Supporting Information

# Synthesis of Chiral α-Amides *via* Synergistic Visible-light-induced Wolff Rearrangement and Asymmetric NHC Catalysis

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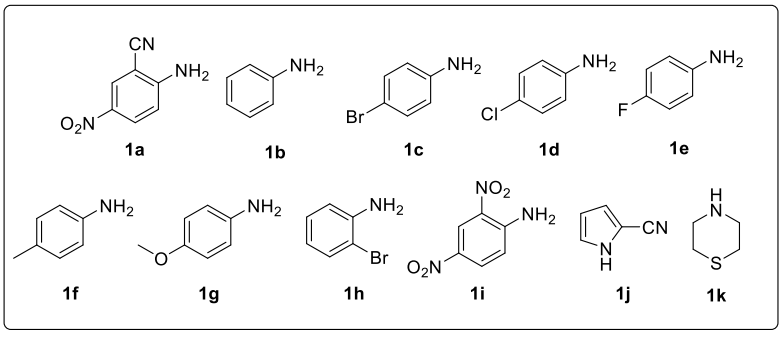
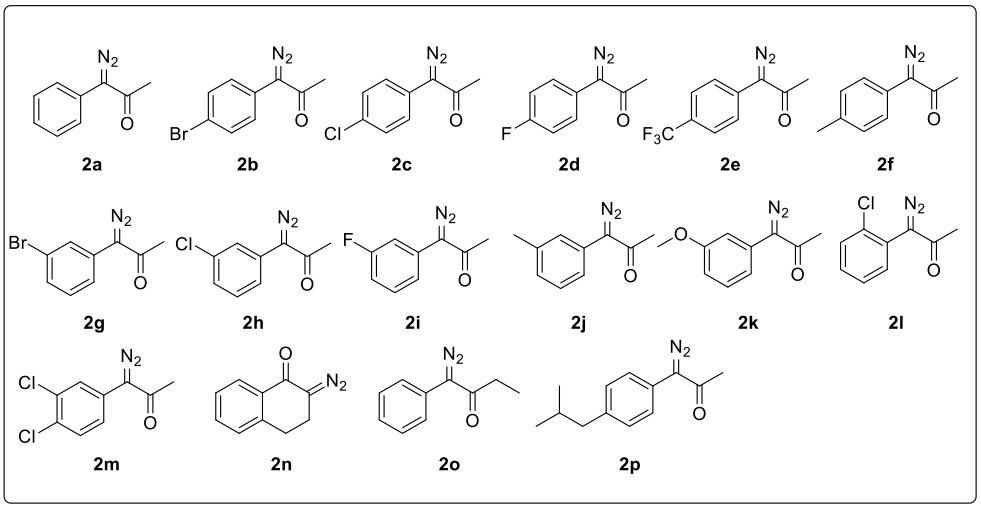
## 1. General Methods and Materials

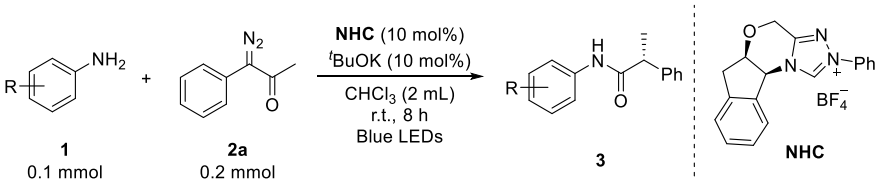
Unless otherwise mentioned, all reactions were carried out under an atmosphere of argon in dry glassware and were monitored by analytical thin-layer chromatography (TLC), which was visualized by ultraviolet light (254 nm). All solvents were obtained from commercial sources and were purified according to standard procedures. All syntheses and manipulations were carried out under a dry argon atmosphere. Purification of the products was accomplished by flash chromatography using silica gel (200-300 mesh). Melting points were determined by electric heating digital melting point meter and were uncorrected. Optical rotation was measured by the Perkin Elmer 341 polarimeter. $^{1}$H NMR spectra were measured on a 400 MHz spectrometer in $CDCl_3$ (101 MHz, $^{13}$C NMR) or DMSO-$d_6$ with chemical shift ($\delta$) given in ppm relative to TMS as internal standard. Data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiple), coupling constants (Hz), integration. High-resolution mass spectra (HRMS) were measured with ESI in a positive mode. The ee value determination was carried out using chiral HPLC with Chiralpak AD-H and IC column on Agilent 1100 with a UV-detector.

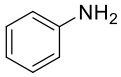
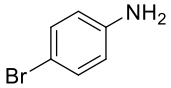
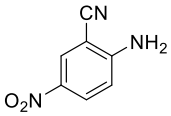
All starting materials commercially available were used directly. Substrates $\alpha$-diazoketones **2** were prepared according to literatures[1, 2].





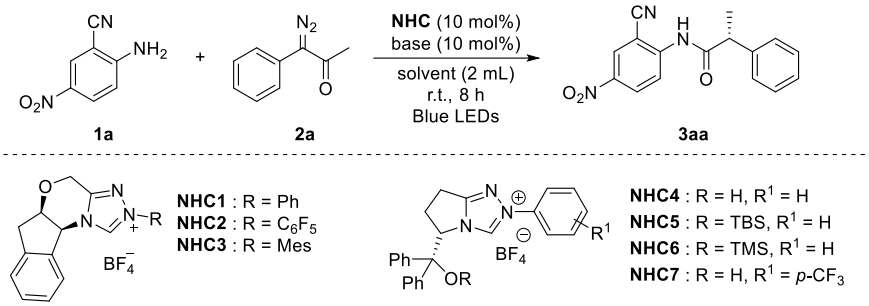

## 2. Preliminary results




| Entry | 1 | Yield (%)[b] | *ee* (%)[c] |
|---|---|---|---|
| **1** |  | 69 | 29 |
| **2** |  | 77 | 41 |
| **3** |  | 74 | 77 |

[a]Unless noted, reactions were performed with **1** (0.10 mmol), **2a** (0.2 mmol), **NHC** (10 mol%) and base (10 mol%) in anhydrous solvent (2 mL) at r.t. under the irridation of 2 W blue LEDs. [b]Isolated yields. [c]Determined by chiral HPLC analysis.

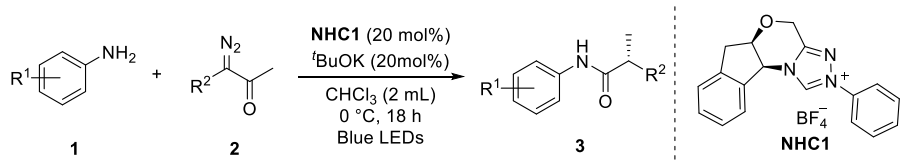
## 3. Optimizations of Reaction Conditions



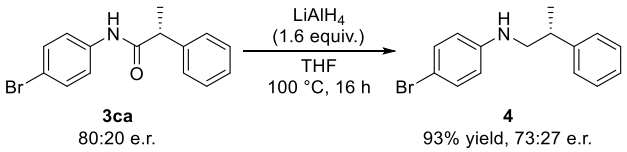

| Entry | **NHC** | Solvent | Base | Yield (%)[b] | *e.r.*[c] |
|---|---|---|---|---|---|
| 1 | **NHC1** | $CHCl_3$ | $^t$BuOK | 74 | 88.5:11.5 |
| 2 | **NHC2** | $CHCl_3$ | $^t$BuOK | trace | - |
| 3 | **NHC3** | $CHCl_3$ | $^t$BuOK | trace | - |
| 3 | **NHC4** | $CHCl_3$ | $^t$BuOK | 74 | 28.5:71.5 |
| 4 | **NHC5** | $CHCl_3$ | $^t$BuOK | 71 | 38.5:61.5 |
| 5 | **NHC6** | $CHCl_3$ | $^t$BuOK | 83 | 30:40 |
| 6 | **NHC7** | $CHCl_3$ | $^t$BuOK | 70 | 33:67 |
| 7 | **NHC1** | DCM | $^t$BuOK | 83 | 76:24 |
| 8 | **NHC1** | DCE | $^t$BuOK | 88 | 73:27 |
| 9 | **NHC1** | MeCN | $^t$BuOK | 56 | 65:35 |
| 10 | **NHC1** | toluene | $^t$BuOK | 85 | 75:25 |
| 11 | **NHC1** | THF | $^t$BuOK | 80 | 80:20 |
| 12 | **NHC1** | $CHCl_3$ | $Na_2CO_3$ | 39 | 87:13 |
| 13 | **NHC1** | $CHCl_3$ | $K_2CO_3$ | 60 | 84:16 |
| 14 | **NHC1** | $CHCl_3$ | $Cs_2CO_3$ | 45 | 74.5:25.5 |
| 15[d] | **NHC1** | $CHCl_3$ | $^t$BuOK | 74 | 90.5:9.5 |
| 16[d,e] | **NHC1** | $CHCl_3$ | $^t$BuOK | 75 | 97:3 |

[a]Unless noted, reactions were performed with **1a** (0.10 mmol), **2a** (0.2 mmol), **NHC** (10 mol%) and base (10 mol%) in anhydrous solvent (2 mL) at r.t. under the irridation of 2 W blue LEDs. [b]Isolated yields. [c]Determined by chiral HPLC analysis. [d]Using **NHC1** (20mol%)and $^t$BuOK (20 mol%) instead. [e]Reaction performed under 0 ℃ for 18 h.

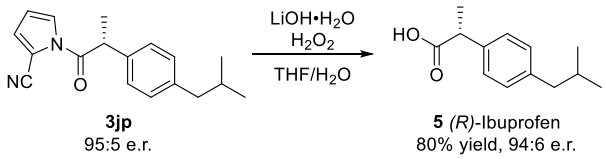
## 4. General procedures for the synthesis of products




**General procedure for the synthesis of product 3**: A dried and argon-filled Schlenk tube was charged with anilines **1** (0.10 mmol), $\alpha$-diazoketones **2** (0.20 mmol, 2.0 equiv.), **NHC2** (0.02 mmol, 20 mol%), and $^{t}$BuOK (0.02 mmol, 20 mol%) in dry $CHCl_3$ (2 mL). The reaction mixture was stirred under the irradiation of 2W blue LEDs at 0 ℃ until the consumption of anilines **1** as monitored by TLC. The solvent was removed in vacuo and the residue was purified by chromatography on silica gel using PE/EA (20:1) as eluent to afford the desired products **3**.




**General procedure for the synthesis of product 4:** In an oven-dried Schlenk tube equipped with a magnetic stirring bar, **3ca** (30.3 mg, 0.1 mmol, 1 equiv.) was dissolved in THF (2.0 mL) under a argon atmosphere. The solution was cooled to 0 ℃ and $LiAlH_4$ (6 mg, 0.16 mmol, 1.6 equiv.) was added. The mixture was heated at 100 ℃ for 12 h. The reaction was diluted with THF (5 mL) and quenched with 15% NaOH (aq., 0.5 mL). The aqueous phase was extracted with EtOAc (3 x 10 mL) and the combined organic layers were washed with brine, dried over anhydrous $Na_2SO_4$, and concentrated under reduced pressure. The crude product was purified by column chromatography (PE/EA = 20:1) to afford **4** (27 mg, 93% yield) as a colorless oil.

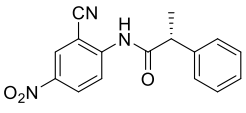



**General procedure for the synthesis of product 5:**[3] In an 10 mL Schlenk tube equipped with a magnetic stirring bar, $H_2O_2$ (30% in water, 0.15 mL) was added to a 0 ℃ solution of the **3** (28 mg, 0.1 mmol, 1.0 equiv.) in THF (1.0 mL) and $H_2O$ (0.33 mL). LiOH•$H_2O$ (12.6 mg, 0.3 mmol) was added, and the reaction mixture was stirred at 0 ℃ for 1.5 hours. $Na_2S_2O_3$ (0.7 M, 0.6 mL) and $NaHCO_3$ (0.5 N, 1.2 mL) were added, and the mixture was stirred at room temperature for 15 min.

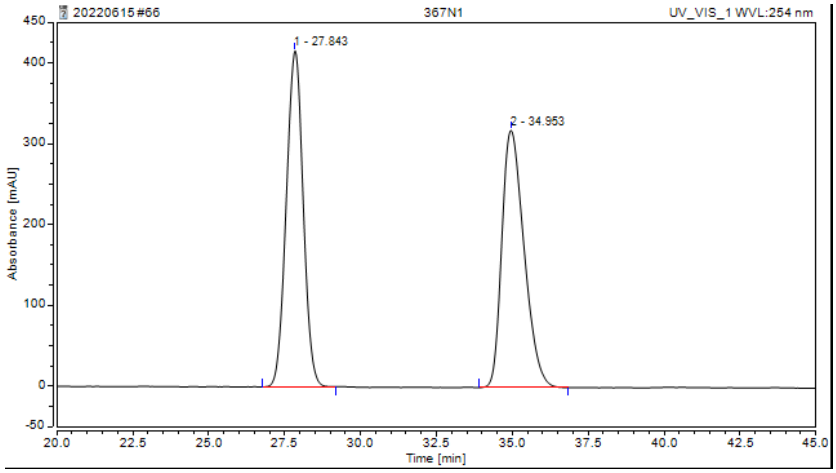
The THF was removed in vacuo, and the resulting aqueous layer was washed with $CH_2Cl_2$ (3 mL), acidified with 10% HCl (aq.), and extracted with EtOAc (2 x 5 mL). The residue was purified by flash chromatography (PE/EA = 2:1) to afford **5** (16.5 mg, 80% yield) as a colorless solid.

## 3. Characterization Data of Products

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-phenylpropanamide (3aa)**

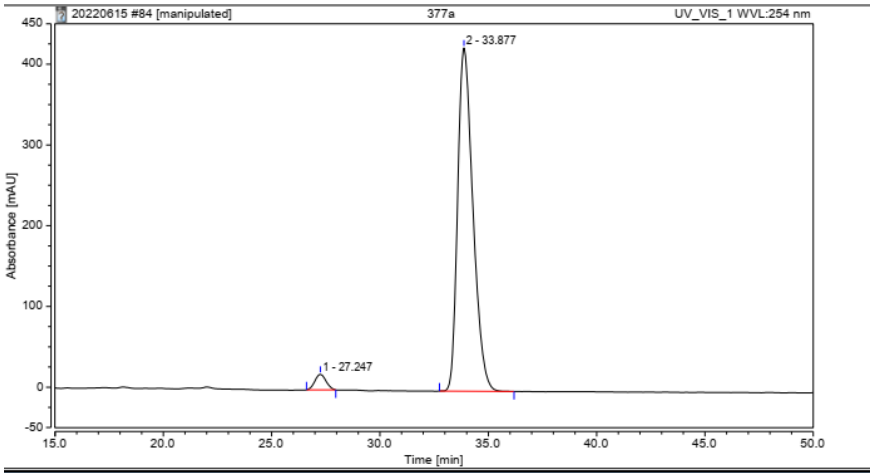


20.7 mg, 75% yield, pale yellow solid; M.p. 103.4-104.0 ℃; $[\alpha]_D^{20}$ = – 0.091 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.75 (d, $J$ = 8.9 Hz, 1H), 8.48 – 8.29 (m, 2H), 7.92 (s, 1H), 7.51 – 7.34 (m, 5H), 3.87 (q, $J$ = 7.2 Hz, 1H), 1.67 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.9, 145.3, 142.5, 138.9, 129.8, 129.3, 128.5, 127.8, 127.7, 120.1, 113.9, 101.6, 48.6, 17.7; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{16}H_{14}N_3O_3$: 296.1030; found: 296.1029; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{minor}$ = 27.247 min, $t_{major}$ = 33.877 min, 97:3 e.r.).




**Integration Results**

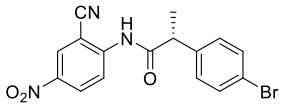
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 27.843 | 268.382 | 416.071 | 49.83 |
| 2 | 34.953 | 270.219 | 318.393 | 50.17 |



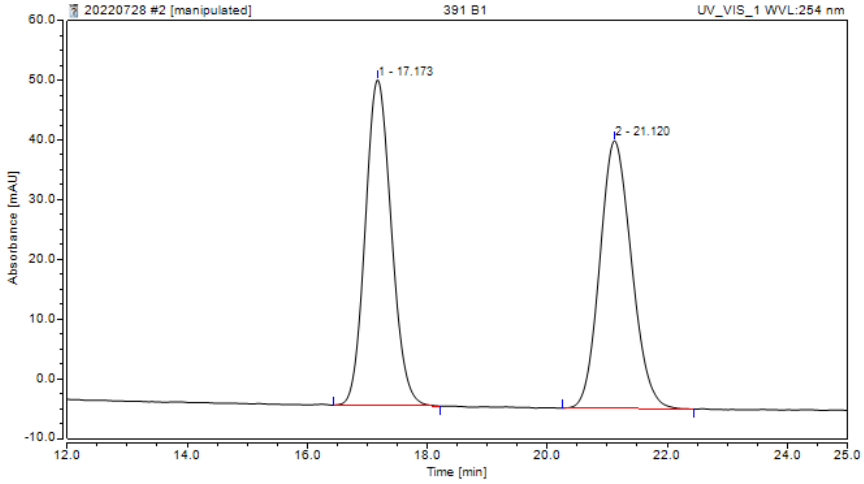

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 27.247 | 11.443 | 19.075 | 3.19 | 4.30 | n.a. |
| 2 | | 33.877 | 347.460 | 424.929 | 96.81 | 95.70 | n.a. |
| **Total:** | | | **358.903** | **444.004** | **100.00** | **100.00** | |

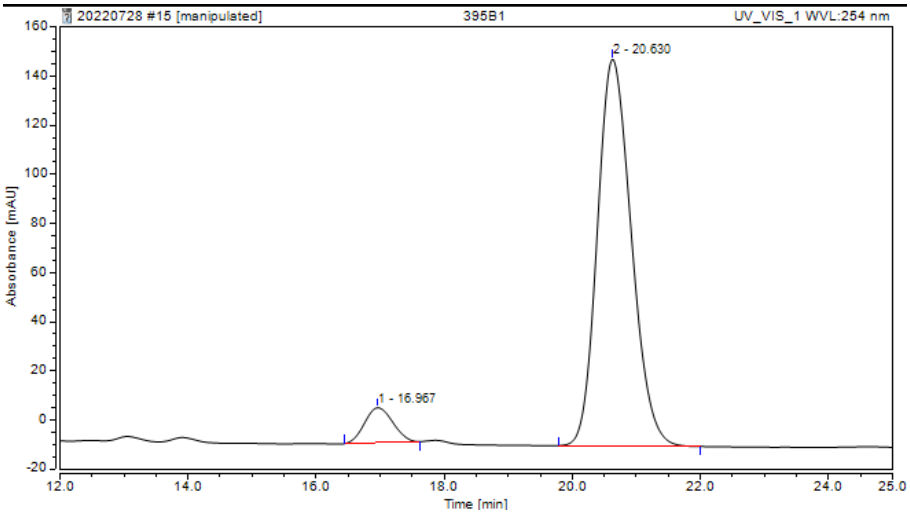
**(*R*)-2-(4-bromophenyl)-*N*-(2-cyano-4-nitrophenyl)propanamide (3ab)**




26.9 mg, 72% yield, pale yellow solid; M.p. 154.5-155.4 °C; $[\alpha]_D^{20}$ = –0.018 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.76 – 8.69 (m, 1H), 8.48 – 8.34 (m, 2H), 7.89 (s, 1H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.29 (s, 2H), 3.82 (q, *J* = 7.1 Hz, 1H), 1.64 (d, *J* = 7.5 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.2, 145.2, 142.7, 138.0, 132.8, 129.4, 129.3, 127.8, 122.4, 120.3, 114.0, 101.7, 48.0, 17.9;; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}BrN_3O_3$: 374.0135; found: 374.0139; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 °C, retention time: $t_{major}$ = 20.630 min, $t_{minor}$ = 16.967 min, 93:7 e.r.).

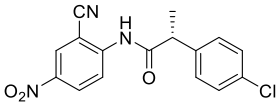



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 17.173 | 27.494 | 54.514 | 49.99 |
| 2 | 21.120 | 27.505 | 44.839 | 50.01 |

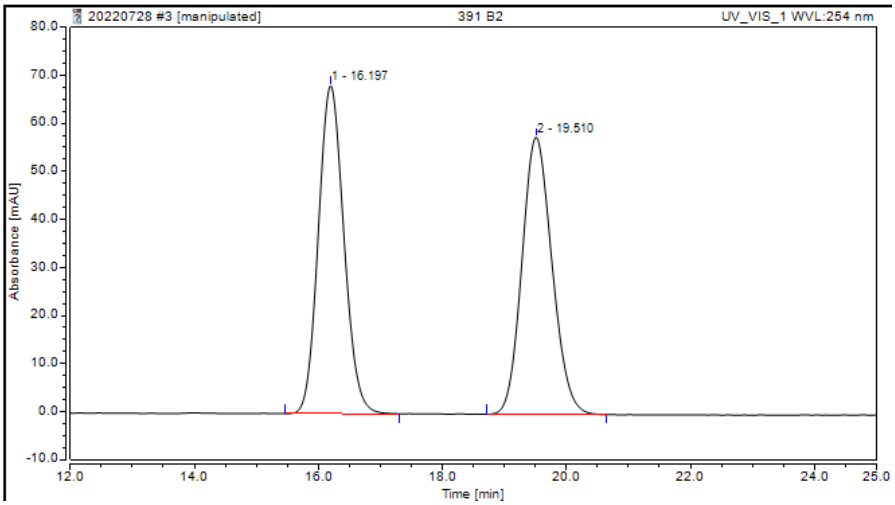



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.967 | 7.278 | 14.222 | 7.00 |
| 2 | 20.630 | 96.766 | 157.471 | 93.00 |

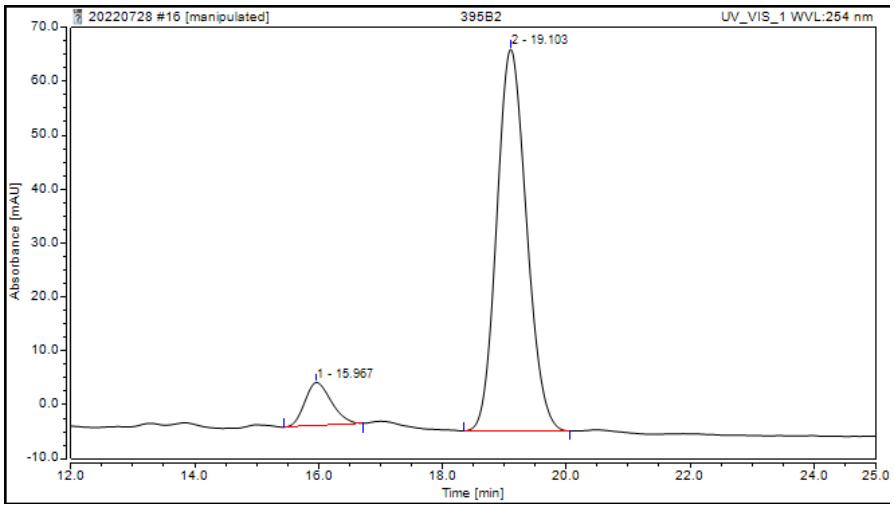
**(*R*)-2-(4-chlorophenyl)-*N*-(2-cyano-4-nitrophenyl)propanamide (3ac)**




23.4 mg, 71% yield, pale yellow solid; M.p. 123.8 – 124.5 ℃; $[\alpha]_D^{20}$ = –0.012 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.79 – 8.66 (m, 1H), 8.46 – 8.36 (m, 2H), 7.89 (s, 1H), 7.45 – 7.30 (m, 4H), 3.84 (q, *J* = 7.1 Hz, 1H), 1.64 (d, *J* = 7.3 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.3, 145.2, 142.7, 137.4, 134.4, 129.8, 129.4, 128.9, 127.8, 120.3, 114.0, 101.7, 47.9, 18.0; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}ClN_3O_3$: 330.0640; found: 330.0646; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 19.103 min, $t_{minor}$ = 15.967 min, 91:9 e.r.).

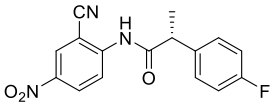



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.197 | 32.488 | 68.261 | 50.08 |
| 2 | 19.510 | 32.390 | 57.671 | 49.92 |

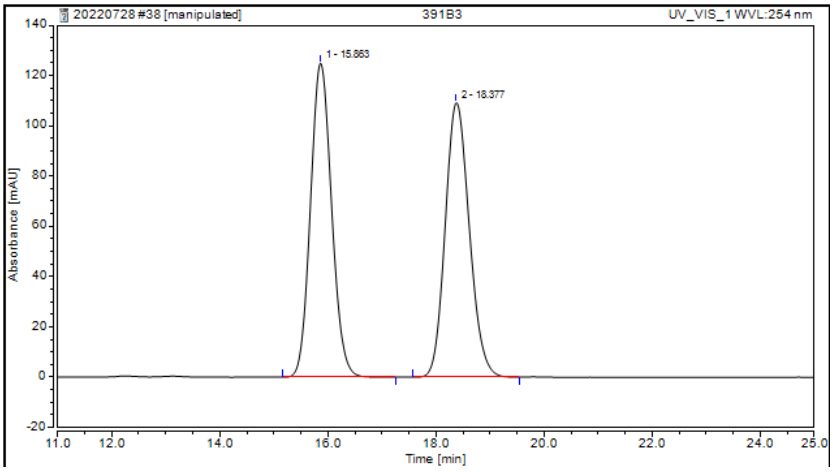



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 15.967 | 3.936 | 7.987 | 9.08 |
| 2 | 19.103 | 39.419 | 70.820 | 90.92 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(4-fluorophenyl)propanamide (3ad)**

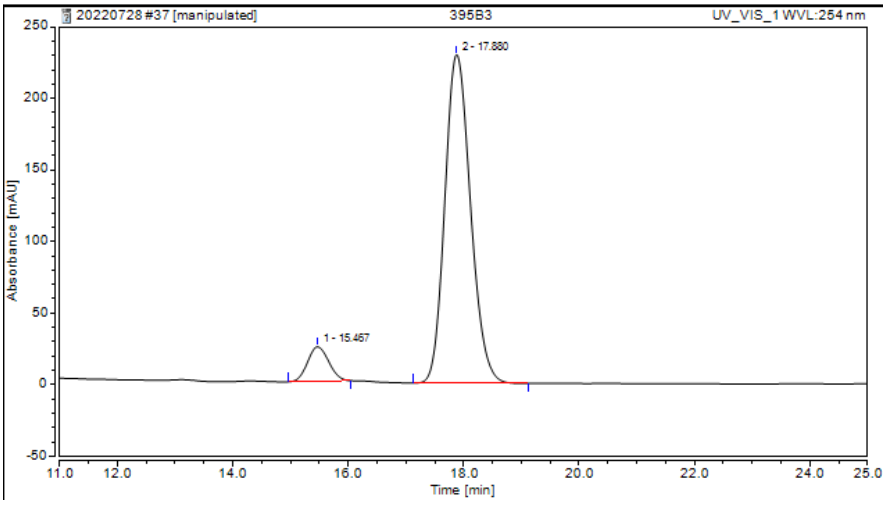


21.6 mg, 69% yield, pale yellow solid; M.p. 126.2 – 126.8 ℃; $[\alpha]_D^{20}$ = –0.013 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.78 – 8.69 (m, 1H), 8.46 – 8.36 (m, 2H), 7.91 (s, 1H), 7.42 – 7.33 (m, 2H), 7.18 – 7.08 (m, 2H), 3.86 (q, $J$ = 7.1 Hz, 1H), 1.65 (d, $J$ = 4.5 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.6, 162.3 (d, $J_{C\text{-}F}$ = 249.2 Hz), 145.2, 142.6, 134.7 (d, $J_{C\text{-}F}$ = 3.4 Hz)**,** 129.4, 129.3 (d, $J_{C\text{-}F}$ = 8.1 Hz)**,** 127.8, 120.2, 116.7 (d, $J_{C\text{-}F}$ = 21.8 Hz)**,** 114.0, 101.7, 47.8, 18.0; **$^{19}$F NMR** (376 MHz, $CDCl_3$) $\delta$ -113.2; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}FN_3O_3$: 314.0935; found: 314.0942; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 17.880 min, $t_{minor}$ = 15.467 min, 92:8 e.r.).




**Integration Results**

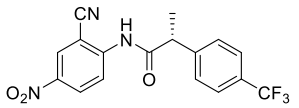
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 15.863 | 56.522 | 125.029 | 50.02 |
| 2 | 18.377 | 56.474 | 109.283 | 49.98 |



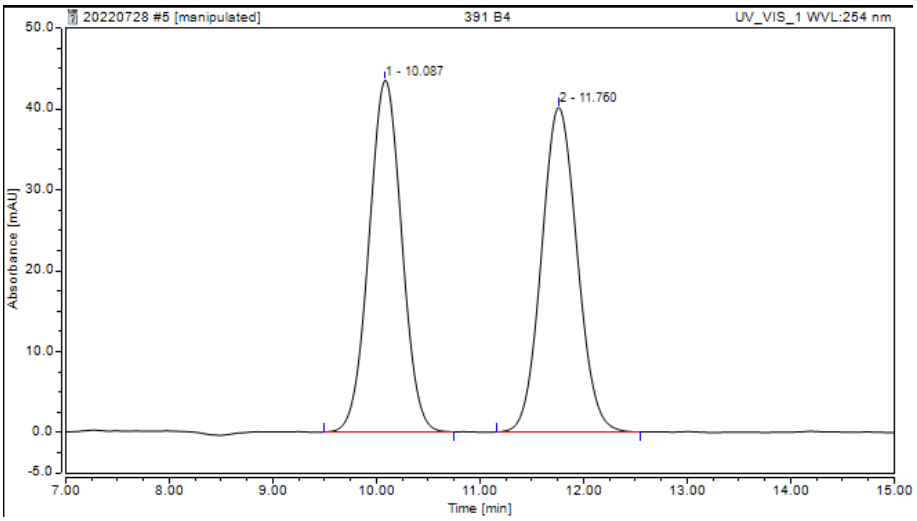

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 15.467 | 10.210 | 24.073 | 7.92 |
| 2 | 17.880 | 118.752 | 229.836 | 92.08 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(4-(trifluoromethyl)phenyl)propanamide (3ae)**

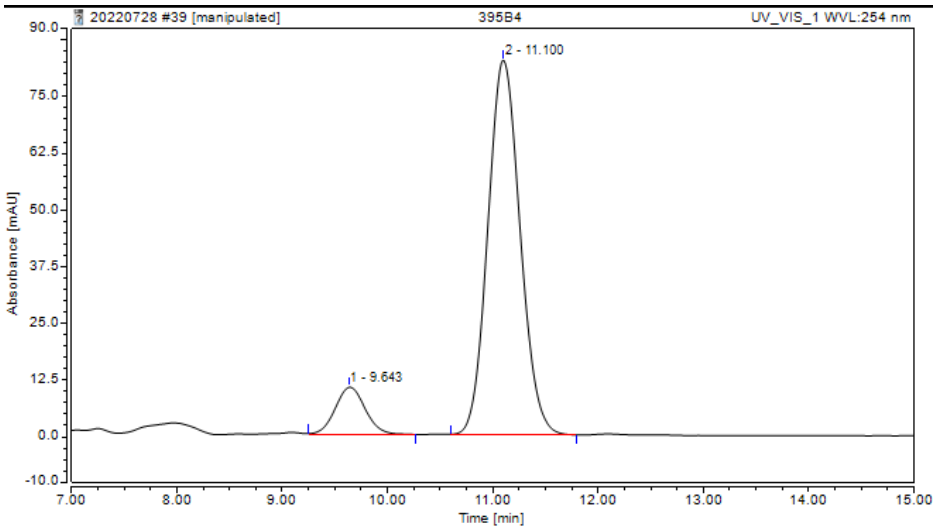



25.4 mg, 70% yield, pale yellow solid; M.p. 167.9 – 168.3 ℃; $[\alpha]_D^{20}$ = –0.010 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.78 – 8.69 (m, 1H), 8.49 – 8.36 (m, 2H), 7.88 (s, 1H), 7.75 – 7.65 (m, 2H), 7.57 – 7.49 (m, 2H), 3.92 (q, $J$ = 7.1 Hz, 1H), 1.68 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 171.8, 145.0, 143.0, 142.8, 130.7 (q, $J_{C\text{-}F}$ = 30 Hz), 129.4, 128.0, 127.8, 126.6 (q, $J_{C\text{-}F}$ = 3.8 Hz), 123.9 (q, $J_{C\text{-}F}$ = 270 Hz), 120.4, 114.0, 101.8, 48.4, 18.1; **$^{19}$F NMR** (376 MHz, $CDCl_3$) $\delta$ -62.7; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{17}H_{13}F_3N_3O_3$: 364.0904; found: 364.0903; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 11.100 min, $t_{minor}$ = 9.643 min, 89.5:10.5 e.r.).




