtered on a short plug of silica gel to remove the catalyst, the solvent was evaporated using a water bath at 50 °C to remove ethylisocyanoacetate in excess and the residue was analysed by ^{1}H NMR spectroscopy.

General procedure for the cyclic products 4a-m

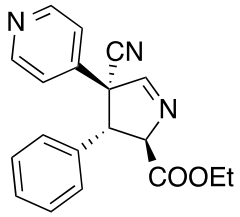
To a solution of **3a-m** (0.1 mmol) in THF (1.0 mL) at 45 °C, DIPEA (0.2 mmol) was added. The solution was stirred until the starting material was consumed. The solvents were removed under reduced pressure and the residue was purified by silica gel chromatography.

(2R,3S)-ethyl 4-cyano-2-isocyano-3-phenyl-4-(pyridin-4-yl)butanoate (3a)



Prepared following general procedure using (*Z*)-3-phenyl-2-(pyridin-4-yl)acrylonitrile **1a** (20.6 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 48 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3a** as a yellow oil (8.1 mg, 25% yield).
^{1}H-NMR (400 MHz, $CDCl_3$): 8.70 (dd, *J* = 4.6 Hz, 1.8 Hz, 2H), 7.43-7.41 (m, 3H), 7.31 (dd, *J* = 4.6 Hz, 1.8 Hz, 2H), 7.09 (dd, *J* = 7.4 Hz, 1.8 Hz, 2H), 4.93 (dd, *J* = 16.0 Hz, 2.4 Hz, 1H), 4.79 (d, *J* = 18.4 Hz, 1H), 4.65 (d, *J* = 2.4 Hz, 1H), 4.30-4.20 (m, 2H), 1.24 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 167.5, 160.8, 151.3, 148.3, 133.6, 129.7, 129.5, 128.1, 119.8, 118.2, 73.3, 68.7, 62.8, 53.2, 14.0; IR (NaCl) / cm^{-1}: 2239 s, 2148 m, 1735 s; HRMS: *m/z* found $[M+H]^+$ 320.1411, $C_{19}H_{17}N_3O_2$ requires 319.1321.

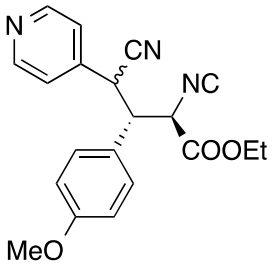
(2R,3R,4R)-ethyl 4-cyano-3-phenyl-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4a)



Prepared following general procedure. Reaction time: 48 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4a** as a yellow oil (27.4 mg, 86% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 19.33 min, t_{min} = 22.26 min, 94% *ee*); $[\alpha]_D^{20}$ = +49 (c = 0.75 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.22 (dd, *J* = 4.4 Hz, 1.6 Hz, 2H), 7.66 (d, *J* = 3.2 Hz, 1H), 7.37 (dd, *J* = 4.8 Hz, 2.0 Hz, 3H), 7.26 (dd, *J* = 4.4 Hz, 1.6 Hz, 2H), 7.12 (dd, *J* = 6.2 Hz, 3.0 Hz, 2H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.27-4.18 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 1.25 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 169.7, 161.5, 151.2, 143.9, 132.8, 129.4, 129.3, 129.2, 129.1, 129.0, 128.6, 123.7, 121.2, 114.4, 79.2, 62.5, 52.1, 14.1; HRMS: *m/z* found $[M+H]^+$ 320.1399, $C_{19}H_{17}N_3O_2$ requires 319.1321.

(2R,3S)-ethyl 4-cyano-2-isocyano-3-(4-methoxyphenyl)-4-(pyridin-4-yl)butanoate (3b)

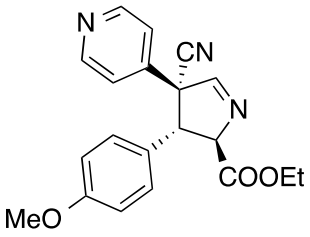


Prepared following general procedure using (*Z*)-3-(4-methoxyphenyl)-2-(pyridin-4-yl)acrylonitrile **1b** (23.6 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3b** as a yellow oil (8.0 mg, 23% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.69 (d, *J* = 5.6 Hz, 2H), 7.50 (d, *J* = 6.0 Hz, 2H), 7.40 (d, *J* = 8.8 Hz, 2H), 6.92 (d, *J* = 8.8 Hz, 2H), 4.93 (dd, *J* = 16.0 Hz, 2.4 Hz, 1H), 4.79 (d, *J* = 18.4 Hz, 1H), 4.65 (d, *J* = 2.4 Hz, 1H), 4.30-4.20 (m, 2H), 3.82 (s, 3H), 1.24 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 167.5, 160.8, 151.3, 148.3, 133.6, 129.7, 129.5, 128.1, 119.8, 118.2,

73.3, 68.7, 62.8, 55.5, 53.2, 14.0; IR (NaCl) / cm^{-1}: 2237 s, 2152 m, 1738 s; HRMS: *m/z* found $[M-H]^-$ 348.1503, $C_{20}H_{19}N_3O_3$ requires 349.1426.

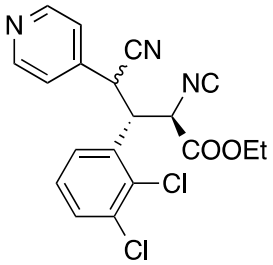
(2R,3R,4R)-ethyl 4-cyano-3-(4-methoxyphenyl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4b)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4b** as a yellow oil (27.6 mg, 79% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 25.10 min, t_{min} = 31.20 min, 85% *ee*); $[\alpha]_D^{20}$ = +64 (c = 0.50 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.21 (d, *J* = 5.6 Hz, 2H), 7.65 (d, *J* = 3.2 Hz, 1H), 7.45 (d, *J* = 6.0 Hz, 2H), 7.36 (d, *J* = 8.8 Hz, 2H), 6.90 (d, *J* = 8.8 Hz, 2H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.27-4.18 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 3.82 (s, 3H), 1.25 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 169.6, 161.4, 151.3, 143.9, 132.9, 129.7, 129.5, 128.1, 121.0, 115.2, 78.3, 68.7, 62.8, 55.5, 53.2, 14.0; HRMS: *m/z* found $[M-H]^-$ 348.1468, $C_{20}H_{19}N_3O_3$ requires 349.1426.

(2R,3S)-ethyl 4-cyano-3-(2,3-dichlorophenyl)-2-isocyano-4-(pyridin-4-yl)butanoate (3c)

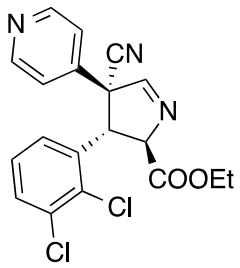


Prepared following general procedure using (*Z*)-3-(2,3-dichlorophenyl)-2-(pyridin-4-yl)acrylonitrile **1c** (27.5 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3c** as a yellow oil (12.4 mg, 32% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.64 (d, *J* = 6.1 Hz, 2H), 7.46 (d, *J* = 7.7 Hz, 1H), 7.28 (d, *J* = 6.3 Hz, 2H), 7.21 (t, *J* = 7.9 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 5.18 (d, *J* = 33.5 Hz, 1H),

4.88-4.74 (m, 2H), 4.26-4.14 (m, 2H), 1.19 (t, *J* = 7.1 Hz, 3H); ^{13}C-NMR (100.6 MHz): 160.2, 151.2, 147.8, 134.8, 134.3, 133.3, 131.5, 128.1, 125.5, 119.7, 117.6, 73.4, 65.3, 62.9, 52.2, 29.7, 13.9; IR (NaCl) / cm^{-1}: 2249 s, 2145 m, 1738 s; HRMS: *m/z* found $[M+H]^+$ 488.0584, $C_{19}H_{15}Cl_2N_3O_2$ requires 487.0541.

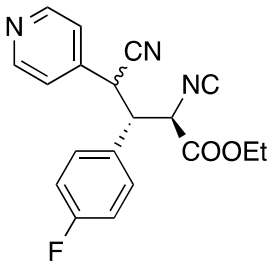
(2R,3S,4R)-ethyl 4-cyano-3-(2,3-dichlorophenyl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4c)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4c** as a yellow oil (40.8 mg, 84% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AS column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 21.3 min, t_{min} = 28.9 min, 93% *ee*); $[\alpha]_D^{20}$ = +68 (c = 0.50 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.62 (d, *J* = 6.1 Hz, 2H), 7.66 (d, *J* = 3.2 Hz, 1H), 7.45 (d, *J* = 7.7 Hz, 1H), 7.27 (d, *J* = 6.3 Hz, 2H), 7.21 (t, *J* = 7.9 Hz, 1H), 6.80 (d, *J* = 7.6 Hz, 1H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.26-4.14 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 1.19 (t, *J* = 7.1 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.4, 151.2, 142.4, 140.5, 138.4, 135.2, 132.9, 132.6, 127.1, 126.5, 126.4, 117.9, 86.8, 61.8, 53.3, 14.7; HRMS: *m/z* found $[M+H]^+$ 488.0577, $C_{19}H_{15}Cl_2N_3O_2$ requires 487.0541.

(2R,3S)-ethyl 4-cyano-3-(4-fluorophenyl)-2-isocyano-4-(pyridin-4-yl)butanoate (3d)

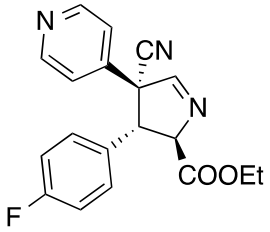


Prepared following general procedure using (*Z*)-3-(4-fluorophenyl)-2-(pyridin-4-yl)acrylonitrile **1d** (22.4 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column

chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3d** as a yellow oil (7.7 mg, 23% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.69 (d, *J* = 6.0 Hz, 2H), 7.49-7.43 (m, 4H), 7.10 (t, *J* = 8.6 Hz, 2H), 4.93 (dd, *J* = 16.0 Hz, 2.4 Hz, 1H), 4.79 (d, *J* = 18.4 Hz, 1H), 4.65 (d, *J* = 2.4 Hz, 1H), 4.20-4.19 (m, 2H), 1.20 (t, *J* = 7.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 165.5, 163.3, 162.4, 151.2, 138.2, 133.0, 130.5, 121.1, 116.3, 115.1, 115.0, 61.8, 50.4, 37.0, 14.7; IR (NaCl) / cm^{-1}: 2249 s, 2158 m, 1746 s; HRMS: *m/z* found $[M+H]^+$ 338.11204, $C_{19}H_{16}FN_3O_2$ requires 337.1227.

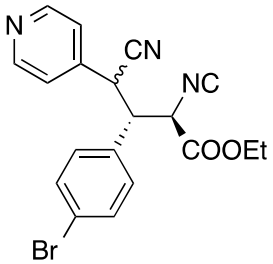
(2R,3R,4R)-ethyl 4-cyano-3-(4-fluorophenyl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4d)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4d** as an orange oil (25.9 mg, 77% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 20.16 min, t_{min} = 23.96 min, 88% *ee*); $[\alpha]_D^{20}$ = +77 (c = 0.75 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.21 (d, *J* = 6.0 Hz, 2H), 7.65 (d, *J* = 3.2 Hz, 1H), 7.45-7.39 (m, 4H), 7.06 (t, *J* = 8.6 Hz, 2H), 5.15 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.25-4.13 (m, 2H), 3.88 (d, *J* = 9.2 Hz, 1H), 1.20 (t, *J* = 7.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.5, 162.8, 151.3, 140.5, 138.4, 135.8, 133.3, 126.6, 126.5, 117.9, 115.6, 87.8, 61.8, 55.4, 14.7; HRMS: *m/z* found $[M+H]^+$ 338.1211, $C_{19}H_{16}FN_3O_2$ requires 337.1227.

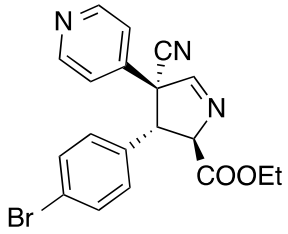
(2R,3S)-ethyl 3-(4-bromophenyl)-4-cyano-2-isocyano-4-(pyridin-4-yl)butanoate (3e)



Prepared following general procedure using (*Z*)-3-(4-bromophenyl)-2-(pyridin-4-yl)acrylonitrile **1e** (28.5 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3e** as a yellow oil (10.7 mg, 27% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.64 (d, *J* = 5.8 Hz, 2H), 7.49 (d, *J* = 8.3 Hz, 2H), 7.22 (d, *J* = 6.0 Hz, 2H), 6.90 (d, *J* = 8.3 Hz, 2H), 4.88 (dd, *J* = 18.2, 2.3 Hz, 1H), 4.73 (d, *J* = 18.3 Hz, 1H), 4.54 (d, *J* = 2.0 Hz, 1H), 4.26-4.10 (m, 2H), 1.20 (t, *J* = 8.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 165.5, 162.4, 151.2, 138.8, 133.0, 131.9, 130.8, 121.1, 119.9, 116.3, 61.8, 50.4, 37.0, 14.7; IR (NaCl) / cm^{-1}: 2250 s, 2150 m, 1744 s; HRMS: *m/z* found $[M+H]^+$ 398.0477, $C_{19}H_{16}BrN_3O_2$ requires 397.0426.

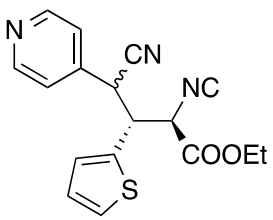
(2R,3R,4R)-ethyl 3-(4-bromophenyl)-4-cyano-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4e)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4e** as a yellow oil (33.7 mg, 85% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 21.0 min, t_{min} = 26.4 min, 89% *ee*); $[\alpha]_D^{20}$ = +12 (c = 0.42 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.56 (d, *J* = 7.4 Hz, 2H), 8.19 (s, 1H), 7.47 (d, *J* = 7.5 Hz, 2H), 7.20 (dd, *J* = 7.4, 2.9 Hz, 4H), 5.04 (d, *J* = 10.6 Hz, 1H), 4.67 (d, *J* = 10.6 Hz, 1H), 4.17 (q, *J* = 5.9 Hz, 2H), 1.38 (t, *J* = 5.9 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.5, 151.3, 140.5, 138.4, 137.6, 132.30, 132.3, 130.9, 126.6, 126.5, 118.0, 116.6, 87.7, 61.8, 55.4, 14.7; HRMS: *m/z* foun$[M+H]^+$ 498.0463, $C_{19}H_{16}BrN_3O_2$ requires 397.0426.

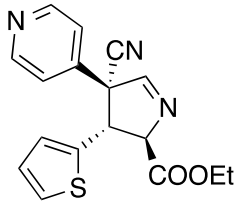
(2R,3R)-ethyl 4-cyano-2-isocyano-4-(pyridin-4-yl)-3-(thiophen-2-yl)butanoate (3f)



Prepared following general procedure using (*Z*)-2-(pyridin-4-yl)-3-(thiophen-2-yl)acrylonitrile **1f** (21.2 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3f** as a yellow oil (6.2 mg, 19% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.62 (d, *J* = 4.7 Hz, 2H), 7.40-7.35 (m, 1H), 7.23 (d, *J* = 4.8 Hz, 2H), 7.11-7.07 (m, 1H), 6.85 (d, *J* = 4.5 Hz, 1H), 4.87 (dd, *J* = 18.1, 1.7 Hz, 1H), 4.72-4.73 (m, 2H), 4.27-4.13 (m, 2H), 1.19 (t, *J* = 8.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 167.1, 160.6, 150.4, 147.8, 133.2, 127.9, 126.5, 124.3, 121.1, 119.7, 118.1, 72.7, 62.9, 62.7, 52.5, 29.7, 13.9; IR (NaCl) / cm^{-1}: 2230 s, 2156 m, 1769 s; HRMS: *m/z* found $[M+Na]^+$ 348.0741, $C_{17}H_{15}N_3O_2S$ requires 325.0885.

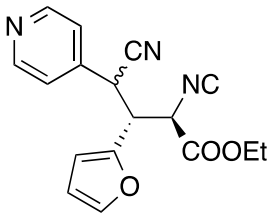
(2R,3R,4R)-ethyl 4-cyano-4-(pyridin-4-yl)-3-(thiophen-2-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4f)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4f** as an orange oil (20.8 mg, 64% yield).

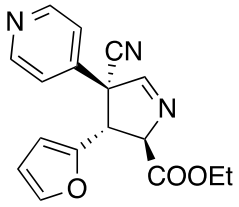
The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 26.1 min, t_{min} = 34.6 min, 90% *ee*); $[\alpha]_D^{20}$ = +37 (c = 0.40 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.67 (d, *J* = 6.4 Hz, 2H), 7.67 (d, *J* = 3.2 Hz, 1H), 7.54-7.53 (m, 1H), 7.42 (dd, *J* = 4.4 Hz, 1.6 Hz, 2H), 7.38 (dd, *J* = 5.0 Hz, 3.0 Hz, 1H), 7.20 (dd, *J* = 5.2 Hz, 1.2 Hz, 1H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.27-4.13 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 1.19 (t, *J* = 8.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 172.5, 151.3, 147.1, 144.0, 138.4, 131.9, 128.5, 126.6, 126.5, 125.7, 118.7, 83.3, 70.0, 61.8, 14.7; HRMS: *m/z* found $[M+Na]^+$ 348.0734, $C_{17}H_{15}N_3O_2S$ requires 325.0885.

(2R,3R)-ethyl 4-cyano-3-(furan-2-yl)-2-isocyano-4-(pyridin-4-yl)butanoate (3g)



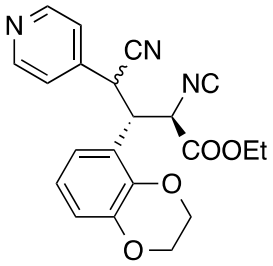
Prepared following general procedure using (*Z*)-3-(furan-2-yl)-2-(pyridin-4-yl)acrylonitrile **1g** (19.6 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3g** as a yellow oil (7.4 mg, 24% yield).
^{1}H-NMR (400 MHz, $CDCl_3$): 8.55 (d, *J* = 6.2 Hz, 2H), 7.42 (d, *J* = 6.5 Hz, 2H), 7.16-7.13 (m, 1H), 6.91 (d, *J* = 3.5 Hz, 1H), 6.29 (dd, *J* = 3.5 Hz, 1.8 Hz, 1H), 4.30 (q, *J* = 7.1 Hz, 2H), 4.21-4.14 (m, 2H), 3.66 (d, *J* = 9.2 Hz, 1H), 1.31 (t, *J* = 7.1 Hz, 3H); ^{13}C-NMR (100.6 MHz): 160.5, 150.4, 147.7, 145.9, 142.1, 136.5, 120.8, 119.5, 112.3, 111.8, 111.7, 61.9, 59.3, 53.5, 53.4, 14.1; IR (NaCl) / cm^{-1}: 2230 s, 2158 m, 1740 s; HRMS: *m/z* found $[M+Na]^+$ 332.1017, $C_{17}H_{15}N_3O_3$ requires 309.1113.

(2R,3R,4R)-ethyl 4-cyano-3-(furan-2-yl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4g)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4g** as a brown oil (22.7 mg, 73% yield).
The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 14.5 min, t_{min} = 18.0 min, 90% *ee*); $[\alpha]_D^{20}$ = +52 (c = 0.92 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.62 (d, *J* = 7.4 Hz, 2H), 8.20 (s, 1H), 7.31-7.29 (m, 3H), 6.24 (t, *J* = 7.4 Hz, 1H), 6.06 (dd, *J* = 7.5, 1.6 Hz, 1H), 5.78 (d, *J* = 10.8 Hz, 1H), 4.80 (d, *J* = 10.8 Hz, 1H), 4.18 (q, *J* = 5.9 Hz, 2H), 1.38 (t, *J* = 5.9 Hz, 3H); ^{13}C-NMR (100.6 MHz): 172.5, 166.8, 151.3, 143.9, 140.5, 138.4, 126.6, 126.5, 118.6, 111.2, 100.3, 81.1, 61.8, 60.2, 14.7; HRMS: *m/z* found $[M+Na]^+$ 332.1024, $C_{17}H_{15}N_3O_3$ requires 309.1113.

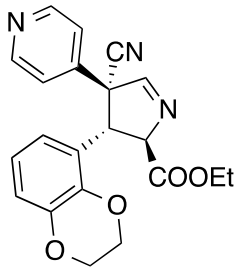
(2R,3S)-ethyl 4-cyano-3-(2,3-dihydrobenzo[b][1,4]dioxin-5-yl)-2-isocyano-4-(pyridin-4-yl)butanoate (3h)



Prepared following general procedure using (*Z*)-3-(2,3-dihydrobenzo[b][1,4]dioxin-5-yl)-2-(pyridin-4-yl)acrylonitrile **1h** (26.4 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3h** as a yellow oil (10.9 mg, 29% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.66 (d, *J* = 6.0 Hz, 2H), 7.40 (d, *J* = 6.2 Hz, 2H), 6.98-6.86 (m, 3H), 4.93 (dd, *J* = 16.0 Hz, 2.4 Hz, 1H), 4.79 (d, *J* = 18.4 Hz, 1H), 4.65 (d, *J* = 2.4 Hz, 1H), 4.26 (s, 4H), 4.00-3.89 (m, 2H), 1.24 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 165.5, 162.4, 151.2, 148.8, 143.5, 135.2, 133.0, 123.4, 121.4, 121.1, 119.2, 116.3, 61.9, 61.8, 60.5, 39.5, 37.1, 14.7; IR (NaCl) / cm^{-1}: 2237 s, 2145 m, 1742 s; HRMS: *m/z* found $[M+H]^+$ 378.1389, $C_{21}H_{19}N_3O_4$ requires 377.1376.

(2R,3S,4R)-ethyl 4-cyano-3-(2,3-dihydrobenzo[b][1,4]dioxin-5-yl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4h)

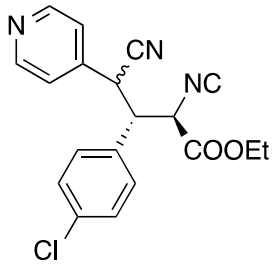


Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4h** as an orange oil (32.1 mg, 85% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 34.8 min, t_{min} = 40.5 min, 70% *ee*); $[\alpha]_D^{20}$ = +31 (c = 0.34 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.59 (d, *J* = 6.0 Hz, 2H), 7.82 (d, *J* = 3.2 Hz, 1H), 7.35 (d, *J* = 6.2 Hz, 2H), 6.95-6.83 (m, 3H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz,

1H), 4.26 (s, 4H), 4.00-3.89 (m, 2H), 3.86 (d, *J* = 9.2 Hz, 1H), 1.24 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.5, 151.3, 148.9, 144.1, 140.5, 138.4, 129.6, 126.6, 126.5, 125.0, 120.7, 118.1, 118.0, 86.8, 61.9, 61.8, 60.5, 47.8, 14.7; HRMS: *m/z* found $[M+H]^+$ 378.1394, $C_{21}H_{19}N_3O_4$ requires 377.1376.

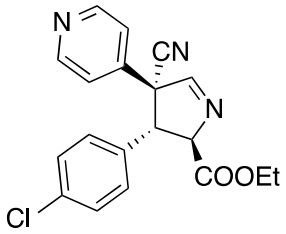
(2R,3S)-ethyl 3-(4-chlorophenyl)-4-cyano-2-isocyano-4-(pyridin-4-yl)butanoate (3i)



Prepared following general procedure using (*Z*)-3-(4-chlorophenyl)-2-(pyridin-4-yl)acrylonitrile **1i** (24.1 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 72 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3i** as a yellow oil (9.1 mg, 26% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.46 (d, *J* = 7.4 Hz, 2H), 7.29 (d, *J* = 7.5 Hz, 2H), 7.24 (d, *J* = 7.5 Hz, 2H), 7.12 (d, *J* = 7.4 Hz, 2H), 4.88 (dd, *J* = 18.2, 2.3 Hz, 1H), 4.64 (d, *J* = 11.4 Hz, 1H), 4.54 (d, *J* = 2.0 Hz, 1H), 4.12 (q, *J* = 6.0 Hz, 2H), 1.34 (t, *J* = 6.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 165.5, 163.3, 162.3, 151.2, 139.6, 132.9, 131.1, 129.0, 121.1, 116.3, 115.1, 61.8, 50.4, 37.0, 14.7; IR (NaCl) / cm^{-1}: 2251 s, 2154 m, 1745 s; HRMS: *m/z* found $[M+H]^+$ 354.0997, $C_{19}H_{16}ClN_3O_2$ requires 353.0931.

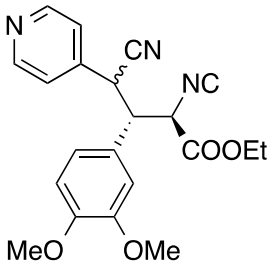
(2R,3R,4R)-ethyl 3-(4-chlorophenyl)-4-cyano-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4i)



Prepared following general procedure. Reaction time: 72 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4i** as a yellow oil (26.2 mg, 74% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 10.9 min, t_{min} = 21.5 min, 91% *ee*); $[\alpha]_D^{20}$ = +15 (c = 0.45 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.56 (d, *J* = 7.4 Hz, 2H), 8.19 (s, 1H), 7.31 (d, *J* = 7.4 Hz, 2H), 7.25 (d, *J* = 7.5 Hz, 2H), 7.20 (d, *J* = 7.4 Hz, 2H), 5.05 (d, *J* = 10.6 Hz, 1H), 4.68 (d, *J* = 10.8 Hz, 1H), 4.17 (q, *J* = 5.9 Hz, 2H), 1.38 (t, *J* = 5.9 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.5, 151.3, 140.5, 138.4, 137.5, 131.8, 130.5, 129.3, 126.6, 126.5, 118.0, 87.7, 61.8, 55.4, 14.7; HRMS: *m/z* found $[M+H]^+$ 354.1001, $C_{19}H_{16}ClN_3O_2$ requires 353.0931.

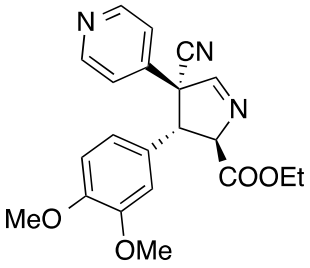
(2R,3S)-ethyl 4-cyano-3-(3,4-dimethoxyphenyl)-2-isocyano-4-(pyridin-4-yl)butanoate (3j)



Prepared following general procedure using (*Z*)-3-(3,4-dimethoxyphenyl)-2-(pyridin-4-yl)acrylonitrile **1j** (26.6 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3j** as an orange oil (11.1 mg, 29% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.70 (d, *J* = 6.2 Hz, 2H), 7.58 (d, *J* = 3.3 Hz, 1H), 7.46 (dd, *J* = 4.4, 2.0 Hz, 1H), 7.32-7.29 (m, 2H), 7.06 (d, *J* = 6.1 Hz, 1H), 4.96 (dd, *J* = 5.1, 2.4 Hz, 1H), 4.77 (d, *J* = 18.1 Hz, 1H), 4.61 (d, *J* = 2.2 Hz, 1H), 4.30-4.24 (m, 2H), 3.91 (s, 3H), 3.89 (s, 3H), 1.25 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 160.8, 151.1, 147.6, 132.0, 128.8, 126.8, 126.0, 125.7, 123.5, 119.7, 118.1, 73.2, 65.7, 62.3, 56.0, 55.8, 52.8, 29.7, 13.9; IR (NaCl) / cm^{-1}: 2240 s, 2155 m, 1740 s; HRMS: *m/z* found $[M-H]^-$ 378.1541, $C_{21}H_{21}N_3O_4$ requires 379.1532.

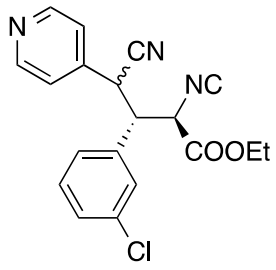
(2R,3R,4R)-ethyl 4-cyano-3-(3,4-dimethoxyphenyl)-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4j)



Prepared following general procedure. Reaction time: 96 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4j** as an orange oil (27.7 mg, 73% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 90:10, flow rate 0.50 mL/min, t_{maj} = 20.7 min, t_{min} = 25.3 min, 91% *ee*); $[\alpha]_D^{20}$ = +66 (c = 0.50 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.53 (d, *J* = 7.4 Hz, 2H), 7.65 (d, *J* = 3.2 Hz, 1H), 7.24 (d, *J* = 7.4 Hz, 2H), 6.96 (dd, *J* = 7.4, 1.5 Hz, 1H), 6.89 (d, *J* = 1.4 Hz, 1H), 6.84 (d, *J* = 7.5 Hz, 1H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.27-4.18 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 3.79 (s, 6H), 1.32 (t, *J* = 5.9 Hz, 3H); ^{13}C-NMR (100.6 MHz): 169.4, 163.8, 150.5, 148.3, 132.1, 126.8, 123.3, 122.8, 119.7, 113.9, 111.1, 73.2, 68.2, 62.6, 56.0, 55.8, 52.1, 14.1.; HRMS: *m/z* found $[M-H]^-$ 378.1551, $C_{21}H_{21}N_3O_4$ requires 379.1532.

(2R,3S)-ethyl 3-(3-chlorophenyl)-4-cyano-2-isocyano-4-(pyridin-4-yl)butanoate (3k)

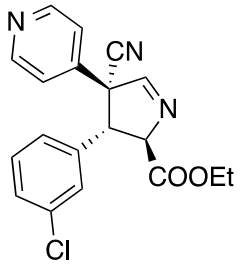


Prepared following general procedure using (*Z*)-3-(3-chlorophenyl)-2-(pyridin-4-yl)acrylonitrile **1k** (24.1 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 72 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3k** as an orange oil (10.6 mg, 30% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.47 (d, *J* = 7.4 Hz, 2H), 7.46 (s, 1H), 7.18 (d, *J* = 4.0 Hz, 2H), 7.13 (d, *J* = 7.4 Hz, 2H), 7.10-7.06 (m, 1H), 4.92 (dd, *J* = 16.0 Hz, 2.4 Hz, 1H), 4.78 (d, *J* = 18.4 Hz, 1H), 4.64 (d, *J* = 2.4 Hz, 1H), 4.26 (qd, *J* = 7.1, 1.7 Hz, 2H), 1.21 (t, *J* = 7.1 Hz,

3H); ^{13}C-NMR (100.6 MHz): 165.5, 162.4, 151.2, 140.5, 134.4, 133.0, 132.3, 130.6, 129.4, 127.2, 121.1, 116.3, 61.8, 45.4, 37.1, 14.7; IR (NaCl) / cm^{-1}: 2236 s, 2149 m, 1740 s; HRMS: *m/z* found $[M+H]^+$ 354.1000, $C_{19}H_{16}ClN_3O_2$ requires 353.0931.

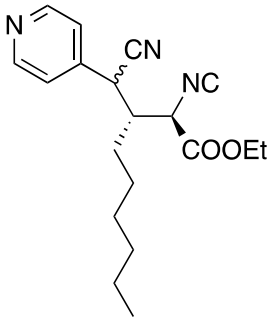
(2R,3R,4R)-ethyl 3-(3-chlorophenyl)-4-cyano-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4k)



Prepared following general procedure. Reaction time: 72 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4k** as an orange oil (30.1 mg, 85% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 9.67 min, t_{min} = 10.6 min, 87% *ee*); $[\alpha]_D^{20}$ = +18 (c = 0.45 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.56 (d, *J* = 7.4 Hz, 2H), 7.75 (d, *J* = 3.2 Hz, 1H), 7.44 (d, *J* = 1.3 Hz, 1H), 7.24-7.18 (m, 4H), 7.15-7.11 (m, 1H), 5.35 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 5.05 (d, *J* = 9.2 Hz, 1H), 4.26 (qd, *J* = 7.1, 1.7 Hz, 2H), 1.31 (t, *J* = 7.1 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.5, 151.3, 142.2, 140.5, 138.4, 133.7, 130.8, 129.7, 128.6, 126.5, 125.0, 118.0, 87.6, 61.8, 56.5, 14.7; HRMS: *m/z* found $[M+H]^+$ 354.0971, $C_{19}H_{16}ClN_3O_2$ requires 353.0931.

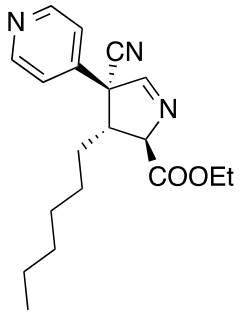
(2R,3R)-ethyl 3-(cyano(pyridin-4-yl)methyl)-2-isocyanononanoate (3l)



Prepared following general procedure using (*Z*)-2-(pyridin-4-yl)non-2-enenitrile **1l** (21.4 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 120 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3l** as a yellow oil (4.2 mg, 13% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.62 (d, *J* = 6.0 Hz, 2H), 7.29 (d, *J* = 4.4 Hz, 2H), 4.41 (s, 1H), 4.36-4.26 (m, 2H), 4.20 (dd, *J* = 10.5, 1.6 Hz, 1H), 3.84 (d, *J* = 10.5 Hz, 1H), 1.64-1.59 (m, 1H), 1.45-1.41 (m, 2H), 1.37-1.29 (m, 10H), 0.97 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 166.8, 162.7, 151.6, 151.5, 133.9, 120.7, 118.5, 61.8, 42.5, 33.9, 33.5, 31.6, 29.3, 28.0, 22.9, 14.7, 14.0; ; IR (NaCl) / cm^{-1}: 2243 s, 2140 m, 1744 s; HRMS: *m/z* found $[M+H]^+$ 328.1935, $C_{19}H_{25}N_3O_2$ requires 327.1947.

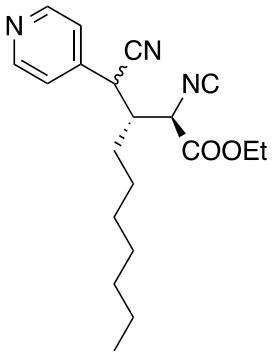
(2R,3R,4R)-ethyl 4-cyano-3-hexyl-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4l)



Prepared following general procedure. Reaction time: 120 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4l** as a yellow oil (19.6 mg, 60% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 10.6 min, t_{min} = 11.5 min, 75% *ee*); $[\alpha]_D^{20}$ = +33 (c = 0.45 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.60 (d, *J* = 6.0 Hz, 2H), 7.60 (d, *J* = 3.2 Hz, 1H), 7.25 (d, *J* = 4.4 Hz, 2H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.36-4.26 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 1.64-1.59 (m, 1H), 1.45-1.41 (m, 2H), 1.37-1.29 (m, 10H), 0.97 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 173.7, 151.0, 147.1, 139.0, 126.9, 119.9, 86.8, 61.8, 52.8, 32.6, 31.6, 29.3, 28.3, 22.9, 14.7, 14.0; HRMS: *m/z* found $[M+H]^+$ 328.1942, $C_{19}H_{25}N_3O_2$ requires 327.1947.

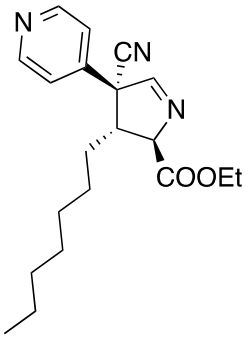
(2R,3R)-ethyl 3-(cyano(pyridin-4-yl)methyl)-2-isocyanodecanoate (3m)



Prepared following general procedure using (*Z*)-2-(pyridin-4-yl)dec-2-enenitrile **1m** (22.8 mg, 0.10 mmol) and catalyst **11a**. Reaction time: 120 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **3m** as a yellow oil (6.5 mg, 19% yield).

^{1}H-NMR (400 MHz, $CDCl_3$): 8.62 (d, *J* = 4.4 Hz, 2H), 7.29 (d, *J* = 4.4 Hz, 2H), 4.87 (dd, *J* = 18.1, 1.7 Hz, 1H), 4.73-4.72 (m, 2H), 4.40-4.31 (m, 2H), 1.90-1.86 (m, 1H), 1.73-1.59 (m, 4H), 1.47-1.42 (m, 2H), 1.35 (t, *J* = 7.0 Hz, 3H), 1.31-1.29 (m, 5H), 0.97 (t, *J* = 7.2 Hz, 3H); ^{13}C-NMR (100.6 MHz): 166.8, 162.7, 151.6, 133.9, 120.68, 120.7, 118.5, 61.8, 42.5, 34.0, 33.5, 31.6, 29.2, 29.0, 28.0, 22.9, 14.7, 14.0; IR (NaCl) / cm^{-1}: 2245 s, 2141 m, 1746 s; HRMS: *m/z* found $[M+H]^+$ 342.2125, $C_{20}H_{27}N_3O_2$ requires 341.2103.

(2R,3R,4R)-ethyl 4-cyano-3-heptyl-4-(pyridin-4-yl)-3,4-dihydro-2H-pyrrole-2-carboxylate (4m)

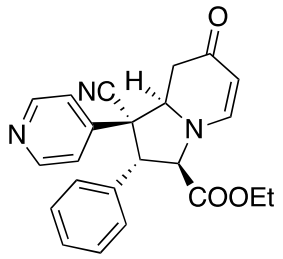


Prepared following general procedure. Reaction time: 120 h. Column chromatography (Solvents Et_2O:petroleum ether 1:1) afforded **4m** as an orange oil (22.2 mg, 65% yield).

The *ee* of the product was determined by CSP-HPLC using a Chiralpak AD column (*n*-hexane/*i*-PrOH 80:20, flow rate 0.50 mL/min, t_{maj} = 10.4 min, t_{min} = 11.3 min, 77% *ee*); $[\alpha]_D^{20}$ = +18 (c = 0.24 in $CHCl_3$); ^{1}H-NMR (400 MHz, $CDCl_3$): 8.60 (d, *J* = 4.4 Hz, 2H), 7.60

(d, *J* = 3.2 Hz, 1H), 7.25 (d, *J* = 4.4 Hz, 2H), 5.25 (dd, *J* = 9.0 Hz, 3.0 Hz, 1H), 4.40-4.31 (m, 2H), 3.90 (d, *J* = 9.2 Hz, 1H), 1.90-1.86 (m, 1H), 1.73-1.59 (m, 4H), 1.47-1.42 (m, 2H), 1.35 (t, *J* = 7.0 Hz, 3H), 1.31-1.29 (m, 5H), 0.97 (t, *J* = 7.2 Hz, 3H);
^{13}C-NMR (100.6 MHz): 173.7, 151.0, 147.1, 139.1, 126.9, 126.8, 119.9, 86.8, 61.8, 52.8, 32.6, 31.6, 29.2, 29.1, 28.3, 22.9, 14.7, 14.0; HRMS: *m/z* found $[M+H]^+$ 342.2131, $C_{20}H_{27}N_3O_2$ requires 341.2103.

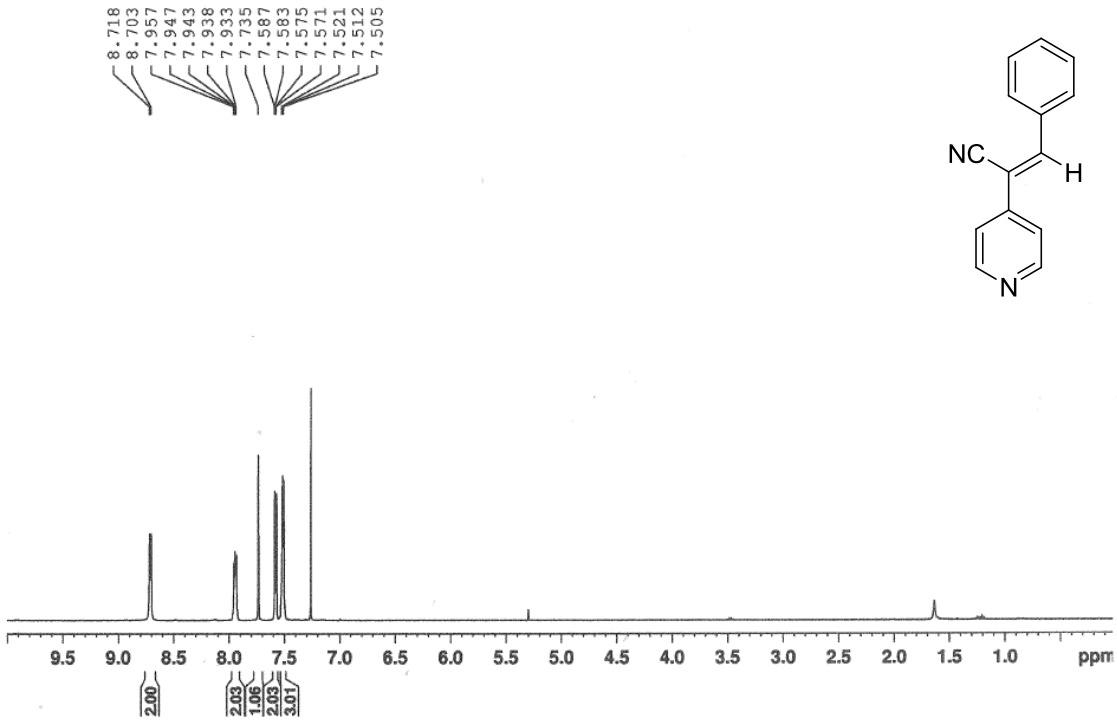
Procedure for the preparation of compound 14



To a solution of imine **4a** (100 mg, 0.31 mmol, 1.0 eq.) in 2.5 mL of methanol was added 2,6-ditert-butyl-4-methylpyridine **13** (6.36 mg, 0.031 mmol, 0.10 eq.) and Danishefsky's diene **12** (121uL, 0.62 mmol, 2.0 eq.). After the reaction mixture was stirred for 24h at room temperature, it was quenched with 1.0 M HCl, extracted with diethyl ether, dried over Na_2SO_4 and concentrated. The crude material was purified by flash chromatography (Solvents DCM:Et_2O 7:3) to give the cycloadduct **14** as a white solid (75.3 mg, 63% yield).
mp = ; ^{1}H-NMR (400 MHz, $CDCl_3$): 8.66 (dd, *J*= 8.0 Hz, 4.0 Hz, 2H), 7.60 (d, *J* = 4.0 Hz, 1H), 7.32-7.30 (m, 3H), 7.19 (d, *J* = 4.0 Hz, 2H), 7.07-7.04 (m, 2H), 4.72-4.66 (m, 2H), 4.21-4.16 (m, 3H), 4.03 (d, *J* = 8.0 Hz, 1H), 3.48 (dd, *J*= 9.6 Hz, 6.2 Hz, 1H), 3.24 (dd, *J*= 9.8 Hz, 6.0 Hz, 1H), 1.18 (t, *J* = 6.0 Hz, 3H); ^{13}C-NMR (100.6 MHz): 194.1, 172.1, 150.1, 149.0, 146.4, 139.2, 129.8, 128.4, 127.0, 124.2, 117.0, 102.5, 69.7, 63.8, 61.4, 56.6, 53.7, 37.1, 14.1; HRMS: *m/z* found $[M+H]^+$ 388.1661, $C_{23}H_{21}N_3O_3$ requires 387.1583.

1 D. L. Hughes, U. H. Dolling, K. M. Ryan, E. F. Schoenewaldt, E. J. J. Grabowski, *J. Org. Chem.* 1987, **52**, 4752-4756.

