Supporting Information

Stereoselective synthesis of highly functionalized tetrahydrocarbazoles through a domino Michael-Henry reaction: an easy access of four contiguous chiral centers

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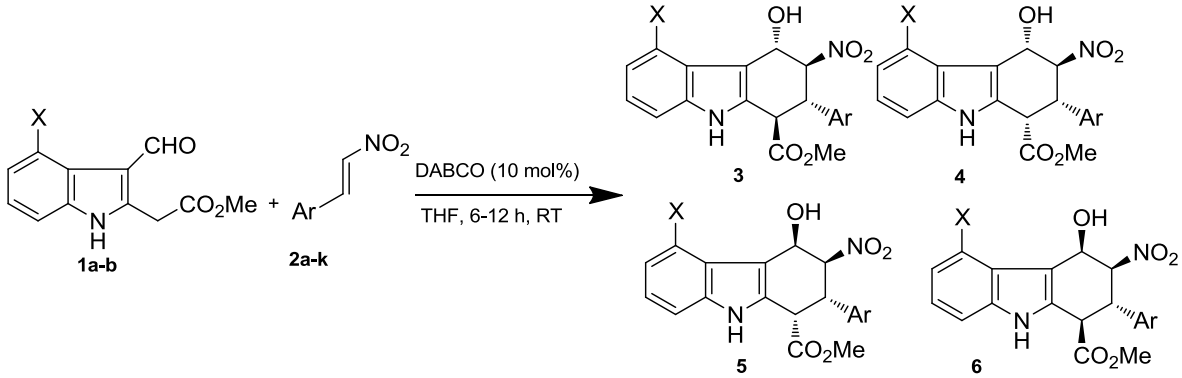
1. General information

All reactions were carried out under air and monitored by TLC using Merck 60 F_{254} pre coated silica gel plates (0.25 mm thickness) and the products were visualized by UV detection. Flash chromatography was carried out with silica gel (200-300 mesh). FT-IR spectra were recorded on a Bruker Tensor-27 spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker Avance (III) 400 MHz spectrometer. Data for ^{1}H NMR are reported as a chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, q = quartet, m = multiplet), coupling constant *J* (Hz), integration, and assignment, data for ^{13}C are reported as a chemical shift. High resolutions mass spectral analyses (HRMS) were carried out using ESI-TOF-MS. HPLC analysis was performed on YL-9100 HPLC, UV detection monitored at appropriate wavelength respectively, using Chiralcel AD-H (0.46 cm x 25 cm) column.

Materials: All β-nitrostyrenes and organocatalyst either synthesized by literature known procedure or purchased from commercial sources**.**

General experimental procedure for the synthesis of highly functionalized tetrahydrocarbazole derivatives (entry 1-18, Table 2):



To a stirred mixture of methyl 3-formyl-1*H*-indole-2-acetates[1] (**1a-b**, 0.20 mmol) and β-nitrostyrenes (**2a-k**, 0.25 mmol) in dry THF (1.0 mL) was added catalyst DABCO (10 mol%) at room temperature for 6-12h (monitored by TLC). After that, THF was evaporated by rotary evaporator under reduced pressure. The crude product was extracted with ethyl acetate, washed with water, dried over Na_2SO_4. The evaporation of the solvent left the crude product which was purified by column chromatography over silica-gel 230-400 mesh using EtOAc/hexane as eluent to furnish the pure product. All the products were fully characterized by their corresponding spectroscopic data (IR, ^{1}H and ^{13}C NMR and HRMS). The diastereomeric ratio was determined by ^{1}H NMR data of crude product and relative configurations were assigned by their coupling constants (*J*) values of the corresponding vicinal H-atoms (**Figure 1**).

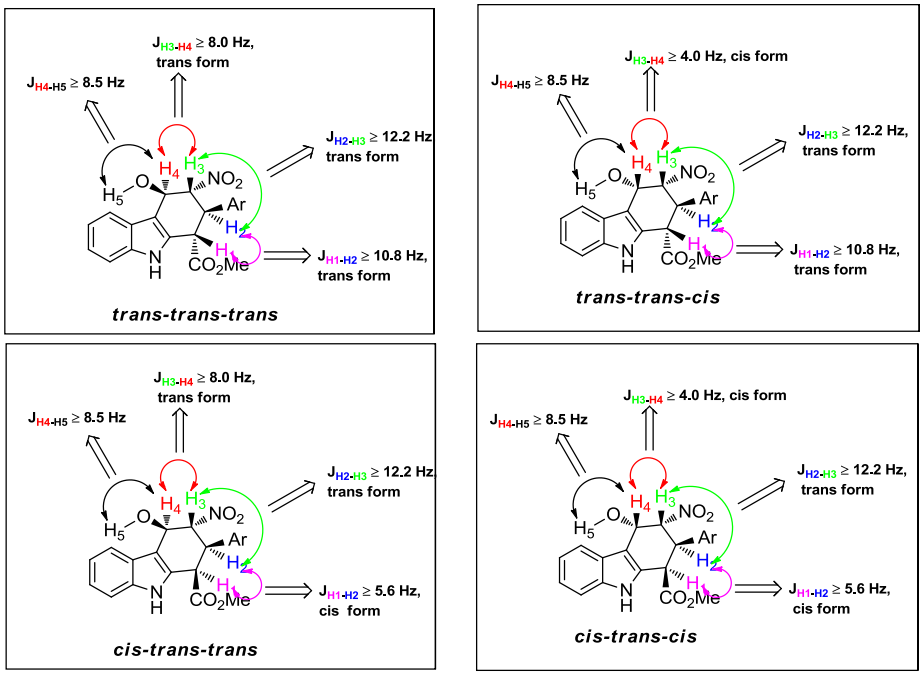
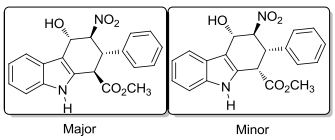


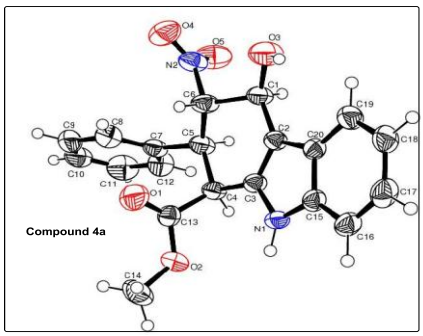
Figure 1 Schematic view of determination of relative configurations

4-Hydroxy-3-nitro-2-phenyl-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 1, Table 2)



Yield 90 %; **IR** (KBr) ν 3446, 3384, 2958, 2922, 2852, 1737, 1633, 1546, 1458, 1317 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d6)** δ (mixture of diastereomers, **3a:4a = 83:17**) 10.32 (s, 0.17H), 10.18 (s, 0.83H), 7.84-7.80 (m, 0.83H), 7.54-7.47 (m, 1.66H), 7.41-7.26 (m, 4.68H), 7.17-7.09 (m, 1H), 7.07-7.02 (m, 0.83H), 5.98 (dd, *J* = 8.04, 12.28 Hz, 0.17H), 5.70 (td, *J* = 8.46, 2.0 Hz, 0.83H), 5.58 (t, 8.28 Hz, 0.17H), 5.31 (dd, *J* = 8.52, 12.28 Hz, 0.83H), 5.21 (d, *J* = 8.24 Hz, 0.83H), 5.00 (d, *J* = 7.28 Hz, 0.17H), 4.52 (dd, *J* = 2.28, 10.8 Hz, 0.83H), 4.29 (d, *J* = 5.52 Hz, 0.17H), 4.20 (dd, *J* = 5.76, 12.32 Hz, 0.17H), 4.08 (dd, *J* = 10.8, 12.28 Hz, 0.83H), 3.59 (s, 2.49H), 3.45 (s, 0.51H); **^{13}C NMR (100 MHz, acetone-d_6)** δ (**major diastereomer 3a)** 170.9, 138.3, 137.8, 129.6, 129.5, 129.5, 129.0, 123.0, 121.0, 120.4, 112.2, 112.2, 112.1, 96.2, 71.0, 52.9, 48.7, 48.4; **HRMS** (ESI) m/z calcd For $C_{20}H_{18}N_2O_5$ $[M+Na]^+$ 389.1113; Found 389.1108.

The relative configurations of compounds **3a** and **4a** were further confirmed by their single crystal X-ray diffraction data.



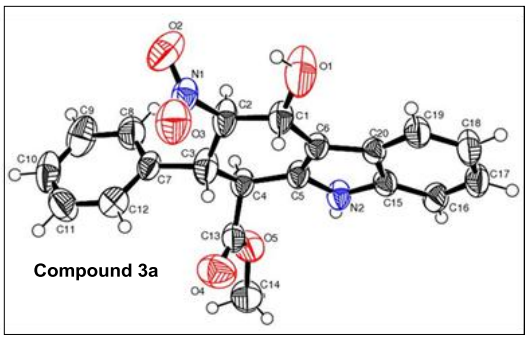
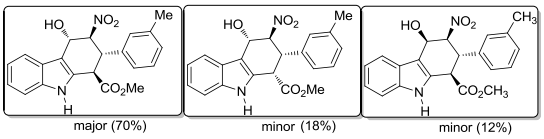


Table 1. Crystal data and structure refinement for **3a and 4a**

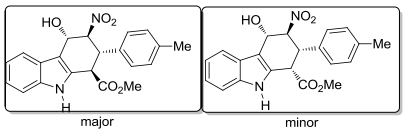
Compound	**Compound 3a**	**Compound 4a**
Empirical formula	$C_{20}H_{18}N_2O_5$	$C_{20}H_{18}N_2O_5$
Molecular weight	366.36	366.36
Temperature	150(2) K	150(2) K
Wavelength (Å)	0.71073 A	0.71073 A
Crystal system, space group	Monoclinic, P 21/c	Monoclinic, P 21/n
a (Å) *b* (Å) *c* (Å) α (°) β (°) γ (°)	a = 9.0098(8) A b = 11.0194(11) A c = 18.008(2) A alpha = 90 deg. beta = 101.284(10) deg. gamma = 90 deg.	a = 8.8760(2) A b = 11.1516(2) A c = 17.9923(6) A alpha = 90 deg. beta = 104.062(3) deg. gamma = 90 deg.
Volume ($Å^3$)	1753.3(3) A^3	1727.54(8) A^3
Z, Calculated density (mg/m^3)	4, 1.388 Mg/m^3	4, 1.409 Mg/m^3
Absorption coefficient (mm^{-1})	0.101 mm^-1	0.103 mm^-1
F(000)	768	768
Crystal size (mm)	0.33 x 0.26 x 0.21 mm	0.34 x 0.28 x 0.21 mm
θ range (deg)	2.92 to 25.00 deg.	2.99 to 25.00 deg.
Limiting indices	-10<=h<=10, -12<=k<=13, -21<=l<=21	-10<=h<=10, -13<=k<=13, -20<=l<=21
Reflections collected / unique	15508 / 3067 [R(int) = 0.0286]	15096 / 3034 [R(int) = 0.0257]
Completeness to θ = 25.00	99.9 %	99.8 %
Max. and min. transmission	0.9791 and 0.9675	0.9788 and 0.9660
Data / restraints / parameters	3067 / 0 / 245	3034 / 0 / 245
Goodness-of-fit on F^2	1.066	1.093
Final R indices [I>2sigma(I)]	R1 = 0.0971, wR2 = 0.2502	R1 = 0.0832, wR2 = 0.2457
R indices (all data)	R1 = 0.1054, wR2 = 0.2567	R1 = 0.0888, wR2 = 0.2516
Largest diff. peak and hole ($e.A^{-3}$)	1.081 and -0.841 e.A^-3	1.484 and -0.549 e.A^-3
CCDC	**928334**	**928335**

4-Hydroxy-3-nitro-2-(3-methylphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 2, Table 2):



Yield 87%; **IR (KBr)** ν 3440, 3381, 2950, 2922, 1733, 1632, 1546, 1458, 1317 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d_6)** δ (mixture of diastereomers **3b:4b = 81:19**) 10.30 (s, 0.19H), 10.15 (s, 0.81H), 7.83-7.80 (m, 0.81H), 7.38-7-35 (m, 1.19H), 7.29-7.20 (m, 2.81H), 7.18-7.11 (m, 2.19H), 7.07-7.02 (m, 1H), 5.96 (dd, *J* = 8.0, 12.28 Hz, 0.19H), 5.68 (td, *J* = 2.52, 8.52 Hz, 0.81H), 5.57 (td, *J* = 0.76, 8.04 Hz, 0.19H), 5.29 (d, *J* = 8.28, 12.04 Hz, 0.81H), 5.24 (d, *J* = Hz 9.04, 0.19H), 5.16 (d, *J* = 8.28 Hz, 0.81H), 4.51 (dd, *J* = 2.28, 10.8 Hz, 0.81H), 4.26 (dd, *J* = 0.76, 5.8 Hz, 0.19H), 4.15 (dd, *J* =6.0, 12.56 Hz, 0.19H), 4.04 (dd, *J* = 10.8, 12.4 Hz, 0.81H), 3.60 (s, 2.43H), 3.46 (s, 0.57H), 2.31 (s, 3.0H); **^{13}C NMR (100 MHz, acetone-d_6)** δ (**major diastereomer 3b)** 170.9, 139.0, 138.3, 137.8, 130.1, 129.7, 129.6, 129.4, 127.0, 126.5, 123.0, 121.0, 120.4, 112.2, 112.1, 96.3, 71.0, 52.9, 48.8, 48.3, 21.4; **HRMS** (ESI) m/z calcd For $C_{21}H_{20}N_2O_5$ $[M+Na]^+$ 403.1270; Found 403.1264.

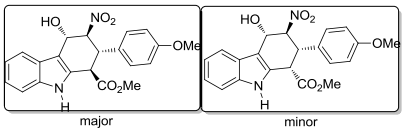
4-Hydroxy-3-nitro-2-(4-methylphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 3, Table 2):



Yield 91%; **IR (KBr)** ν 3442, 3387, 2950, 1735, 1611, 1547, 1458, 1317 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d_6)** δ (**mixture of diastereomers**, **3c:4c** = 78:22) 10.30 (s, 0.22H), 10.15 (s,

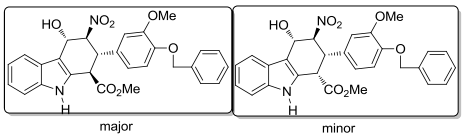
0.78H), 7.84-7.80 (m, 1H), 7.41-7.34 (m, 2.78H), 7.28-7.26 (m, 0.22H), 7.16-7.11 (m, 3H), 7.07-7.02 (m, 1H), 5.97 (dd, *J* = 8.12, 12.28 Hz, 0.22H), 5.69 (td, *J* = 8.28, 2.24 Hz, 0.78H), 5.58 (td, *J* = 9.04, 1.00 Hz, 0.22H), 5.27 (dd, *J* = 8.52 Hz, 12.28, 0.78H), 5.26 (d, *J* = 9.04 Hz, 0.22H), 5.19 (d, *J* = 8.28 Hz, 0.78H), 4.48 (dd, *J* = 2.28, 10.8 Hz, 0.78H), 4.26 (dd, *J* = 0.76, 6.04 Hz, 0.22H), 4.14 (dd, *J* = 6.00, 12.52 Hz, 0.22H,), 4.04 (dd, *J* = 10.76, 12.32 Hz, 0.78H), 3.60 (s, 2.34H), 3.50 (s, 0.66H), 2.29 (br s, 3H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ (**major diastereomer 3c)** 170.9, 138.6, 138.3, 134.7, 130.2, 129.3, 129.4, 127.0, 123.0, 121.0, 120.4, 112.2, 112.1, 96.3, 71.0, 52.9, 48.8, 48.0, 21.1; **HRMS** (ESI) m/z calcd For $C_{21}H_{20}N_2O_5$ $[M+Na]^+$ 403.1270; Found 403.1264.

4-Hydroxy-3-nitro-2-(4-methoxyphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 4, Table 2):



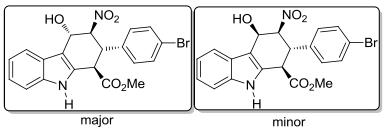
Yield 86%; **IR** (KBr) ν 3388, 3051, 3003, 2955, 2924, 2853, 1749, 1720, 1611, 1583, 1552, 1513, 1456, 1375 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 3d:4d** = 80:20) 10.30 (s, 0.20H), 10.16 (s, 0.80H), 7.84-7.80 (m, 0.80H), 7.66-7.64 (m, 0.20H), 7.45-7.43 (m, 0.20H), 7.41-7.37 (m, 2.60H), 7.32-7.30 (m, 0.20H), 7.15-7.02 (m, 2H), 6.91-6.87 (m, 2H), 5.94 (dd, *J* = 8.00, 12.28 Hz, 0.20H), 5.69 (td, *J* = 8.27, 2.24 Hz, 0.80H), 5.59 (m, 0.20H), 5.26 (dd, *J* = 8.52, 12.32 Hz, 0.80H), 5.25 (d, *J* = 9.04 Hz, 0.20H), 5.19 (d, *J* = 8.28 Hz, 0.80H), 4.48 (dd, *J* = 2.28, 10.80 Hz, 0.80H), 4.25 (dd, *J* = 0.72, 5.76 Hz, 0.20H), 4.12 (dd, *J* = 5.76, 12.28 Hz, 0.20H), 4.01 (dd, *J* = 10.8, 12.28 Hz, 0.80H), 3.77 (m, 3H), 3.60 (s, 2.40H), 3.48 (s, 0.60H); **^{13}C NMR (100 MHz, CD$_3$COCD$_3$)** δ **(major diastereomer 3d)** 171.0, 160.4, 138.3, 130.6, 130.2, 129.7, 129.5, 127.0, 122.9, 121.0, 120.4, 114.8, 112.2, 96.7, 70.9, 55.5, 52.8, 48.8, 47.7; **HRMS** (ESI) m/z calcd For $C_{21}H_{20}N_2O_6$ $[M+Na]^+$ 419.1219; Found 419.1214.

4-Hydroxy-3-nitro-2-(4-benzyloxy-3-methoxyphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 5, Table 2):



Yield 86%; **IR** (KBr) ν 3405, 3059, 3033, 2926, 2853, 1745, 1552, 1516, 1457, 1430, 1376cm^{-1}; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 3e:4e** = 84:16) 10.31 (s, 0.16H), 10.16 (s, 0.84H), 7.83-7.80 (m, 1H), 7.50-7.48 (m, 1.84H), 7.41-7.30 (m, 3.86H), 7.20-6.90 (m, 2.16H), 7.07-6.02 (m, 1.16H), 6.99-6.90 (m, 2H), 5.96 (dd, *J* = 8.04, 12.56 Hz, 0.16H), 5.71-5.68 (td, *J* = 8.28, 2.28 Hz, 1H), 5.59 (dd, *J* = 1.00, 9.04 Hz, 0.16H), 5.31 (d, *J* = 8.52 Hz, 12.28, 0.84H), 5.25 (d, *J* = 9.04 Hz, 0.16H), 5.20 (d, *J* = 8.04 Hz, 0.84H), 5.09 (s, 0.32H), 5.08 (s, 1.68H), 4.53 (dd, *J* = 2.28, 10.8 Hz, 0.84H), 4.28 (d, *J* = 5.28 Hz, 0.16H), 4.13 (dd, *J* = 5.76, 12.56 Hz, 0.16H,), 4.02 (dd, *J*= 10.8, 12.36 Hz, 0.84H), 3.83 (s, 2.52H), 3.81 (s, 0.48H), 3.61 (s, 2.52H), 3.47 (s, 0.48H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 3e)** 171.0, 150.8, 149.3, 138.5, 138.3, 130.6, 129.5, 129.3, 128.7, 128.6, 127.0, 122.9, 122.0, 121.0, 120.4, 114.5, 113.2, 112.2, 112.1, 96.3, 71.4, 70.9, 56.4, 52.9, 48.9, 48.1; **HRMS** (ESI) m/z calcd For $C_{28}H_{26}N_2O_7$ $[M+Na]^+$ 525.1638; Found 525.1632.

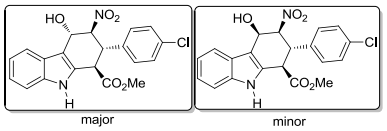
4-Hydroxy-3-nitro-2-(4-bromophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 6, Table 2):



Yield 87%; **IR** (KBr) ν 3522, 3388, 3058, 2955, 2924, 2953, 1732, 1622, 1591, 1490, 1458, 1375 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture diastereomers **3f:6f** = 78:22) 10.33 (s, 0.22H), 10.18 (s, 0.78H), 7.82-7-79 (m, 0.78H), 7.71-7.65 (m, 0.22H), 7.56-7.44 (m, 4H), 7.39-7.35 (m, 1H), 7.17-7.02 (m, 2H), 5.70 (td, *J* = 8.28, 2.28 Hz, 0.78H), 5.63 (m, 0.44H), 5.30 (dd, *J* = 8.52, 12.28 Hz, 0.78H), 5.24 (d, *J* = 8.0 Hz, 0.78H), 5.03 (d, *J* = 7.28 Hz, 0.22H), 4.54-4.53 (dd, *J* = 2.28, 10.8 Hz, 0.78H), 4.47 (dd, *J* =10.8, 11.8 Hz, 0.22H), 4.24 (d, *J* = 10.8 Hz, 0.22H), 4.08 (dd, *J* = 10.76 Hz, 12.28 0.78H,), 3.65 (s, 0.66H), 3.62 (s, 2.34H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 3f)** 170.7, 140.3, 137.2, 132.6,

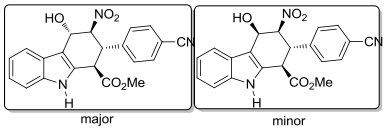
132.5, 131.6, 129.3, 123.0, 121.0, 120.4, 112.3, 112.1, 96.0, 70.8, 53.0, 52.9, 48.4, 47.8; **HRMS** (ESI) m/z calcd For $C_{20}H_{17}BrN_2O_5$ $[M+Na]^+$ 467.0219; Found 467.0216 and $[M+2+Na]^+$ 469.0194.

4-Hydroxy-3-nitro-2-(4-chlorophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 7, Table 2):

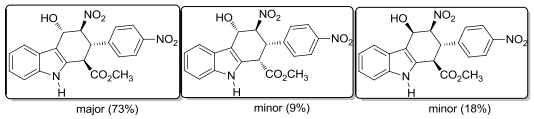


Yield 92%; **IR** (KBr) ν 3448, 3386, 2956, 2924, 2854, 1735, 1623, 1598, 1550, 1460, 1376 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **3g:6g** = 77:23) 10.22 (s, 0.23H), 10.19 (s, 0.77H), 7.81-7.79 (m, 0.77H), 7.66-7.64 (m, 0.23H), 7.58-7.51 (m, 2H), 7.42-7.35 (m, 3H), 7.18-7.02 (m, 2H), 5.70 (td, *J* = 8.28, 2.24 Hz, 0.77H), 5.59 (m, 0.46 H), 5.31 (dd, *J* = 8.52, 12.28 Hz, 0.77H), 5.24 (d, *J* = 8.04 Hz, 0.77H), 5.03 (d, *J* = 7.28 Hz, 0.23H), 4.564 (dd, *J* = 2.28, 10.8 Hz, 0.77H), 4.50 (dd, *J* = 10.8, 12.04 Hz, 0.23H,), 4.25 (dd, *J* = 2.4, 10.52 Hz, 0.23H), 4.08 (dd, *J* = 10.8, 12.28 Hz, 0.77H), 3.64 (s, 0.69H), 3.62 (s, 2.31H); **^{13}C NMR (100 MHz, acetone-d6)** δ **(major diastereomer 3g)** 170.7, 138.3, 136.8, 134.4, 131.3, 129.6, 129.3, 126.97, 123.0, 121.0, 120.4, 112.3, 112.1, 96.1, 70.8, 53.0, 48.5, 47.6; **HRMS** (ESI) m/z calcd For $C_{20}H_{17}N_2O_5Cl$ $[M+Na]^+$ 423.0724; Found 423.0718.

4-hydroxy-3-nitro-2-(4-cyanophenyl)-1-carboxymethyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 8, Table 2): Yield 90%; **IR** (KBr) ν 3397, 3060, 2952, 2923, 2853, 2235, 1748, 1611, 1552, 1459, 1374 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 3h:6h** = 85:15) 10.29 (s, 0.15H), 10.25 (s, 0.85H), 7.85-7.73 (m, 4.70H), 7.67-7.63 (m, 0.30H), 7.40-7.36 (m, 1H), 7.18-7.03 (m, 2H), 5.74-5.71 (m, 1H), 5.65 (dd, *J* = 4.0, 7.24 Hz, 0.15H), 5.40-5.33 (m, 1.70H), 5.14 (d, *J* = 7.28 Hz, 0.15H), 4.62 (dd, *J* = 2.24, 10.56 Hz, 0.85H), 4.56 (dd, *J* = 10.76, 12.28 Hz, 0.15H,), 4.29 (d, *J* = 10.8 Hz, 0.15H), 4.18 (dd, *J* = 11.04, 12.28 Hz, 0.85H), 3.64 (s, 0.45H), 3.62 (s, 2.55H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 3h)** 170.6, 143.3, 138.3, 133.4, 130.7, 129.0, 127.0, 123.1, 121.0, 120.5, 119.0, 113.0, 112.3, 112.1, 95.8, 70.8, 53.1, 48.3, 48.2; **HRMS** (ESI) m/z calcd For $C_{21}H_{17}N_3O_5$ $[M+Na]^+$ 414.1066; Found 414.1060.

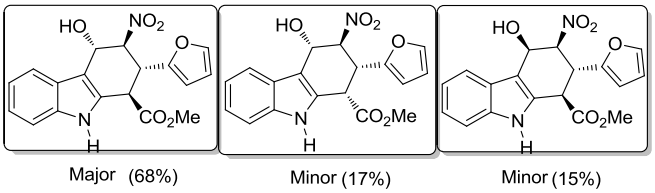


4-Hydroxy-3-nitro-2-(4-nitrophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 9, Table 2):



Yield 93%; **IR** (KBr) ν 3525, 3395, 3109, 3078, 2956, 2923, 2853, 1739, 1603, 1551, 1520, 1350 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**3i:4i:6i** = 73:9:18) 10.38 (s, 0.09H), 10.27 (s, 0.18H), 10.23 (s, 0.73H), 8.27-8.22 (m, 2H), 7.87-7.66 (m, 3H), 7.40-7.37 (m, 1H), 7.18-7.04 (m, 2H), 6.01 (dd, *J* = 8.0, 11.76 Hz, 0.09H), 5.74 (m, 0.91H), 5.67 (dd, *J* = 3.76, 7.0 Hz, 0.18H), 5.61 (t, *J* = 8.04 Hz, 0.09H), 5.43-5.37 (m, 0.91H), 5.33 (d, *J* = 8.28 Hz, 0.73H), 5.14 (d, *J* = 7.04 Hz, 0.09H), 4.67-4.63 (m, 0.91H), 4.45 (d, *J* = 5.76 Hz, 0.09H), 4.41-4.39 (m, 0.09H), 4.33 (d, *J* = 10.8 Hz, 0.18H), 4.26 (dd, *J* = 11.04, 12.28 Hz, 0.73H), 3.65 (s, 0.54H), 3.62 (s, 2.19H), 3.49 (s, 0.27H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 3i)** 170.5, 148.82, 145.3, 138.3, 131.0, 128.9, 126.9, 124.6, 123.1, 121.0, 120.5, 112.3, 112.1, 95.8, 70.8, 53.1, 48.2, 48.0; **HRMS** (ESI) m/z calcd For $C_{20}H_{17}N_3O_7$ $[M+Na]^+$ 434.0964; Found 434.0959.