**Integration Results**

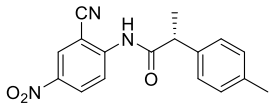
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 10.087 | 15.905 | 43.481 | 49.86 |
| 2 | 11.760 | 15.992 | 40.124 | 50.14 |



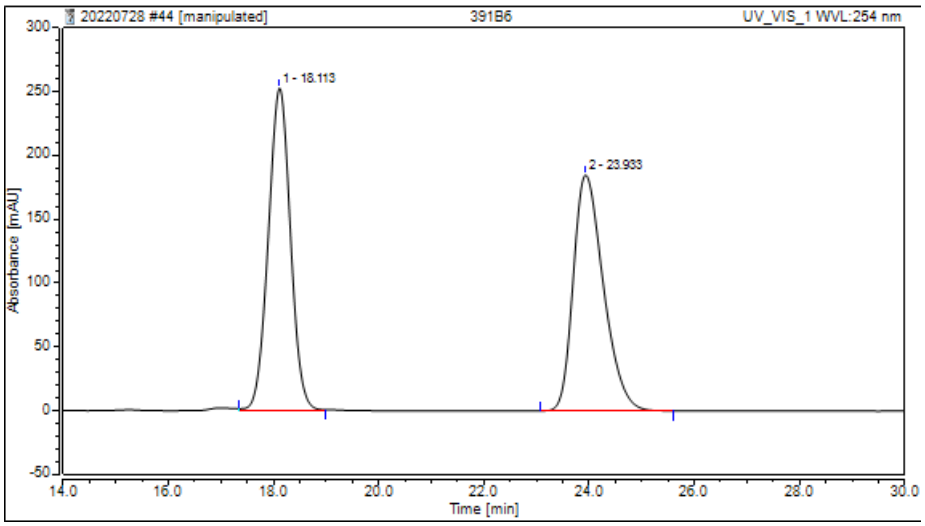

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 9.643 | 3.426 | 10.387 | 10.48 |
| 2 | 11.100 | 29.266 | 82.555 | 89.52 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(*p*-tolyl)propanamide (3af)**

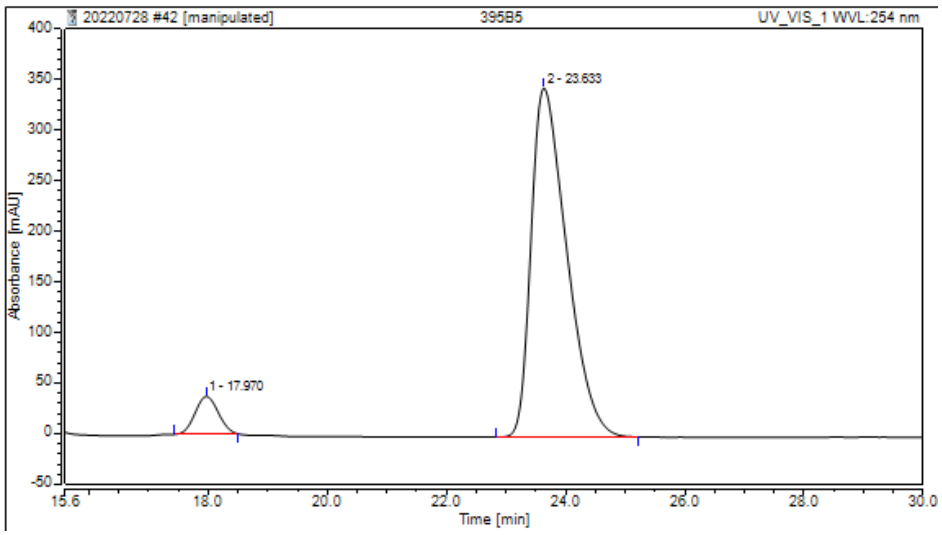


22.2 mg, 72% yield, pale yellow solid; M.p. 118.5 – 119.3 ℃; $[\alpha]_D^{20}$ = – 0.031 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.81 – 8.68 (m, 1H), 8.44 – 8.33 (m, 2H), 7.95 (s, 1H), 7.30 – 7.23 (m, 4H), 3.83 (q, *J* = 7.2 Hz, 1H), 2.37 (s, 3H), 1.64 (d, *J* = 7.2 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 173.1, 145.4, 142.4, 138.3, 135.8, 130.4, 129.3, 127.8, 127.5, 120.0, 113.9, 101.5, 48.1, 21.1, 17.7; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{17}H_{16}N_3O_3$: 310.1186; found: 310.1182; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 23.633 min, $t_{minor}$ = 17.970 min, 93:7 e.r.).




**Integration Results**

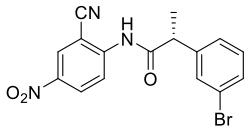
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 18.113 | 123.372 | 252.792 | 50.15 |
| 2 | 23.933 | 122.653 | 184.715 | 49.85 |



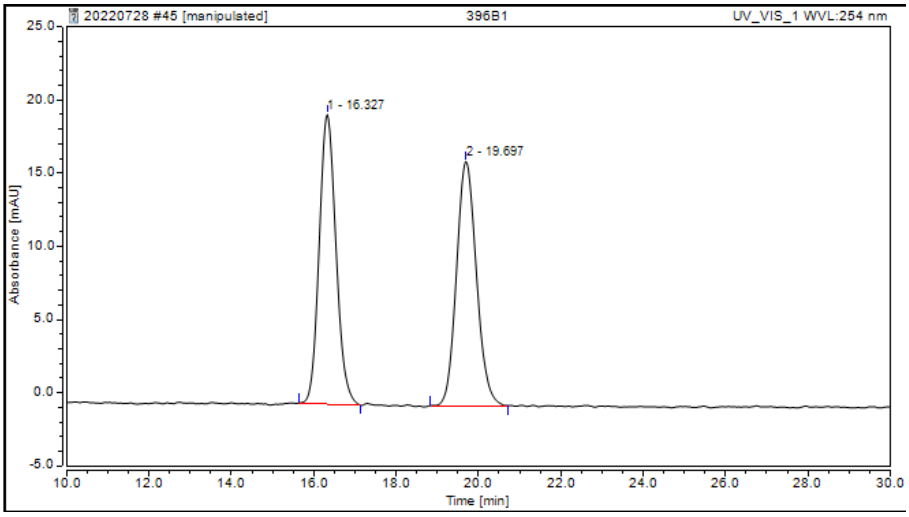

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 17.970 | 16.840 | 37.232 | 6.60 |
| 2 | 23.633 | 238.275 | 344.653 | 93.40 |

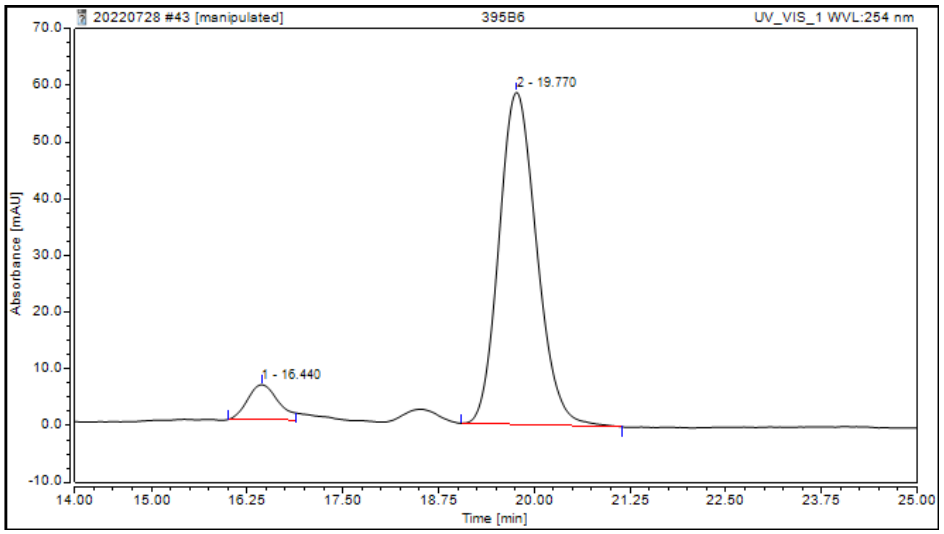
**(*R*)-2-(3-bromophenyl)-*N*-(2-cyano-4-nitrophenyl)propanamide (3ag)**




25.4 mg, 68% yield, pale yellow solid; M.p. 109.1 – 109.7 ℃; $[\alpha]_D^{20}$ = – 0.034 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.78 – 8.69 (m, 1H), 8.47 – 8.38 (m, 2H), 7.89 (s, 1H), 7.58 – 7.46 (m, 2H), 7.36 – 7.31 (m, 2H), 3.82 (q, *J* = 7.1 Hz, 1H), 1.65 (d, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.0, 145.1, 142.7, 141.2, 131.6, 131.2, 130.7, 129.4, 127.8, 126.3, 123.7, 120.3, 114.0, 101.8, 48.2, 17.9; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}BrN_3O_3$: 374.0135; found: 374.0134; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 19.770 min, $t_{minor}$ = 16.440 min, 92:8 e.r.).

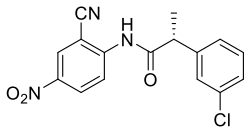



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.327 | 9.353 | 19.801 | 50.00 |
| 2 | 19.697 | 9.354 | 16.702 | 50.00 |

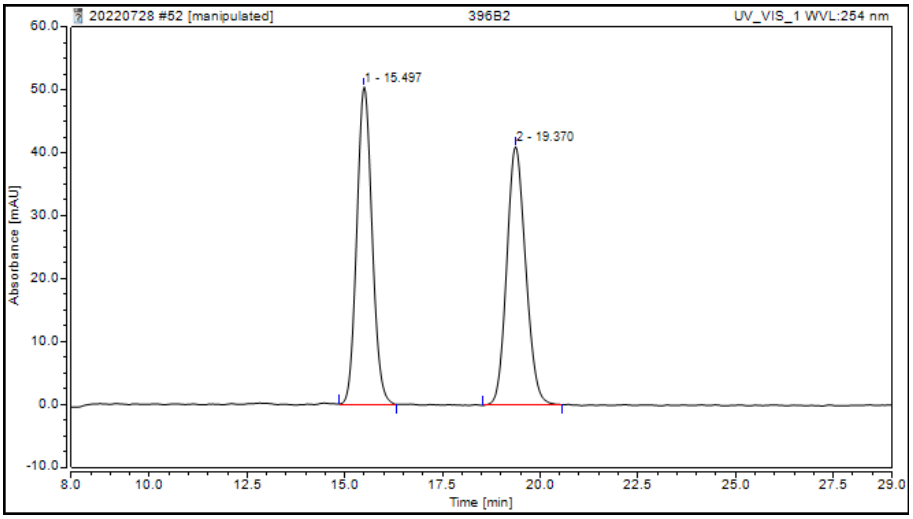



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.440 | 2.851 | 6.179 | 7.87 |
| 2 | 19.770 | 33.373 | 58.554 | 92.13 |

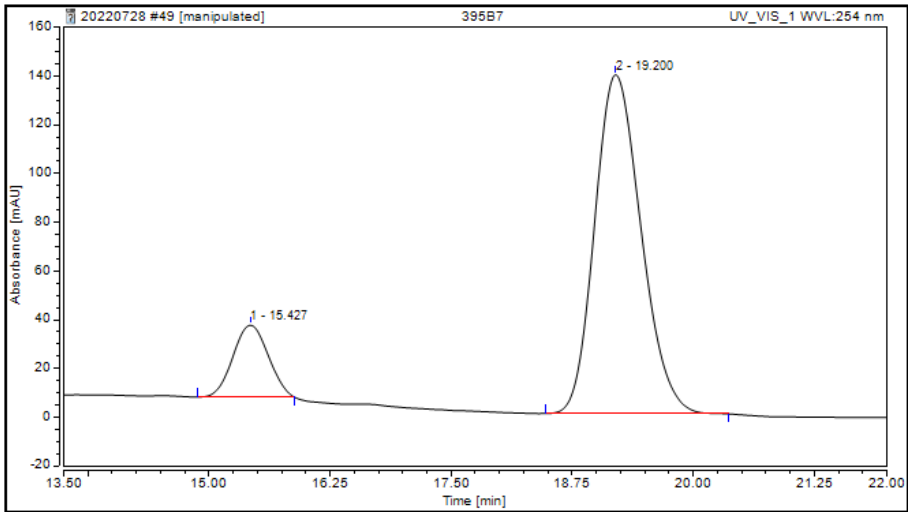
**(*R*)-2-(3-chlorophenyl)-*N*-(2-cyano-4-nitrophenyl)propanamide (3ah)**




21.1 mg, 64% yield, pale yellow solid; M.p. 115.2 – 115.9 ℃; $[\alpha]_D^{20}$ = – 0.037 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.80 – 8.66 (m, 1H), 8.51 – 8.33 (m, 2H), 7.94 (s, 1H), 7.43 – 7.27 (m, 4H), 3.85 (q, *J* = 7.1 Hz, 1H), 1.65 (d, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.1, 145.1, 142.7, 140.9, 135.5, 130.9, 129.4, 128.6, 127.9, 127.8, 125.9, 120.4, 114.0, 101.8, 48.1, 17.9; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}ClN_3O_3$: 330.0640; found: 330.0638; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 19.200 min, $t_{minor}$ = 15.427 min, 86:14 e.r.).

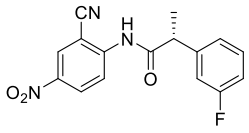



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 15.497 | 22.900 | 50.443 | 49.87 |
| 2 | 19.370 | 23.024 | 41.068 | 50.13 |

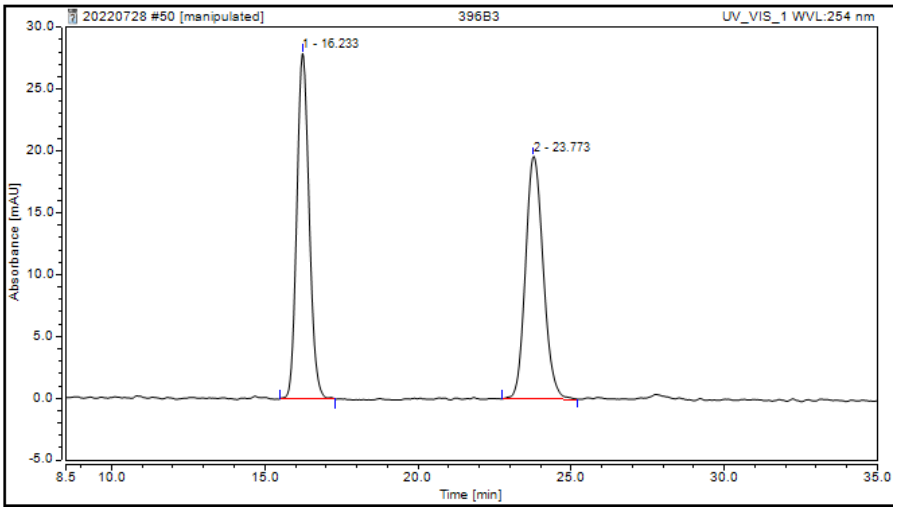



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 15.427 | 12.410 | 29.447 | 13.87 |
| 2 | 19.200 | 77.096 | 139.039 | 86.13 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(3-fluorophenyl)propanamide (3ai)**

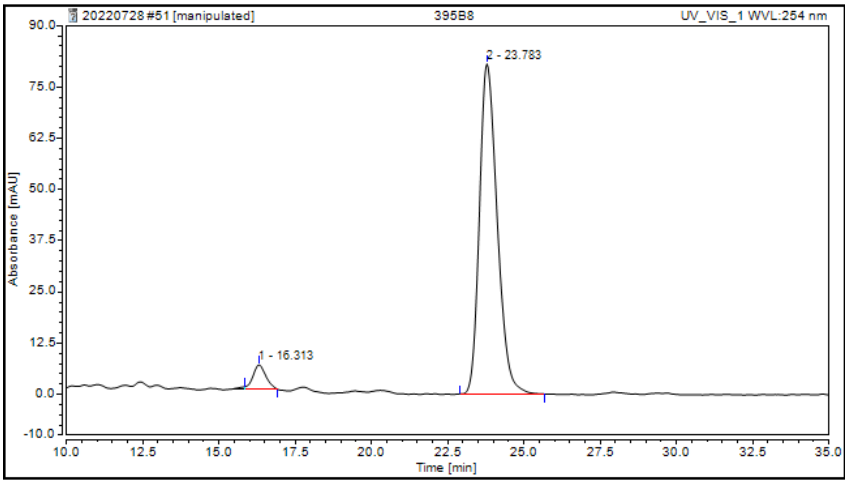


21.9 mg, 70% yield, pale yellow solid; M.p. 110.7 – 111.3 ℃; $[\alpha]_D^{20}$ = – 0.031 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.80 – 8.69 (m, 1H), 8.48 – 8.34 (m, 2H), 7.91 (s, 1H), 7.48 – 7.38 (m, 1H), 7.22 – 7.16 (m, 1H), 7.15 – 7.02 (m, 2H), 3.87 (q, $J$ = 7.1 Hz, 1H), 1.66 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.1, 163.4 (d, $J_{C\text{-}F}$ = 249.7 Hz), 145.2, 142.7, 141.3 (d, $J_{C\text{-}F}$ = 7.0 Hz), 131.4 (d, $J_{C\text{-}F}$ = 8.4 Hz), 128.6 (d, $J_{C\text{-}F}$ = 160.3 Hz), 123.5, 123.4, 120.2, 115.5 (d, $J_{C\text{-}F}$ = 21.2 Hz), 114.7 (d, $J_{C\text{-}F}$ = 21.9 Hz), 113.9, 101.7, 48.2, 17.8; **$^{19}$F NMR** (376 MHz, $CDCl_3$) $\delta$ -110.7; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}FN_3O_3$: 314.0935; found: 314.0933; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 23.783 min, $t_{minor}$ = 16.313 min, 95:5 e.r.).




**Integration Results**

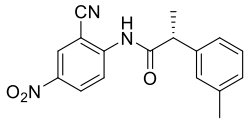
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 16.233 | 13.072 | 27.940 | 49.71 |
| 2 | 23.773 | 13.222 | 19.645 | 50.29 |



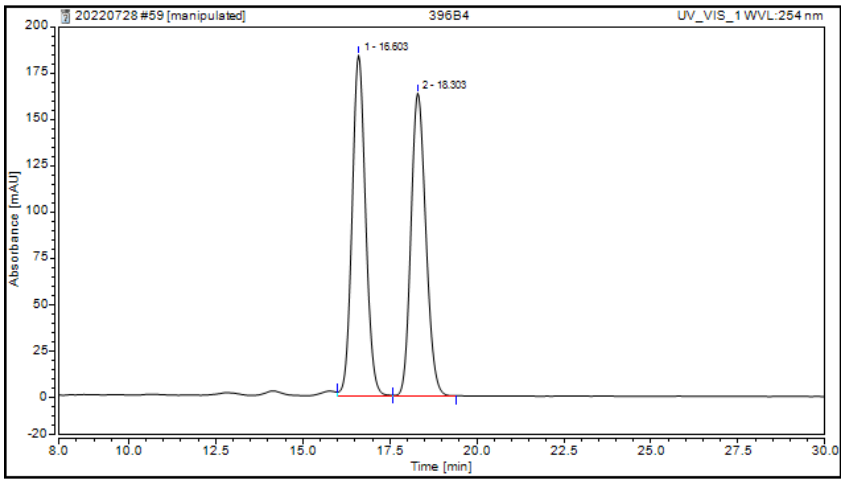

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 16.313 | 2.920 | 5.905 | 5.10 |
| 2 | 23.783 | 54.354 | 80.578 | 94.90 |

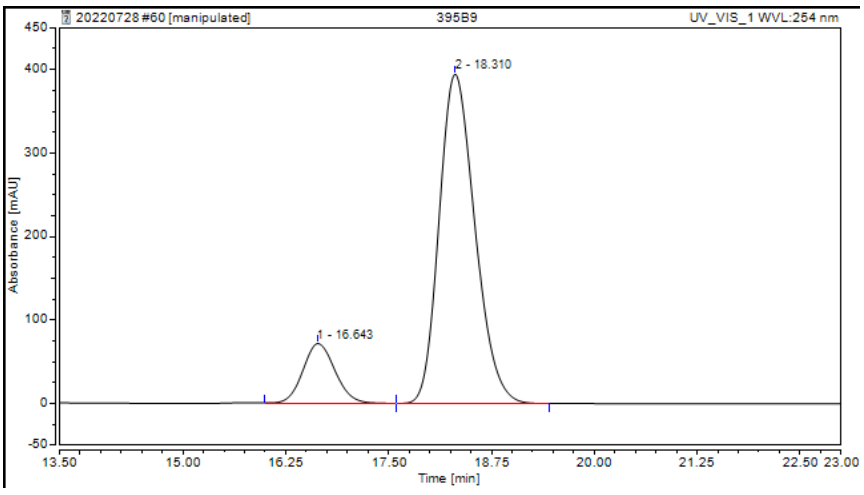
**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(*m*-tolyl)propanamide (3aj)**



21.3 mg, 69% yield, pale yellow solid; M.p. 105.6 – 106.2 ℃; $[\alpha]_D^{20}$ = – 0.042 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.81 – 8.69 (m, 1H), 8.45 – 8.33 (m, 2H), 7.98 (s, 1H), 7.37 – 7.29 (m, 1H), 7.23 – 7.12 (m, 3H), 3.83 (q, *J* = 7.2 Hz, 1H), 2.39 (s, 3H), 1.65 (d, *J* = 7.2 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 173.0, 145.4, 142.4, 139.7, 138.8, 129.6, 129.3, 129.2, 128.3, 127.8, 124.7, 120.0, 113.9, 101.6, 48.4, 21.4, 17.5; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{17}H_{16}N_3O_3$: 310.1186; found: 310.1181; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 18.310 min, $t_{minor}$ = 16.643 min, 86:14 e.r.).

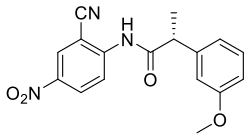



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.603 | 82.610 | 183.800 | 50.53 |
| 2 | 18.303 | 80.877 | 163.373 | 49.47 |

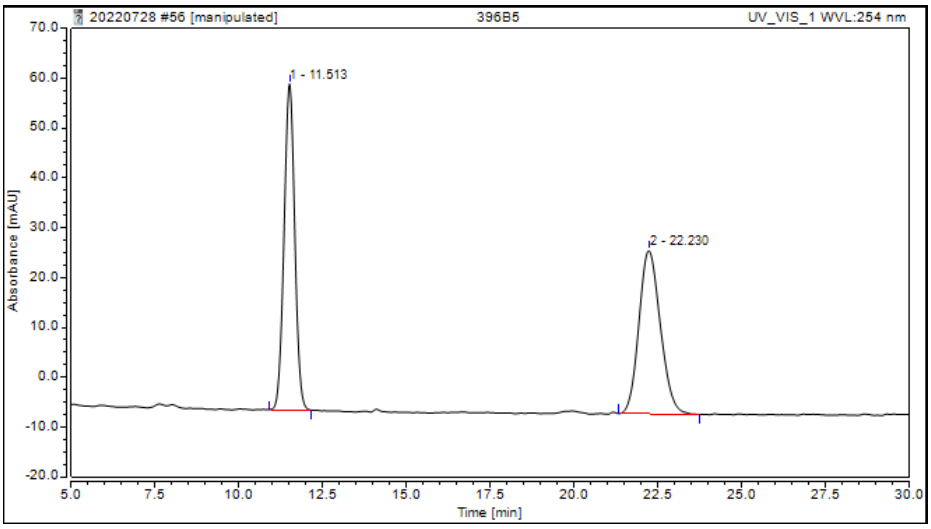



| Integration Results | | | | |
|---|---|---|---|---|
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
| 1 | 16.643 | 32.831 | 71.757 | 14.17 |
| 2 | 18.310 | 198.885 | 394.335 | 85.83 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(3-methoxyphenyl)propanamide (3ak)**

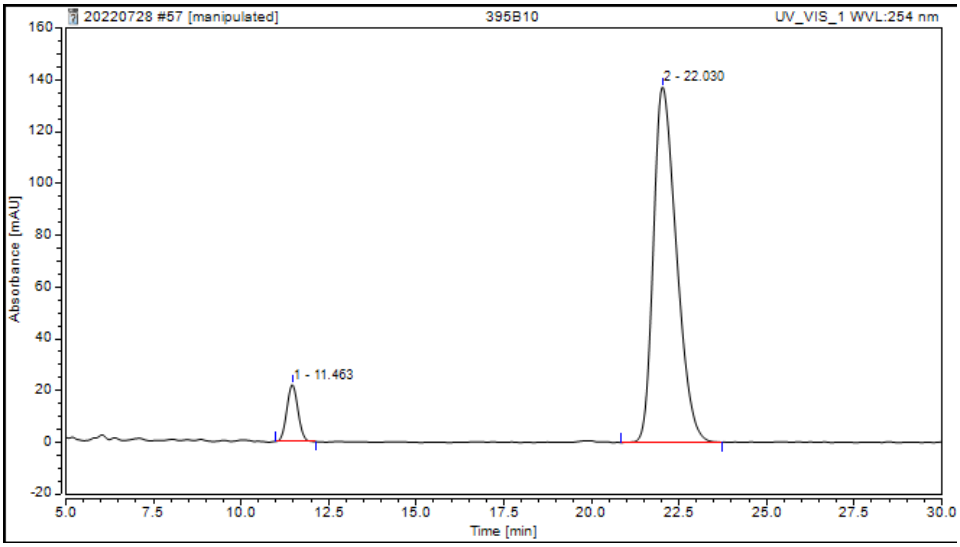


24.1 mg, 74% yield, pale yellow solid; M.p. 101.4 – 101.9 ℃; $[\alpha]_D^{20}$ = – 0.021 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.79 – 8.68 (m, 1H), 8.44 – 8.33 (m, 2H), 7.98 (s, 1H), 7.43 – 7.32 (m, 1H), 7.03 – 6.85 (m, 3H), 3.89 – 3.78 (m, 4H), 1.66 (d, $J$ = 7.4 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.7, 160.6, 145.3, 142.5, 140.3, 130.9, 129.3, 127.8, 120.1, 119.9, 113.9, 113.7, 113.5, 101.6, 55.3, 48.5, 17.5; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{17}H_{16}N_3O_4$: 326.1135; found: 326.1136; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 75/25, flow rate = 1.8 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 22.030 min, $t_{minor}$ = 11.463 min, 93:7 e.r.).




**Integration Results**

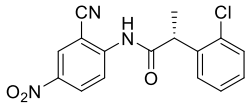
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 11.513 | 24.231 | 65.455 | 49.96 |
| 2 | 22.230 | 24.270 | 32.771 | 50.04 |



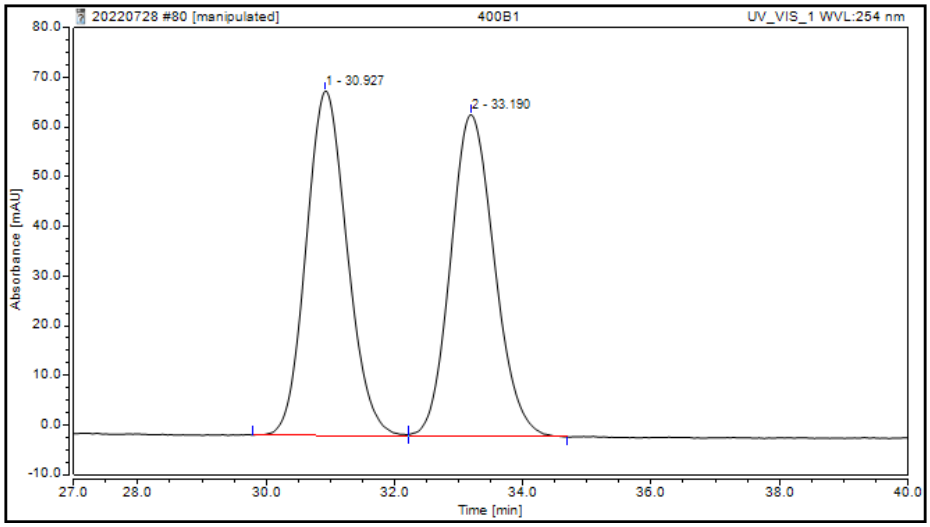

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 11.463 | 8.106 | 21.993 | 7.21 |
| 2 | 22.030 | 104.276 | 137.328 | 92.79 |

**(*R*)-2-(2-chlorophenyl)-*N*-(2-cyano-4-nitrophenyl)propanamide (3al)**

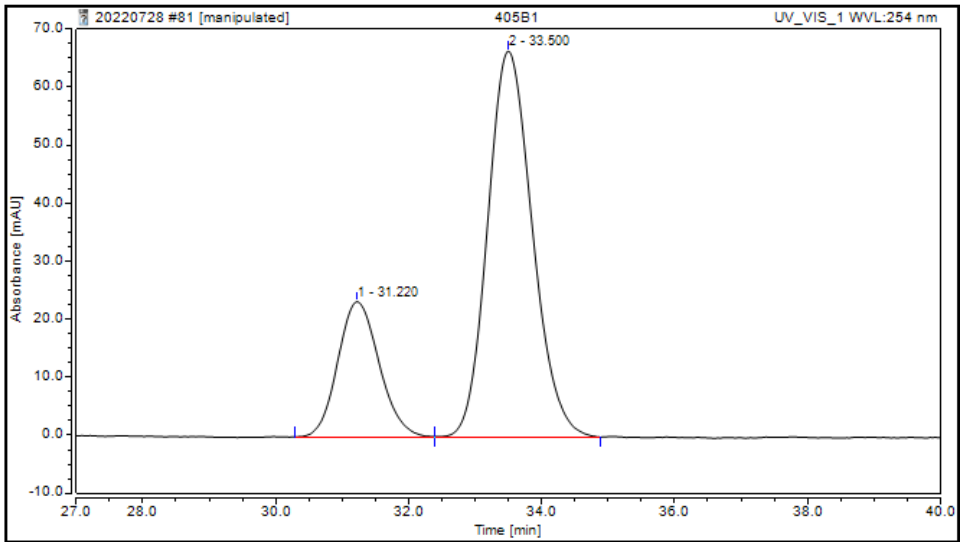


20.7 mg, 63% yield, pale yellow solid; M.p. 177.7 – 178.3 °C; $[\alpha]_D^{20}$ = – 0.020 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.81 – 8.68 (m, 1H), 8.47 – 8.33 (m, 2H), 8.03 (s, 1H), 7.53 – 7.43 (m, 2H), 7.41 – 7.28 (m, 2H), 4.40 (q, *J* = 7.0 Hz, 1H), 1.67 (d, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.0, 145.4, 142.6, 136.4, 133.8, 130.4, 129.6, 129.3, 128.6, 128.1, 127.9, 120.3, 113.9, 101.8, 44.5, 16.7; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{13}ClN_3O_3$: 330.0640; found: 330.0648; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 °C, retention time: $t_{major}$ = 33.500 min, $t_{minor}$ = 31.220 min, 75.5:24.5 e.r.).