Compound **1a**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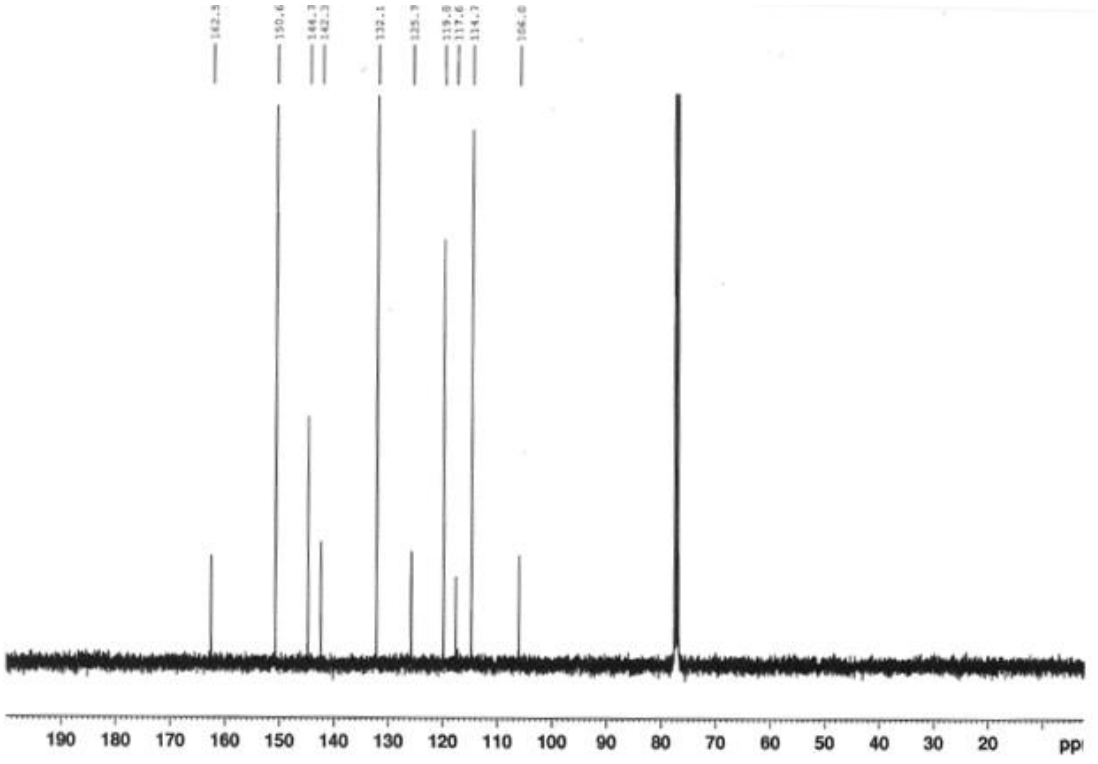
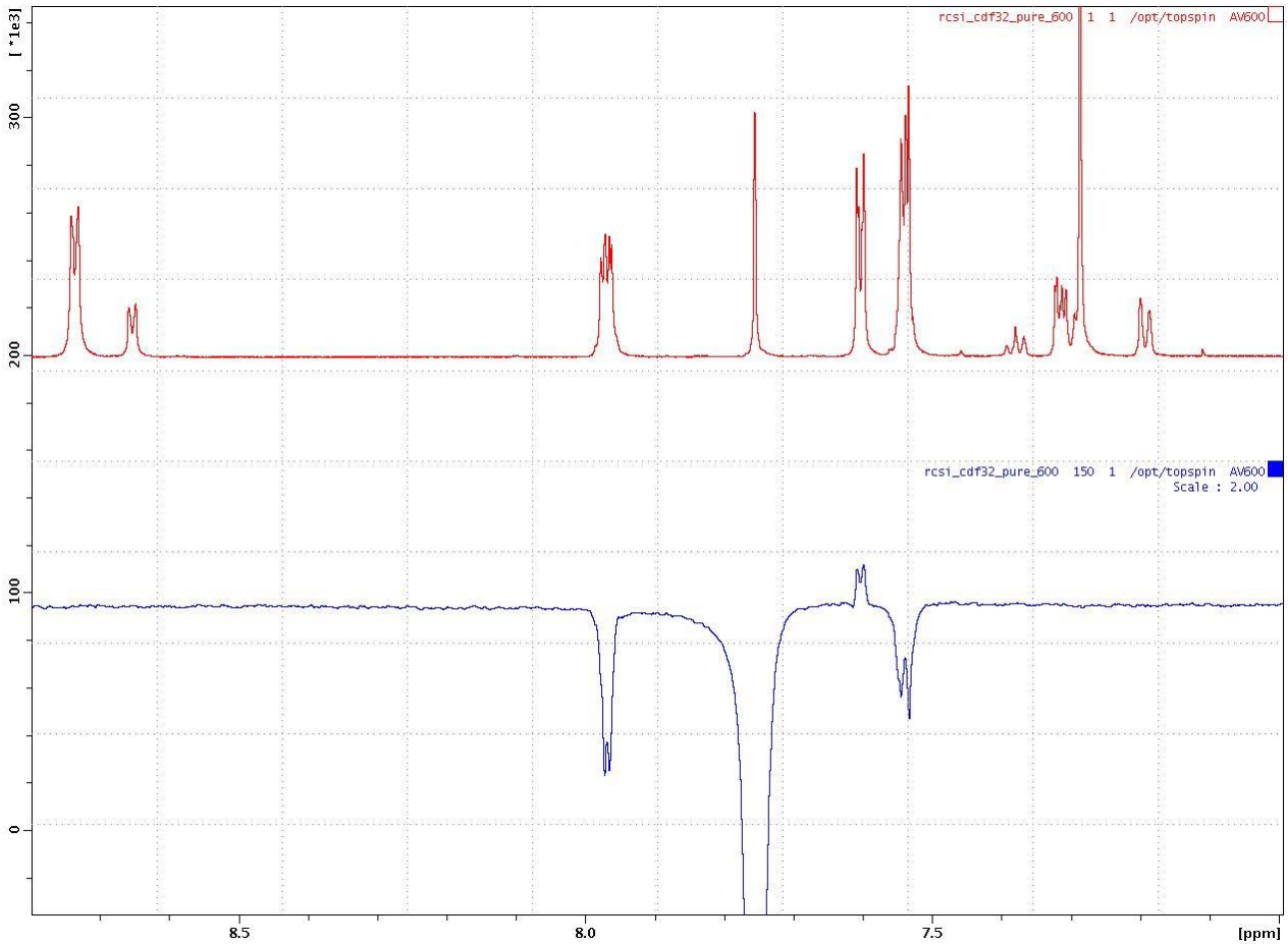
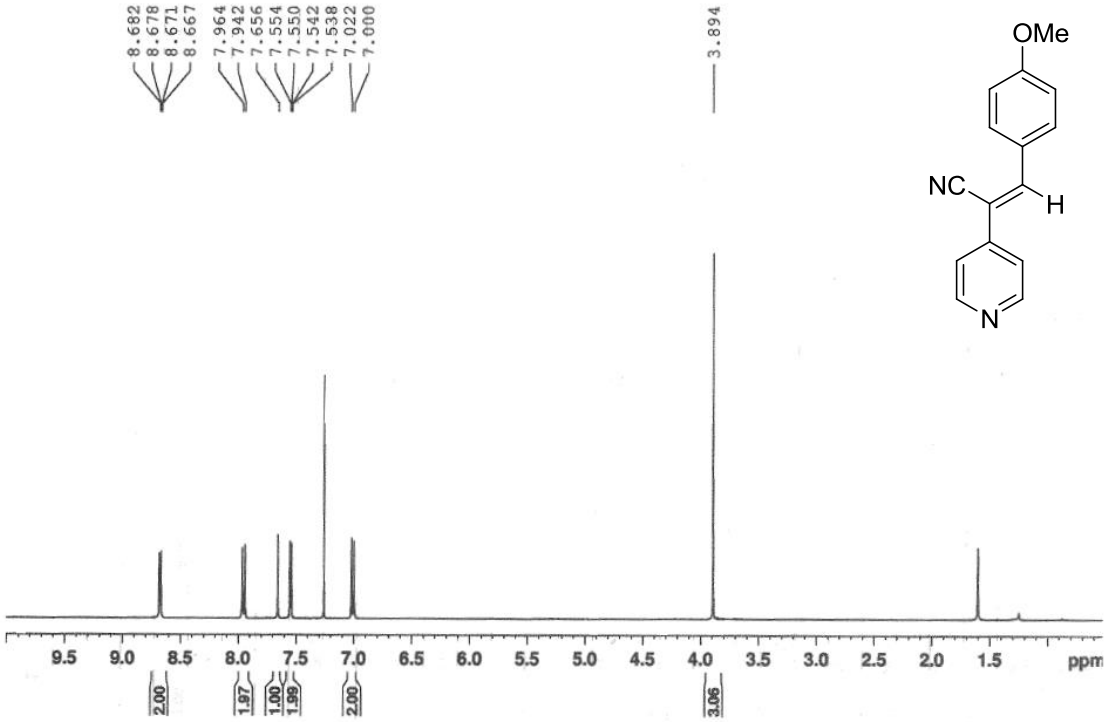
8.703
7.957
7.947
7.943
7.938
7.933
7.735
7.587
7.583
7.575
7.571
7.521
7.512
7.505
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
2.00
2.03
1.06
2.03
3.01


162.5
150.6
144.3
142.3
132.1
125.9
119.8
117.6
114.7
104.8
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
ppm

NOE is from the double bond proton to the pyridyl ring



Compound **1b**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8.678
8.671
8.667
7.964
7.942
7.656
7.554
7.550
7.542
7.538
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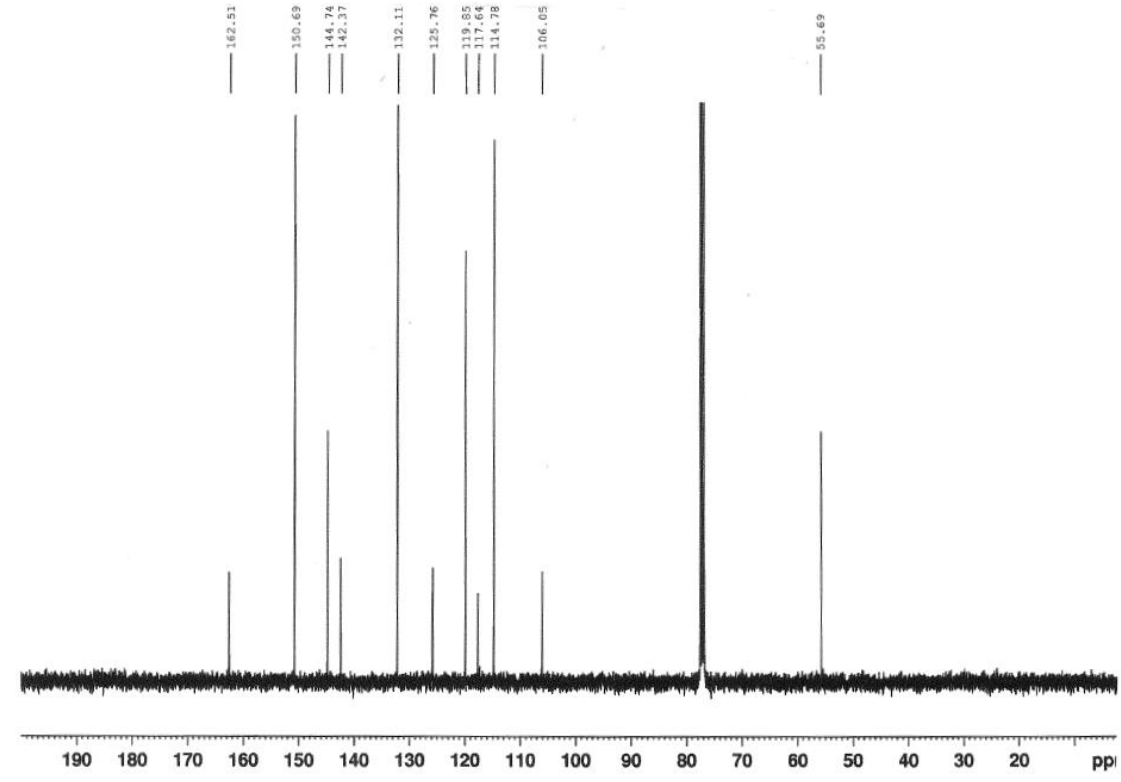
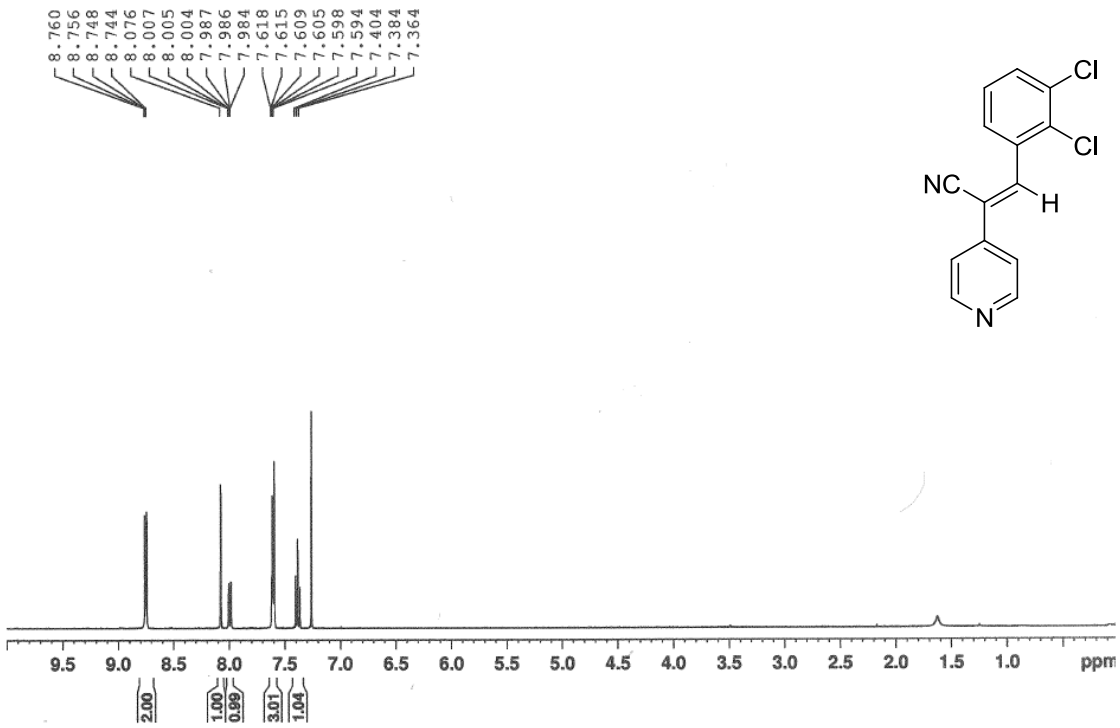
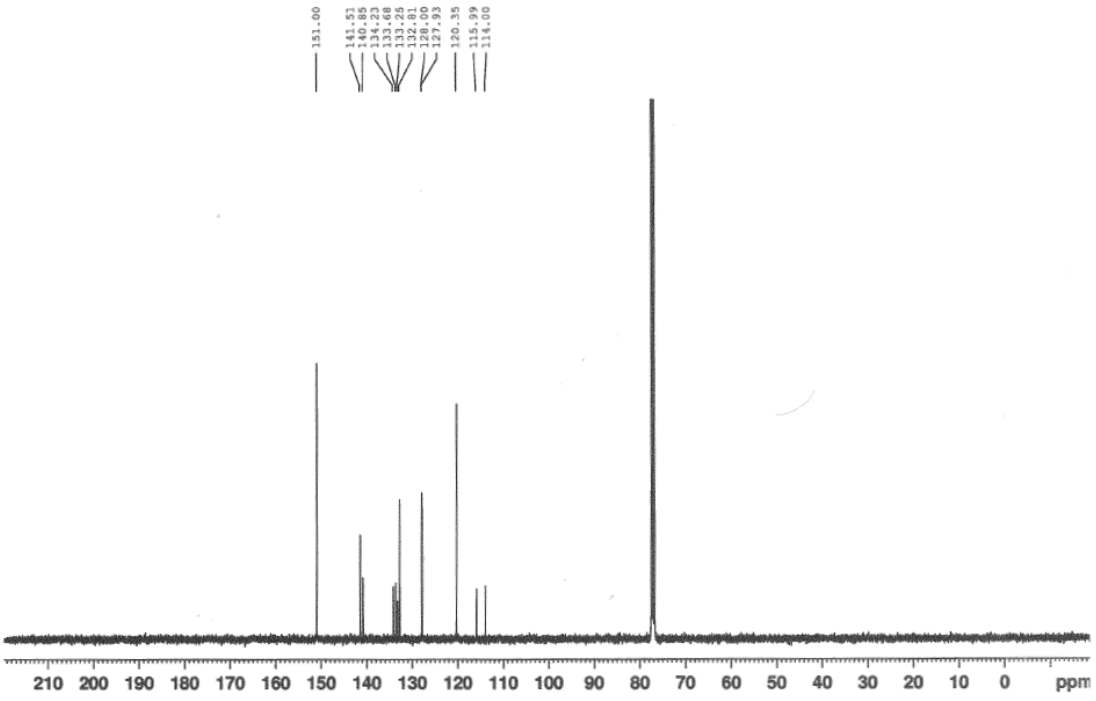
7.000
3.894
OMe
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 ppm
2.00
1.97
1.00
1.99
2.00
3.06

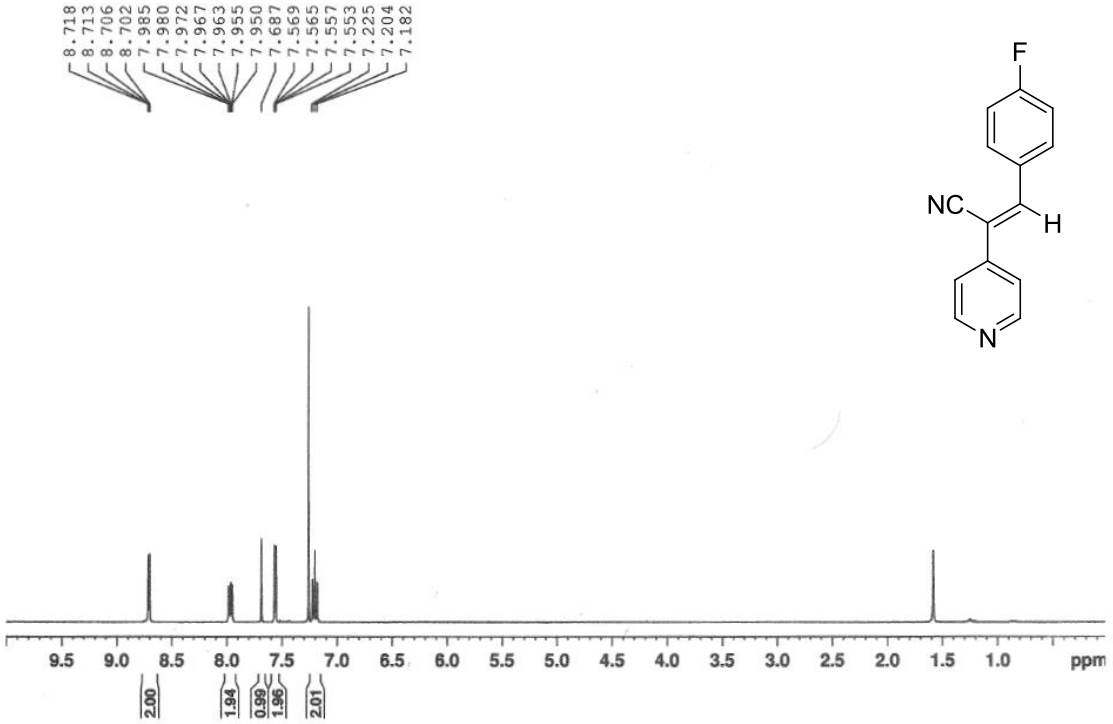

162.51
150.69
144.74
142.37
132.11
125.76
119.85
117.64
114.78
106.05
55.69
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

Compound **1c**


8.760
8.756
8.748
8.744
8.076
8.007
8.005
8.004
7.987
7.986
7.984
7.618
7.615
7.609
7.605
7.598
7.594
7.404
7.384
7.364
Cl
Cl
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
1.00
0.99
3.01
1.04


151.00
141.51
140.85
134.23
133.68
133.25
132.81
128.00
127.93
120.35
115.99
114.00
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

Compound **1d**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8.713
8.706
8.702
7.985
7.980
7.972
7.967
7.963
7.955
7.950
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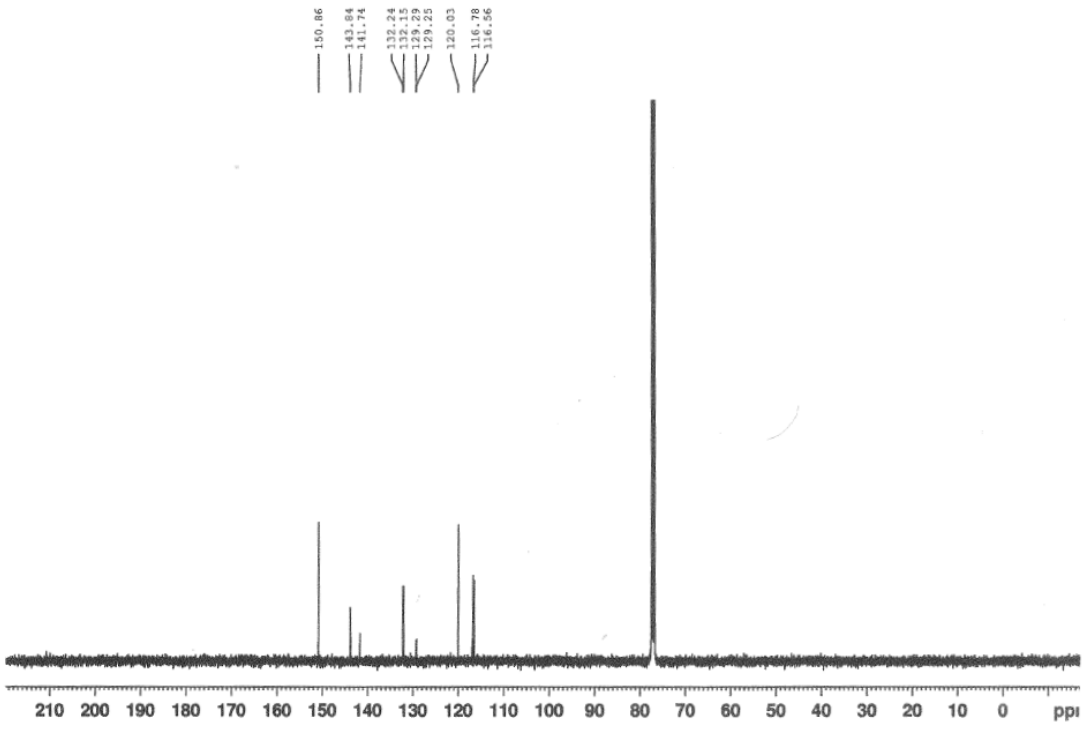
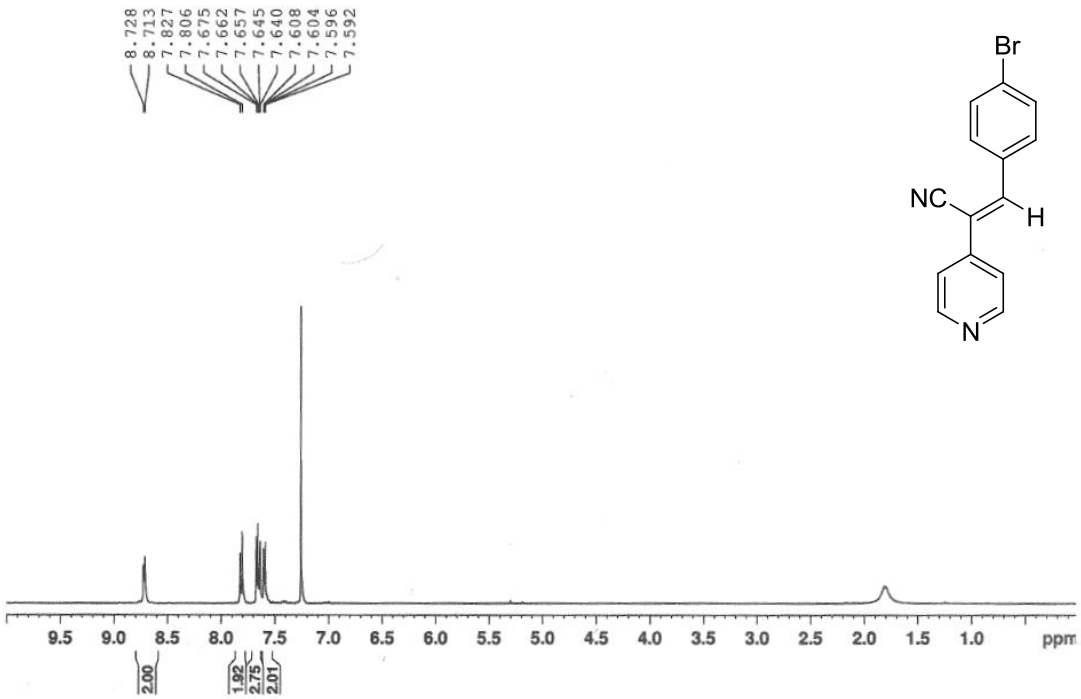
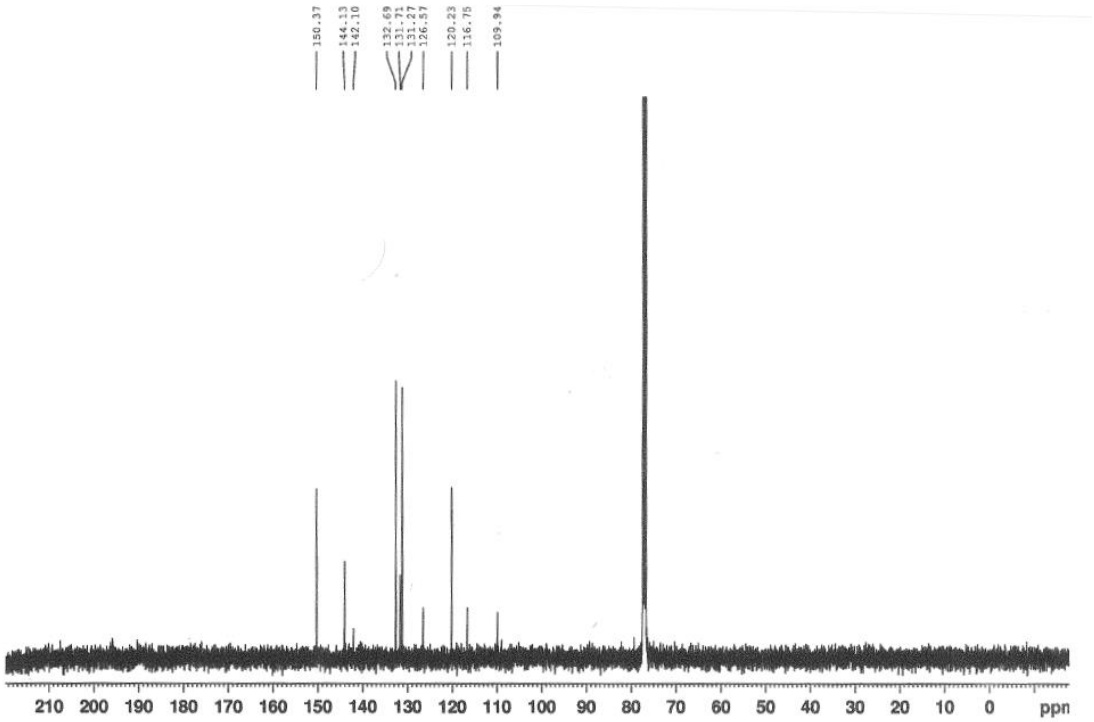
7.569
7.565
7.557
7.553
7.225
7.204
7.182
F
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
2.00
1.94
0.99
1.96
2.01

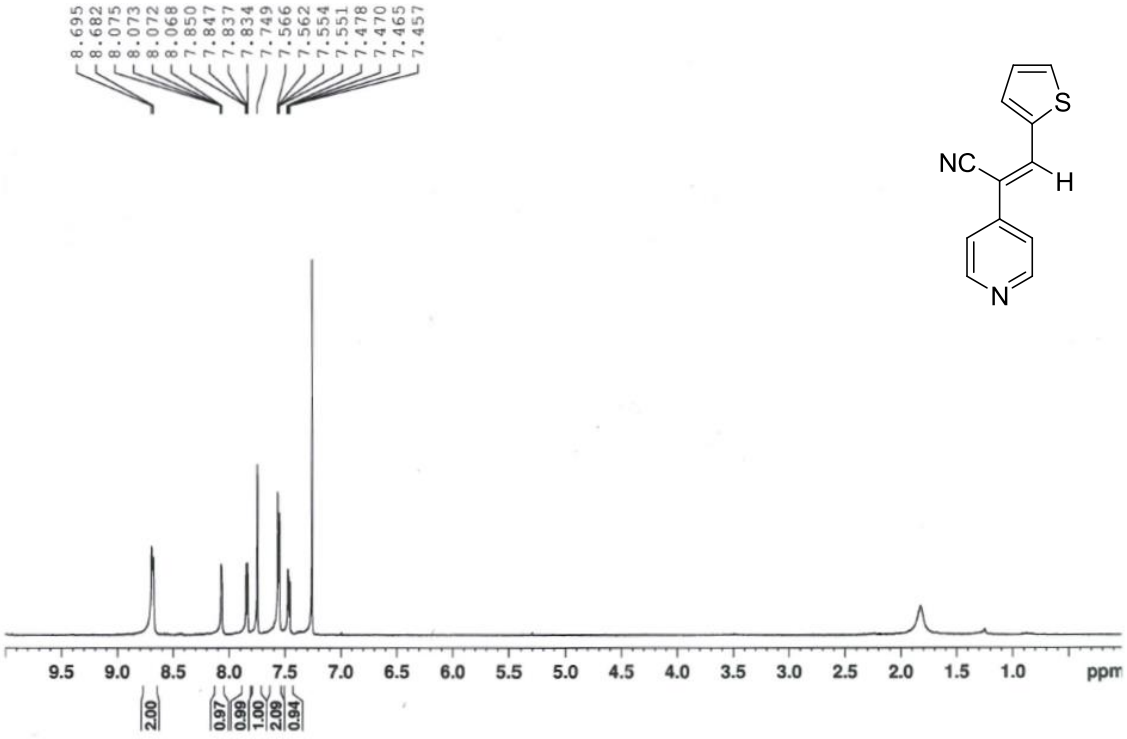

150.86
143.84
141.74
132.24
132.15
129.29
129.25
120.03
116.78
116.56
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

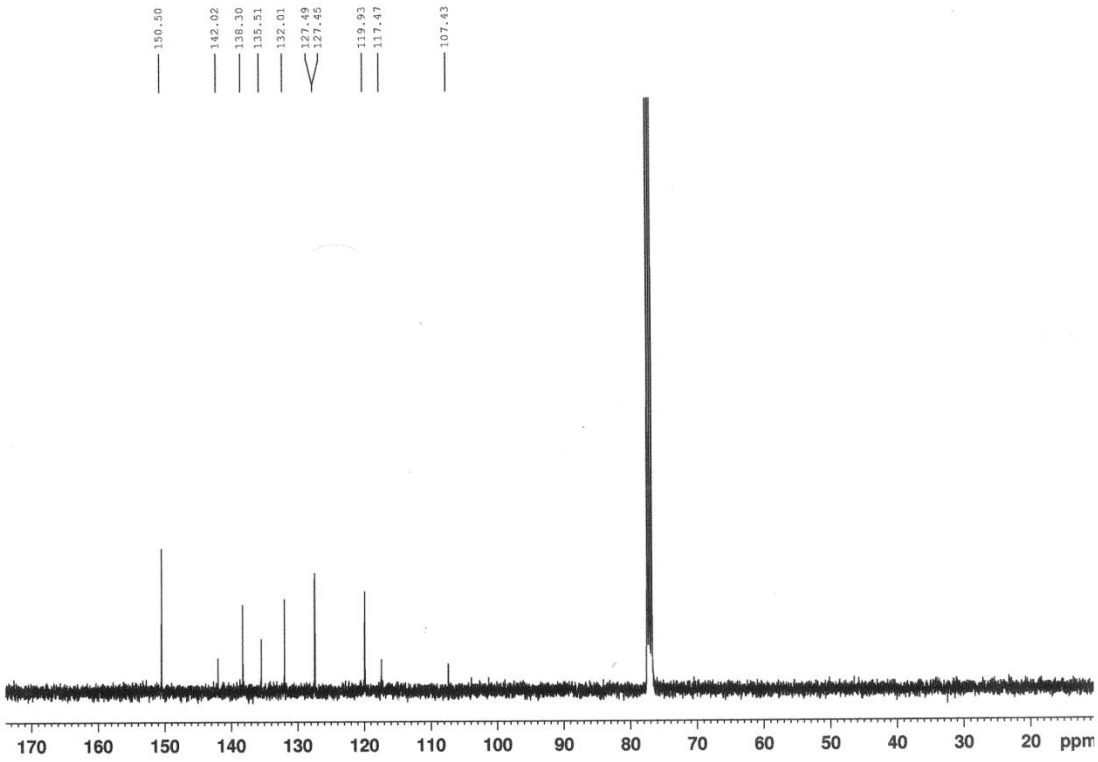
Compound **1e**


8.728
8.713
7.827
7.806
7.675
7.662
7.657
7.645
7.640
7.608
7.604
7.596
7.592
Br
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
1.92
2.75
2.01

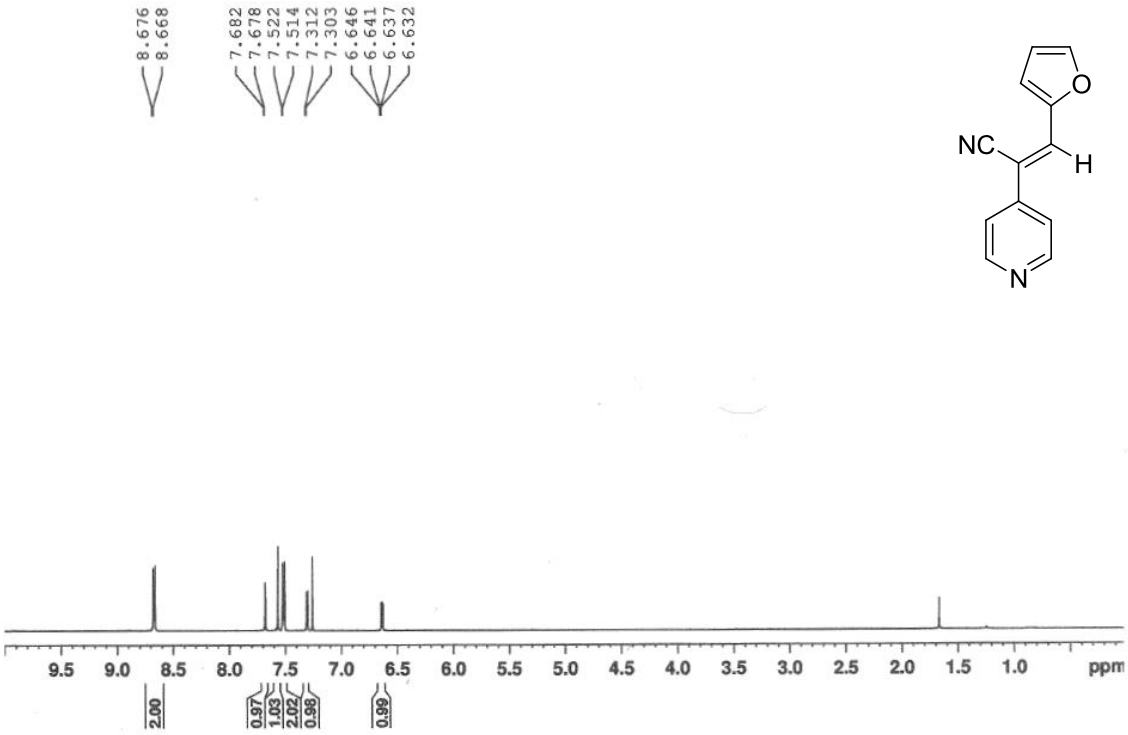

150.37
144.13
142.10
132.69
131.71
131.27
126.57
120.23
116.75
109.94
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

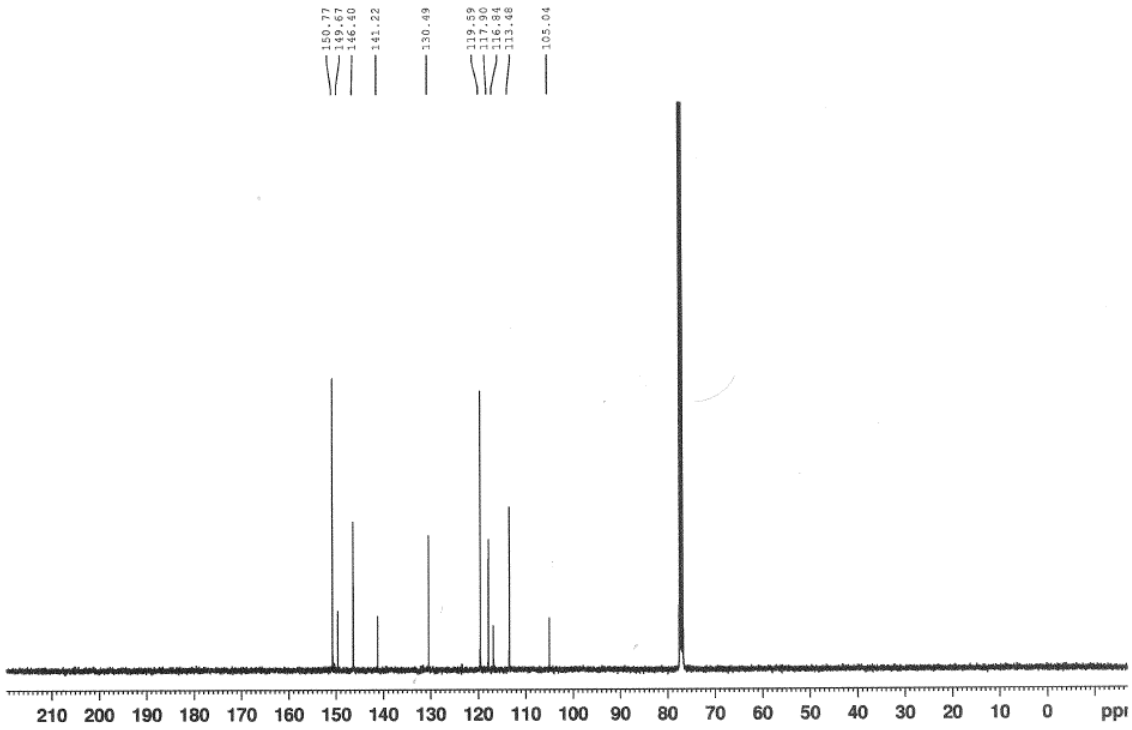
Compound **1f**


8.695
8.682
8.075
8.073
8.072
8.068
7.850
7.847
7.837
7.834
7.749
7.566
7.562
7.554
7.551
7.478
7.470
7.465
7.457
S
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
0.97
0.99
1.00
2.09
0.94

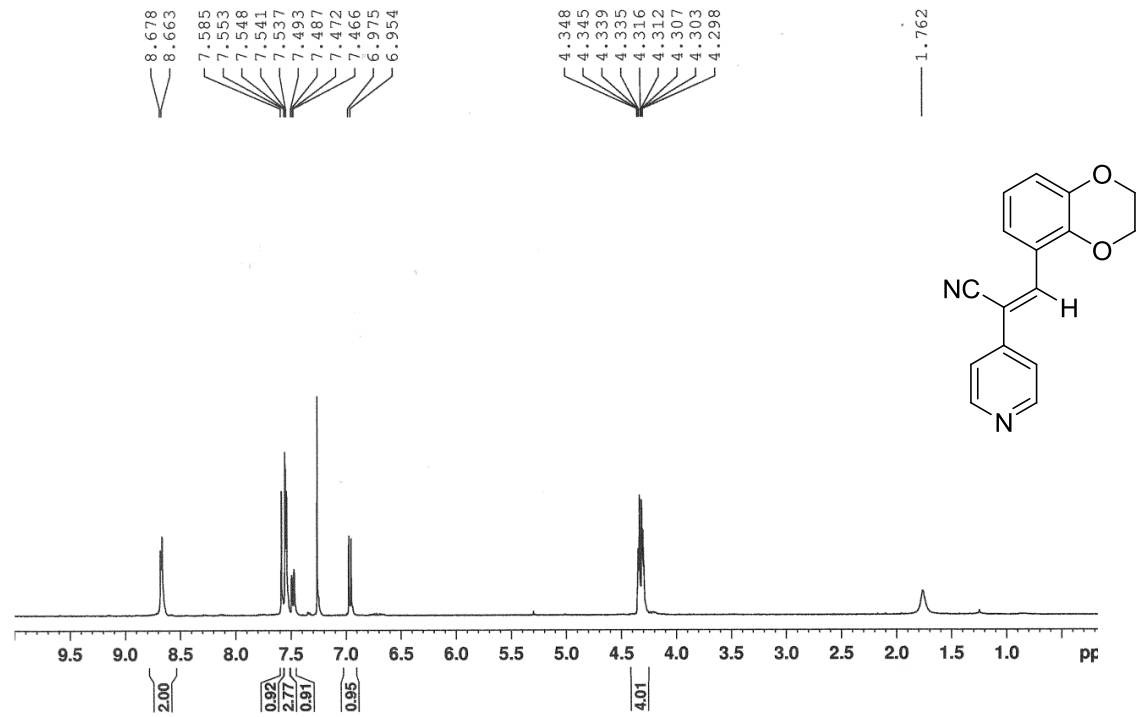

150.50
142.02
138.30
135.51
132.01
127.49
127.45
119.93
117.47
107.43
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

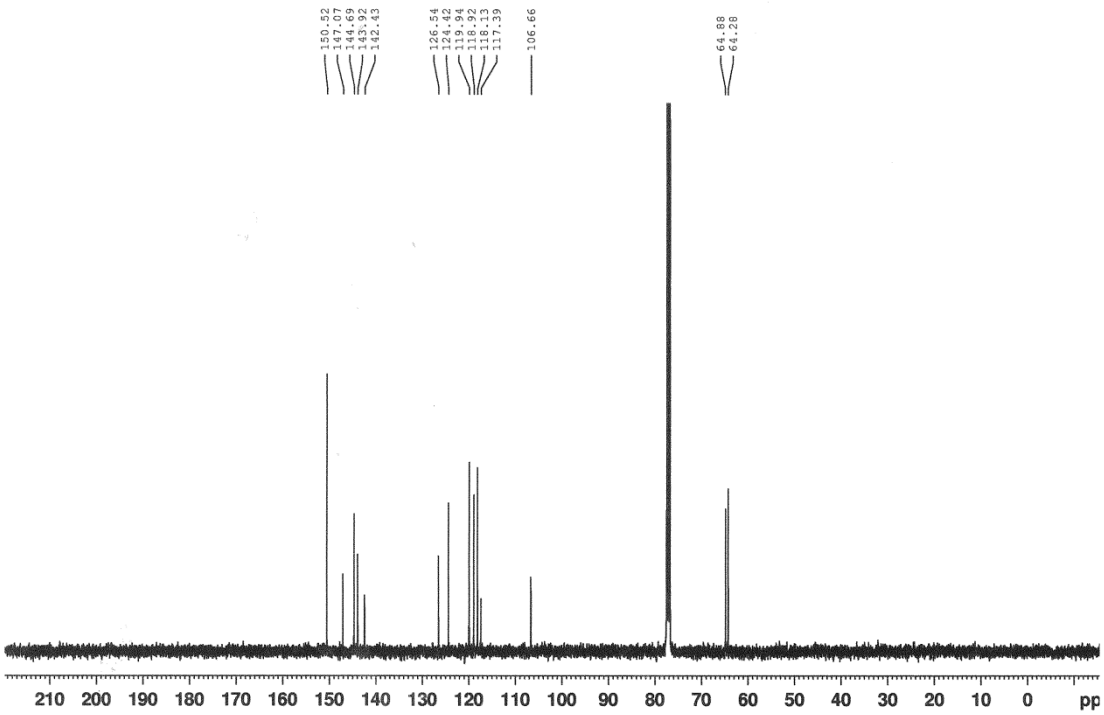
Compound **1g**


8.676
8.668
7.682
7.678
7.522
7.514
7.312
7.303
6.646
6.641
6.637
6.632
O
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
0.97
1.03
2.02
0.98
0.99

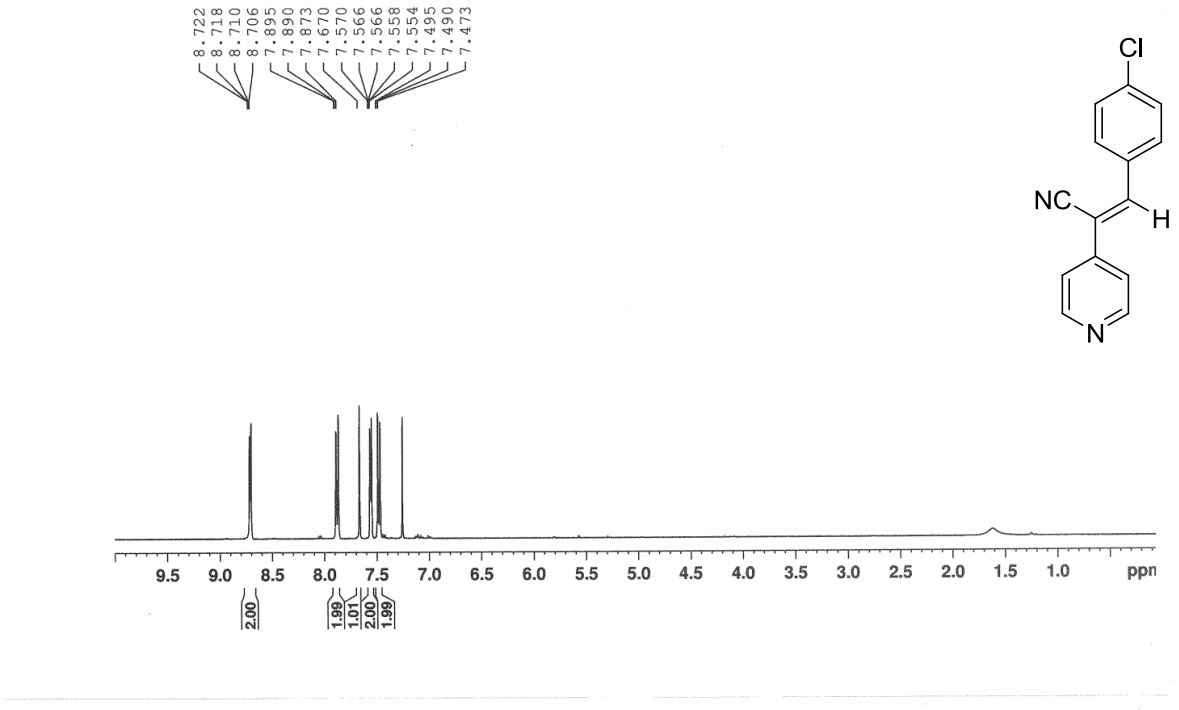

150.77
149.67
146.40
141.22
130.49
119.59
117.90
116.84
113.48
105.04
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

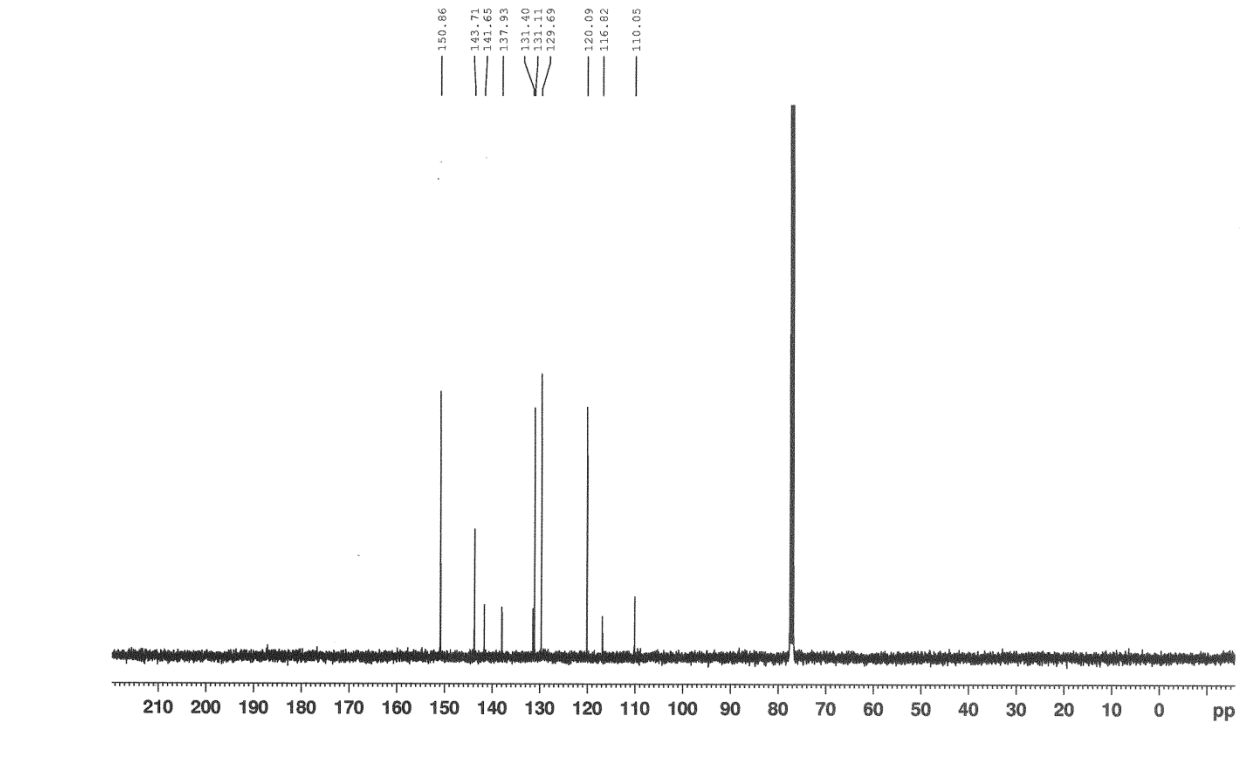
Compound **1h**


8.678
8.663
7.585
7.553
7.548
7.541
7.537
7.493
7.487
7.472
7.466
6.975
6.954
4.348
4.345
4.339
4.335
4.316
4.312
4.307
4.303
4.298
1.762
O
O
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
2.00
0.92
2.77
0.91
0.95
4.01

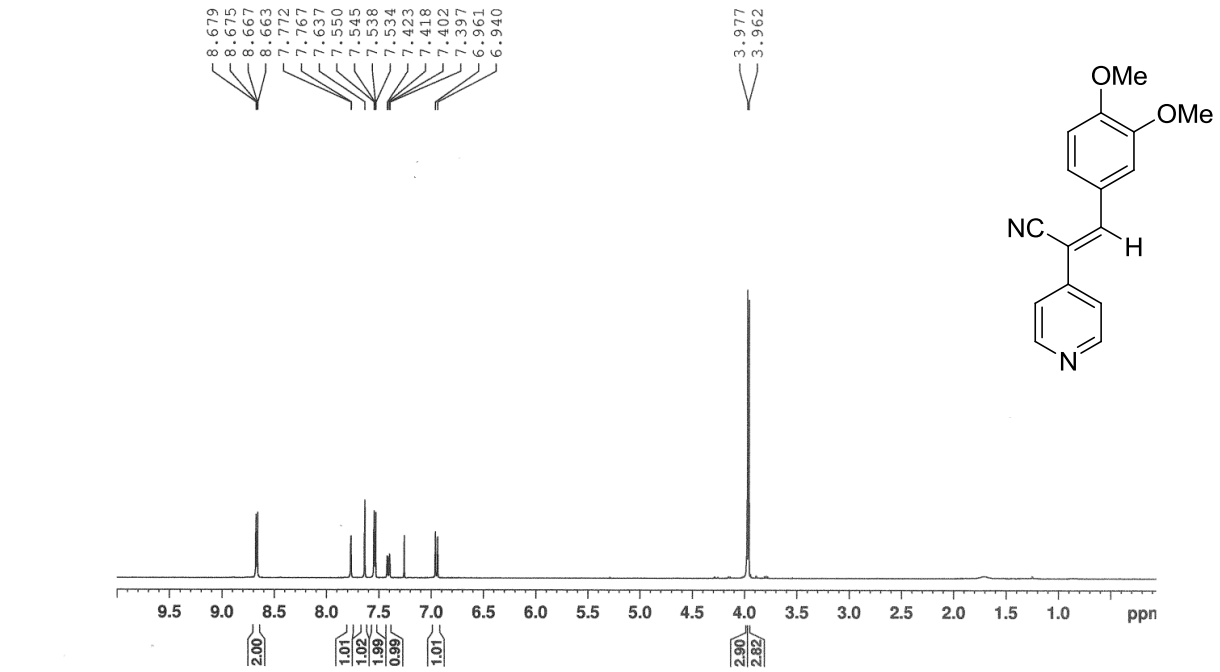

150.52
147.07
144.69
143.92
142.43
126.54
124.42
119.94
118.92
118.13
117.39
106.66
64.88
64.28
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

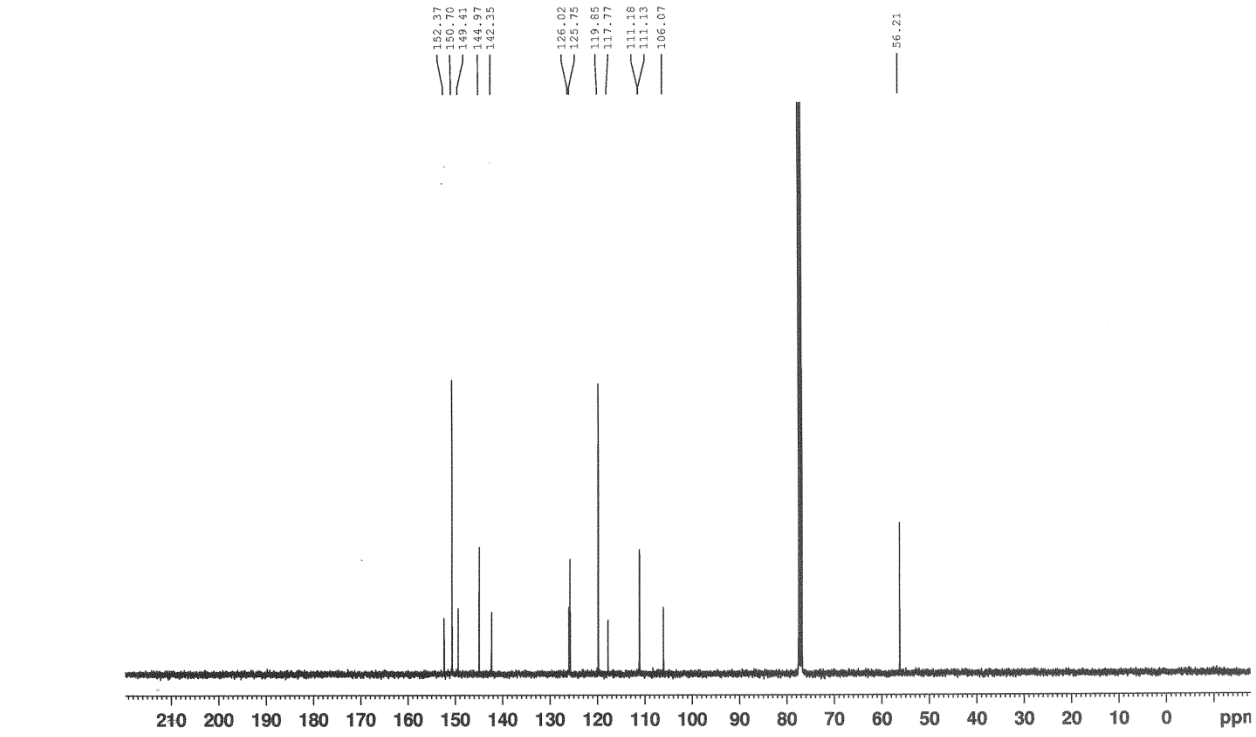
Compound **1i**


8.722
8.718
8.710
8.706
7.895
7.890
7.873
7.670
7.570
7.566
7.566
7.558
7.554
7.495
7.490
7.473
Cl
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
1.99
1.01
2.00
1.99