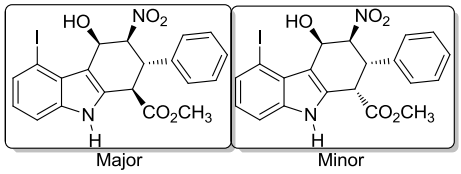
4-Hydroxy-3-nitro-2-furyl-1-carboxymethyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 10, Table 2):



Yield 84%; **IR** (KBr) ν 3378, 2985, 2924, 2853, 1747, 1621, 1552, 1457, 1375 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **3j:4j:6j** = 68:17:15) 10.34 (s, 0.17H), 10.24 (s, 0.15H), 10.20 (s, 0.68H), 7.81-7.78 (m, 1H), 7.53-7.47 (m, 1H), 7.39-7.35 (m, 1H), 7.16-7.02 (m, 2H), 6.37-6.28 (m, 2H), 5.78

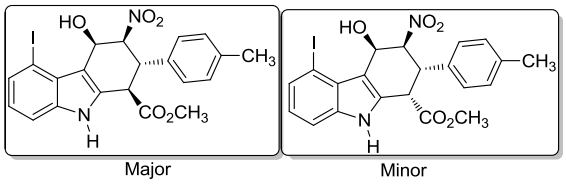
(dd, *J* = 8.28, 12.04 Hz, 0.17H), 5.68 (td, *J* = 8.8, 2.28 Hz, 0.68H), 5.63 (dd, *J* = 3.76, 7.28 Hz, 0.15H), 5.56 (t, *J* = 9.04 Hz, 0.17H), 5.51 (dd, *J* = 3.76, 12.32 Hz, 0.15H), 5.26 (d, *J* = 9.28 Hz, 0.17H), 5.18-5.13 (m, 1.36H), 5.01 (d, *J* = 7.28 Hz, 0.15H), 4.65 (dd, *J* = 10.52, 12.04 Hz, 0.17H), 4.57 (dd, *J* = 2.28, 10.8 Hz, 0.68H), 4.37 (dd, *J* = 0.76, 6.04 Hz, 0.15H), 4.32 (dd, *J* = 5.8, 12.04 Hz, 0.17H), 4.27 (dd, *J* = 10.8, 12.04 Hz, 0.68H), 4.26 (d, *J* = 10.52 Hz, 0.15H), 3.72 (s, 0.51H), 3.69 (s, 2.04H), 3.56 (s, 0.54H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 3j)** 170.7, 150.9, 144.1, 138.4, 128.8, 126.9, 123.1, 121.0, 120.4, 112.3, 111.4, 109.7, 108.6, 94.9, 70.5, 53.1, 46.1, 41.8; HRMS (ESI) m/z calcd For $C_{18}H_{16}N_2O_6$ $[M+Na]^+$ 379.0906; Found 379.0901.

4-Hydroxy-5-iodo-3-nitro-2-phenyl-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 11, Table 2):



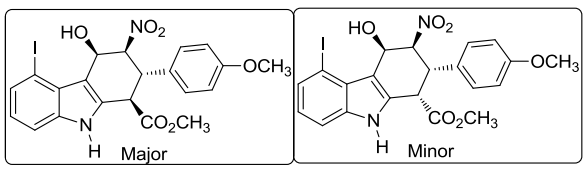
Yield 92%; **IR** (KBr) ν 3455, 3365, 2955, 2924, 2853, 1734, 1605, 1545, 1453, 1377 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **5ba:6ba** = 10:90) 10.67 (s, 0.10H), 10.50 (s, 0.90H), 7.59-7.53 (m, 3H), 7.45-7.42 (m, 1H), 7.37-7.33 (m, 2H), 7.29-7.25 (m, 1H), 6.95-6.90 (m, 1H), 6.33 (dd, *J* = 3.76, 7.0 Hz, 0.10H), 6.22 (dd, *J* = 3.48, 6.52 Hz, 0.90H), 6.14 (dd, *J* = 3.76, 12.56 Hz, 0.10H), 5.67 (dd, *J* = 3.52, 12.28 Hz, 0.90H), 4.90 (d, *J* = 6.52 Hz, 0.90H), 4.70 (d, *J* = 7.04 Hz, 0.10H), 4.56 (dd, *J* = 6.52, 12.52 Hz, 0.10H,), 4.53 (dd, *J* = 10.8, 12.32 Hz, 0.90H), 4.43 (d, *J* = 6.52 Hz, 0.10H), 4.26 (d, *J* = 10.76 Hz, 0.90H), 3.63 (s, 2.70H), 3.34 (s, 0.30H) ; **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(**major diastereomer **6ba)** 170.6, 140.8, 138.5, 133.2, 132.1, 129.5, 129.4, 128.6, 128.4, 124.6, 112.6, 112.4, 90.8, 83.9, 63.4, 52.9, 49.6, 40.9; **HRMS** (ESI) m/z calcd For $C_{20}H_{16}IN_2O_5Cl$ $[M+Na]^+$ 515.0080; Found 515.0074.

4-Hydroxy-5-iodo-3-nitro-2-(4-methylphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 12, Table 2):



Yield 93%; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ **(mixture of diastereomers 5bc:6bc** = 14:86) 10.66 (s, 0.14H), 10.47 (s, 0.86H), 7.59-7.56 (m, 1H), 7.45-7.40 (m, 3H), 7.17-7.14 (m, 2H), 6.94-6.89 (m, 1H), 6.31 (dd, *J* = 3.76, 7.04 Hz, 0.14H), 6.21 (dd, *J* = 3.52, 6.52 Hz, 0.86H), 6.12 (dd, *J* = 3.76, 12.56 Hz, 0.14H), 5.62 (dd, *J* = 3.52, 12.28 Hz, 0.86H), 4.84 (d, *J* = 6.52 Hz, 0.86H), 4.65 (d, *J* = 7.04 Hz, 0.14H), 4.49 (dd, *J* = 10.8, 12.28 Hz, 0.86H,), 4.49 (d, *J* = 6.52, 12.32 Hz, 0.14H), 4.40 (d, *J* = 6.52 Hz, 0.14H), 4.22 (d, *J* = 10.52 Hz, 0.86H), 3.63 (s, 2.58H), 3.35 (s, 0.42H), 2.29 (br s, 3H); **^{13}C NMR (100 MHz,** acetone-d$_6$**)** δ **(major diastereomer 6bc)**170.6, 138.4, 137.8, 137.7, 133.3, 132.1, 130.1, 130.0, 129.2, 124.6, 112.6, 112.3, 90.8, 83.9, 63.4, 52.9, 49.6, 40.4, 21.1; **HRMS** (ESI) m/z calcd For $C_{21}H_{19}N_2O_5I$ $[M+Na]^+$ 529.0236; Found 529.0231.

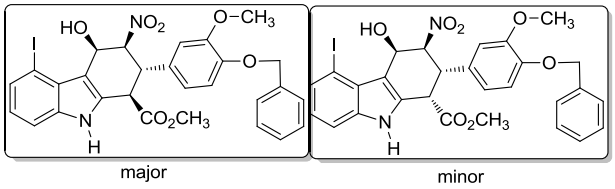
4-Hydroxy-5-iodo-3-nitro-2-(4-methoxyphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 13, Table 2):



Yield 90%; **IR** (KBr) ν 3445, 3371, 2924, 2853, 1734, 1611, 1544, 1513, 1254 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers, **5bd:6bd** = 24:76)10.77 (s, 0.24H), 10.54 (s, 0.76H), 7.73-7.71 (d, *J* = 8.28 Hz, 0.24H), 7.58-7.55 (m, 0.76H), 7.46-7.42 (m, 2.76H), 7.29-7.25 (m, 0.48H), 6.94-6.88 (m, 2.76H), 6.29 (d, *J* = 3.48 Hz, 0.24H), 6.19 (d, *J* = 3.52 Hz, 0.76H), 6.09 (dd, *J* = 3.76, 12.56 Hz, 0.24H), 5.60 (dd, *J* = 3.52, 12.28 Hz, 0.76H), 4.89 (br s, 1H), 4.49 (dd, *J* = 6.56, 12.56 Hz, 0.24H), 4.46 (dd, *J* = 10.8, 12.56 Hz, 0.76H,), 4.39 (d, *J* = 6.80 Hz, 0.24H), 4.21 (d, *J* = 10.80 Hz, 0.76H), 3.78 (s, 0.72H), 3.77 (s, 2.28H), 3.64 (s, 2.28H), 3.37 (s, 0.72H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 6bd)** 171.1, 160.1, 138.5, 133.3, 133.2, 132.5, 132.0, 130.4, 128.6, 124.5, 114.8, 114.7,

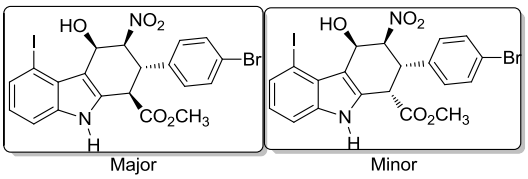
112.7, 90.9, 63.4, 55.5, 53.0, 49.6, 40.1; **HRMS** (ESI) m/z calcd For $C_{21}H_{19}N_2O_6I$ $[M+Na]^+$ 545.0185; Found 545.0180.

4-Hydroxy-5-iodo-3-nitro-2-(4-benzyloxy-3-methoxyphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 14, Table 2):



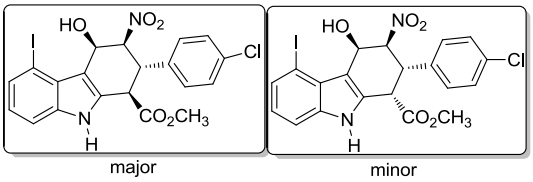
Yield 88%; **IR** (KBr) ν 3395, 3063, 3032, 2926, 2853, 1735, 1609, 1554, 1516, 1456 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **5be:6be** = 15:85) 10.66 (s, 0.15H), 10.48 (s, 0.85H), 7.58-7.56 (m, 1H), 7.50-7.29 (m, 6H), 7.20-7.19 (d, *J* = 2.0 Hz, 1H), 7.04-6.80 (m, 3H), 6.31 (dd, *J* = 3.80, 7.04 Hz, 0.15H), 6.21 (dd, *J* = 3.28, 6.28 Hz, 0.85H), 6.11 (dd, *J* = 3.76, 12.32 Hz, 0.15H), 5.65 (dd, *J* = 3.28, 12.28 Hz, 0.85H), 5.09 (s, 0.3 H), 5.08 (s, 1.7H), 4.86 (d, *J* = 6.28 Hz, 0.85H), 4.67 (d, *J* = 7.04 Hz, 0.15H), 4.49 (m, 0.15H), 4.48 (dd, *J* = 10.8, 12.40 Hz, 0.85H,), 4.34 (d, *J* = 6.52 Hz, 0.15H), 4.26 (d, *J* = 10.80 Hz, 0.85H), 3.83 (s, 0.45H), 3.82 (s, 2.55H), 3.65 (s, 2.55H), 3.36 (s, 0.45H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 6be)** 170.9, 150.8, 148.8, 138.6, 138.4, 133.7, 133.4, 132.1, 129.2, 128.6 (2C), 128.5 (2C), 124.6, 121.5, 114.7, 113.4, 112.6, 112.3, 90.8, 83.9, 63.4, 56.3, 53.0, 49.7, 40.5; **HRMS** (ESI) m/z calcd For $C_{28}H_{25}N_2O_7I$ $[M+Na]^+$ 651.0604; Found 651.0599.

4-Hydroxy-5-iodo-3-nitro-2-(4-bromophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 15, Table 2):



Yield 88%; **IR** (KBr) ν 3444, 3388, 2953, 2924, 2854, 1737, 1637, 1547, 1453, 1374 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 5bf:6bf** =12: 88) 10.71 (s, 0.12H), 10.52 (s, 0.88H), 7.73 (d, *J* = 8.46 Hz, 0.12H), 7.54 (m, 4.64H), 7.44 (m, 1H), 7.31 (m, 0.24H), 6.92 (t, *J* = 8.03 Hz, 1H), 6.33 (dd, *J* = 3.76, 7.03 Hz, 0.12H), 6.23 (dd, *J* = 3.51, 6.52 Hz, 0.88H), 6.12 (dd, *J* = 3.77, 12.30 Hz, 0.12H), 5.66 (dd, *J* = 3.52, 12.30 Hz, 0.88H), 4.93 (d, *J* = 6.53 Hz, 0.88H), 4.74 (d, *J* = 7.02 Hz, 0.12H), 4.53 (dd, *J* = 10.80, 12.30 Hz, 0.88H), 4.58 (m, 0.12H,), 4.46 (d, *J* = 6.53 Hz, 0.12H), 4.25 (d, *J* = 10.80 Hz, 0.88H), 3.65 (s, 2.64H), 3.39 (s, 0.36H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 6bf)** 170.5, 140.4, 138.5, 132.7, 132.6, 132.2, 131.6, 128.5, 124.7, 121.9, 112.7, 112.3, 90.7, 83.9, 63.4, 53.1, 49.3, 40.5; **HRMS** (ESI) m/z calcd For $C_{20}H_{16}IN_2O_5Br$ $[M+Na]^+$ 592.9185; Found 592.9179.

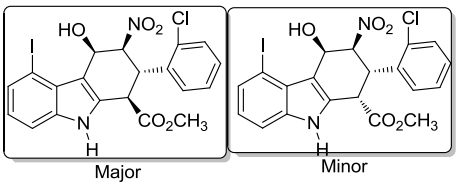
4-Hydroxy-5-iodo-3-nitro-2-(4-chlorophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 16, Table 2):



Yield 91%; **IR** (KBr) ν 3386, 3358, 2951, 2924, 2853, 1735, 1613, 1547, 1493 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 5bg:6bg** = 8:92) 10.69 (s, 0.08H), 10.51 (s, 0.92H), 7.60-7.56 (m, 3H), 7.46-7.38 (m, 3H), 6.94-6.90 (m, 1H), 6.33 (dd, *J* = 3.76, 7.0 Hz, 0.08H), 6.23 (dd, *J* = 3.24, 6.28 Hz, 0.92H), 6.12 (dd, *J* = 3.76, 12.56 Hz, 0.08H), 5.66 (dd, *J* = 3.52, 12.28 Hz, 0.92H), 4.92 (d, *J* = 6.52 Hz, 0.92H), 4.73 (d, *J* = 6.76 Hz, 0.08H), 4.58 (dd, *J* = 6.52, 12.56 Hz, 0.08H,), 4.54 (dd, *J* = 10.76, 12.28 Hz, 0.92H), 4.46 (d, *J* = 6.52 Hz, 0.08H), 4.26 (d, *J* = 10.8 Hz, 0.92H), 3.65 (s, 2.76H), 3.40 (s, 0.24H) ; **^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 6bg)** 170.4, 139.8, 138.5, 133.7,

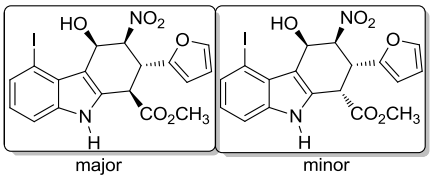
133.0, 132.1, 132.2, 129.5, 128.5, 124.7, 112.7, 112.3, 90.7, 83.9, 63.4, 53.1, 49.3, 40.4; **HRMS** (ESI) m/z calcd For $C_{20}H_{16}ClN_2O_5I$ $[M+Na]^+$ 548.9690; Found 548.9685 and $[M+2+Na]^+$ 550.9657.

4-Hydroxy-5-iodo-3-nitro-2-(2-chlorophenyl)-1-carboxymethyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 17, Table 2):



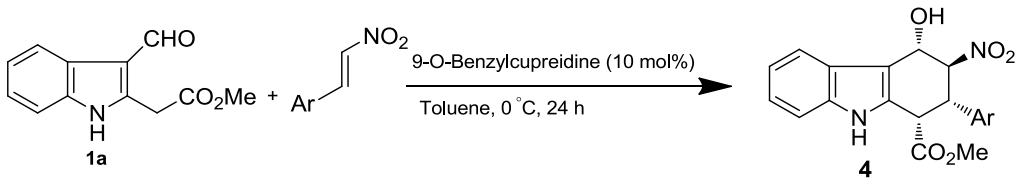
Yield 86%; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 5bk:6bk = 34:66**) 10.70 (s, 0.34H), 10.57 (s, 0.66H), 7.80-7.78 (d, *J* = 7.52 Hz, 1H), 7.60-7.44 (m, 3H), 7.39-7.27 (m, 2H), 6.96-6.90 (m, 1H), 6.36 (dd, *J* = 3.76, 7.04 Hz, 0.34H), 6.26 (dd, *J* = 3.48, 6.04 Hz, 0.66H), 6.14 (dd, *J* = 3.76, 12.04 Hz, 0.34H), 5.68 (dd, *J* = 3.28, 12.04 Hz, 0.66H), 5.14 (t, *J* = 11.28, 11.52 Hz, 0.66H), 5.03 (dd, *J* = 6.52, 12.32 Hz, 0.34H), 4.99 (d, *J* = 6.0 Hz, 0.66H), 4.90 (dd, *J* = 0.76, 7.28 Hz, 0.34H), 4.55 (d, *J* = 6.52 Hz, 0.34H), 4.20 (d, *J* = 10.80 Hz, 0.66H), 3.60 (s, 1.98H), 3.33 (s, 1.02H); **^{13}C NMR (100 MHz, acetone-d6)** δ (**major diastereomer 6bk)** 170.7, 138.9, 136.7, 132.1, 132.0, 131.0, 130.6, 129.6, 128.5, 128.4, 127.6, 124.8, 124.6, 112.5, 91.1, 83.9, 63.5, 52.9, 49.5, 37.0; HRMS (ESI) m/z calcd For $C_{20}H_{16}IN_2O_5Cl$ $[M+Na]^+$ 548.9690; Found 548.9685 and $[M+2+Na]^+$ 550.9687.

4-Hydroxy-5-iodo-3-nitro-2-furyl-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (entry 18, Table 2):



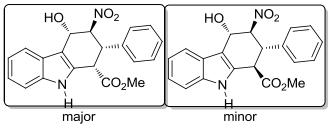
Yield 89%; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **5bj:6bj = 31:69**) 10.68 (s, 0.31H), 10.51 (s, 0.69H), 7.59-7.56 (m, 1H), 7.48-7.43 (m, 2H), 6.95-6.89 (m, 1H), 6.39-6.29 (m, 2H), 6.27 (dd, *J* = 3.76, 7.04 Hz, 0.31H), 6.23 (dd, *J* = 3.28, 6.28 Hz, 0.69H), 5.92 (dd, *J* = 3.76, 12.28 Hz, 0.31H), 5.52 (dd, *J* = 3.28, 12.28 Hz, 0.69H), 4.89 (d, *J* = 6.28 Hz, 0.69H), 4.70 (dd, *J* = 10.76, 12.28 Hz, 0.69H), 4.68 (d, *J* = 7.28 Hz, 0.31H), 4.64 (dd, *J* = 6.52, 12.28 Hz, 0.31H), 4.48 (d, *J* = 6.8 Hz, 0.31H), 4.28 (d, *J* = 10.8 Hz, 0.69H), 3.73 (s, 2.07H), 3.47 (s, 0.93H); **^{13}C NMR (100 MHz, acetone-d$_6$)** δ (major isomer **6bj**) 170.5, 153.6, 143.1, 138.6, 132.1, 128.5, 124.6, 112.7, 111.5, 108.7, 107.5, 88.9, 86.6, 63.1, 63.1, 52.8, 47.2, 35.0; **HRMS** (ESI) m/z calcd For $C_{18}H_{15}N_2O_6I$ $[M+Na]^+$ 504.9872; Found 504.9867.

General procedure for enantioselective, catalytic domino Michael-Henry reaction for the synthesis of 1-methoxycarbonyl-2-aryl-4-hydroxy-3-nitro-1,2,3,4-tetrahydro-9*H*-carbazoles:



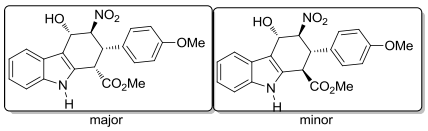
To a stirred mixture of methyl 3-formyl-1*H*-indole-2-acetate (**1a**) (0.20 mmol) and β-nitrostyrenes (**2a, 2d and 2f,** 0.25 mmol) in dry toluene (1.0 mL) was added 9-O-benzylcupridine (10 mol%) at 0 °C for 24h. After that, the reaction mixture was extracted with ethyl acetate, washed with water, dried over Na_2SO_4. The evaporation of the solvent left the crude product which was purified by column chromatography over silica-gel 230-400 mesh using EtOAc/hexane as eluent to furnish the pure product. All the products were fully characterized by their corresponding spectroscopic data (IR, ^{1}H and ^{13}C NMR and HRMS). The diastereomeric ratio was determined by ^{1}H NMR of crude products and relative configurations of major diastereomer was ***cis-trans-trans.*** The Enantiomeric excess (ee) of major diastereomer was determined by HPLC using Chiralpak AD-H column

4-Hydroxy-3-nitro-2-phenyl-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (Scheme 4)

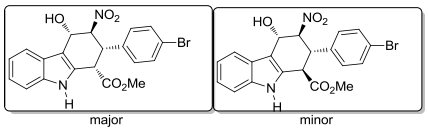


Yield 89%; **IR** (KBr) ν 3446, 3384, 2958, 2922, 2852, 1737, 1633, 1546, 1458, 1317 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (**mixture of diastereomers 3a:4a** = 16:84) 10.31 (s, 0.84H), 10.16 (s, 0.16H), 7.84-7.80 (m, 0.84H), 7.49-7.47 (m, 0.16H), 7.41-7.29 (m, 6H), 7.17-7.12 (m, 1.16H), 7.07-7.03 (m, 0.84H), 5.98 (dd, *J* = 8.04, 12.28 Hz, 0.84H), 5.70 (td, 8.52, 2.48 Hz, 0.16H), 5.58 (t, *J* = 8.0, 8.28 Hz, 0.84H), 5.31 (dd, *J* = 8.28, 12.32 Hz, 0.16H), 5.25 (d, *J* = 9.28 Hz, 0.84H), 5.18 (d, *J* = 8.28 Hz, 0.16H), 4.53 (dd, *J* = 2.28, 10.8 Hz, 0.16H), 4.29 (d, *J* = 5.28 Hz, 0.84H), 4.20 (dd, *J* = 6.04, 12.28 Hz, 0.84H), 4.08 (dd, *J* = 10.8, 12.04 Hz, 0.16H), 3.59 (s, 0.45H), 3.45 (s, 2.55H);**^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 4a)** 172.0, 138.8, 138.0, 131.0, 130.0, 129.5, 129.4, 127.7, 123.6, 121.5, 120.8, 113.3, 112.6, 92.9, 72.3, 52.9, 48.4, 47.7; **HRMS** (ESI) m/z calcd For $C_{20}H_{18}N_2O_5$ $[M+Na]^+$ 389.1113; Found 389.1108. Enantiomers of major isomer **4a** were separated by HPLC using a Chiralpak AD-H column (20 : 80 i-PrOH/hexane, UV 220 nm, flow rate 1 mL/min) $T_{R(major)}$ = 14.83 min, $T_{R(minor)}$ = 33.18 min. Major isomer **4a** was obtained in 82% ee.

4-Hydroxy-3-nitro-2-(4-methoxyphenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (Scheme 4): Yield 88%; **IR** (KBr) ν 3388, 3051, 3003, 2955, 2924, 2853, 1745, 1699, 1552, 1516, 1457 cm^{-1}; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **4d:3d** = 86:16) 10.30 (s, 0.86H), 10.15 (s, 0.14H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.40-7.30 (m, 3H), 7.14 (t, *J* = 14.52 Hz, 1H), 7.05 (t, *J* = 14.08 Hz, 1H), 6.90 (d, *J* = 14.52 Hz, 2H), 5.93 (dd, *J* = 8.04, 12.32 Hz, 0.86H), 5.68 (td, *J* = 8.0, 2.76 Hz, 0.14H), 5.56 (t, *J* = 8.56 Hz, 0.86H), 5.25 (dd, *J* = 8.28, 12.28 Hz, 0.14H), 5.23 (d, *J* = 9.28 Hz, 0.86H), 5.15 (d, *J* = 8.0 Hz, 0.14H), 4.47 (dd, *J* = 2.0, 10.76 Hz, 0.14H), 4.24 (d, *J* = 5.6 Hz, 0.86H), 4.11 (dd, *J* = 5.6, 12.28 Hz, 0.86H), 4.01 (m, 0.14H), 3.78 (s, 3.0H), 3.60 (s, 0.42H), 3.48 (s, 2.58H) ;**^{13}C NMR (100 MHz, acetone-d$_6$)** δ **(major diastereomer 4d)** 171.7, 160.4, 138.3, 130.6, 130.2, 129.2, 127.2, 123.0, 121.0, 120.3, 114.8, 112.8, 112.1, 92.7, 71.6, 55.5, 52.5, 48.0, 46.6; **HRMS** (ESI) m/z calcd For $C_{21}H_{20}N_2O_6$ $[M+Na]^+$ 419.1219; Found 419.1214. Enantiomers of major isomer were separated by HPLC using a Chiralpak AD-H column (20 : 80 i-PrOH/hexane, UV 220 nm, flow rate 1 mL/min) $T_{R(major)}$ = 17.77 min, $T_{R(minor)}$ = 51.12 min. Major isomer **4d** was obtained in 90% ee

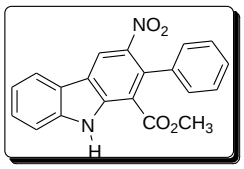


4-hydroxy-3-nitro-2-(4-bromophenyl)-1-methoxycarbonyl-1,2,3,4-tetrahydro-9*H*-carbazole (Scheme 4):



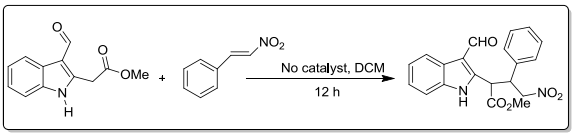
Yield 93%; **IR** (KBr) 3522, 3388, 3058, 2955, 2924, 2953, 1732, 1622, 1591, 1490 cm^{-1} ; **^{1}H NMR (400 MHz, acetone-d$_6$)** δ (mixture of diastereomers **4f:3f** = 92:8) 10.33 (s, 0.92H), 10.18 (s, 0.08H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.60-7.45 (m, 2H), 7.42-7.36 (m, 3H), 7.17-7.13 (m, 1H), 7.07-7.04 (m, 1H), 5.94 (dd, *J* = 8.04, 12.32 Hz, 0.92H), 5.70 (td, *J* = 2.24, 8.28 Hz, 0.08H), 5.57 (t, *J* = 8.28 Hz, 0.92H), 5.32 (dd, *J* = 8.28, 12.04 Hz, 0.08H), 5.29 (d, *J* = 9.32 Hz, 0.92H), 5.23 (d, *J* = 8.24 Hz, 0.08H), 4.54 (dd, *J* = 2.24, 10.8 Hz, 0.08H), 4.30 (d, *J* = 6.0 Hz, 0.92H), 4.21 (dd, *J* = 6.0, 12.32 Hz, 0.92H), 4.07 (dd, *J* = 10.8, 12.04 Hz, 0.08H), 3.62 (s, 0.24H), 3.50 (s, 2.76H) ;**^{13}C NMR (100 MHz, acetone-d$_6$)** δ (major diastereomers **4f**) 171.5, 138.3, 136.9, 132.6, 131.2, 130.2, 127.1, 123.2, 122.6, 121.6, 120.4, 112.8, 112.2, 92.4, 71.7, 52.7, 47.6, 46.6; HRMS (ESI) m/z calcd For $C_{20}H_{17}BrN_2O_5$ $[M+Na]^+$ 467.0219; Found 467.0216 and $[M+2+Na]^+$ 469.0194. Enantiomers of major isomers were separated by HPLC using a Chiralpak AD-H column (20 : 80 i-PrOH/hexane, UV 220 nm, flow rate 1 mL/min) $T_{R(major)}$ = 15.30 min, $T_{R(minor)}$ = 32.73 min. Major isomer **4f** was obtained in 92% ee.