**Integration Results**

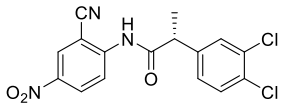
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 30.927 | 51.359 | 69.390 | 50.04 |
| 2 | 33.190 | 51.281 | 64.780 | 49.96 |



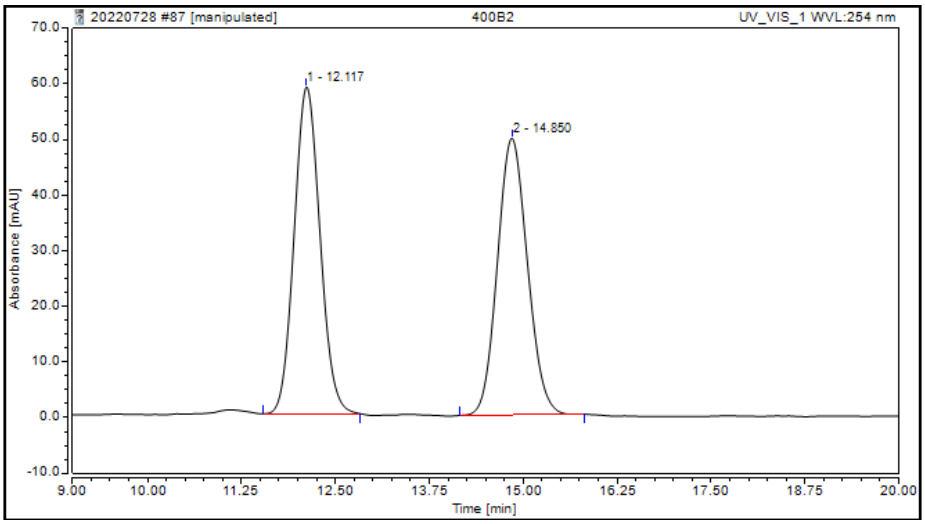

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 31.220 | 16.850 | 23.351 | 24.57 |
| 2 | 33.500 | 51.740 | 66.483 | 75.43 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2-(3,4-dichlorophenyl)propanamide (3am)**

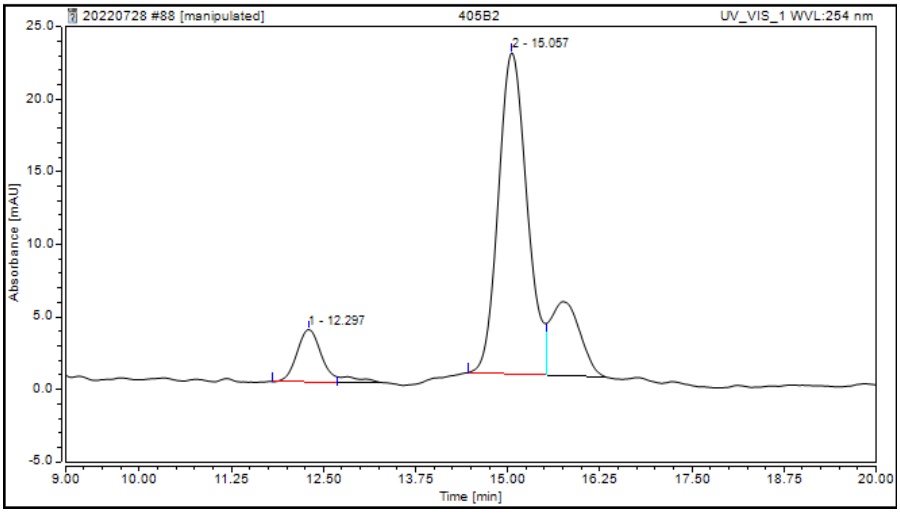


24.0 mg, 66% yield, pale yellow solid; M.p. 178.9 – 179.6 ℃; $[\alpha]_D^{20}$ = –0.015 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.78 – 8.67 (m, 1H), 8.48 – 8.38 (m, 2H), 7.91 (s, 1H), 7.56 – 7.44 (m, 2H), 7.26 (s, 1H), 3.82 (q, *J* = 7.1 Hz, 1H), 1.64 (d, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 171.7, 145.0, 142.8, 139.1, 133.7, 132.7, 131.5, 129.6, 129.5, 127.8, 126.9, 120.4, 114.1, 101.9, 47.7, 18.1; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{16}H_{12}Cl_2N_3O_3$: 364.0250; found: 364.0259; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 15.057 min, $t_{minor}$ = 12.297 min, 88:12 e.r.).




**Integration Results**

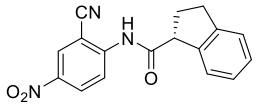
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 12.117 | 23.369 | 58.745 | 50.41 |
| 2 | 14.850 | 22.993 | 49.728 | 49.59 |



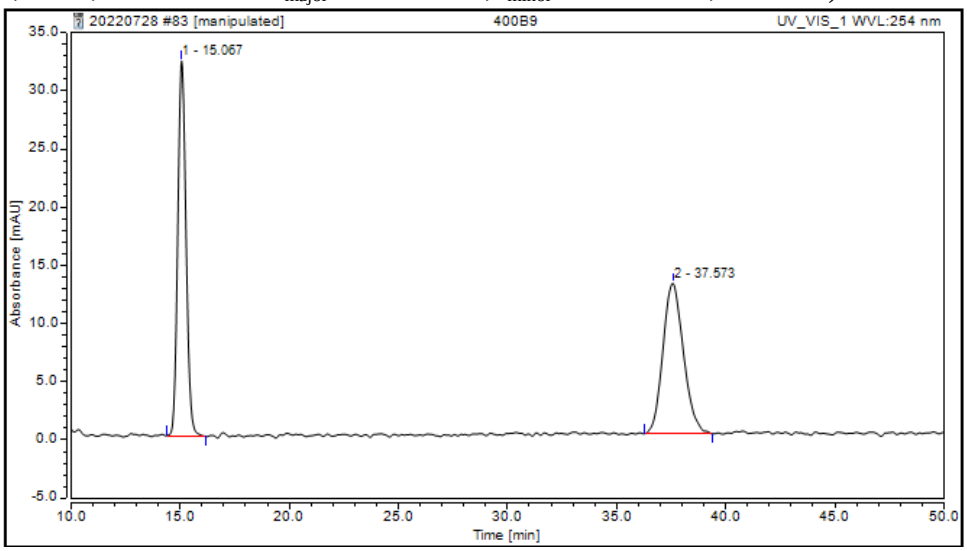

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 12.297 | 1.349 | 3.605 | 11.92 |
| 2 | 15.057 | 9.964 | 22.132 | 88.08 |

**(*R*)-*N*-(2-cyano-4-nitrophenyl)-2,3-dihydro-1*H*-indene-1-carboxamide (3an)**

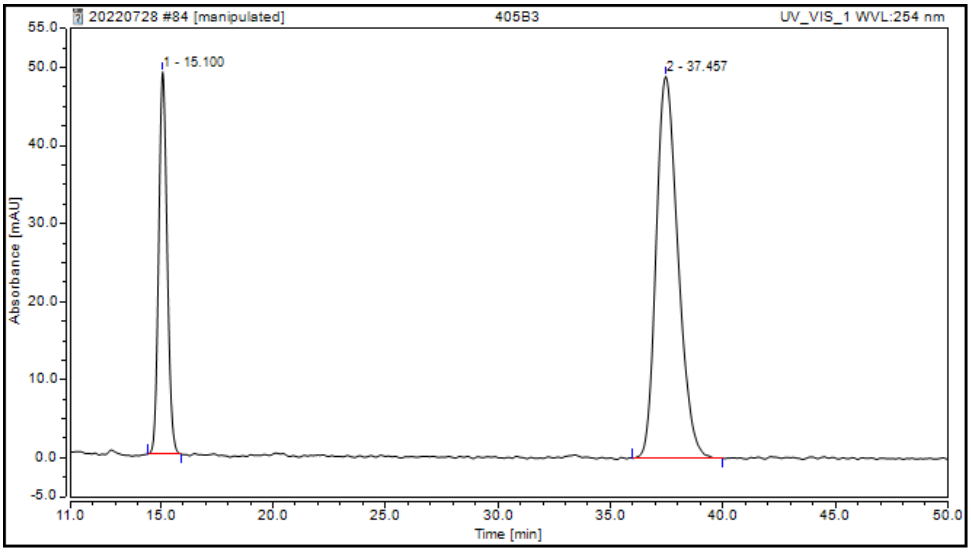


18.4 mg, 60% yield, pale yellow solid; M.p. 152.8 – 153.5 ℃; $[\alpha]_D^{20}$ = – 0.017 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.85 – 8.71 (m, 1H), 8.53 – 8.28 (m, 2H), 8.08 (s, 1H), 7.49 – 7.28 (m, 4H), 4.26 – 4.16 (m, 1H), 3.24 – 3.13 (m, 1H), 3.09 – 2.98 (m, 1H), 2.67 – 2.47 (m, 2H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.8, 145.4, 144.8, 142.7, 139.0, 129.4, 128.9, 127.9, 127.6, 125.8, 124.9, 120.4, 114.0, 101.8, 53.7, 31.6, 30.5; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{17}H_{14}N_3O_3$: 308.1030; found: 308.1036; **HPLC** (Daicel Chiralpak IC column, *n*-hexane/*i*-PrOH = 80/20, flow rate = 1.5 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 37.457 min, $t_{minor}$ = 15.100 min, 72:28 e.r.).




**Integration Results**

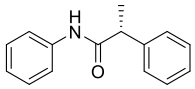
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 15.067 | 14.133 | 32.241 | 49.92 |
| 2 | 37.573 | 14.176 | 12.955 | 50.08 |



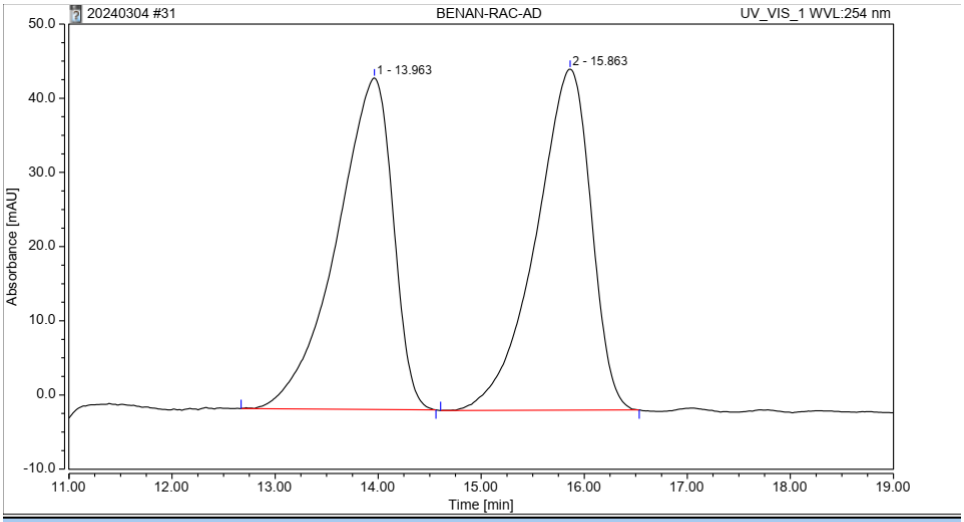

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 15.100 | 21.300 | 48.935 | 27.95 |
| 2 | 37.457 | 54.903 | 48.887 | 72.05 |

**(*R*)-*N*,2-diphenylpropanamide (3ba)**[4]

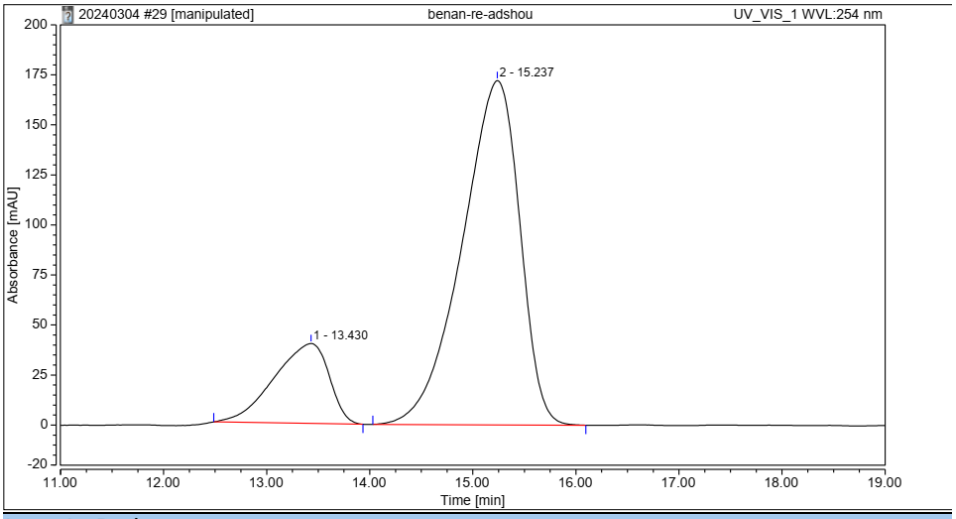


21.4 mg, 95% yield, white solid; M.p. 126.8 – 127.5 ℃; $[\alpha]_D^{20}$ = –0.137 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.45 – 7.22 (m, 9H), 7.14 – 7.01 (m, 2H), 3.71 (q, *J* = 7.1 Hz, 1H), 1.60 (d, *J* = 7.2 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.3, 140.9, 137.8, 129.1, 128.9, 127.7, 127.6, 124.2, 119.7, 48.1, 18.5; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{16}NO$: 226.1226; found: 226.1223; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 15.237 min, $t_{minor}$ = 13.430 min, 82:18 e.r.).




**Integration Results**

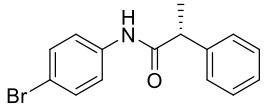
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 13.963 | 28.288 | 44.699 | 49.76 | 49.31 | n.a. |
| 2 | | 15.863 | 28.559 | 45.948 | 50.24 | 50.69 | n.a. |
| **Total:** | | | **56.847** | **90.646** | **100.00** | **100.00** | |



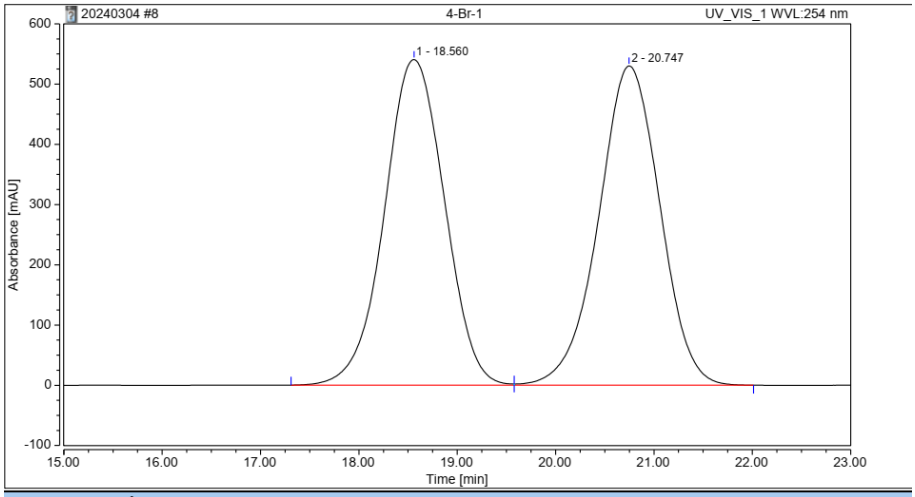

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 13.430 | 24.665 | 39.925 | 18.12 | 18.83 | n.a. |
| 2 | | 15.237 | 111.442 | 172.081 | 81.88 | 81.17 | n.a. |
| **Total:** | | | **136.107** | **212.006** | **100.00** | **100.00** | |

**(*R*)-*N*-(4-bromophenyl)-2-phenylpropanamide (3ca)** [4]

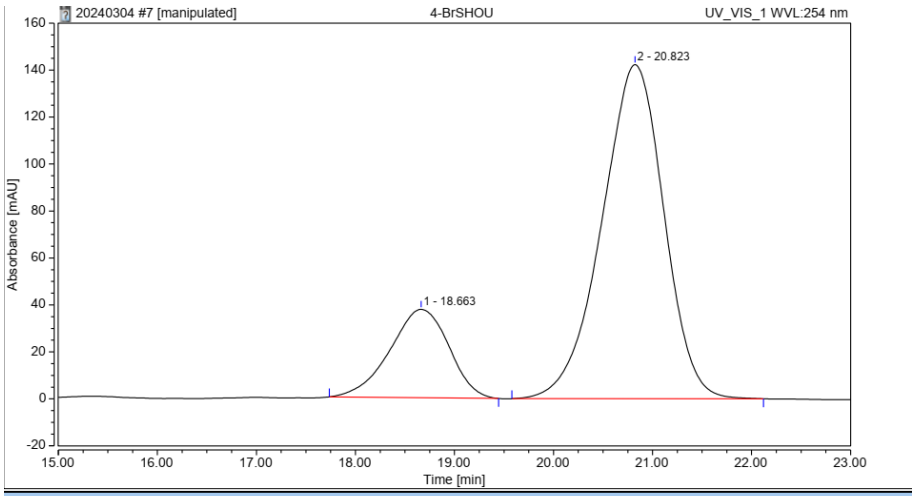



26.5 mg, 87% yield, white solid; M.p. 110.1 – 110.9 ℃; $[\alpha]_D^{20}$ = –0.064 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.44 – 7.27 (m, 9H), 7.16 (s, 1H), 3.70 (q, $J$ = 7.2 Hz, 1H), 1.58 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.3, 140.6, 136.9, 131.8, 129.2, 127.6, 121.2, 116.7, 116.7, 48.1, 18.5; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{15}BrNO$: 304.0332; found: 304.0331; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 20.832 min, $t_{minor}$ = 18.663 min, 80:20 e.r.).




**Integration Results**

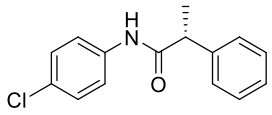
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 18.560 | 382.439 | 540.521 | 49.97 | 50.49 | n.a. |
| 2 | | 20.747 | 382.920 | 530.036 | 50.03 | 49.51 | n.a. |
| **Total:** | | | **765.359** | **1070.556** | **100.00** | **100.00** | |



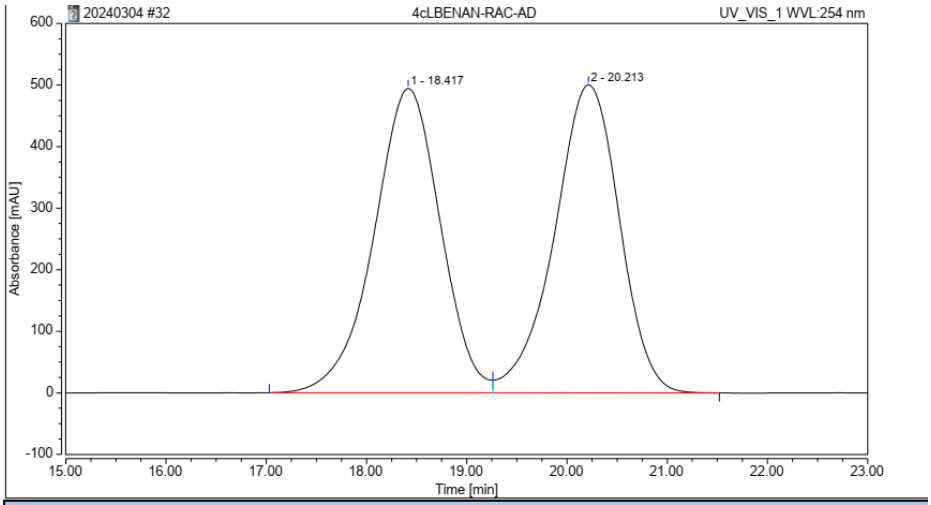

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 18.663 | 25.970 | 37.632 | 20.08 | 20.92 | n.a. |
| 2 | | 20.823 | 103.388 | 142.283 | 79.92 | 79.08 | n.a. |
| **Total:** | | | **129.358** | **179.915** | **100.00** | **100.00** | |

**(*R*)-*N*-(4-chlorophenyl)-2-phenylpropanamide (3da)** [4]

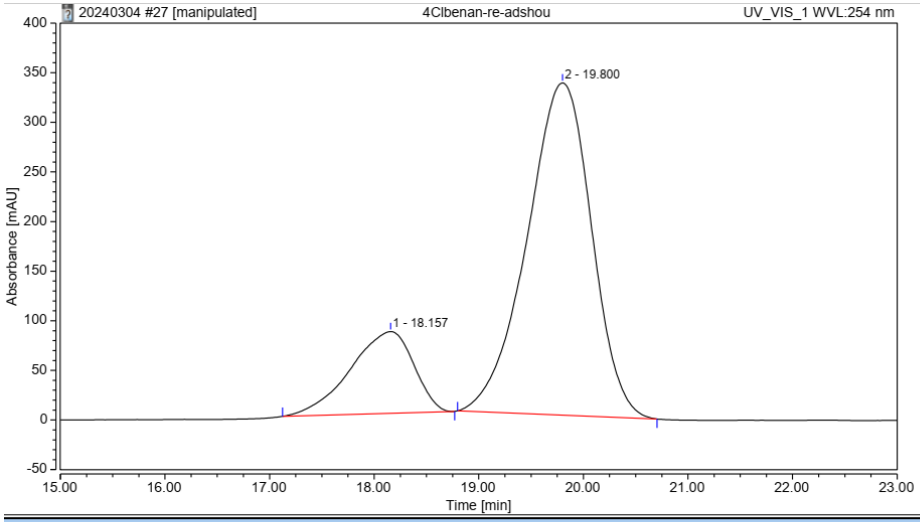


23.4 mg, 90% yield, white solid; M.p. 101.3 – 102.0 ℃; $[\alpha]_D^{20}$ = –0.131 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.41 – 7.06 (m, 10H), 3.70 (q, $J$ = 7.1 Hz, 1H), 1.58 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.5, 140.6, 136.4, 129.1, 129.1, 128.8, 127.6, 121.1, 47.9, 18.5; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{15}ClNO$: 260.0837; found: 260.0834; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 19.800 min, $t_{minor}$ = 18.157 min, 80.5:19.5 e.r.).




**Integration Results**

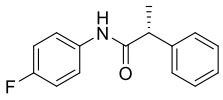
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 18.417 | 379.203 | 494.203 | 50.19 | 49.69 | n.a. |
| 2 | | 20.213 | 376.312 | 500.325 | 49.81 | 50.31 | n.a. |
| **Total:** | | | **755.515** | **994.527** | **100.00** | **100.00** | |



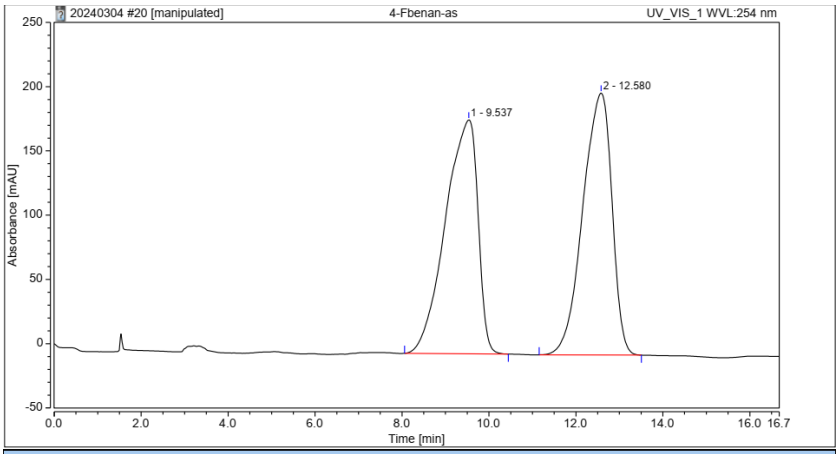

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 18.157 | 57.810 | 82.276 | 19.49 | 19.72 | n.a. |
| 2 | | 19.800 | 238.851 | 334.931 | 80.51 | 80.28 | n.a. |
| **Total:** | | | **296.661** | **417.207** | **100.00** | **100.00** | |

**(*R*)-*N*-(4-fluorophenyl)-2-phenylpropanamide (3ea)** [4]

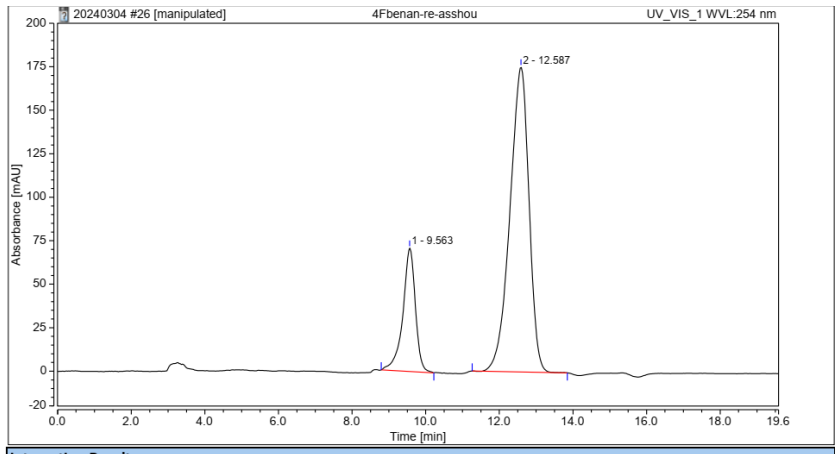


21.4 mg, 88% yield, white solid; M.p. 92.8 – 93.7 ℃; $[\alpha]_D^{20}$ = –0.120 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.47 – 7.26 (m, 8H), 6.93 (t, $J$ = 8.4 Hz, 2H), 3.70 (q, $J$ = 7.1 Hz, 1H), 1.57 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.5, 159.3 (d, $J_{C\text{-}F}$ = 243.1 Hz), 140.8, 133.8 (d, $J_{C\text{-}F}$ = 3.2 Hz), 129.1, 127.6, 127.5, 121.7 (d, $J_{C\text{-}F}$ = 8.1 Hz), 115.4 (d, $J_{C\text{-}F}$ = 22.4 Hz), 47.8, 18.5; **$^{19}$F NMR** (376 MHz, CDCl3) $\delta$ -118.0; **HRMS** (ESI) m/z calcd for $[M + H]^+$ $C_{15}H_{15}FNO$: 244.1132; found: 244.1130; **HPLC** (Daicel Chiralpak AS-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 12.587 min, $t_{minor}$ = 9.563 min, 79:21 e.r.).




**Integration Results**

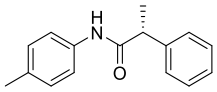
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 9.537 | 157.571 | 181.988 | 49.97 | 47.18 | n.a. |
| 2 | | 12.580 | 157.789 | 203.772 | 50.03 | 52.82 | n.a. |
| **Total:** | | | **315.360** | **385.760** | **100.00** | **100.00** | |



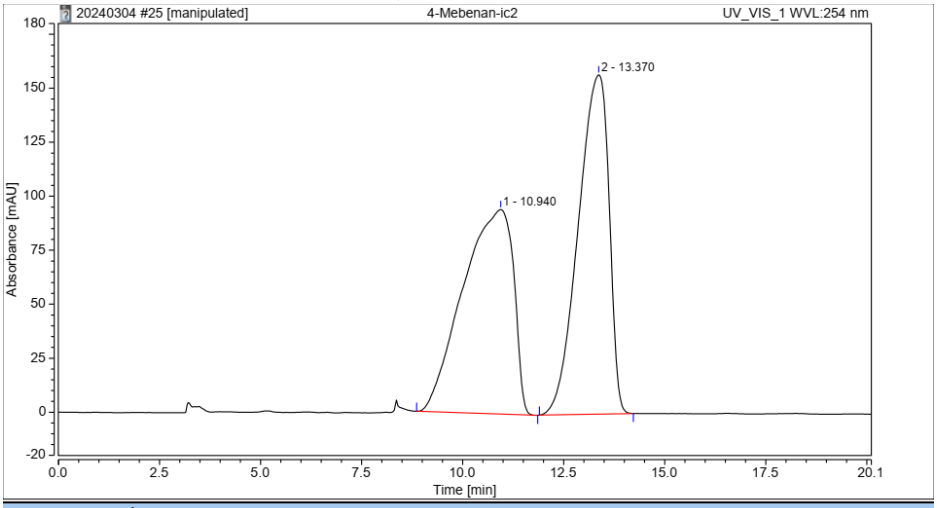

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 9.563 | 27.897 | 70.935 | 20.97 | 28.81 | n.a. |
| 2 | | 12.587 | 105.168 | 175.299 | 79.03 | 71.19 | n.a. |
| **Total:** | | | **133.065** | **246.233** | **100.00** | **100.00** | |

**(*R*)-2-phenyl-*N*-(p-tolyl)propanamide (3fa)** [4]

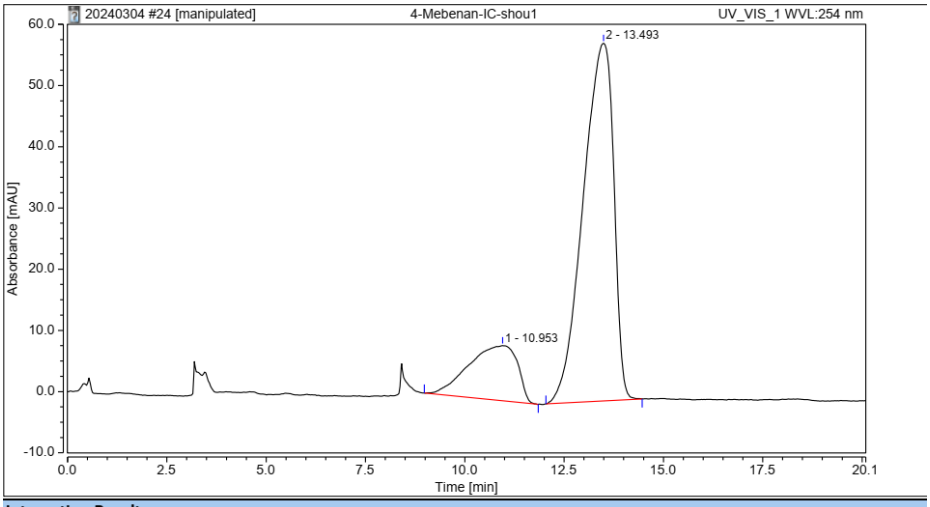


22.0 mg, 92% yield, white solid; M.p. 116.4 – 118.2 ℃; $[\alpha]_D^{20}$ = –0.186 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.41 – 7.14 (m, 8H), 7.05 (d, *J* = 8.0 Hz, 2H), 3.69 (q, *J* = 7.2, 6.6 Hz, 1H), 2.27 (s, 3H), 1.57 (d, *J* = 7.2 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.2, 141.0, 135.3, 133.8, 129.3, 129.0, 127.6, 127.4, 119.8, 47.9, 20.8, 18.5; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{16}H_{18}NO$: 240.1383; found: 240.1390; **HPLC** (Daicel Chiralpak IC-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 13.493 min, $t_{minor}$ = 10.953 min, 80.5:19.5 e.r.).