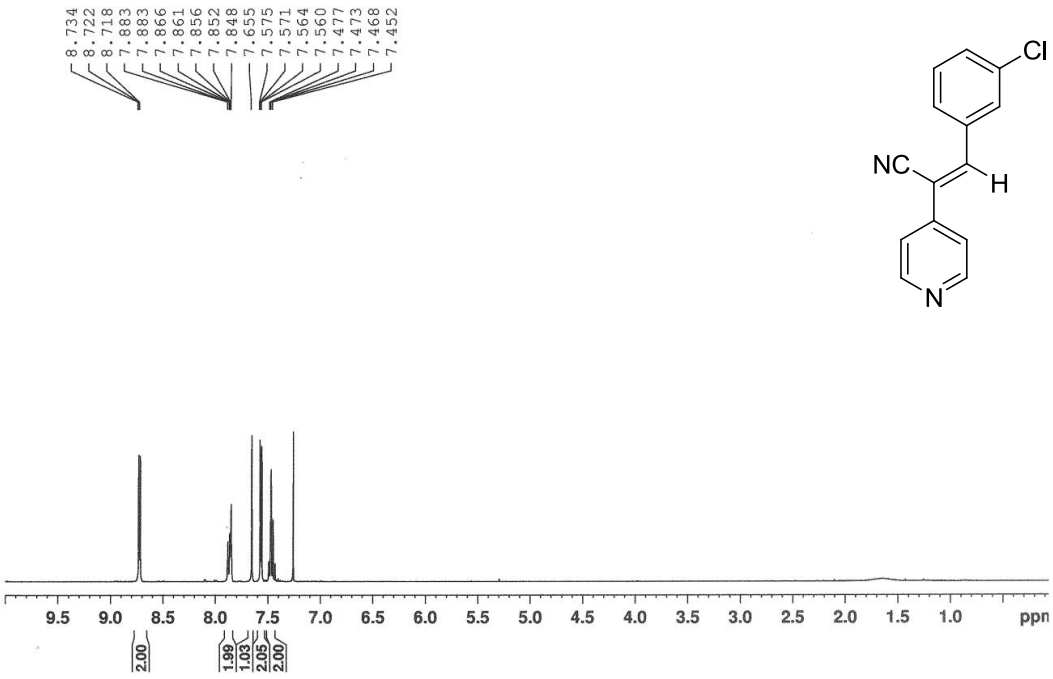

150.86
143.71
141.65
137.93
131.40
131.11
129.69
120.09
116.82
110.05
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 pp

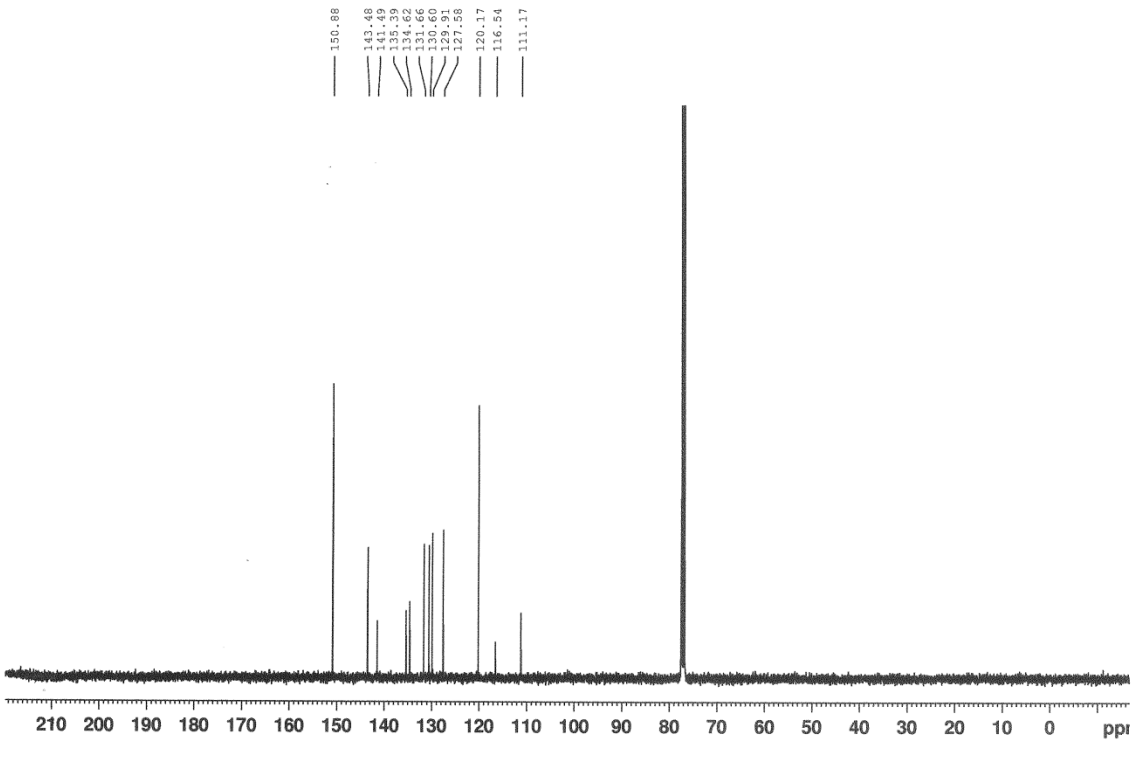
Compound **1j**


8.679
8.675
8.667
8.663
7.772
7.767
7.637
7.550
7.545
7.538
7.534
7.423
7.418
7.402
7.397
6.961
6.940
3.977
3.962
OMe
OMe
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
1.01
1.02
1.99
0.99
1.01
2.90
2.82

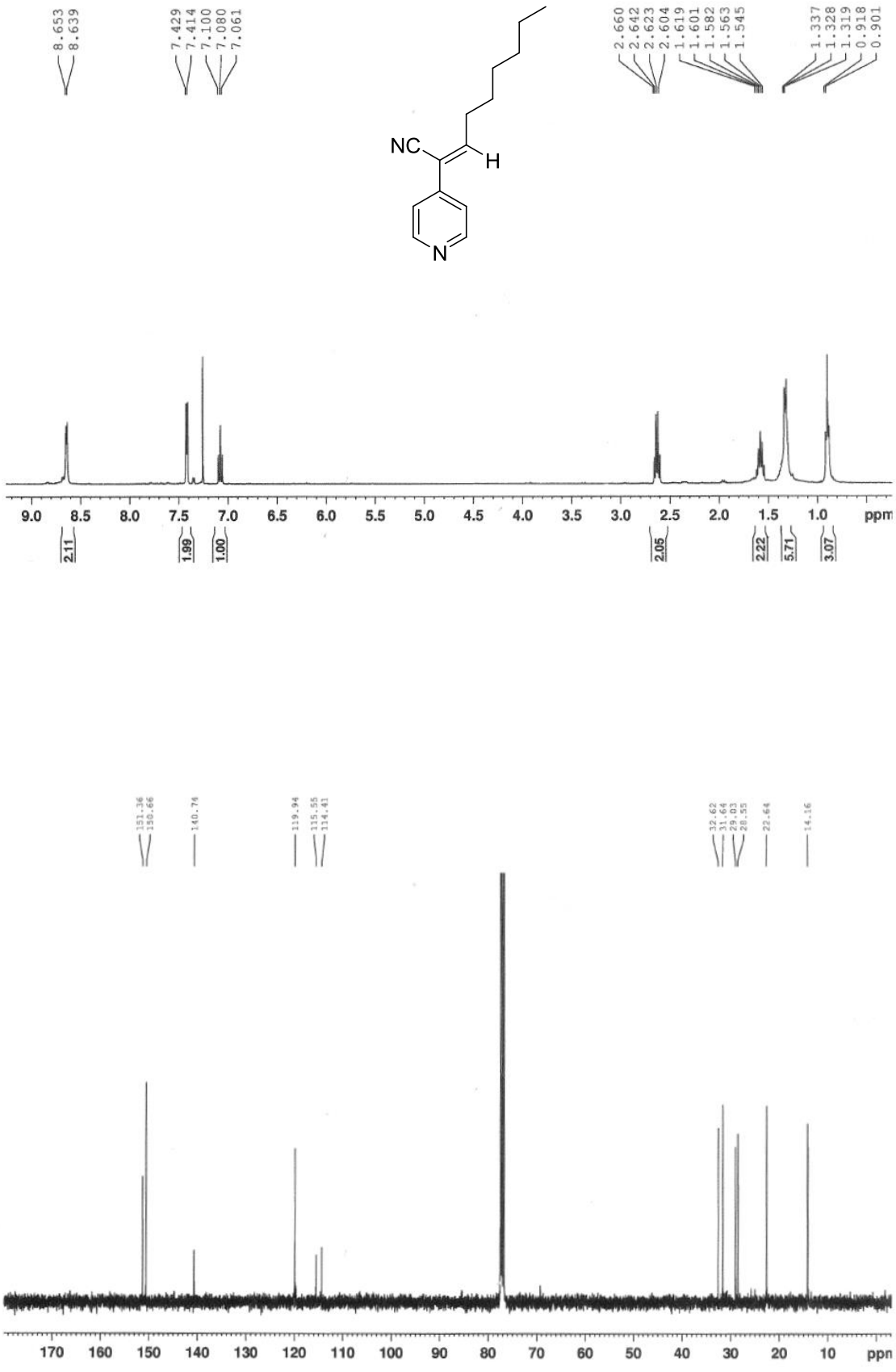

152.37
150.70
149.41
144.97
142.35
126.02
125.75
119.85
117.77
111.18
111.13
106.07
56.21
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

Compound **1k**

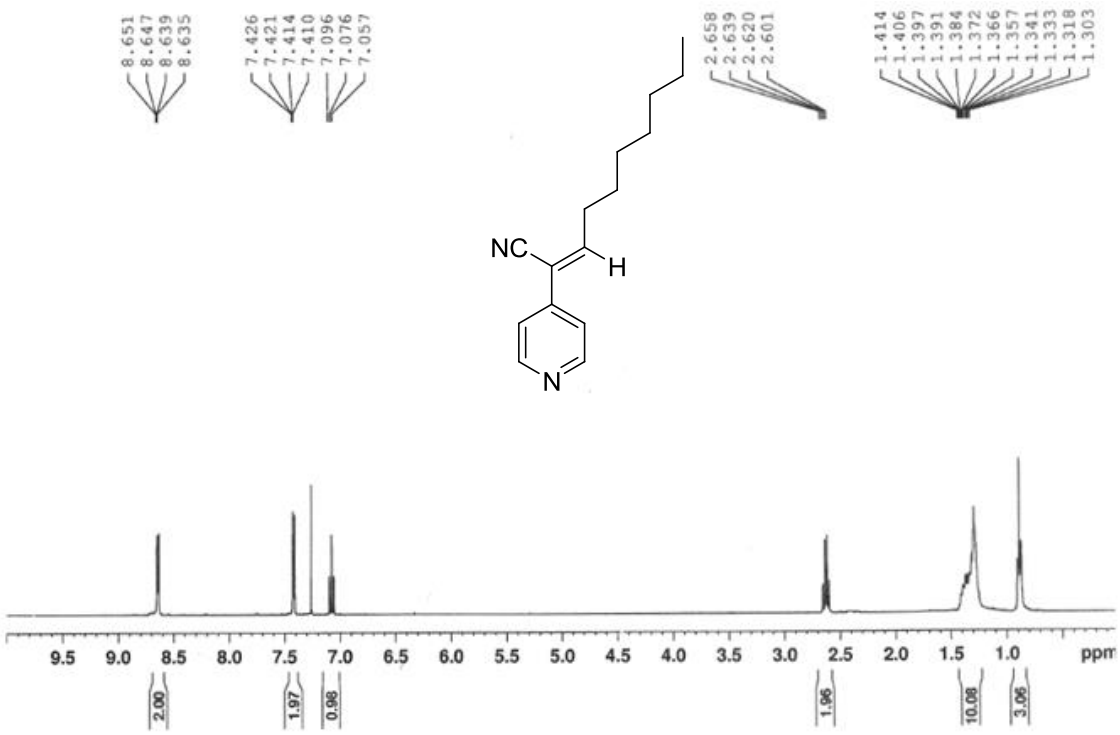

8.734
8.722
8.718
7.883
7.883
7.866
7.861
7.856
7.852
7.848
7.655
7.575
7.571
7.564
7.560
7.477
7.473
7.468
7.452
Cl
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
1.99
1.03
2.05
2.00

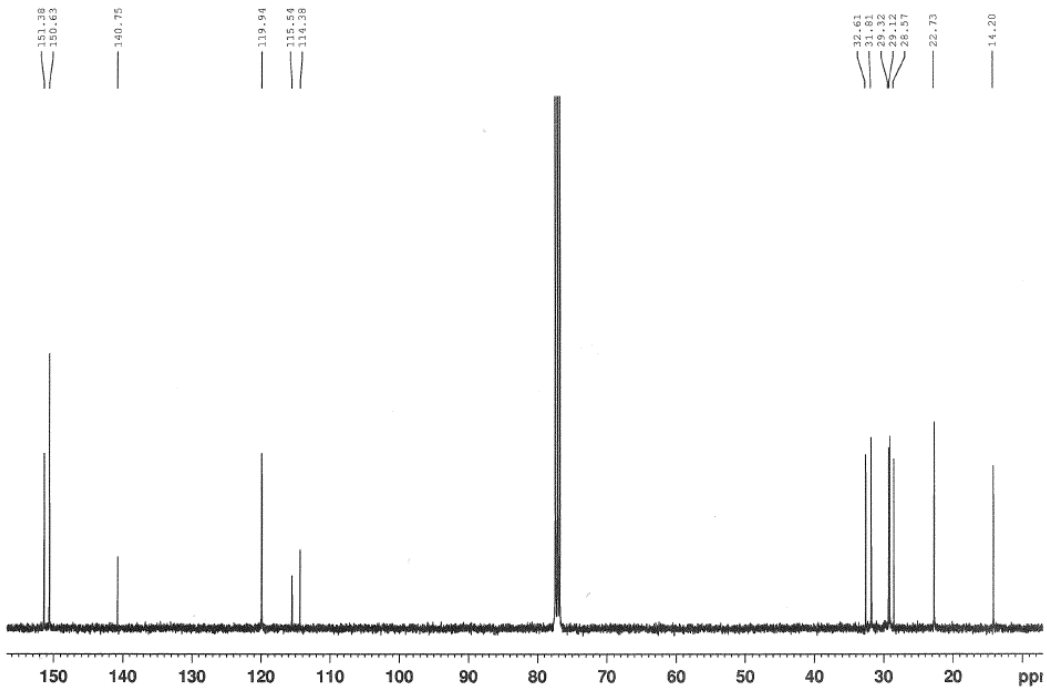

150.88
143.48
141.49
135.39
134.62
131.66
130.60
129.91
127.58
120.17
116.54
111.17
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

Compound **1l**

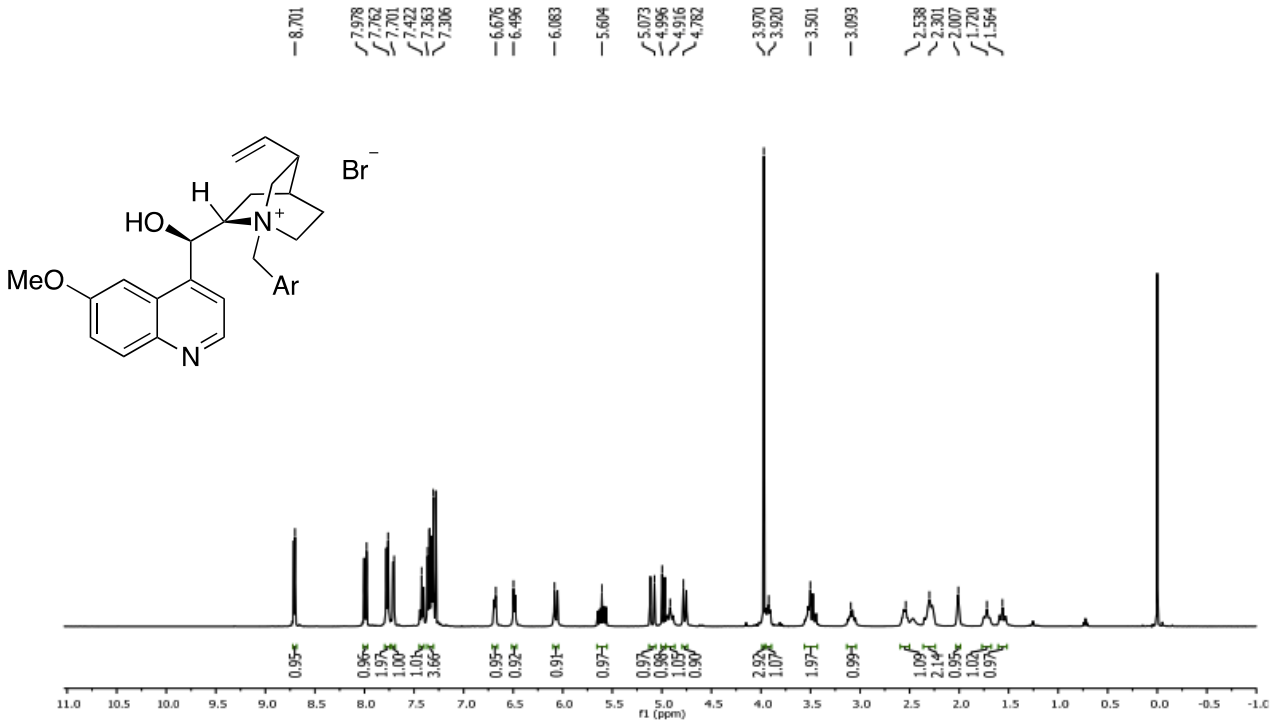

8.653
8.639
7.429
7.414
7.100
7.080
7.061
2.660
2.642
2.623
2.604
1.619
1.601
1.582
1.563
1.545
1.337
1.328
1.319
0.918
0.901
NC
H
N
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
2.11
1.99
1.00
2.05
2.22
5.71
3.07
151.36
150.66
140.74
119.94
115.55
114.41
32.62
31.64
29.03
28.55
22.64
14.16
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

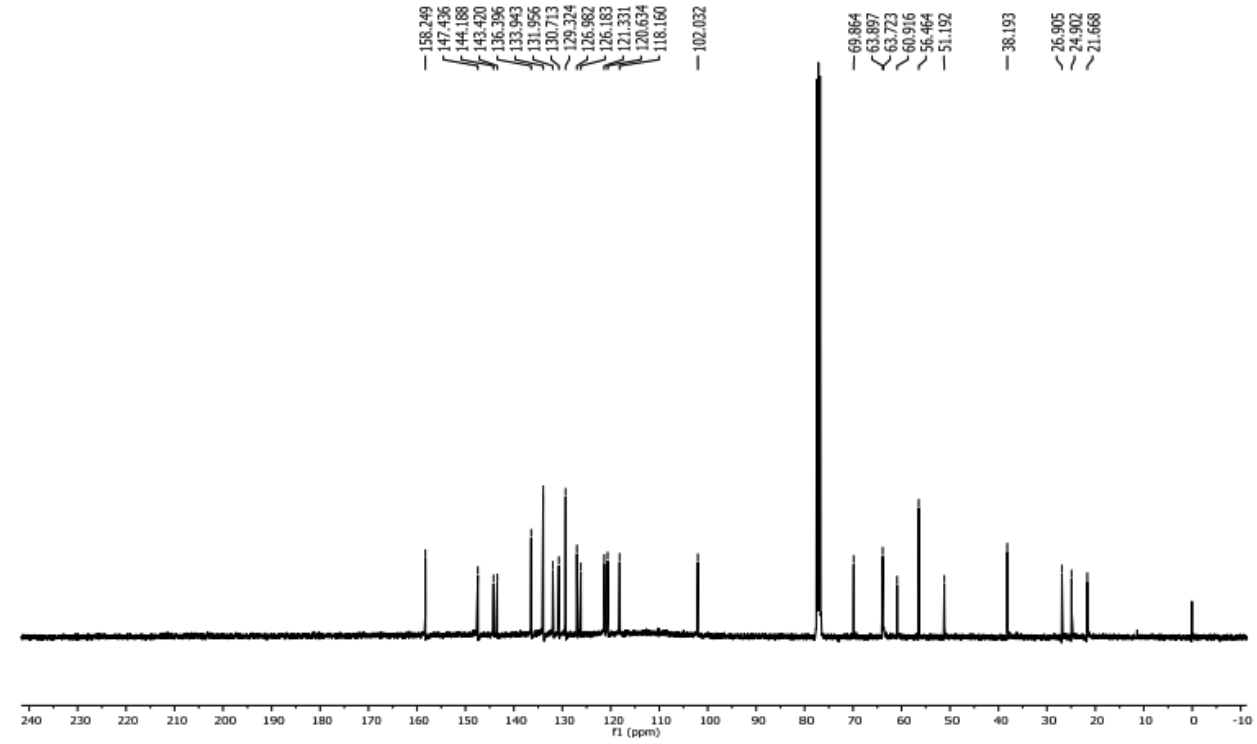
Compound **1m**


8.651
8.647
8.639
8.635
7.426
7.421
7.414
7.410
7.096
7.076
7.057
2.658
2.639
2.620
2.601
1.414
1.406
1.397
1.391
1.384
1.372
1.366
1.357
1.341
1.333
1.318
1.303
NC
H
N
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
2.00
1.97
0.98
1.96
10.08
3.06

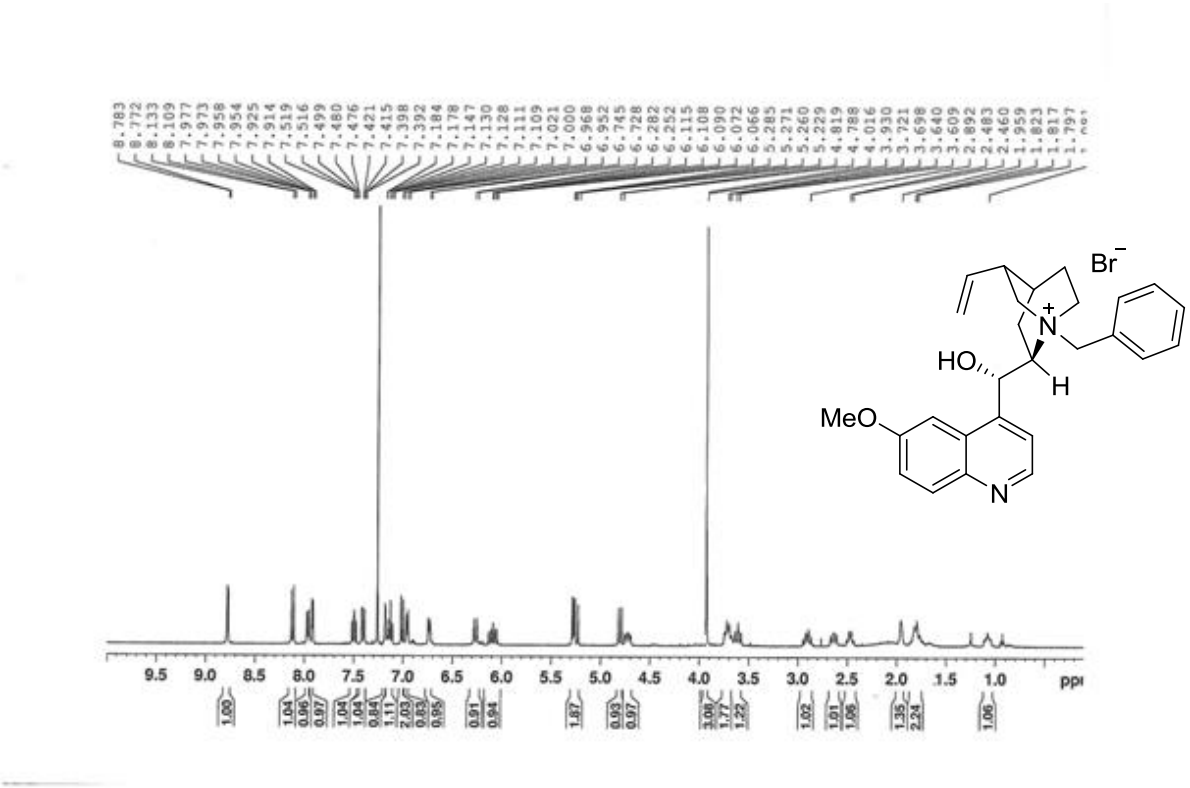

151.38
150.63
140.75
119.94
115.54
114.38
32.61
31.51
29.32
29.12
28.57
22.73
14.20
150 140 130 120 110 100 90 80 70 60 50 40 30 20
ppm

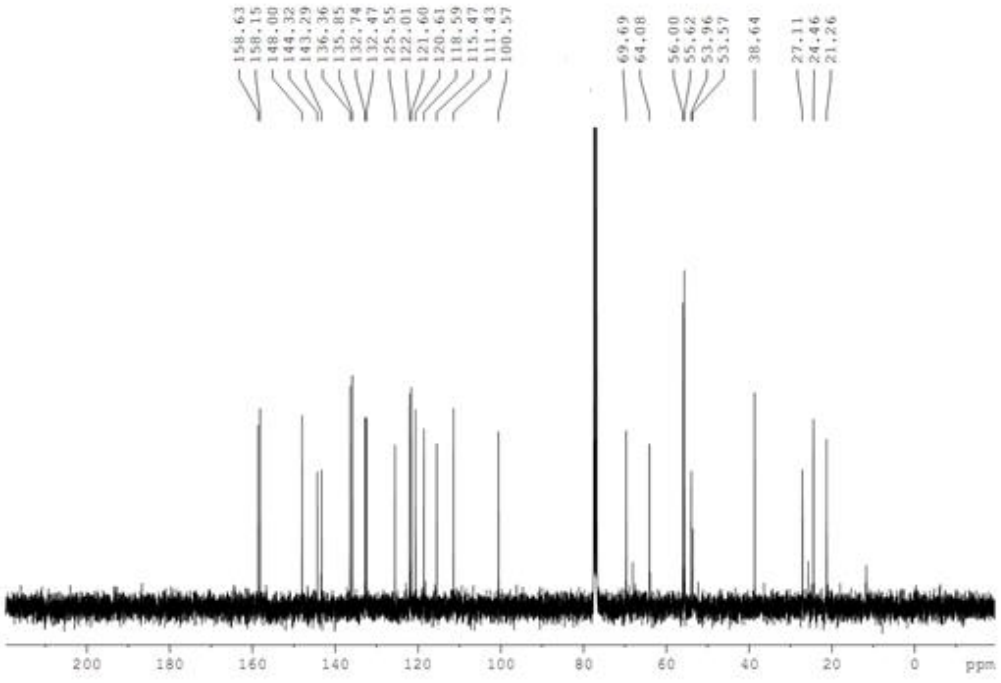
Catalyst **10**


8.701
7.978
7.762
7.701
7.422
7.363
7.306
6.676
6.496
6.083
5.604
5.073
4.996
4.916
4.782
3.970
3.920
3.501
3.093
2.538
2.301
2.007
1.720
1.564
Br⁻
H
HO
N⁺
Ar
MeO
N
f1 (ppm)

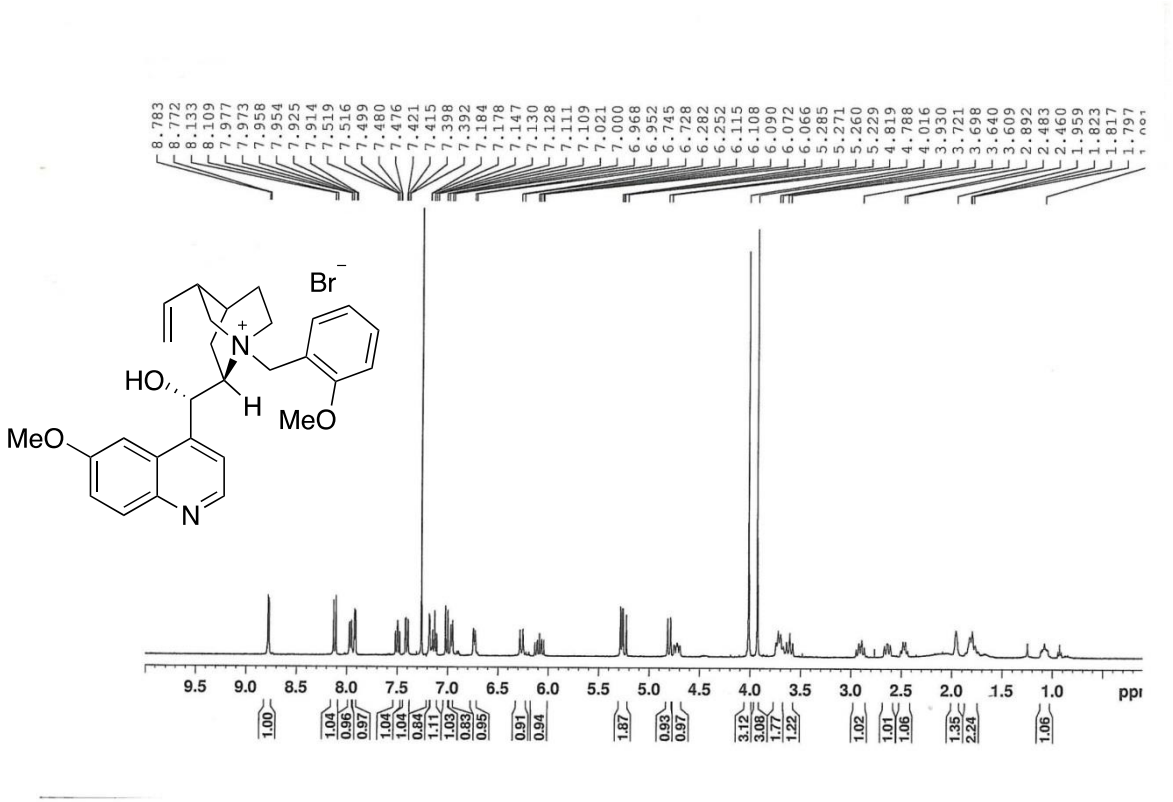

158.249
147.436
144.188
143.420
136.396
133.943
131.956
130.713
129.324
126.982
126.183
121.331
120.634
118.160
102.032
69.864
63.897
63.723
60.916
56.464
51.192
38.193
26.905
24.902
21.668
f1 (ppm)