Synthesis of 1-methoxycarboyl-3-nitro-2-phenyl-9*H*-carbazole (13): To a stirred mixture of methyl 3-formyl-1*H*-indole-2-acetate (**1a**) (0.20 mmol) and β-nitrostyrenes (**2a,** 0.25 mmol) in THF (1.0 mL) was added DABCO (10 mol%) for 6h. After that, the reaction mixture was quenched with 4N HCl (4.0 mL) at 0 °C for 1h and then the reaction mixture was stirred at room temperature for 16 h (monitored by TLC). The reaction mixture was extracted with EtOAc, washed with $NaHCO_3$ and brine, dried over Na_2SO_4. The evaporation of the solvent left the crude product which was purified by column chromatography over silica-gel 230-400 mesh using EtOAc/hexane as eluent to furnish the pure product (62%). The product was fully characterized by their corresponding spectroscopic data (^1H and ^{13}C NMR and HRMS).



1-Methoxycarboyl-3-nitro-2-phenyl-9*H*-carbazole (13): Yield 62 %; **^{1}H NMR (400 MHz, $CDCl_3$)** 10.01 (s, 1H), 8.72 (s, 1H), 8.12 (d, *J* = 7.76 Hz, 1H), 7.57-7.55 (m, 2H), 7.42-7.35 (m, 4H), 7.29-7.26 (m, 2H), 3.55 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 167.6, 143.7, 141.4, 140.6, 137.0, 135.4, 128.5, 128.2, 127.8, 123.3, 122.2, 121.4, 121.0, 120.1, 112.7, 111.8, 52.2; **HRMS** (ESI) m/z calcd For $C_{20}H_{14}N_2O_4[M+Na]^+$ 369.0851; Found 369.0846.

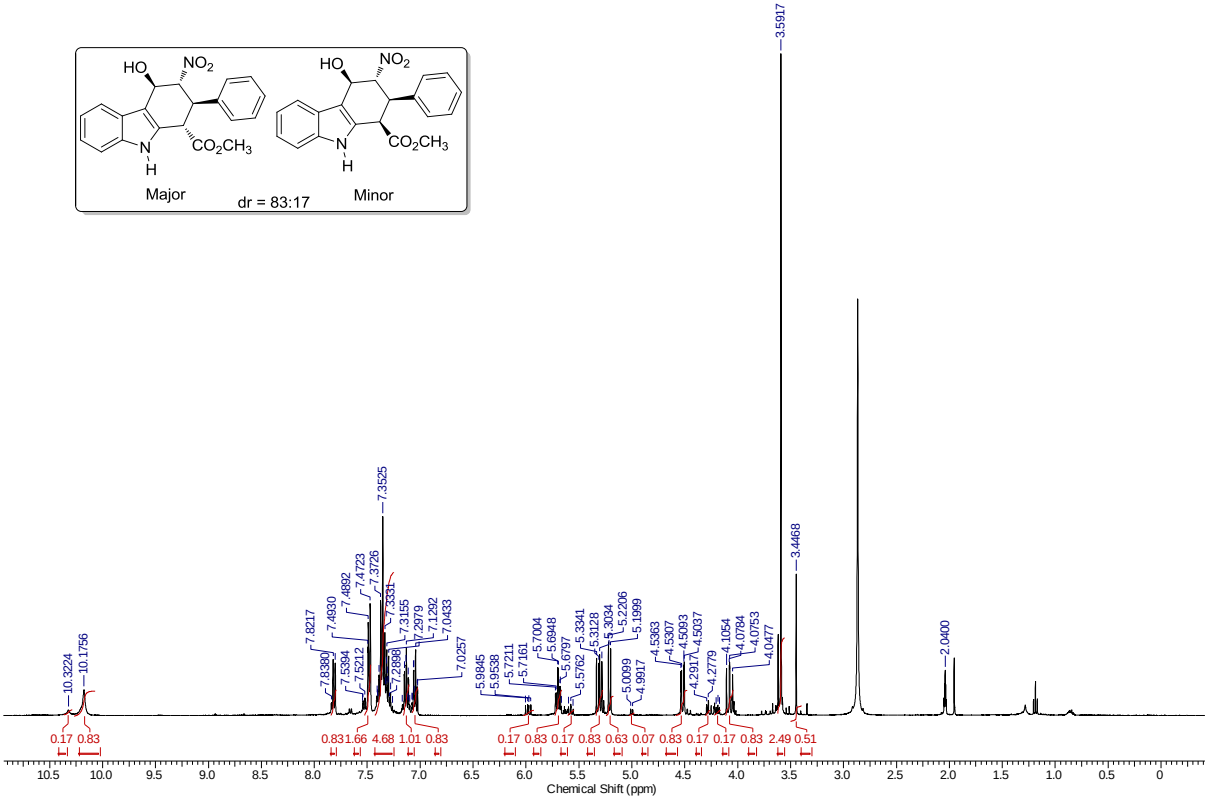
Synthesis of methyl 3-formyl-1*H*-indole-1-nitro-2-phenylbutanoate (Table 1, entry 1):

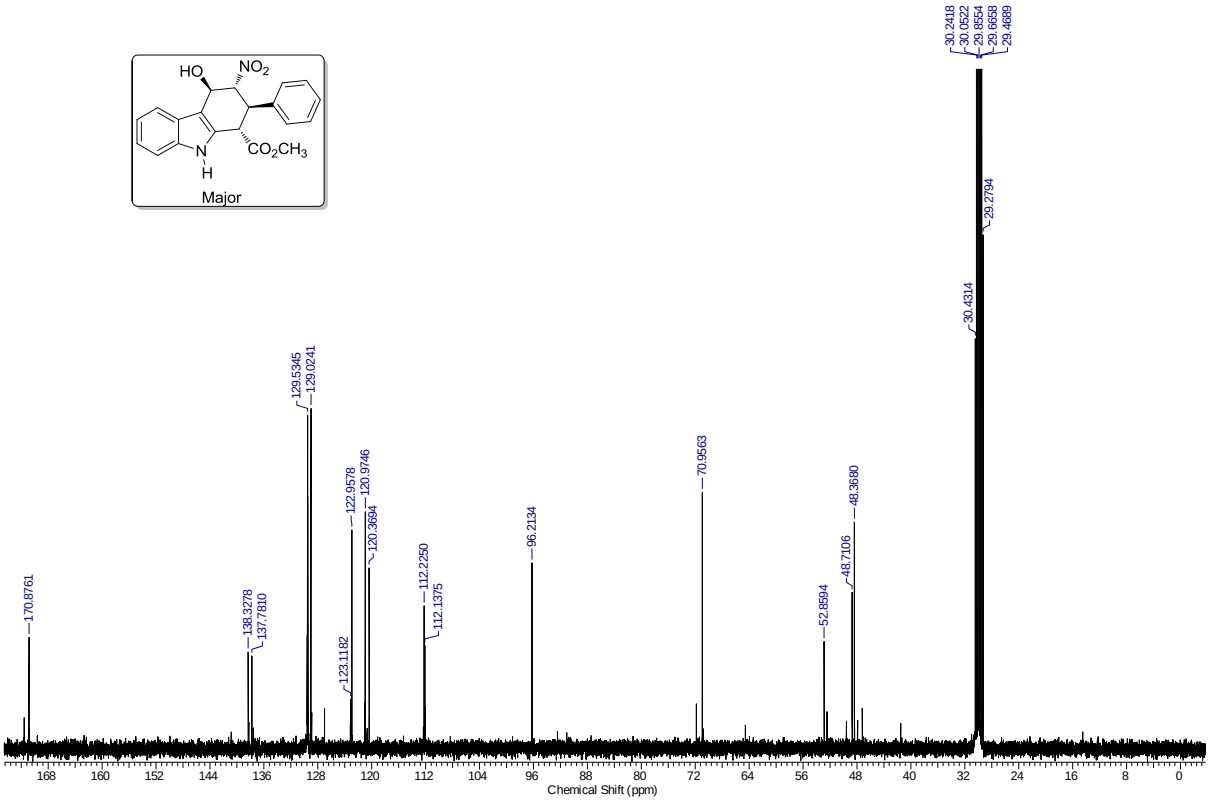


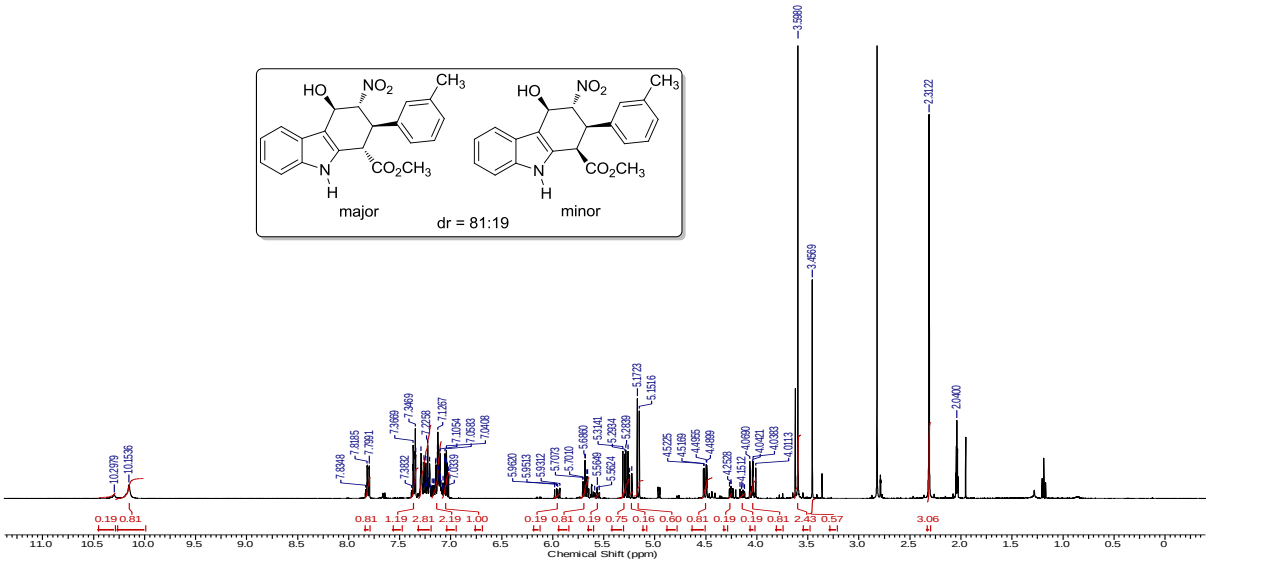
Yield 16 %; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.18 (s, 1H), 9.38 (br s, 1H), 8.03-8.01 (m, 1H), 7.39-7.36 (m, 1H), 7.31-7.23 (m, 5H), 7.05-7.03 (m, 2.0H), 5.23 (d, *J* = 7.52 Hz, 1H), 4.92-4.83 (m, 2H), 4.42-4.36 (m, 1H), 3.77 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 184.6, 171.9, 138.5, 135.0, 134.9, 129.0, 128.9, 128.7, 127.7, 126.4, 124.2, 122.9, 119.1, 117.7, 76.5, 53.1, 47.3, 46.1 ; **HRMS** (ESI) m/z calcd For $C_{20}H_{18}N_2O_5$ $[M+Na]^+$ 389.1210; Found 389.1216.

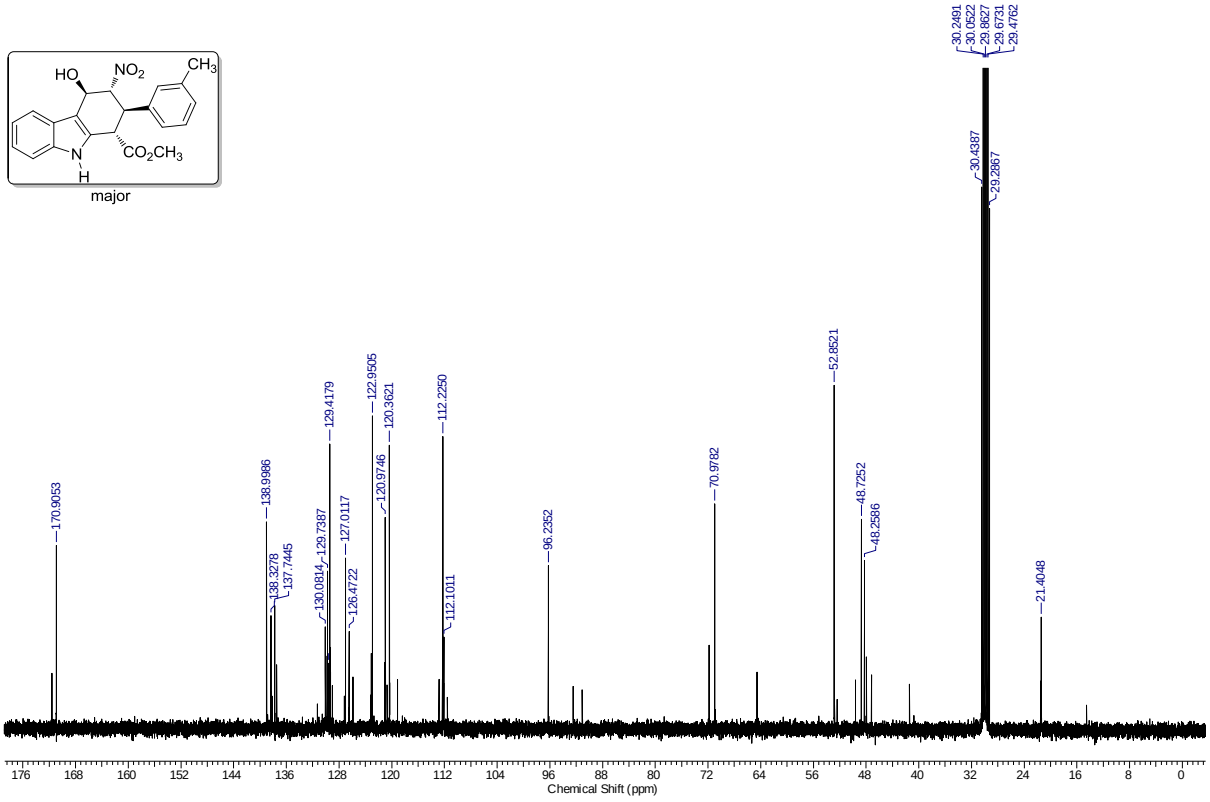
References:

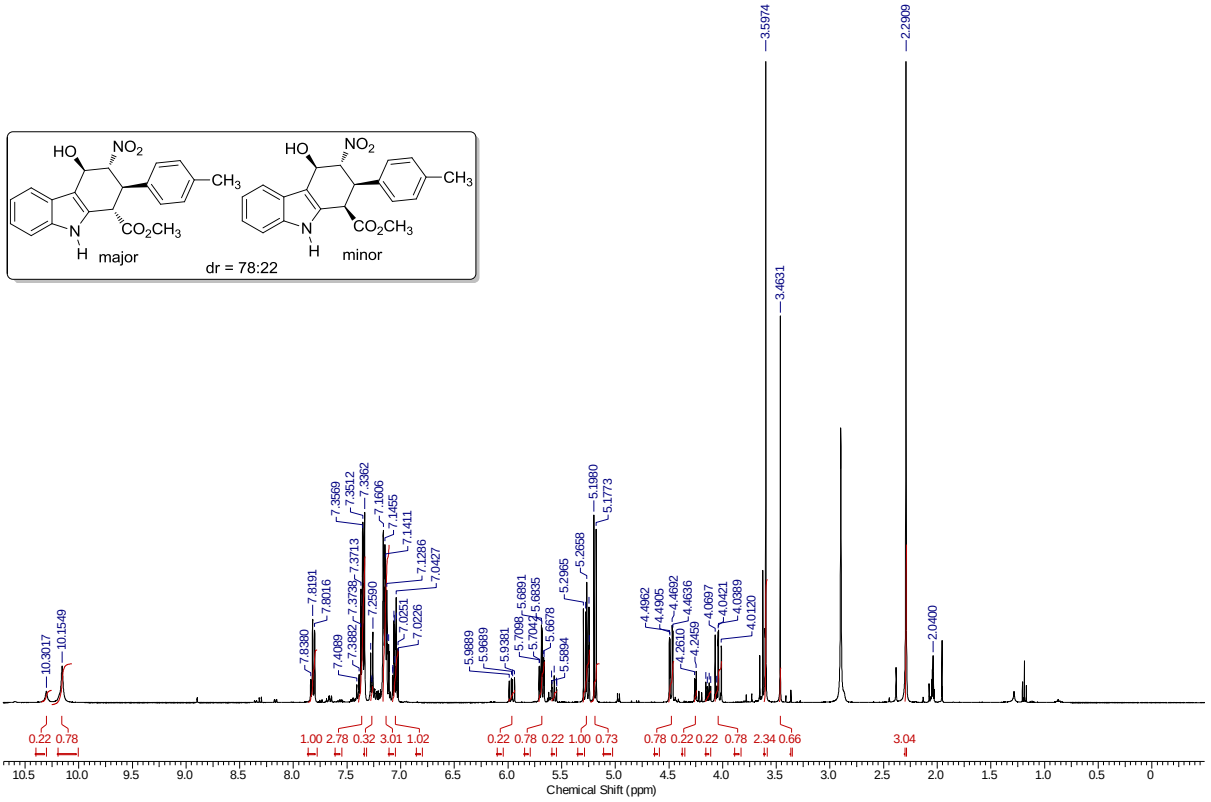
1. (*a*) M. Somei, H. Ohnishi and Y. Shoken, *Chem. Pharm. Bull.*, 1986, **34** 677; (*b*) M. Somei, T. Kawasaki, K. Shimizu, Y. Fukui and T. Ohta *Chem. Pharm. Bull*. 1991, **39** 1905; (c) T. Kawasaki, atsushi Kodama, Tokiko Nishida, Kazuhisa shimizu, Masanori Somei *Heterocycles* 1991, **32**, 221.

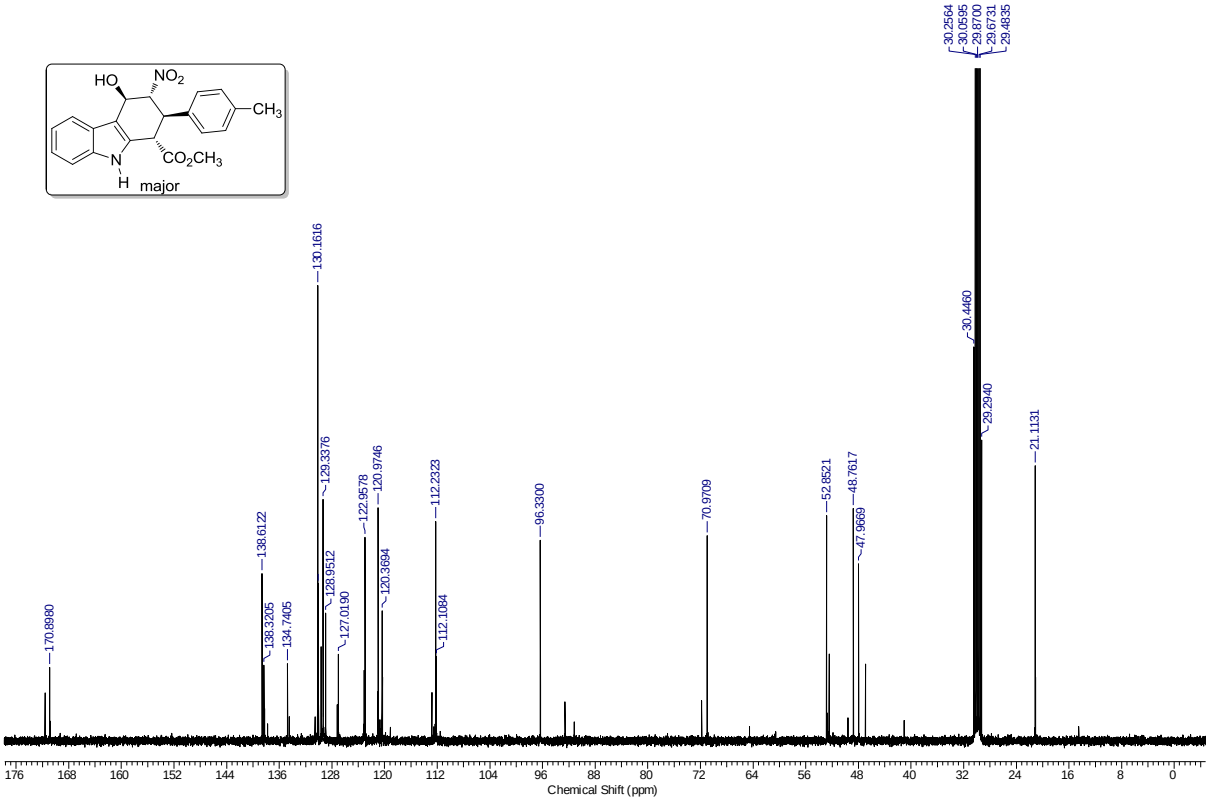

HO
NO2
CO2CH3
N
H
Major
dr = 83:17
Minor
Chemical Shift (ppm)

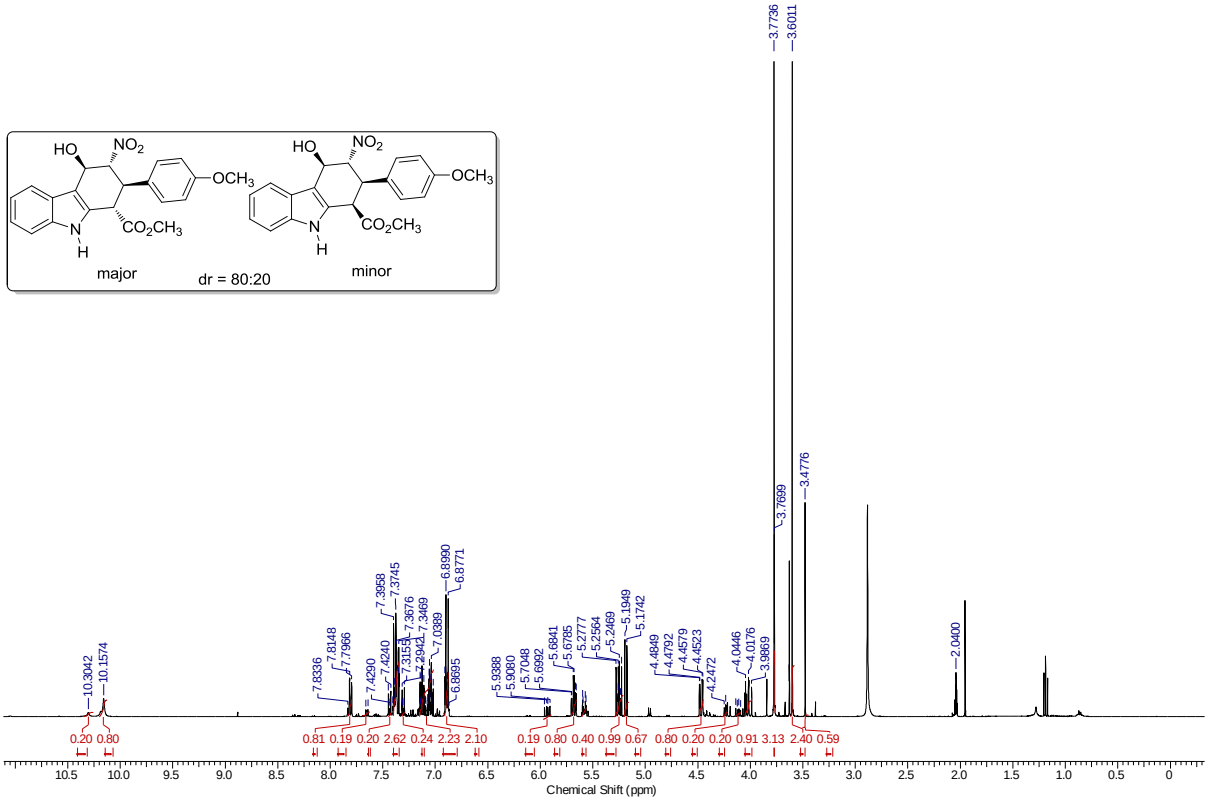

HO
NO2
CO2CH3
N
H
Major
Chemical Shift (ppm)