**Integration Results**

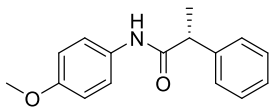
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 10.940 | 137.558 | 94.692 | 49.83 | 37.60 | n.a. |
| 2 | | 13.370 | 138.477 | 157.142 | 50.17 | 62.40 | n.a. |
| **Total:** | | | **276.035** | **251.833** | **100.00** | **100.00** | |



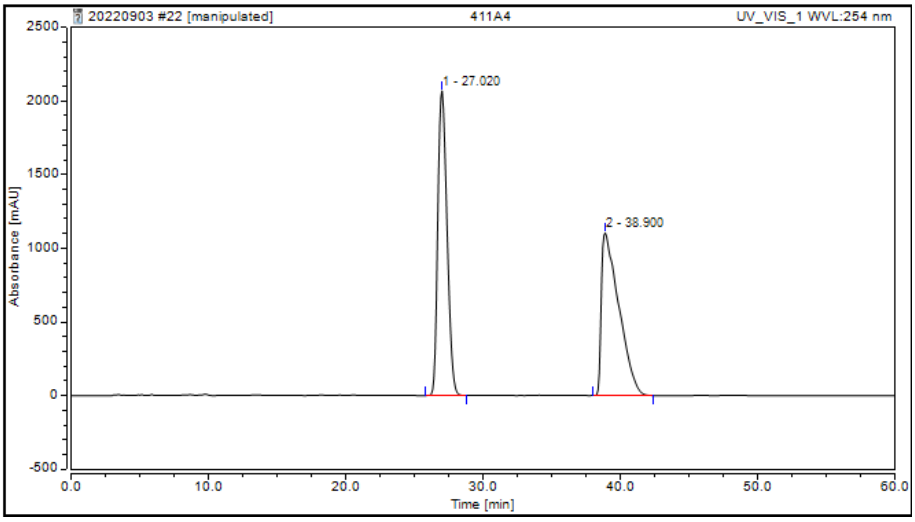

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 10.953 | 12.671 | 8.998 | 19.54 | 13.34 | n.a. |
| 2 | | 13.493 | 52.181 | 58.433 | 80.46 | 86.66 | n.a. |
| **Total:** | | | **64.852** | **67.431** | **100.00** | **100.00** | |

**(*R*)-*N*-(4-methoxyphenyl)-2-phenylpropanamide (3ga)** [4]

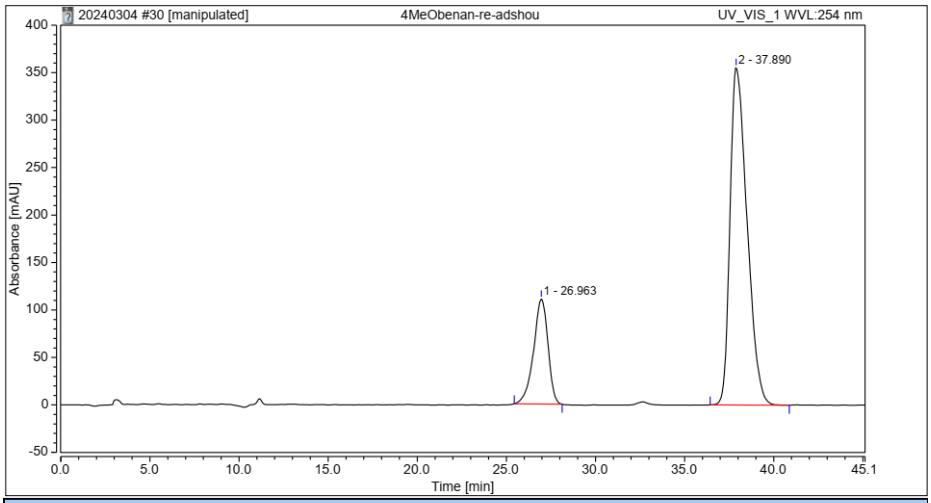


22.7 mg, 89% yield, white solid; M.p. 133.2 – 133.8 ℃; $[\alpha]_D^{20}$ = –0.194 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.42 – 7.26 (m, 7H), 7.08 (s, 1H), 6.84 – 6.72 (m, 2H), 3.75 (s, 3H), 3.69 (q, *J* = 7.1 Hz, 1H), 1.58 (d, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.2, 156.3, 141.1, 130.9, 129.1, 127.7, 127.5, 121.6, 114.0, 55.4, 47.8, 18.6; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{16}H_{18}NO_2$: 256.1332; found: 256.1324; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 37.890 min, $t_{minor}$ = 26.963 min, 79:21 e.r.).




**Integration Results**

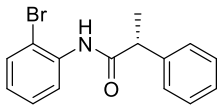
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 27.020 | 1609.290 | 2068.986 | 49.68 |
| 2 | 38.900 | 1629.989 | 1104.995 | 50.32 |



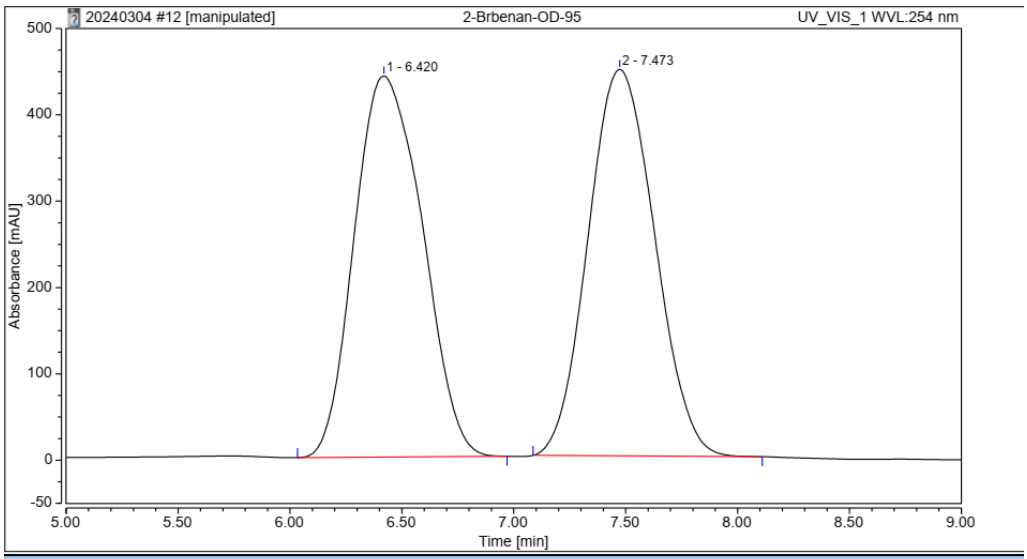

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 26.963 | 103.524 | 110.707 | 20.79 | 23.74 | n.a. |
| 2 | | 37.890 | 394.403 | 355.698 | 79.21 | 76.26 | n.a. |
| **Total:** | | | **497.927** | **466.405** | **100.00** | **100.00** | |

**(*R*)-*N*-(2-bromophenyl)-2-phenylpropanamide (3ha)** [5]

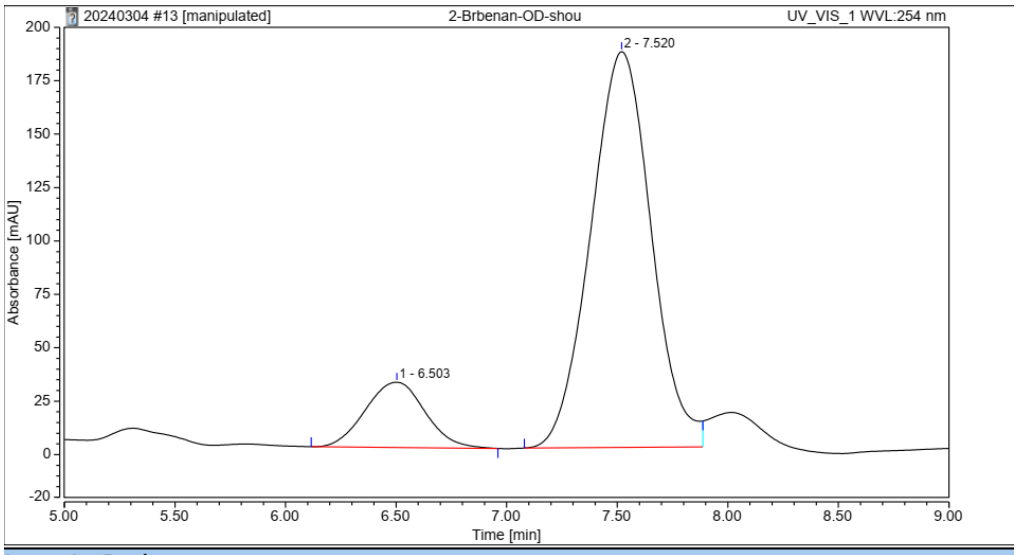


24.9 mg, 82% yield, white solid; M.p. 83.3 – 84.6 ℃; $[\alpha]_D^{20}$ = –0.077 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 8.35 (d, $J$ = 8.3 Hz, 1H), 7.61 (s, 1H), 7.45 – 7.19 (m, 8H), 6.91 (t, $J$ = 7.7 Hz, 1H), 3.79 (q, $J$ = 7.2 Hz, 1H), 1.65 (d, $J$ = 7.2 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 172.4, 140.2, 135.6, 132.1, 129.3, 128.3, 127.9, 127.8, 125.0, 121.3, 113.1, 48.4, 17.9; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{15}BrNO$: 304.0332; found: 304.0340; **HPLC** (Daicel Chiralpak OD-H column, *n*-hexane/*i*-PrOH = 95/5, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{minor}$ = 6.503 min, $t_{major}$ = 7.520 min, 86:14 e.r.).




**Integration Results**

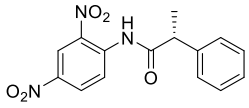
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.420 | 155.637 | 441.445 | 50.21 | 49.66 | n.a. |
| 2 | | 7.473 | 154.351 | 447.441 | 49.79 | 50.34 | n.a. |
| **Total:** | | | **309.988** | **888.886** | **100.00** | **100.00** | |



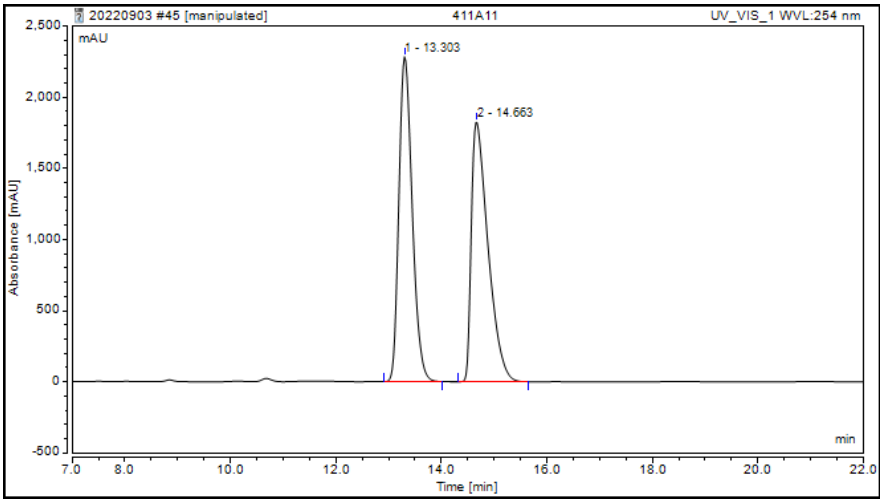

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.503 | 9.569 | 30.576 | 14.00 | 14.16 | n.a. |
| 2 | | 7.520 | 58.785 | 185.293 | 86.00 | 85.84 | n.a. |
| **Total:** | | | **68.354** | **215.869** | **100.00** | **100.00** | |

**(*R*)-*N*-(2,4-dinitrophenyl)-2-phenylpropanamide (3ia)**

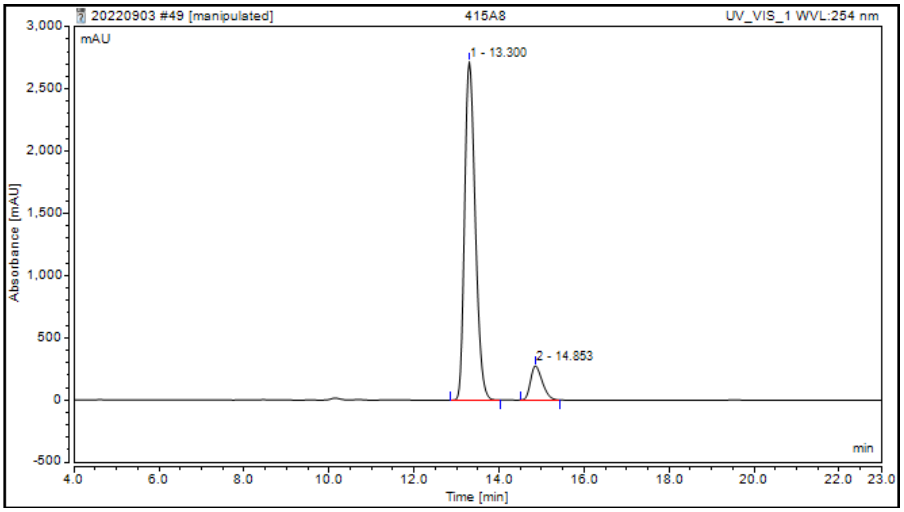


27.7 mg, 88% yield, white solid; M.p. 129.0 – 129.7 ℃; $[\alpha]_D^{20}$ = –0.129 (c = 0.1 in $CH_3OH$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 10.58 (s, 1H), 9.21 – 8.94 (m, 2H), 8.55 – 8.33 (m, 1H), 7.52 – 7.30 (m, 5H), 3.88 (q, $J$ = 7.1 Hz, 1H), 1.66 (d, $J$ = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 173.7, 141.5, 139.9, 138.9, 134.7, 130.1, 129.5, 128.3, 127.8, 122.0, 121.9(7), 49.3, 17.7; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{14}ClN_3O_5$: 316.0928; found: 316.0933; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 13.300 min, $t_{minor}$ = 14.853 min, 90:10 e.r.).




**Integration Results**

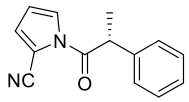
| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 13.303 | 668.542 | 2286.699 | 50.04 |
| 2 | 14.663 | 667.587 | 1829.493 | 49.96 |



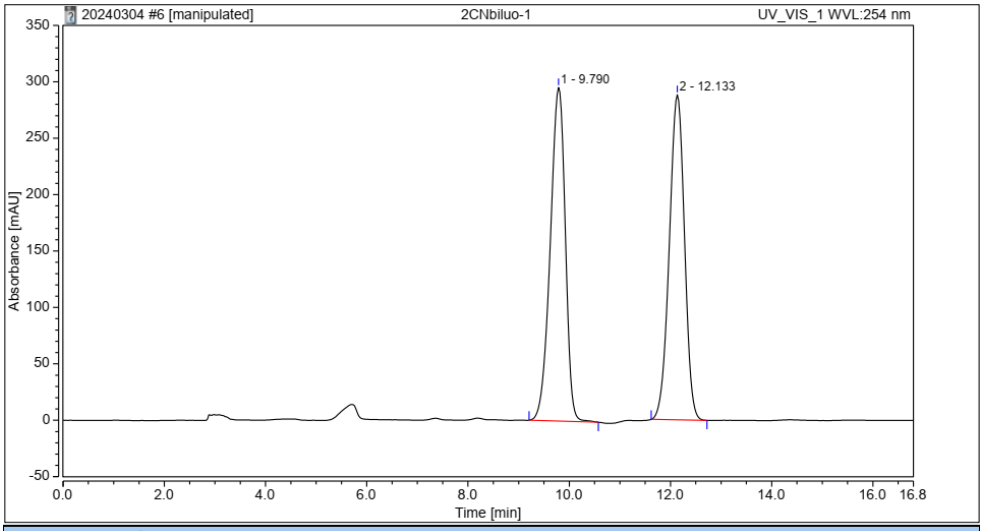

**Integration Results**

| Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % |
|---|---|---|---|---|
| 1 | 13.300 | 787.673 | 2719.675 | 89.97 |
| 2 | 14.853 | 87.829 | 274.554 | 10.03 |

**(*R*)-1-(2-phenylpropanoyl)-1*H*-pyrrole-2-carbonitrile (3ja)**[3]

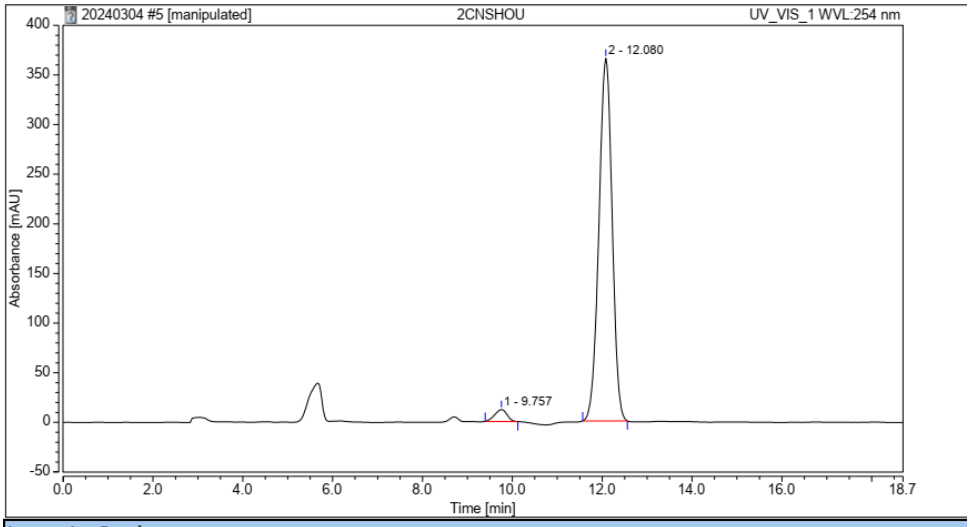


21.3 mg, 95% yield, white solid; M.p. 75.6 – 76.7 ℃; $[\alpha]_D^{20}$ = –10.340 (c = 0.5 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.38-7.26 (m, 6H), 6.96 (s, 1H), 6.23 (s, 1H), 4.42 (q, *J* = 6.8 Hz, 1H), 1.63 (d, *J* = 6.9 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 170.5, 139.3, 129.4, 127.8, 127.1, 126.4, 124.7, 113.2, 113.0, 103.6, 45.8, 20.1; **HRMS** (ESI) m/z calcd for $[M+Na]^+$ $C_{14}H_{12}N_2NaO$: 247.0842; found: 247.0833; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 12.080 min, $t_{minor}$ = 9.757 min, 97:3 e.r.).




**Integration Results**

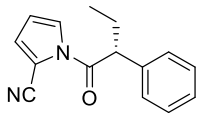
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 9.790 | 101.571 | 295.782 | 50.40 | 50.65 | n.a. |
| 2 | | 12.133 | 99.945 | 288.172 | 49.60 | 49.35 | n.a. |
| **Total:** | | | **201.515** | **583.953** | **100.00** | **100.00** | |



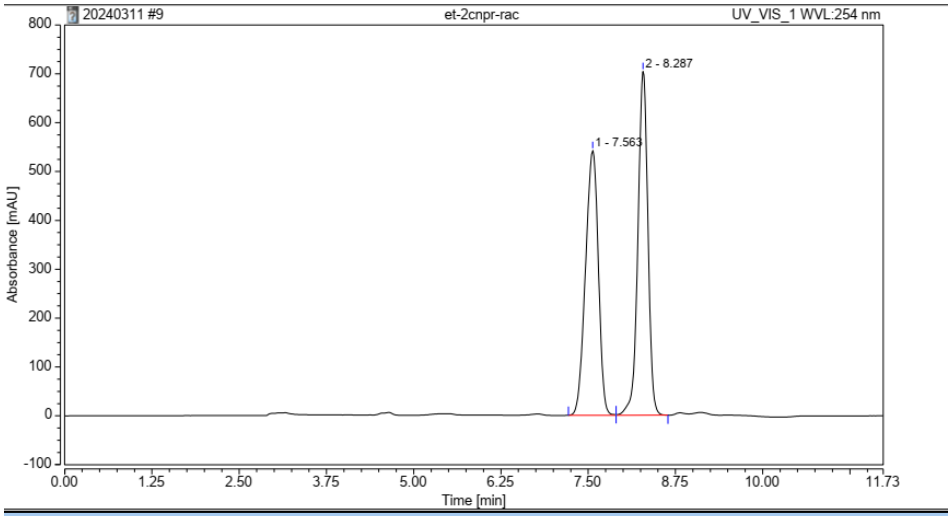

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 9.757 | 3.796 | 11.985 | 2.95 | 3.18 | n.a. |
| 2 | | 12.080 | 124.891 | 365.297 | 97.05 | 96.82 | n.a. |
| **Total:** | | | **128.687** | **377.282** | **100.00** | **100.00** | |

**(*R*)-1-(2-phenylbutanoyl)-1*H*-pyrrole-2-carbonitrile (3jo)** [3]

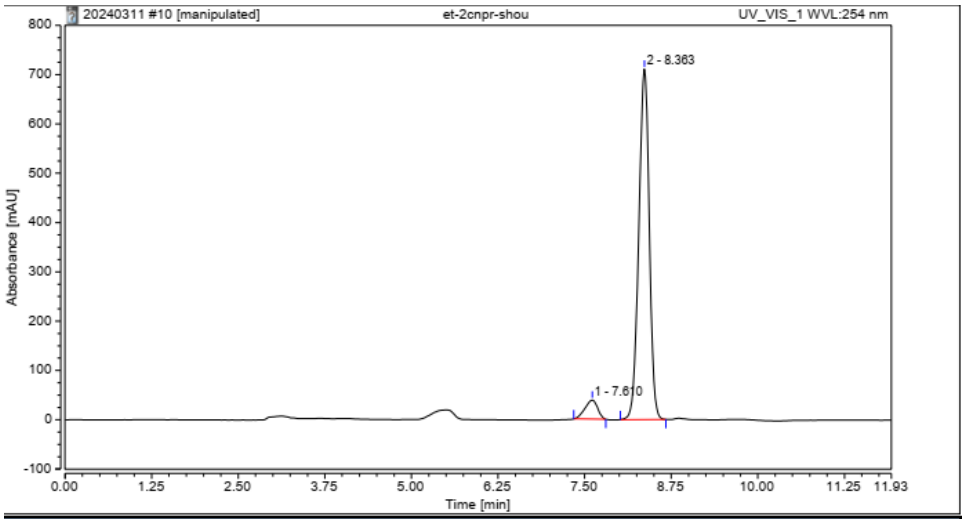


21.2 mg, 89% yield, white solid, M.p. 85.7-87.3 ℃; $[\alpha]_D^{20}$ = –3.628 (c = 0.2 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.43 – 7.18 (m, 6H), 6.96 (s, 1H), 6.25 (q, $J$ = 3.0 Hz, 1H), 4.13 (t, $J$ = 7.2 Hz, 1H), 2.30-2.21 (m, 1H), 1.98-1.87 (m, 1H), 0.96 (t, $J$ = 7.3 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 170.0, 137.5, 129.3, 128.0, 127.7, 126.5, 124.6, 113.2, 112.9, 103.6, 53.1, 27.7, 11.9; **HRMS** (ESI) m/z calcd for $[M+Na]^+$ $C_{15}H_{14}N_2NaO$: 261.0998; found: 261.0991; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 8.363 min, $t_{minor}$ = 7.610 min, 94:6 e.r.).




**Integration Results**

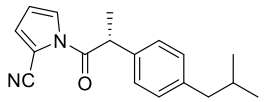
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 7.563 | 115.384 | 542.124 | 49.65 | 43.51 | n.a. |
| 2 | | 8.287 | 117.020 | 703.746 | 50.35 | 56.49 | n.a. |
| **Total:** | | | **232.404** | **1245.871** | **100.00** | **100.00** | |



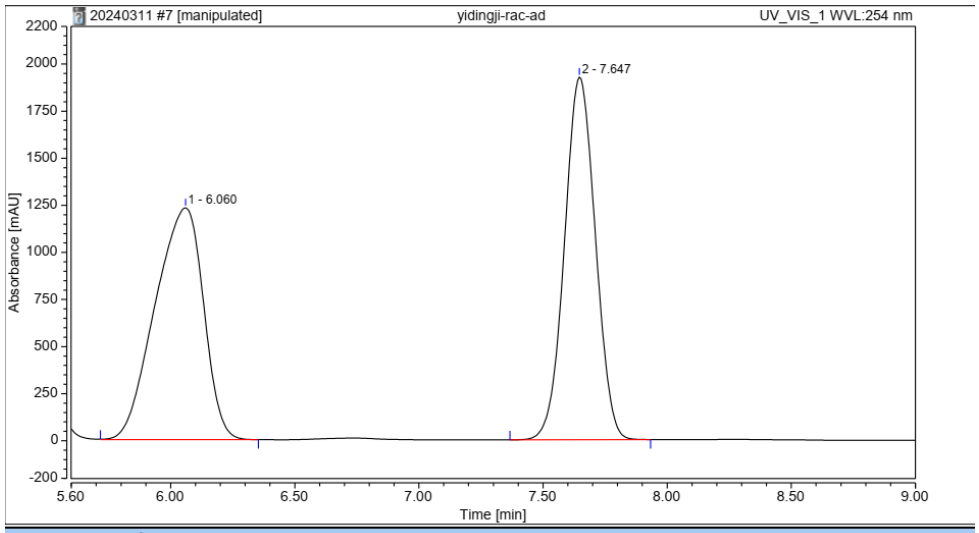

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 7.610 | 8.213 | 38.681 | 6.19 | 5.16 | n.a. |
| 2 | | 8.363 | 124.566 | 710.693 | 93.81 | 94.84 | n.a. |
| **Total:** | | | **132.779** | **749.373** | **100.00** | **100.00** | |

**(*R*)-1-(2-(4-isobutylphenyl)propanoyl)-1*H*-pyrrole-2-carbonitrile (3jp)**

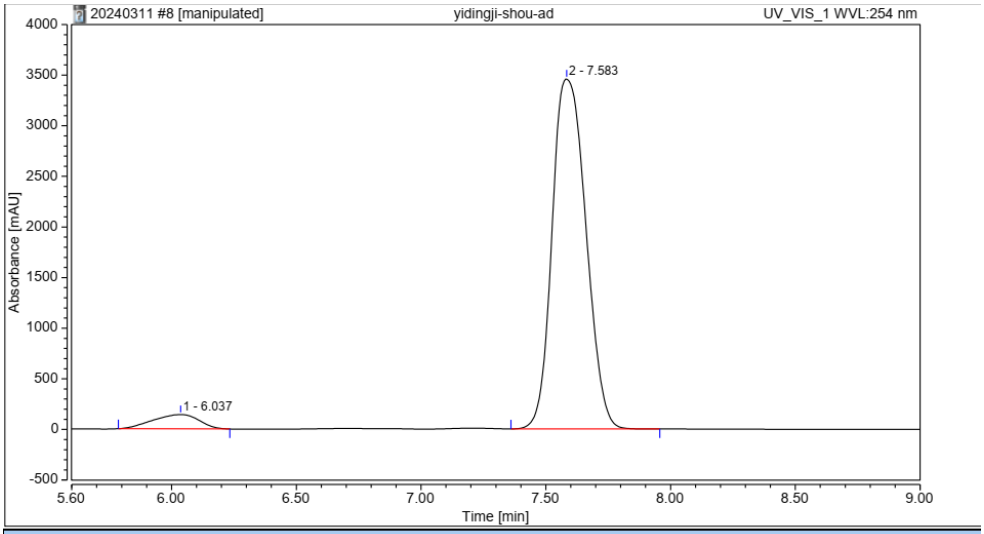


25.2 mg, 90% yield, white solid, M.p. 85.7-87.3 ℃; $[\alpha]_D^{20}$ = –1.891 (c = 0.1 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.33 (s, 1H), 7.20 (d, $J$ = 8.2 Hz, 2H), 7.12 (d, $J$ = 8.2 Hz, 2H), 6.95 (s, 1H), 6.23 (s, 1H), 4.37 (q, $J$ = 6.9 Hz, 1H), 2.44 (d, $J$ = 7.2 Hz, 2H), 1.88-1.78 (m, 1H), 1.61 (d, $J$ = 6.8 Hz, 3H), 0.88 (d, $J$ = 6.7 Hz, 6H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 170.6, 141.4, 136.5, 130.1, 126.8, 126.3, 124.8, 113.2, 112.9, 103.6, 45.4, 44.9, 30.1, 22.3, 20.1; **HRMS** (ESI) m/z calcd for $[M+Na]^+$ $C_{18}H_{20}N_2NaO$: 303.1468; found: 303.1460; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 254 nm, 25 ℃, retention time: $t_{major}$ = 7.583 min, $t_{minor}$ = 6.037 min, 95:5 e.r.).




**Integration Results**

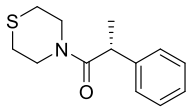
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.060 | 278.442 | 1230.976 | 50.09 | 39.00 | n.a. |
| 2 | | 7.647 | 277.495 | 1925.286 | 49.91 | 61.00 | n.a. |
| **Total:** | | | **555.937** | **3156.261** | **100.00** | **100.00** | |



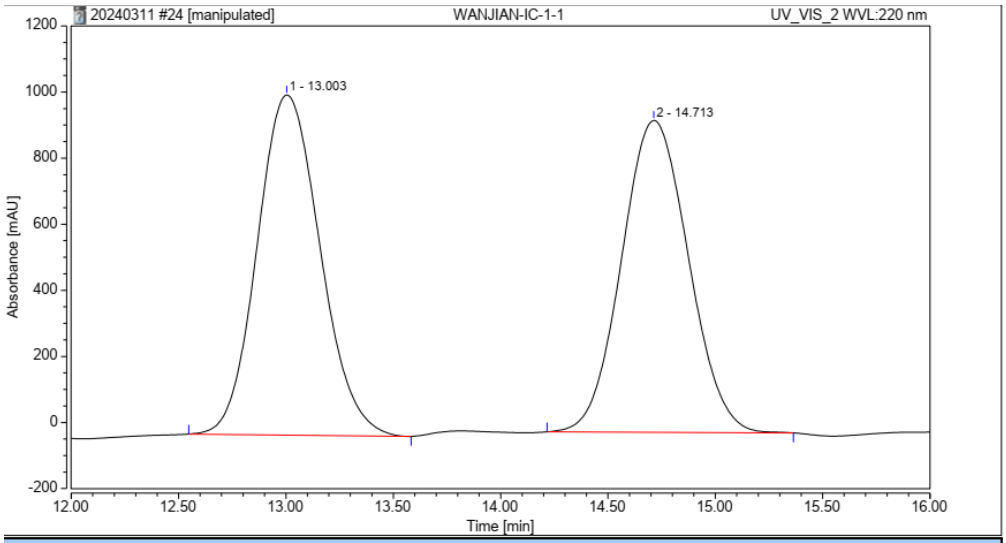

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.037 | 30.270 | 141.702 | 5.28 | 3.94 | n.a. |
| 2 | | 7.583 | 543.216 | 3457.861 | 94.72 | 96.06 | n.a. |
| **Total:** | | | **573.486** | **3599.563** | **100.00** | **100.00** | |

**(R)-2-phenyl-1-thiomorpholinopropan-1-one (3ka)**

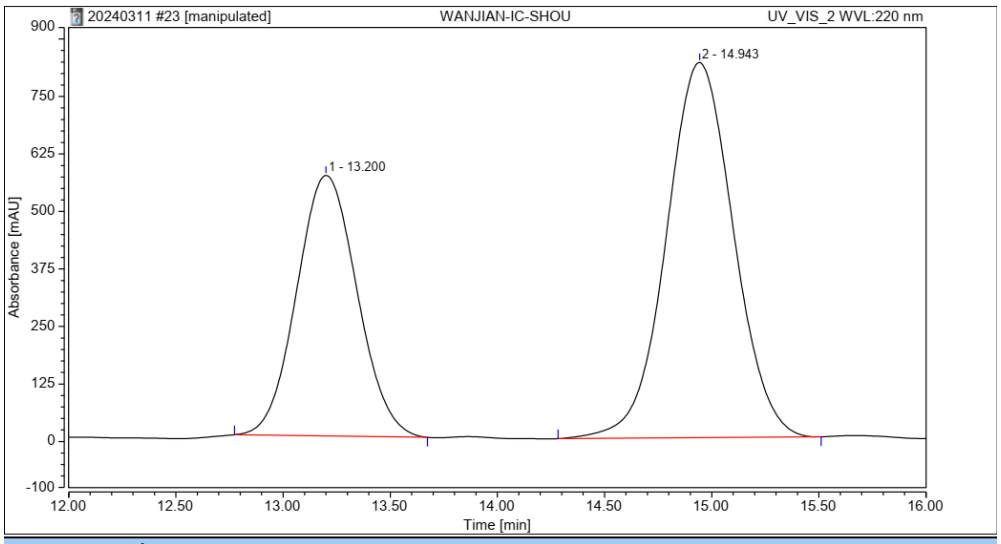


21.6 mg, 92% yield, colorless oil, $[\alpha]_D^{20}$ = –0.073 (c = 0.1 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.36-7.29 (m, 2H), 7.28-7.19 (m, 3H), 4.38-4.16 (m, 1H), 3.83 (q, $J$ = 6.9 Hz, 1H), 3.79-3.69 (m, 1H), 3.64-3.41 (m, 2H), 2.63-2.44 (m, 2H), 2.27-2.18 (m, 1H), 1.94-1.84 (m, 1H), 1.44 (d, $J$ = 6.8 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 171.9, 141.8, 129.0, 127.2, 126.9, 48.1, 44.6, 43.5, 27.2, 27.0, 20.8; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{13}H_{18}NOS$: 235.3450; found: 235.3456; **HPLC** (Daicel Chiralpak IC-H column, *n*-hexane/*i*-PrOH = 90/10, flow rate = 1.0 mL/min, 220 nm, 25 ℃, retention time: $t_{major}$ = 14.943 min, $t_{minor}$ = 13.200 min, 61.5:38.5 e.r.).