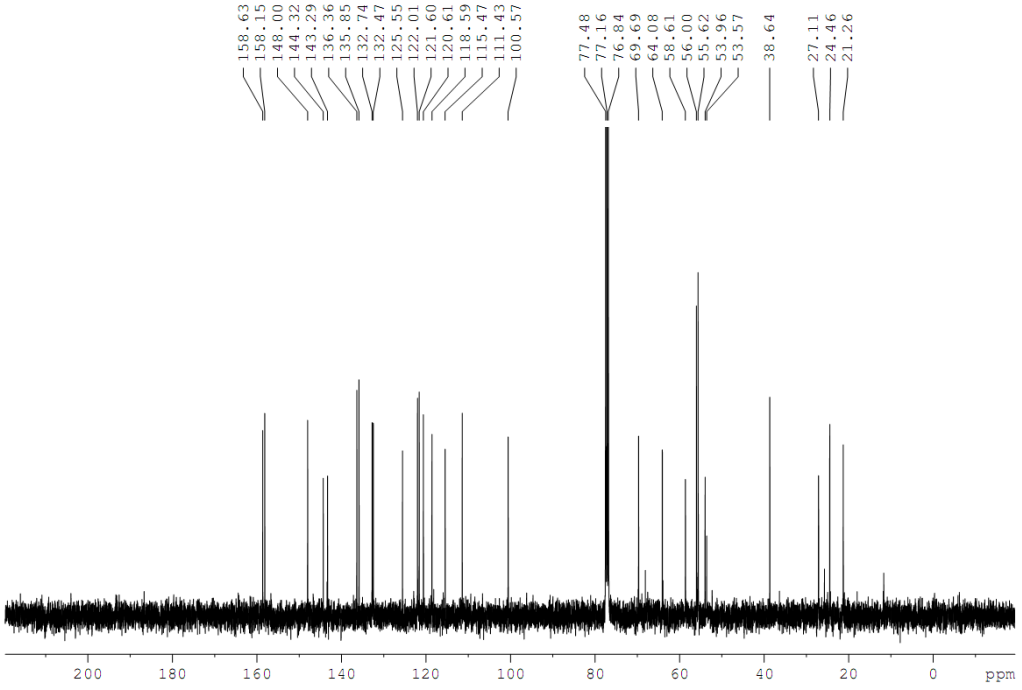
Catalyst **11a**



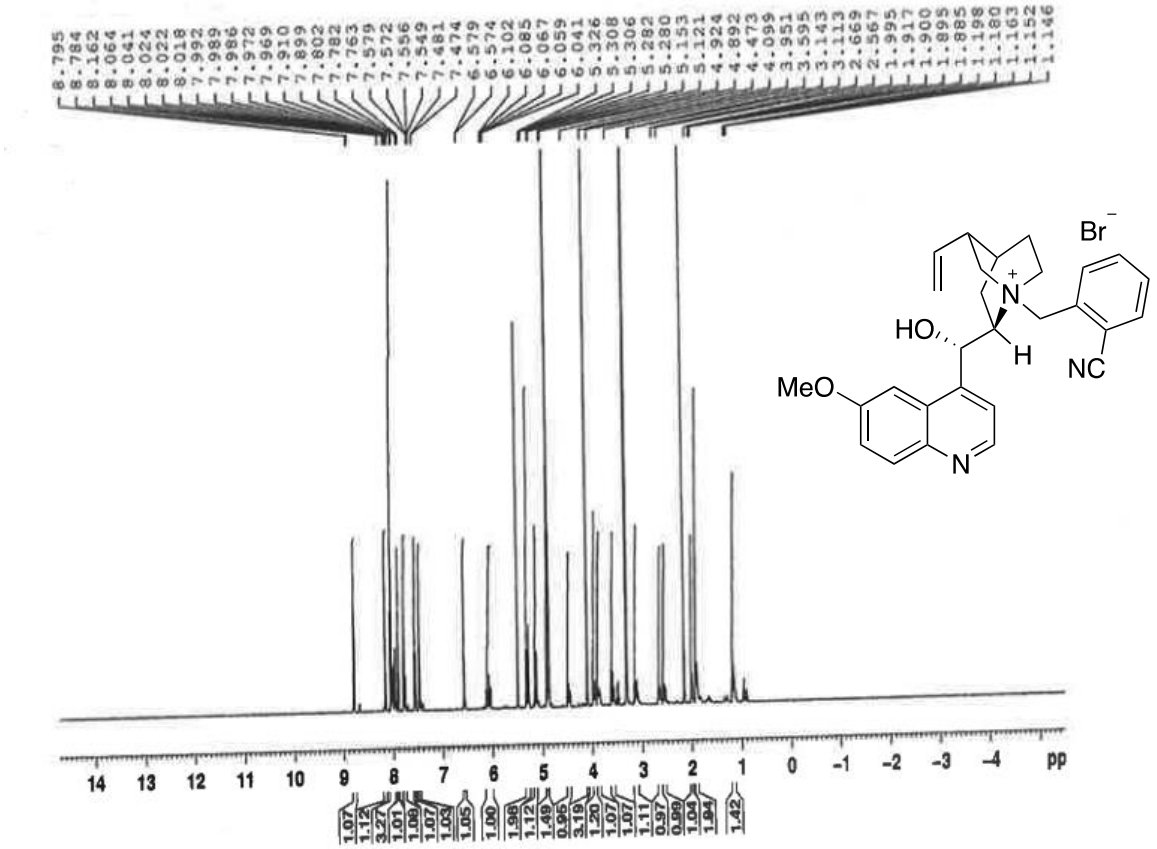


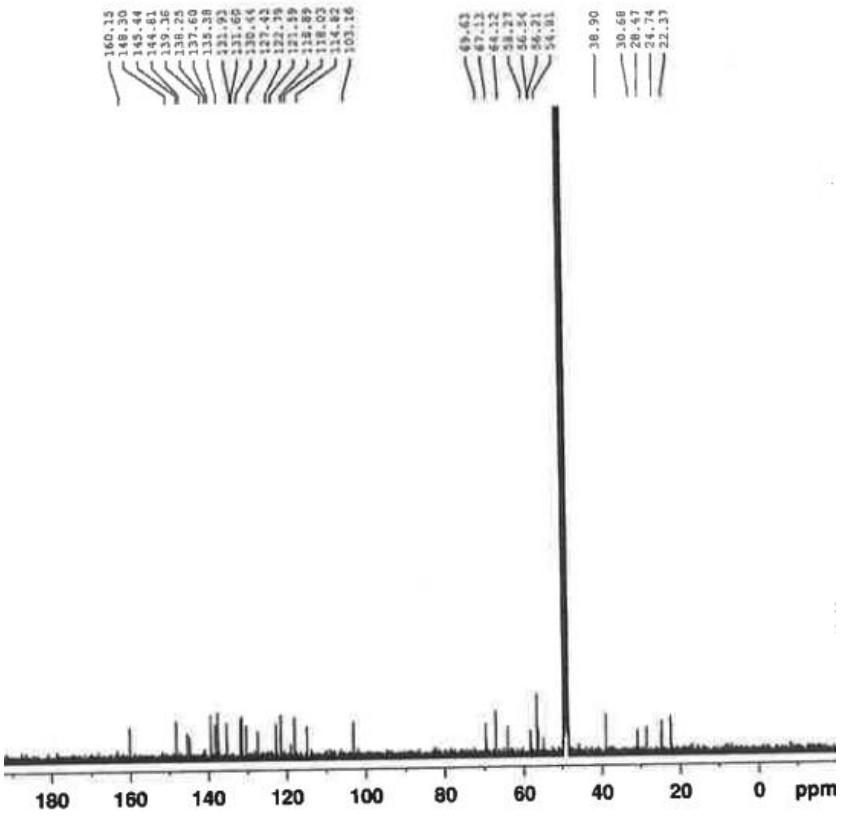
Catalyst **11b**



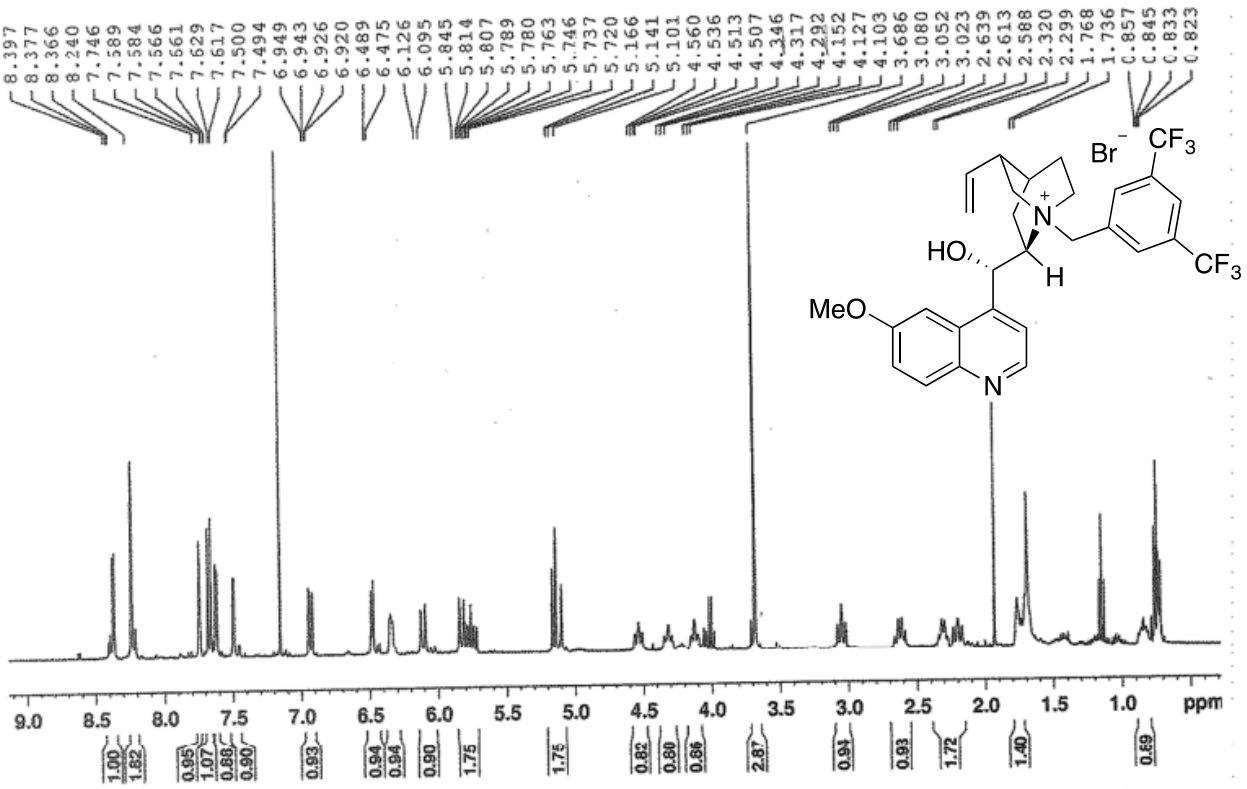


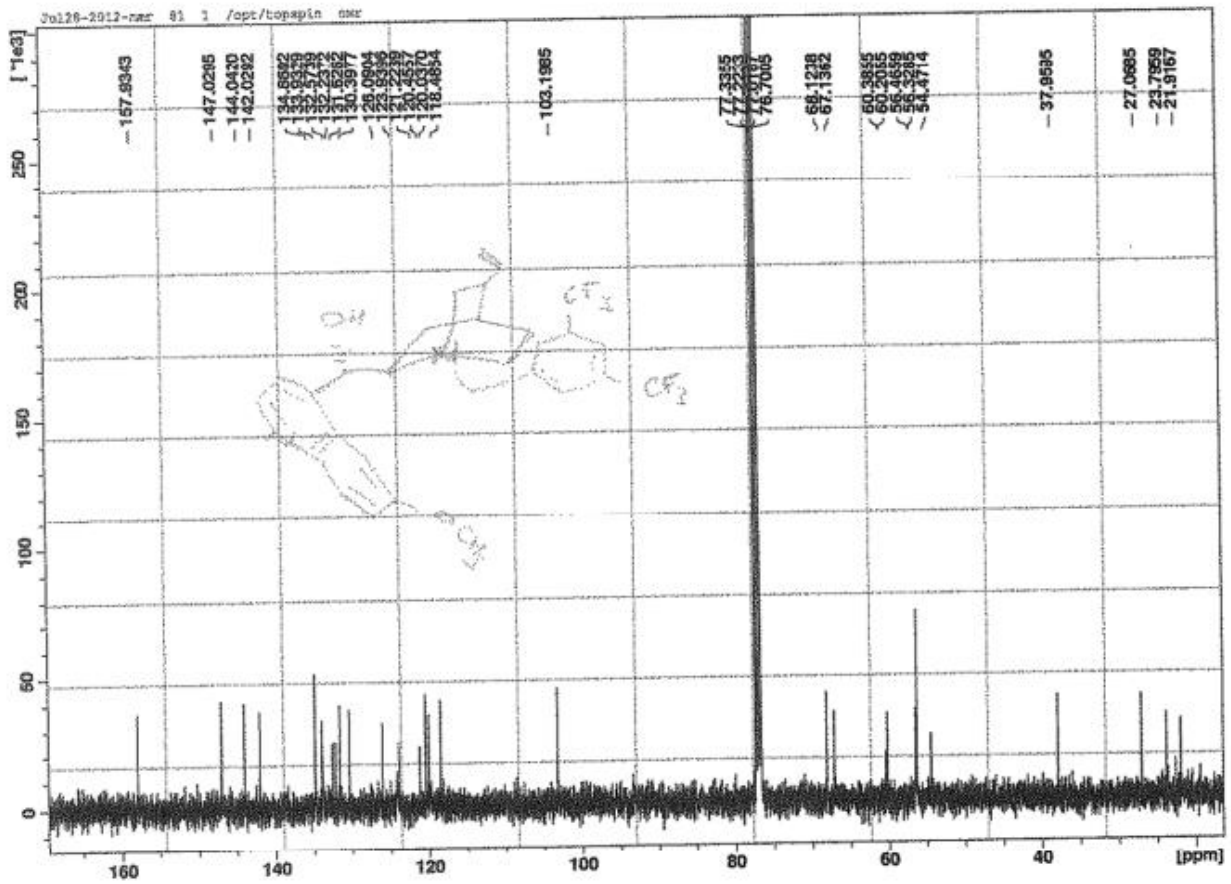
Catalyst **11c**



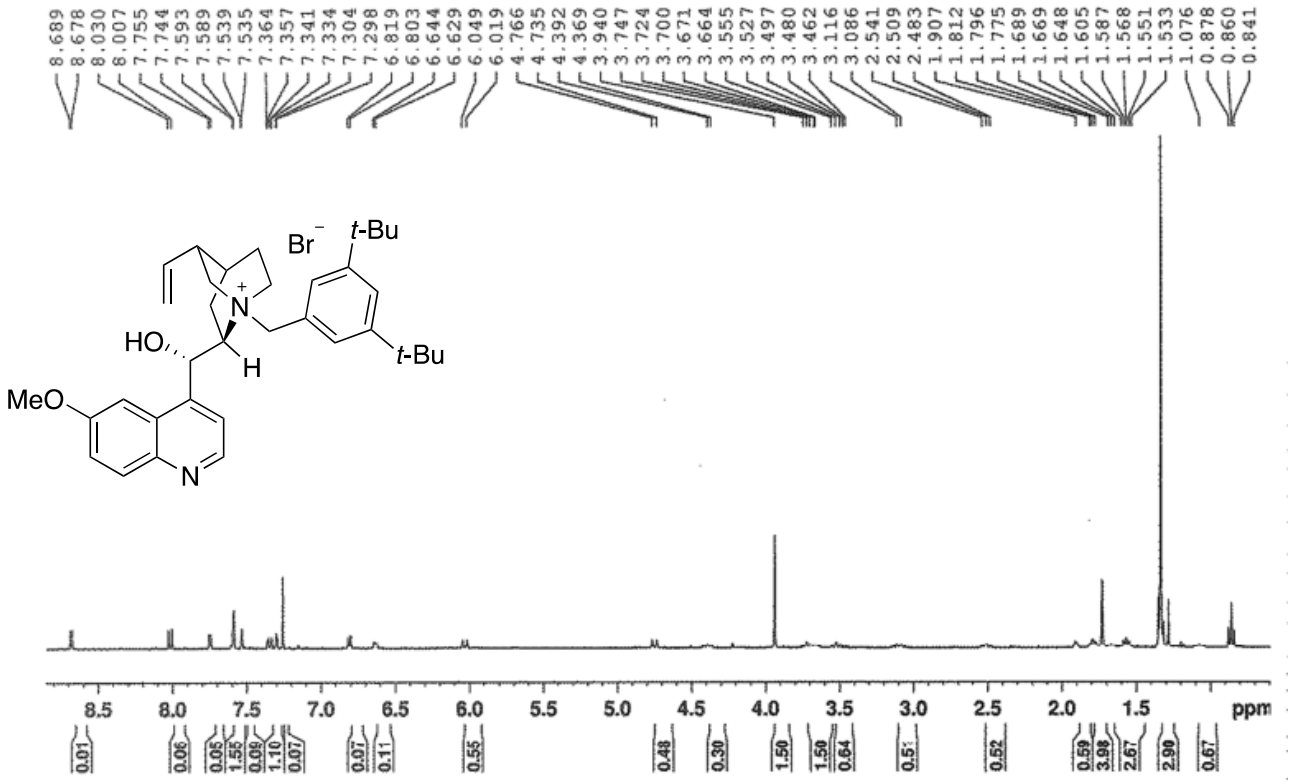


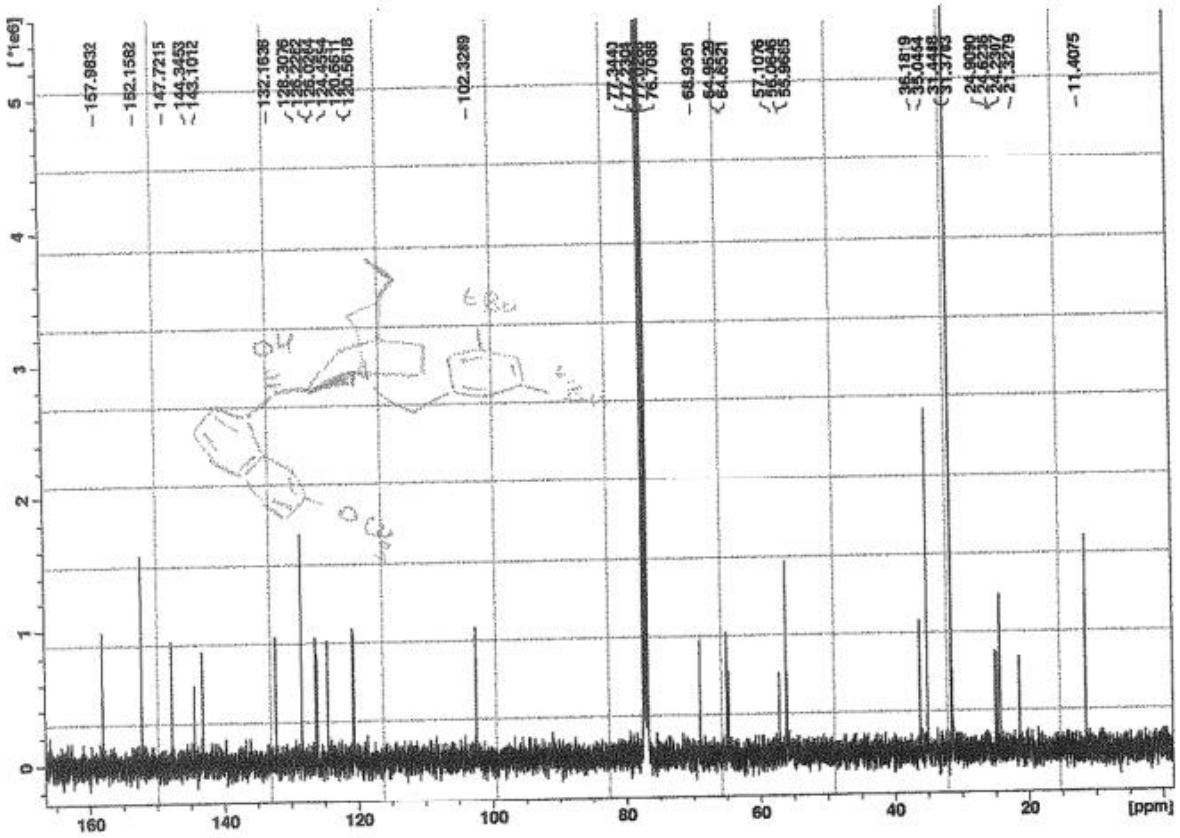
Catalyst **11d**



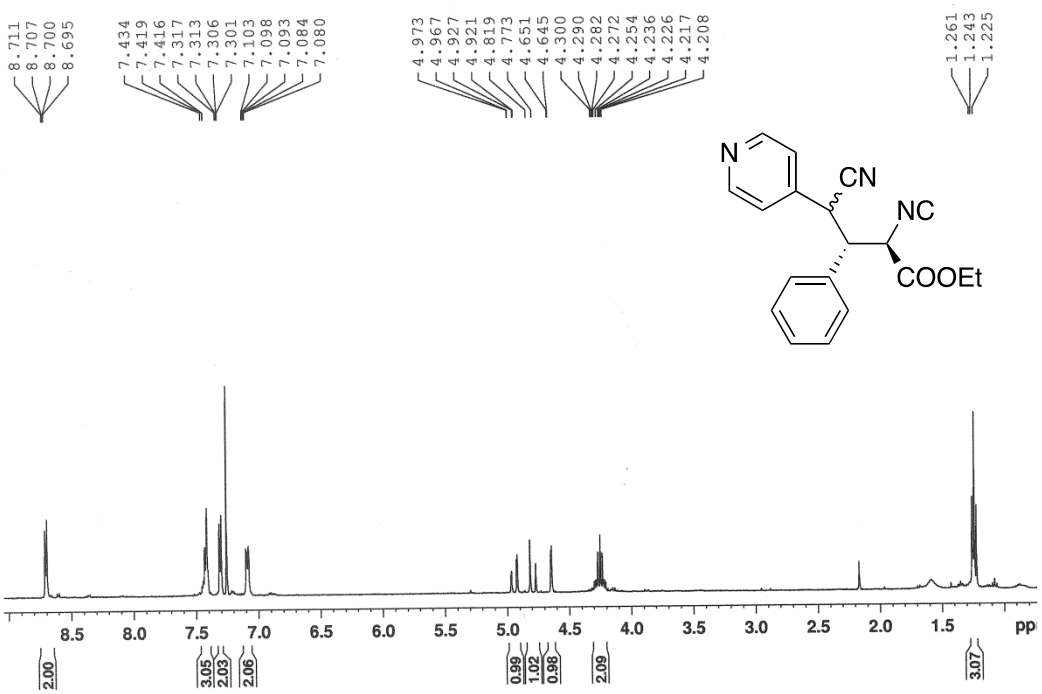


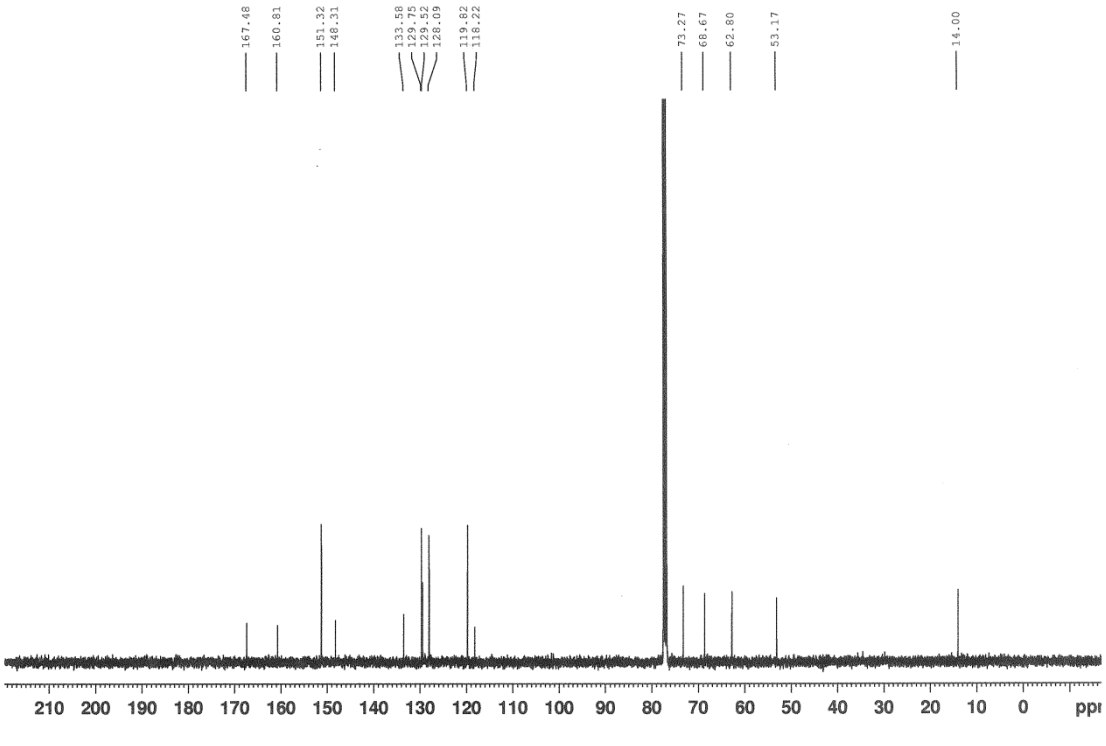
Catalyst **11e**



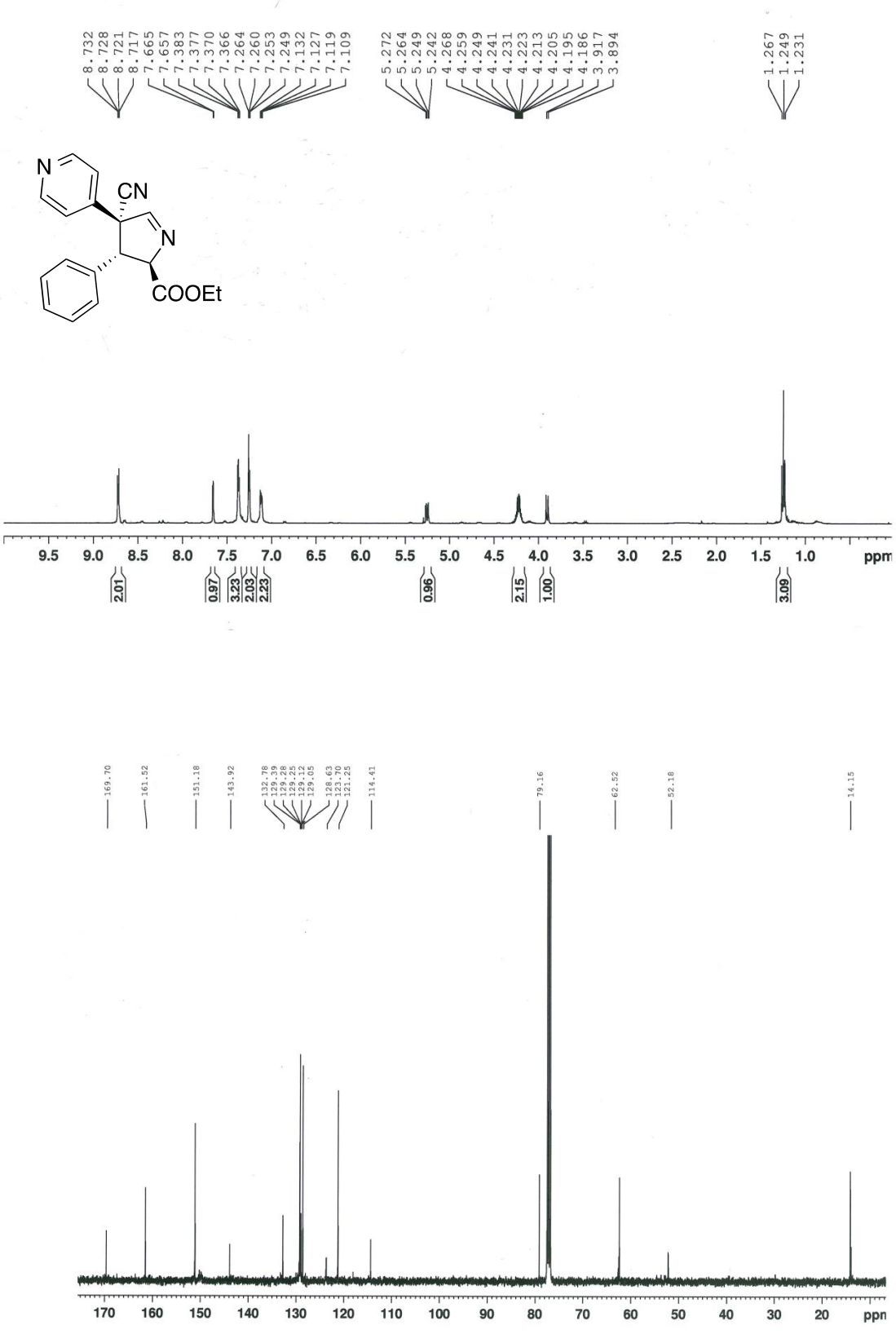


Compound **3a**

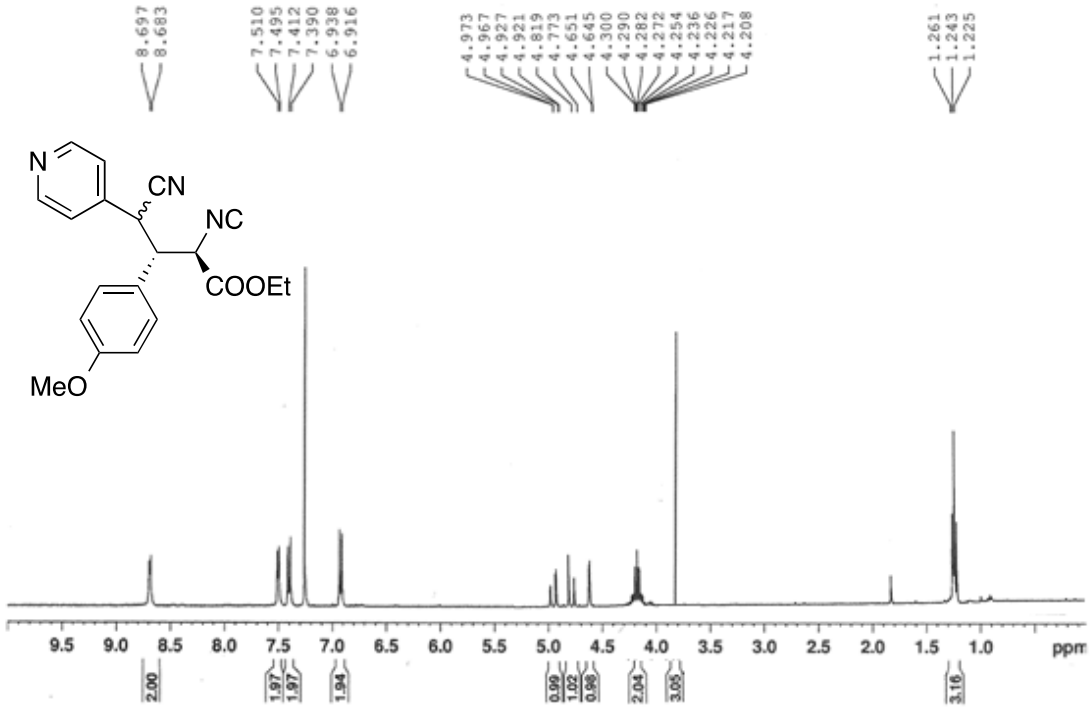

8.711
8.707
8.700
8.695
7.434
7.419
7.416
7.317
7.313
7.306
7.301
7.103
7.098
7.093
7.084
7.080
4.973
4.967
4.927
4.921
4.819
4.773
4.651
4.645
4.300
4.290
4.282
4.272
4.254
4.236
4.226
4.217
4.208
1.261
1.243
1.225
N
CN
NC
COOEt
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
2.00
3.05
2.03
2.06
0.99
1.02
0.98
2.09
3.07

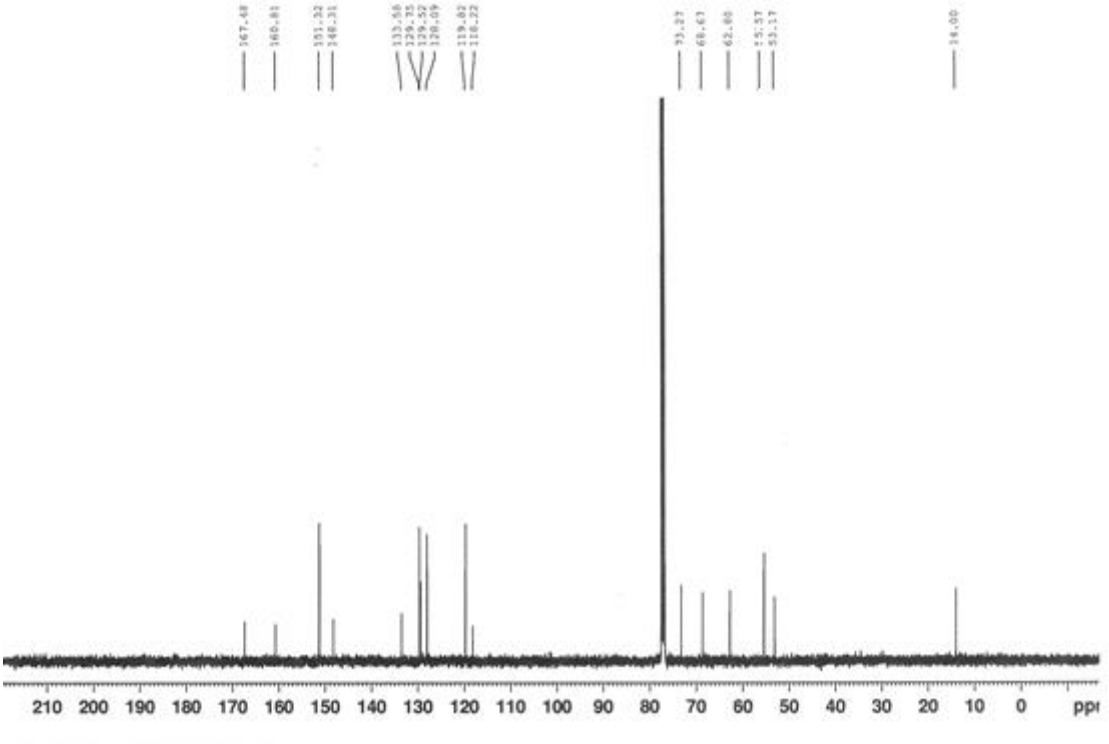

167.48
160.81
151.32
148.31
133.58
129.75
129.52
128.09
119.82
118.22
73.27
68.67
62.80
53.17
14.00
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Compound **4a**

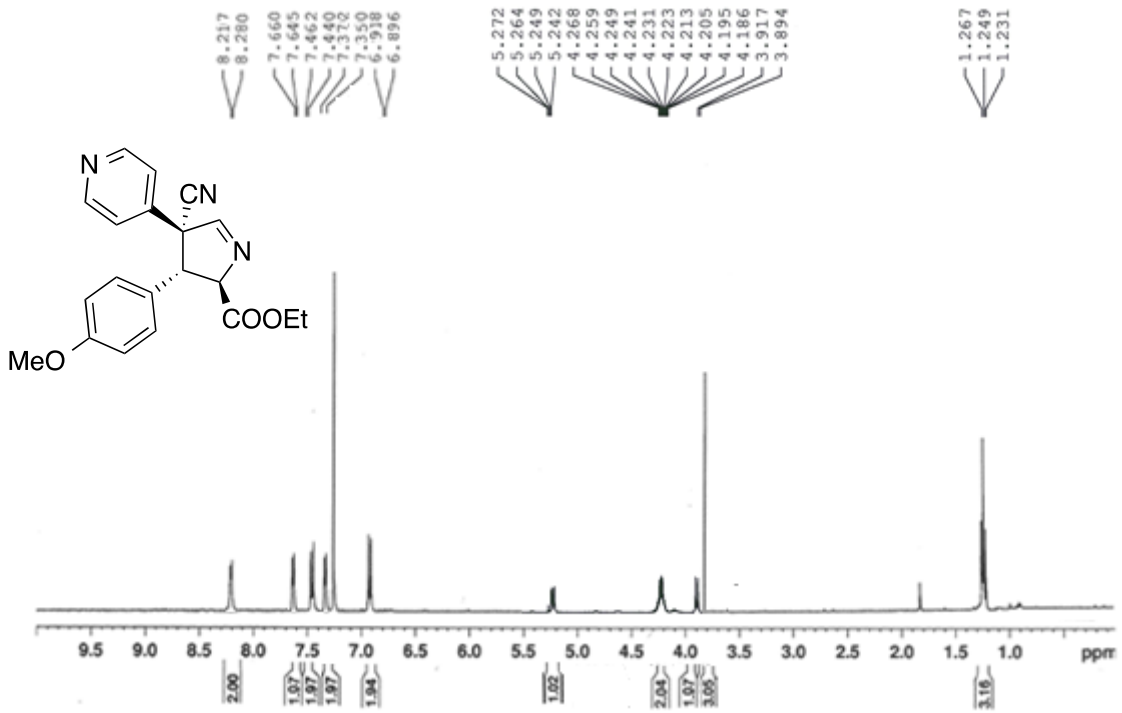

8.732
8.728
8.721
8.717
7.665
7.657
7.383
7.377
7.370
7.366
7.264
7.260
7.253
7.249
7.132
7.127
7.119
7.109
5.272
5.264
5.249
5.242
4.268
4.259
4.249
4.241
4.231
4.223
4.213
4.205
4.195
4.186
3.917
3.894
1.267
1.249
1.231
N
CN
N
COOEt
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.01
0.97
3.23
2.03
2.23
0.96
2.15
1.00
3.09
169.70
161.52
151.18
143.92
132.78
129.39
129.28
129.25
129.12
129.05
128.63
123.70
121.25
114.41
79.16
62.52
52.18
14.15
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

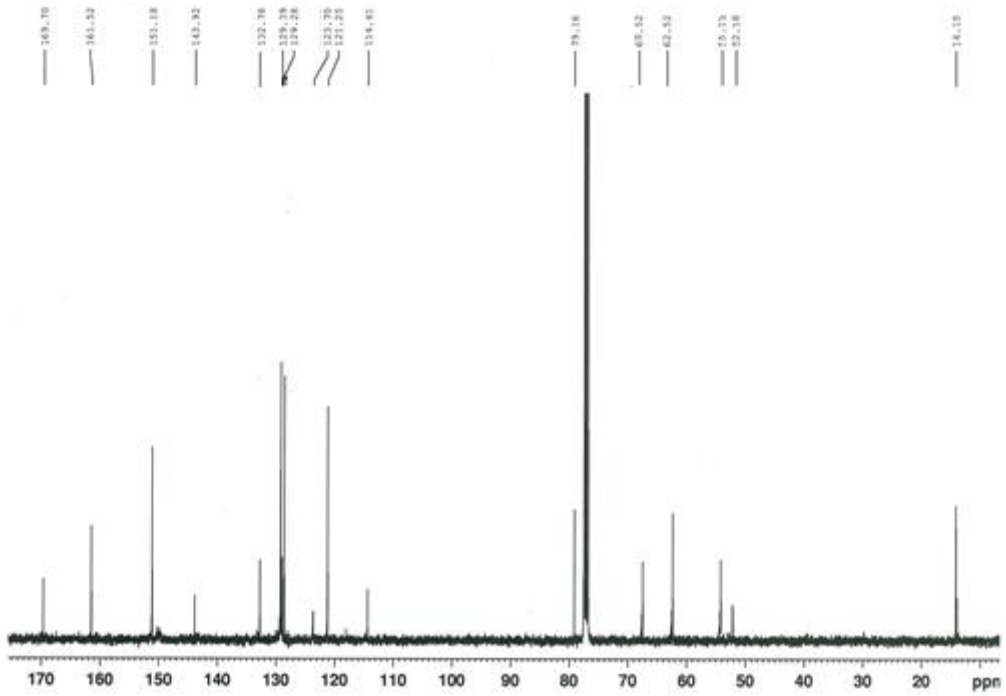
Compound **3b**


8.697
8.683
7.510
7.495
7.412
7.390
6.938
6.916
4.973
4.967
4.927
4.921
4.819
4.773
4.651
4.645
4.300
4.290
4.282
4.272
4.254
4.236
4.226
4.217
4.208
1.261
1.243
1.225
N
CN
NC
COOEt
MeO
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
2.00
1.97
1.97
1.94
0.99
1.02
0.98
2.04
3.05
3.16

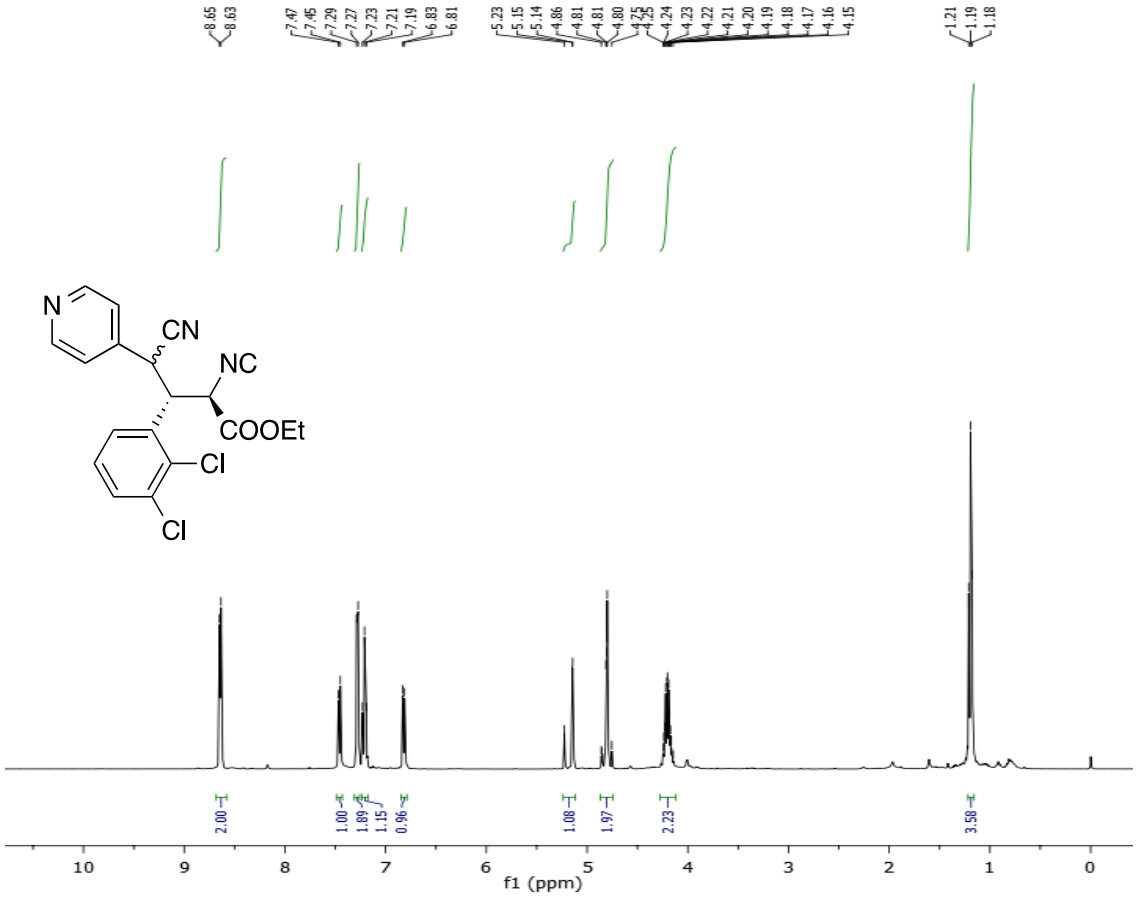

167.48
160.81
151.32
146.31
133.56
129.75
129.22
126.09
119.82
116.22
93.27
68.61
62.80
55.37
53.17
14.00
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

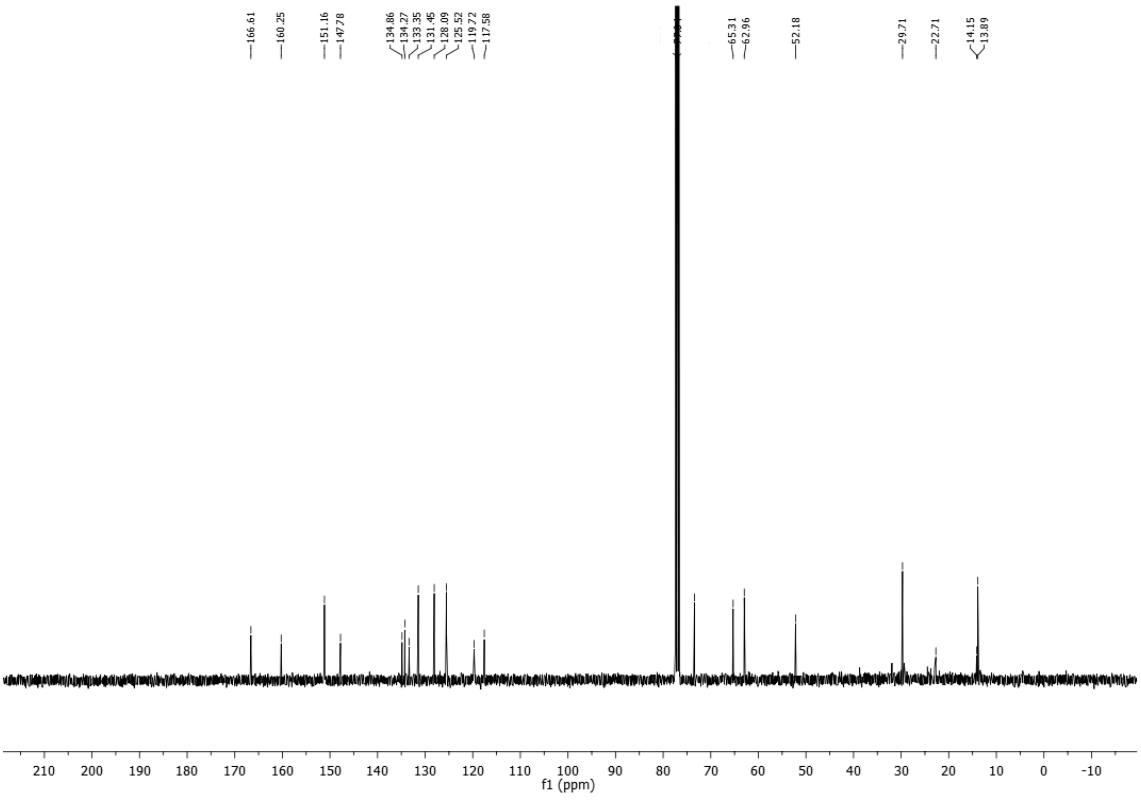
Compound **4b**


8.217
8.280
7.660
7.645
7.462
7.440
7.372
7.350
6.918
6.896
5.272
5.264
5.249
5.242
4.268
4.259
4.249
4.241
4.231
4.223
4.213
4.205
4.195
4.186
3.917
3.894
1.267
1.249
1.231
N
CN
N
COOEt
MeO
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
2.00
1.07
1.97
1.97
1.94
1.02
2.04
1.07
3.05
3.16

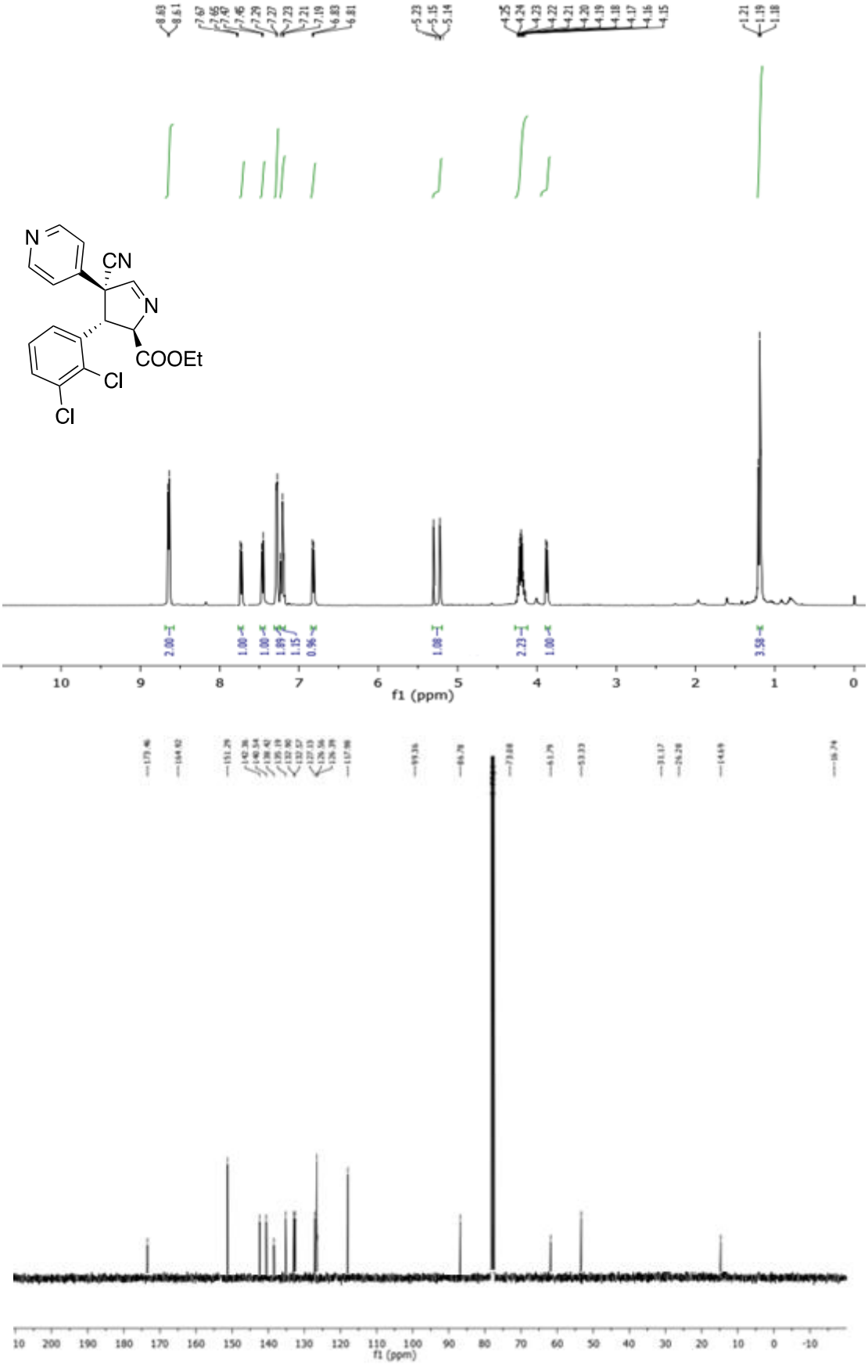

170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20

Compound **3c**

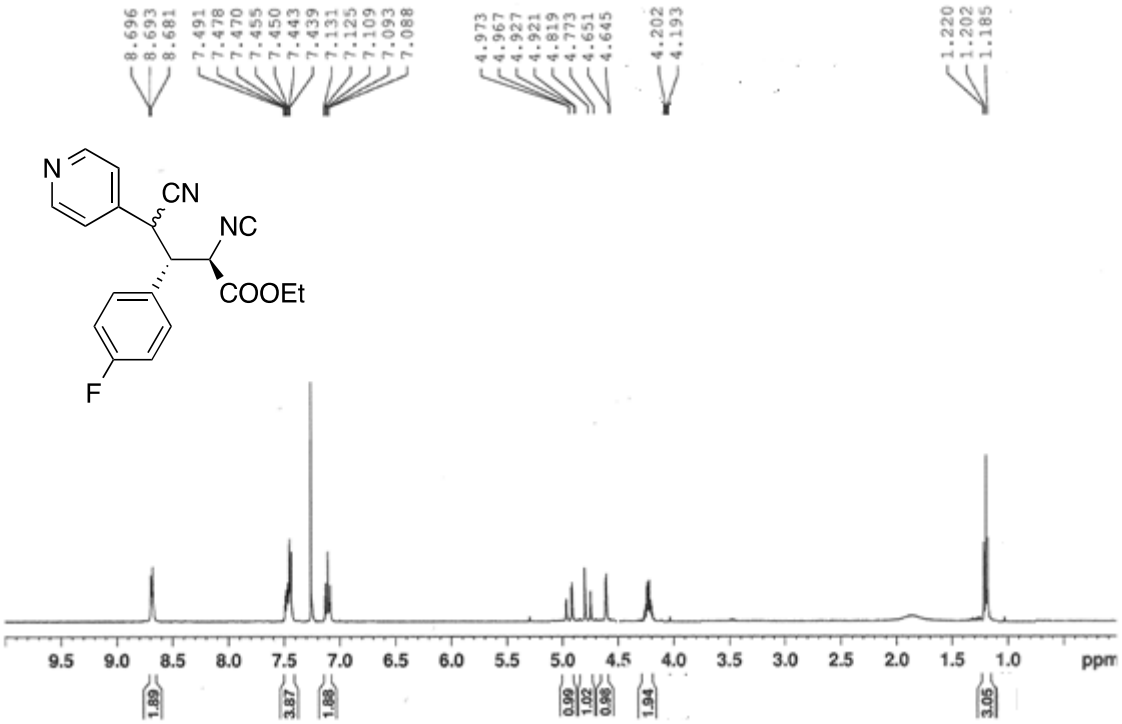

8.65
8.63
7.47
7.45
7.29
7.27
7.23
7.21
7.19
6.83
6.81
5.23
5.15
5.14
4.86
4.81
4.81
4.80
4.25
4.24
4.23
4.22
4.21
4.20
4.19
4.18
4.17
4.16
4.15
1.21
1.19
1.18
N
CN
NC
COOEt
Cl
Cl
2.00
1.00
1.89
1.15
0.96
1.08
1.97
2.23
3.58
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)

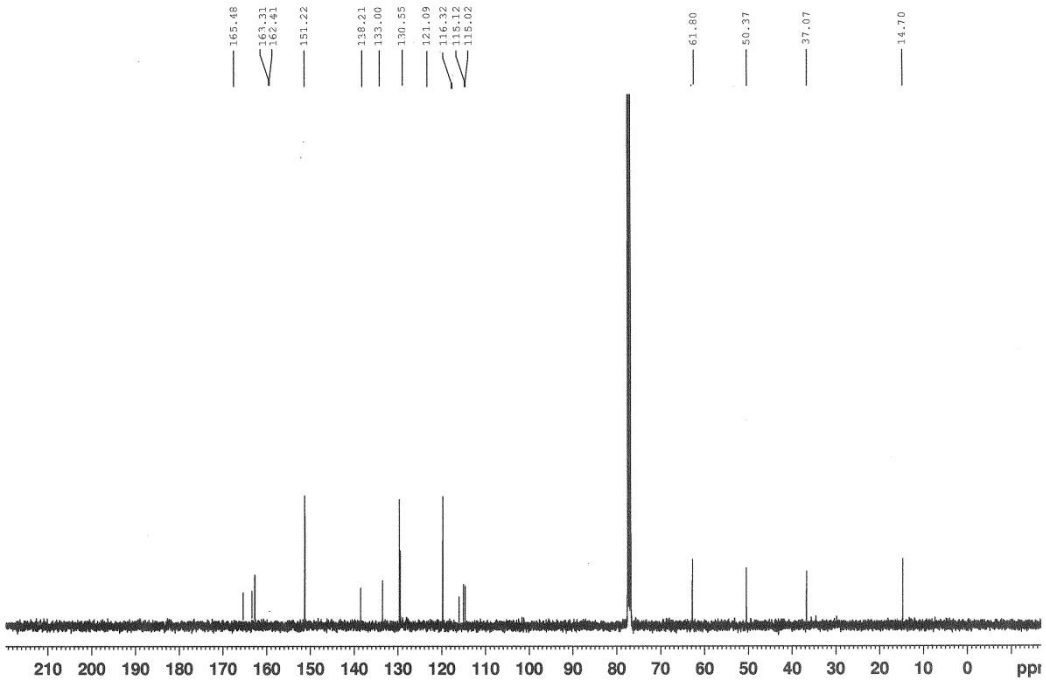

166.61
160.25
151.16
147.78
134.86
134.27
133.35
131.45
128.09
125.52
119.72
117.58
65.31
62.96
52.18
29.71
22.71
14.15
13.89
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

Compound **4c**

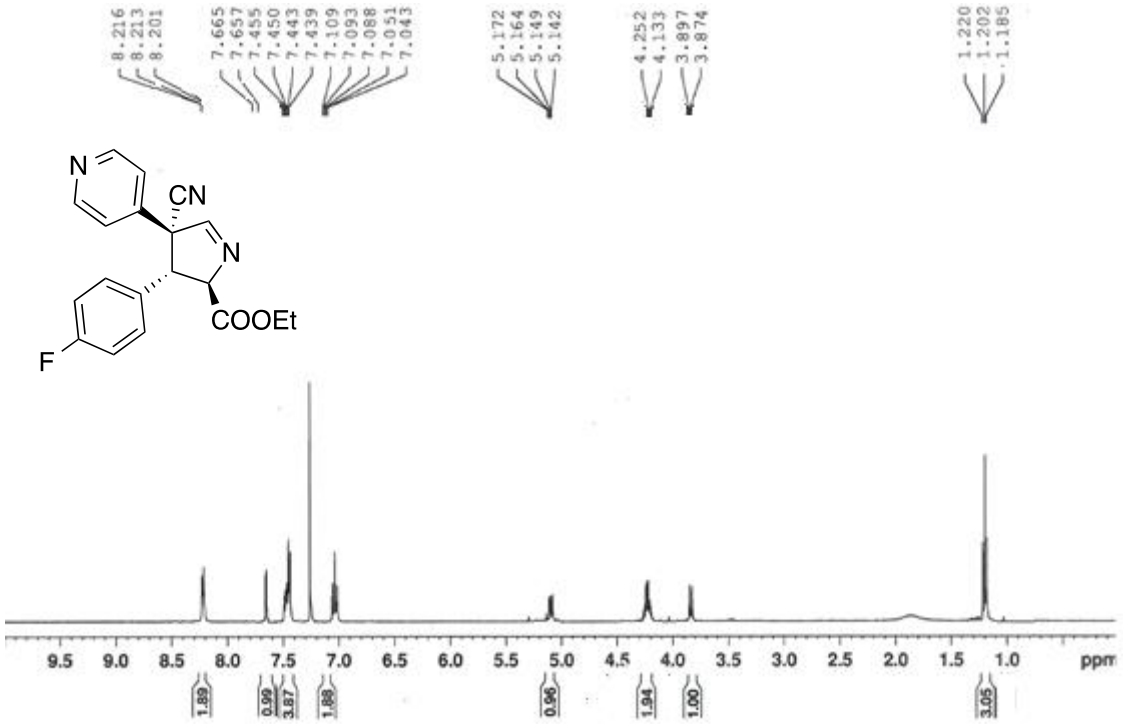


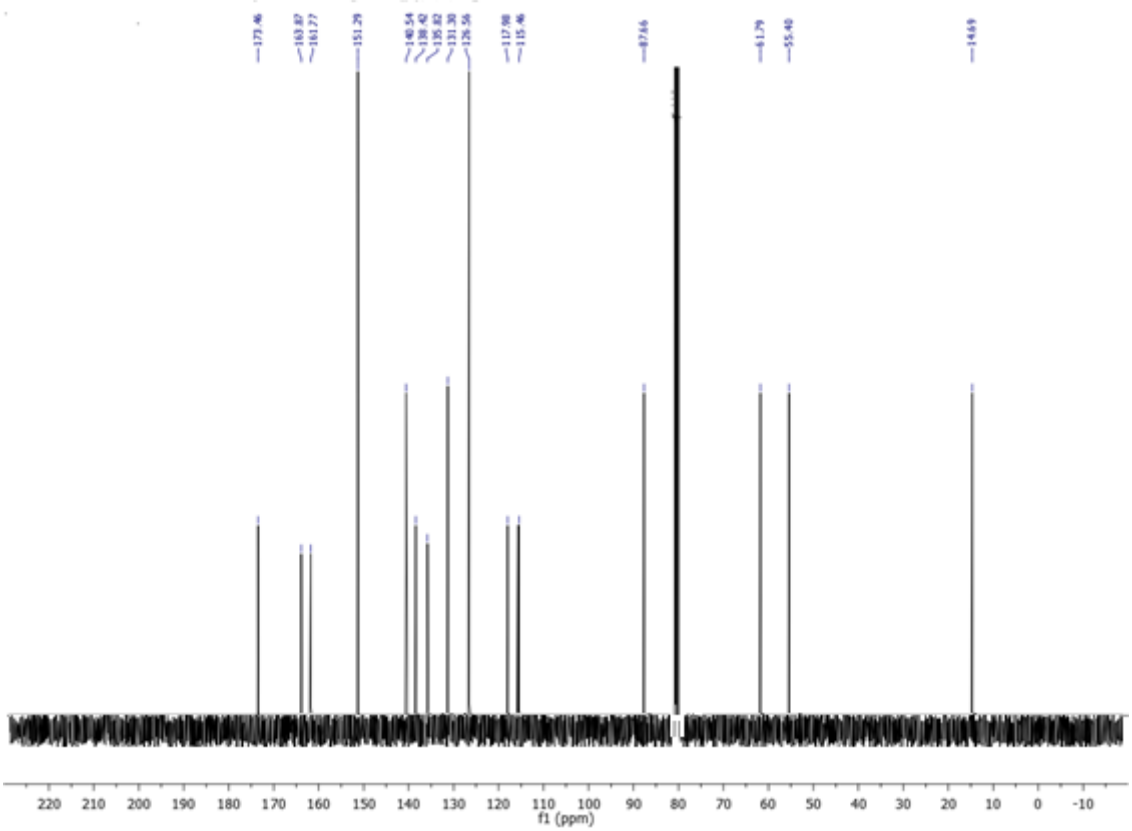
Compound **3d**


8.696
8.693
8.681
7.491
7.478
7.470
7.455
7.450
7.443
7.439
7.131
7.125
7.109
7.093
7.088
4.973
4.967
4.927
4.921
4.819
4.773
4.651
4.645
4.202
4.193
1.220
1.202
1.185
N
CN
NC
COOEt
F
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
1.89
3.87
1.88
0.99
1.02
0.96
1.94
3.05

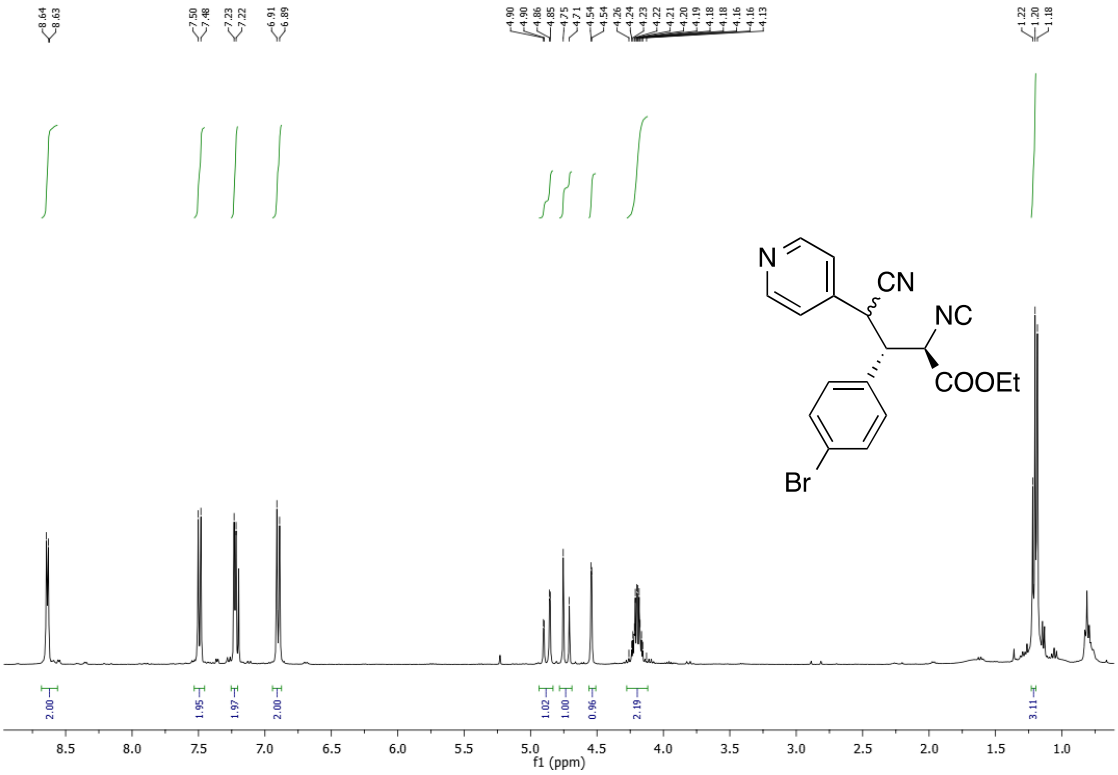

165.48
163.31
162.41
151.22
138.21
133.00
130.55
121.09
116.32
115.12
115.02
61.80
50.37
37.07
14.70
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

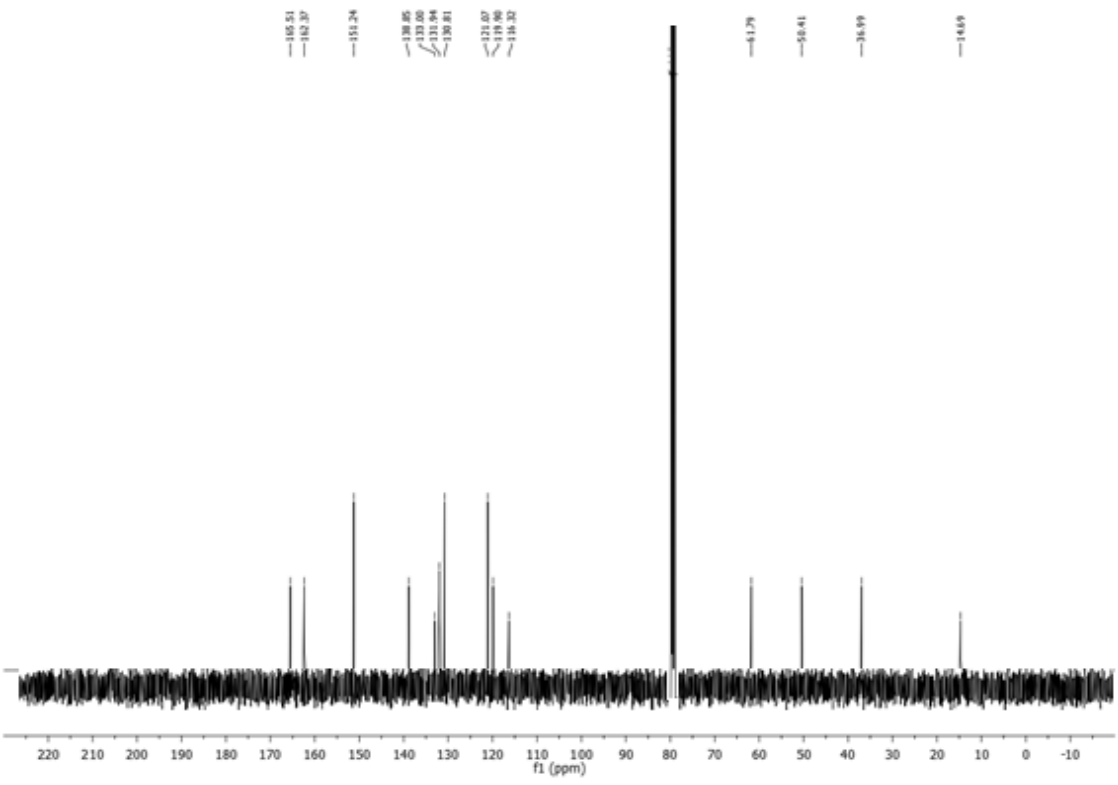
Compound **4d**


8.216
8.213
8.201
7.665
7.657
7.455
7.450
7.443
7.439
7.109
7.093
7.088
7.051
7.043
5.172
5.164
5.149
5.142
4.252
4.133
3.897
3.874
1.220
1.202
1.185
N
CN
N
COOEt
F
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
1.89
0.99
3.87
1.88
0.96
1.94
1.00
3.05