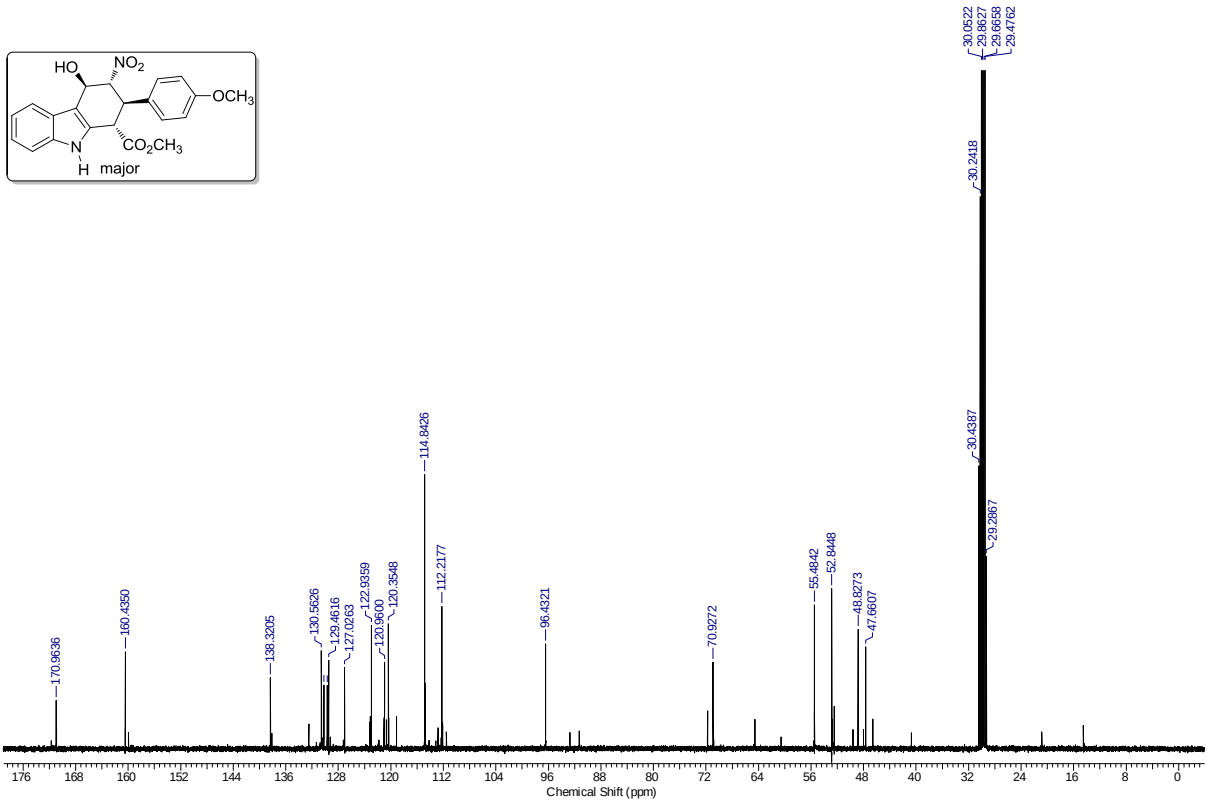

HO
NO2
CH3
CO2CH3
N
H
major
minor
dr = 81:19
Chemical Shift (ppm)

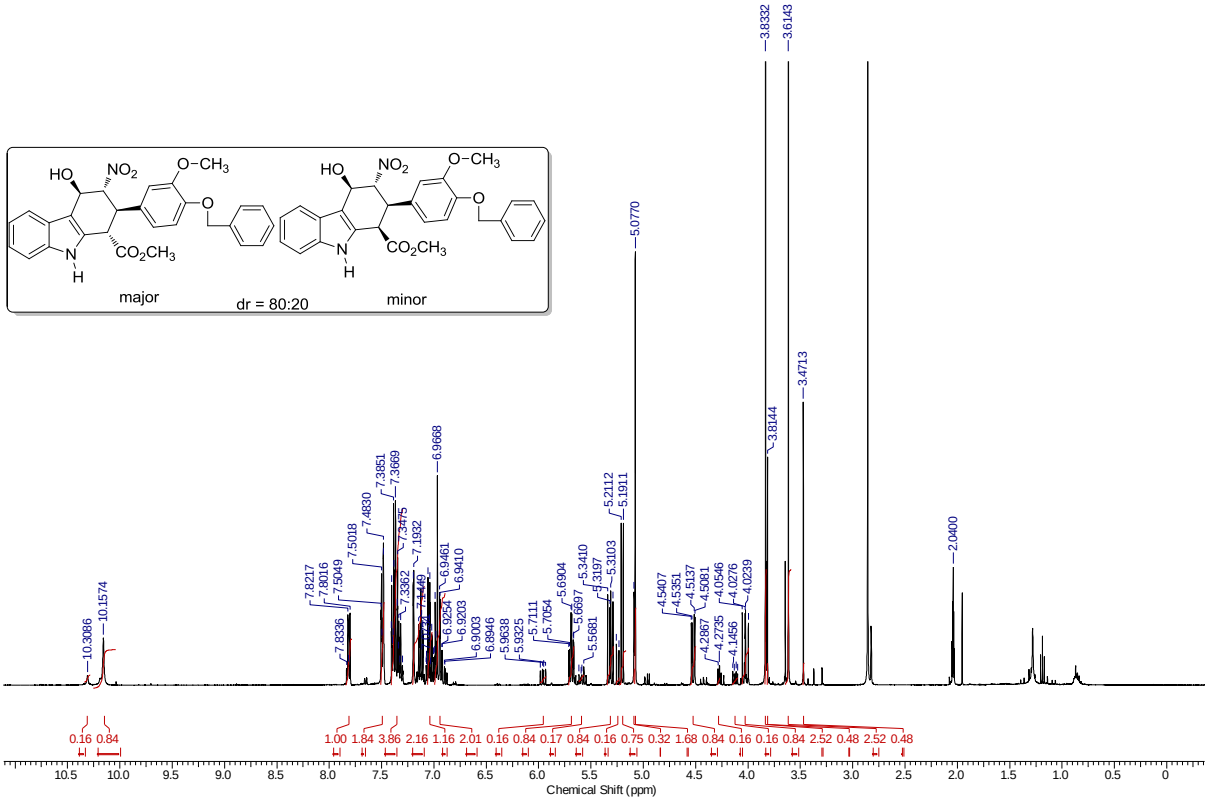

major
Chemical Shift (ppm)

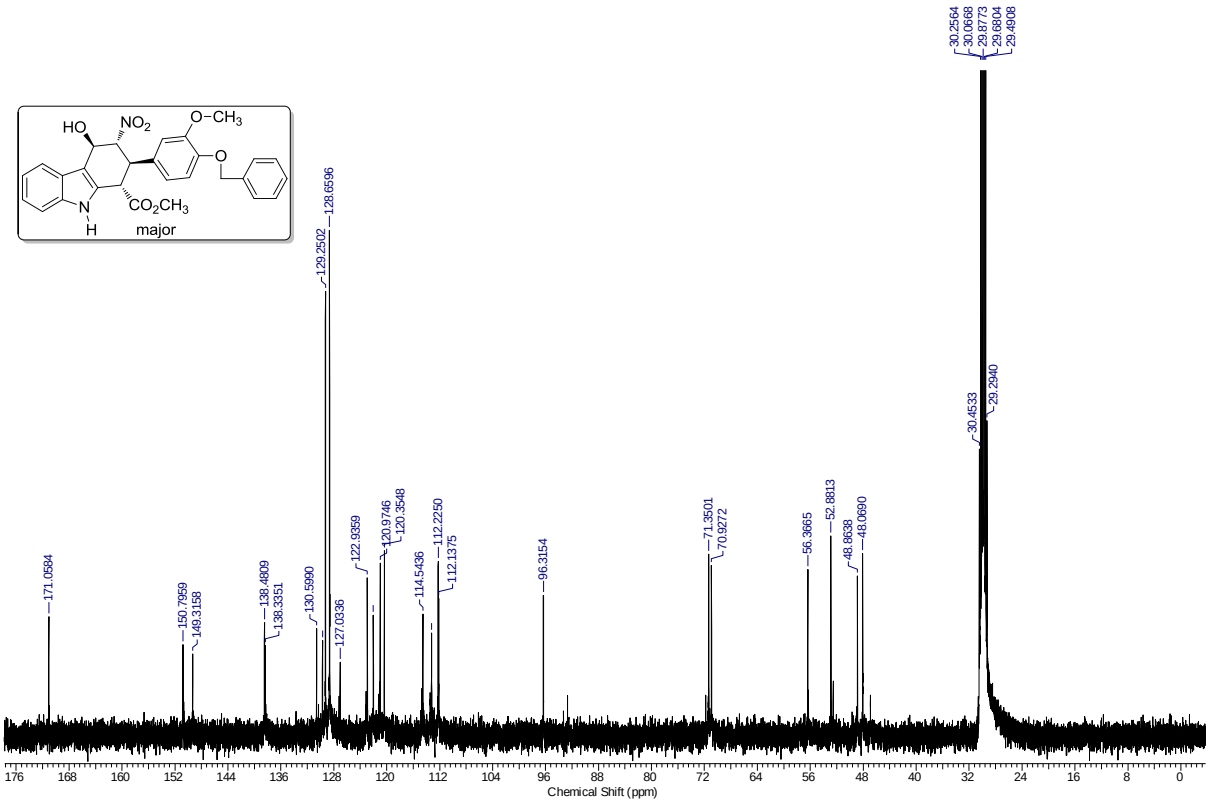

HO
NO2
CH3
CO2CH3
N
H
major
minor
dr = 78:22
Chemical Shift (ppm)

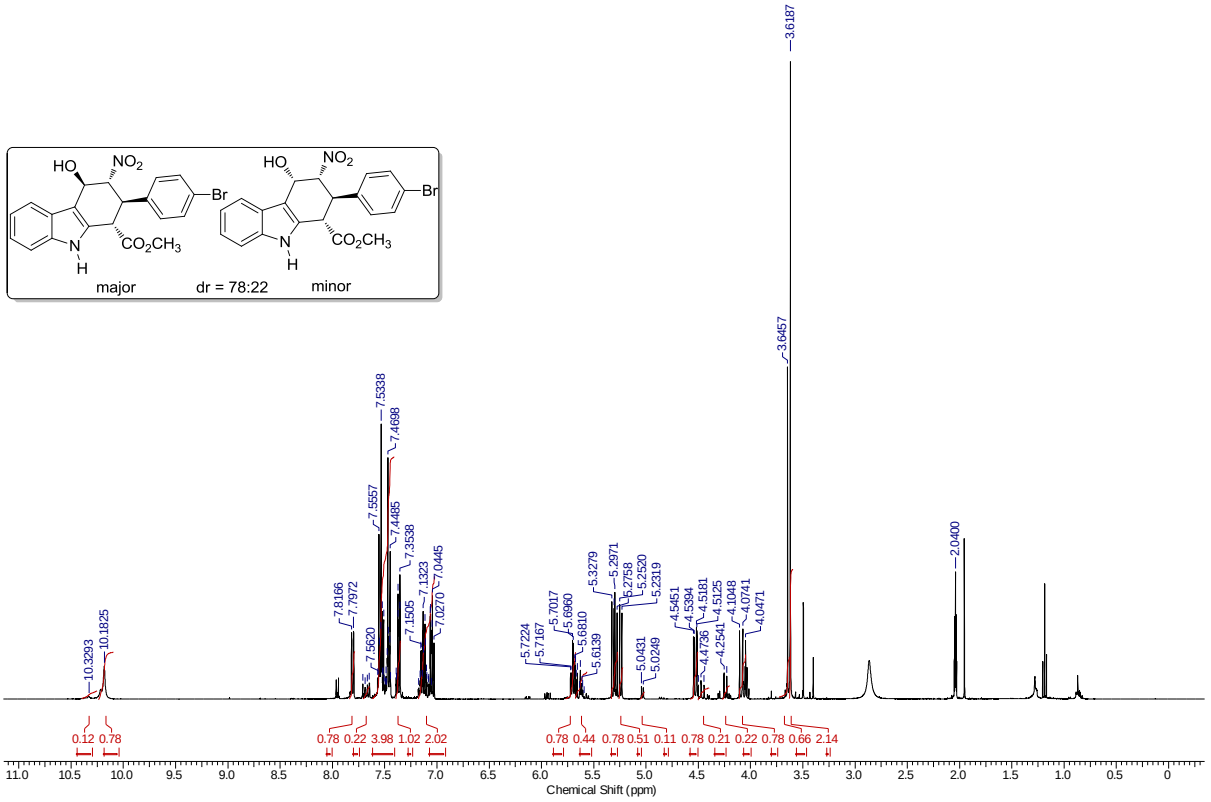

HO
NO2
CH3
CO2CH3
N
H
major
Chemical Shift (ppm)

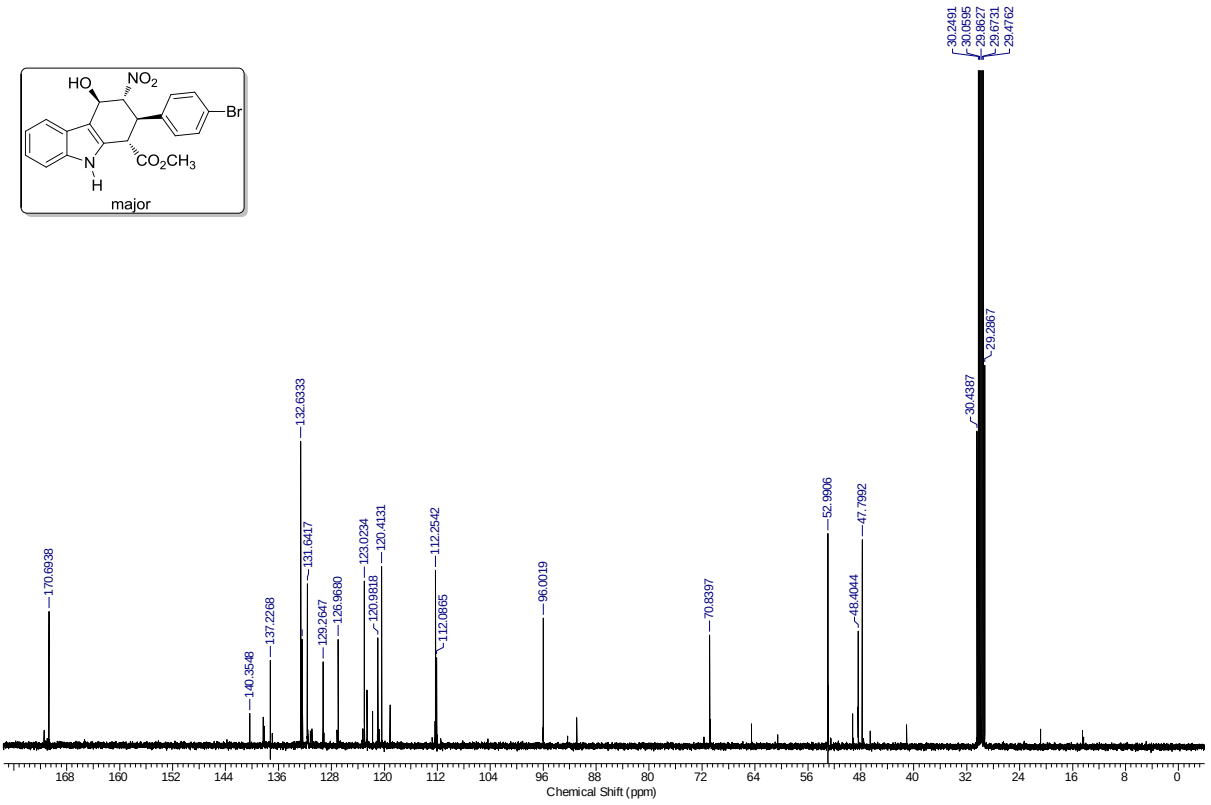

HO
NO2
OCH3
CO2CH3
N
H
major
dr = 80:20
minor
Chemical Shift (ppm)

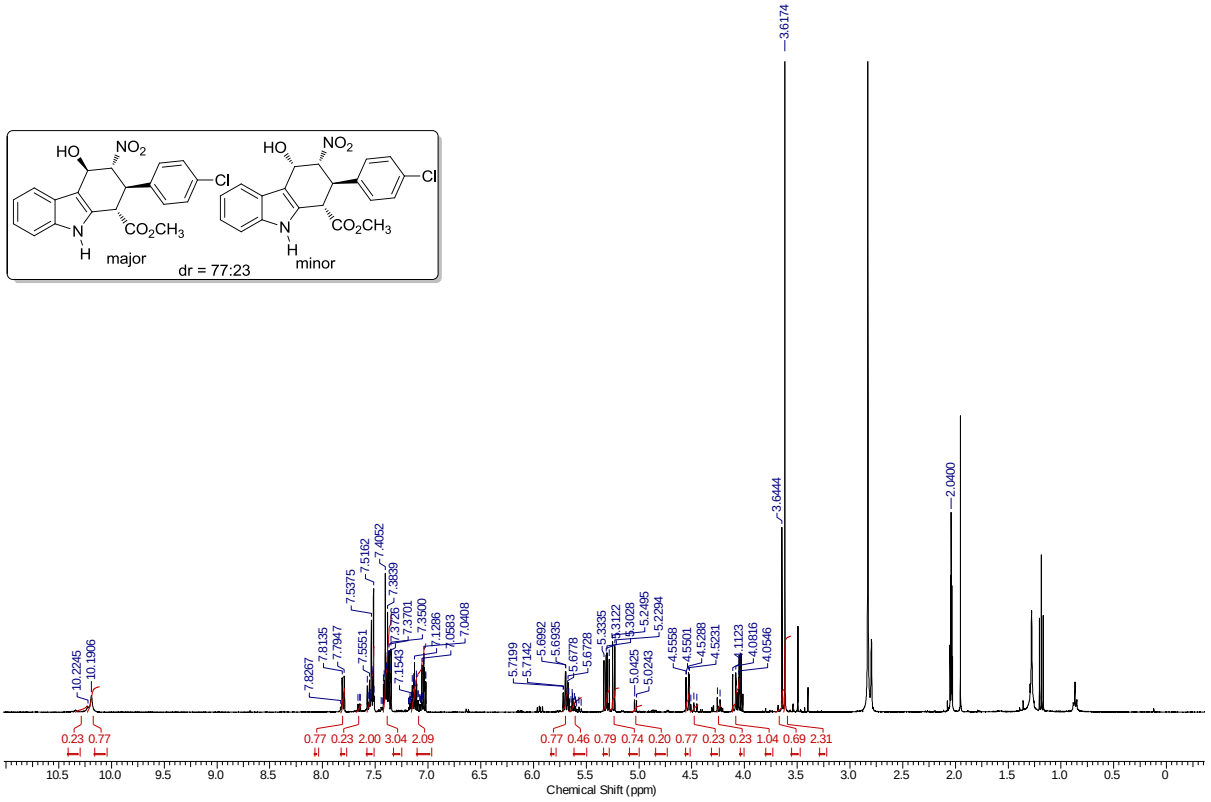

HO
NO2
OCH3
CO2CH3
N
H
major
Chemical Shift (ppm)

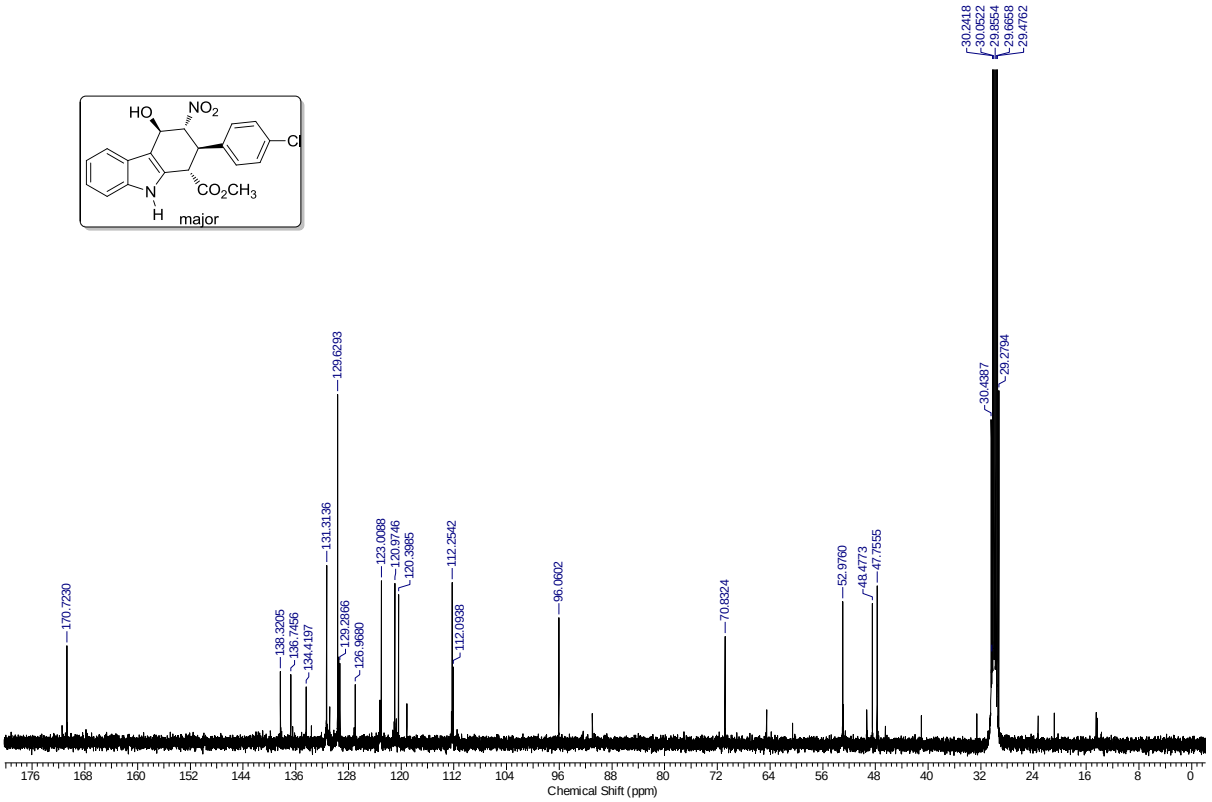

major
dr = 80:20
minor
Chemical Shift (ppm)

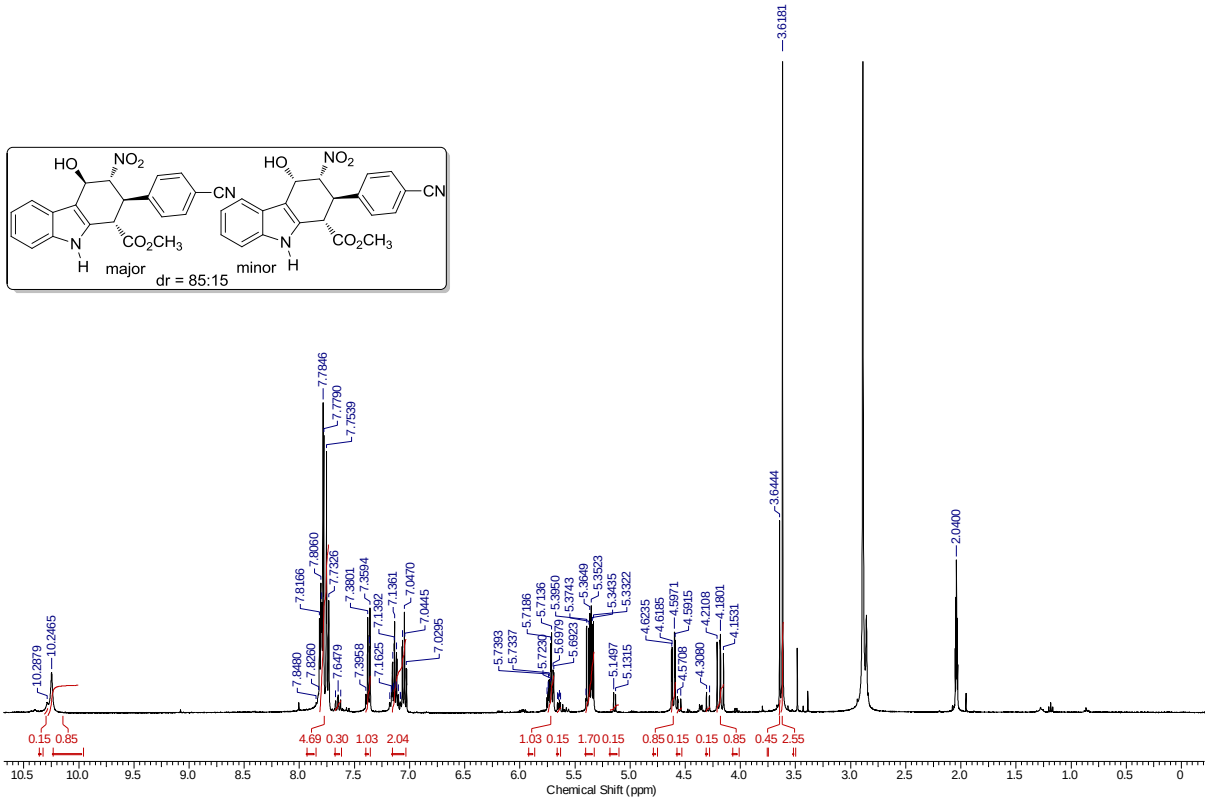

major
Chemical Shift (ppm)

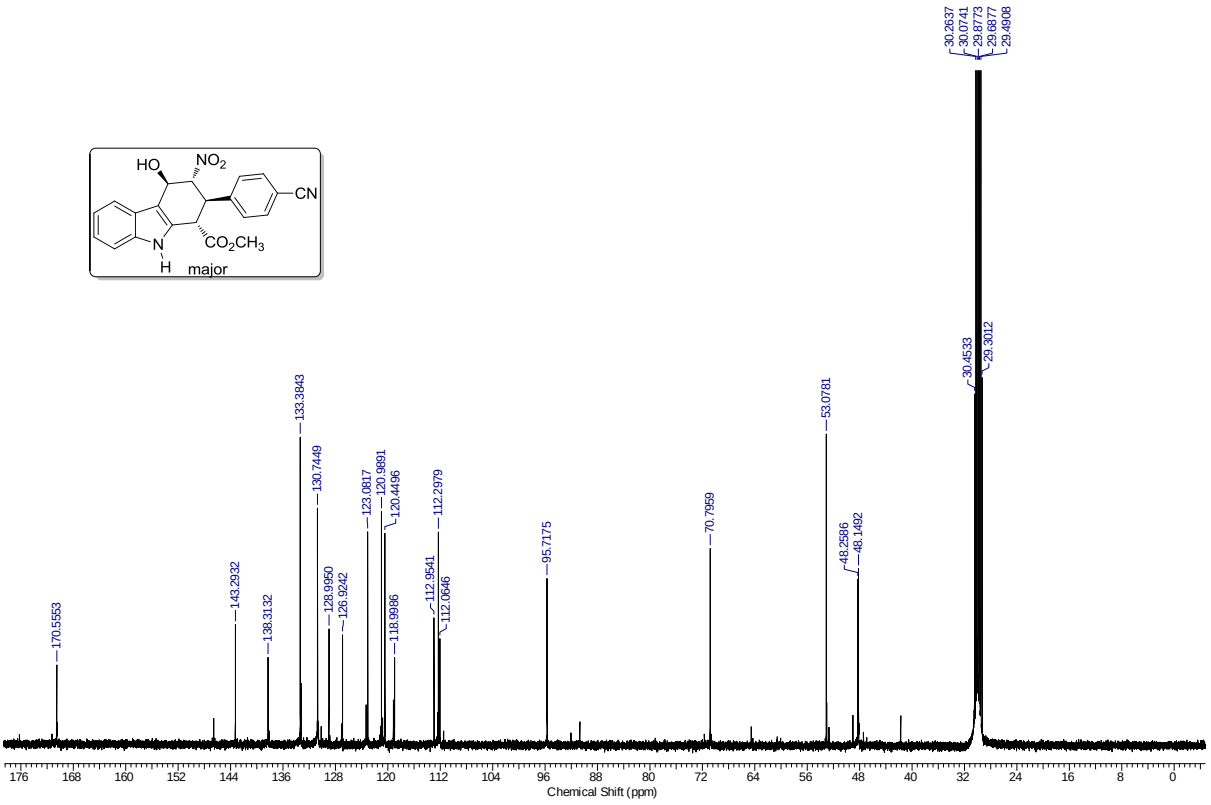

major
dr = 78:22
minor
Chemical Shift (ppm)