**Integration Results**

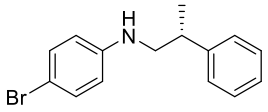
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 13.003 | 349.304 | 1029.046 | 50.64 | 52.17 | n.a. |
| 2 | | 14.713 | 340.470 | 943.612 | 49.36 | 47.83 | n.a. |
| **Total:** | | | **689.774** | **1972.659** | **100.00** | **100.00** | |



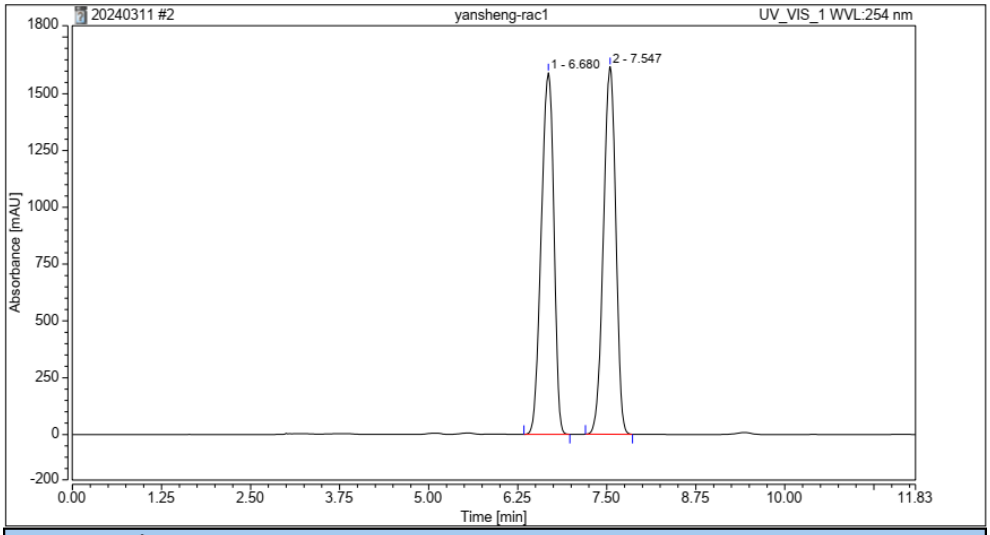

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 13.200 | 185.008 | 566.361 | 38.46 | 40.98 | n.a. |
| 2 | | 14.943 | 296.045 | 815.712 | 61.54 | 59.02 | n.a. |
| **Total:** | | | **481.054** | **1382.073** | **100.00** | **100.00** | |

**(*R*)-4-bromo-*N*-(2-phenylpropyl)aniline (4)**

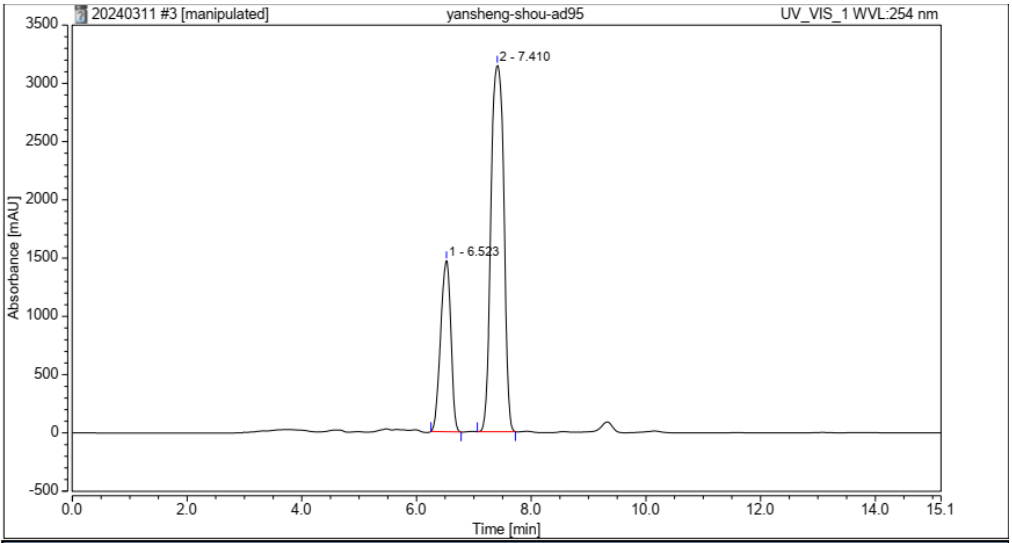


27.0 mg, 93% yield, colorless oil; $[\alpha]_D^{20}$ = 0.113 (c = 0.2 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 7.33 (t, $J$ = 7.4 Hz, 2H), 7.28-7.19 (m, 5H), 6.43 (d, $J$ = 8.3 Hz, 2H), 3.59 (s, 1H), 3.33-3.28 (m, 1H), 3.22-3.17 (m,1H), 3.08-3.01 (m, 1H), 1.33 (d, $J$ = 6.9 Hz, 1H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 147.0, 144.2, 131.9, 128.7, 127.2, 126.7, 114.5, 108.8, 50.8, 39.1, 19.7; **HRMS** (ESI) m/z calcd for $[M+H]^+$ $C_{15}H_{17}BrN$: 290.0539; found: 290.0533; **HPLC** (Daicel Chiralpak AD-H column, *n*-hexane/*i*-PrOH = 95/5, flow rate = 1.0 mL/min, 254 nm, 25 °C, retention time: $t_{major}$ = 7.410 min, $t_{minor}$ = 6.523 min, 73:27 e.r.).




**Integration Results**

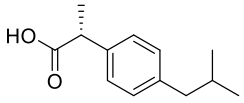
| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.680 | 326.454 | 1592.233 | 50.07 | 49.59 | n.a. |
| 2 | | 7.547 | 325.511 | 1618.648 | 49.93 | 50.41 | n.a. |
| **Total:** | | | **651.965** | **3210.882** | **100.00** | **100.00** | |



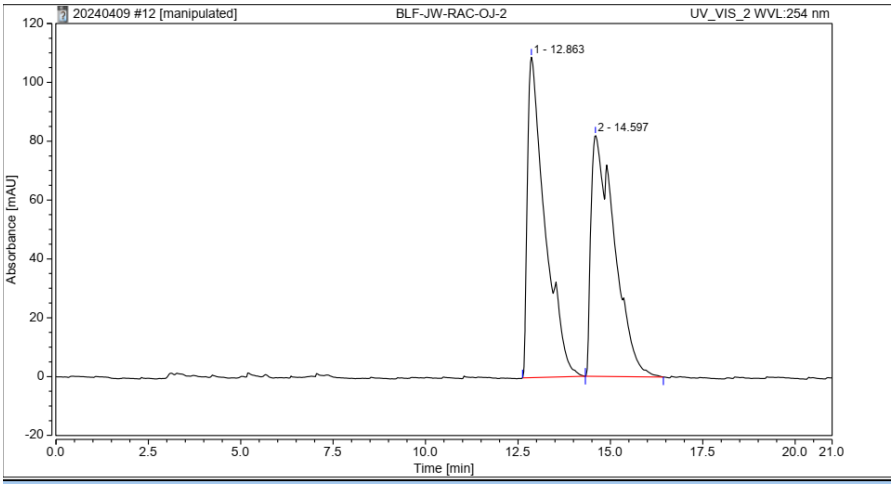

**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 6.523 | 304.183 | 1468.908 | 27.15 | 31.83 | n.a. |
| 2 | | 7.410 | 816.343 | 3145.788 | 72.85 | 68.17 | n.a. |
| **Total:** | | | **1120.526** | **4614.696** | **100.00** | **100.00** | |

**(*R*)-2-(4-isobutylphenyl)propanoic acid (5)**[6]

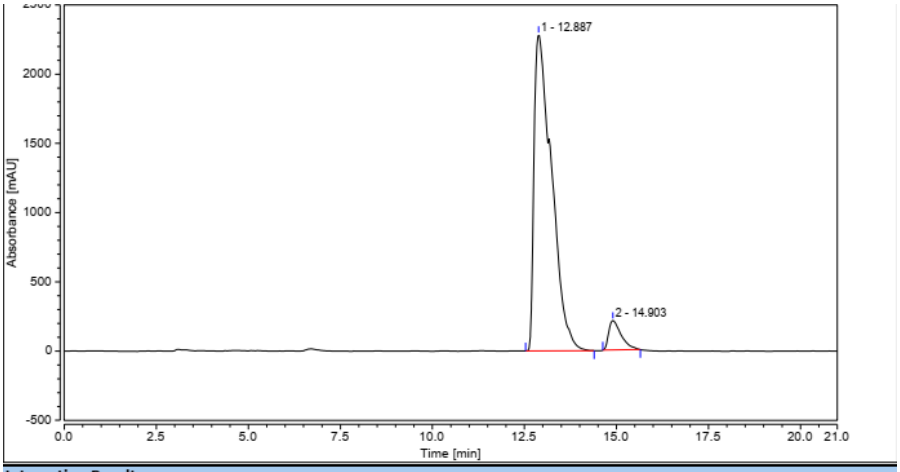


17.5 mg, 85% yield, white solid; $[\alpha]_D^{20}$ = –23.597 (c = 0.5 in $CHCl_3$); **$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 11.40 (s, 1H), 7.21 (d, $J$ = 7.7 Hz, 2H), 7.08 (d, $J$ = 7.7 Hz, 2H), 3.69 (q, $J$ = 7.3 Hz, 1H), 2.43 (d, $J$ = 7.2 Hz, 2H), 1.88-1.78 (m, 1H), 1.48 (d, $J$ = 7.2 Hz, 3H), 0.89 (d, $J$ = 6.5 Hz, 6H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) $\delta$ 181.3, 140.8, 137.0, 129.3, 127.3, 45.01, 44.99, 30.1, 22.4, 18.0; **HPLC** (Daicel Chiralpak OJ-H column, *n*-hexane/*i*-PrOH = 95/5, flow rate = 1.0 mL/min, 254 nm, 25 °C, retention time: $t_{major}$ = 12.887 min, $t_{minor}$ = 14.903 min, 94:6 e.r.).




**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 12.863 | 60.049 | 108.938 | 49.79 | 57.04 | n.a. |
| 2 | | 14.597 | 60.566 | 82.033 | 50.21 | 42.96 | n.a. |
| **Total:** | | | **120.615** | **190.971** | **100.00** | **100.00** | |




**Integration Results**

| No. | Peak Name | Retention Time min | Area mAU*min | Height mAU | Relative Area % | Relative Height % | Amount n.a. |
|---|---|---|---|---|---|---|---|
| 1 | | 12.887 | 1268.628 | 2284.842 | 93.79 | 91.48 | n.a. |
| 2 | | 14.903 | 84.007 | 212.778 | 6.21 | 8.52 | n.a. |
| **Total:** | | | **1352.634** | **2497.620** | **100.00** | **100.00** | |

## References


1. B. Xu, S.-F. Zhu, X.-D. Zuo, Z.-C. Zhang and Q.-L. Zhou, Enantioselective N-H Insertion Reaction of α-Aryl α-Diazoketones: An Efficient Route to Chiral α-Aminoketones, *Angew. Chem. Int. Ed.*, 2014**, 53**, 3913-3916.

2. Q. Lu, S. Mondal, S. Cembellín and F. Glorius, MnI/AgI Relay Catalysis: Traceless Diazo-Assisted C($sp^2$)–H/C($sp^3$)–H Coupling to β-(Hetero)Aryl/Alkenyl Ketones, *Angew. Chem. Int. Ed.*, 2018**, 57**, 10732-10736.

3. S. Cuesta-Galisteo, J. Schörgenhumer, C. Hervieu and C. Nevado, Dual Nickel/Photoredox-Catalyzed Asymmetric Carbamoylation of Benzylic C(sp3)-H Bonds, *Angew. Chem. Int. Ed.*, 2024, **63**, e202313717.

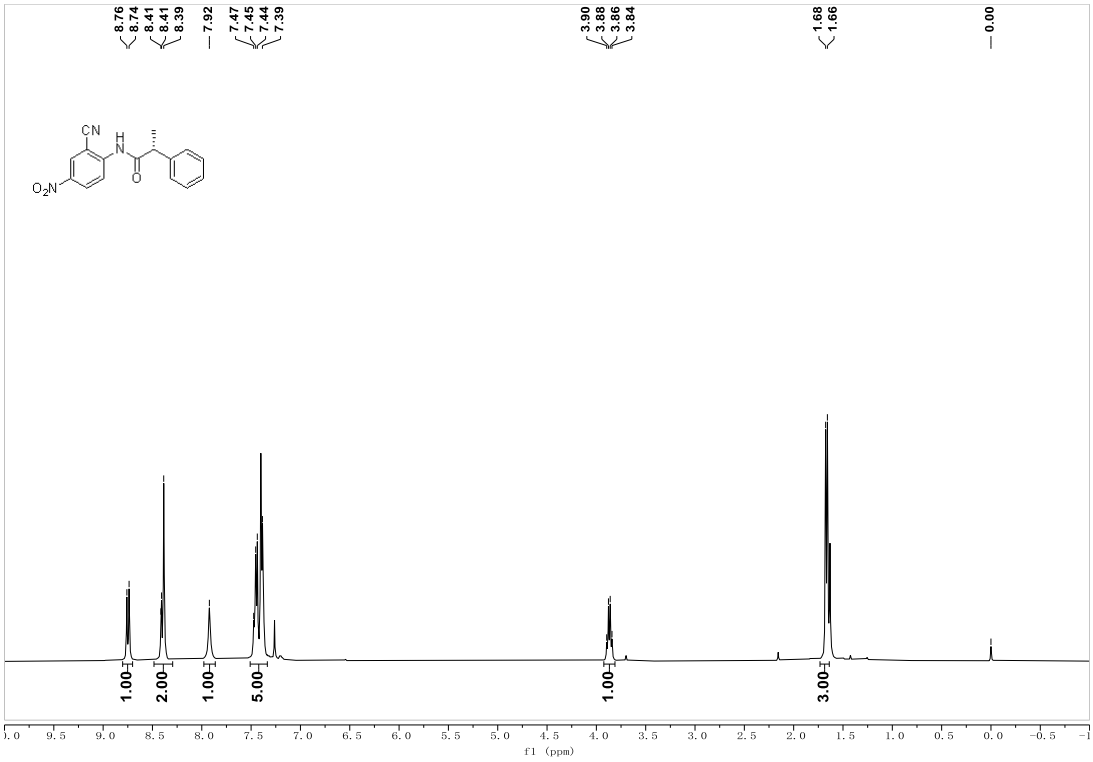
4. J.-B. Pan, Z.-C. Yang, X.-G. Zhang, M.-L. Li and Q.-L. Zhou, Enantioselective Synthesis of Chiral Amides by a Phosphoric Acid Catalyzed Asymmetric Wolff Rearrangement, *Angew. Chem. Int. Ed.*, 2023, **62**, e202308122.

5. T. Kubota, N. Sawada, L.-L. Zhou and C. J. Welch, Enantioseparation of benzazoles and benzanilides on polysaccharide-based chiral columns, *Chirality*, 2009, **22**, 382-388.

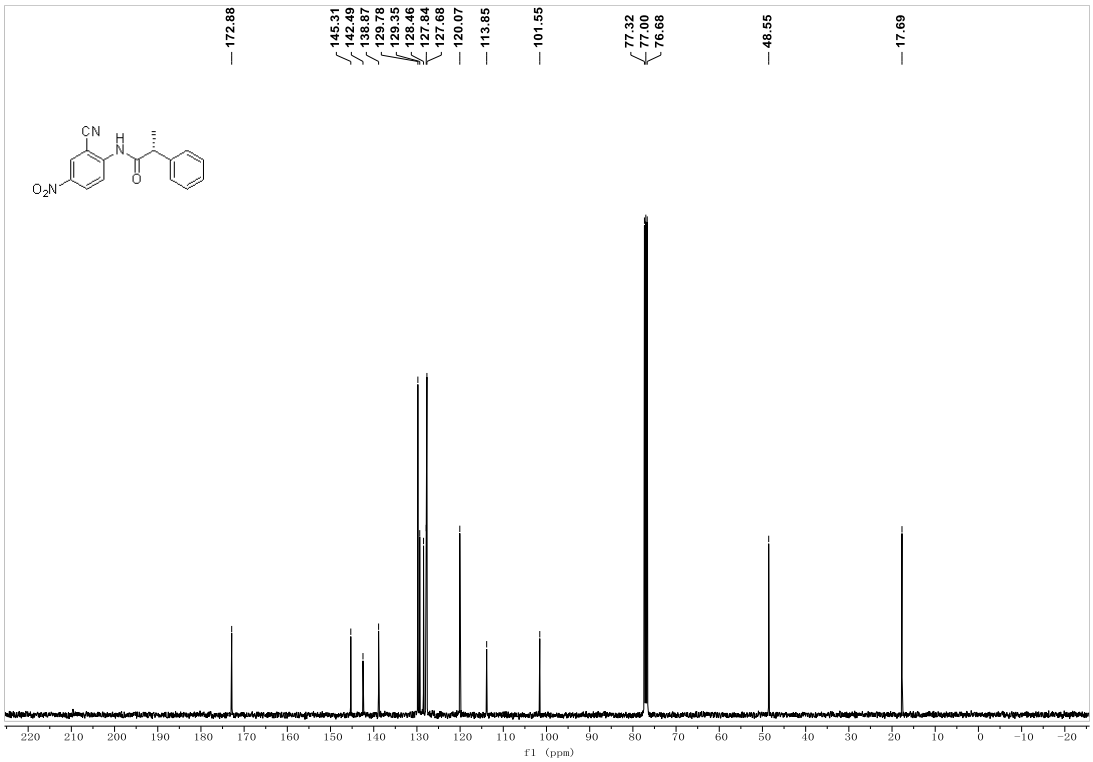
6. Y.-H. Yao, H.-Y. Yang, M. Chen, F. Wu, X.-X. Xu and Z.-H. Guan, Asymmetric Markovnikov Hydroaminocarbonylation of Alkenes Enabled by Palladium-Monodentate Phosphoramidite Catalysis, *J. Am. Chem. Soc.*, 2021, **143**, 85−91.

## 5. NMR Spectra

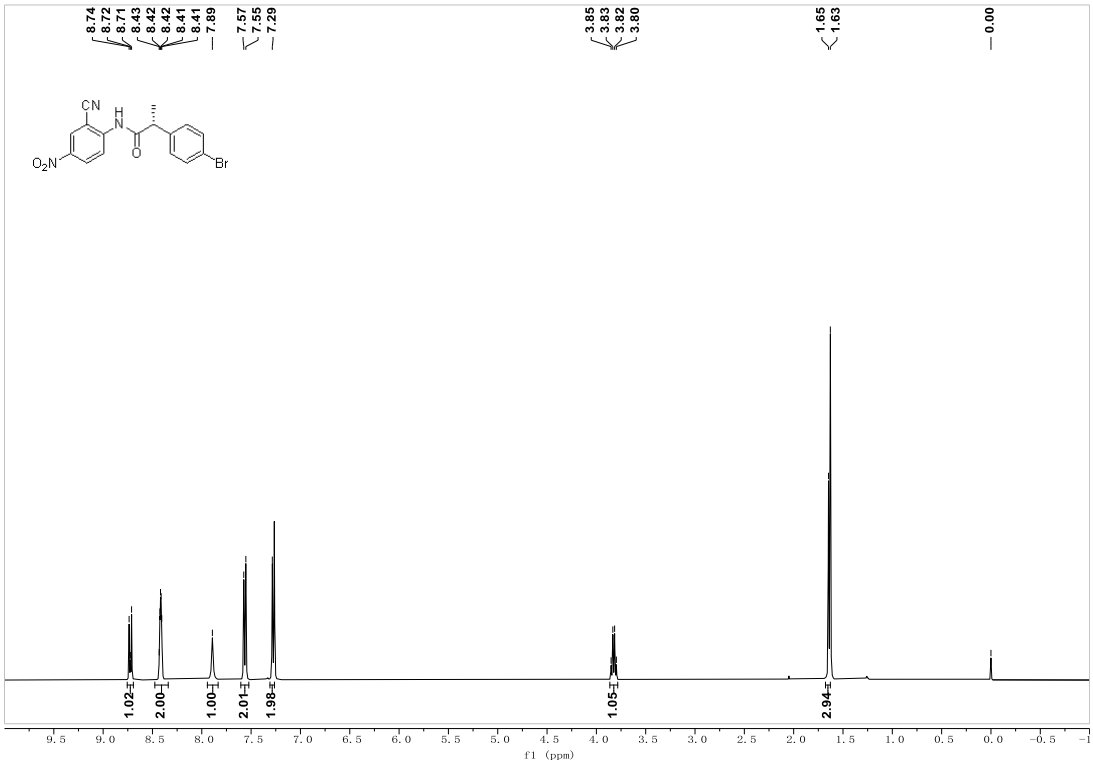
$^{1}$H NMR spectrum of compound (**3aa**)



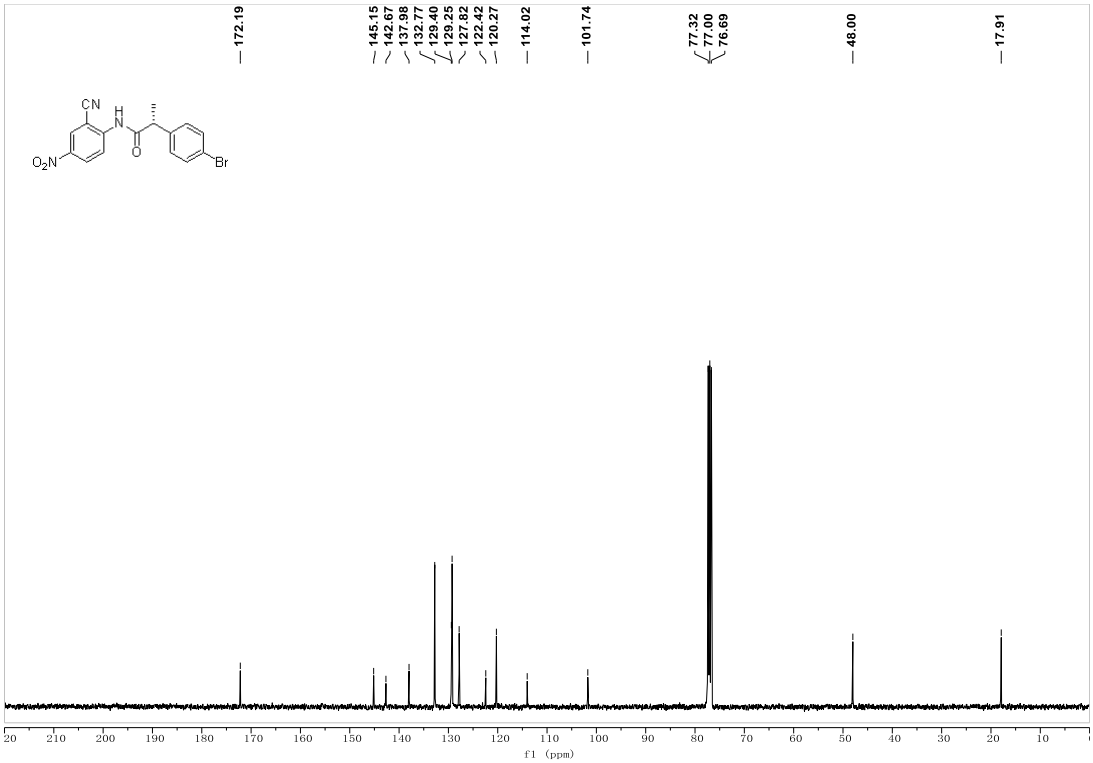

$^{13}$C NMR spectrum of compound (**3aa**)



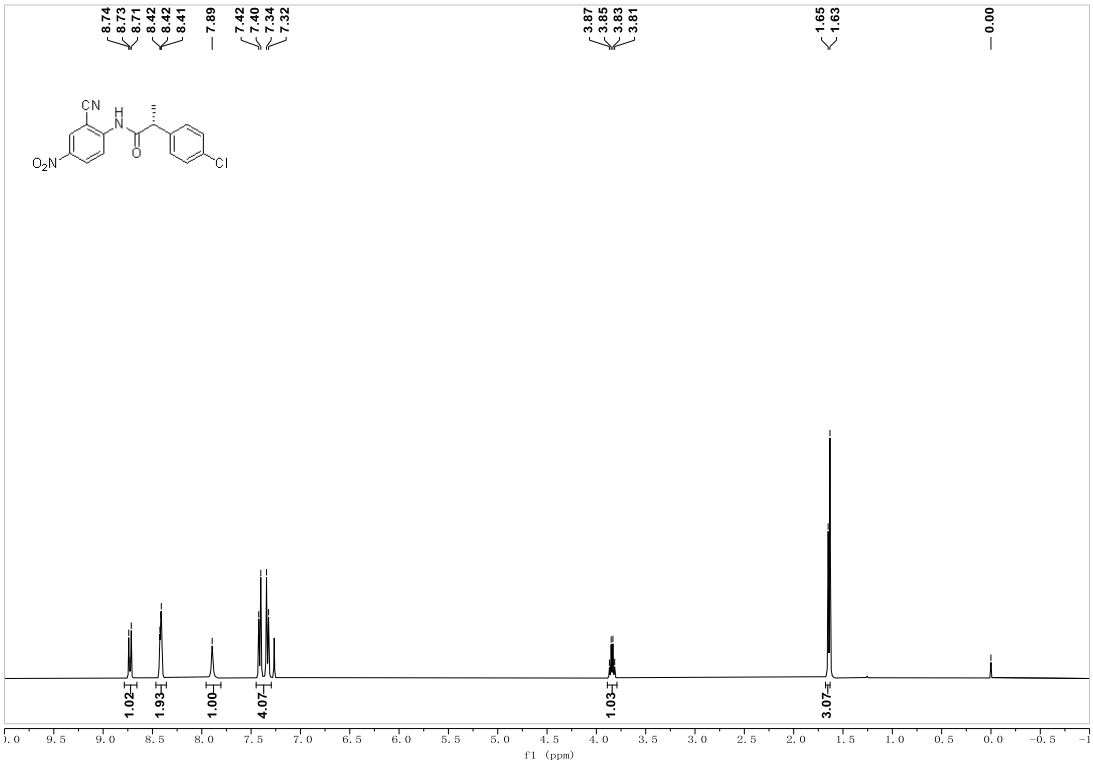
$^{1}$H NMR spectrum of compound (**3ab**)



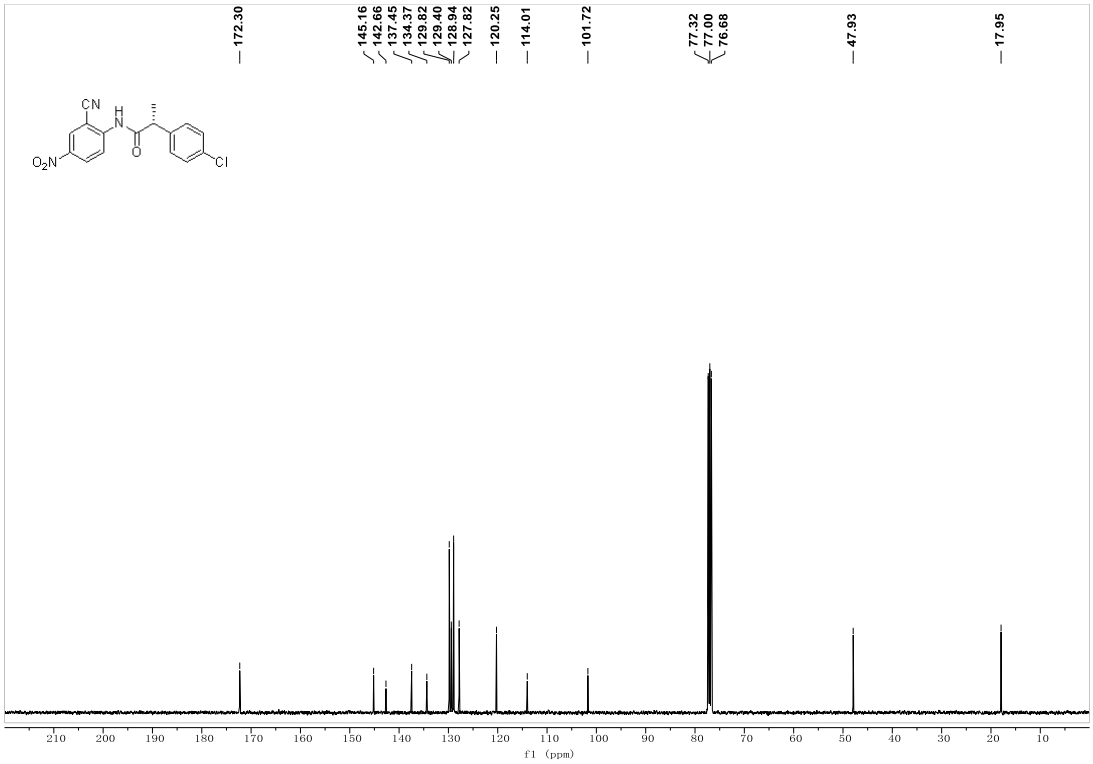

$^{13}$C NMR spectrum of compound (**3ab**)



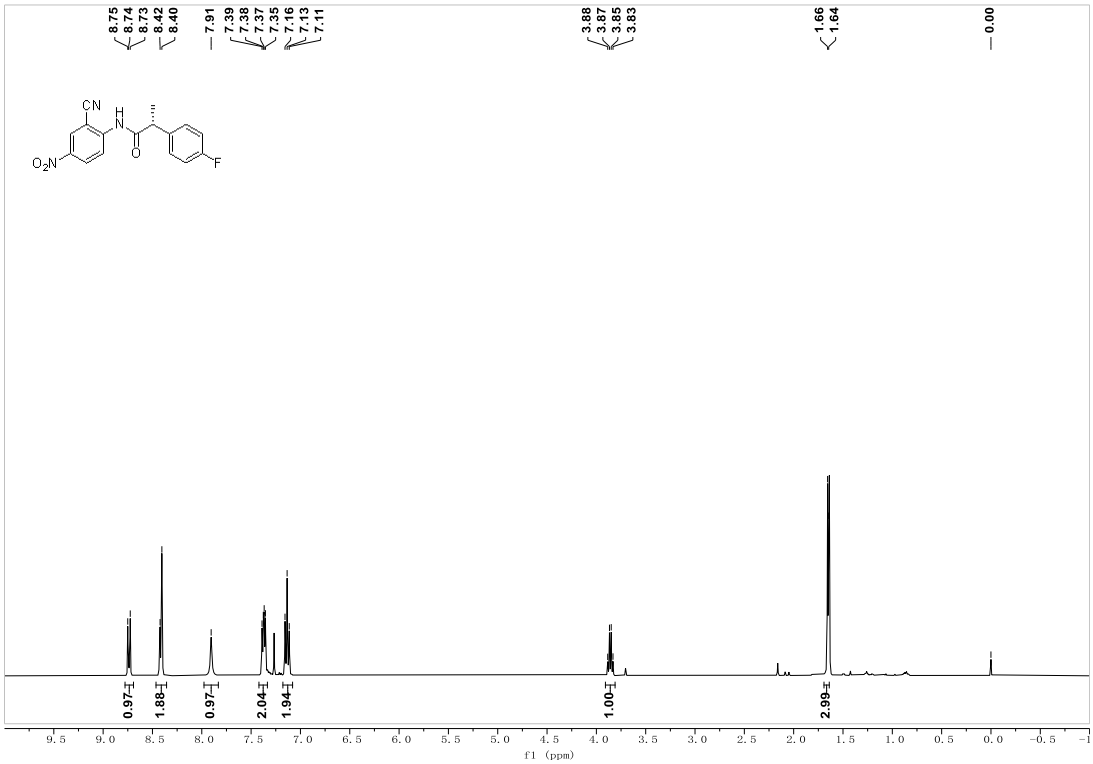
$^{1}$H NMR spectrum of compound (**3ac**)