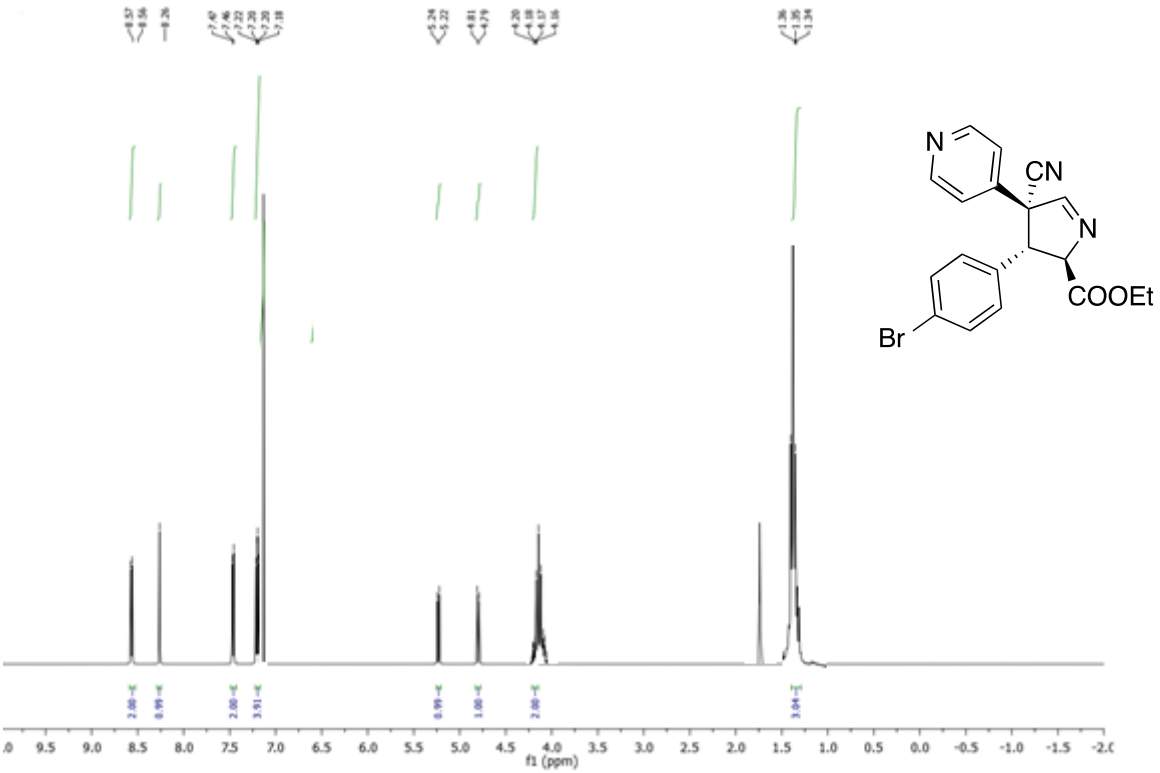

220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

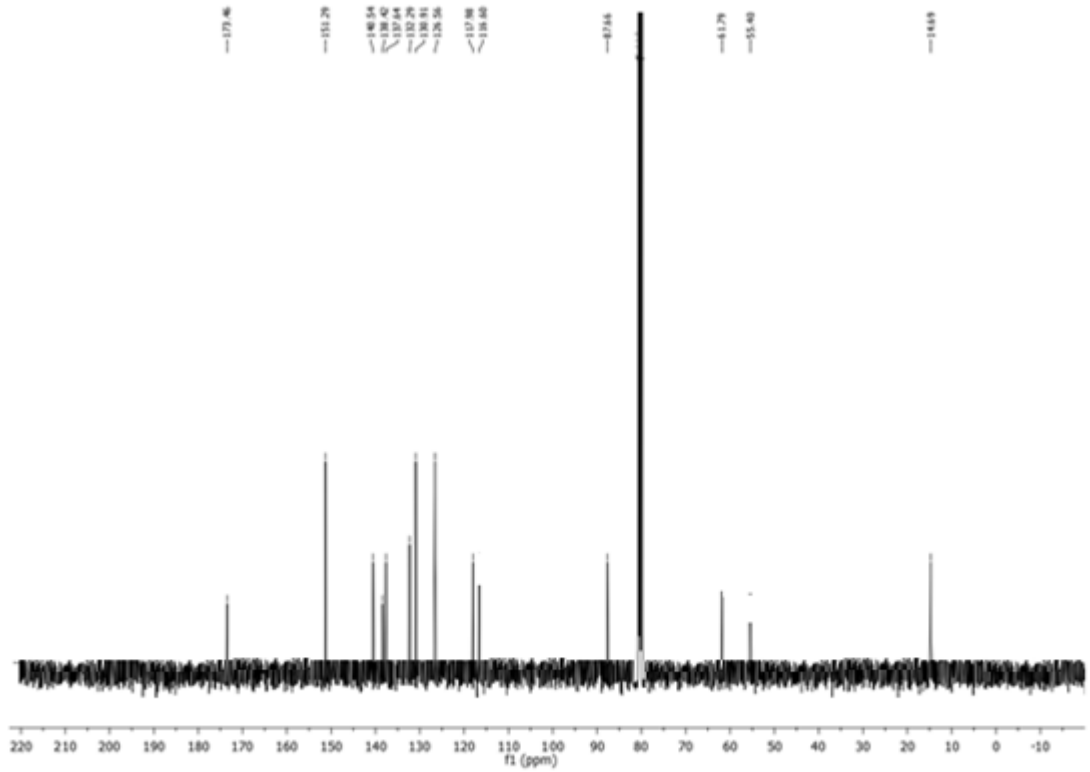
Compound **3e**



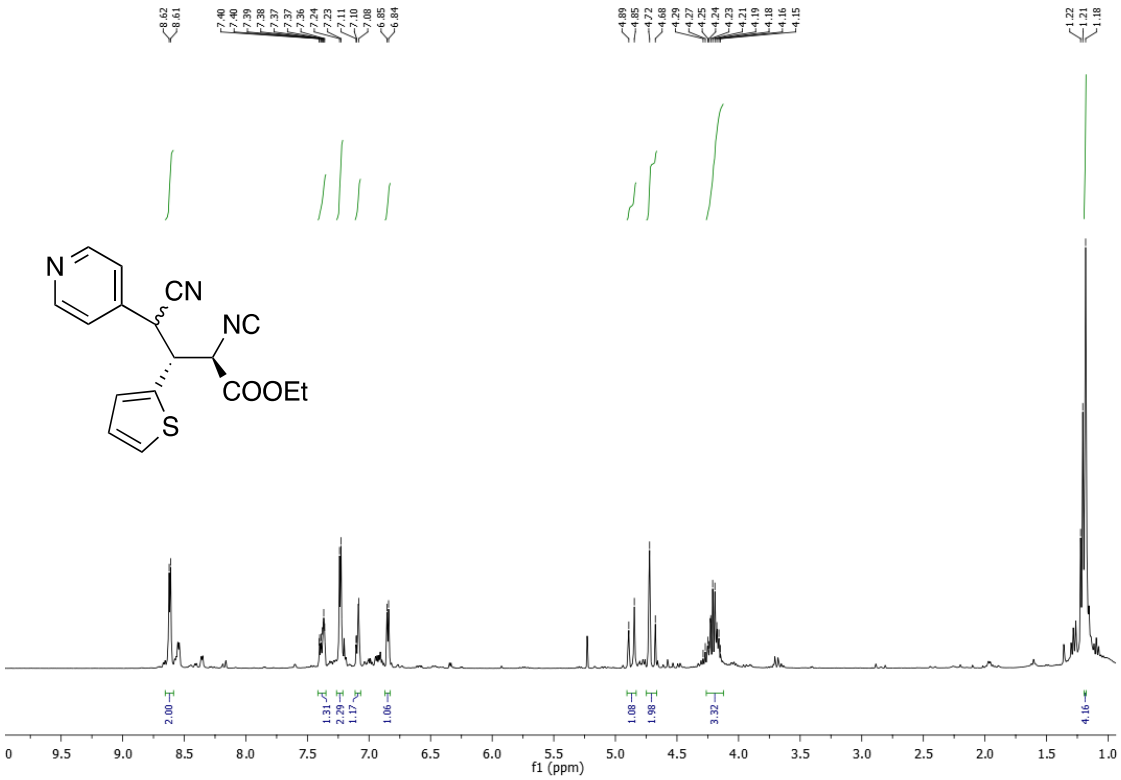


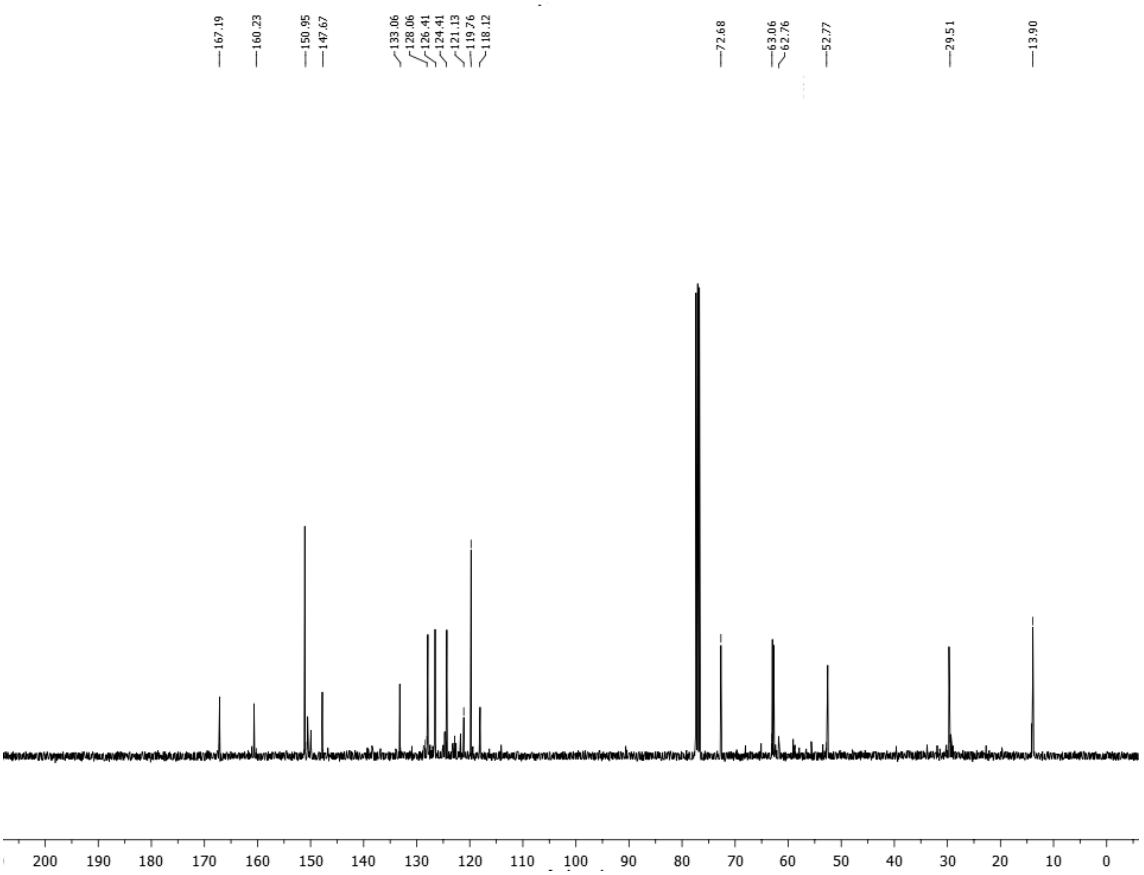
Compound **4e**



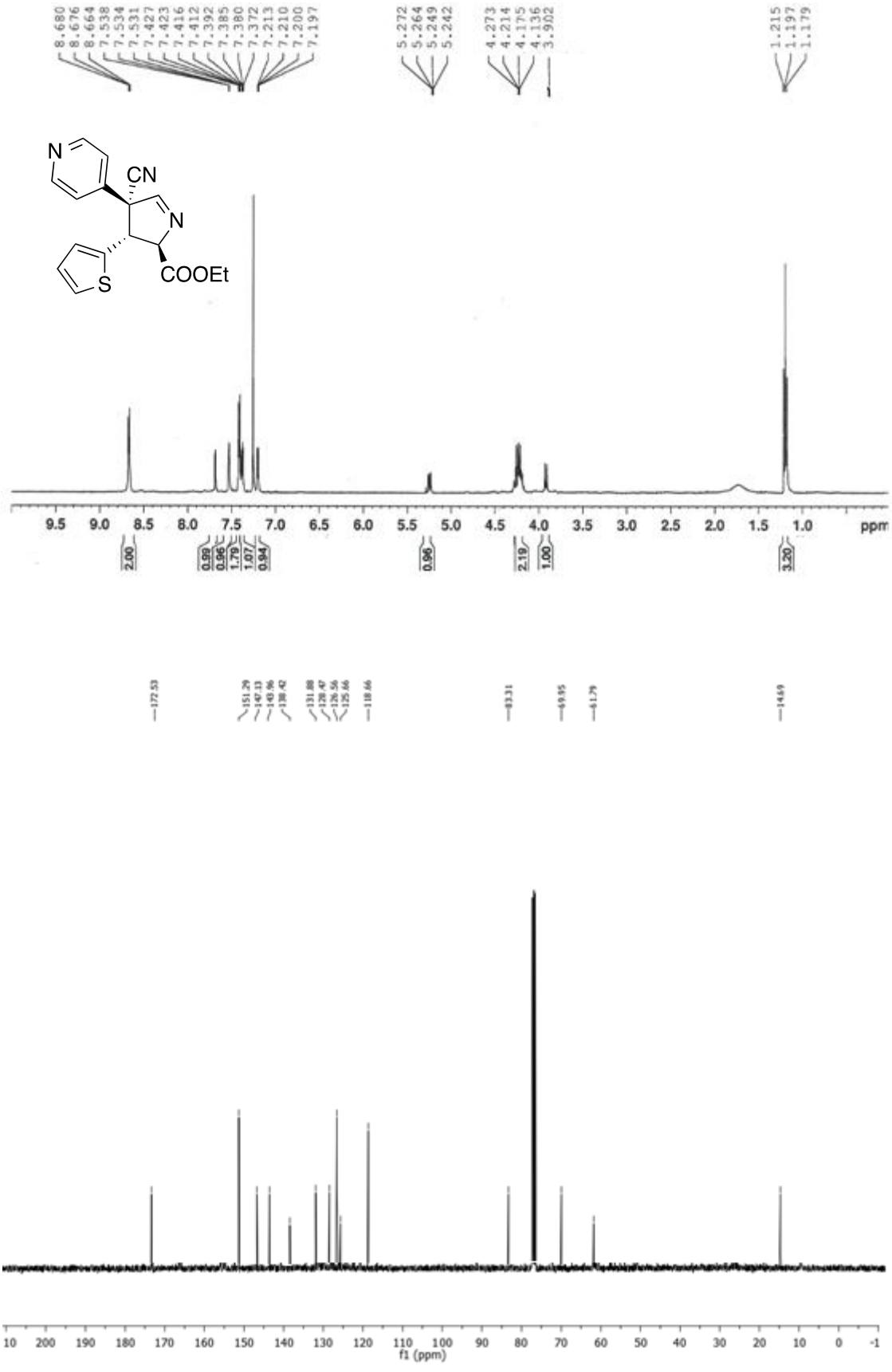


Compound **3f**

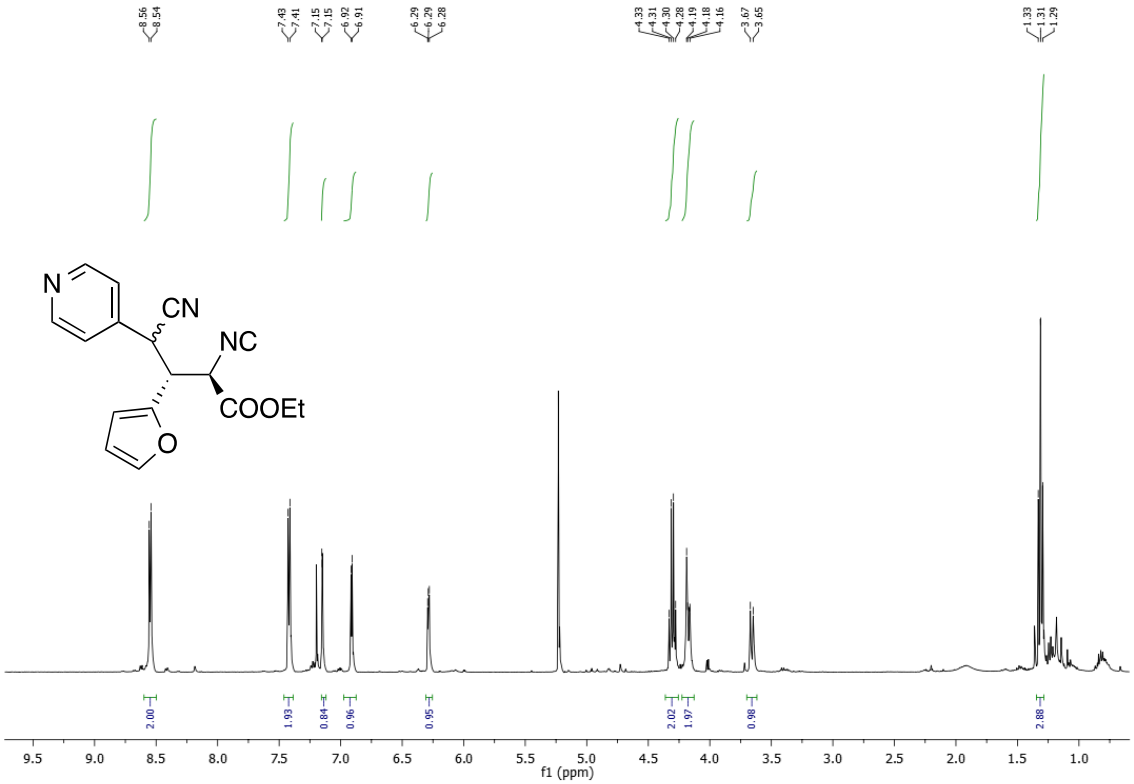

8.62
8.61
7.40
7.40
7.39
7.38
7.37
7.37
7.36
7.24
7.23
7.11
7.10
7.08
6.85
6.84
4.89
4.85
4.72
4.68
4.29
4.27
4.25
4.24
4.23
4.21
4.19
4.18
4.16
4.15
1.22
1.21
1.18
N
CN
NC
COOEt
S
2.00
1.31
2.29
1.17
1.06
1.08
1.98
3.32
4.16
f1 (ppm)

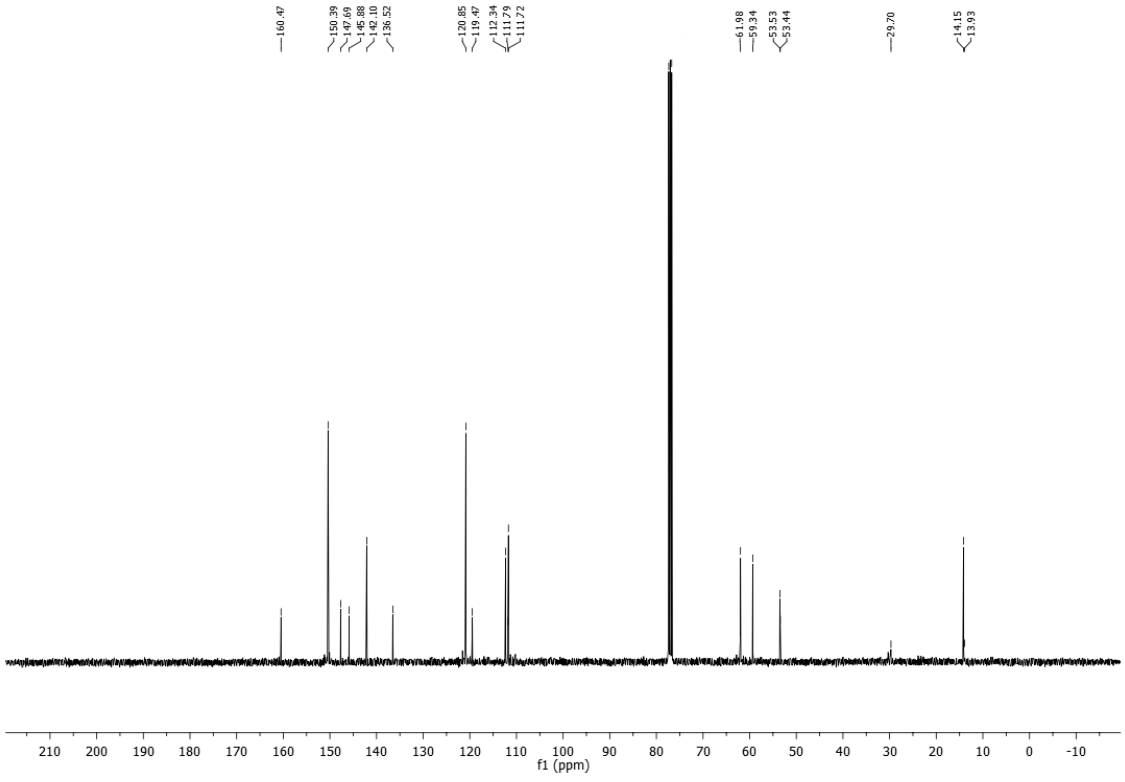

167.19
160.23
150.95
147.67
133.06
128.06
126.41
124.41
121.13
119.76
118.12
72.68
63.06
62.76
52.77
29.51
13.90

Compound **4f**

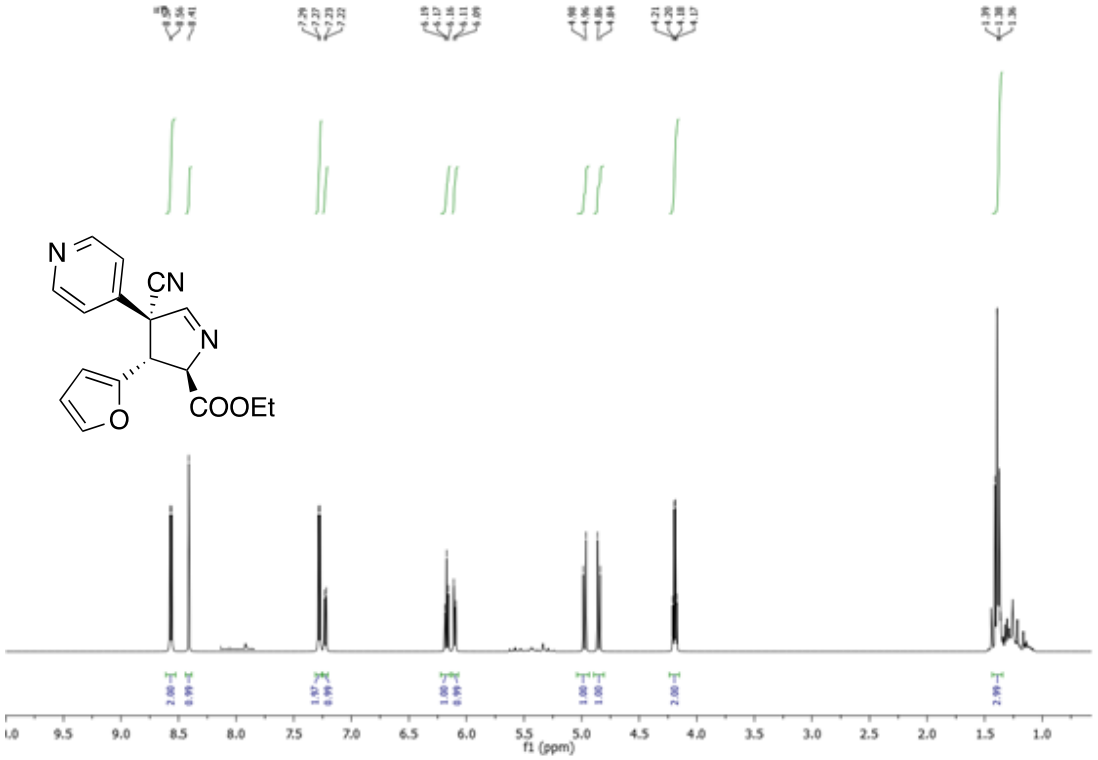

8.680
8.676
8.664
7.538
7.534
7.531
7.427
7.423
7.416
7.412
7.392
7.385
7.380
7.372
7.213
7.210
7.200
7.197
5.272
5.264
5.249
5.242
4.273
4.214
4.175
4.136
3.902
1.215
1.197
1.179
N
CN
N
S
COOEt
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
0.99
0.96
1.79
1.07
0.94
0.96
2.19
1.00
3.20
172.53
151.29
147.13
140.96
138.42
131.88
128.47
126.56
125.66
118.66
83.31
69.95
61.79
14.69
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

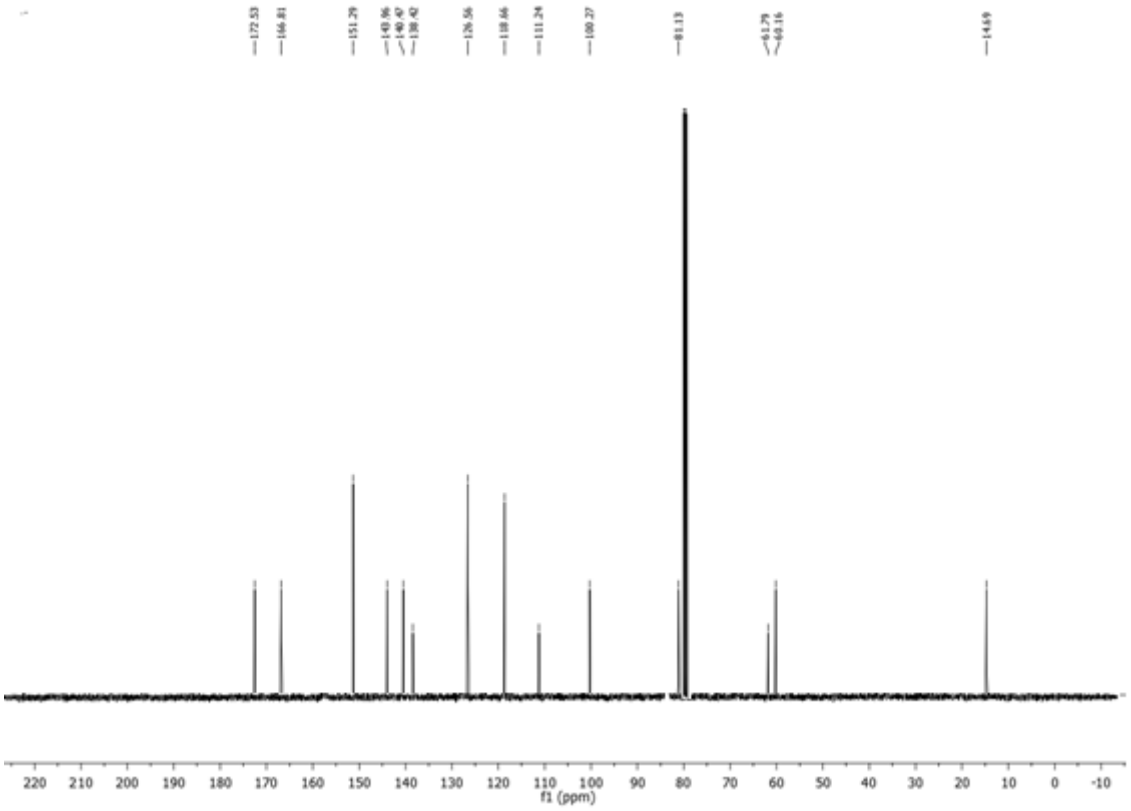
Compound **3g**


8.56
8.54
7.43
7.41
7.15
7.15
6.92
6.91
6.29
6.29
6.28
4.33
4.31
4.30
4.28
4.19
4.18
4.16
3.67
3.65
1.33
1.31
1.29
N
CN
NC
COOEt
O
2.00
1.93
0.84
0.96
0.95
2.02
1.97
0.98
2.88
f1 (ppm)

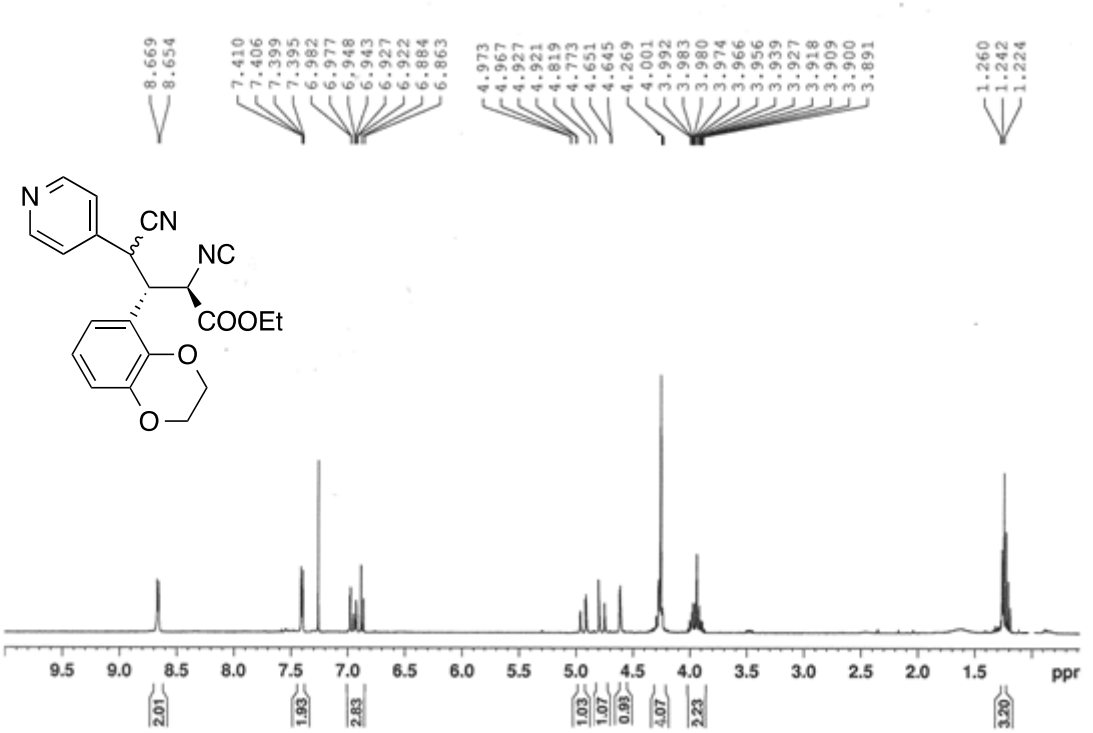

160.47
150.39
147.69
145.88
142.10
136.52
120.85
119.47
112.34
111.79
111.72
61.98
59.34
53.53
53.44
29.70
14.15
13.93
f1 (ppm)

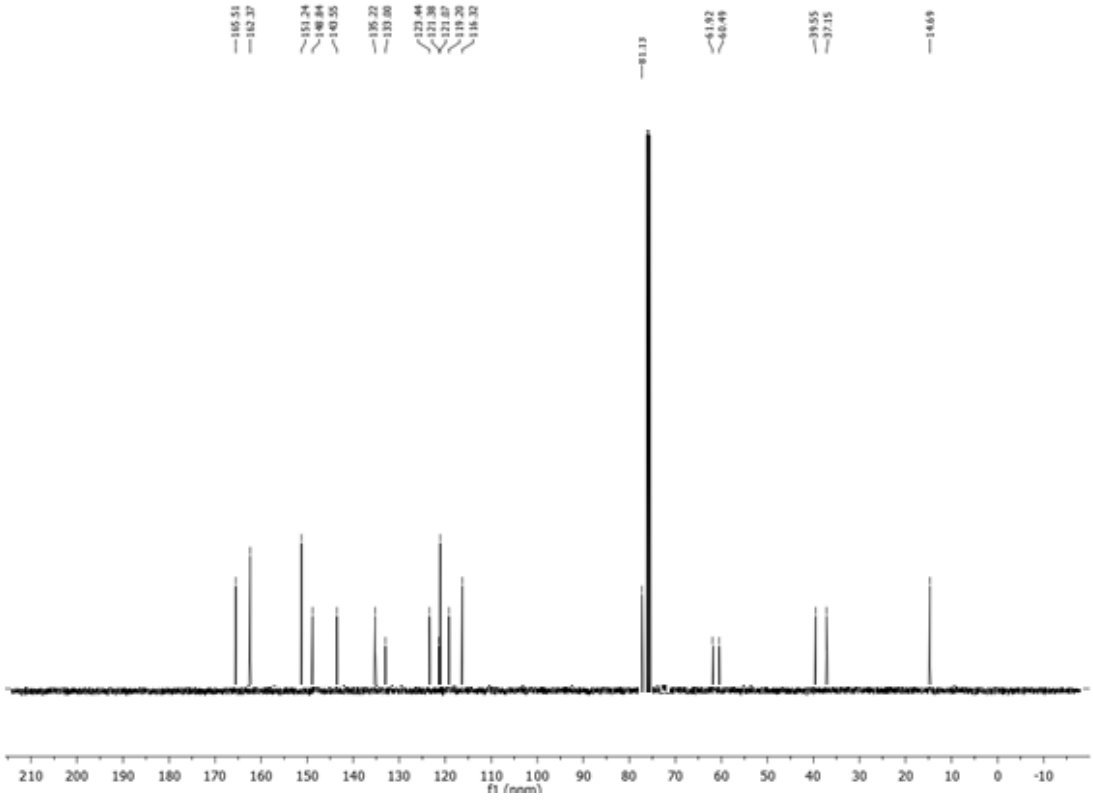
Compound **4g**



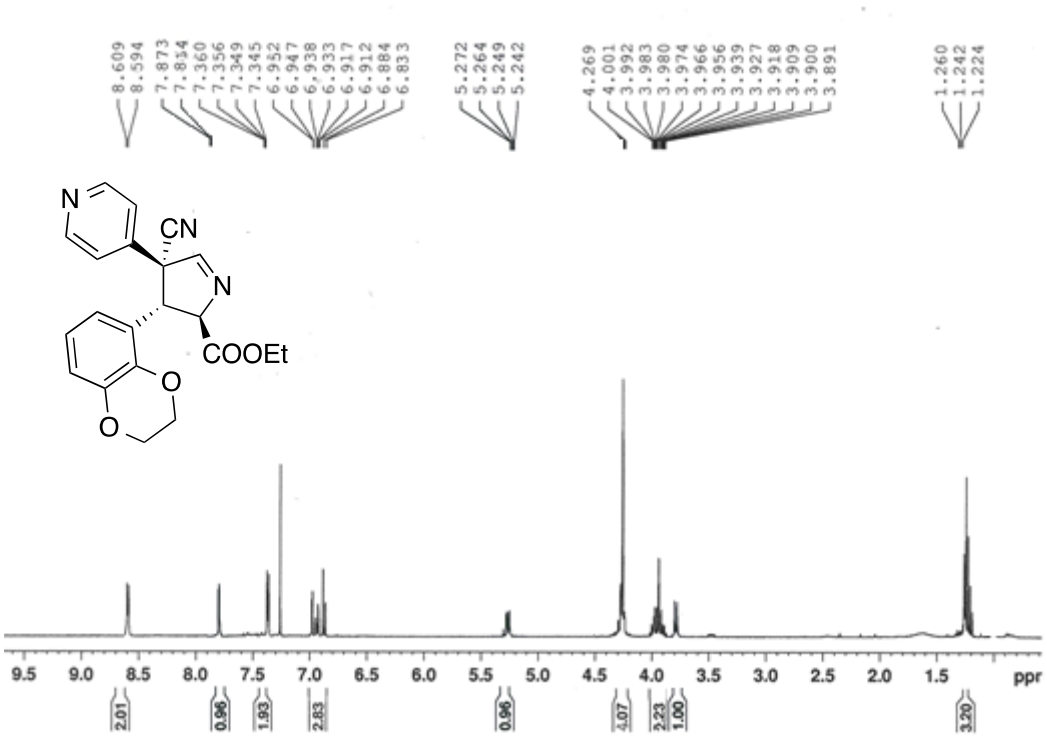


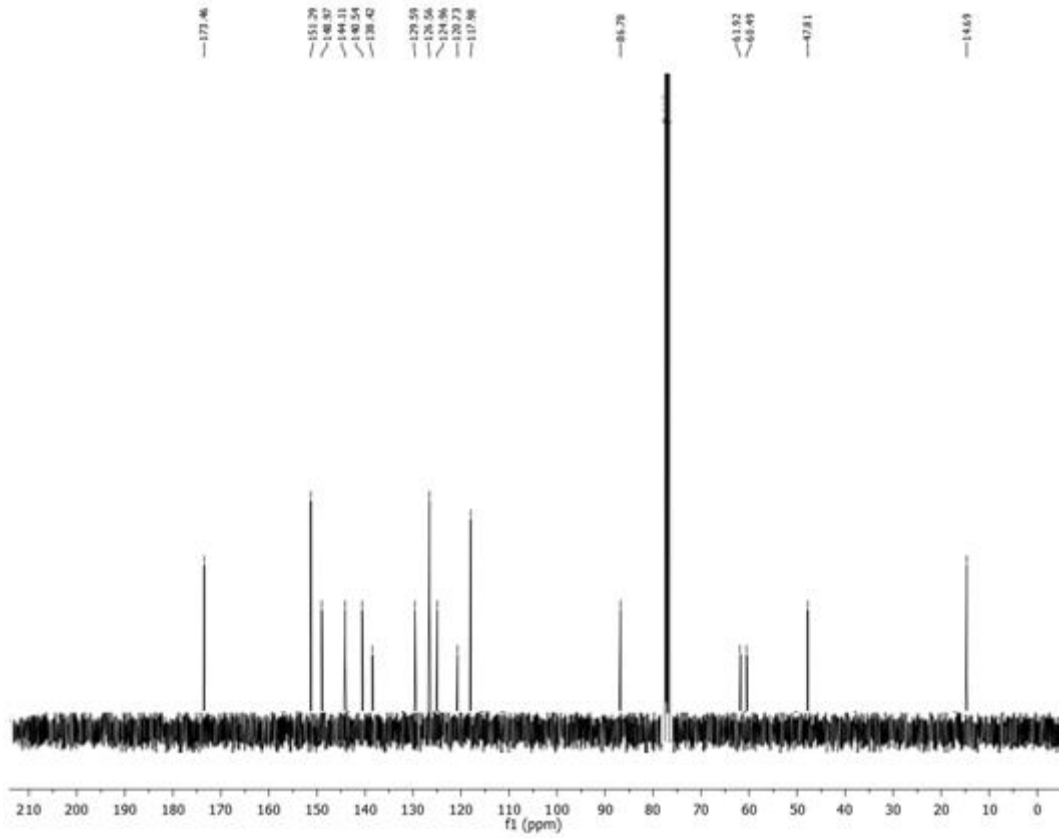
Compound **3h**


8.669
8.654
7.410
7.406
7.399
7.395
6.982
6.977
6.948
6.943
6.927
6.922
6.884
6.863
4.973
4.967
4.927
4.921
4.819
4.773
4.651
4.645
4.269
4.001
3.992
3.983
3.980
3.974
3.966
3.956
3.939
3.927
3.918
3.909
3.900
3.891
1.260
1.242
1.224
N
CN
NC
COOEt
O
O
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 ppr
2.01
1.93
2.83
1.03
1.07
0.99
4.07
2.23
3.20

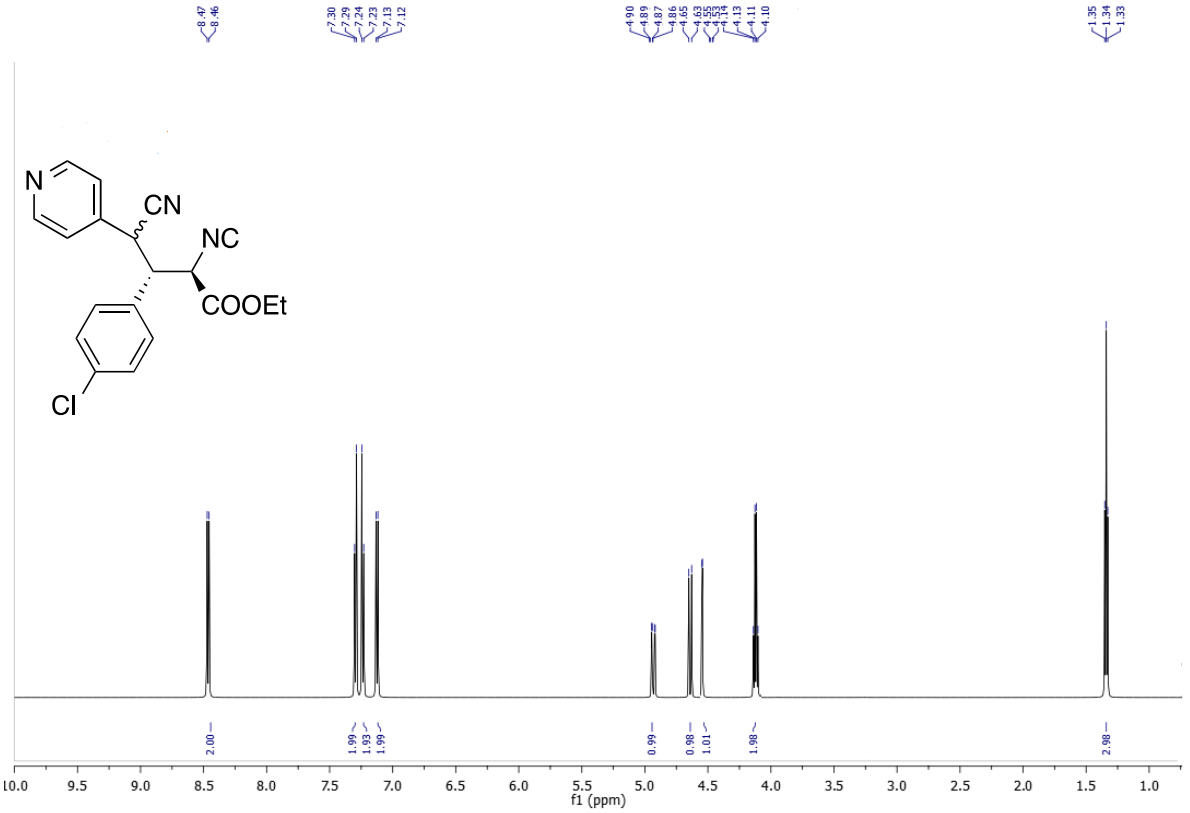

165.51
162.37
151.24
140.84
140.55
135.22
133.00
123.44
121.38
121.07
119.20
116.32
81.13
61.92
60.49
39.55
37.15
14.69
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

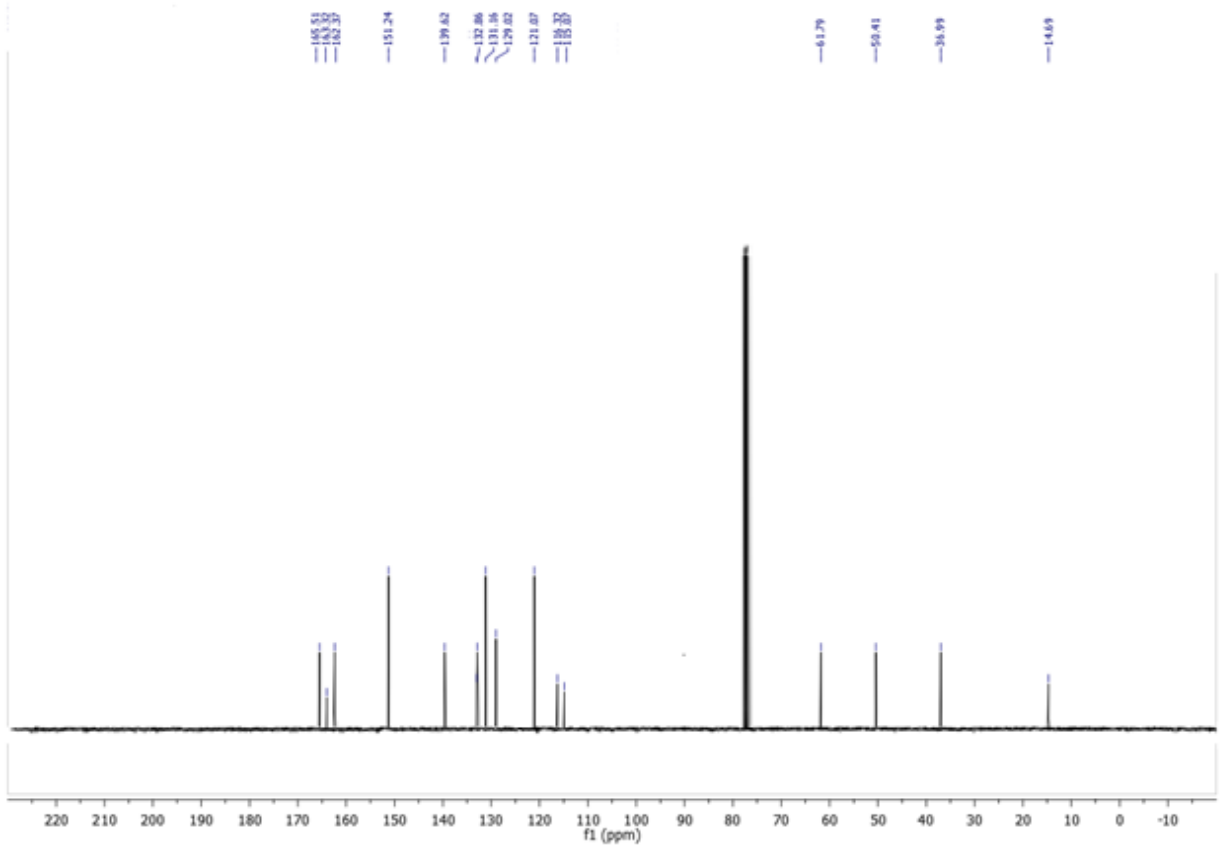
Compound **4h**


8.609
8.594
7.873
7.854
7.360
7.356
7.349
7.345
6.952
6.947
6.938
6.933
6.917
6.912
6.884
6.833
5.272
5.264
5.249
5.242
4.269
4.001
3.992
3.983
3.980
3.974
3.966
3.956
3.939
3.927
3.918
3.909
3.900
3.891
1.260
1.242
1.224
N
CN
N
COOEt
O
O
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 ppr
2.01
0.96
1.93
2.83
0.96
4.07
2.23
1.00
3.20