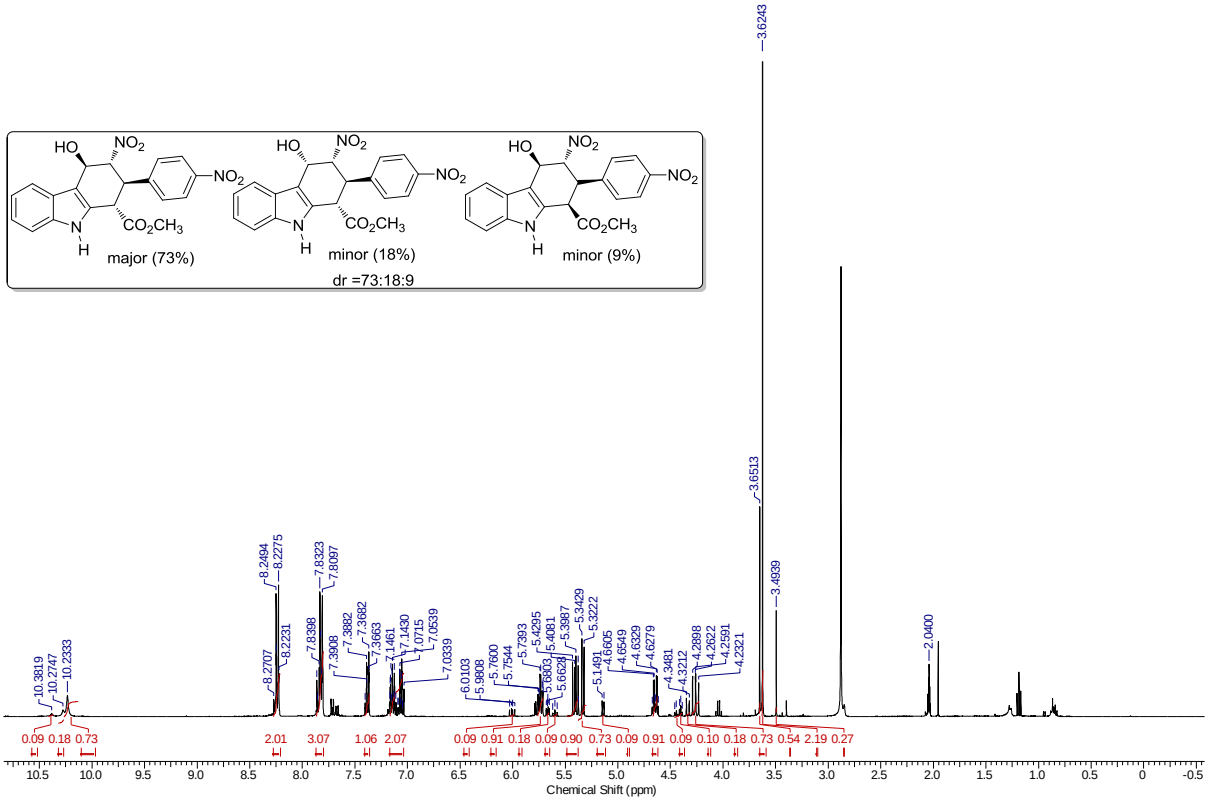

major
Chemical Shift (ppm)

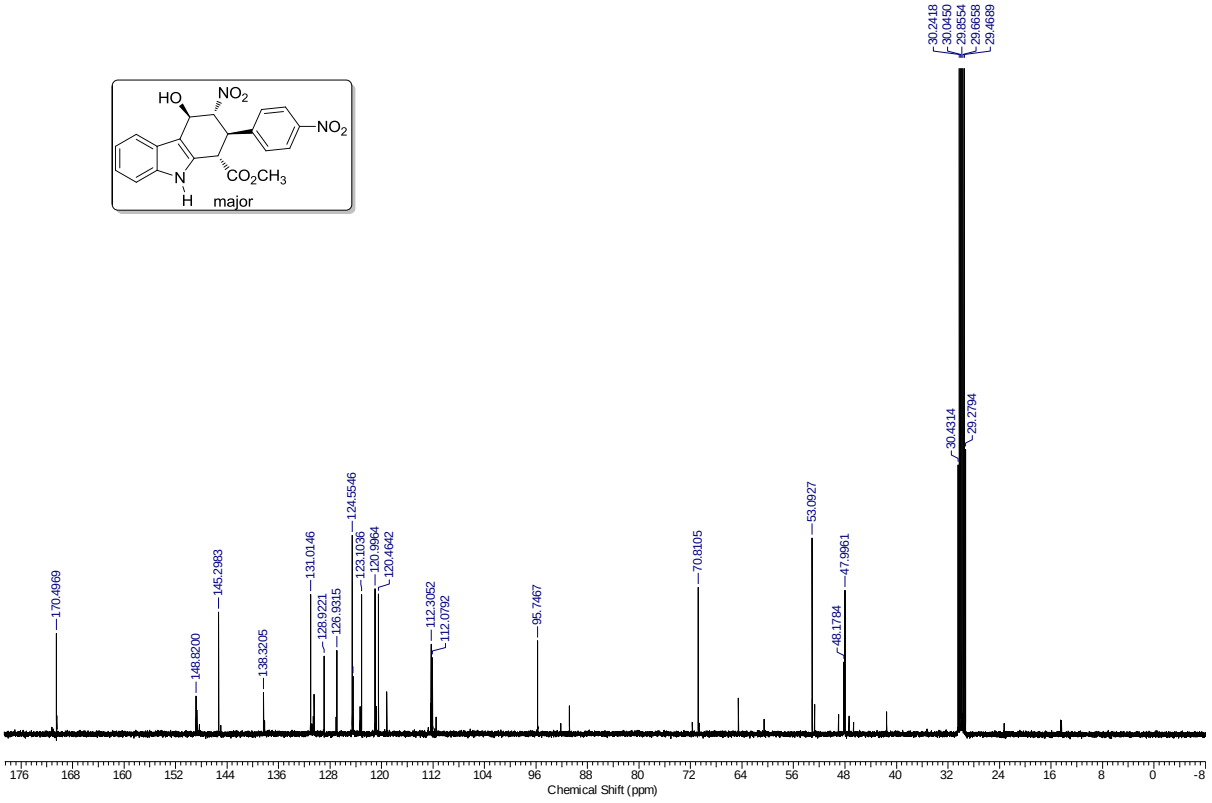

HO
NO2
Cl
CO2CH3
N
H
major
dr = 77:23
minor
Chemical Shift (ppm)

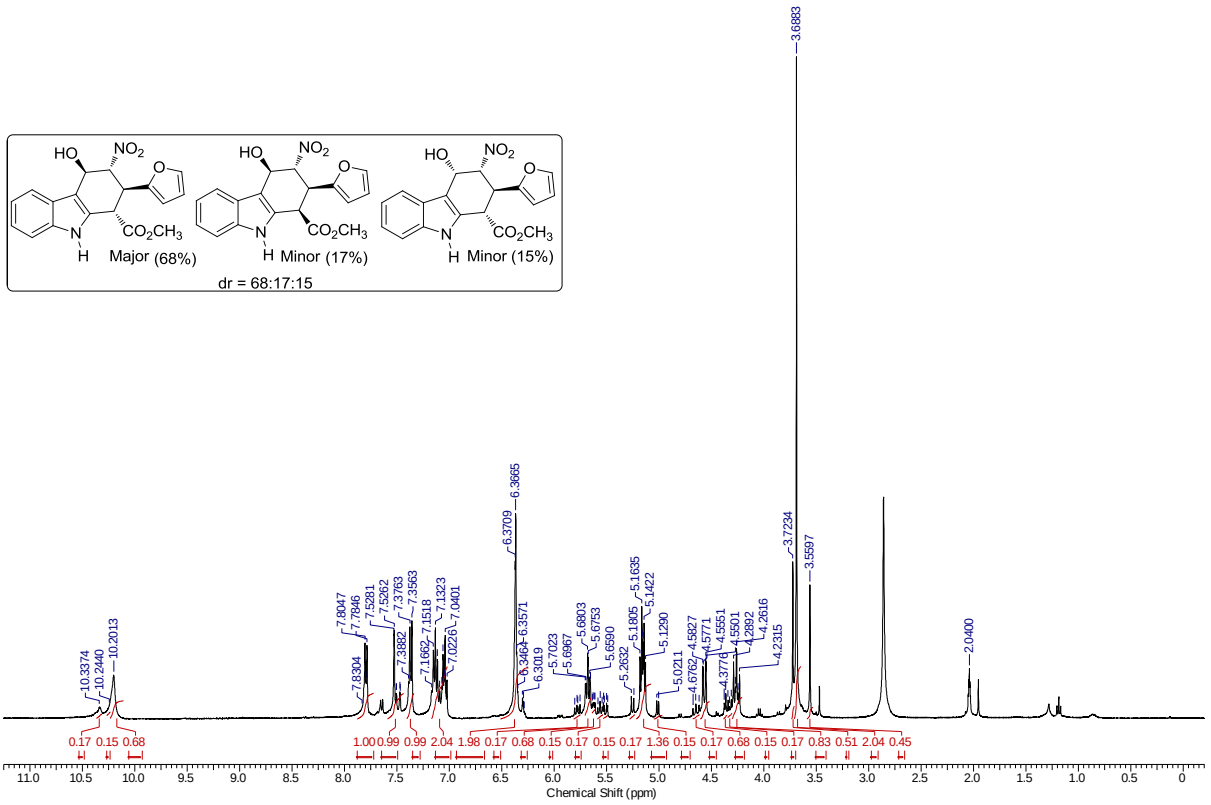

HO
NO2
Cl
CO2CH3
N
H
major
Chemical Shift (ppm)

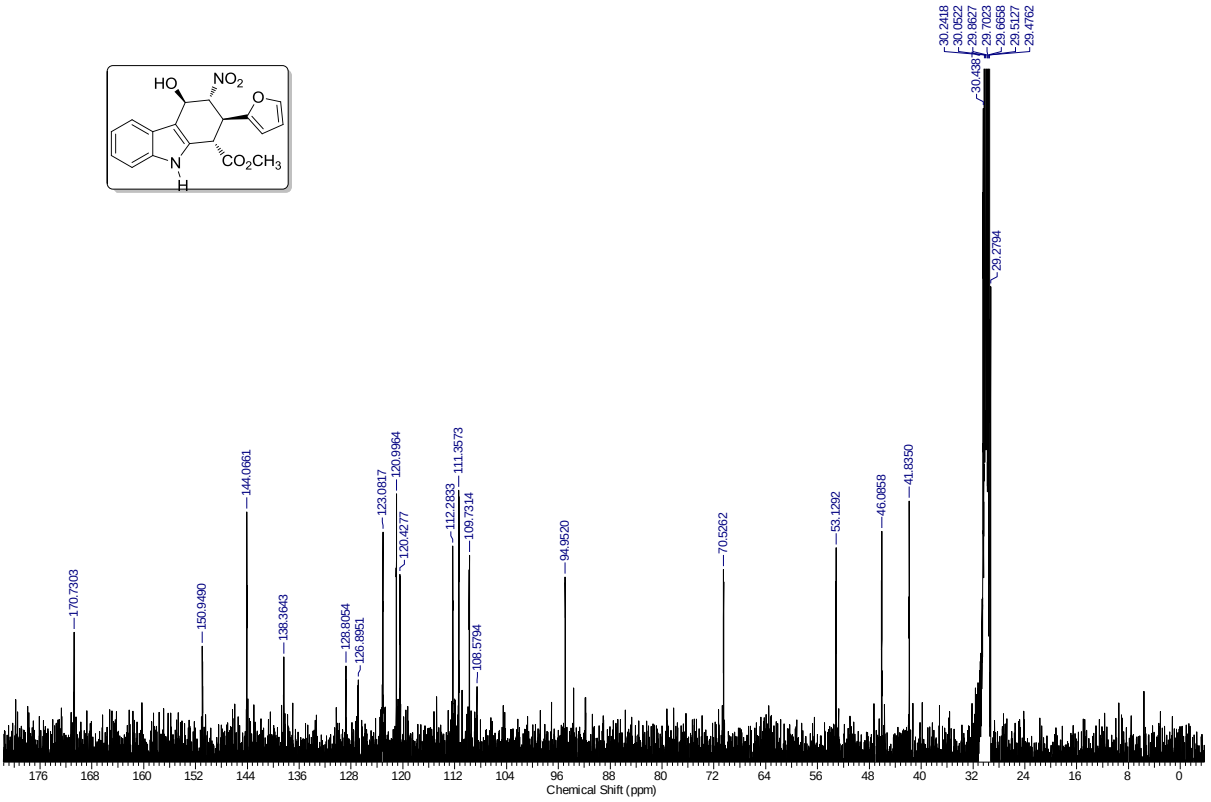

major
minor
dr = 85:15
Chemical Shift (ppm)

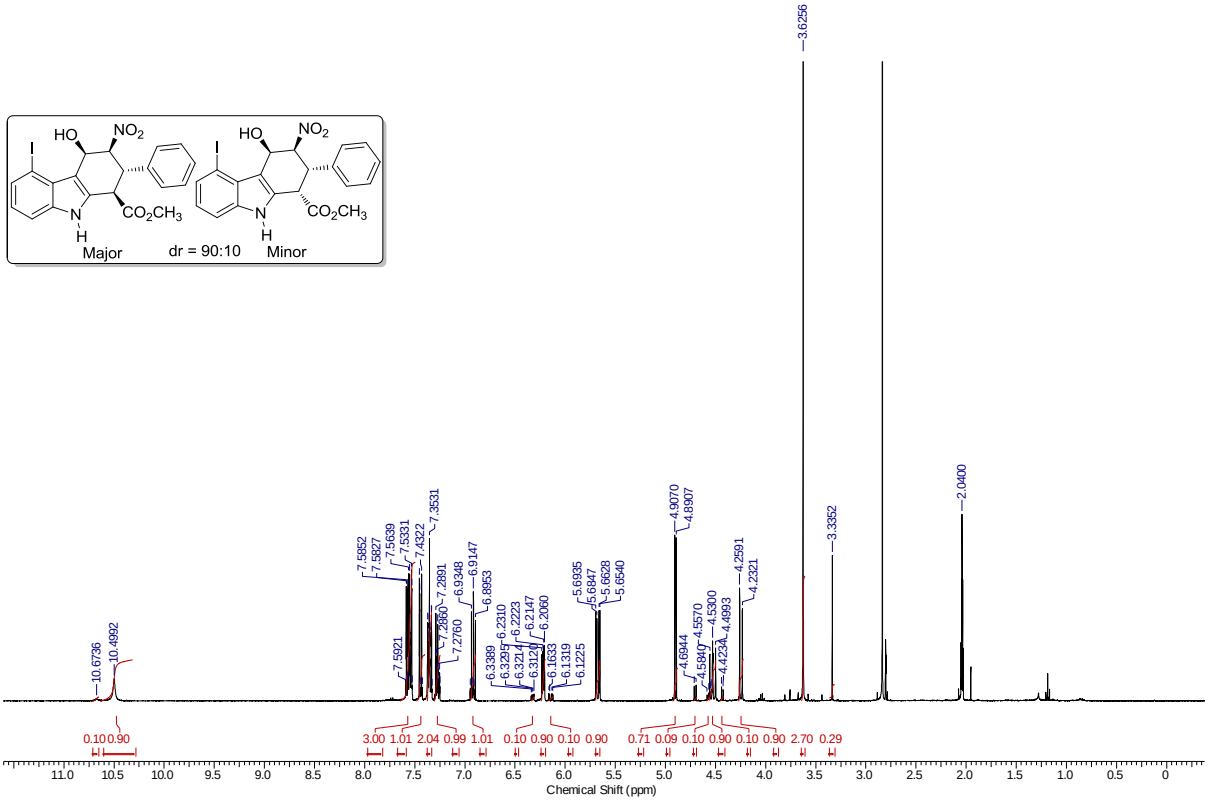

major
Chemical Shift (ppm)

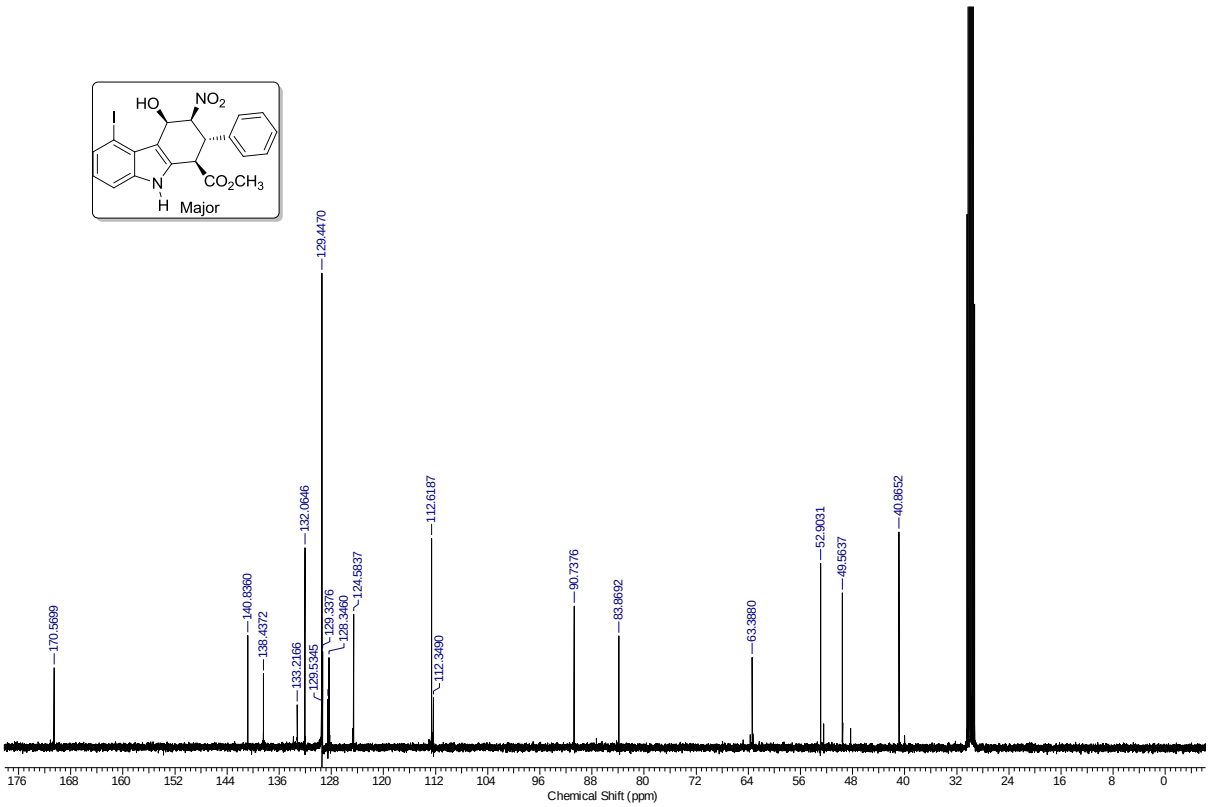

major (73%)
minor (18%)
minor (9%)
dr =73:18:9
Chemical Shift (ppm)

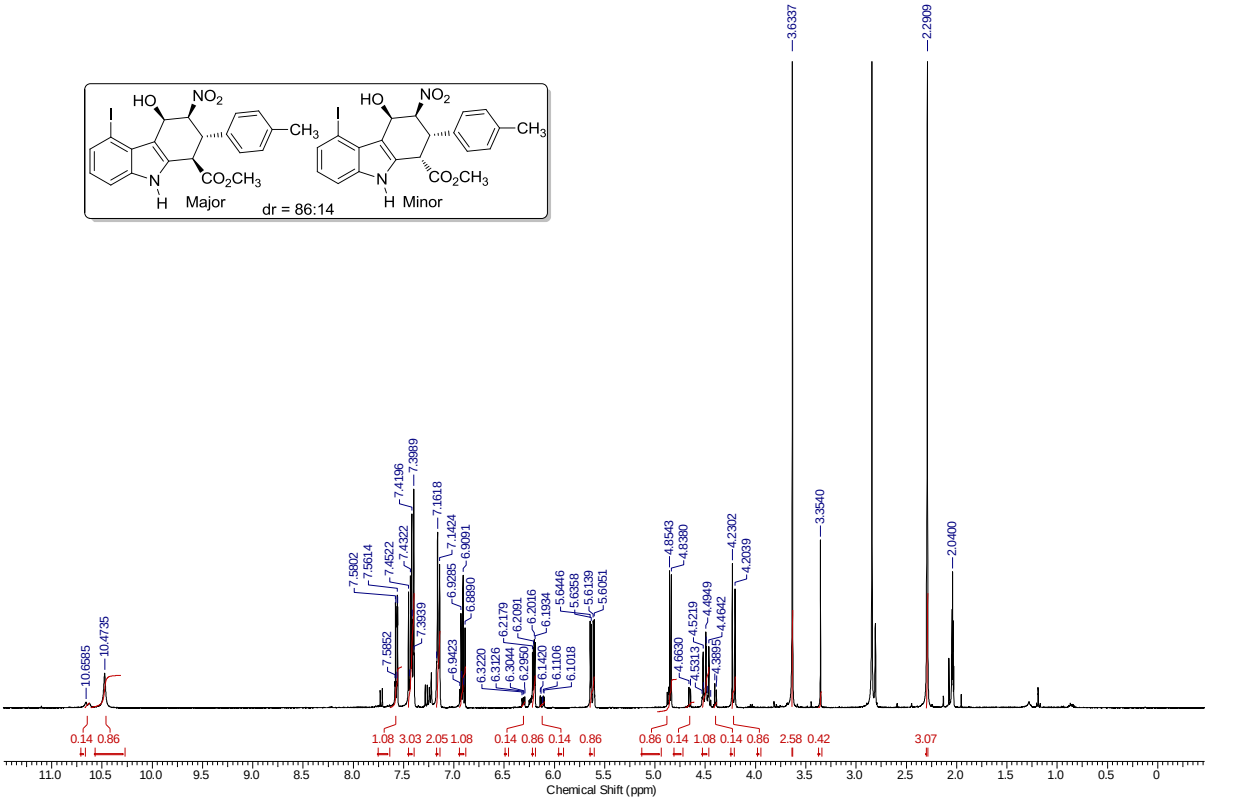

major
Chemical Shift (ppm)

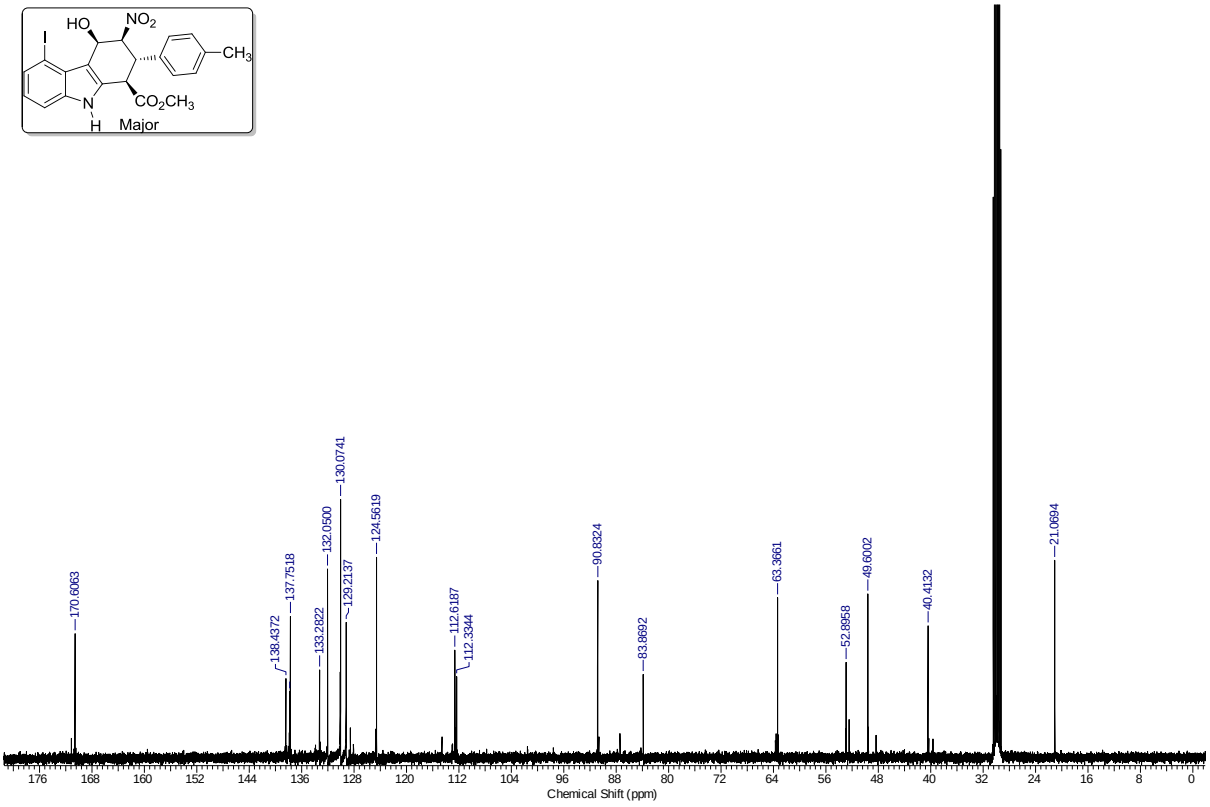

HO
NO2
O
N
H
CO2CH3
Major (68%)
Minor (17%)
Minor (15%)
dr = 68:17:15
Chemical Shift (ppm)