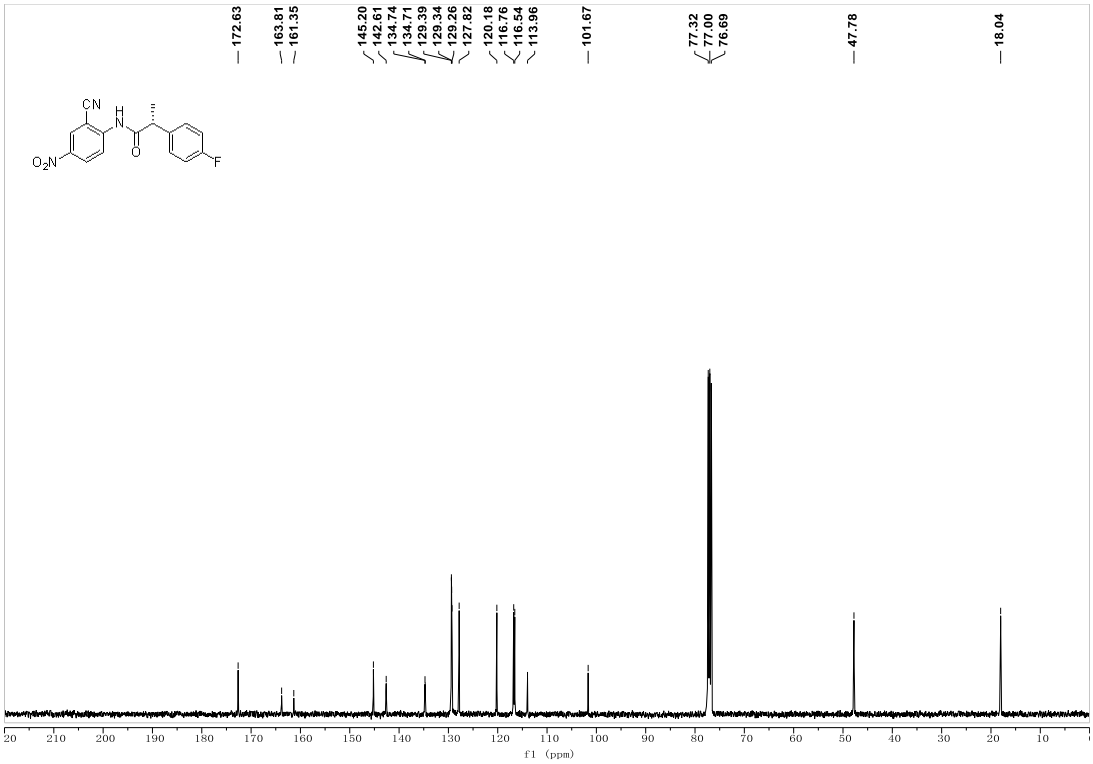

$^{13}$C NMR spectrum of compound (**3ac**)



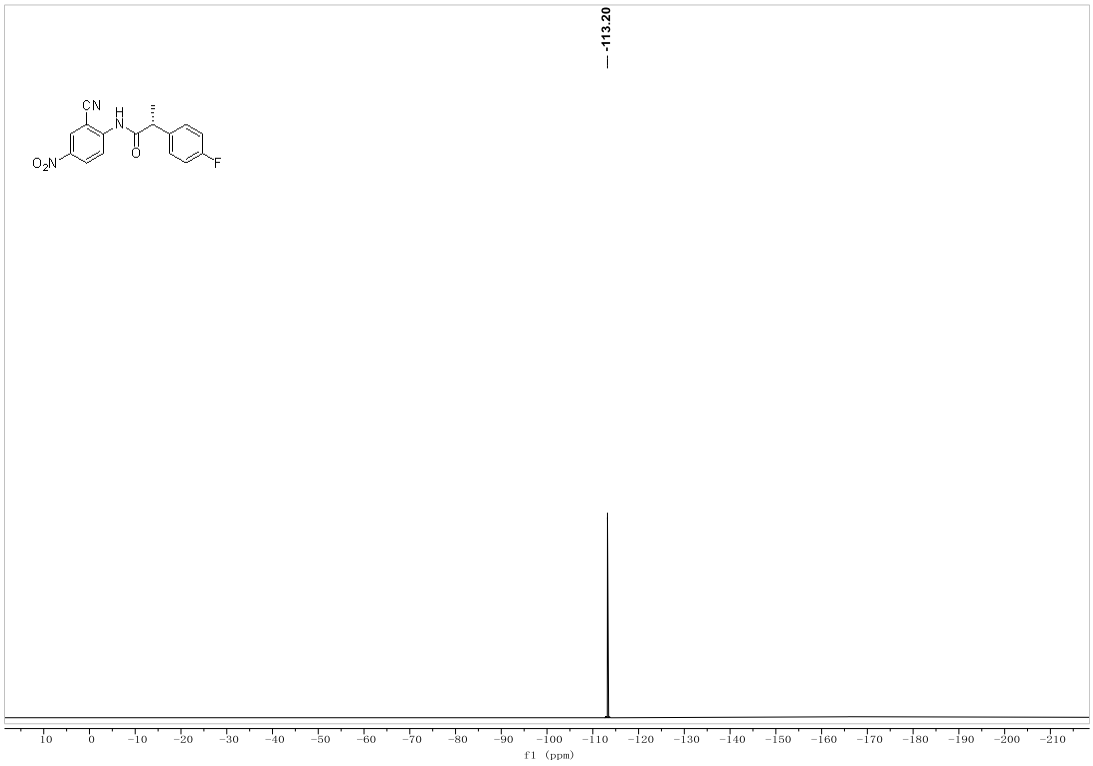
$^{1}$H NMR spectrum of compound (**3ad**)



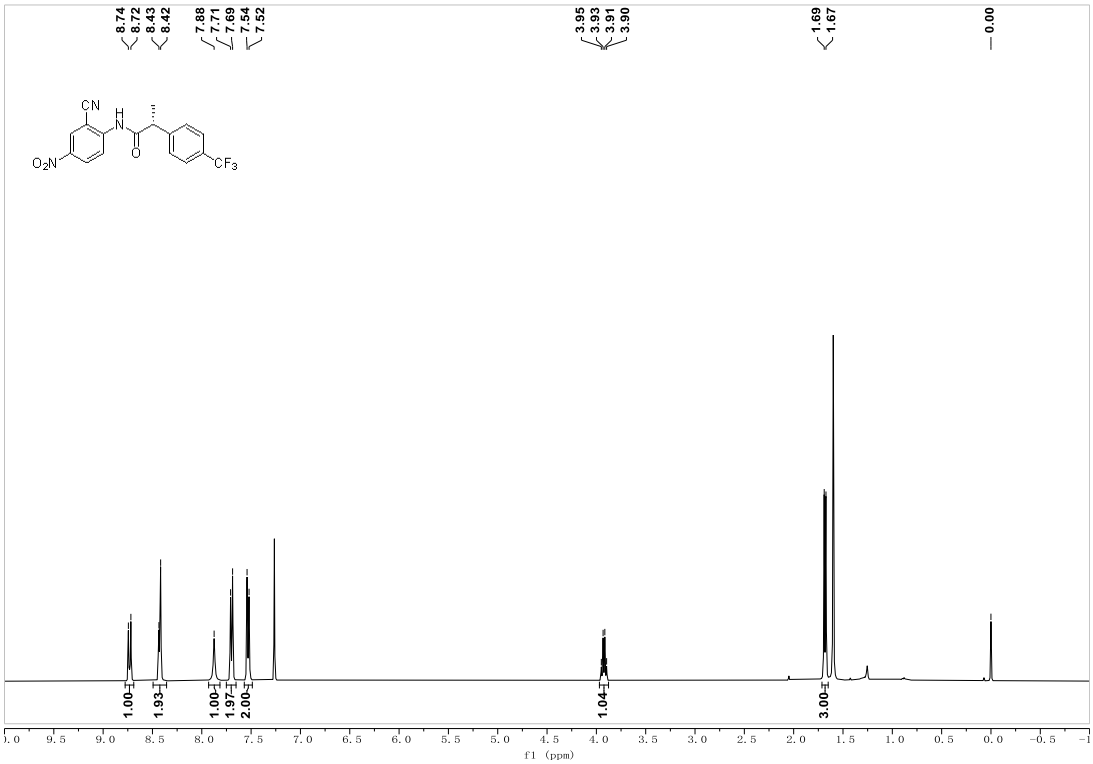

$^{13}$C NMR spectrum of compound (**3ad**)



$^{19}$F NMR spectrum of compound (**3ad**)



$^{1}$H NMR spectrum of compound (**3ae**)

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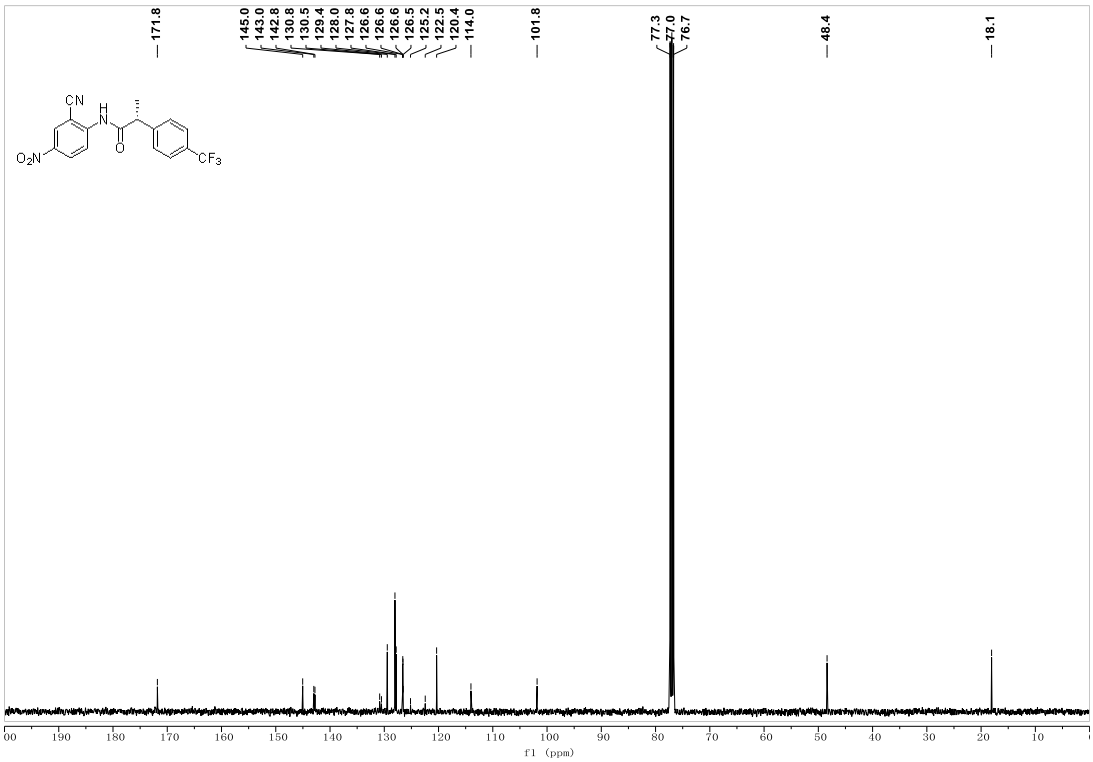
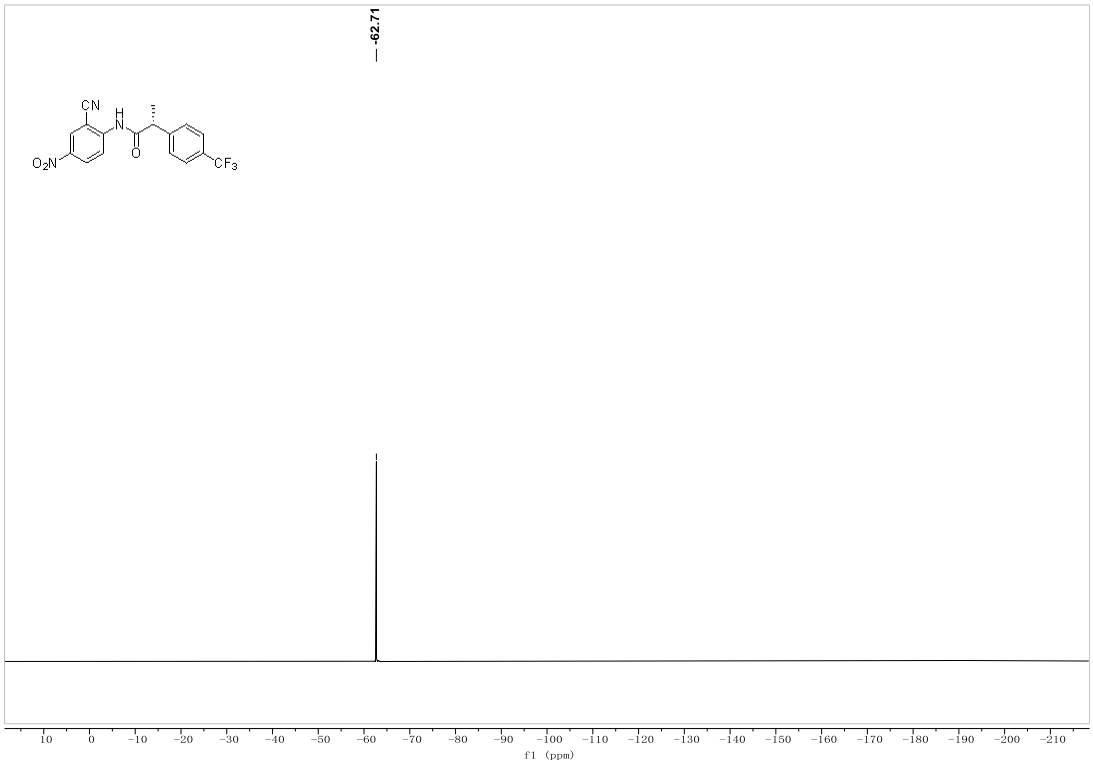
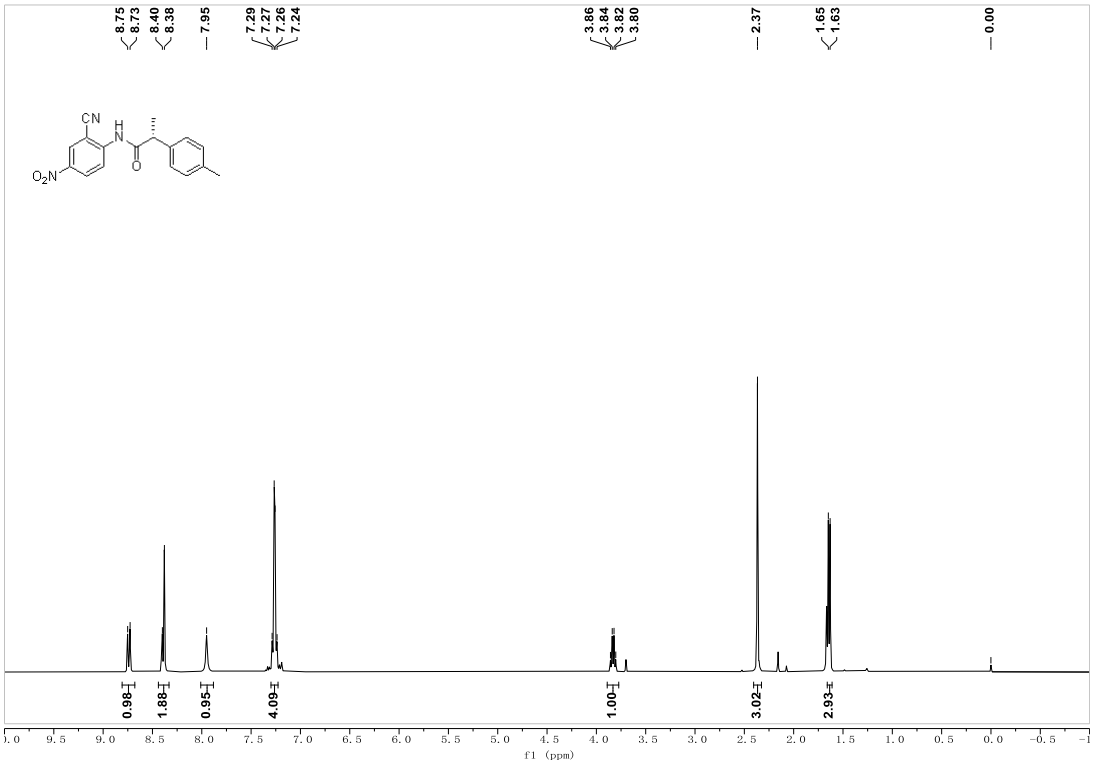


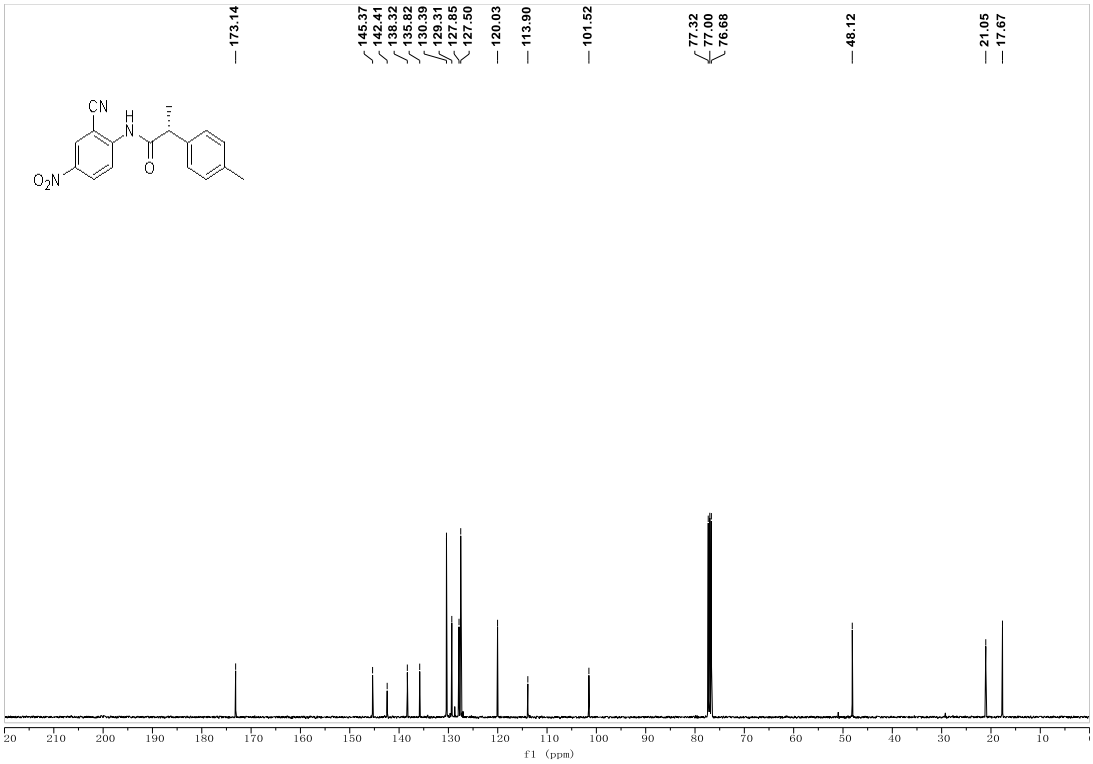
$^{19}$F NMR spectrum of compound (**3ae**)



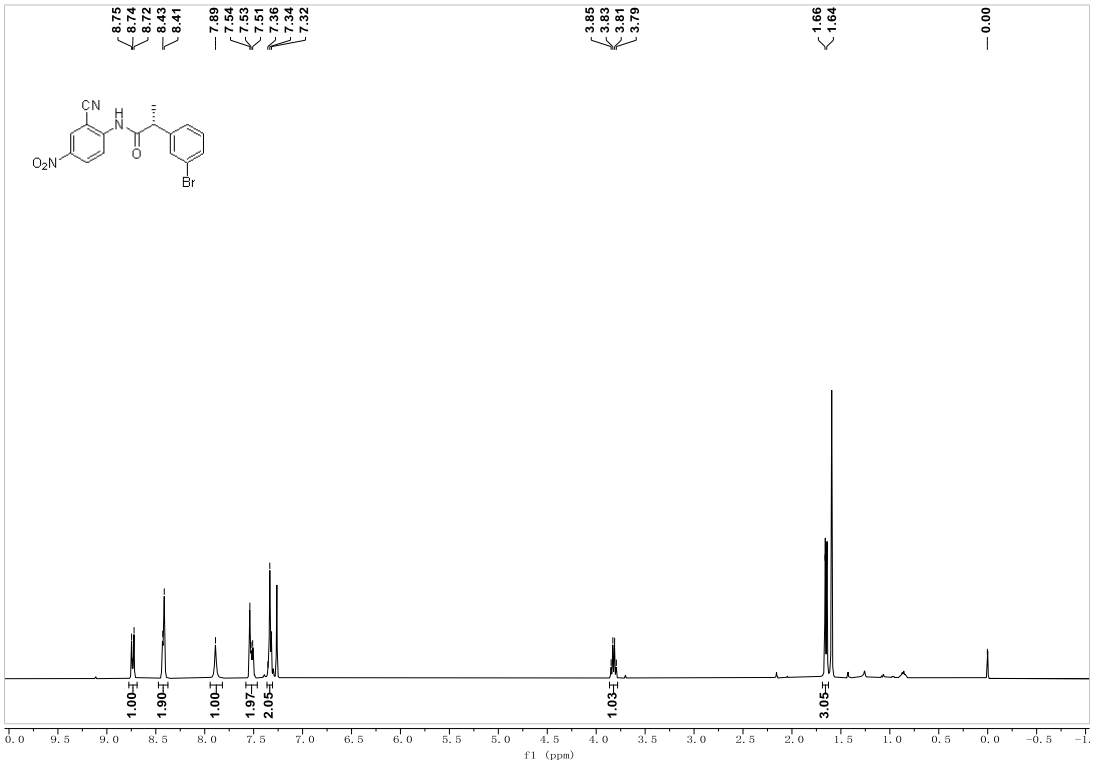
$^{1}$H NMR spectrum of compound (**3af**)



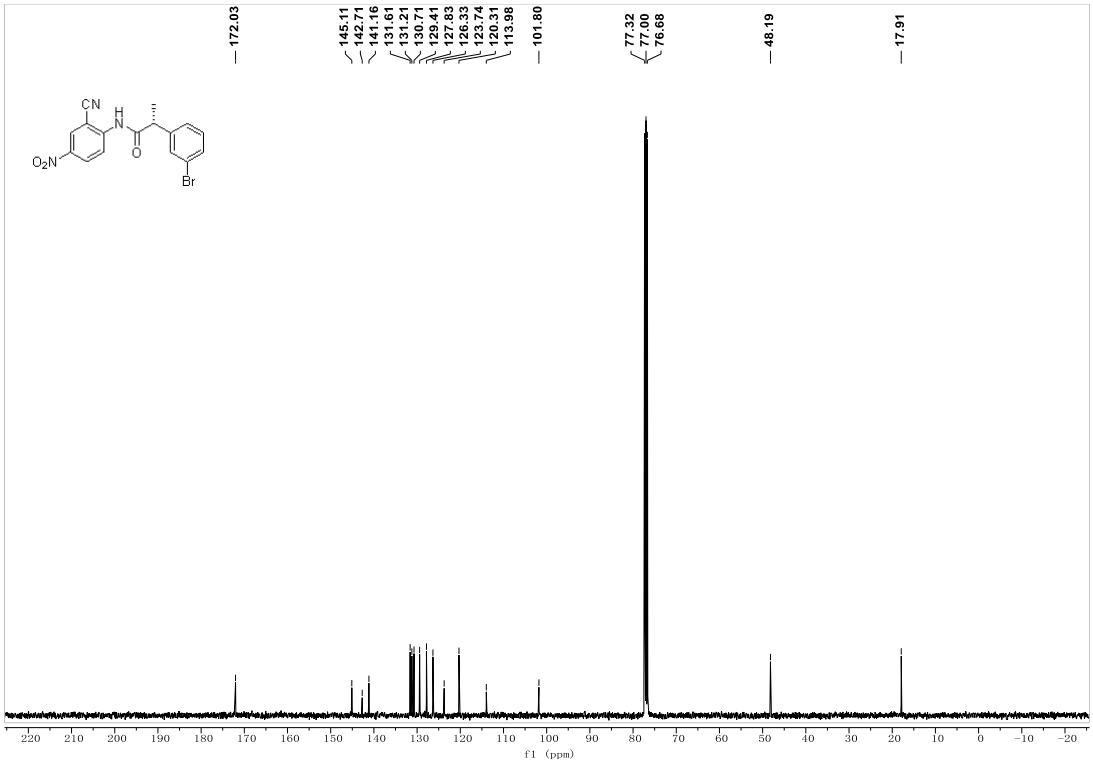

$^{13}$C NMR spectrum of compound (**3af**)



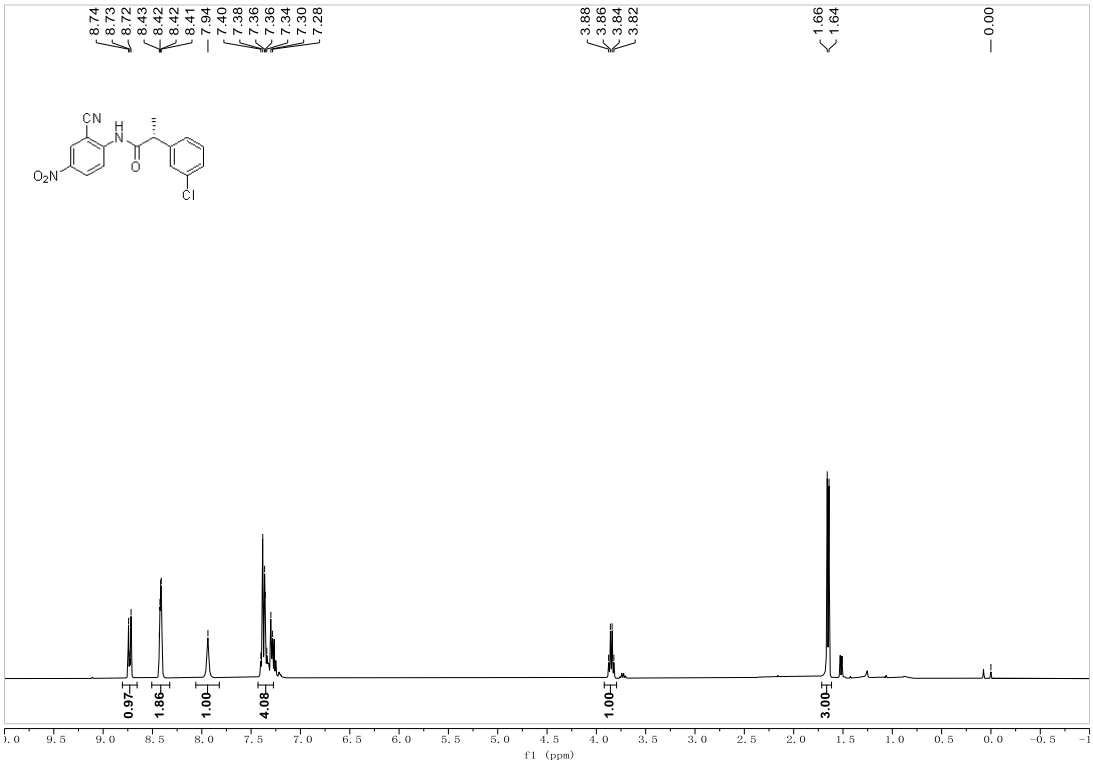
$^{1}$H NMR spectrum of compound (**3ag**)



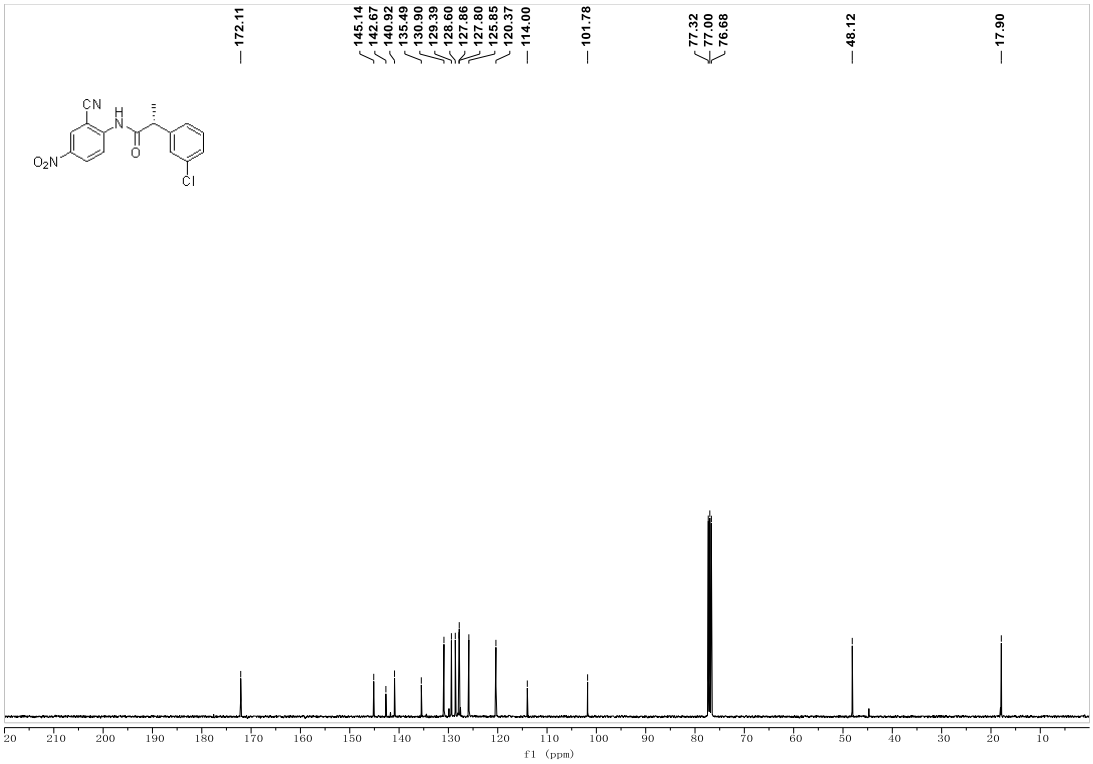

$^{13}$C NMR spectrum of compound (**3ag**)



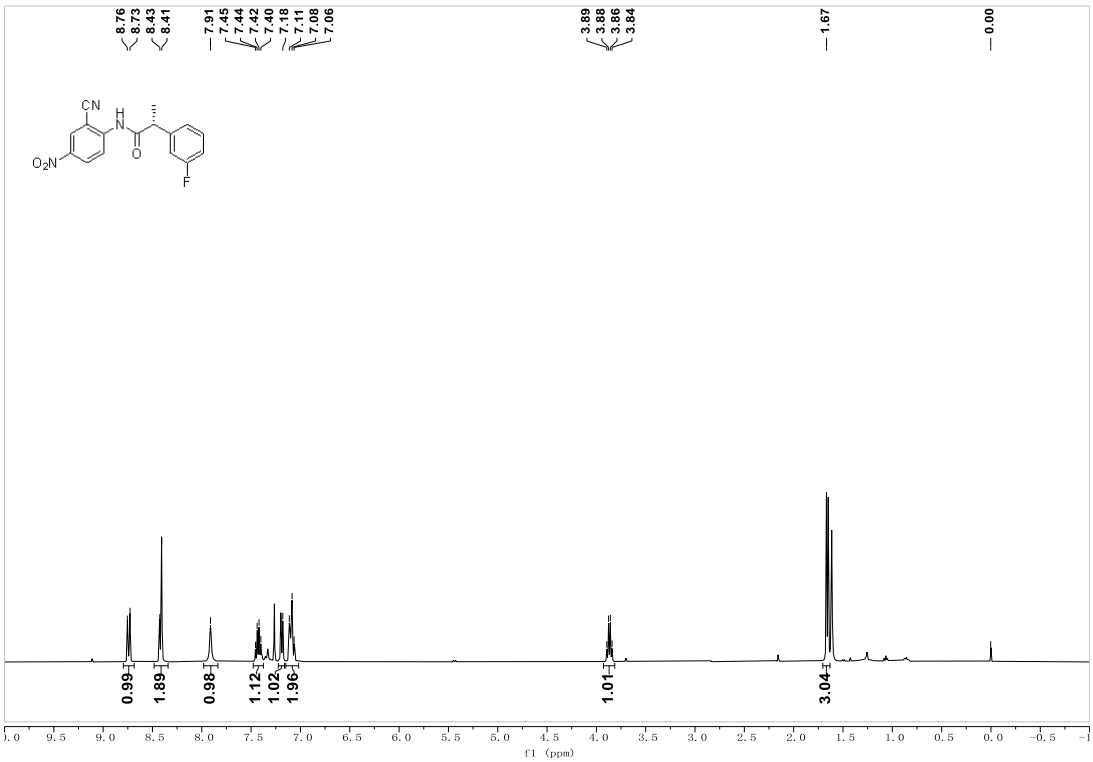
$^{1}$H NMR spectrum of compound (**3ah**)