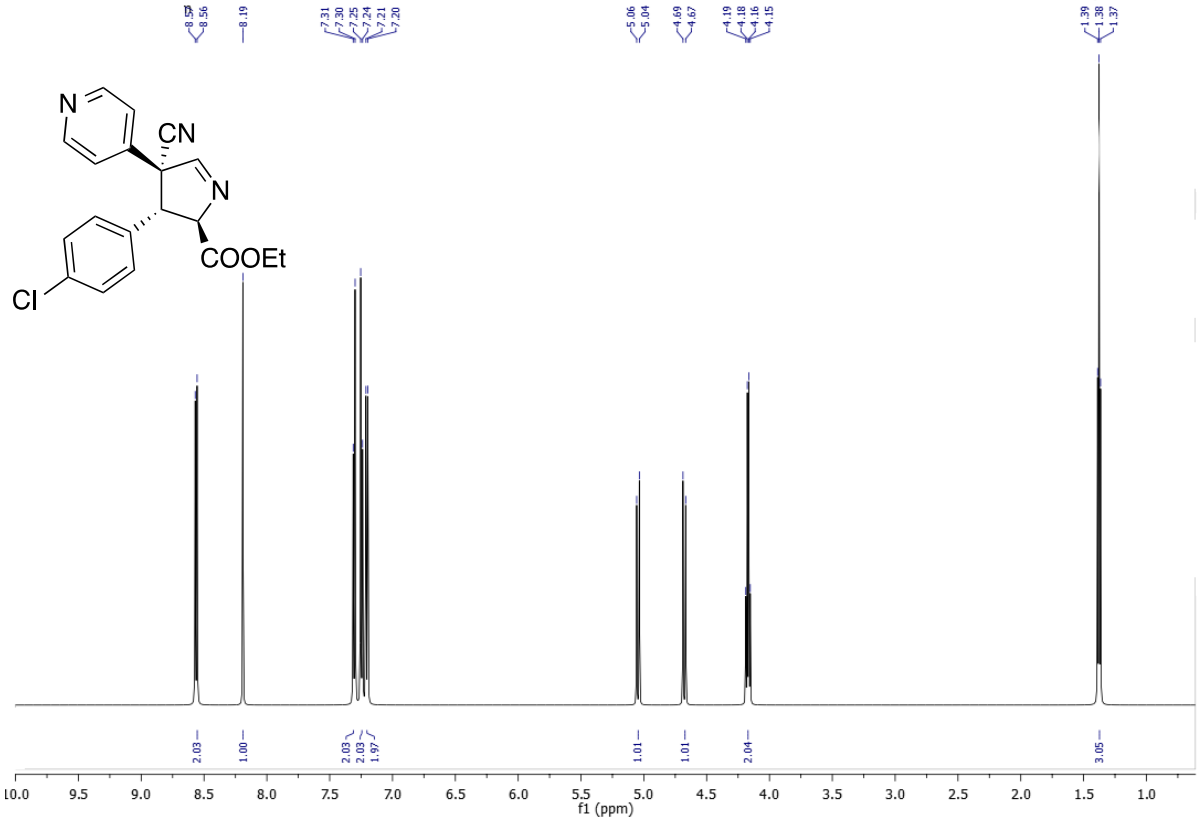

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

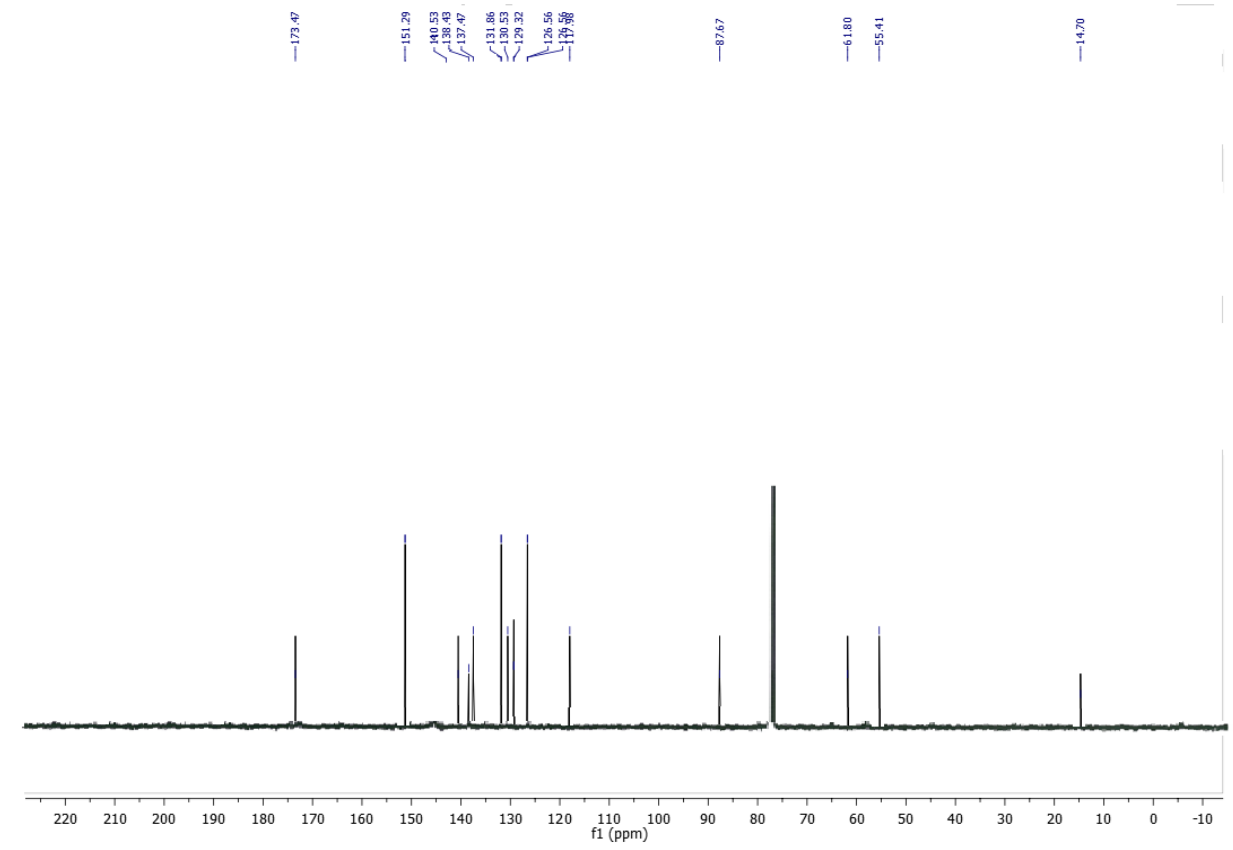
Compound **3i**



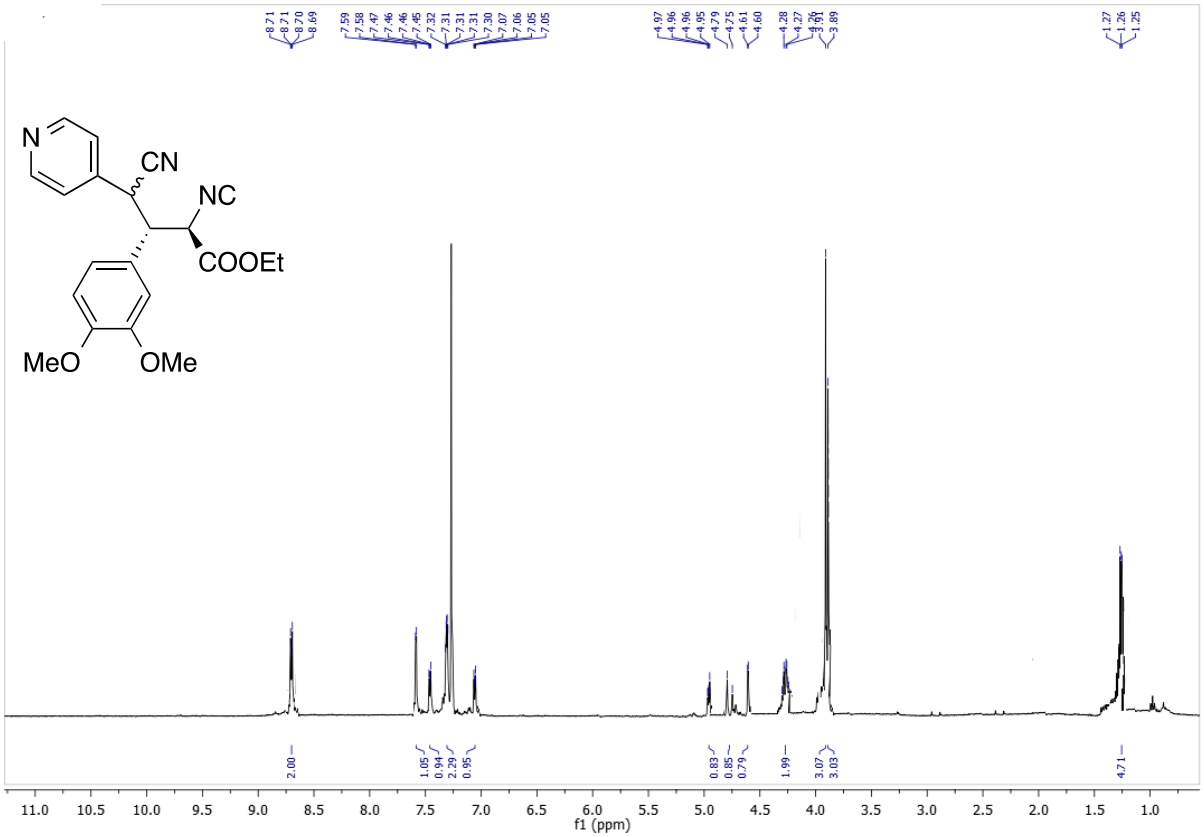


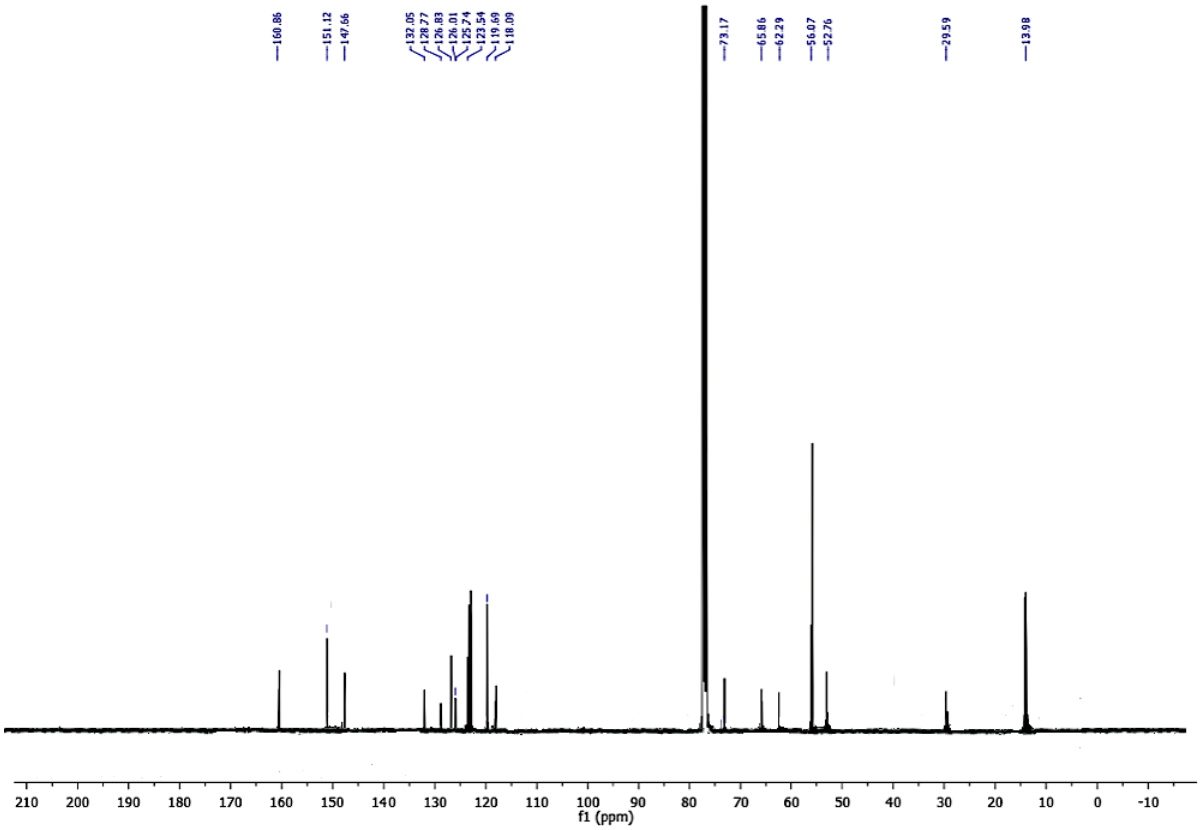
Compound **4i**


8.57
8.56
8.19
7.31
7.30
7.25
7.24
7.21
7.20
5.06
5.04
4.69
4.67
4.19
4.18
4.16
4.15
1.39
1.38
1.37
N
CN
N
COOEt
Cl
2.03
1.00
2.03
2.03
1.97
1.01
1.01
2.04
3.05
f1 (ppm)

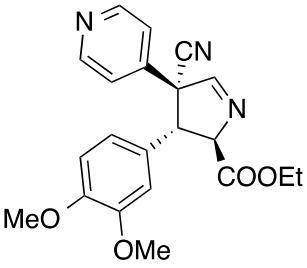

173.47
151.29
140.53
138.43
137.47
131.86
130.53
129.32
126.56
125.66
117.98
87.67
61.80
55.41
14.70
f1 (ppm)

Compound **3j**

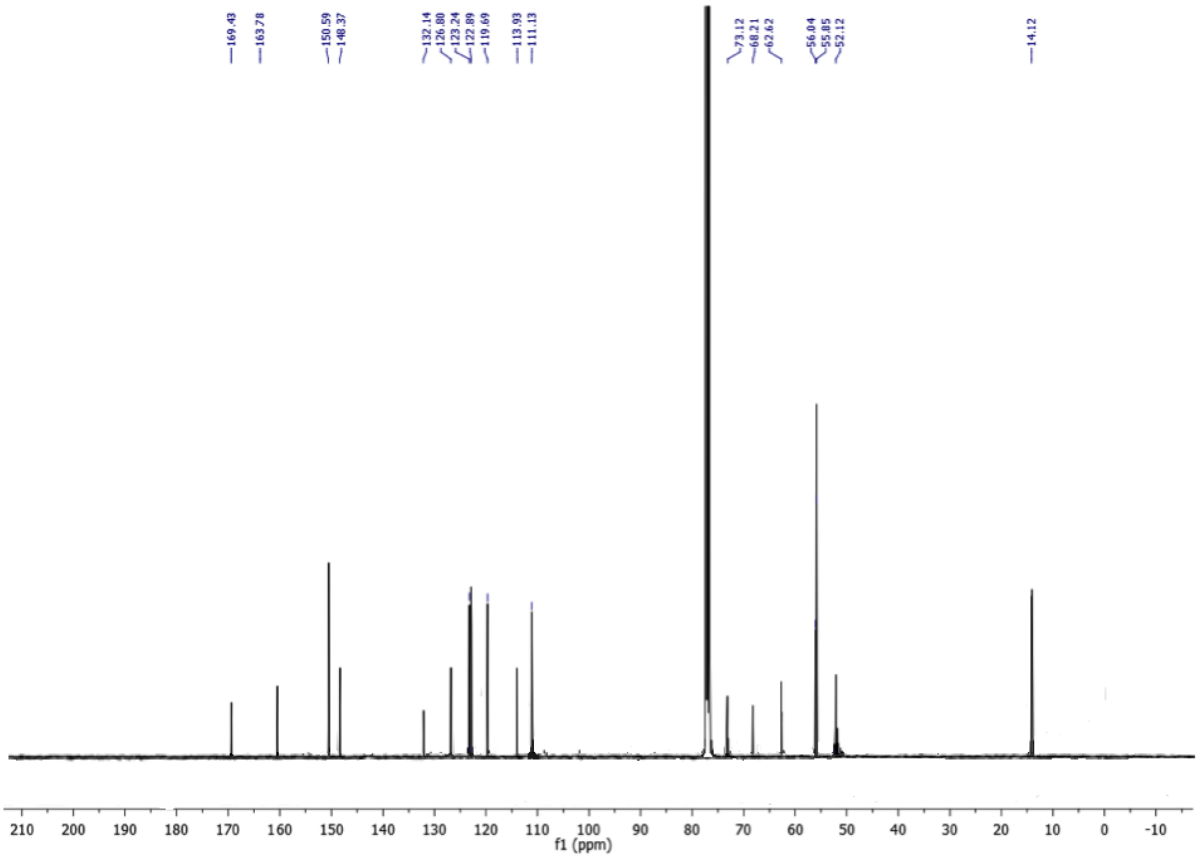




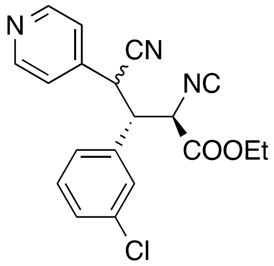
Compound **4j**

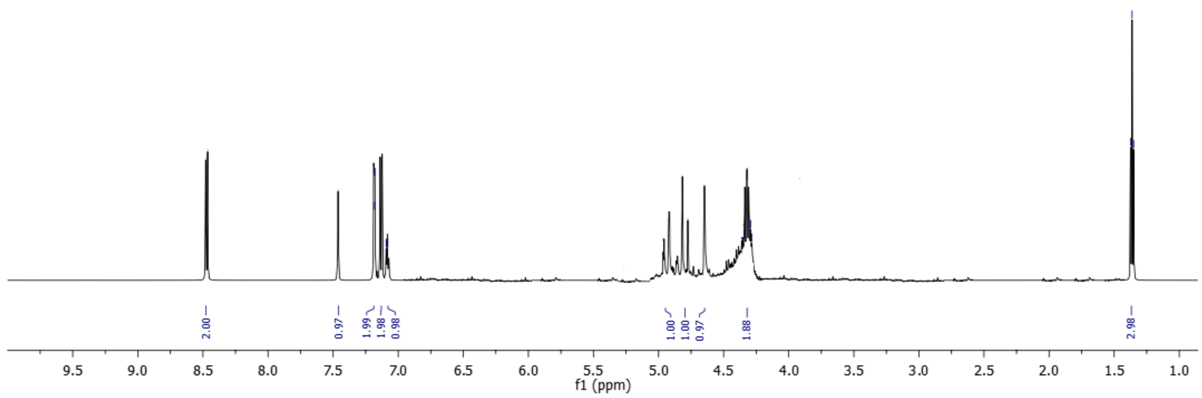

N
CN
N
COOEt
MeO
OMe

8.54
8.52
7.66
7.64
7.25
7.23
6.96
6.95
6.94
6.94
6.89
6.88
6.85
6.83
5.27
5.26
5.24
5.24
4.27
4.26
4.24
4.23
4.21
4.20
4.19
4.18
3.90
3.79
1.33
1.32
1.31
2.00
0.99
1.98
0.98
1.02
0.99
1.00
2.09
0.99
5.99
3.01
f1 (ppm)


169.43
163.78
150.59
148.37
132.14
126.80
123.24
122.89
119.69
113.93
111.13
73.12
68.21
62.62
56.04
55.85
52.12
14.12
f1 (ppm)

Compound **3k**


N
CN
NC
COOEt
Cl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8.46
7.46
7.19
7.18
7.18
7.14
7.12
7.09
7.09
7.09
7.08
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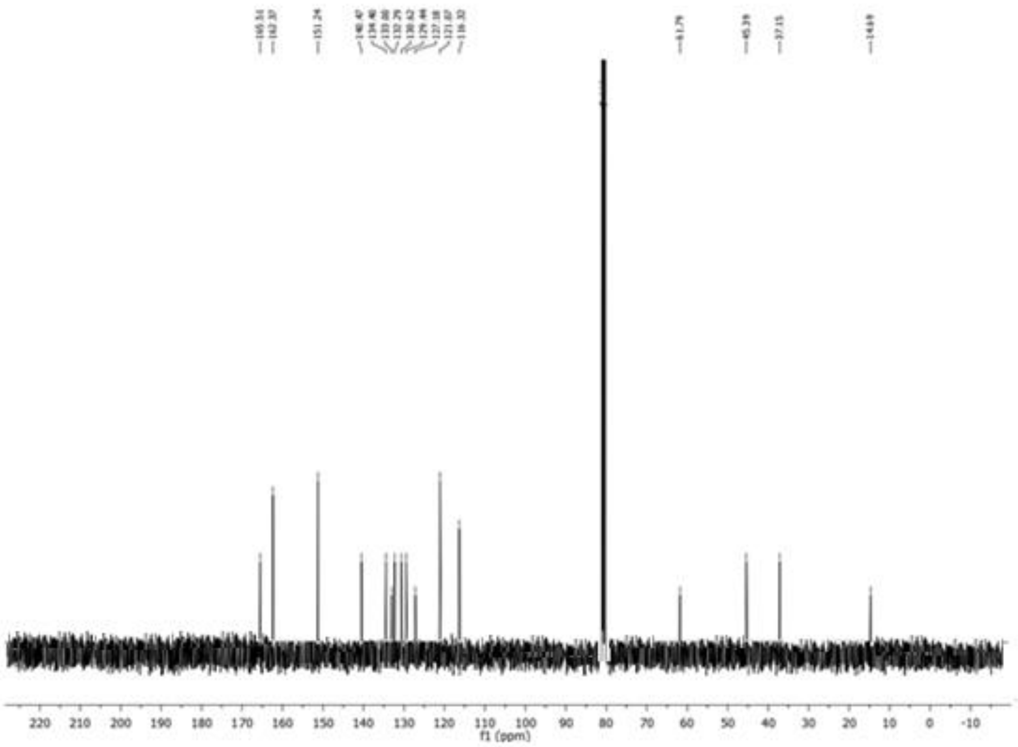
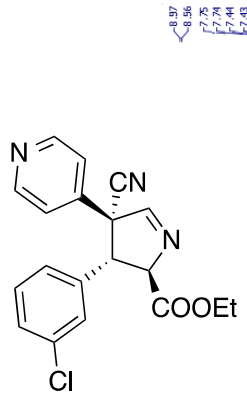
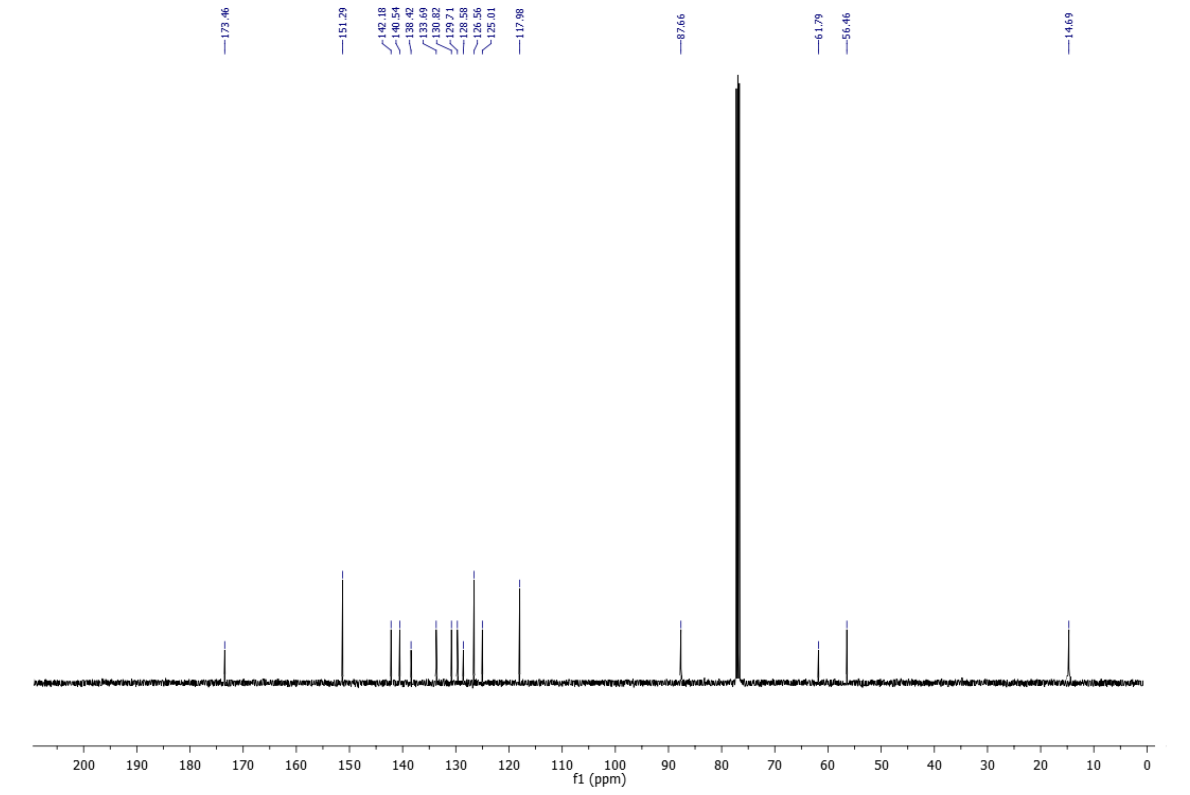
4.89
4.88
4.84
4.83
4.73
4.68
4.54
4.54
4.23
4.22
4.21
4.20
4.19
4.17
4.16
4.15
1.37
1.36
1.35
2.00
0.97
1.99
1.98
0.98
1.00
1.00
0.97
1.88
2.98
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
f1 (ppm)


220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

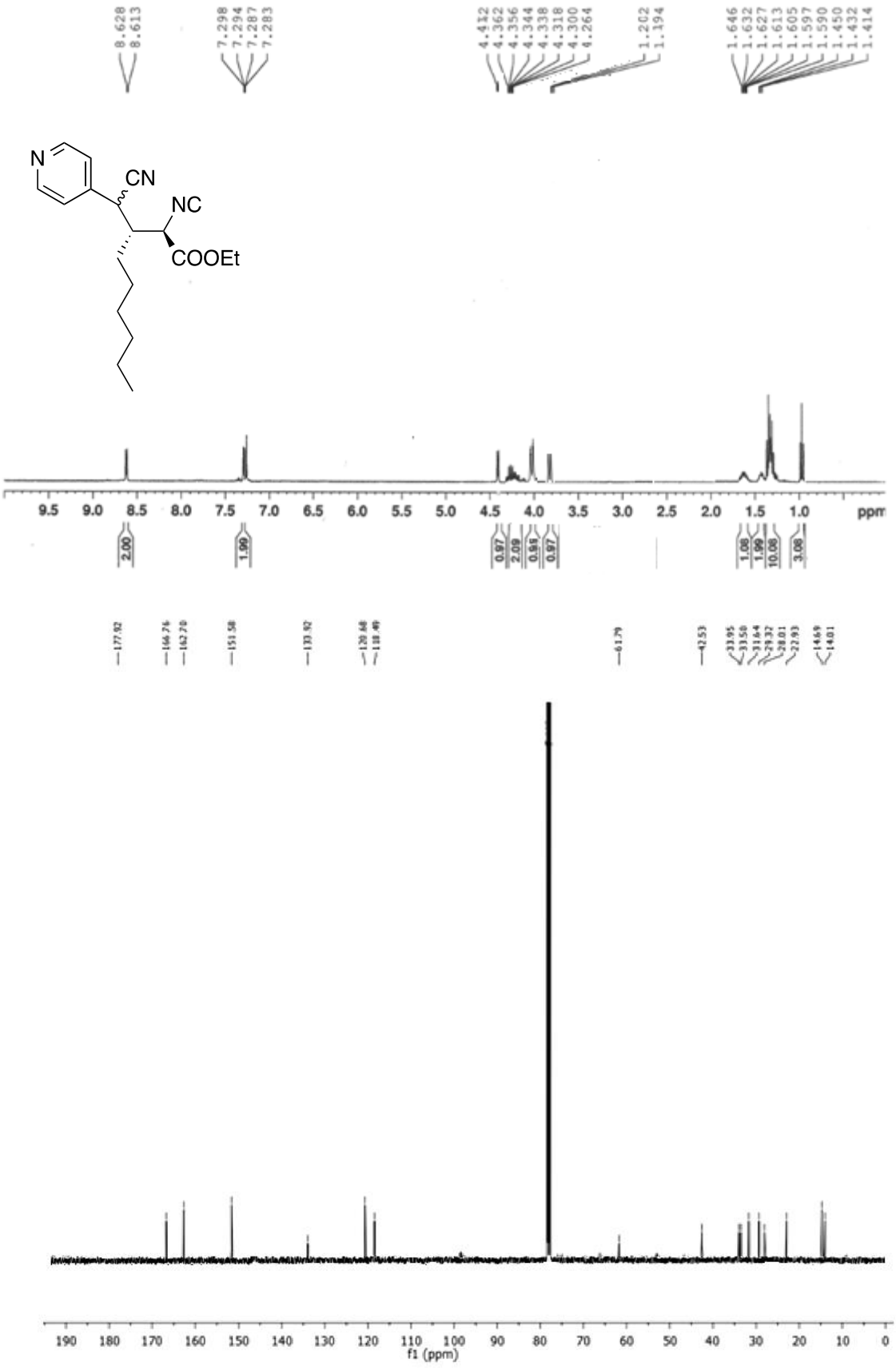
Compound **4k**


N
CN
N
COOEt
Cl

8.97
8.56
7.75
7.74
7.44
7.43
7.24
7.23
7.22
7.21
7.20
7.19
7.18
7.15
7.14
7.13
7.12
7.11
5.37
5.36
5.34
7.33
5.06
5.04
4.27
4.26
4.25
4.24
1.38
1.37
1.36
2.00
1.00
0.97
3.95
1.01
0.99
1.01
2.01
3.03
f1 (ppm)


173.46
151.29
142.18
140.54
138.42
133.69
130.82
129.71
128.58
126.56
125.01
117.98
87.66
61.79
56.46
14.69
f1 (ppm)

Compound **3l**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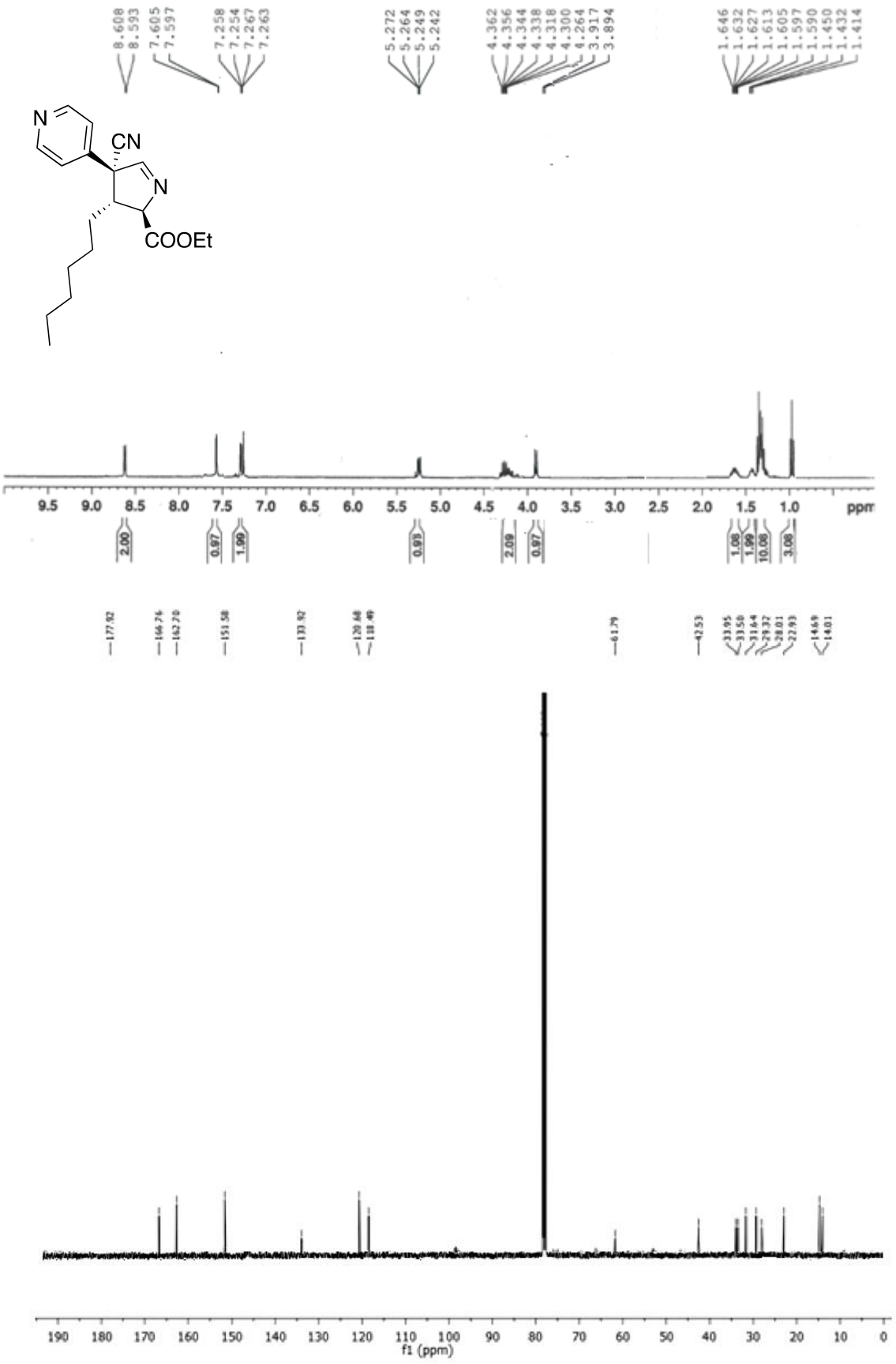
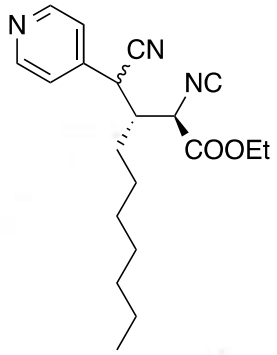
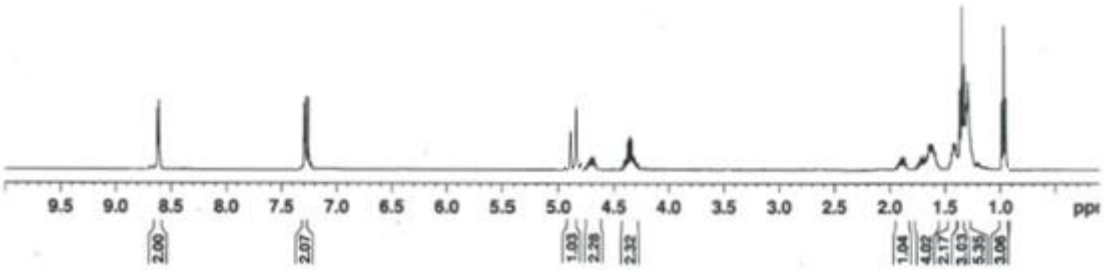
8.613
7.298
7.294
7.287
7.283
4.432
4.362
4.356
4.344
4.338
4.318
4.300
4.264
1.202
1.194
1.646
1.632
1.627
1.613
1.605
1.597
1.590
1.450
1.432
1.414
N
CN
NC
COOEt
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
ppm
2.00
1.99
0.97
2.09
0.84
0.87
1.08
1.99
10.06
3.08
177.82
166.76
162.70
151.58
133.92
120.68
118.49
61.79
42.53
33.95
33.56
31.64
29.32
28.01
22.93
14.69
14.01
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

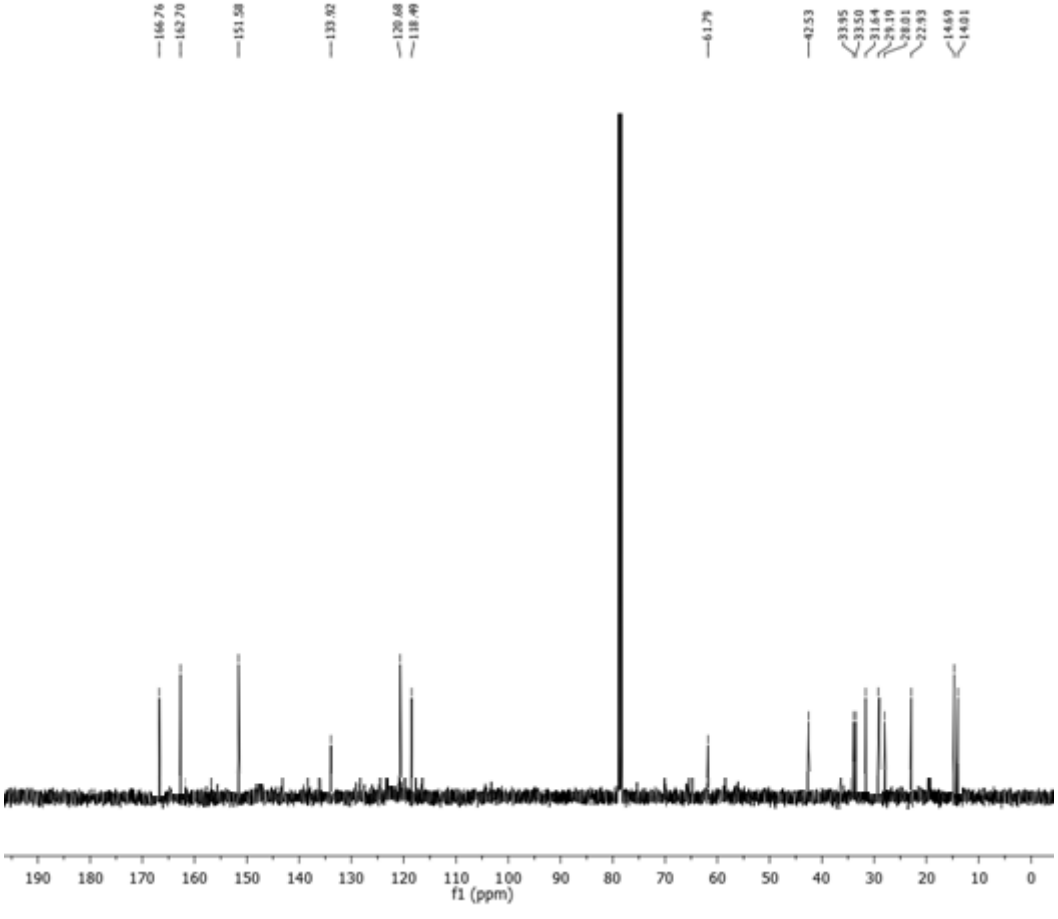
Compound **4l**


8.608
8.593
7.605
7.597
7.258
7.254
7.267
7.263
5.272
5.264
5.249
5.242
4.362
4.356
4.344
4.338
4.318
4.300
4.264
3.917
3.894
1.646
1.632
1.627
1.613
1.605
1.597
1.590
1.450
1.432
1.414
N
CN
N
COOEt
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
0.97
1.00
0.93
2.09
0.97
1.08
1.99
10.06
3.08
177.92
166.74
162.70
151.58
133.92
120.68
118.49
61.79
42.53
33.95
33.50
31.64
29.32
28.01
22.93
14.69
14.01
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

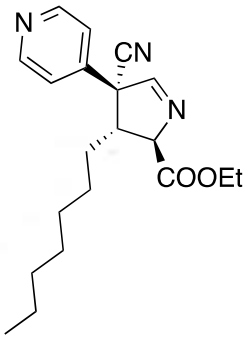
Compound **3m**

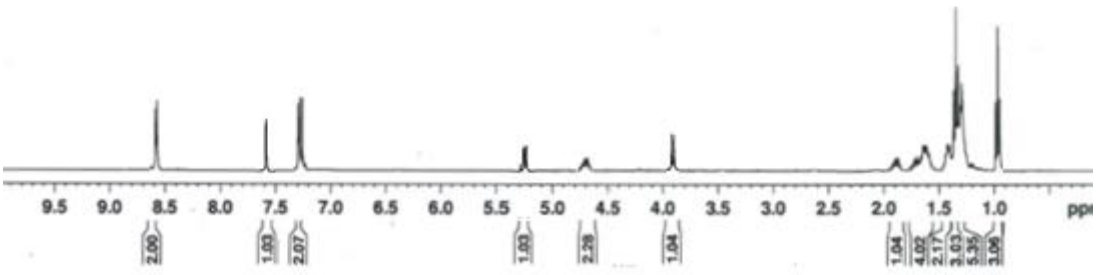

N
CN
NC
COOEt

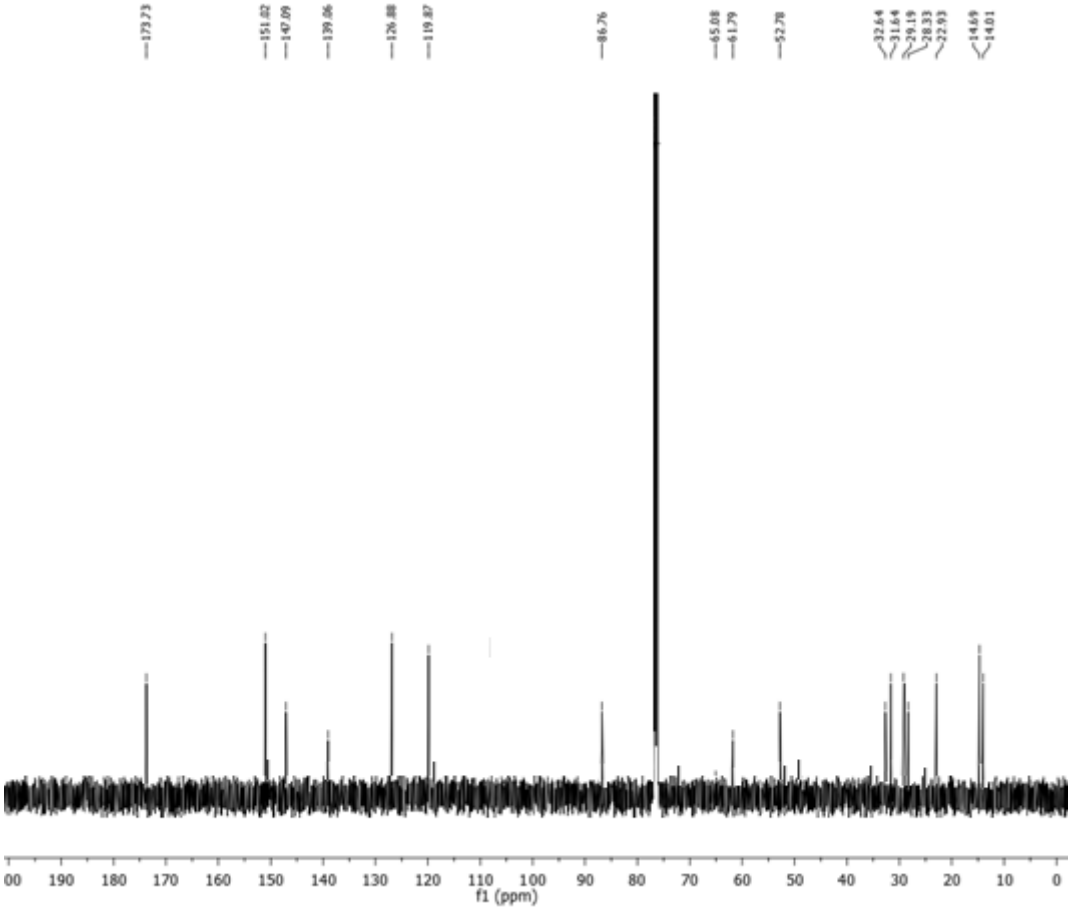

9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
2.00
2.07
1.03
2.28
2.32
1.04
4.02
2.17
3.03
5.35
3.06


166.76
162.70
151.58
133.92
120.68
118.49
61.79
42.53
33.95
33.50
31.64
29.19
28.01
22.53
14.69
14.01
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

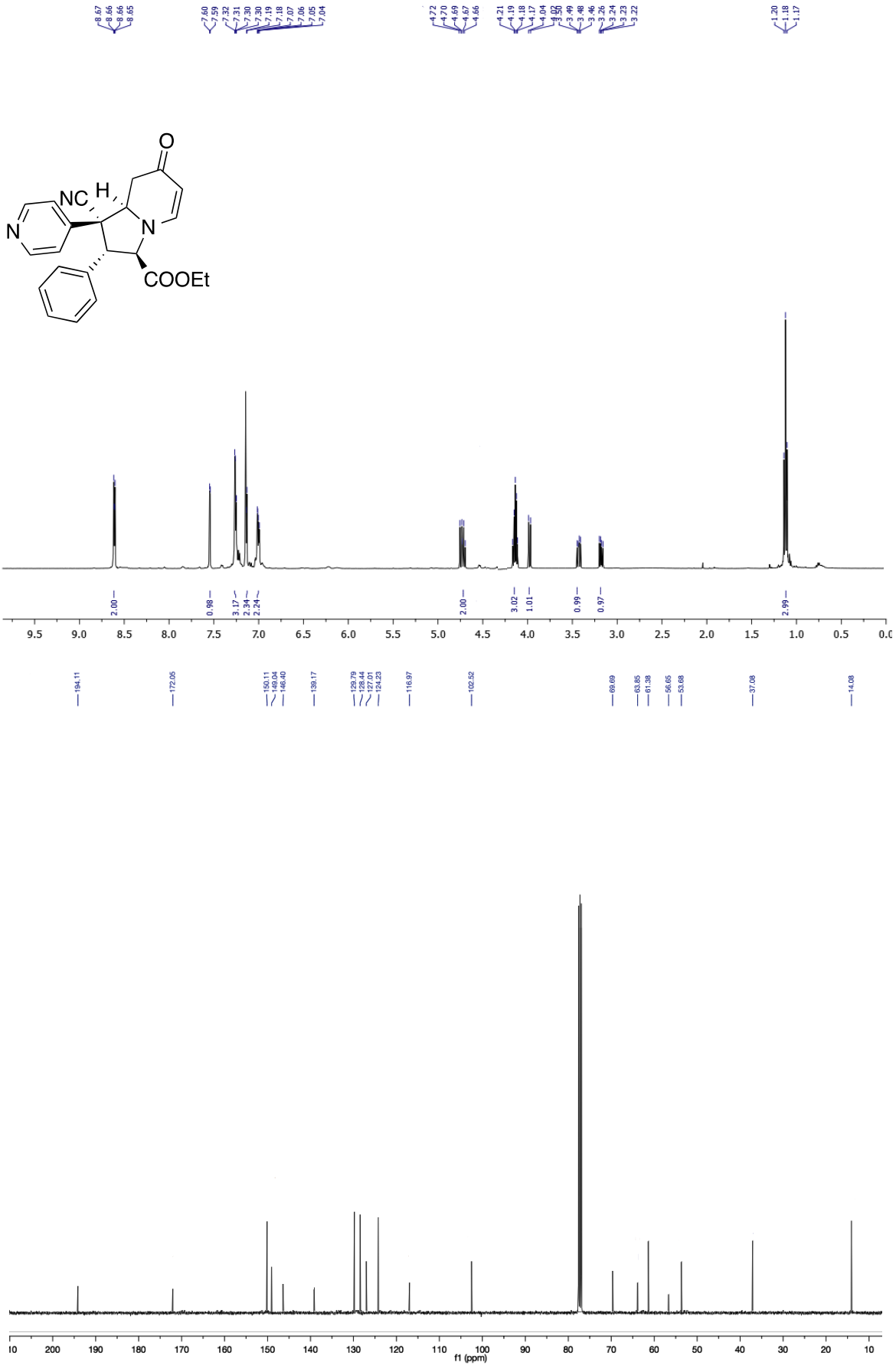
Compound **4m**


N
CN
N
COOEt

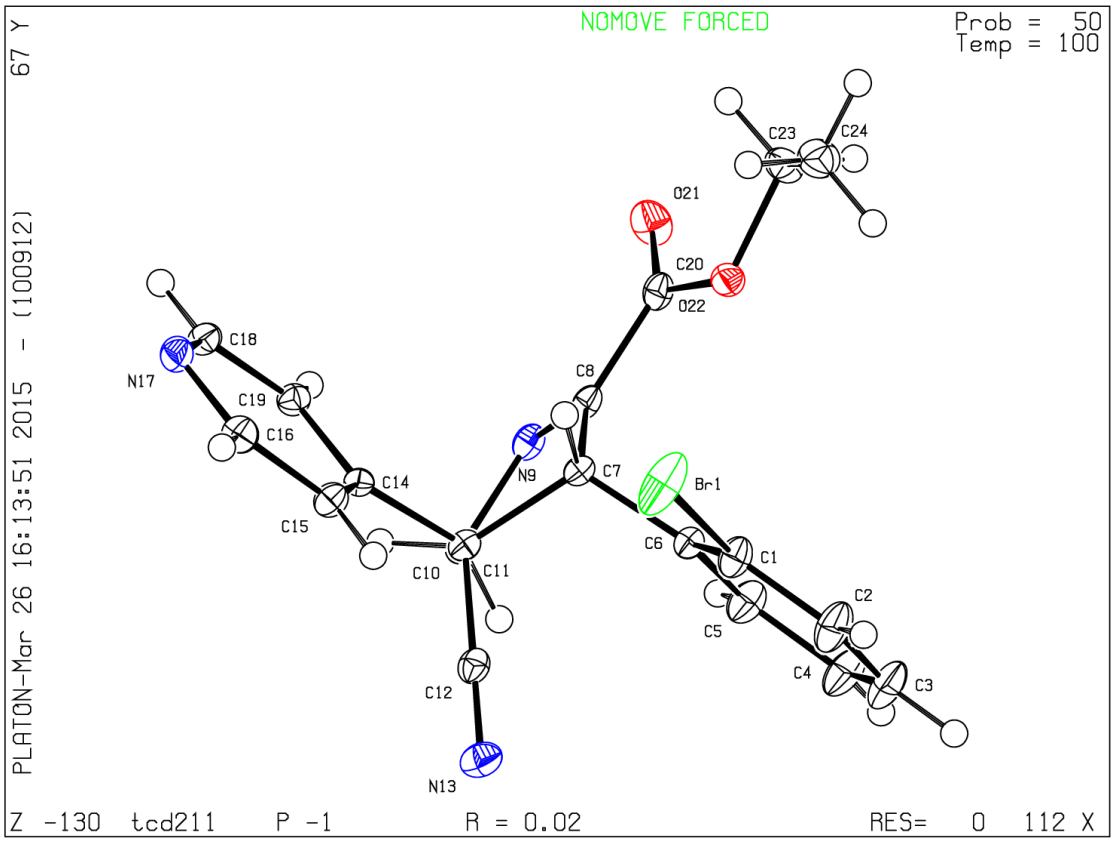

9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
2.00 1.93 2.07 1.93 2.28 1.94 1.84 4.02 2.17 3.03 5.35 3.09


173.73
151.82
147.09
139.46
126.88
119.87
86.76
65.08
61.79
52.78
32.64
31.64
29.19
28.33
22.93
14.69
14.01
f1 (ppm)

Compound **14**



x-ray of compound **4e**



A specimen of $C_{19}H_{16}BrN_3O_2$, approximate dimensions 0.060 mm x 0.200 mm x 0.340 mm, was used for the X-ray crystallographic analysis. The X-ray intensity data were measured at 100(2)K using an Oxford Cryosystems Cobra low temperature device using a MiTeGen micromount. See Table 1 for collection parameters and exposure time. Bruker APEX software was used to correct for Lorentz and polarization effects.

A total of 865 frames were collected. The total exposure time was 2.40 hours. The integration of the data using a triclinic unit cell yielded a total of 28566 reflections to a maximum θ angle of 28.49° (0.75 Å resolution), of which 4437 were independent (average redundancy 6.438, completeness = 99.5%, R_{int} = 2.66%, R_{sig} = 1.81%) and 3861 (87.02%) were greater than $2\sigma(F^2)$.The final cell constants of a = 8.5662(3) Å, b = 10.0537(4) Å, c = 10.3737(4) Å, α = 100.5375(11)°, β = 92.3787(11)°, γ = 90.0950(10)°, volume = 877.54(6) $Å^3$, are based upon the refinement of the XYZ-centroids of reflections above 20 σ(I). Data were corrected for absorption effects using the numerical method (SADABS). The calculated minimum and maximum transmission coefficients (based on crystal size) are 0.5450 and 0.8837.

The structure was solved and refined using the Bruker SHELXTL Software Package, using the space group P$\bar{1}$, with Z = 2 for the formula unit, $C_{19}H_{16}BrN_3O_2$.The final anisotropic full-matrix least-squares refinement on F^2 with 227 variables converged at R1 = 2.48%, for the observed data and wR2 = 6.11% for all data. The goodness-of-fit was 1.015. The largest peak

in the final difference electron density synthesis was 0.373 $e^-/Å^3$ and the largest hole was -0.806 $e^-/Å^3$ with an RMS deviation of 0.053 $e^-/Å^3$. On the basis of the final model, the calculated density was 1.507 g/cm^3 and F(000), 404 e^-.

References:

Bruker APEX v2014.11-0, Bruker AXS Inc., Madison, Wisconsin, USA.

SADABS (2014/5) Bruker AXS Inc., Madison, Wisconsin, USA; Sheldrick, G. M. University of Göttingen, Germany.

SHELXL-2014, (2014), Bruker AXS Inc., Madison, Wisconsin, USA; Sheldrick, G. M. University of Göttingen, Germany.

Table 1: Data collection details for TCD211.

Axis	dx/mm	2θ/°	ω/°	φ/°	χ/°	Width/°	Frames	Time/s	Wavelength/Å	Voltage/kV	Current/mA	Temperature/K
Omega	45.000	23.75	15.77	0.00	-54.74	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	24.86	322.40	79.47	82.39	2.00	35	10.00	0.71073	50	30.0	100
Omega	45.000	23.75	15.77	204.00	-54.74	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	24.86	273.28	321.72	48.03	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	24.86	277.93	214.38	38.51	2.00	60	10.00	0.71073	50	30.0	100
Omega	45.000	23.75	15.77	102.00	-54.74	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	23.75	15.77	255.00	-54.74	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	24.86	273.22	49.00	48.19	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	24.86	268.80	282.85	54.85	2.00	63	10.00	0.71073	50	30.0	100
Phi	45.000	23.75	283.65	360.00	23.00	2.00	180	10.00	0.71073	50	30.0	100
Omega	45.000	23.75	15.77	306.00	-54.74	2.00	61	10.00	0.71073	50	30.0	100
Omega	45.000	8.75	359.77	180.00	-54.74	2.00	62	10.00	0.71073	50	30.0	100
Omega	50.000	27.66	322.98	53.33	71.18	2.00	38	10.00	0.71073	50	30.0	100

Table 2. Crystal data and structure refinement for tcd211.