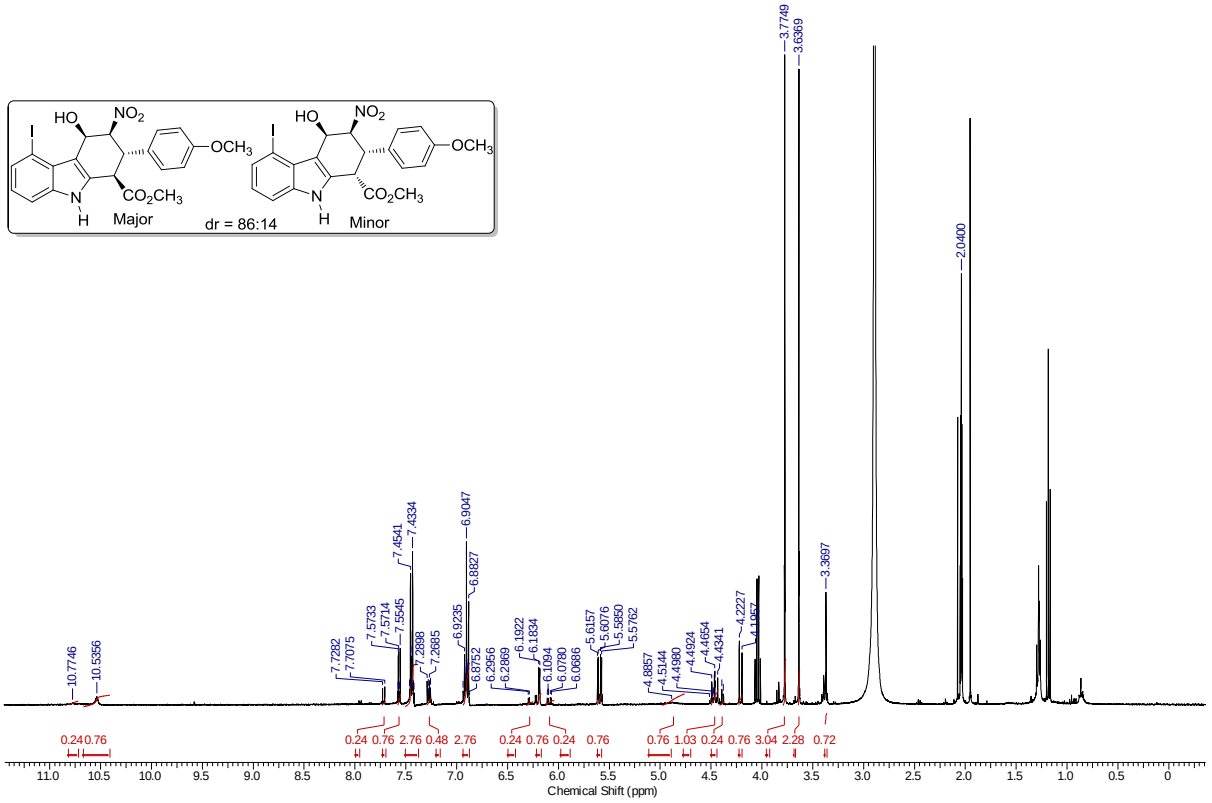

HO
NO2
O
N
H
CO2CH3
Chemical Shift (ppm)

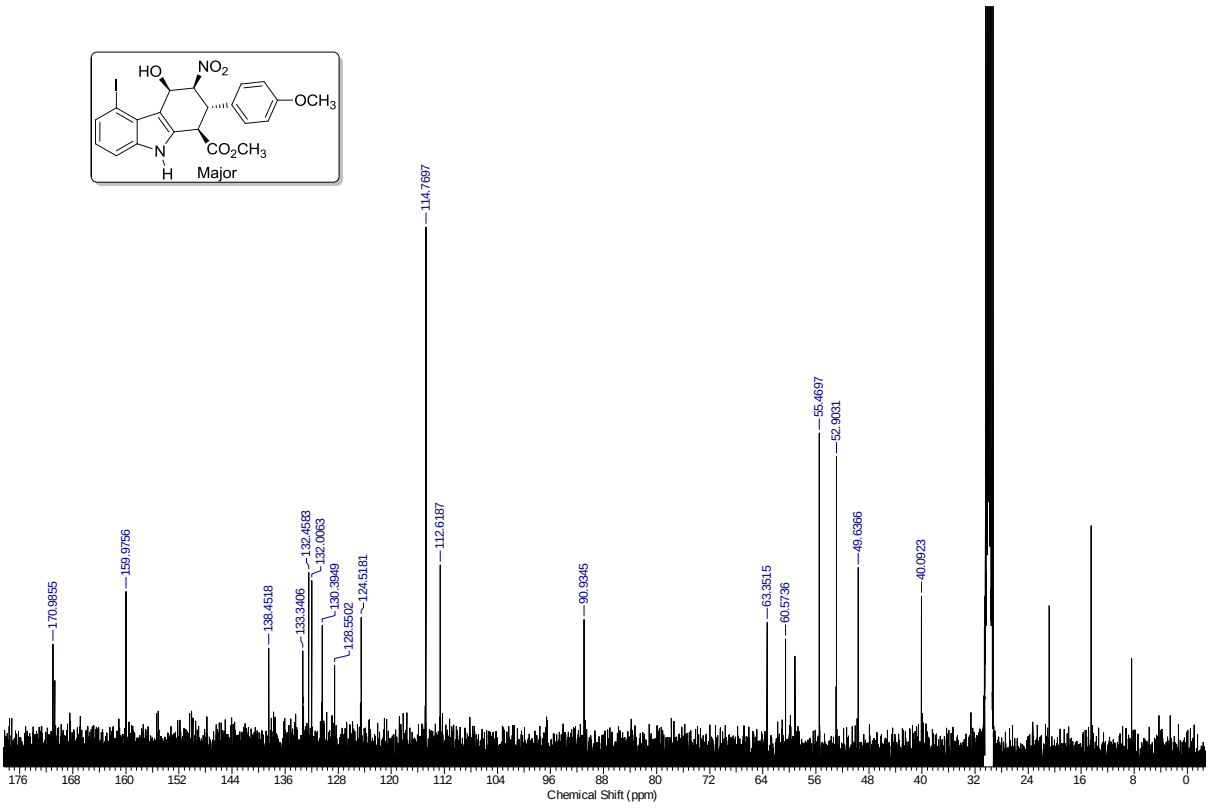

HO
NO2
I
N
H
CO2CH3
Major
dr = 90:10
Minor
Chemical Shift (ppm)

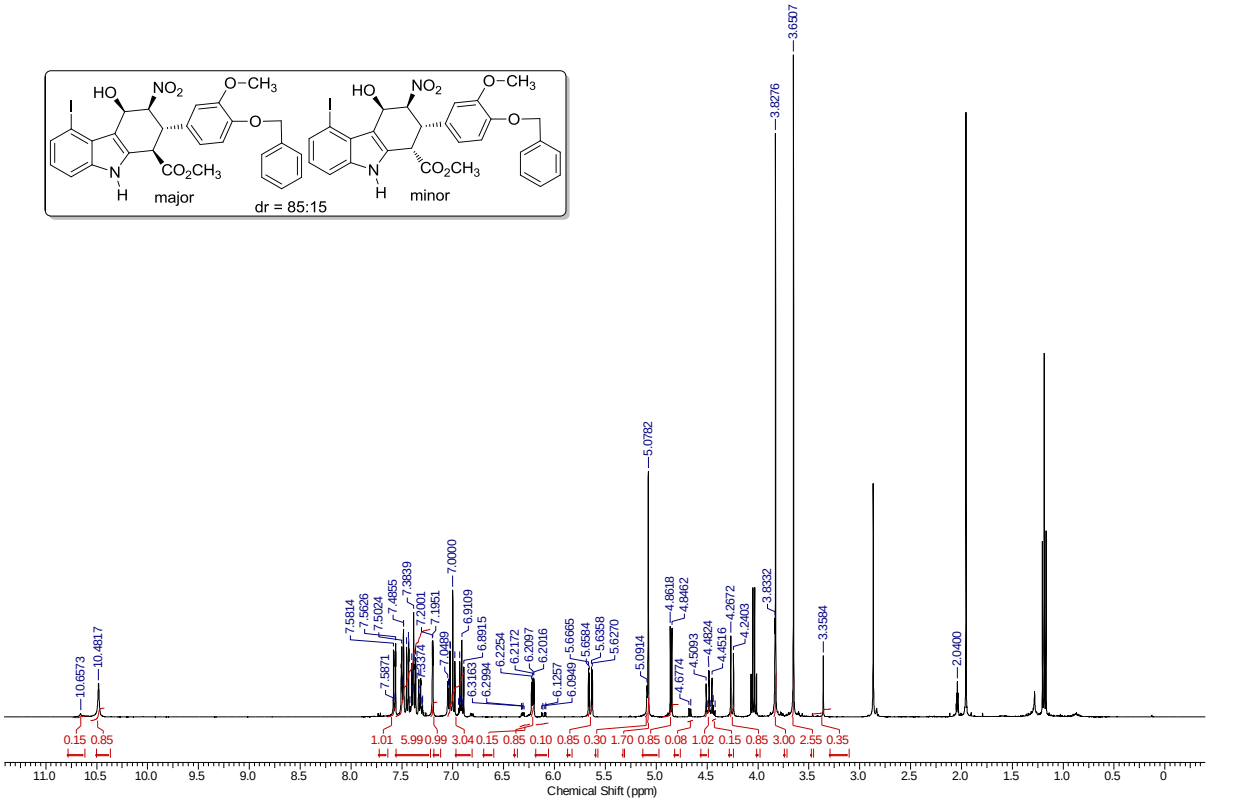

HO
NO2
I
N
H
CO2CH3
Major
Chemical Shift (ppm)

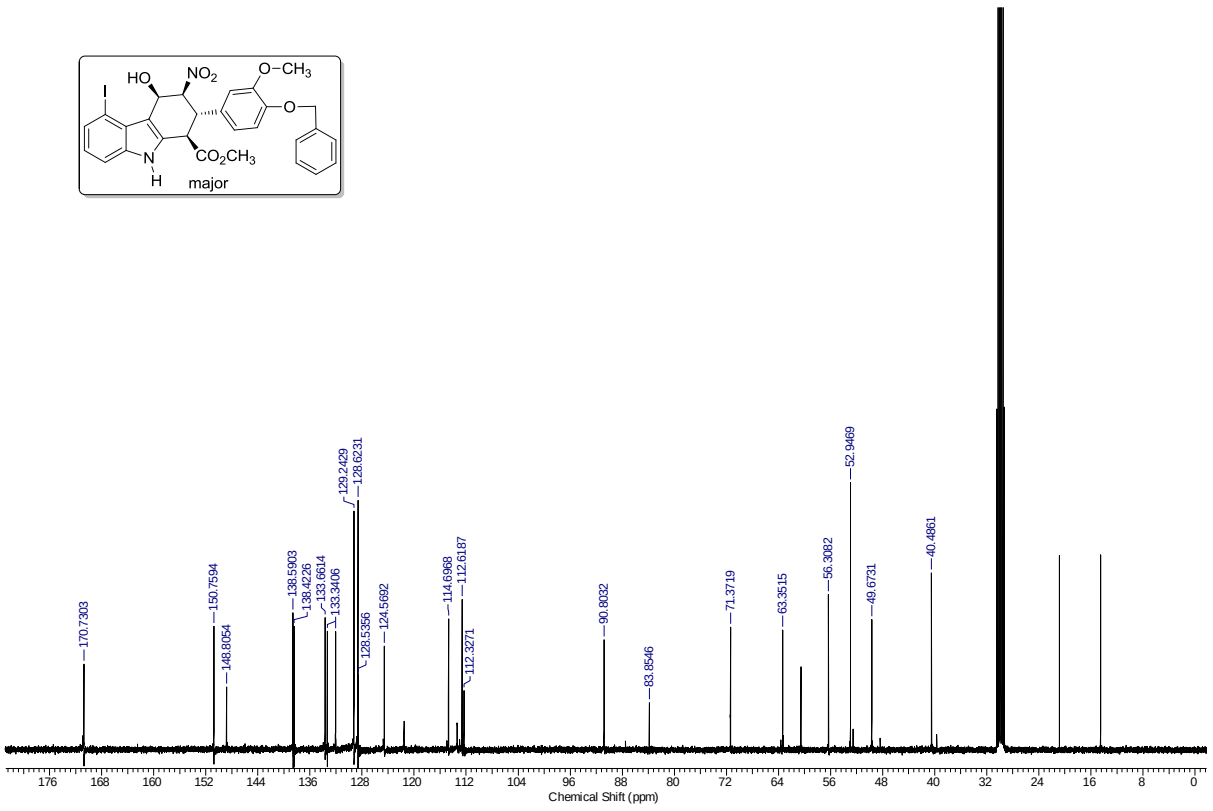

HO
NO2
CH3
CO2CH3
N
H
Major
dr = 86:14
Minor
Chemical Shift (ppm)

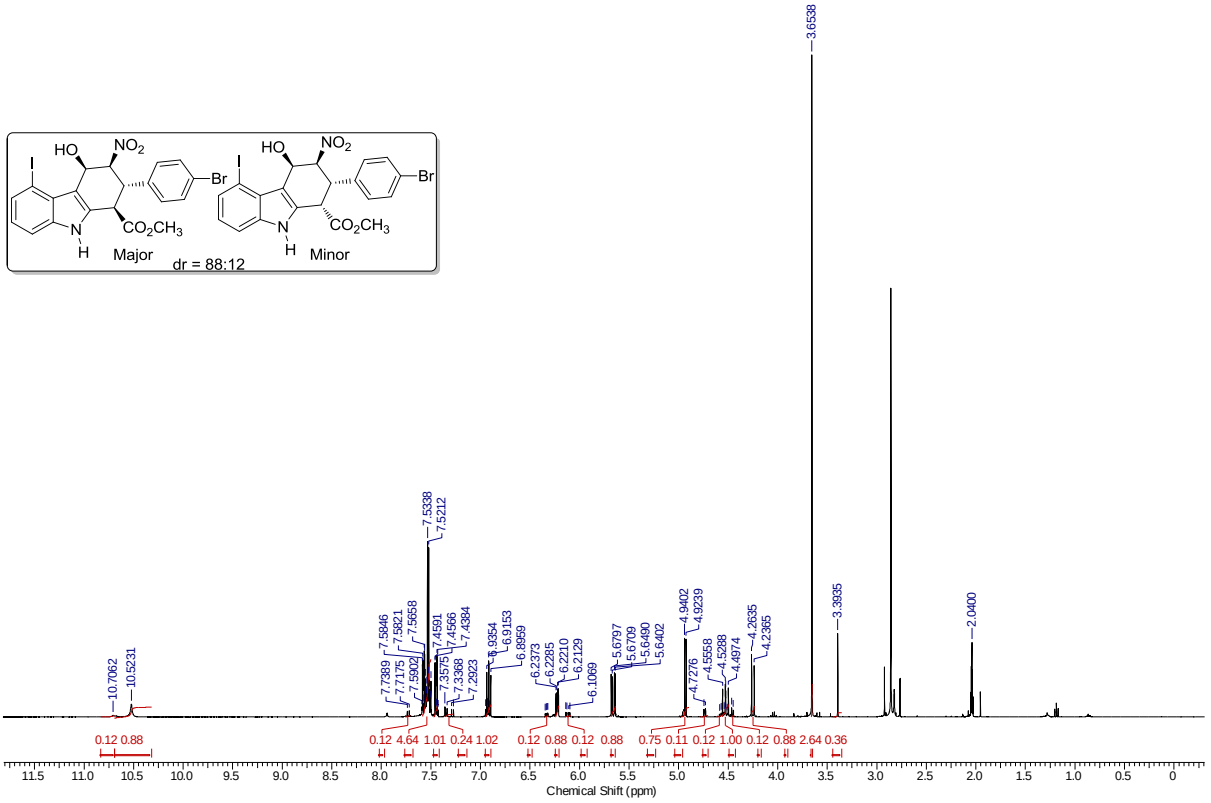

HO
NO2
CH3
CO2CH3
N
H
Major
Chemical Shift (ppm)

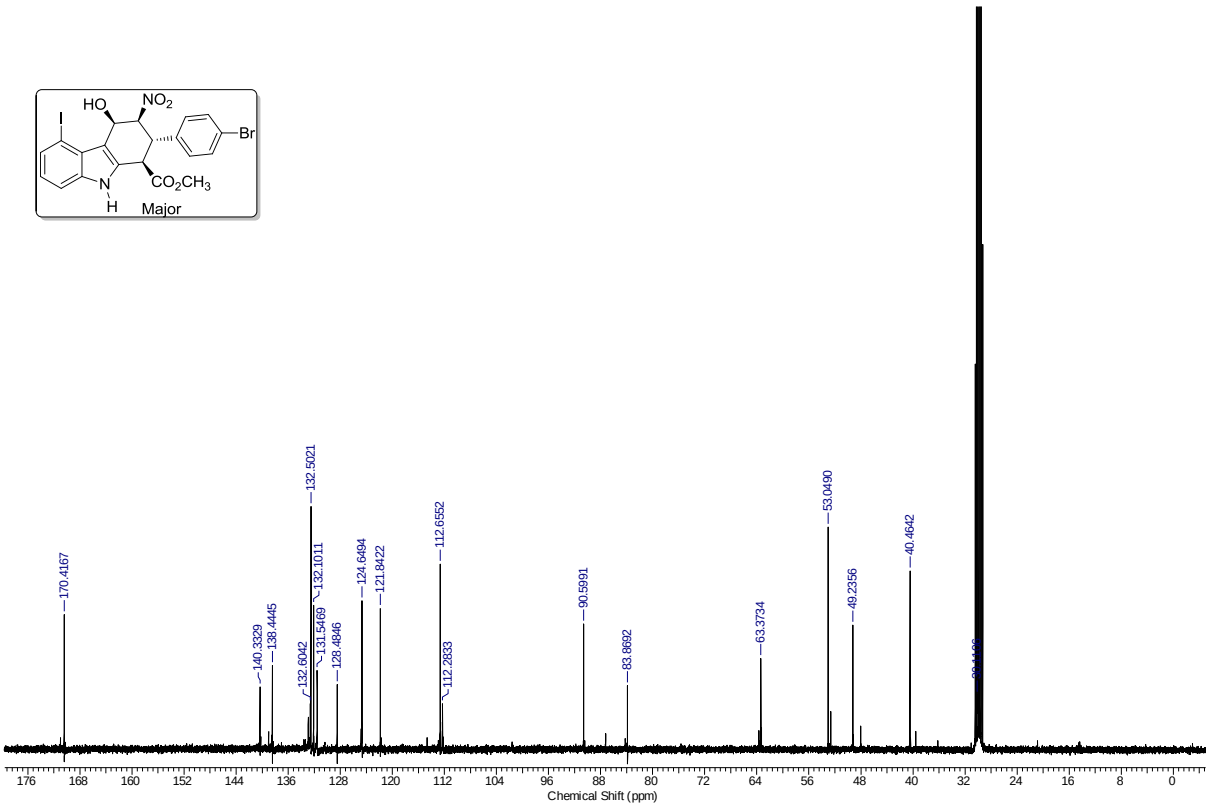

HO
NO2
OCH3
CO2CH3
N
H
Major
dr = 86:14
Minor
Chemical Shift (ppm)

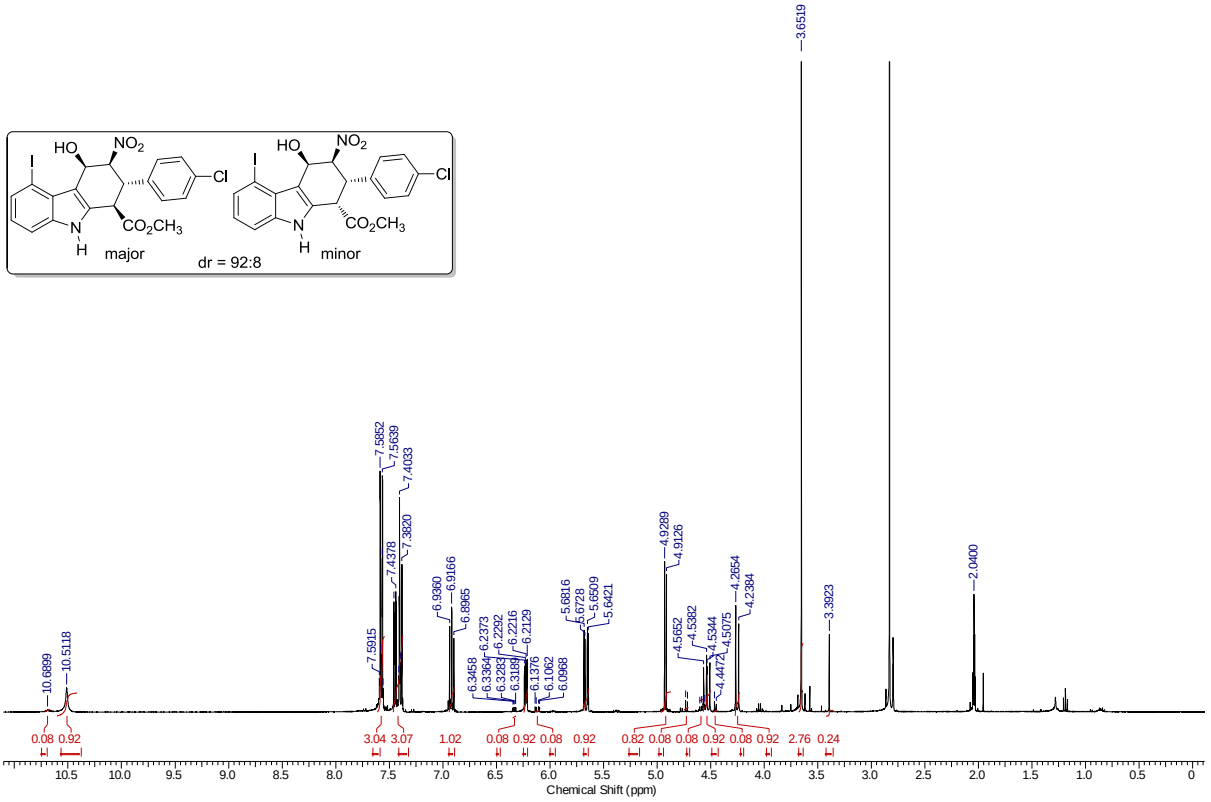

HO
NO2
OCH3
CO2CH3
N
H
Major
Chemical Shift (ppm)

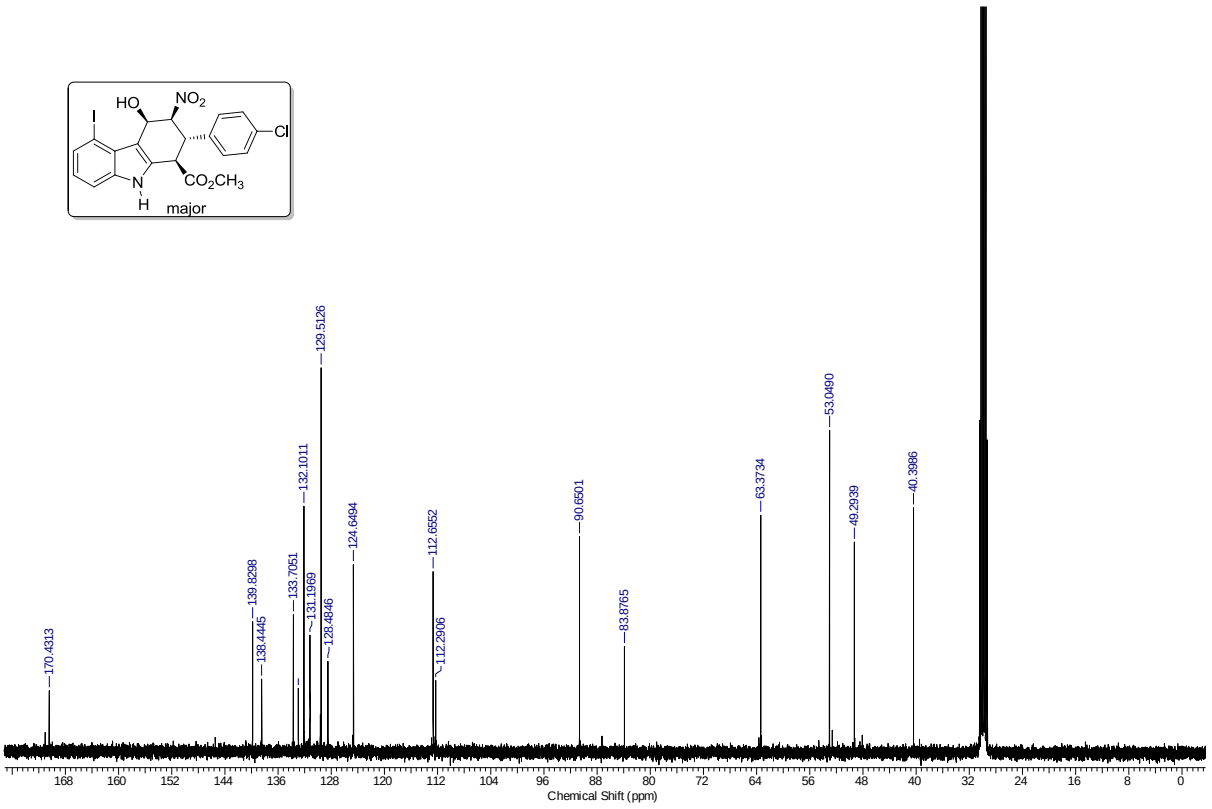


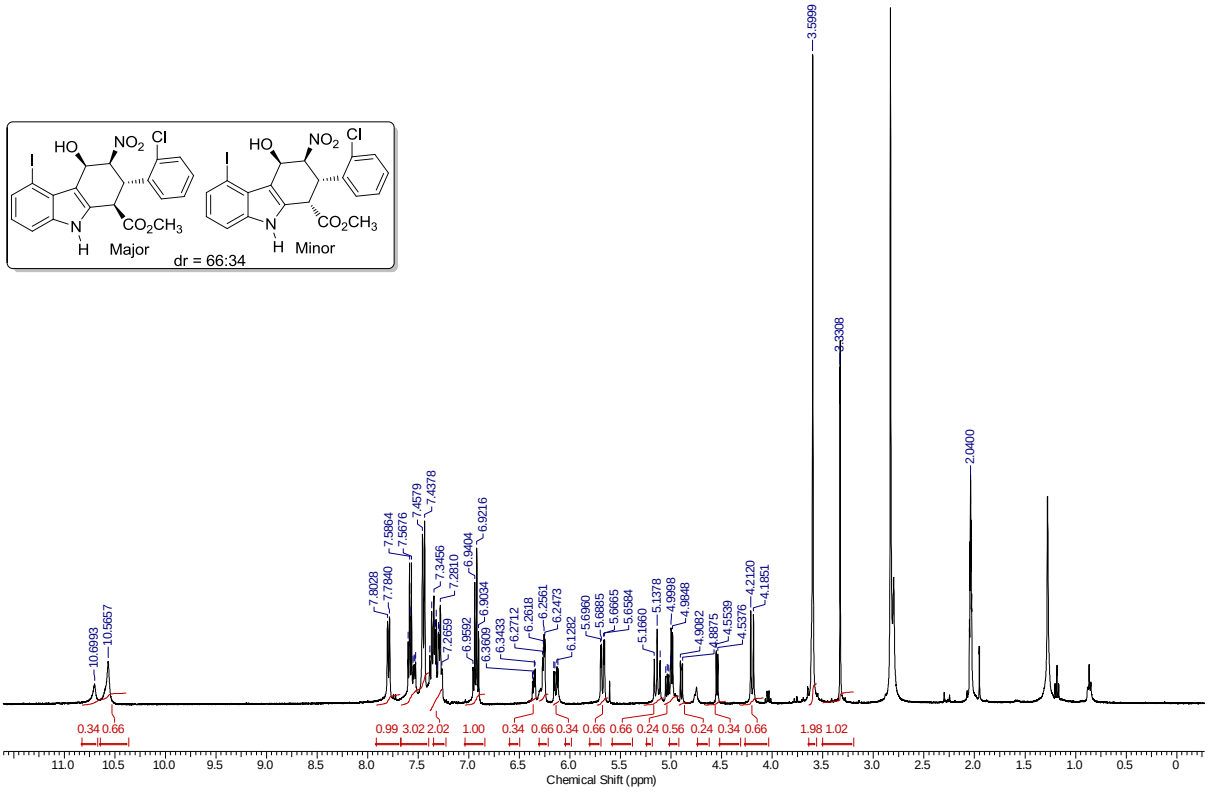


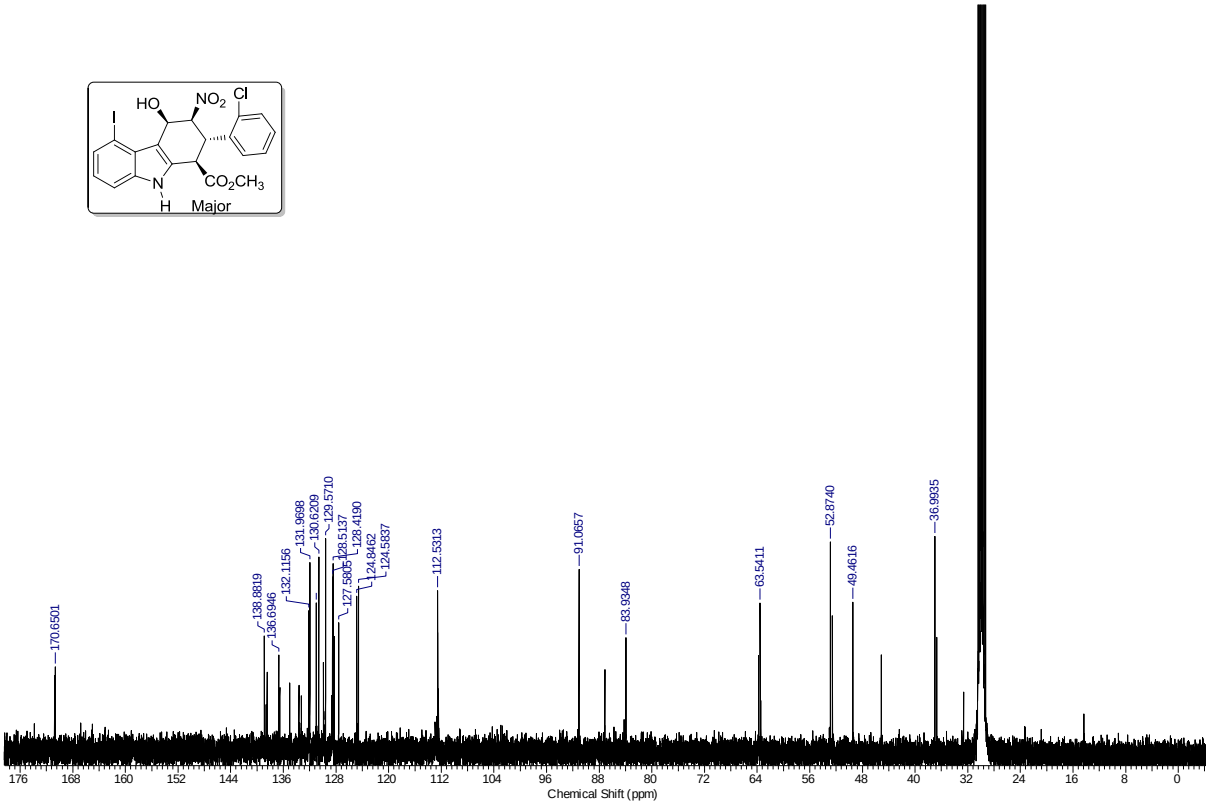

HO
NO2
Br
CO2CH3
N
H
Major
dr = 88:12
Minor
3.6538
7.5338
7.5212
2.0400
3.3935
Chemical Shift (ppm)