$^{13}$C NMR spectrum of compound (**3ah**)



$^{1}$H NMR spectrum of compound (**3ai**)

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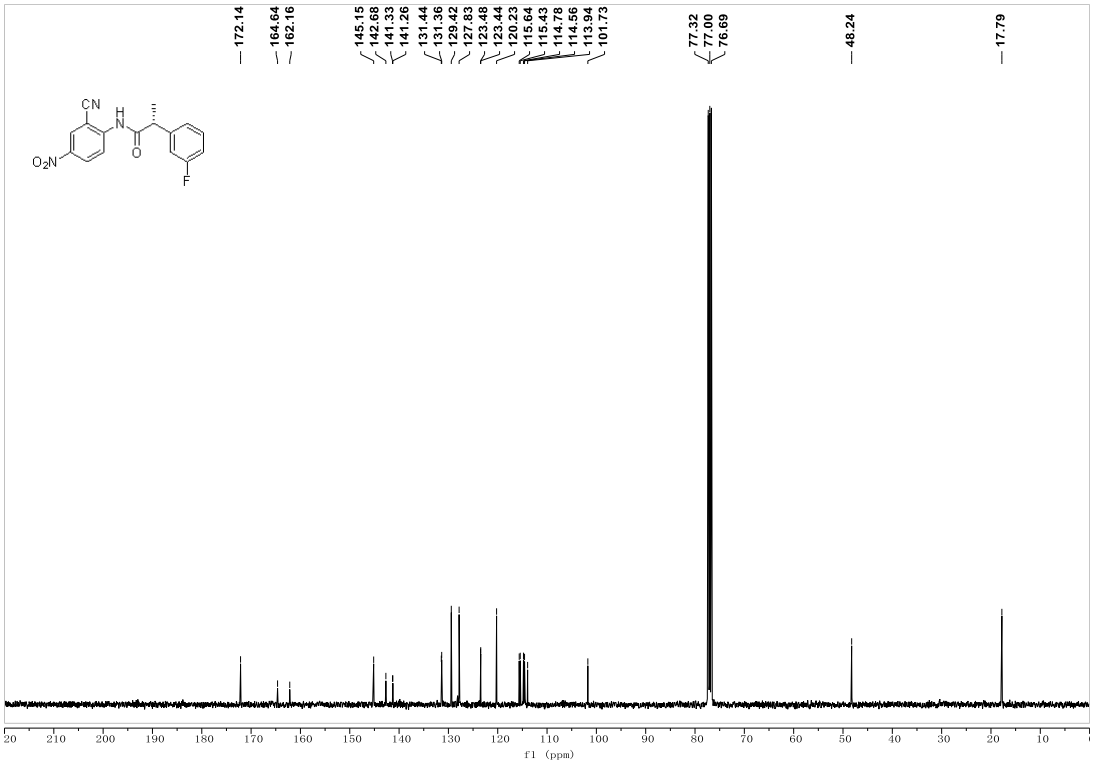
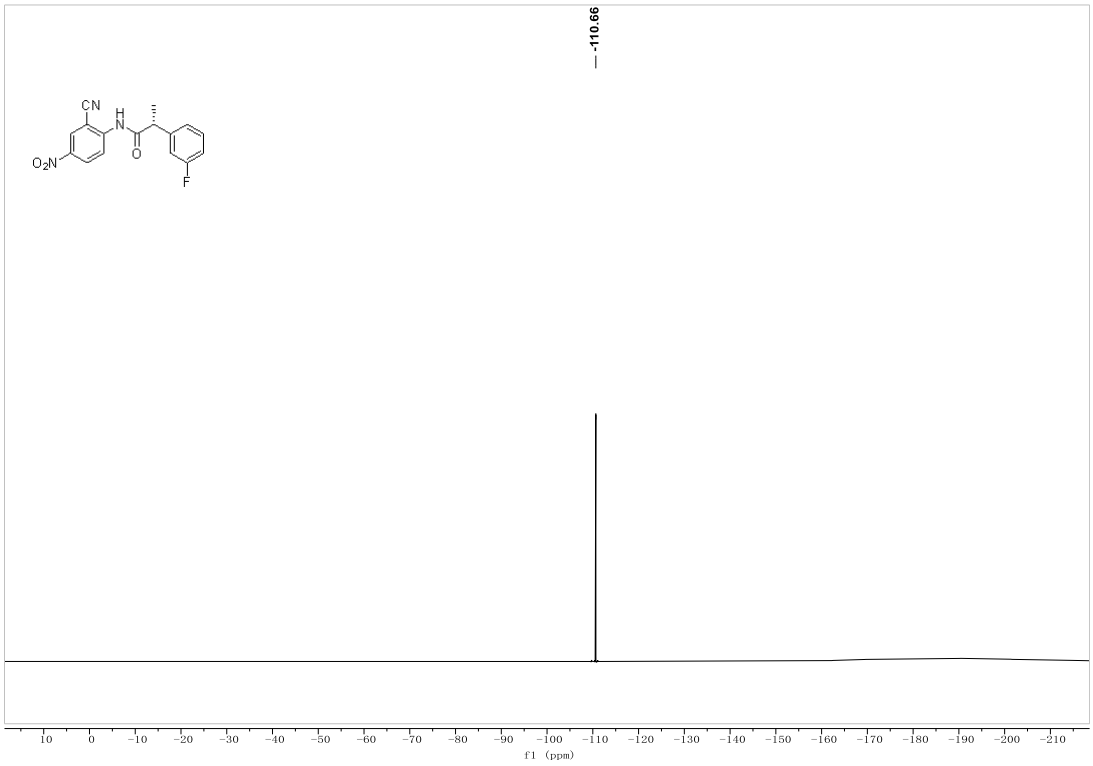


$^{19}$F NMR spectrum of compound (**3ai**)



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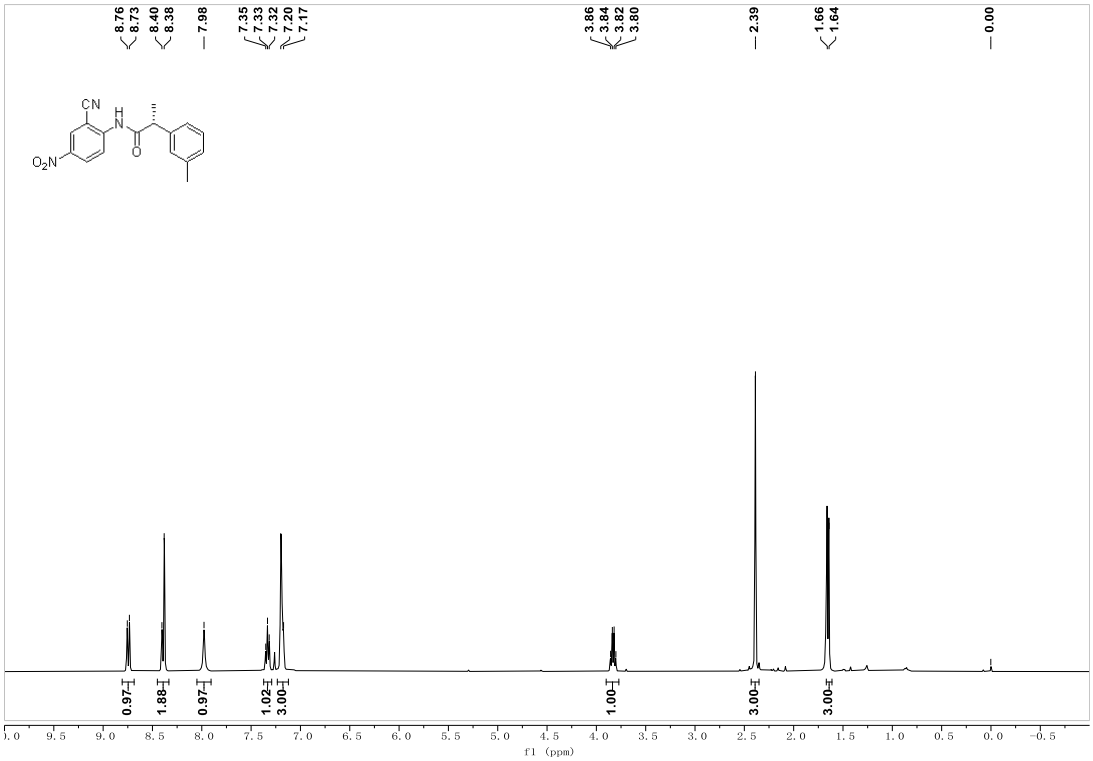


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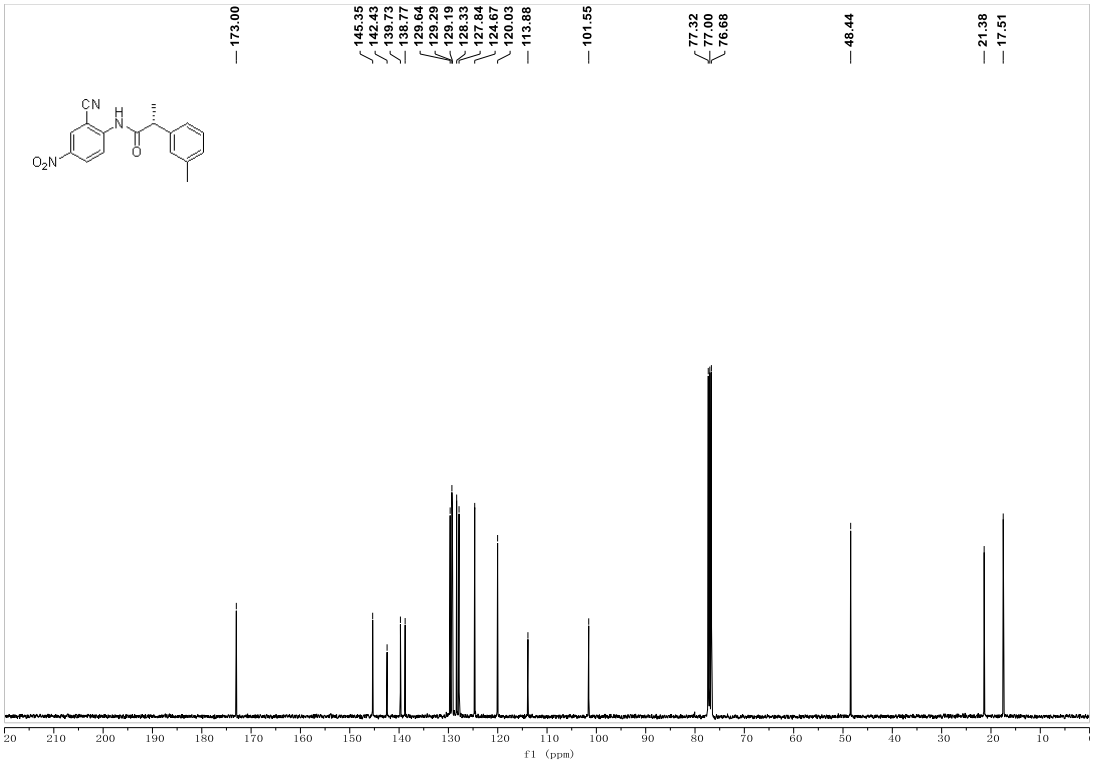

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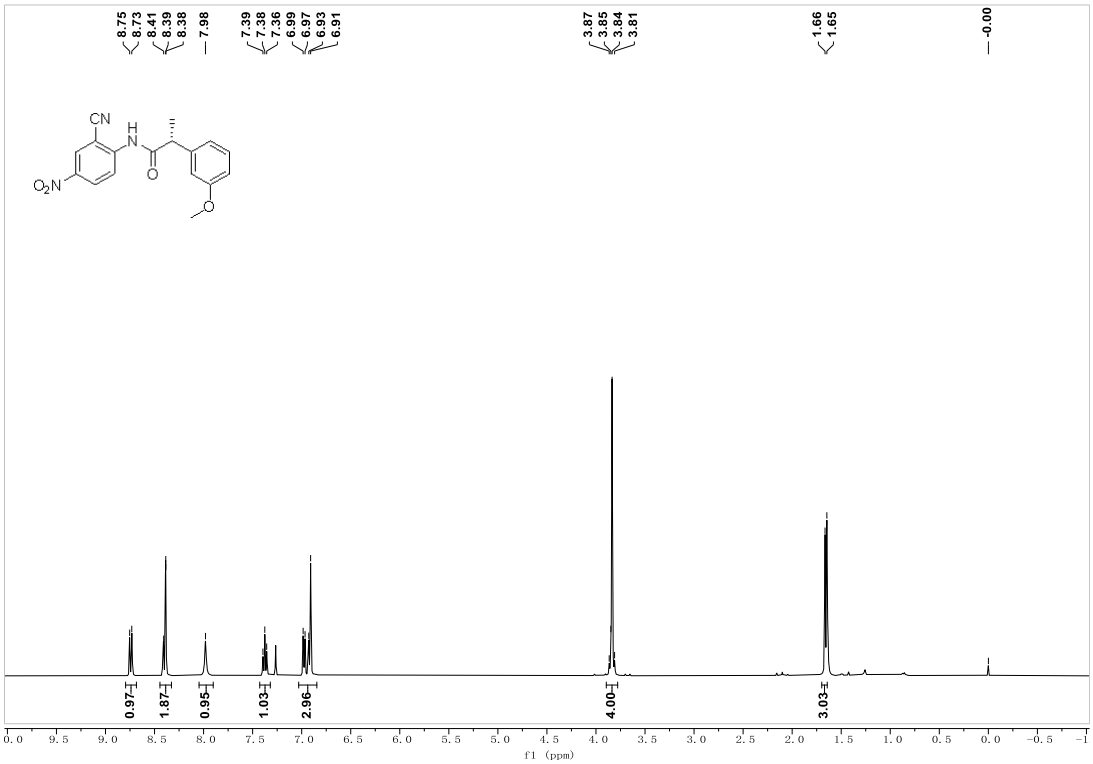


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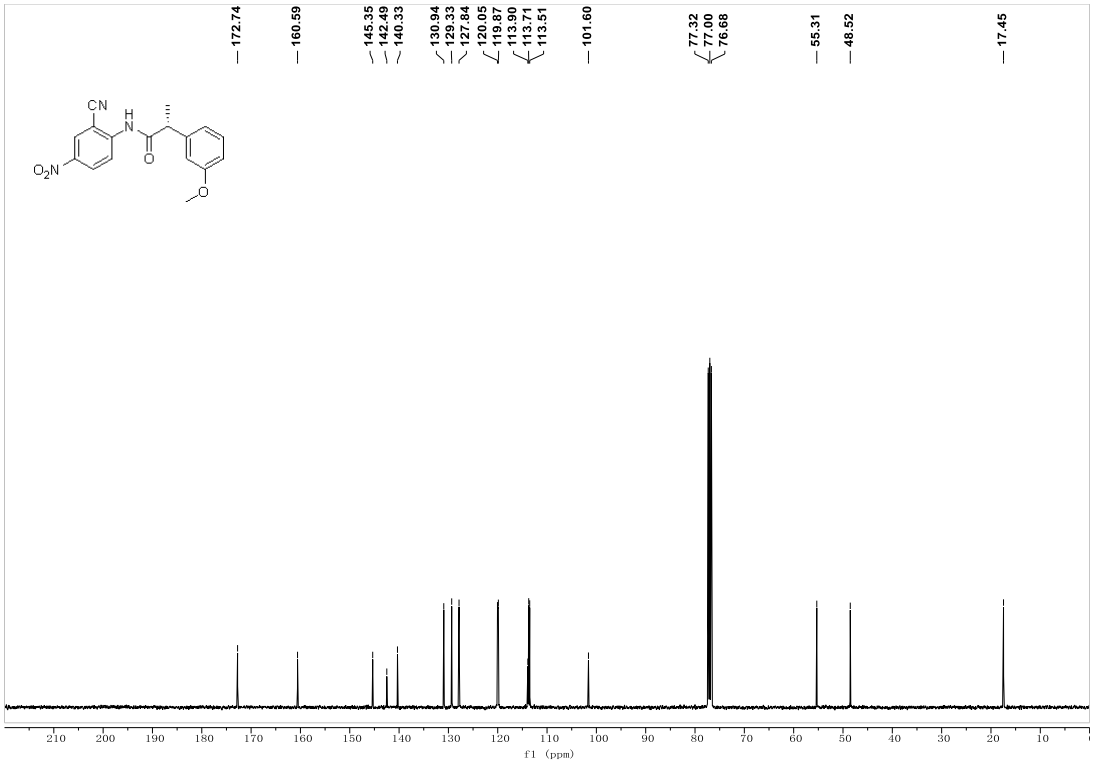

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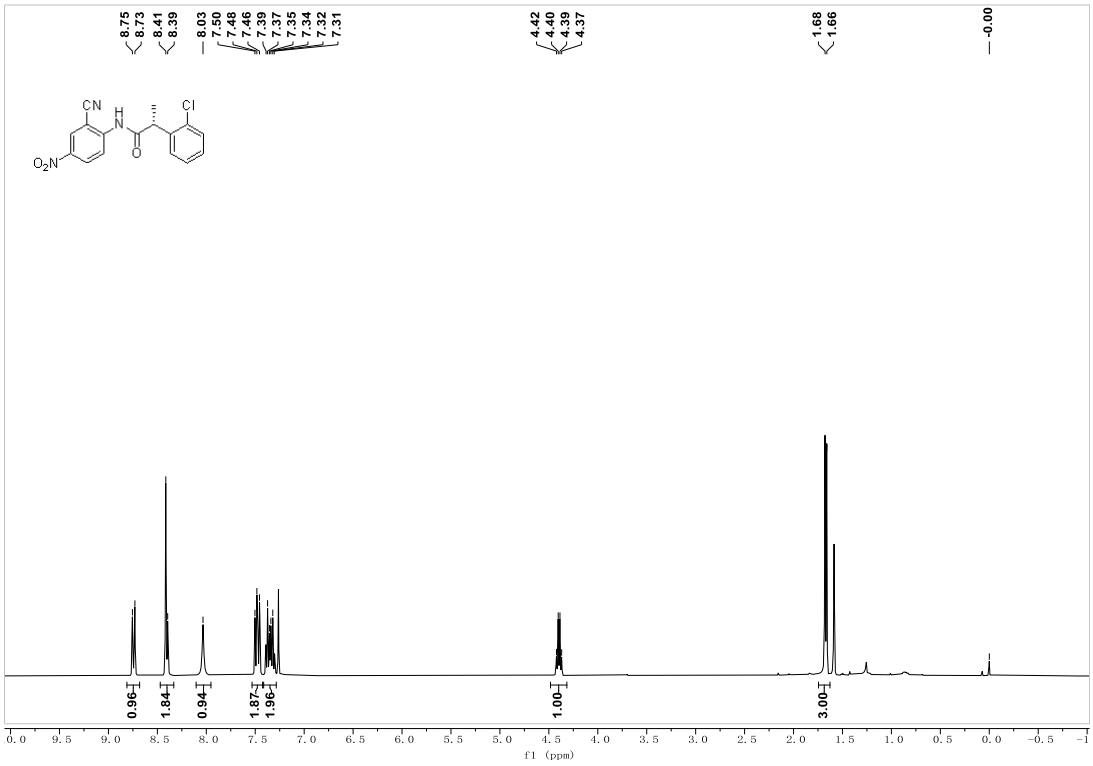
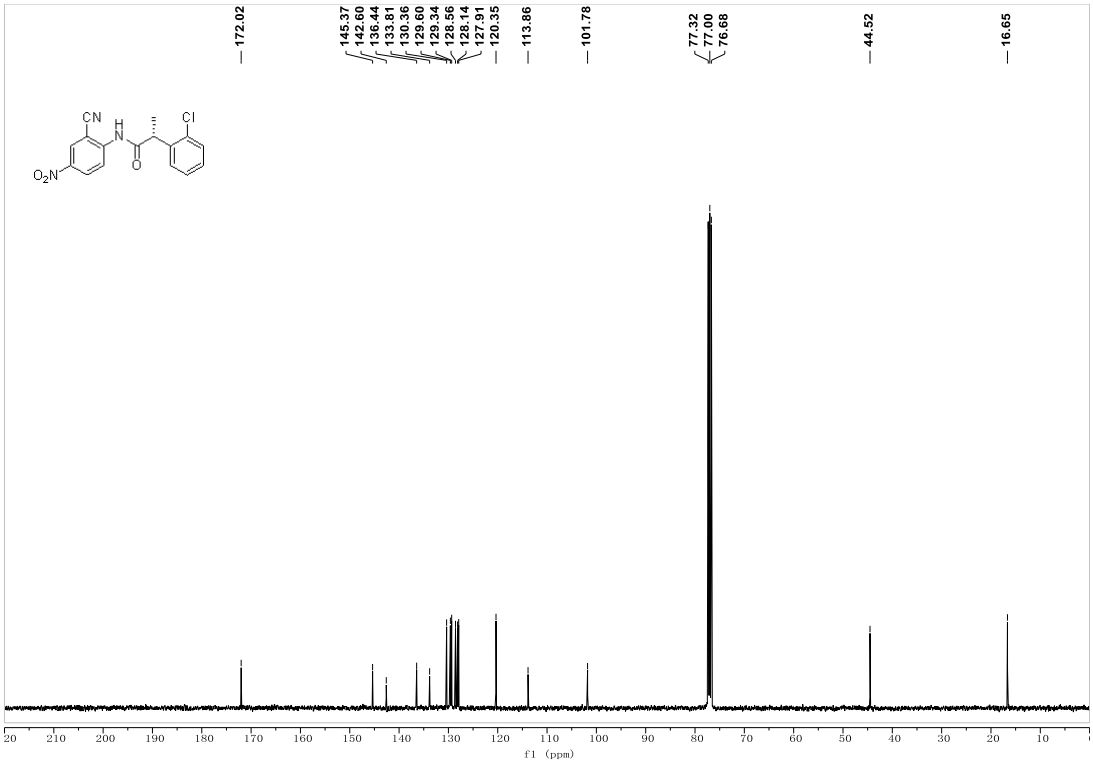



$^{13}$C NMR spectrum of compound (**3al**)



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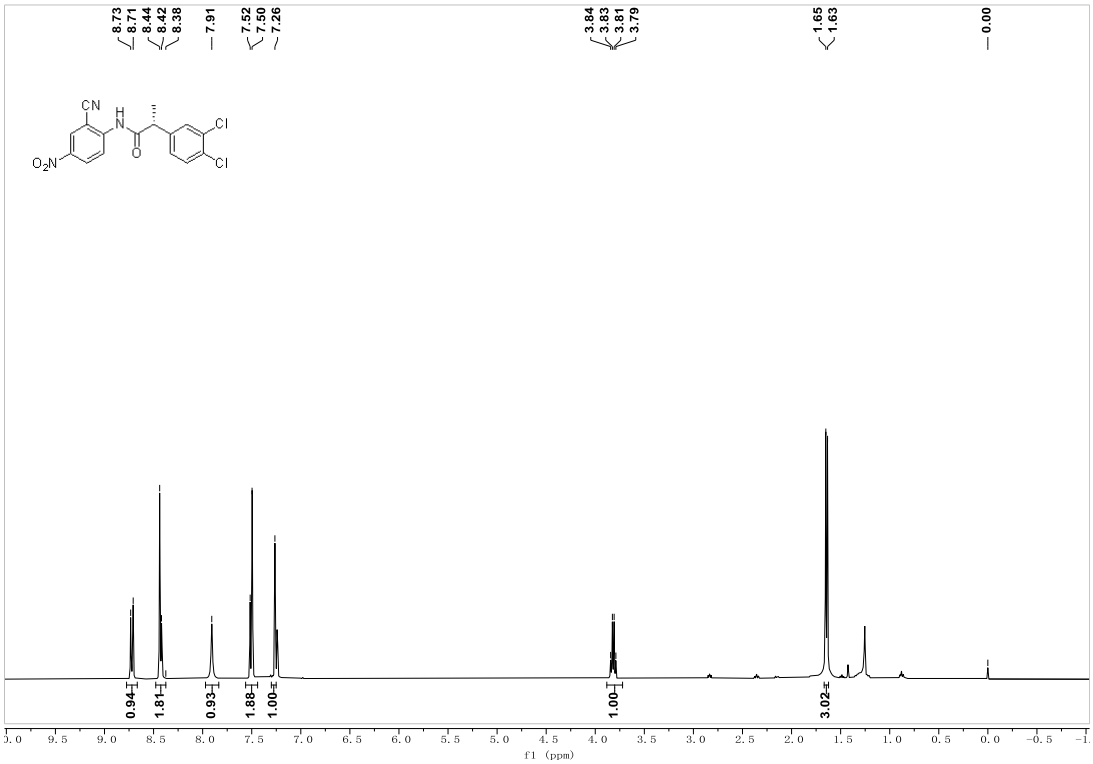
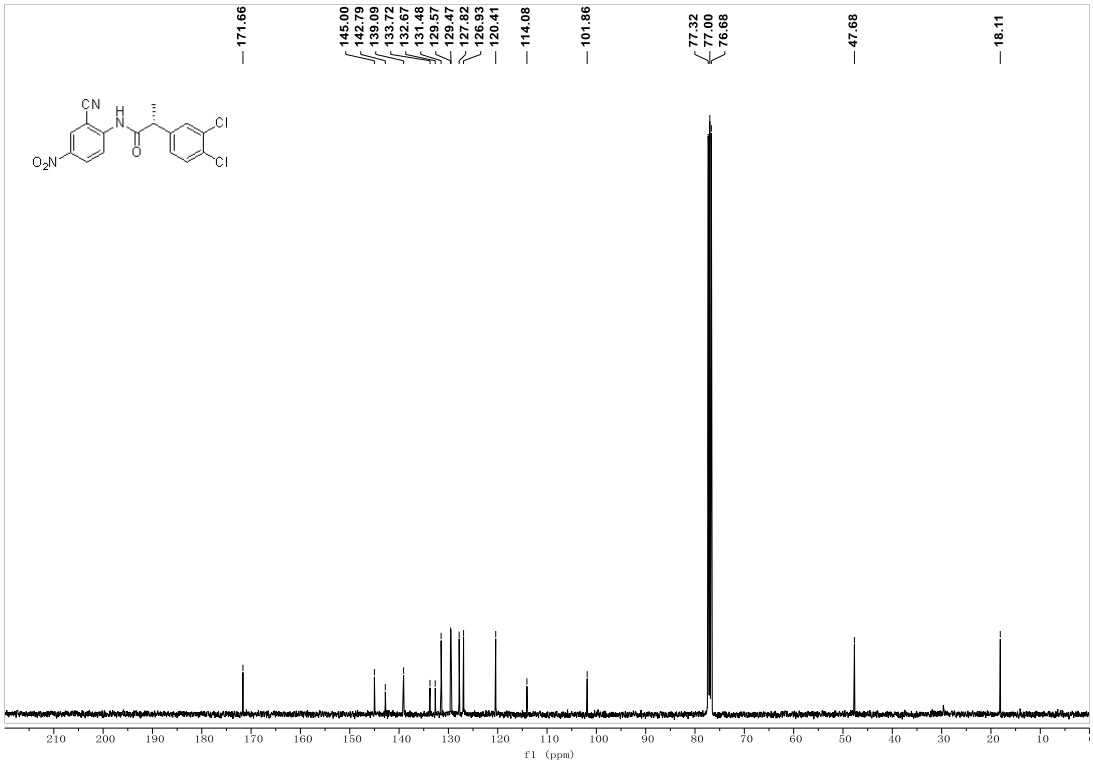



$^{13}$C NMR spectrum of compound (**3am**)



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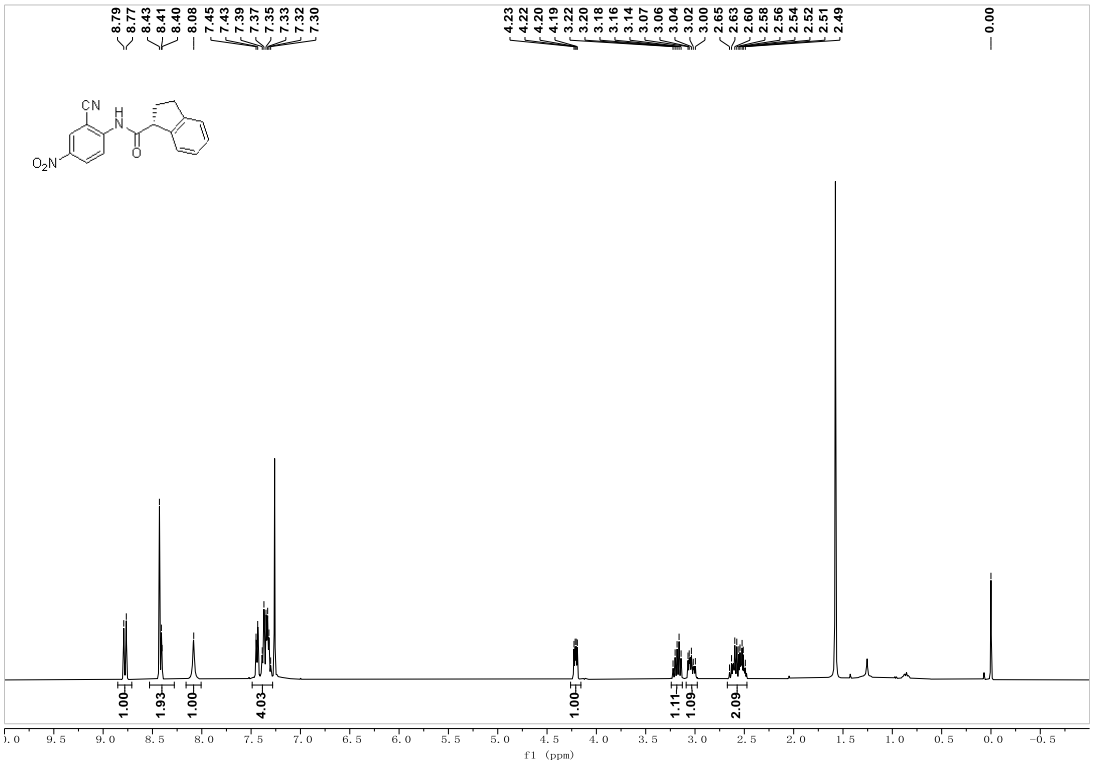