Identification code	tcd211	
Empirical formula	$C_{19}H_{16}BrN_3O_2$	
Formula weight	398.26	
Temperature	100(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	$P\bar{1}$	
Unit cell dimensions	a = 8.5662(3) Å	α= 100.5375(11)°.
	b = 10.0537(4) Å	β= 92.3787(11)°.
	c = 10.3737(4) Å	γ = 90.0950(10)°.
Volume	877.54(6) $Å^3$	
Z	2	
Density (calculated)	1.507 Mg/m^3	
Absorption coefficient	2.359 mm^{-1}	
F(000)	404	
Crystal size	0.340 x 0.200 x 0.060 mm^3	
Theta range for data collection	1.999 to 28.487°.	
Index ranges	$-11\leq h\leq 11$, $-13\leq k\leq 13$, $-13\leq l\leq 13$	
Reflections collected	28566	
Independent reflections	4437 [R(int) = 0.0266]	
Completeness to theta = 25.242°	100.0 %	
Absorption correction	Numerical	
Max. and min. transmission	0.8837 and 0.5450	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	4437 / 0 / 227	
Goodness-of-fit on F^2	1.015	
Final R indices [$I>2\sigma(I)$]	R1 = 0.0248, wR2 = 0.0576	
R indices (all data)	R1 = 0.0329, wR2 = 0.0611	
Largest diff. peak and hole	0.373 and -0.806 $e.Å^{-3}$	
Abs. structure Flack	0.022	

Table 3. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for tcd211. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Br(1)	5124(1)	5498(1)	2081(1)	32(1)
C(1)	2966(2)	5031(1)	1825(1)	18(1)
C(2)	2585(2)	3788(2)	1039(2)	25(1)
C(3)	1036(2)	3382(2)	852(2)	27(1)
C(4)	-121(2)	4216(2)	1437(2)	27(1)
C(5)	278(2)	5456(2)	2211(2)	21(1)
C(6)	1833(2)	5891(1)	2432(1)	14(1)
C(7)	2249(2)	7221(1)	3331(1)	12(1)
C(8)	1088(2)	8323(1)	3178(1)	14(1)
C(10)	435(2)	7825(1)	5096(1)	14(1)
C(11)	2100(2)	7216(1)	4845(1)	13(1)
C(12)	2186(2)	5836(1)	5131(1)	15(1)
C(14)	3417(2)	8094(1)	5608(1)	13(1)
C(15)	4893(2)	7550(1)	5774(1)	16(1)
C(16)	6094(2)	8400(2)	6385(1)	18(1)
C(18)	4497(2)	10228(1)	6667(1)	16(1)
C(19)	3214(2)	9471(1)	6071(1)	14(1)
C(20)	1101(2)	9047(1)	2032(1)	15(1)
C(23)	2408(2)	9110(2)	74(1)	19(1)
C(24)	3846(2)	8436(2)	-519(2)	23(1)
N(9)	110(1)	8630(1)	4071(1)	15(1)
N(13)	2250(2)	4763(1)	5355(1)	20(1)
N(17)	5926(1)	9728(1)	6830(1)	18(1)
O(21)	402(1)	10076(1)	1972(1)	23(1)
O(22)	2010(1)	8391(1)	1116(1)	15(1)

Table 4. Bond lengths [Å] and angles [°] for tcd211.

Br(1)-C(1)	1.9023(14)	C(23)-O(22)	1.4563(17)
C(1)-C(6)	1.3929(19)	C(23)-C(24)	1.506(2)
C(1)-C(2)	1.391(2)	C(23)-H(23A)	0.9900
C(2)-C(3)	1.383(2)	C(23)-H(23B)	0.9900
C(2)-H(2)	0.9500	C(24)-H(24A)	0.9800
C(3)-C(4)	1.385(2)	C(24)-H(24B)	0.9800
C(3)-H(3)	0.9500	C(24)-H(24C)	0.9800
C(4)-C(5)	1.387(2)		
C(4)-H(4)	0.9500	C(6)-C(1)-C(2)	122.09(14)
C(5)-C(6)	1.398(2)	C(6)-C(1)-Br(1)	120.77(11)
C(5)-H(5)	0.9500	C(2)-C(1)-Br(1)	117.12(11)
C(6)-C(7)	1.5165(18)	C(3)-C(2)-C(1)	119.44(14)
C(7)-C(8)	1.5150(18)	C(3)-C(2)-H(2)	120.3
C(7)-C(11)	1.5820(18)	C(1)-C(2)-H(2)	120.3
C(7)-H(7)	1.0000	C(2)-C(3)-C(4)	119.95(14)
C(8)-N(9)	1.2714(18)	C(2)-C(3)-H(3)	120.0
C(8)-C(20)	1.5039(19)	C(4)-C(3)-H(3)	120.0
C(10)-N(9)	1.4674(18)	C(5)-C(4)-C(3)	119.89(15)
C(10)-C(11)	1.5655(18)	C(5)-C(4)-H(4)	120.1
C(10)-H(10A)	0.9900	C(3)-C(4)-H(4)	120.1
C(10)-H(10B)	0.9900	C(4)-C(5)-C(6)	121.63(14)
C(11)-C(12)	1.4723(19)	C(4)-C(5)-H(5)	119.2
C(11)-C(14)	1.5311(18)	C(6)-C(5)-H(5)	119.2
C(12)-N(13)	1.1459(19)	C(1)-C(6)-C(5)	116.98(13)
C(14)-C(15)	1.3949(19)	C(1)-C(6)-C(7)	122.24(12)
C(14)-C(19)	1.3943(18)	C(5)-C(6)-C(7)	120.75(12)
C(15)-C(16)	1.391(2)	C(8)-C(7)-C(6)	112.29(11)
C(15)-H(15)	0.9500	C(8)-C(7)-C(11)	99.16(10)
C(16)-N(17)	1.3414(19)	C(6)-C(7)-C(11)	114.94(11)
C(16)-H(16)	0.9500	C(8)-C(7)-H(7)	110.0
C(18)-N(17)	1.3397(19)	C(6)-C(7)-H(7)	110.0
C(18)-C(19)	1.3918(19)	C(11)-C(7)-H(7)	110.0
C(18)-H(18)	0.9500	N(9)-C(8)-C(20)	120.95(12)
C(19)-H(19)	0.9500	N(9)-C(8)-C(7)	117.31(12)
C(20)-O(21)	1.2061(17)	C(20)-C(8)-C(7)	121.74(11)
C(20)-O(22)	1.3335(16)	N(9)-C(10)-C(11)	106.13(11)

N(9)-C(10)-H(10A)	110.5	C(19)-C(18)-H(18)	117.7
C(11)-C(10)-H(10A)	110.5	C(18)-C(19)-C(14)	118.22(13)
N(9)-C(10)-H(10B)	110.5	C(18)-C(19)-H(19)	120.9
C(11)-C(10)-H(10B)	110.5	C(14)-C(19)-H(19)	120.9
H(10A)-C(10)-H(10B)	108.7	O(21)-C(20)-O(22)	125.79(13)
C(12)-C(11)-C(14)	109.88(11)	O(21)-C(20)-C(8)	124.40(13)
C(12)-C(11)-C(10)	111.12(11)	O(22)-C(20)-C(8)	109.80(11)
C(14)-C(11)-C(10)	113.56(11)	O(22)-C(23)-C(24)	106.05(11)
C(12)-C(11)-C(7)	111.65(11)	O(22)-C(23)-H(23A)	110.5
C(14)-C(11)-C(7)	108.59(10)	C(24)-C(23)-H(23A)	110.5
C(10)-C(11)-C(7)	101.82(10)	O(22)-C(23)-H(23B)	110.5
N(13)-C(12)-C(11)	179.87(17)	C(24)-C(23)-H(23B)	110.5
C(15)-C(14)-C(19)	118.08(13)	H(23A)-C(23)-H(23B)	108.7
C(15)-C(14)-C(11)	120.44(12)	C(23)-C(24)-H(24A)	109.5
C(19)-C(14)-C(11)	121.32(12)	C(23)-C(24)-H(24B)	109.5
C(14)-C(15)-C(16)	118.95(13)	H(24A)-C(24)-H(24B)	109.5
C(14)-C(15)-H(15)	120.5	C(23)-C(24)-H(24C)	109.5
C(16)-C(15)-H(15)	120.5	H(24A)-C(24)-H(24C)	109.5
N(17)-C(16)-C(15)	123.87(13)	H(24B)-C(24)-H(24C)	109.5
N(17)-C(16)-H(16)	118.1	C(8)-N(9)-C(10)	108.90(11)
C(15)-C(16)-H(16)	118.1	C(18)-N(17)-C(16)	116.22(12)
N(17)-C(18)-C(19)	124.66(13)	C(20)-O(22)-C(23)	116.25(11)
N(17)-C(18)-H(18)	117.7		

Table 5. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for tcd211. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Br(1)	13(1)	26(1)	47(1)	-15(1)	-1(1)	4(1)
C(1)	14(1)	17(1)	20(1)	-1(1)	-2(1)	1(1)
C(2)	24(1)	17(1)	28(1)	-7(1)	-3(1)	5(1)
C(3)	30(1)	16(1)	31(1)	-6(1)	-5(1)	-3(1)
C(4)	21(1)	23(1)	34(1)	-4(1)	-2(1)	-8(1)
C(5)	16(1)	19(1)	25(1)	-2(1)	2(1)	-2(1)
C(6)	16(1)	12(1)	14(1)	1(1)	0(1)	-1(1)
C(7)	11(1)	11(1)	14(1)	1(1)	1(1)	0(1)
C(8)	11(1)	11(1)	16(1)	-1(1)	-2(1)	0(1)
C(10)	11(1)	15(1)	17(1)	1(1)	1(1)	0(1)
C(11)	12(1)	12(1)	15(1)	1(1)	1(1)	0(1)
C(12)	12(1)	16(1)	16(1)	1(1)	0(1)	-2(1)
C(14)	14(1)	12(1)	12(1)	3(1)	1(1)	-2(1)
C(15)	14(1)	14(1)	18(1)	2(1)	0(1)	0(1)
C(16)	14(1)	20(1)	19(1)	4(1)	0(1)	0(1)
C(18)	19(1)	13(1)	16(1)	2(1)	2(1)	-2(1)
C(19)	15(1)	13(1)	15(1)	2(1)	1(1)	1(1)
C(20)	14(1)	16(1)	16(1)	0(1)	-3(1)	0(1)
C(23)	22(1)	20(1)	17(1)	7(1)	0(1)	2(1)
C(24)	26(1)	22(1)	22(1)	4(1)	6(1)	0(1)
N(9)	12(1)	14(1)	17(1)	0(1)	-1(1)	0(1)
N(13)	17(1)	17(1)	26(1)	5(1)	0(1)	-2(1)
N(17)	17(1)	20(1)	16(1)	2(1)	-1(1)	-4(1)
O(21)	25(1)	22(1)	22(1)	5(1)	0(1)	11(1)
O(22)	18(1)	14(1)	15(1)	3(1)	1(1)	1(1)

Table 6. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for tcd211.

	x	y	z	U(eq)
H(2)	3382	3224	634	30
H(3)	766	2532	324	33
H(4)	-1185	3939	1308	33
H(5)	-525	6023	2601	25
H(7)	3325	7517	3162	14
H(10A)	-354	7094	5040	17
H(10B)	416	8403	5977	17
H(15)	5075	6615	5475	19
H(16)	7093	8016	6493	21
H(18)	4349	11166	6980	20
H(19)	2227	9882	5983	17
H(23A)	2623	10077	436	23
H(23B)	1540	9046	-595	23
H(24A)	4695	8514	154	35
H(24B)	4161	8878	-1236	35
H(24C)	3617	7478	-861	35

Table 7. Torsion angles [°] for tcd211.

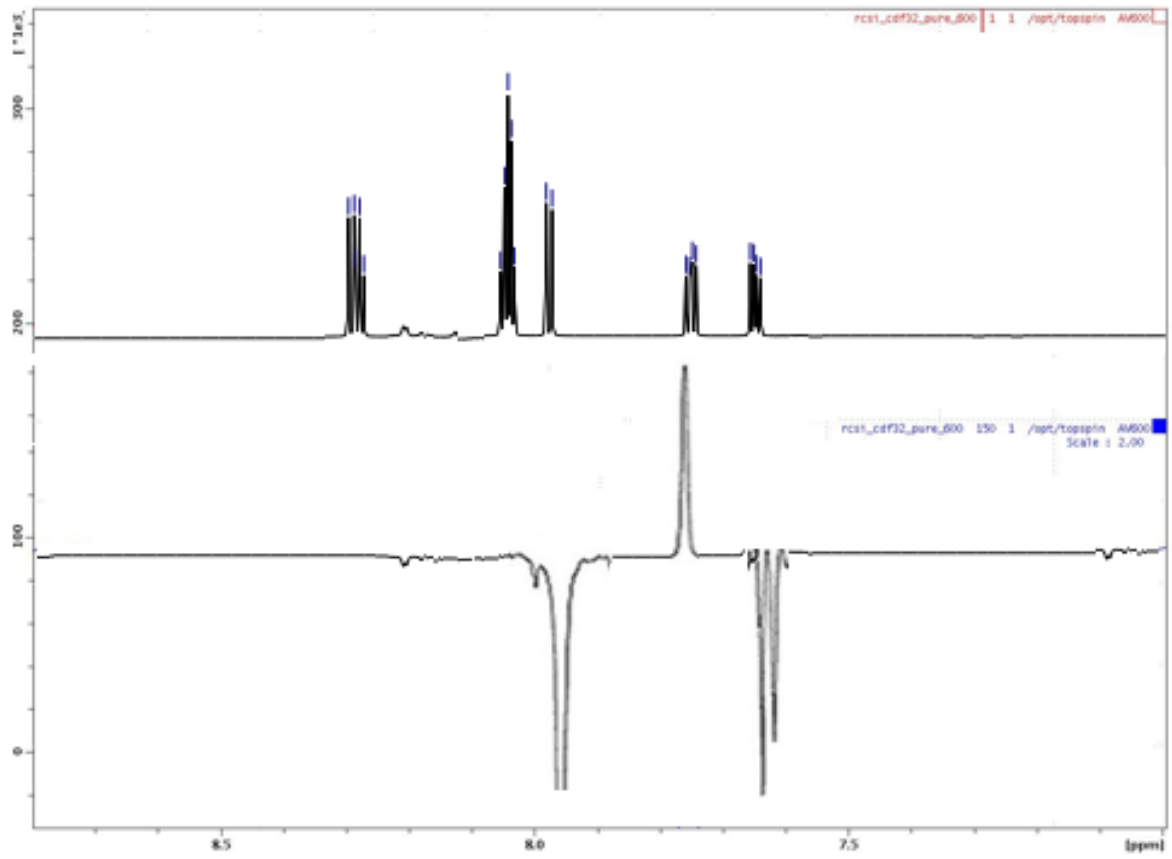
C(6)-C(1)-C(2)-C(3)	-0.3(2)	C(14)-C(15)-C(16)-N(17)	-0.1(2)
Br(1)-C(1)-C(2)-C(3)	178.11(13)	N(17)-C(18)-C(19)-C(14)	0.0(2)
C(1)-C(2)-C(3)-C(4)	0.5(3)	C(15)-C(14)-C(19)-C(18)	0.36(19)
C(2)-C(3)-C(4)-C(5)	-0.2(3)	C(11)-C(14)-C(19)-C(18)	-175.08(12)
C(3)-C(4)-C(5)-C(6)	-0.5(3)	N(9)-C(8)-C(20)-O(21)	12.5(2)
C(2)-C(1)-C(6)-C(5)	-0.4(2)	C(7)-C(8)-C(20)-O(21)	-166.43(14)
Br(1)-C(1)-C(6)-C(5)	-178.70(11)	N(9)-C(8)-C(20)-O(22)	-168.33(12)
C(2)-C(1)-C(6)-C(7)	177.56(14)	C(7)-C(8)-C(20)-O(22)	12.69(17)
Br(1)-C(1)-C(6)-C(7)	-0.74(19)	C(20)-C(8)-N(9)-C(10)	-176.45(12)
C(4)-C(5)-C(6)-C(1)	0.8(2)	C(7)-C(8)-N(9)-C(10)	2.58(16)
C(4)-C(5)-C(6)-C(7)	-177.20(14)	C(11)-C(10)-N(9)-C(8)	14.53(14)
C(1)-C(6)-C(7)-C(8)	142.84(13)	C(19)-C(18)-N(17)-C(16)	-0.4(2)
C(5)-C(6)-C(7)-C(8)	-39.29(18)	C(15)-C(16)-N(17)-C(18)	0.4(2)
C(1)-C(6)-C(7)-C(11)	-104.80(15)	O(21)-C(20)-O(22)-C(23)	11.7(2)
C(5)-C(6)-C(7)-C(11)	73.07(16)	C(8)-C(20)-O(22)-C(23)	-167.42(11)
C(6)-C(7)-C(8)-N(9)	104.00(14)	C(24)-C(23)-O(22)-C(20)	159.74(12)
C(11)-C(7)-C(8)-N(9)	-17.86(15)		
C(6)-C(7)-C(8)-C(20)	-76.98(15)		
C(11)-C(7)-C(8)-C(20)	161.16(12)		
N(9)-C(10)-C(11)-C(12)	-143.20(11)		
N(9)-C(10)-C(11)-C(14)	92.33(13)		
N(9)-C(10)-C(11)-C(7)	-24.19(13)		
C(8)-C(7)-C(11)-C(12)	142.16(11)		
C(6)-C(7)-C(11)-C(12)	22.24(16)		
C(8)-C(7)-C(11)-C(14)	-96.55(12)		
C(6)-C(7)-C(11)-C(14)	143.53(11)		
C(8)-C(7)-C(11)-C(10)	23.52(12)		
C(6)-C(7)-C(11)-C(10)	-96.39(12)		
C(12)-C(11)-C(14)-C(15)	37.75(17)		
C(10)-C(11)-C(14)-C(15)	162.90(12)		
C(7)-C(11)-C(14)-C(15)	-84.63(14)		
C(12)-C(11)-C(14)-C(19)	-146.92(12)		
C(10)-C(11)-C(14)-C(19)	-21.77(18)		
C(7)-C(11)-C(14)-C(19)	90.71(14)		
C(19)-C(14)-C(15)-C(16)	-0.3(2)		
C(11)-C(14)-C(15)-C(16)	175.18(12)		

Table 8. Hydrogen bonds for tcd211 [Å and °].

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
C(7)-H(7)...Br(1)	1.00	2.66	3.1945(13)	114
C(10)-H(10A)...N(13)#1	0.99	2.44	3.4240(18)	174
C(10)-H(10B)...O(21)#2	0.99	2.51	3.4723(17)	164
C(19)-H(19)...N(9)#2	0.95	2.51	3.4440(18)	169
C(23)-H(23B)...O(21)#3	0.99	2.42	3.3450(18)	155

Symmetry transformations used to generate equivalent atoms:

#1 -x,-y+1,-z+1 #2 -x,-y+2,-z+1 #3 -x,-y+2,-z



Compound **4a**

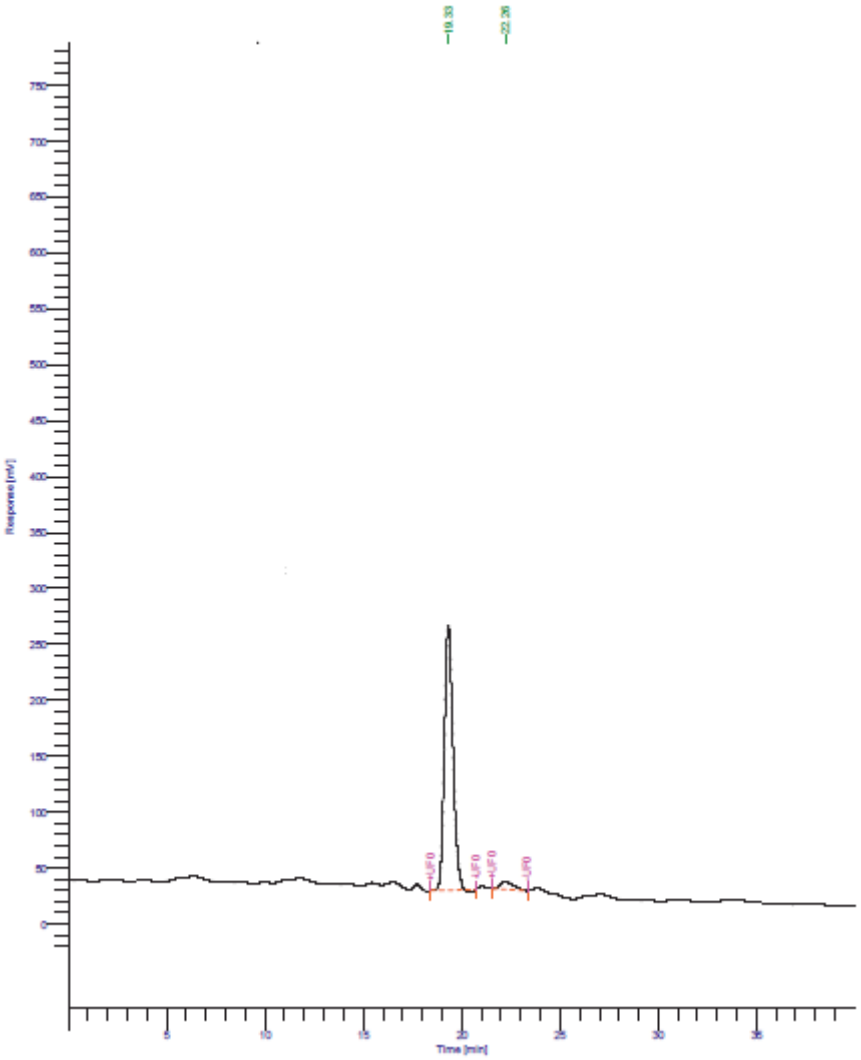
DEFAULT REPORT

Peak #	Time [min]	Area [µV·s]	Height [µV]	Area [%]	Norm. Area [%]	BL	Area/Height [s]
1	19.333	7279814.28	237440.09	95.60	95.60	MM	30.6596
2	22.260	334916.96	6898.29	4.40	4.40	MM	48.5507
		7614731.24	244338.38	100.00	100.00		

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



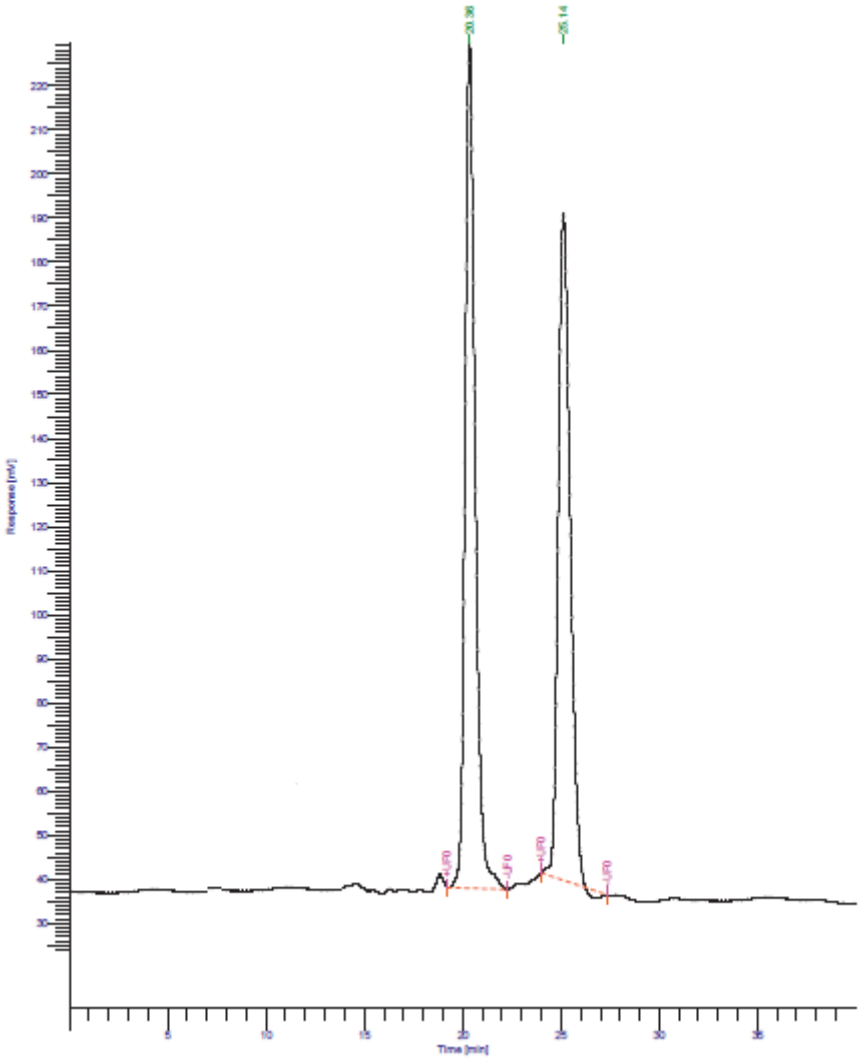
DEFAULT REPORT

Peak #	Time [min]	Area [µV·s]	Height [µV]	Area [%]	Norm. Area [%]	BL	Area/Height [s]
1	20.363	6849945.79	191832.26	51.57	51.57	MM	35.7080
2	25.137	6434092.96	151501.21	48.43	48.43	MM	42.4689
		13284038.75	343333.47	100.00	100.00		

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4b**

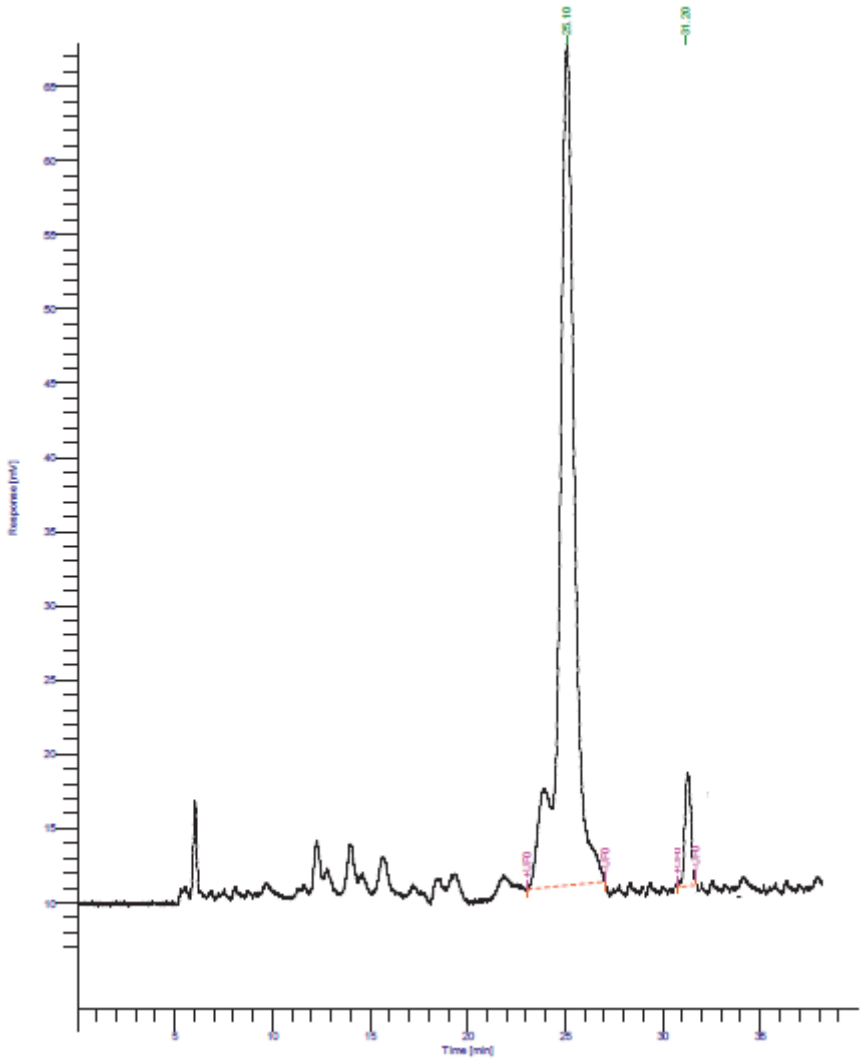
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		25.102	3053395.36	56709.24	92.60	92.60			*MM	3.0534	3.0534
2		31.196	244025.00	9980.83	7.40	7.40			*MM	0.2440	0.2440
			3297420.35	66690.07	100.00	100.00				3.2974	3.2974

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



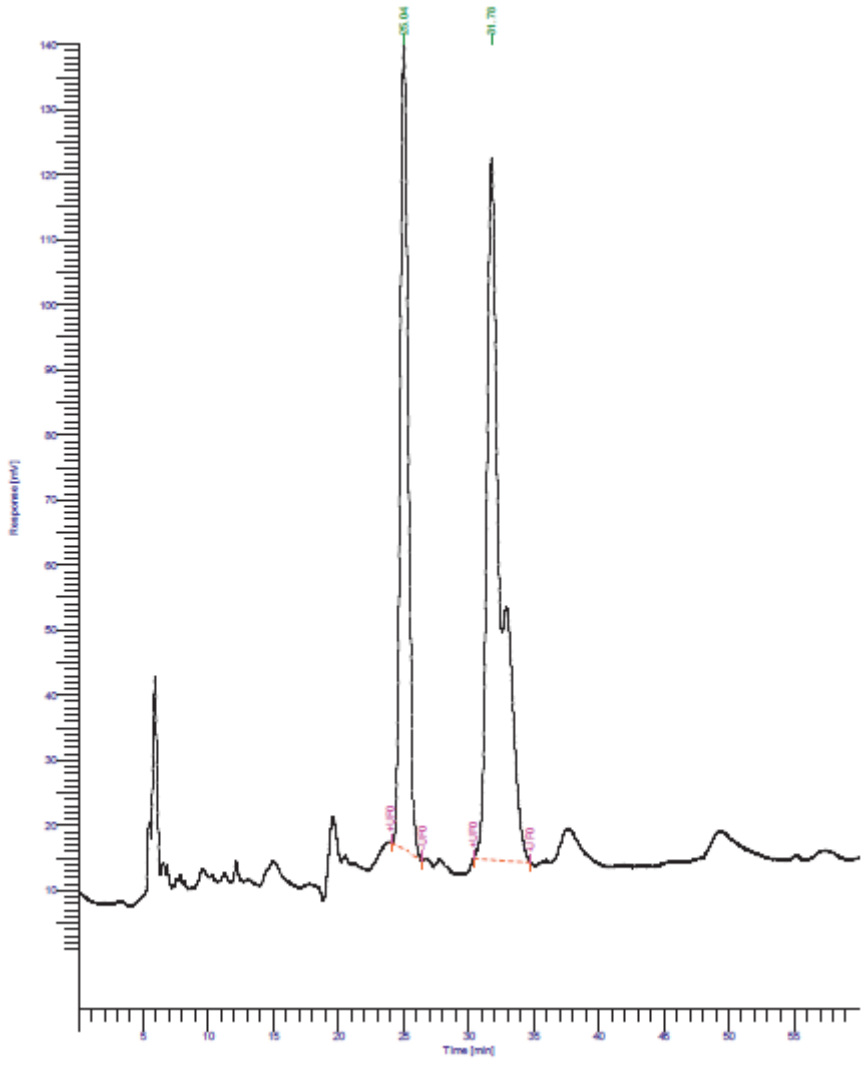
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		25.036	7524018.48	123777.51	47.62	47.62			*MM	7.5240	7.5240
2		31.783	8276041.21	107730.29	52.38	52.38			*MM	8.2760	8.2760
			15800059.69	231507.80	100.00	100.00				15.8001	15.8001

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4c**

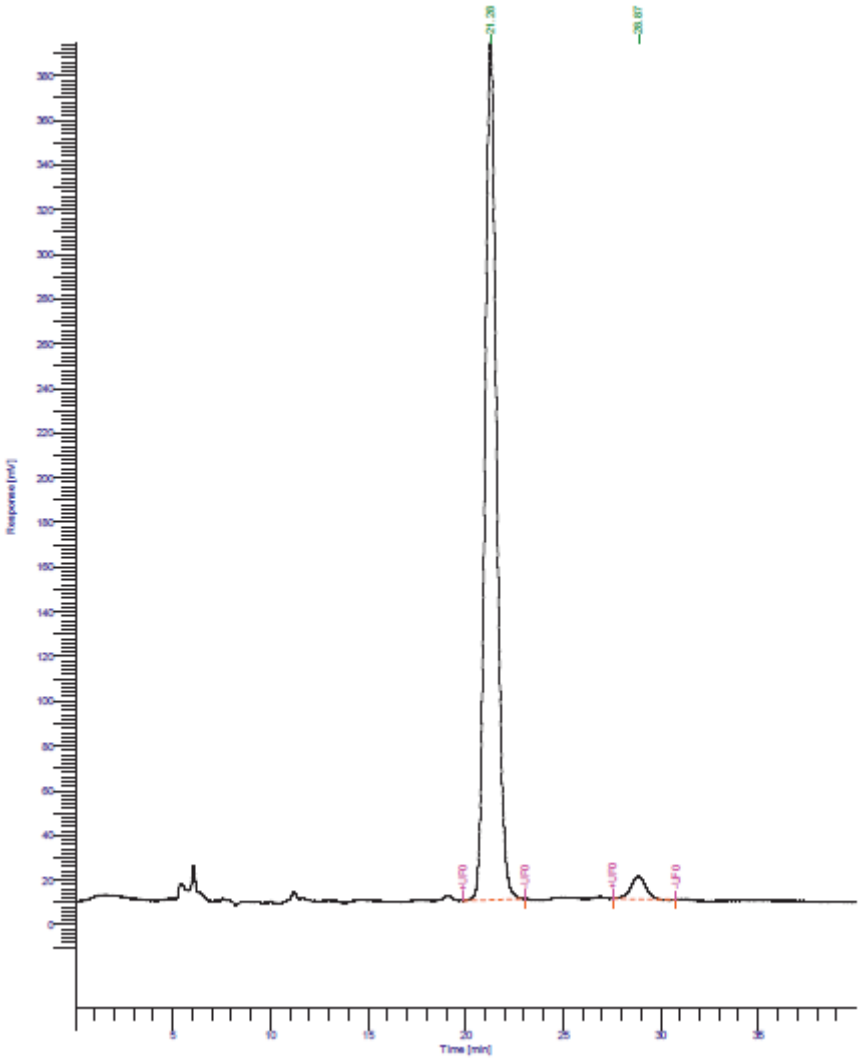
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		21.281	15814197.72	383764.42	96.66	96.66			*MM	15.8142	15.8142
2		28.871	546550.70	10557.47	3.34	3.34			*MM	0.5466	0.5466
			16360748.42	394321.89	100.00	100.00				16.3607	16.3607

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



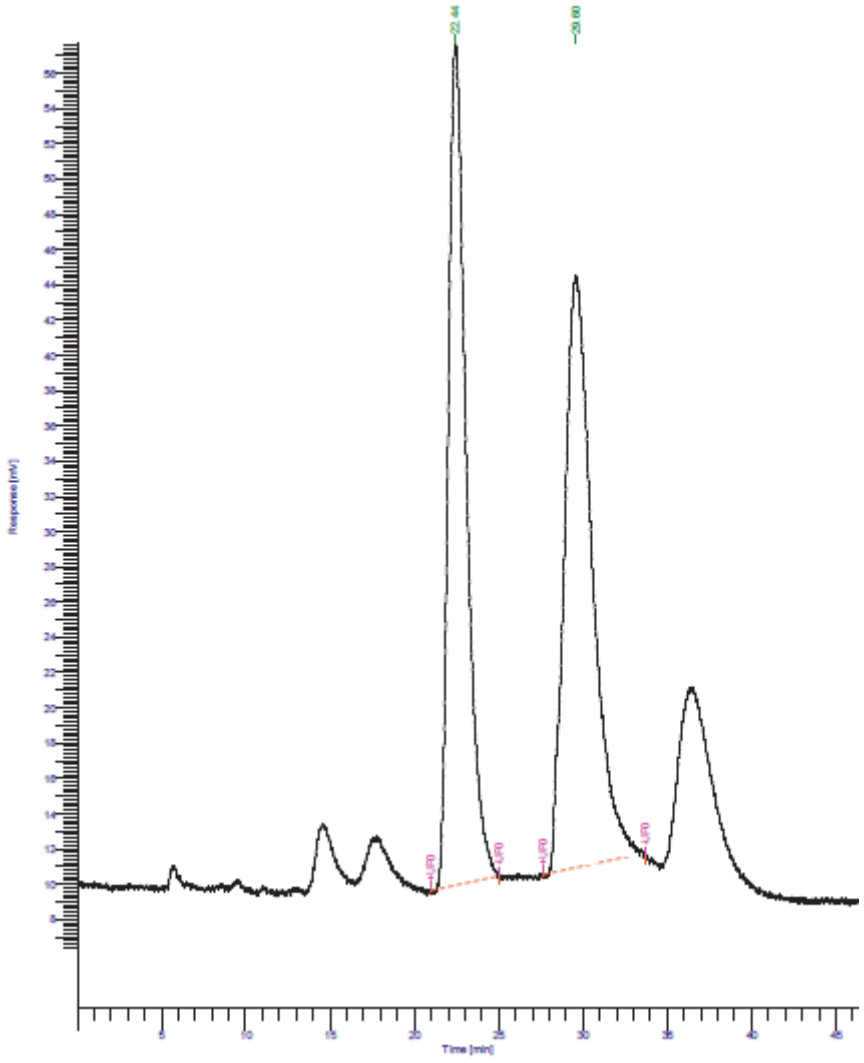
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		22.440	3513658.12	47823.64	54.41	54.41			*MM	3.5137	3.5137
2		29.597	2944221.48	29335.04	45.59	45.59			*MM	2.9442	2.9442
			6457879.60	77158.67	100.00	100.00				6.4579	6.4579

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4d**

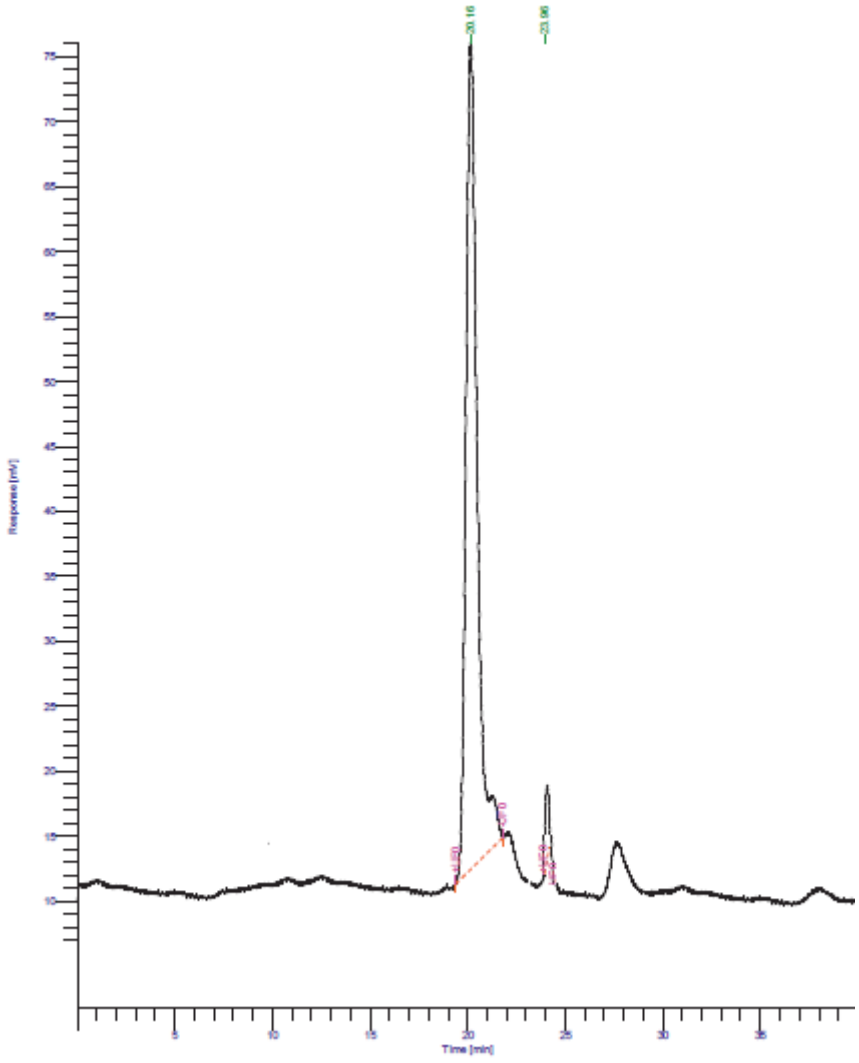
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		20.159	2566526.93	63644.08	94.24	94.24			*MM	2.5665	2.5665
2		23.958	156846.91	9312.72	5.76	5.76			*MM	0.1568	0.1568
			2723373.85	72956.80	100.00	100.00				2.7234	2.7234

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



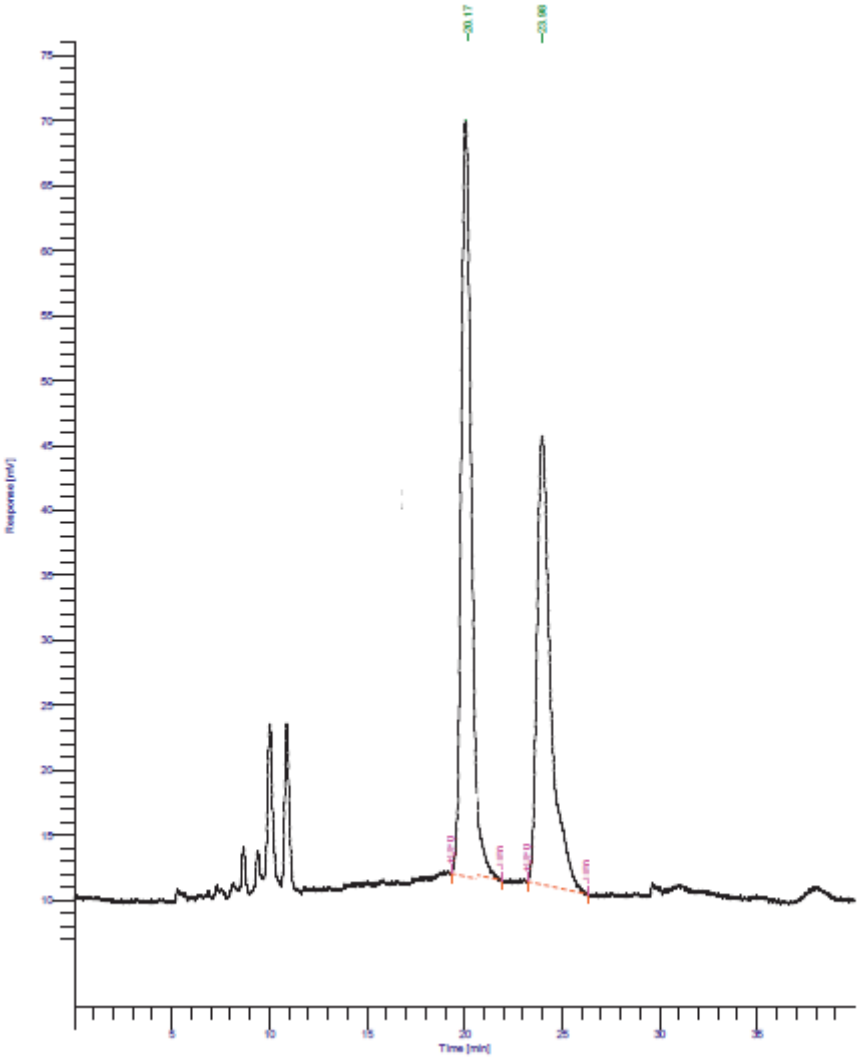
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		20.174	1851402.87	55596.42	52.19	52.19			*MM	1.8514	1.8514
2		23.980	1695971.53	34518.28	47.81	47.81			*MM	1.6960	1.6960
			3547374.41	90114.70	100.00	100.00				3.5474	3.5474

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4e**

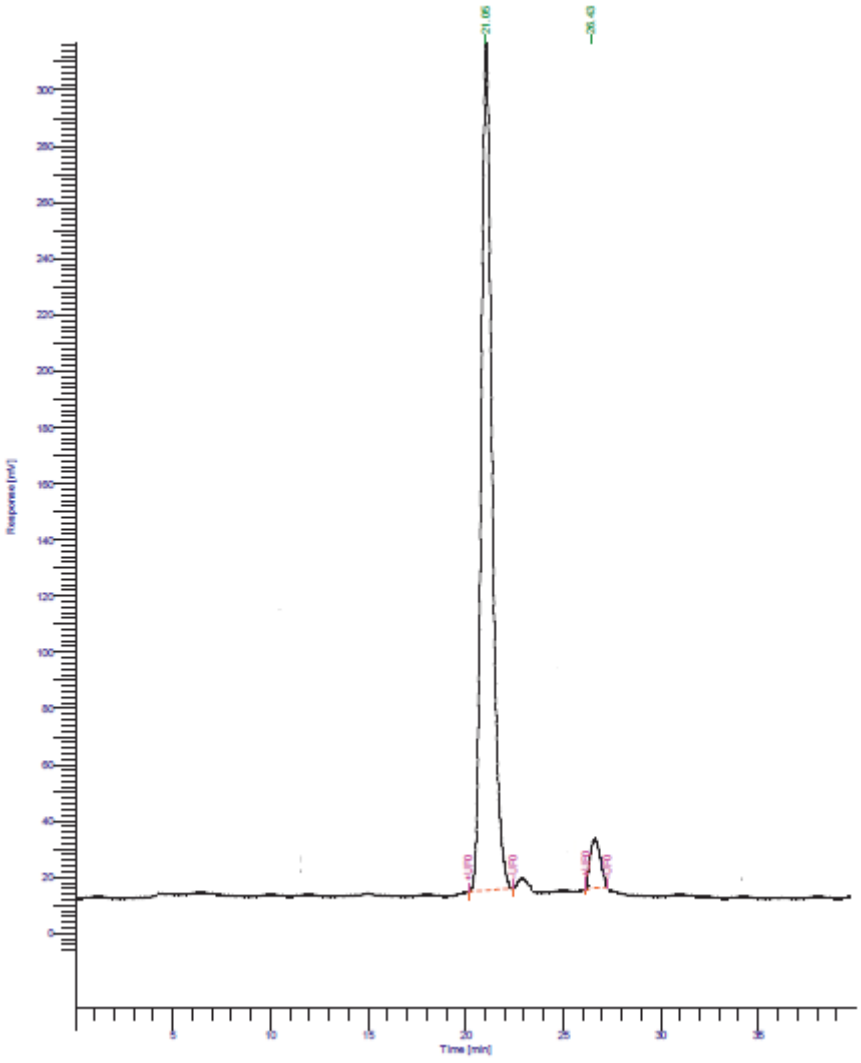
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		21.047	11620941.24	301696.99	94.74	94.74			*MM	11.6209	11.6209
2		26.429	644842.10	17482.85	5.26	5.26			*MM	0.6448	0.6448
			12265783.34	319179.84	100.00	100.00				12.2658	12.2658

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



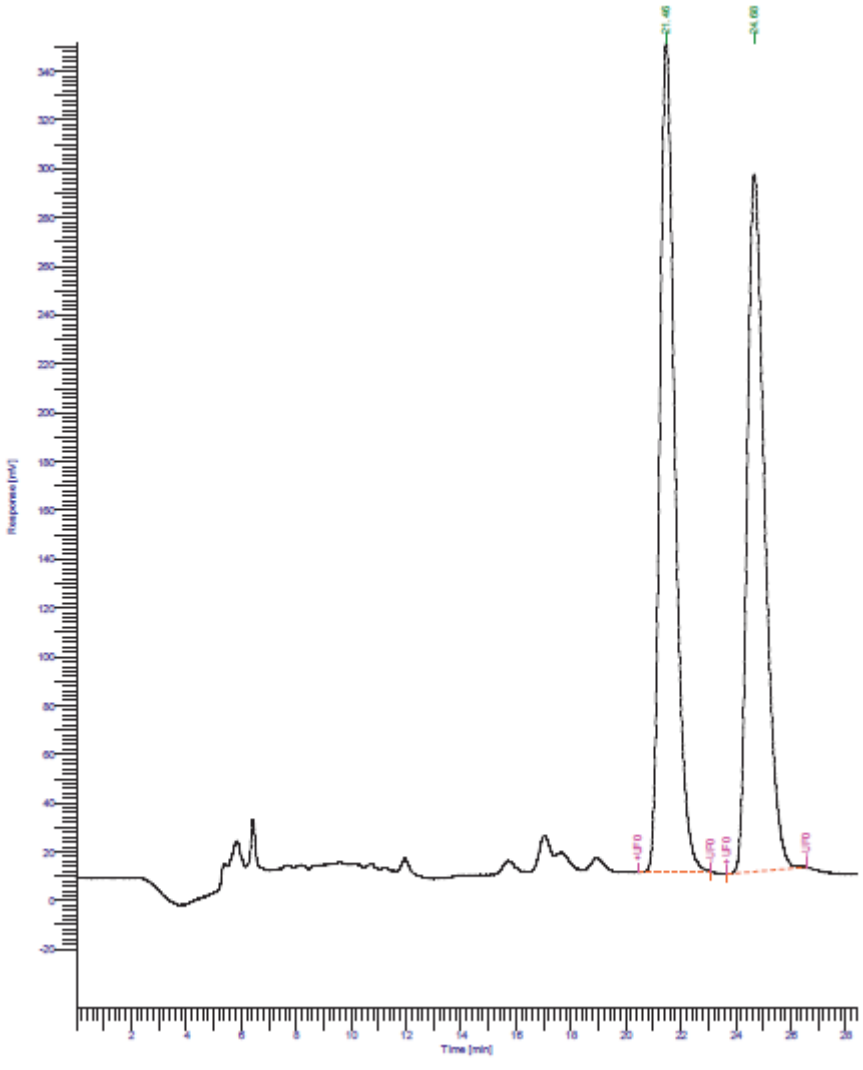
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		21.465	13030290.32	340131.27	50.81	50.81			*MM	13.0303	13.0303
2		24.677	12615184.93	285791.87	49.19	49.19			*MM	12.6152	12.6152
			25645475.25	625923.14	100.00	100.00				25.6455	25.6455