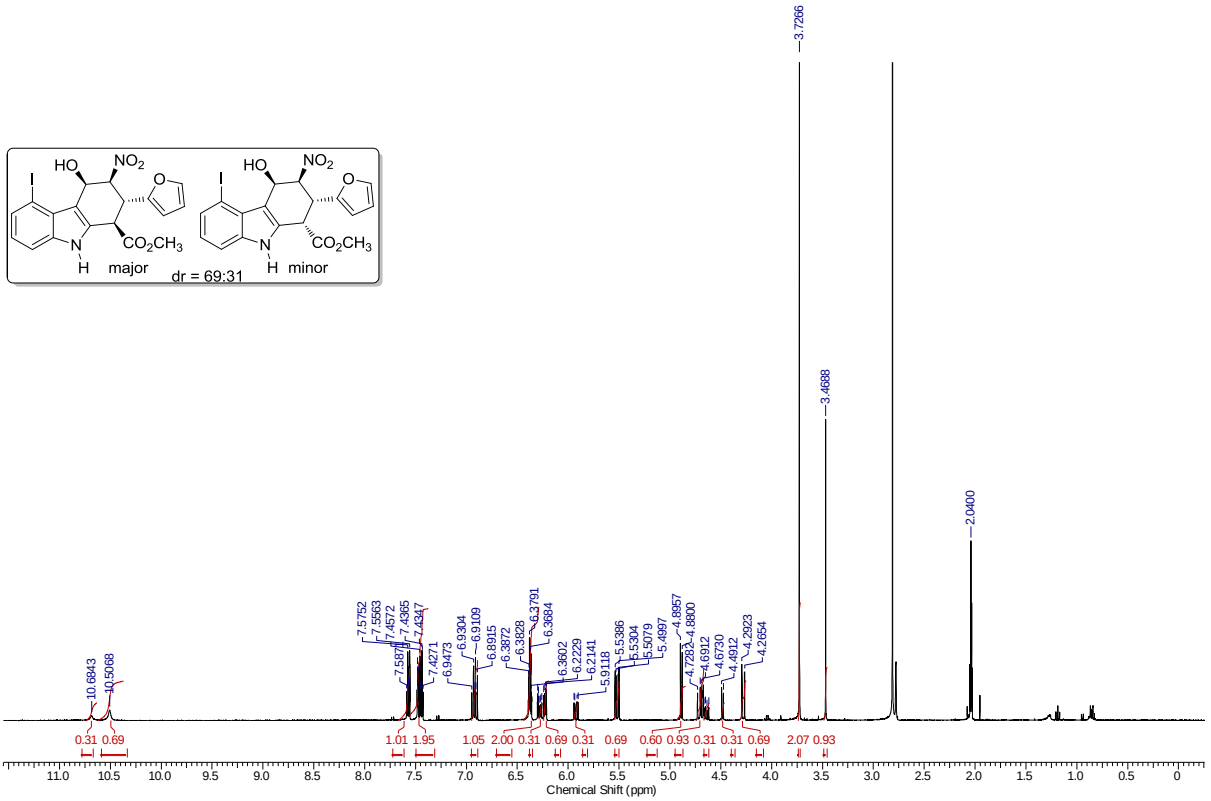

HO
NO2
Br
CO2CH3
N
H
Major
170.4167
132.5021
132.1011
131.5469
128.4846
124.6494
121.8422
112.6552
112.2833
90.5991
83.8692
63.3734
53.0490
49.2356
40.4642
Chemical Shift (ppm)

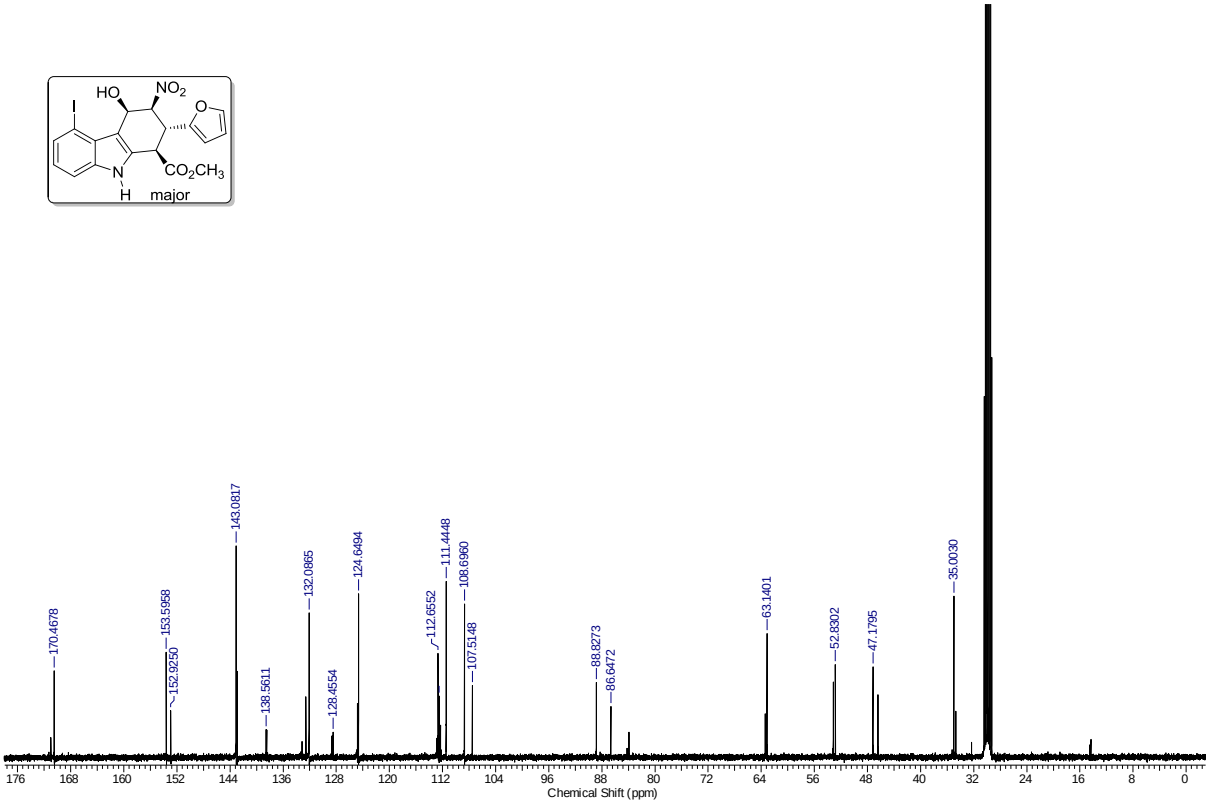

HO
NO2
I
Cl
N
H
CO2CH3
major
dr = 92:8
minor
Chemical Shift (ppm)

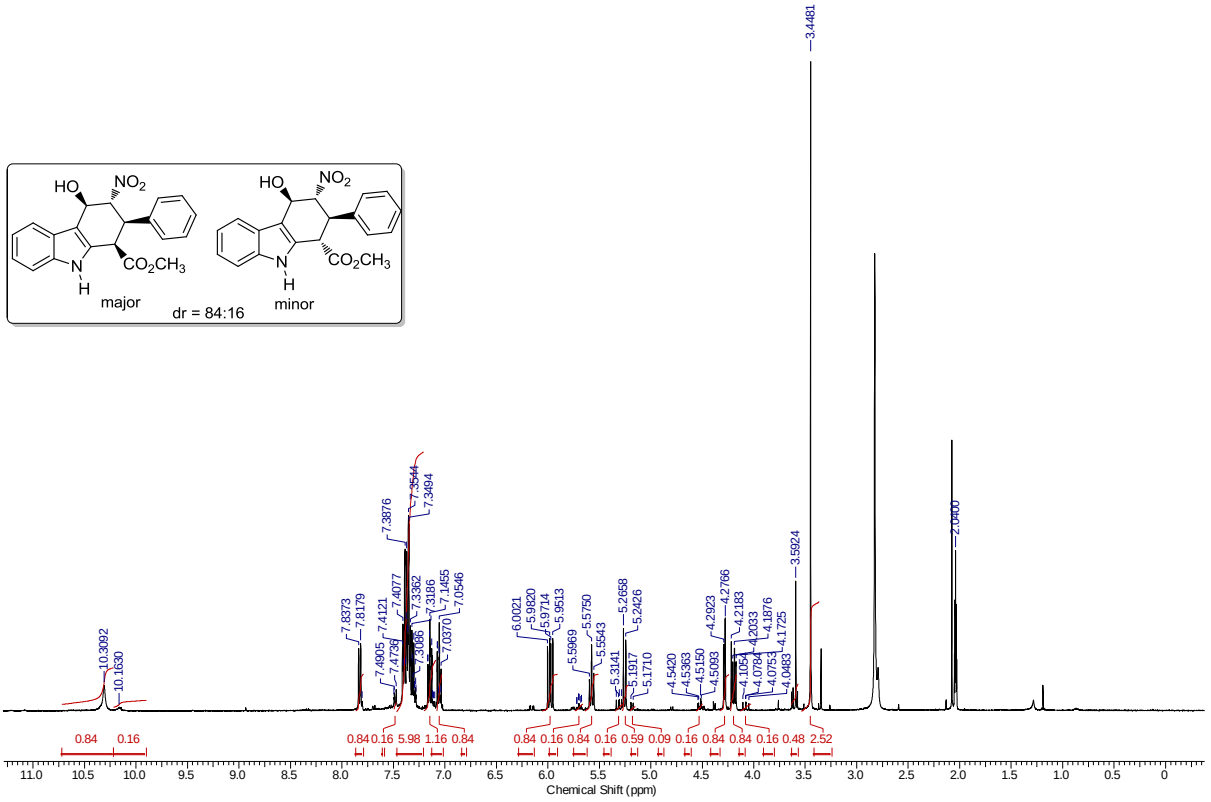

HO
NO2
I
Cl
N
H
CO2CH3
major
Chemical Shift (ppm)

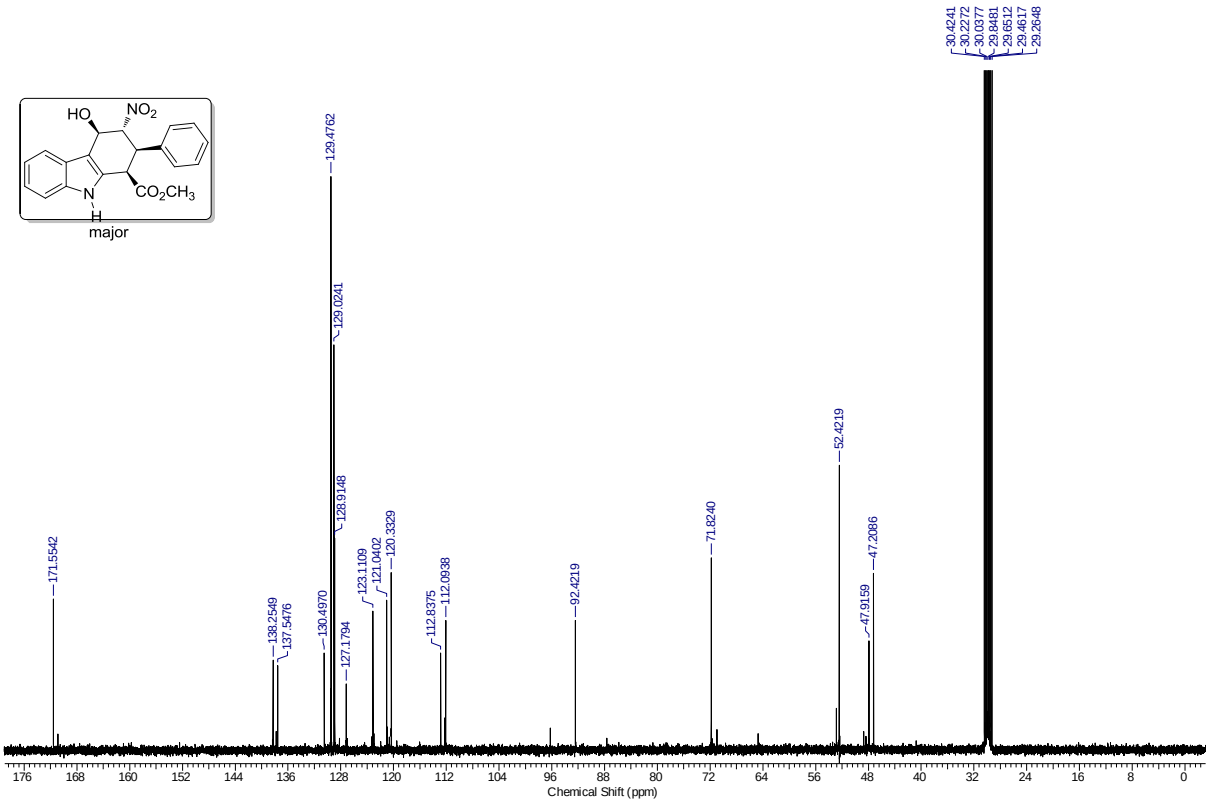

HO
NO2
Cl
I
N
H
CO2CH3
Major
Minor
dr = 66:34
Chemical Shift (ppm)

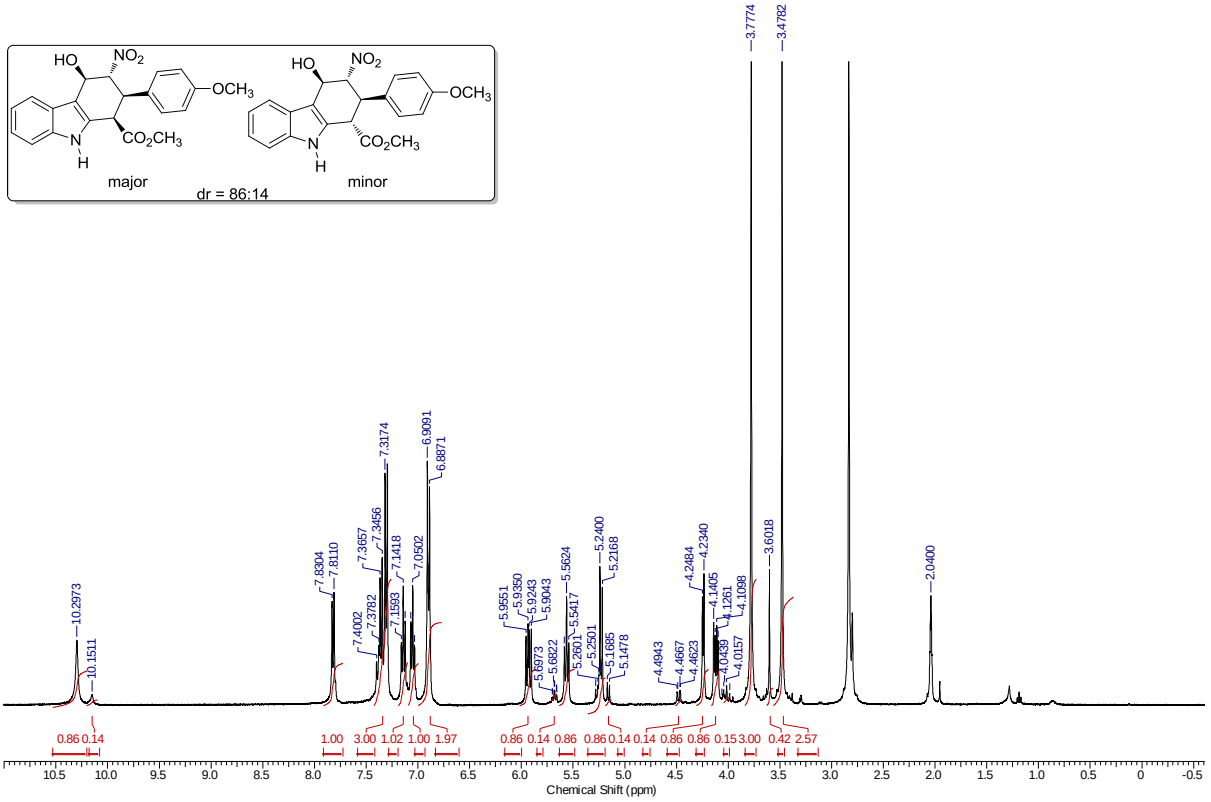

HO
NO2
Cl
I
N
H
CO2CH3
Major
Chemical Shift (ppm)

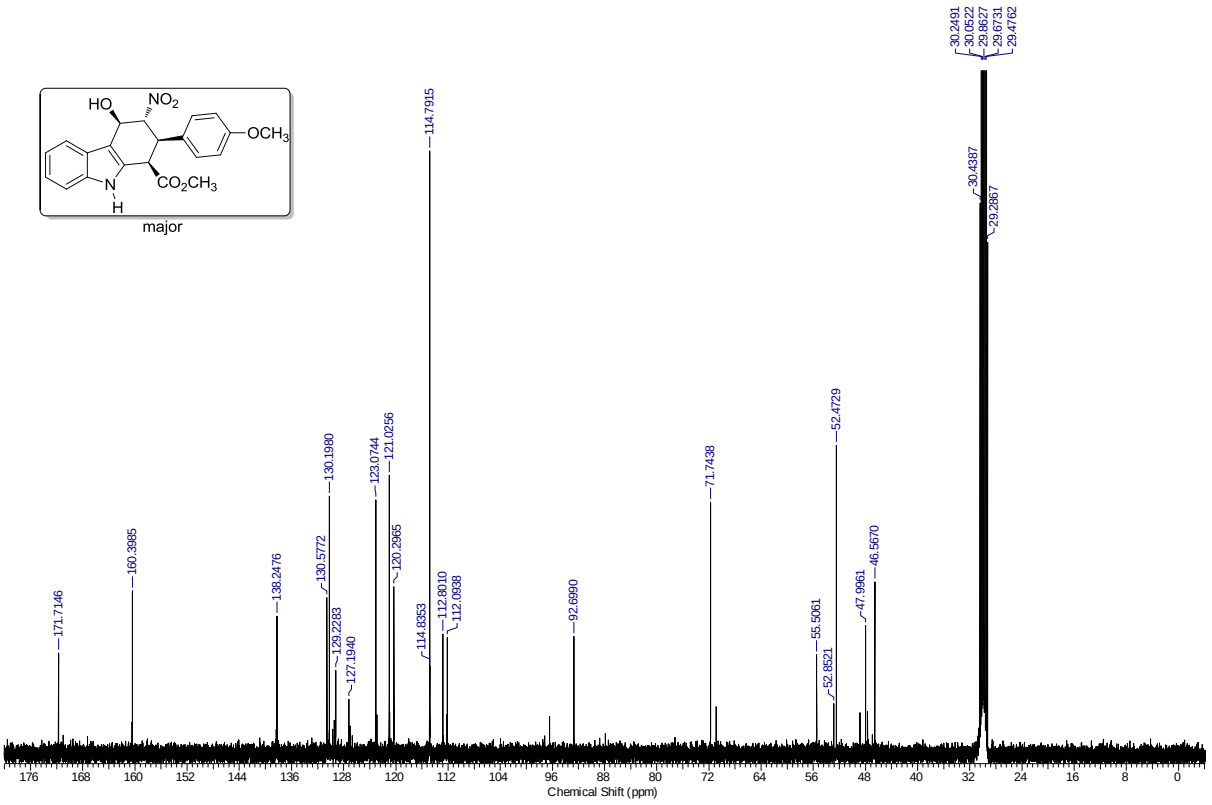

HO
NO2
O
I
N
H
CO2CH3
major
dr = 69:31
minor
3.7266
3.4688
2.0400
Chemical Shift (ppm)

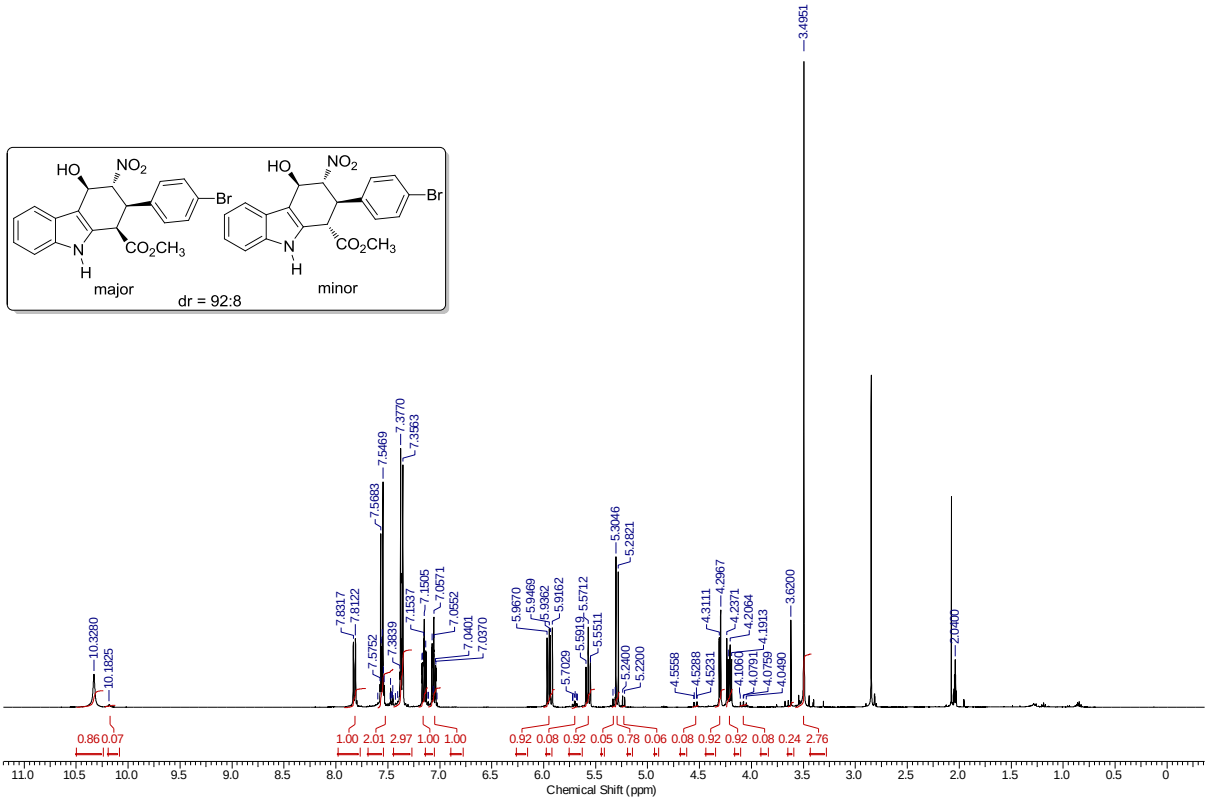

HO
NO2
O
I
N
H
CO2CH3
major
170.4678
153.5958
152.9250
143.0817
138.5611
132.0865
128.4554
124.6494
112.6552
111.4448
108.6960
107.5148
88.8273
86.6472
63.1401
52.8302
47.1795
35.0030
Chemical Shift (ppm)

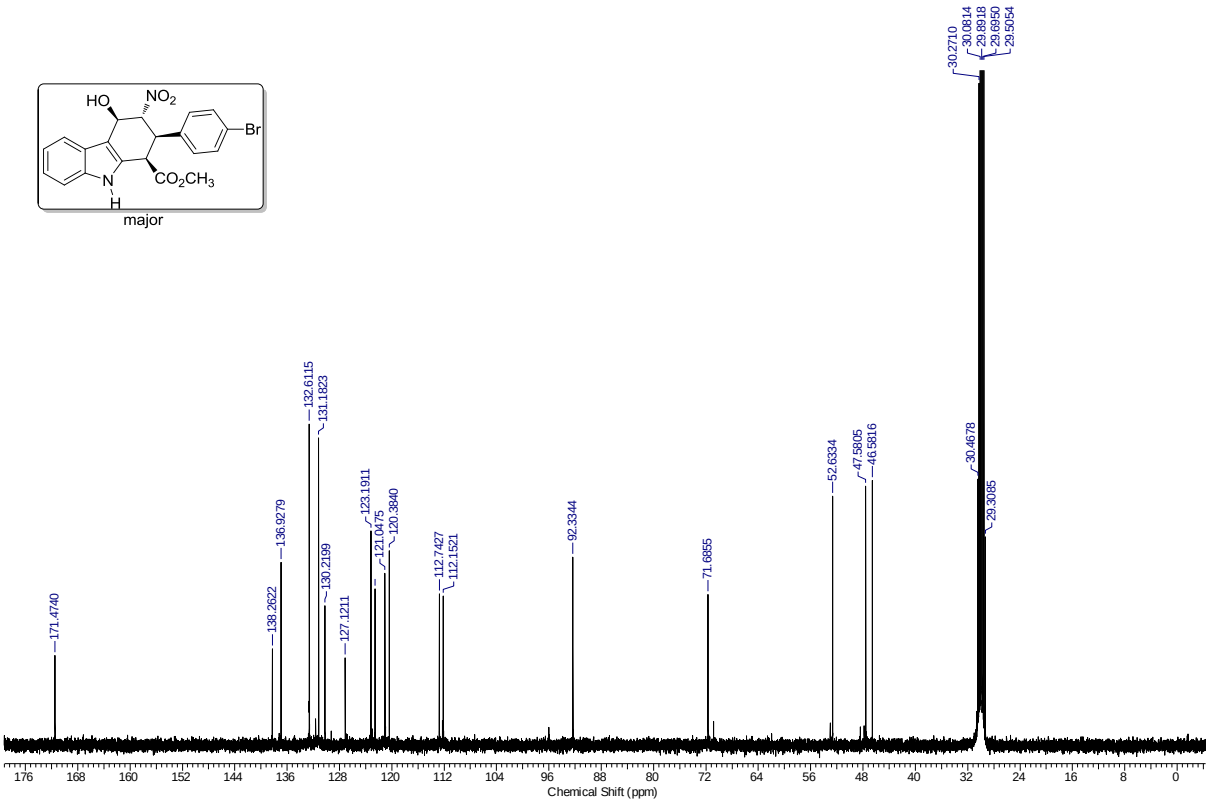

HO
NO2
CO2CH3
N
H
major
dr = 84:16
minor
Chemical Shift (ppm)

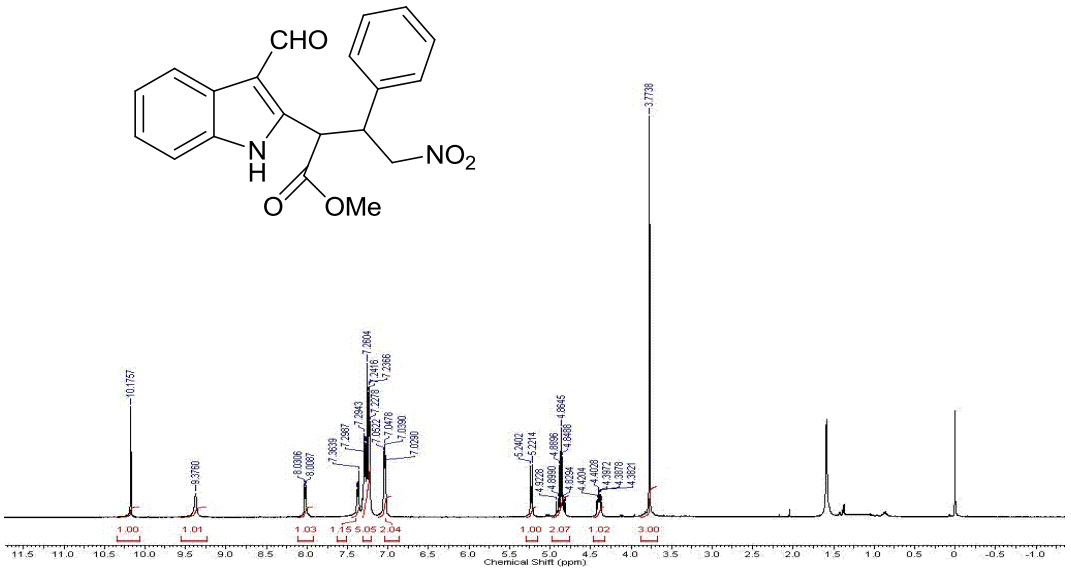

major
Chemical Shift (ppm)

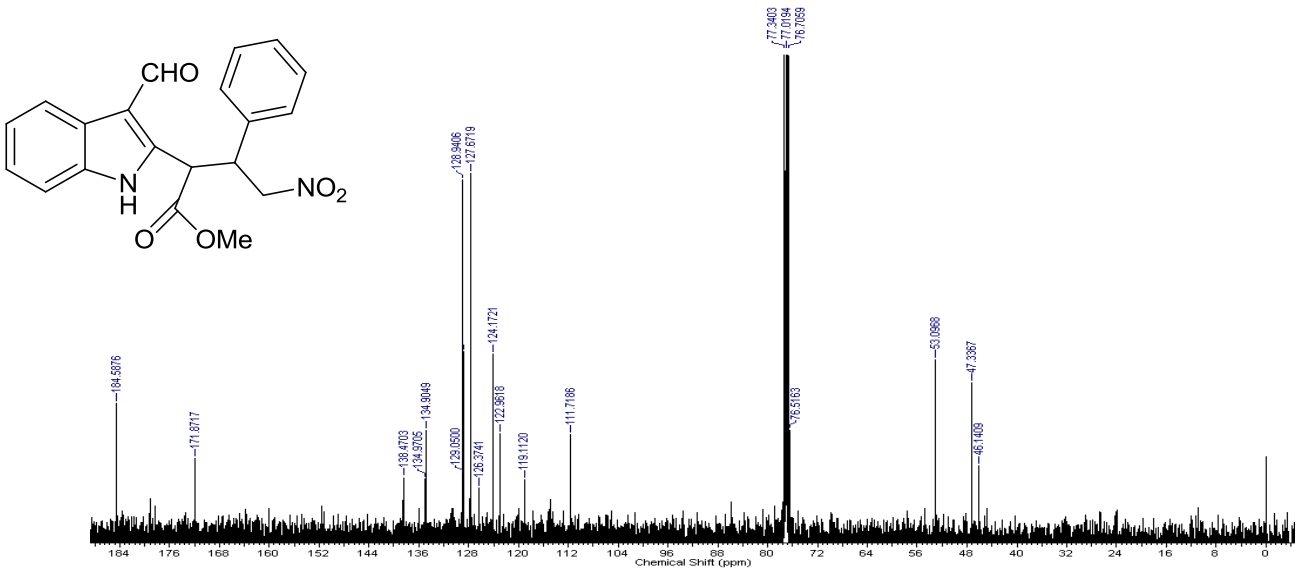

major
dr = 86:14
minor
Chemical Shift (ppm)

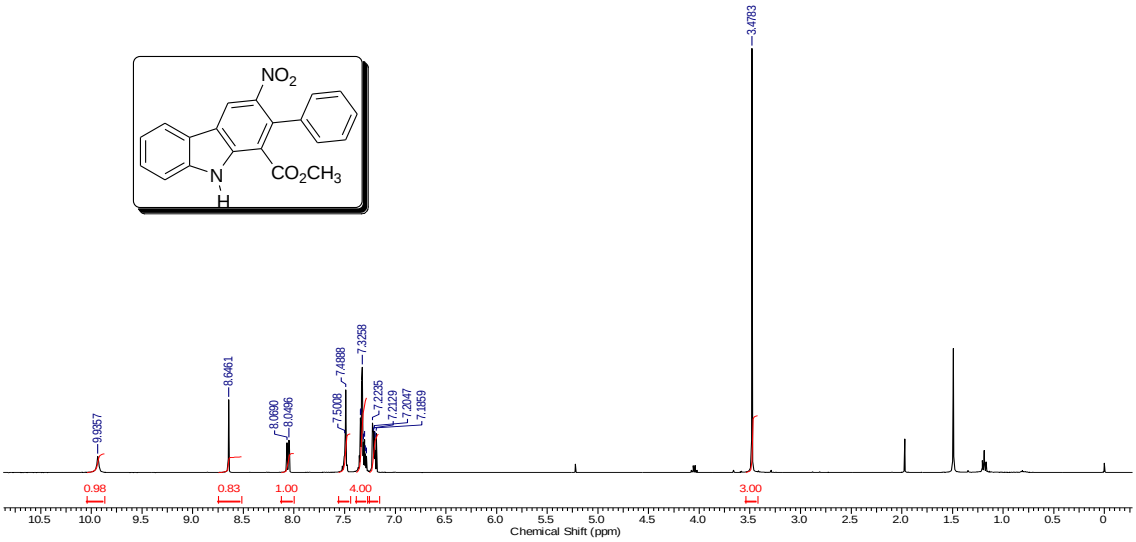

major
Chemical Shift (ppm)

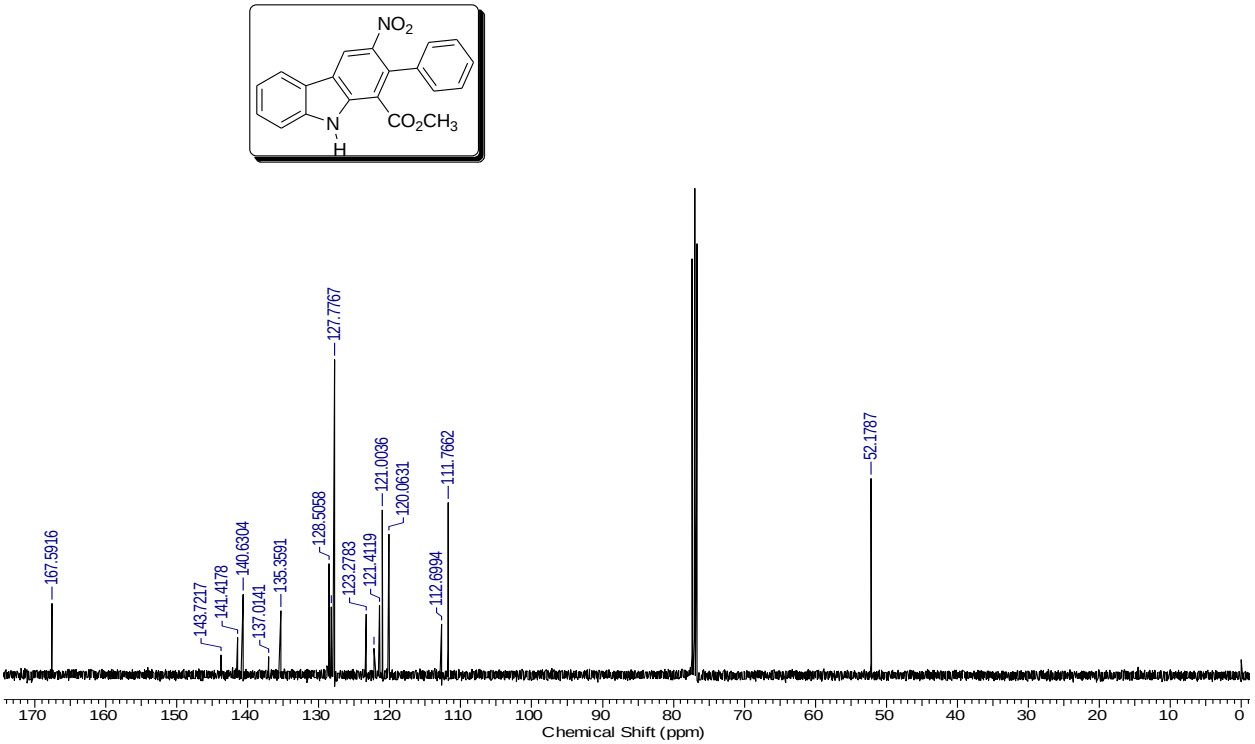

HO
NO2
Br
CO2CH3
N
H
major
dr = 92:8
minor
Chemical Shift (ppm)

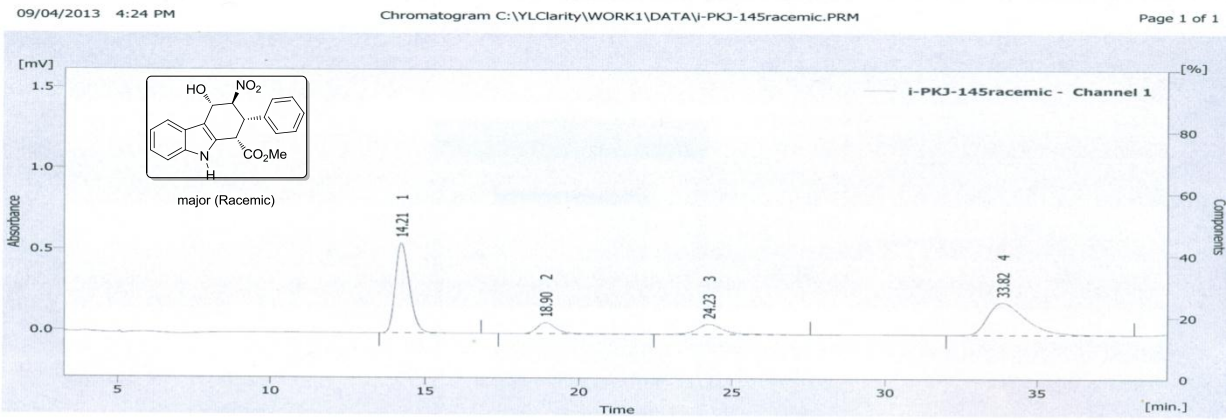

HO
NO2
Br
CO2CH3
N
H
major
Chemical Shift (ppm)


CHO
N
H
O
OMe
NO2
Chemical Shift (ppm)


CHO
N
H
O
OMe
NO2
Chemical Shift (ppm)

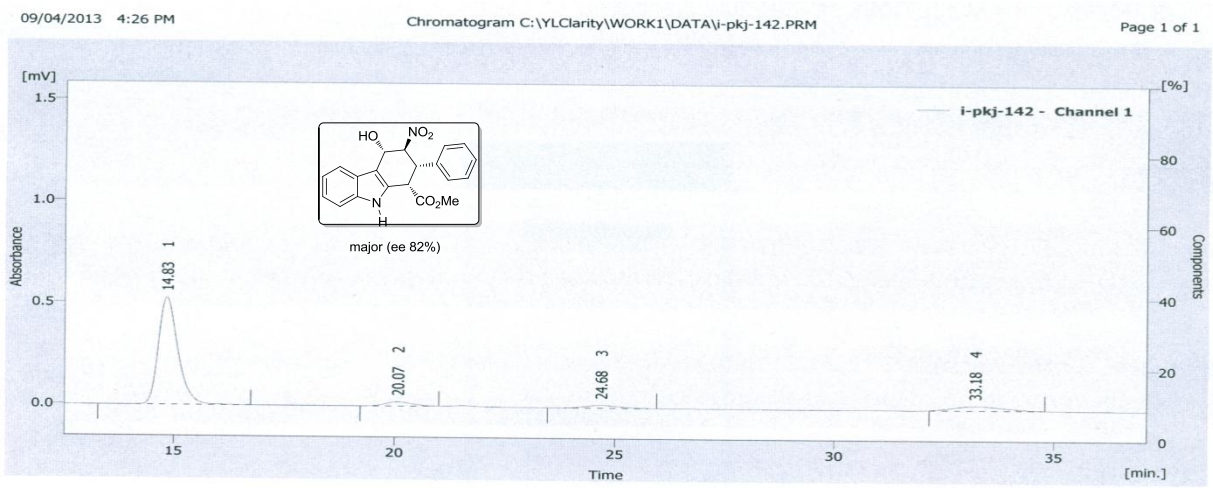

NO2
CO2CH3
N
H
9.9357
8.6461
8.0690
8.0496
7.5008
7.4888
7.3258
7.2235
7.2129
7.2047
7.1859
3.4783
0.98
0.83
1.00
4.00
3.00
Chemical Shift (ppm)


NO2
CO2CH3
N
H
167.5916
143.7217
141.4178
140.6304
137.0141
135.3591
128.5058
127.7767
123.2783
121.4119
121.0036
120.0631
112.6994
111.7662
52.1787
Chemical Shift (ppm)



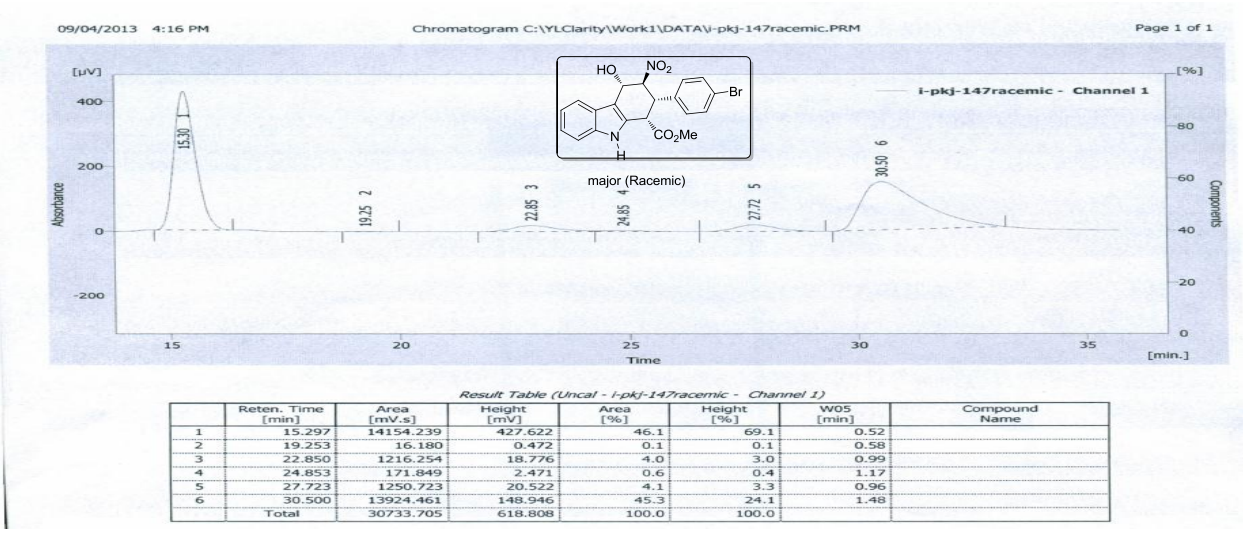
Result Table (Uncal - i-PKJ-145racemic - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	14.210	17686.913	555.138	41.9	62.4	0.49	
2	18.897	3020.277	69.823	7.1	7.8	0.64	
3	24.230	3858.405	63.483	9.1	7.1	0.88	
4	33.823	17690.539	201.194	41.9	22.6	1.33	
	Total	42256.133	889.638	100.0	100.0		



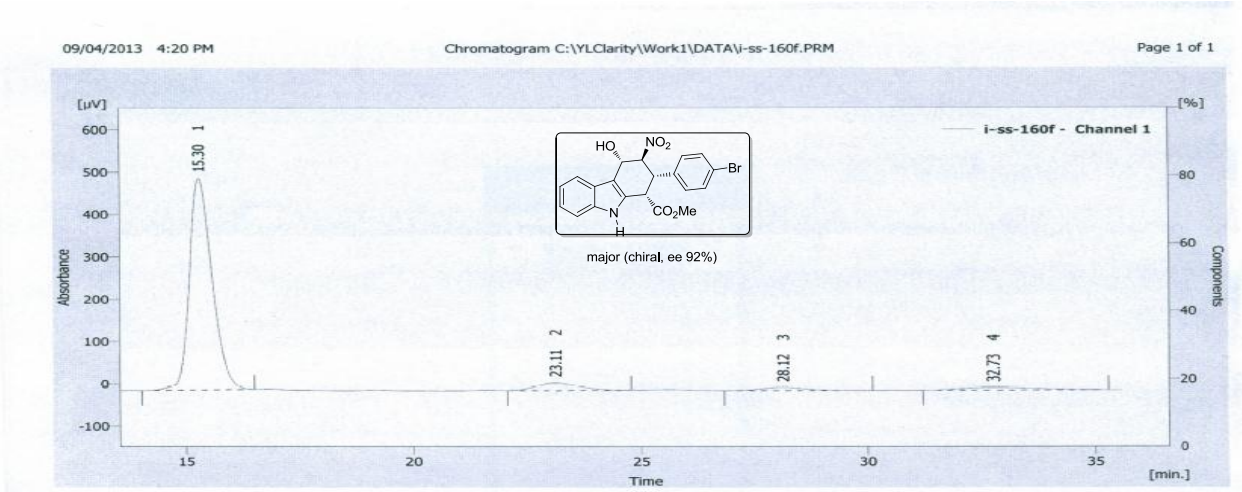
Result Table (Uncal - i-pkj-142 - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	14.833	16493.836	527.328	83.5	90.3	0.47	
2	20.067	852.026	20.809	4.3	3.6	0.65	
3	24.680	726.951	13.850	3.7	2.4	0.82	
4	33.183	1691.346	21.963	8.6	3.8	1.24	
	Total	19764.159	583.950	100.0	100.0		



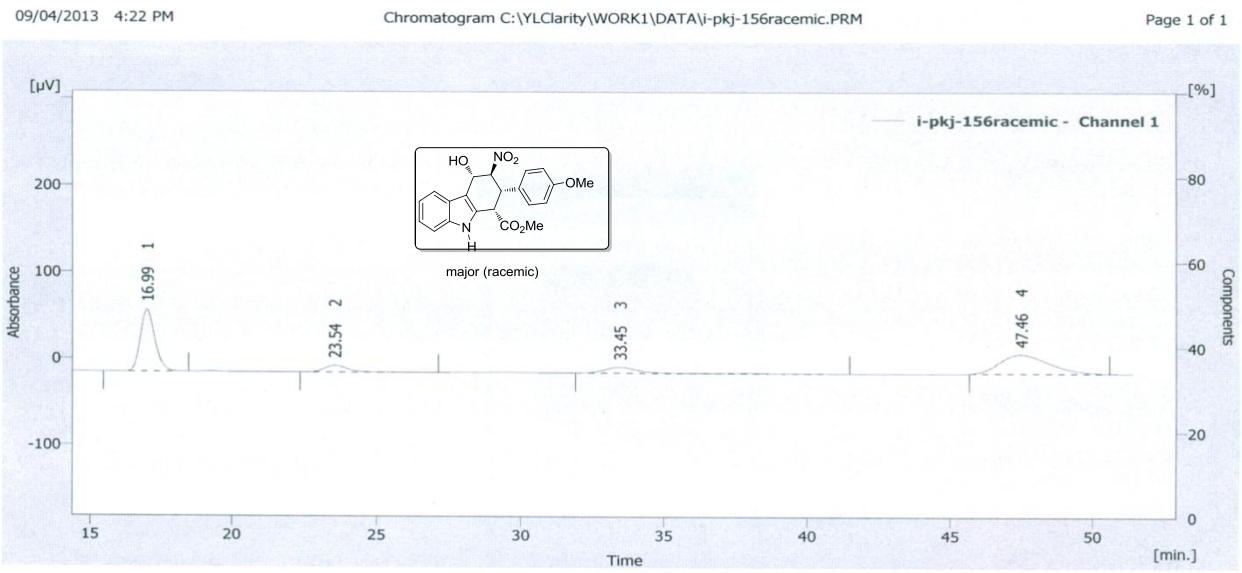
Result Table (Uncal - i-pkj-147racemic - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	15.297	14154.239	427.622	46.1	69.1	0.52	
2	19.253	16.180	0.472	0.1	0.1	0.58	
3	22.850	1216.254	18.776	4.0	3.0	0.99	
4	24.853	171.849	2.471	0.6	0.4	1.17	
5	27.723	1250.723	20.522	4.1	3.3	0.96	
6	30.500	13924.461	148.946	45.3	24.1	1.48	
	Total	30733.705	618.808	100.0	100.0		



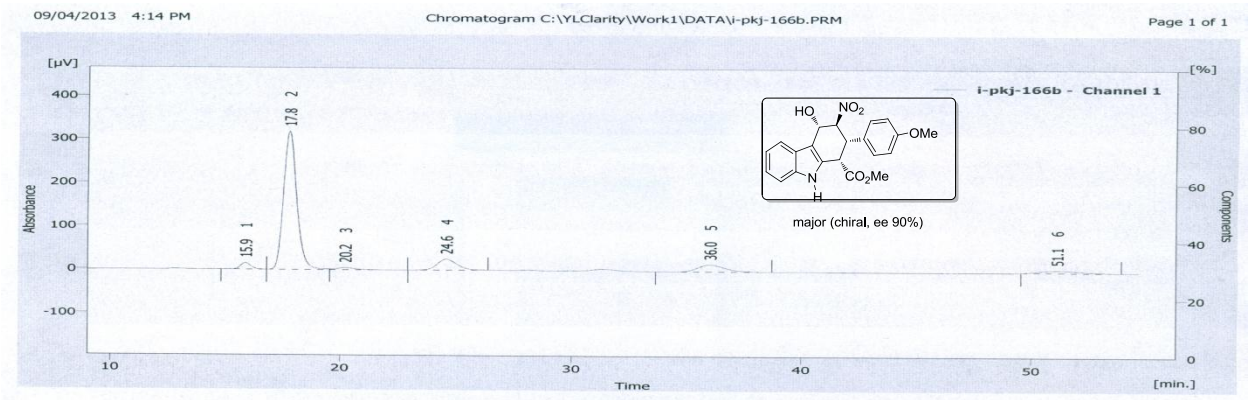
Result Table (Uncal - i-ss-160f - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	15.303	17590.990	500.264	88.5	94.1	0.54	
2	23.107	1148.259	18.220	5.8	3.4	0.99	
3	28.123	460.891	7.106	2.3	1.3	1.00	
4	32.730	678.114	5.986	3.4	1.1	1.84	
	Total	19878.254	531.575	100.0	100.0		



Result Table (Uncal - i-pkj-156racemic - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	16.993	2572.353	71.744	40.5	66.1	0.55	
2	23.543	449.658	7.744	7.1	7.1	0.85	
3	33.447	621.276	6.832	9.8	6.3	1.19	
4	47.457	2704.926	22.299	42.6	20.5	1.91	
	Total	6348.213	108.618	100.0	100.0		



Result Table (Uncal - i-pkj-166b - Channel 1)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]	W05 [min]	Compound Name
1	15.893	469.907	15.096	2.8	3.9	0.47	
2	17.773	12591.553	318.691	74.4	82.7	0.60	
3	20.193	288.376	4.911	1.7	1.3	0.81	
4	24.553	1508.833	25.157	8.9	6.5	0.91	
5	36.027	1362.333	15.987	8.1	4.1	1.30	
6	51.123	695.237	5.650	4.1	1.5	1.97	
	Total	16916.239	385.492	100.0	100.0		