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4f**

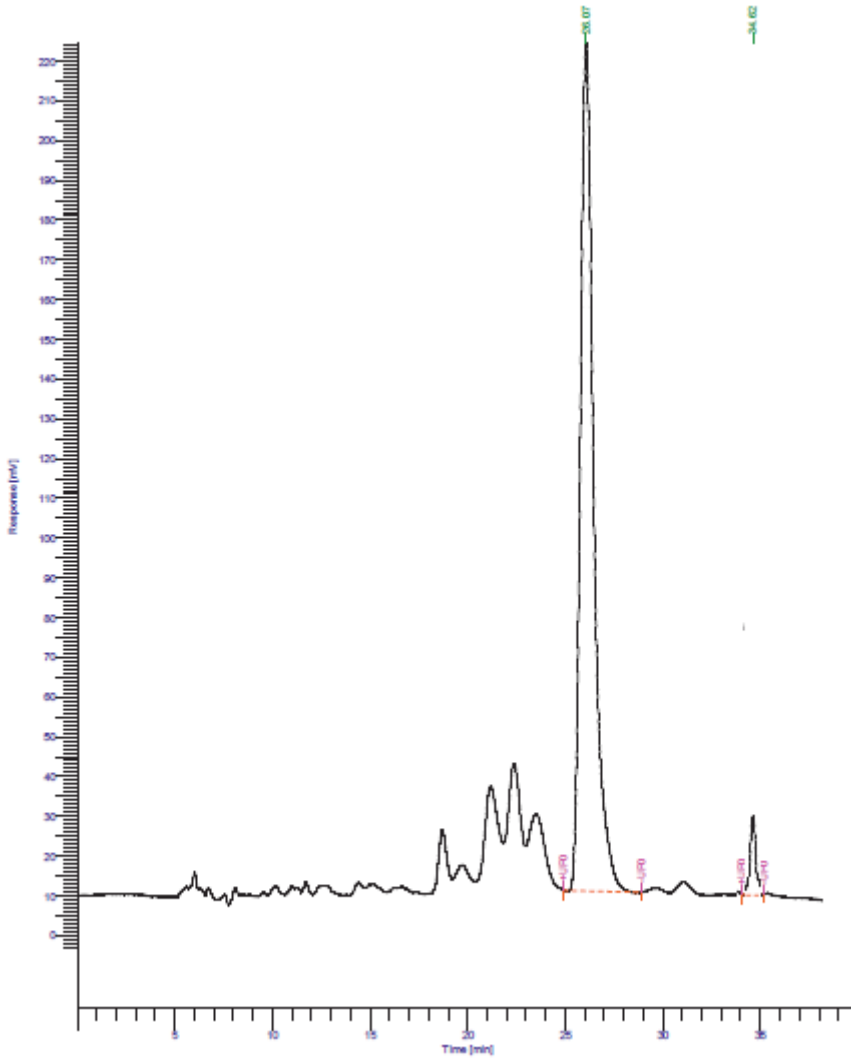
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		26.070	9998147.15	213485.45	95.23	95.23			*MM	9.9981	9.9981
2		34.621	501248.44	25979.40	4.77	4.77			*MM	0.5012	0.5012
			10499395.59	239464.86	100.00	100.00				10.4994	10.4994

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



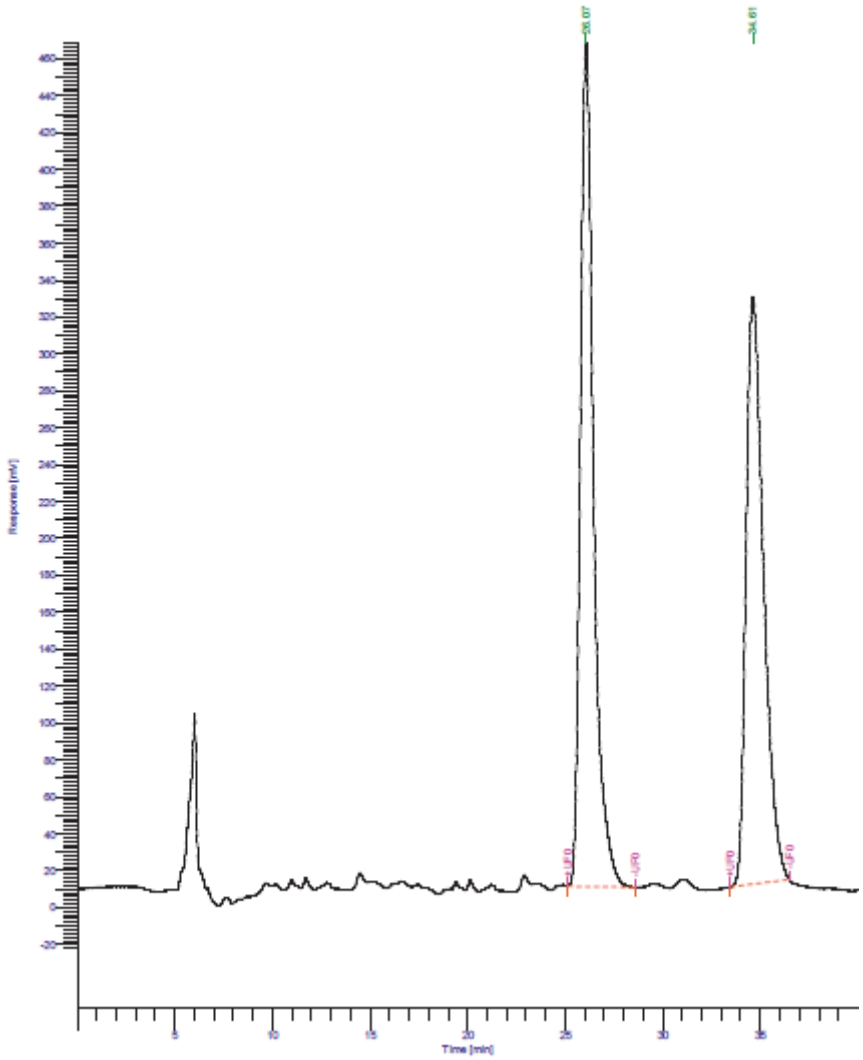
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		26.070	21393298.04	457365.91	51.97	51.97			*MM	21.3933	21.3933
2		34.613	19773924.81	318457.55	48.03	48.03			*MM	19.7739	19.7739
			41167222.86	775823.46	100.00	100.00				41.1672	41.1672

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4g**

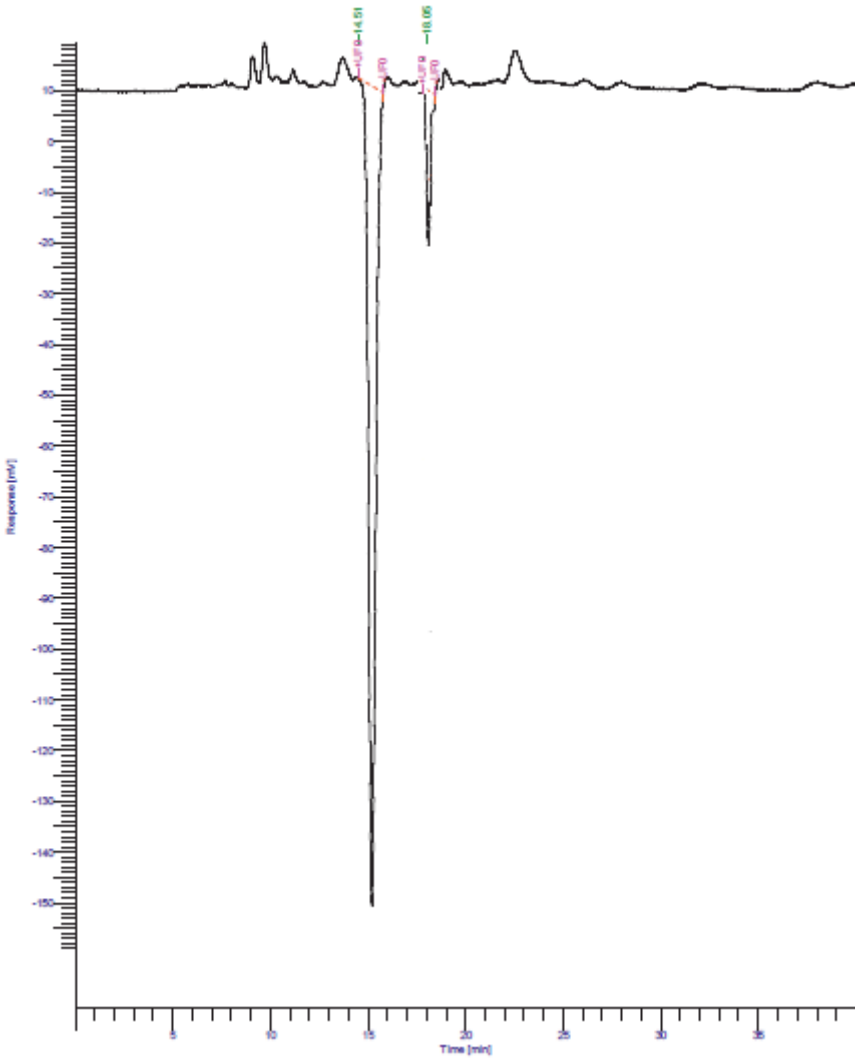
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		14.513	3985509.70	-5.82	95.52	95.52			*MM	3.9855	3.9855
2		18.047	186961.93	-610.54	4.48	4.48			*MM	0.1870	0.1870
			4172471.62	-616.36	100.00	100.00				4.1725	4.1725

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



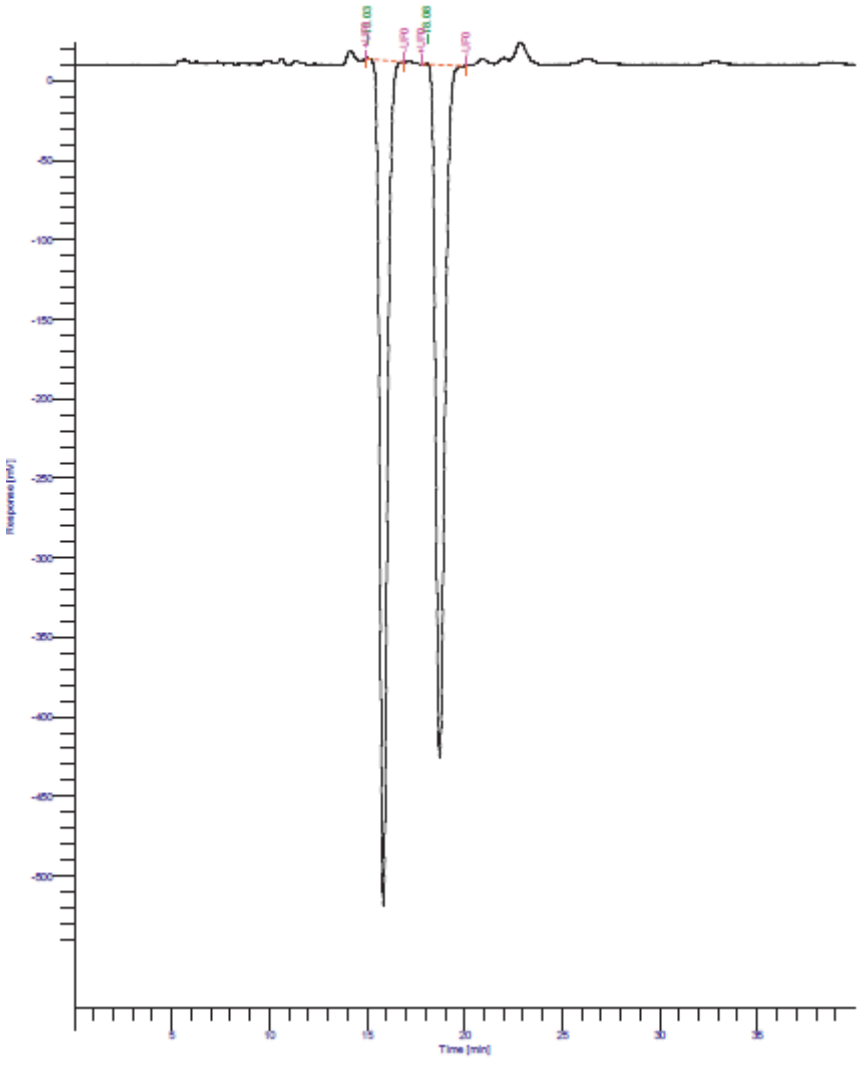
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		15.026	2475.59	446.90	47.94	47.94			*MM	0.0025	0.0025
2		18.084	2687.89	360.29	52.06	52.06			*MM	0.0027	0.0027
			5163.49	807.19	100.00	100.00				0.0052	0.0052

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4h**

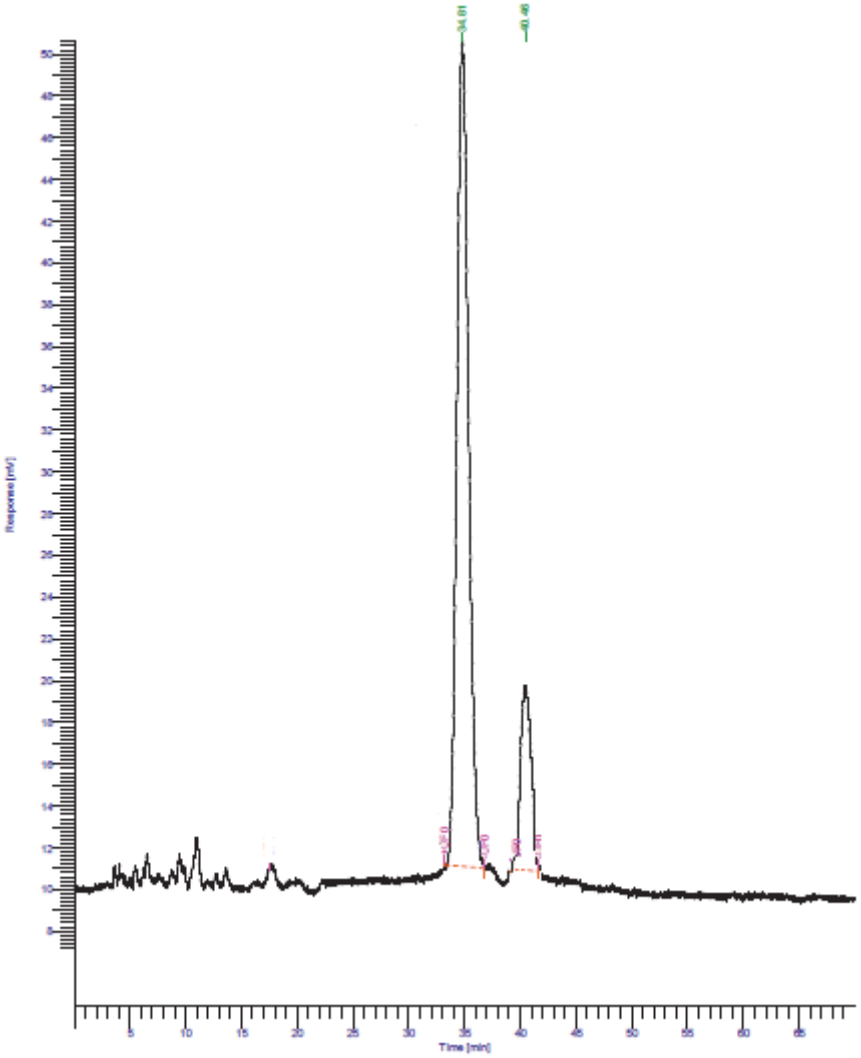
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		34.811	2887736.87	39546.49	84.68	84.68			*MM	2.8877	2.8877
2		40.458	522405.47	8446.39	15.32	15.32			*MM	0.5224	0.5224
			3410142.34	47992.88	100.00	100.00				3.4101	3.4101

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



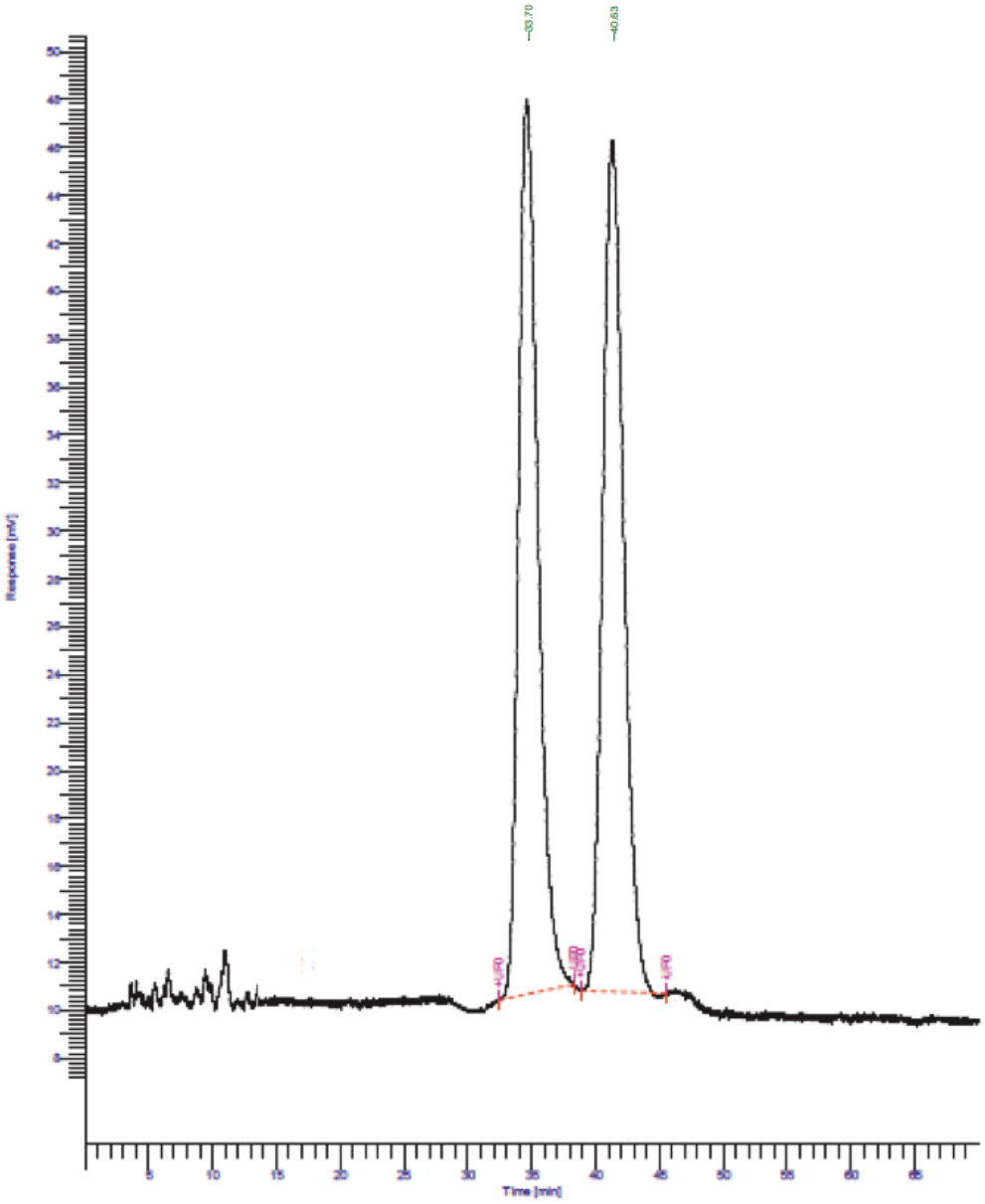
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		33.704	11103085.96	120356.98	49.21	49.21			*MM	11.1031	11.1031
2		40.627	11457920.72	114391.12	50.79	50.79			*MM	11.4579	11.4579
			22561006.68	234748.09	100.00	100.00				22.5610	22.5610

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4i**

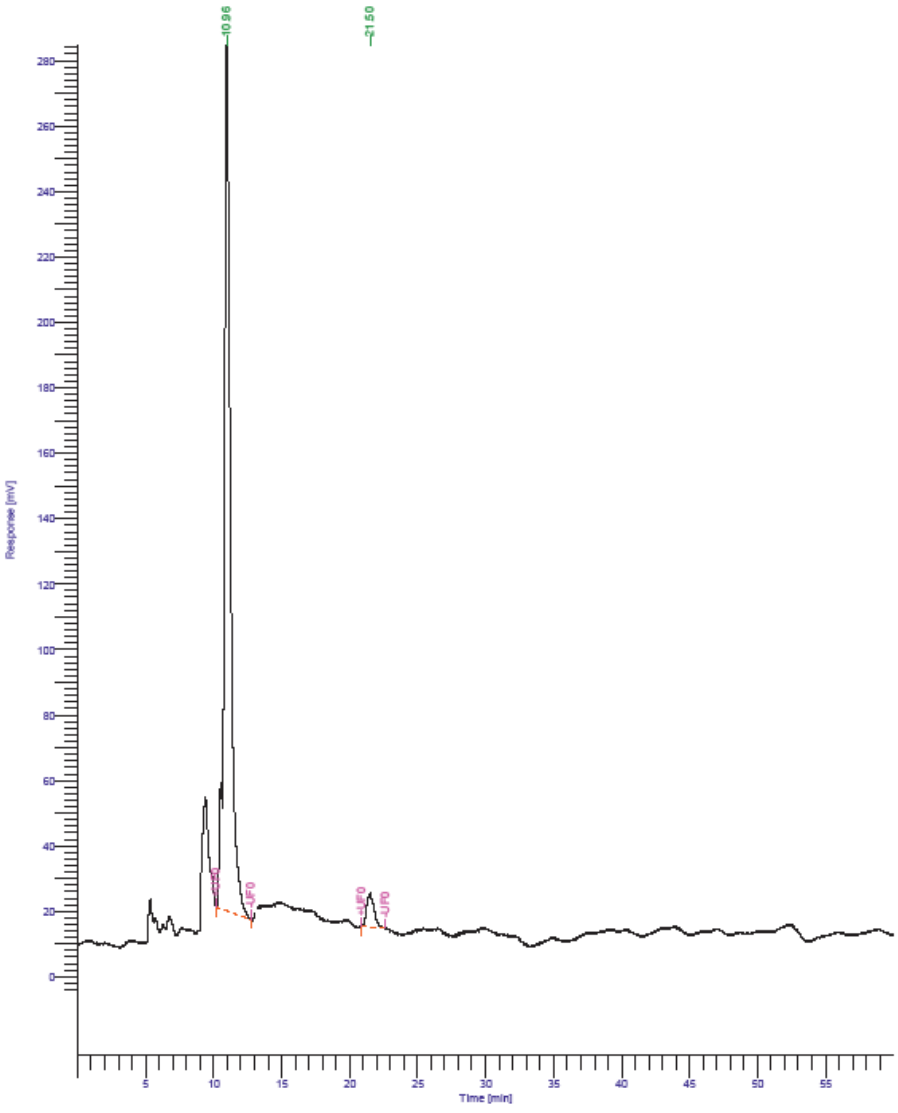
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		10.963	8292999.03	264686.55	95.55	95.55			*MM	8.2930	8.2930
2		21.501	385952.34	10258.69	4.45	4.45			*MM	0.3860	0.3860
			8678951.37	274945.23	100.00	100.00				8.6790	8.6790

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



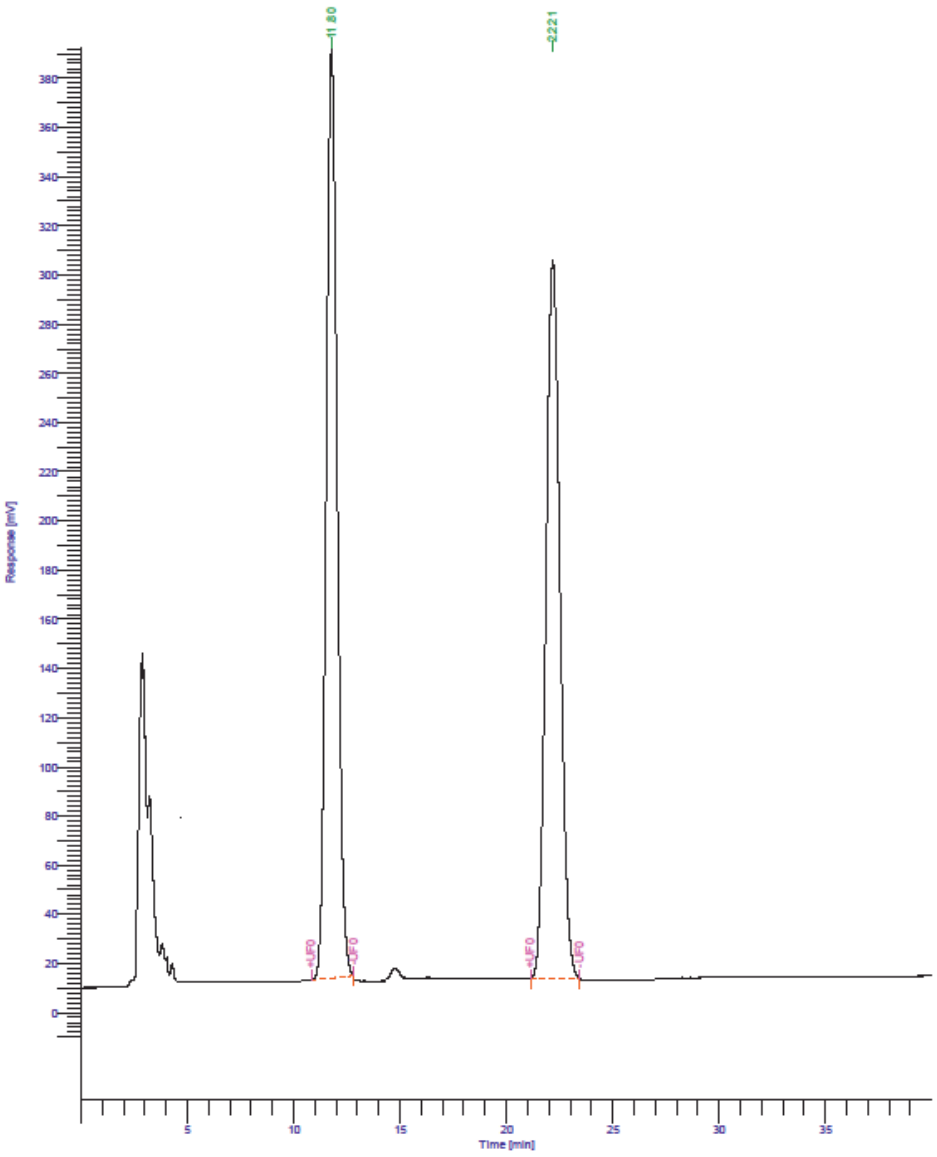
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		11.803	13588185.55	378660.86	50.12	50.12			*MM	13.5882	13.5882
2		22.207	13521557.26	292169.26	49.88	49.88			*MM	13.5216	13.5216
			27109742.81	670830.12	100.00	100.00				27.1097	27.1097

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4j**

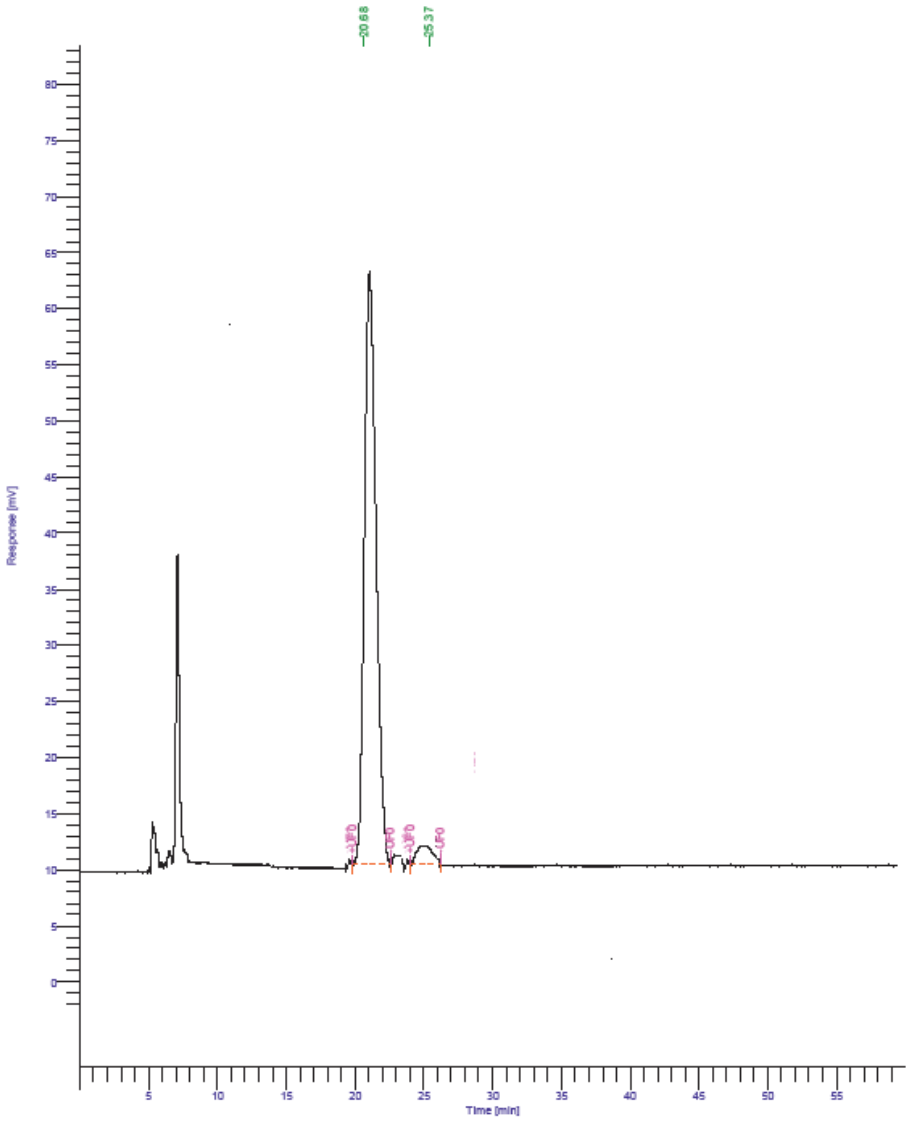
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		20.680	875775.86	24580.93	95.34	95.34			*MM	0.8758	0.8758
2		25.337	42847.99	4387.82	4.66	4.66			*MM	0.0428	0.0428
			918623.84	28968.76	100.00	100.00				0.9186	0.9186

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



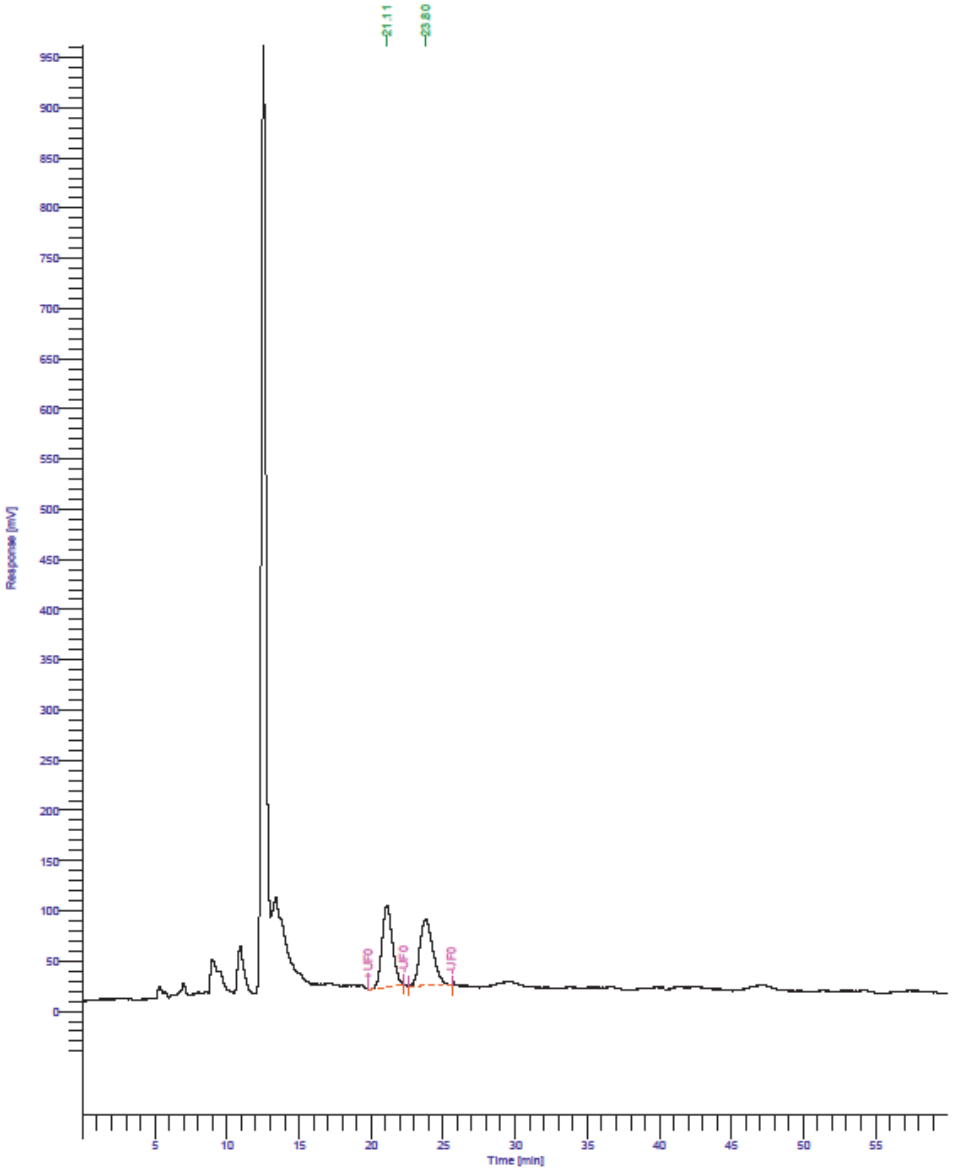
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		21.105	4026077.49	81595.88	49.17	49.17			*MM	4.0261	4.0261
2		23.797	4162187.75	65771.46	50.83	50.83			*MM	4.1622	4.1622
			8188265.24	147367.33	100.00	100.00				8.1883	8.1883

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4k**

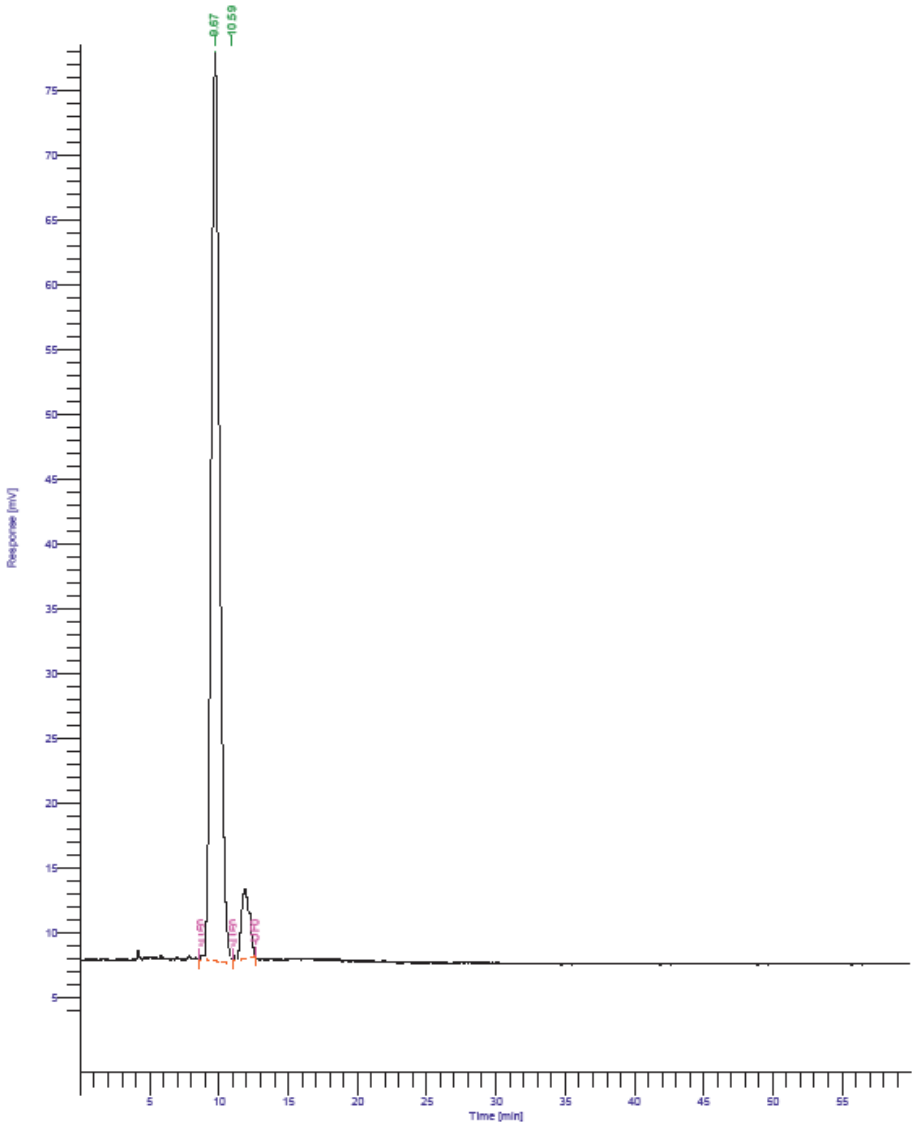
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		9.673	1279729.78	60909.74	93.67	93.67			*MM	1.2797	1.2797
2		10.589	1095743.06	64493.19	6.33	6.33			*MM	1.0957	1.0957
			2375472.84	125402.93	100.00	00.00				2.3755	2.3755

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



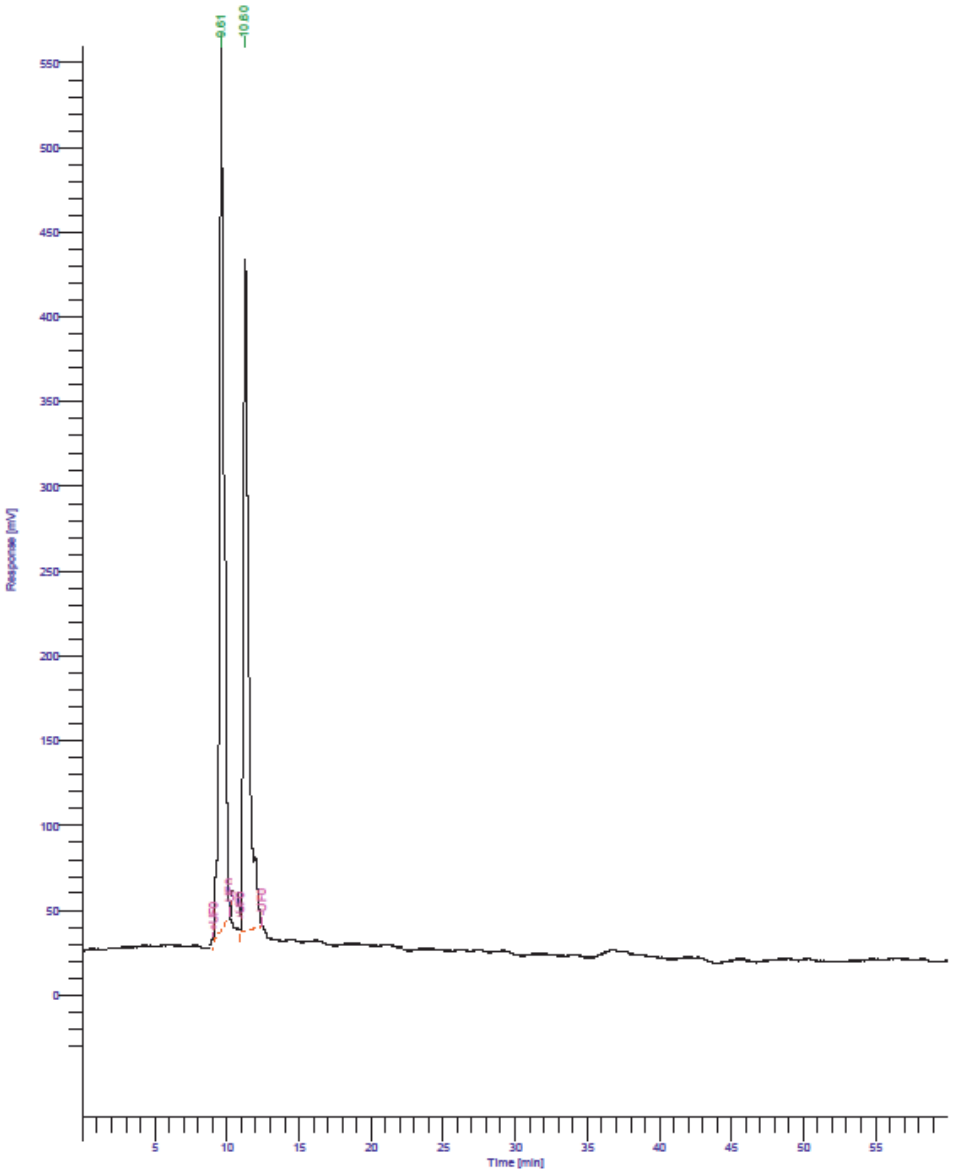
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		9.614	11483168.33	521382.76	49.17	49.17			*MM	11.4832	11.4832
2		10.597	2153549.42	134403.76	50.83	50.83			*MM	2.1535	2.1535
			13636717.75	655786.52	100.00	100.00				13.6367	13.6367

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4l**

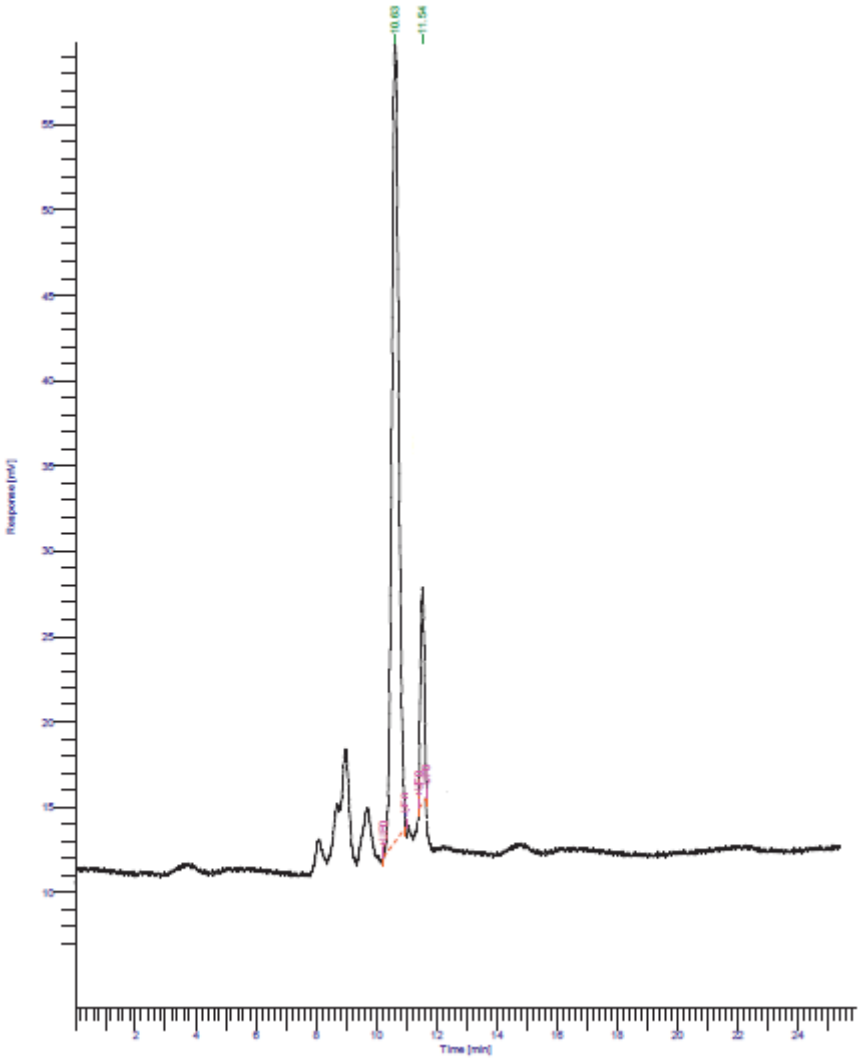
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		10.626	760779.44	46877.16	87.26	87.26			*MM	0.7608	0.7608
2		11.543	111054.89	12666.25	12.74	12.74			*MM	0.1111	0.1111
			871834.33	59543.41	100.00	100.00				0.8718	0.8718

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



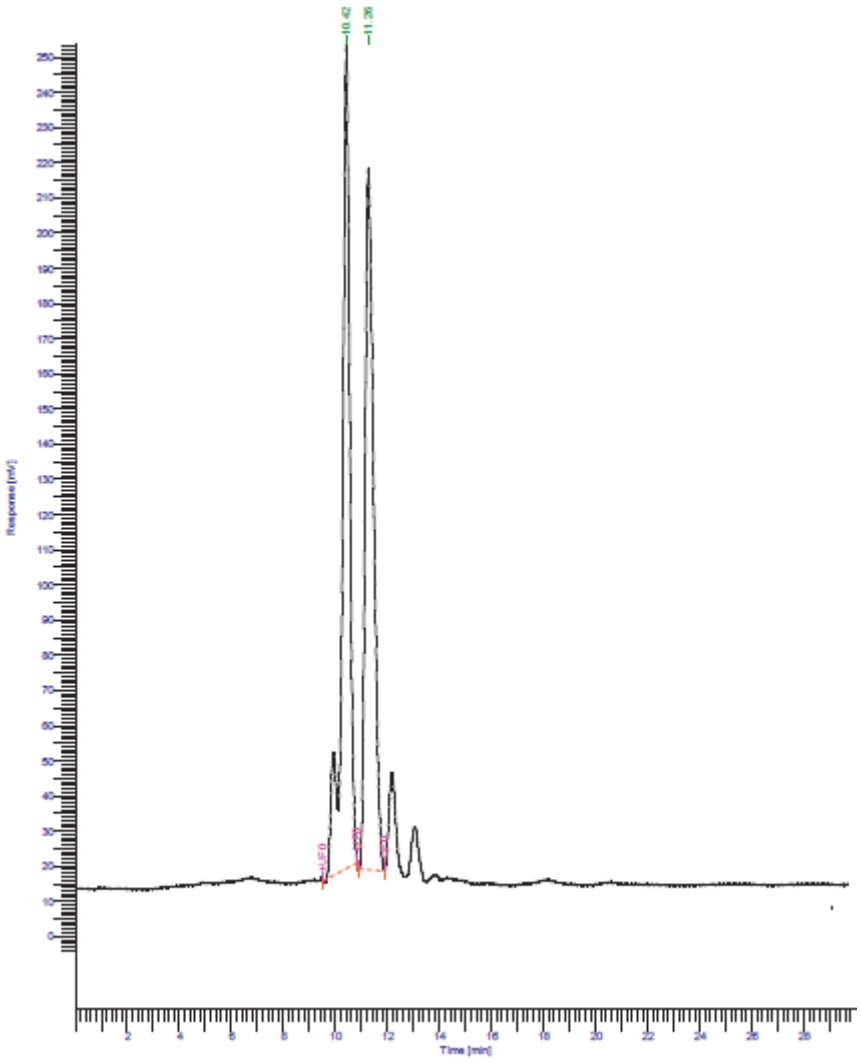
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		10.421	4735158.98	234566.81	51.23	51.23			*MM	4.7352	4.7352
2		11.264	4508570.90	199301.53	48.77	48.77			*MM	4.5086	4.5086
			9243729.88	433868.34	100.00	100.00				9.2437	9.2437

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



Compound **4m**

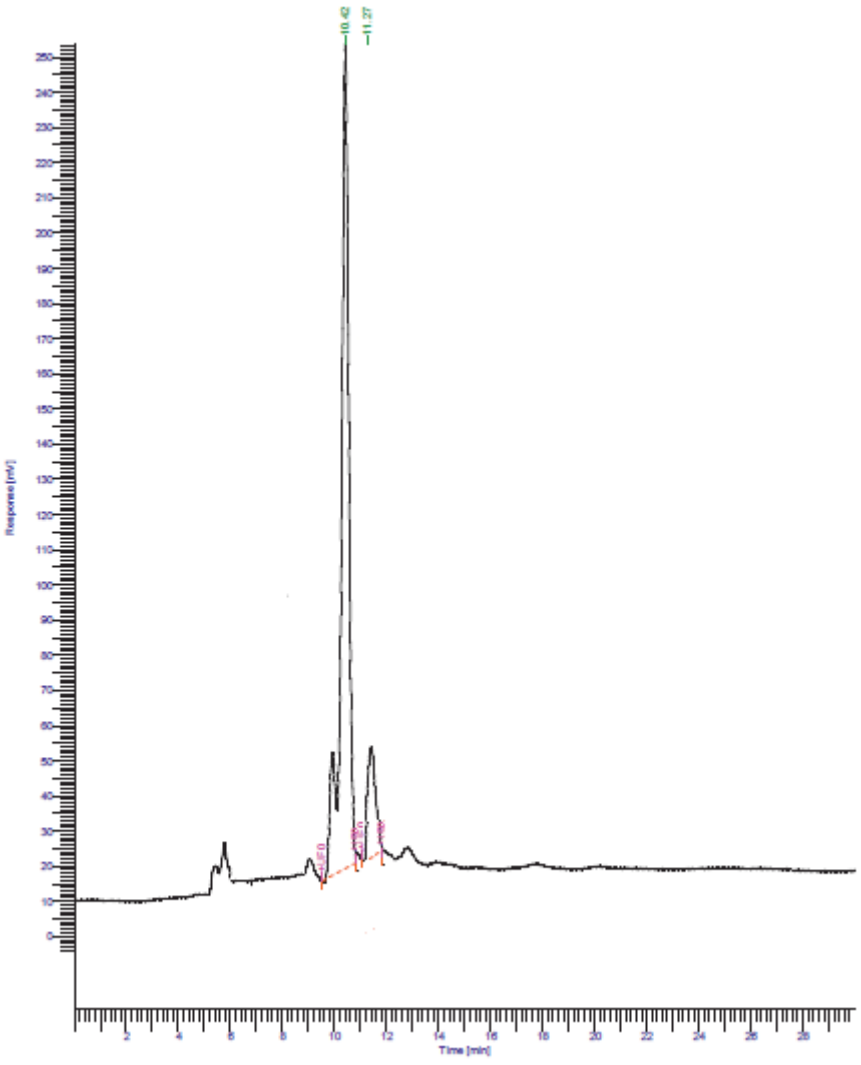
DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		10.421	4735158.98	234566.81	88.52	88.52			*MM	4.7352	4.7352
2		11.271	614128.48	60721.21	11.48	11.48			*MM	0.6141	0.6141
			5349287.46	295288.02	100.00	100.00				5.3493	5.3493

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found



DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [uV*sec]	Height [uV]	Area [%]	Norm. Area [%]	Cal. Range	Volt Range	BL	Raw Amount	Adjusted Amount
1		8.331	20650676.04	1.22e+06	49.48	49.48			*MM	20.6507	20.6507
2		9.563	21086575.66	1.17e+06	50.52	50.52			*MM	21.0866	21.0866
			41737251.70	2.40e+06	100.00	100.00				41.7373	41.7373

Missing Component Report

Component	Expected Retention (Calibration File)

All components were found