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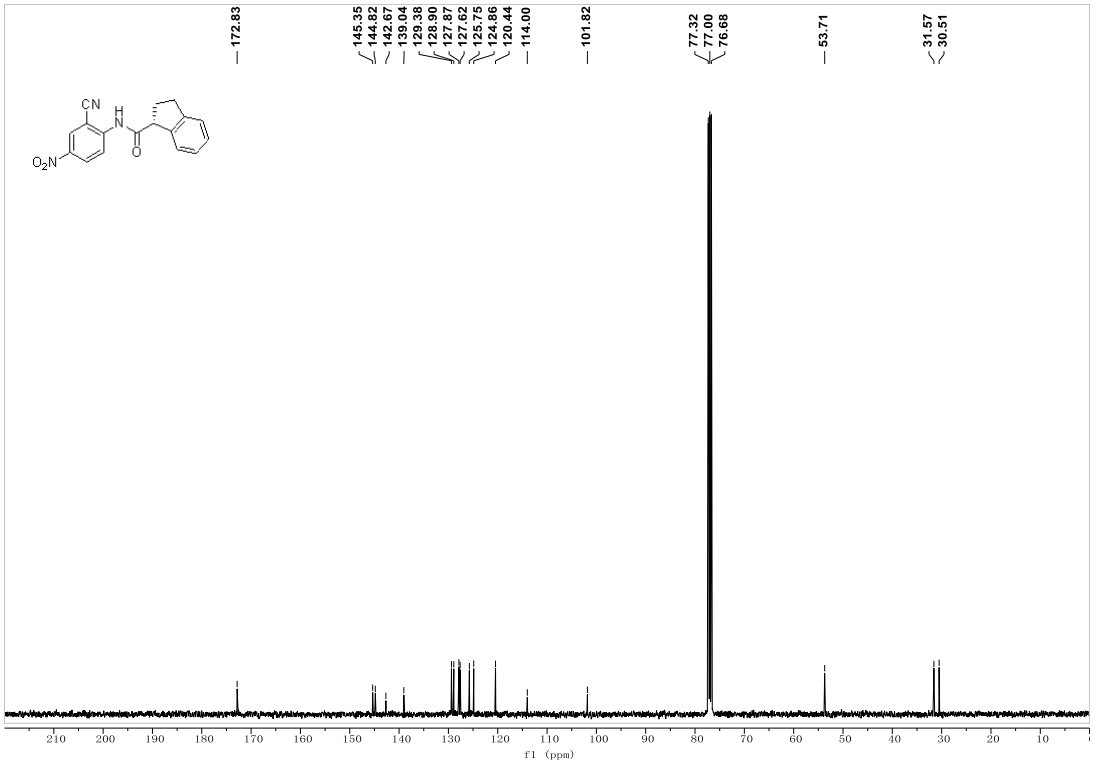

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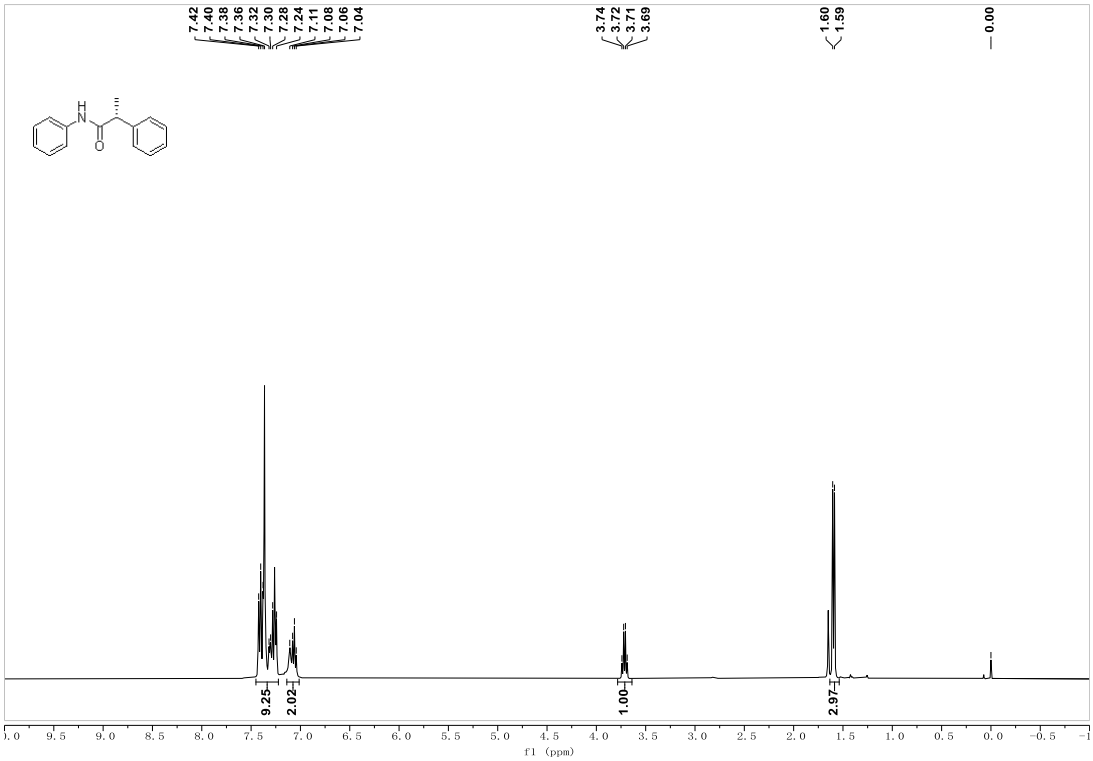


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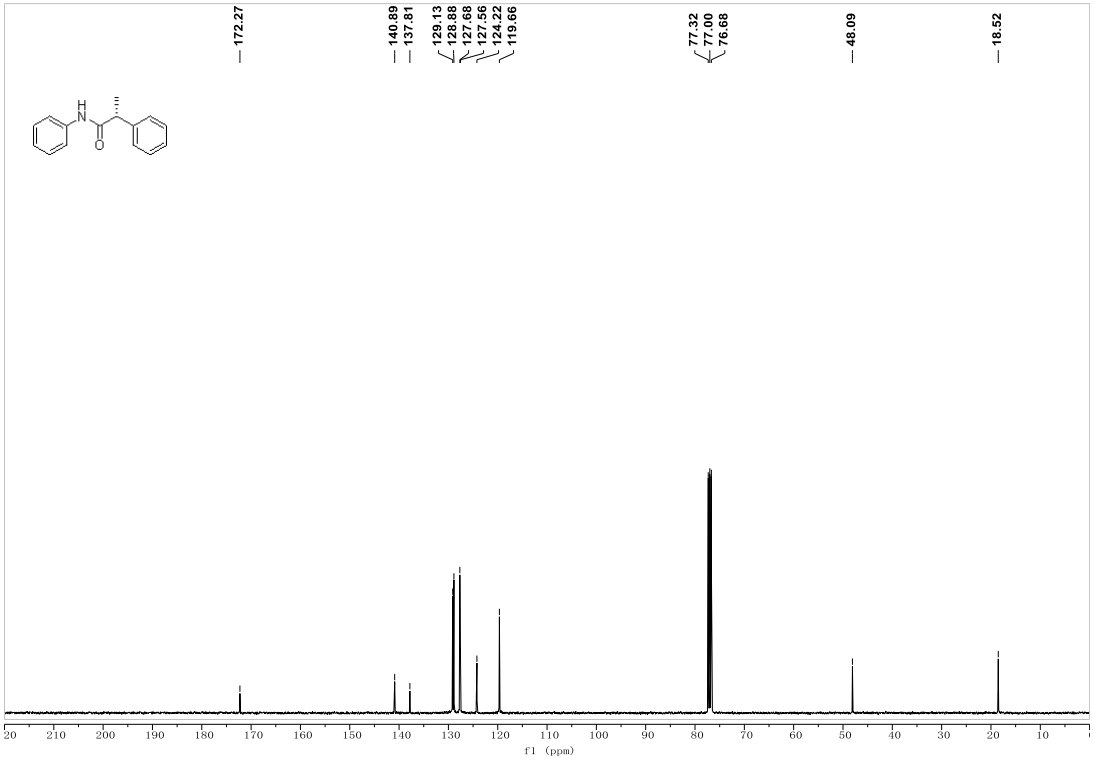

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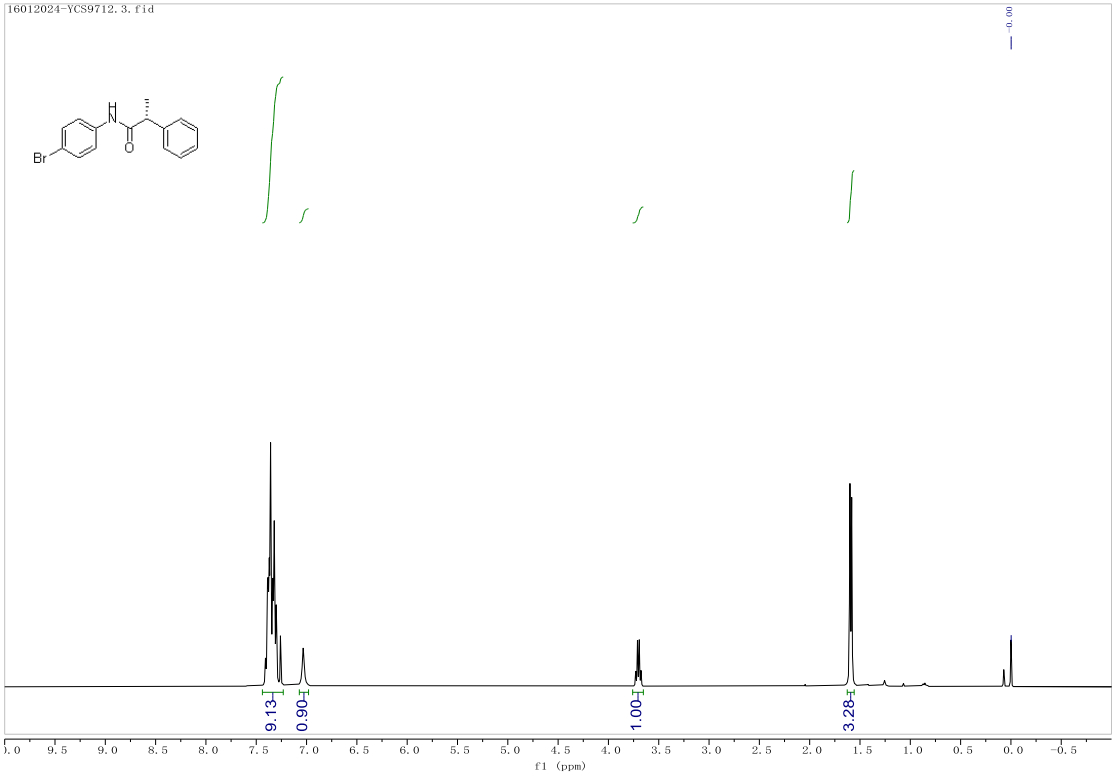


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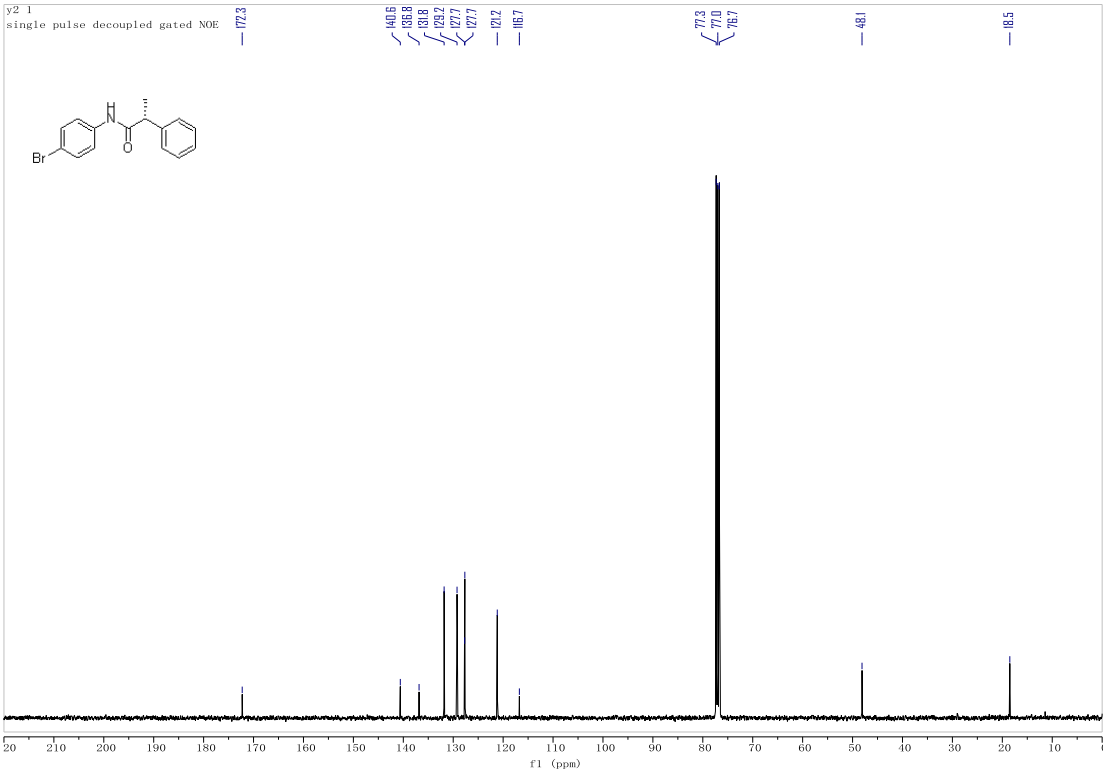

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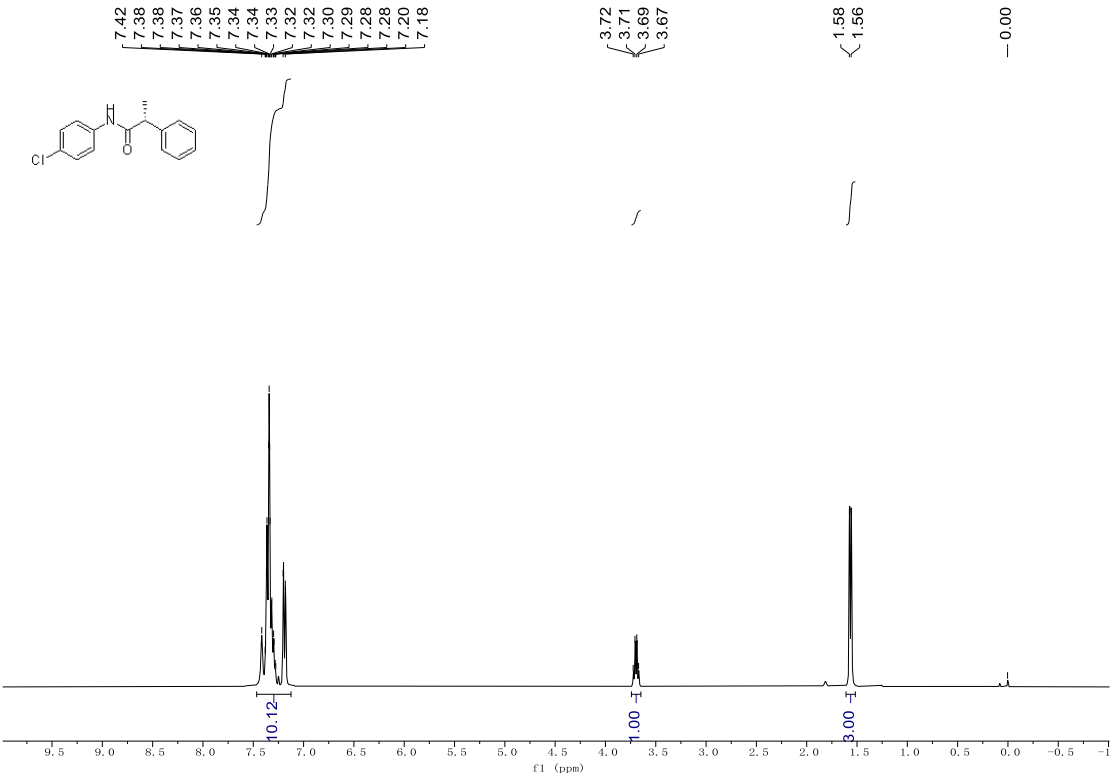
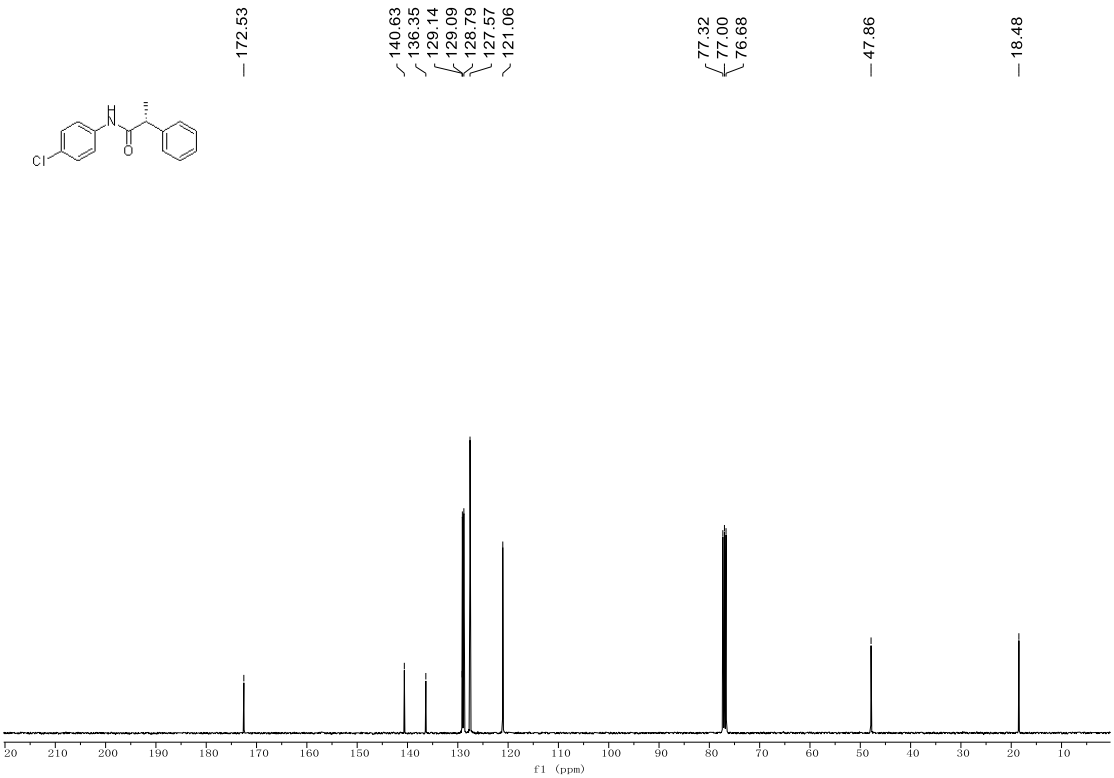



$^{13}$C NMR spectrum of compound (**3da**)



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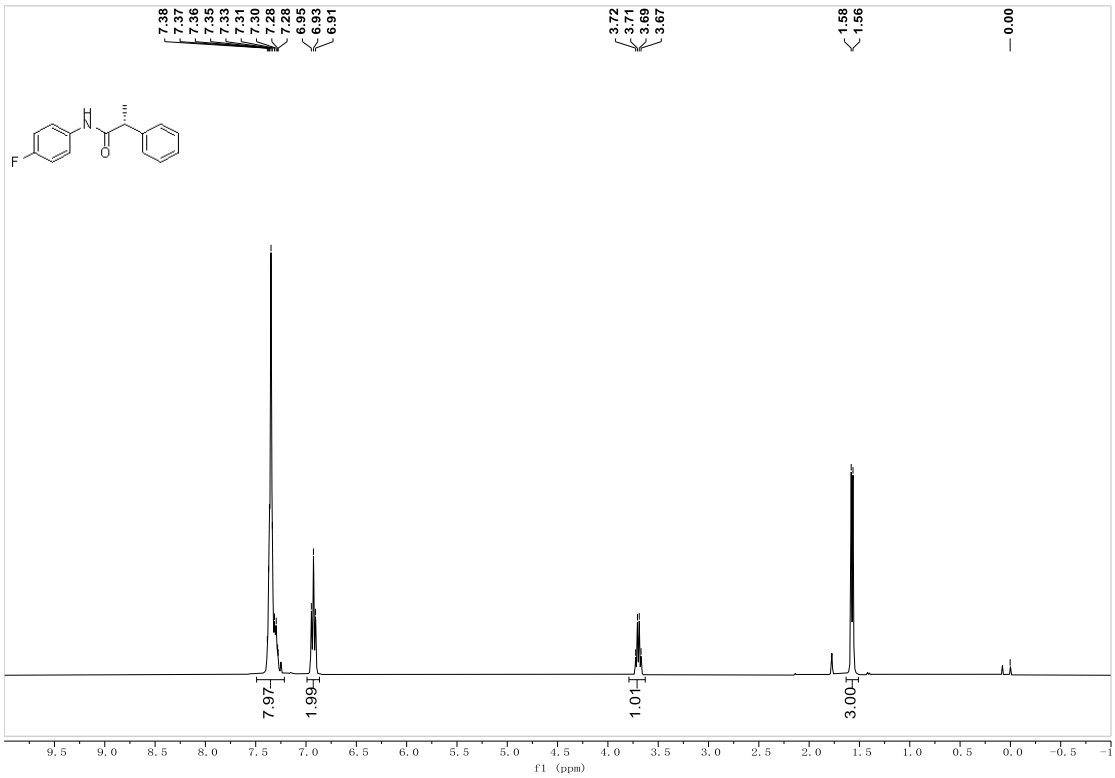


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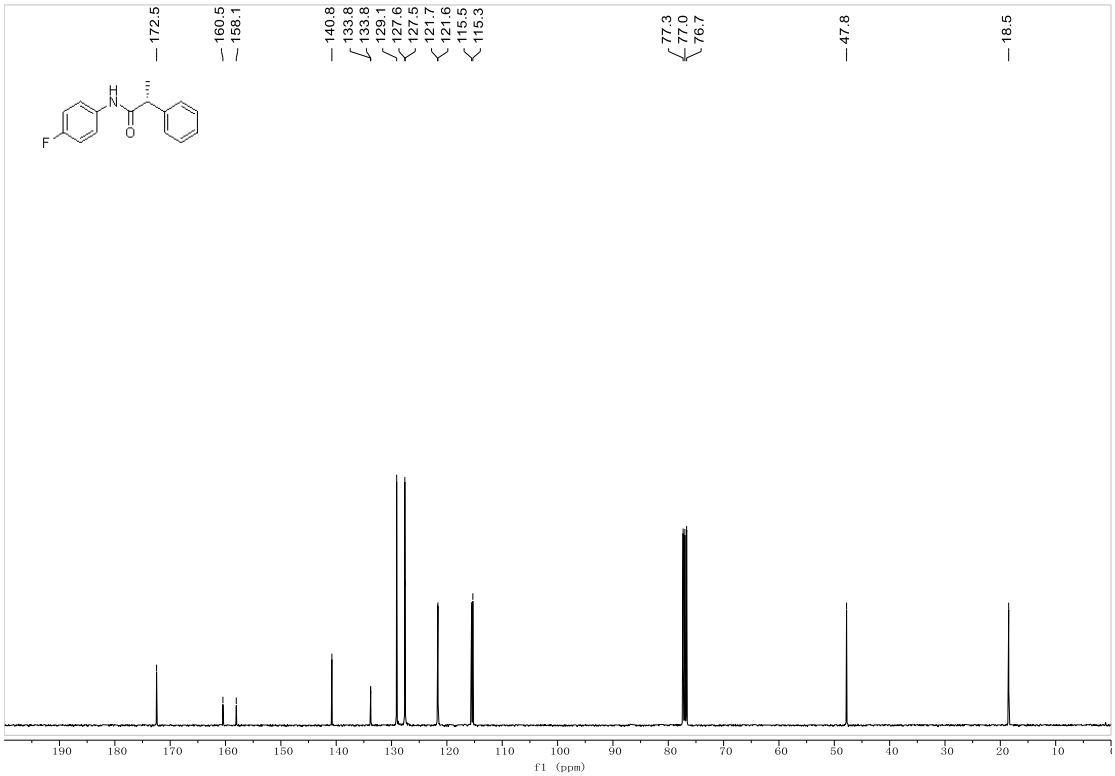
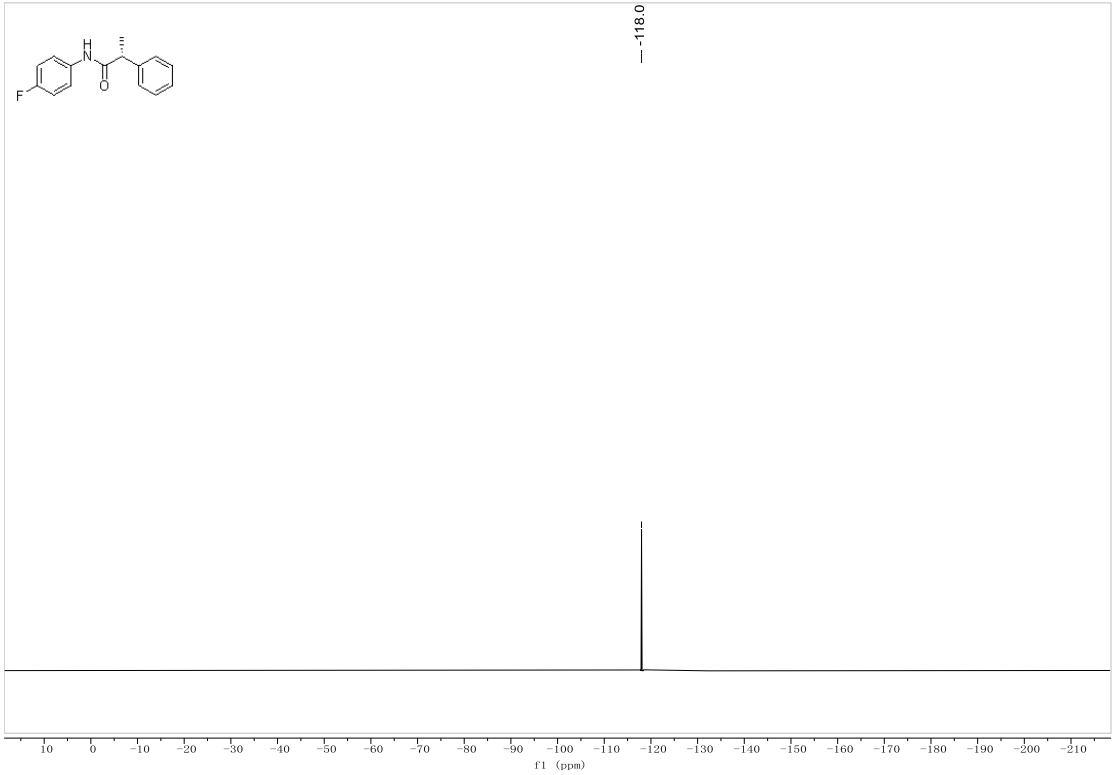


$^{19}$F NMR spectrum of compound (**3ea**)



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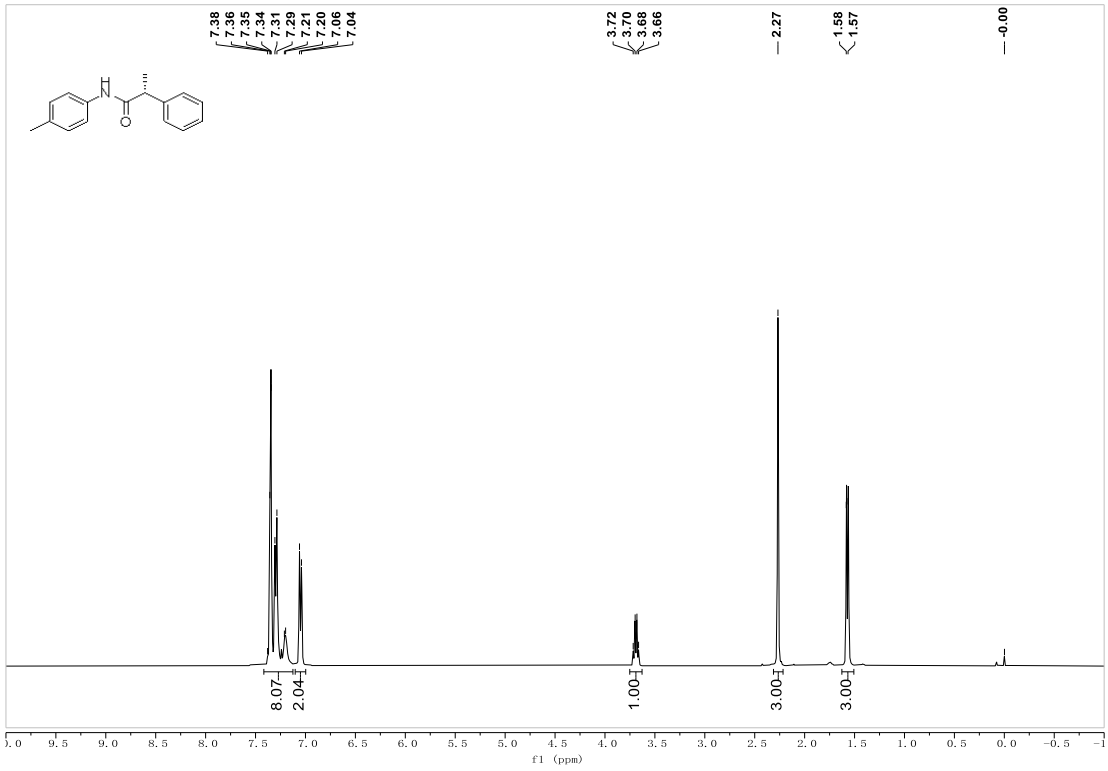
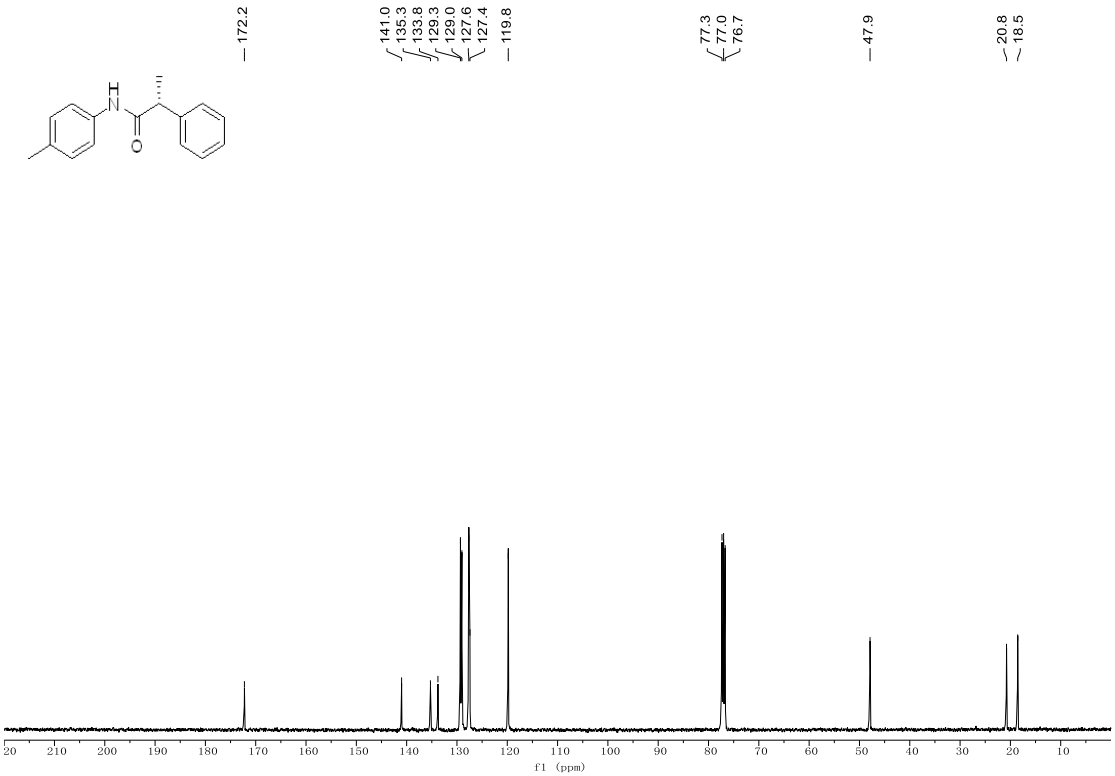



$^{13}$C NMR spectrum of compound (**3fa**)



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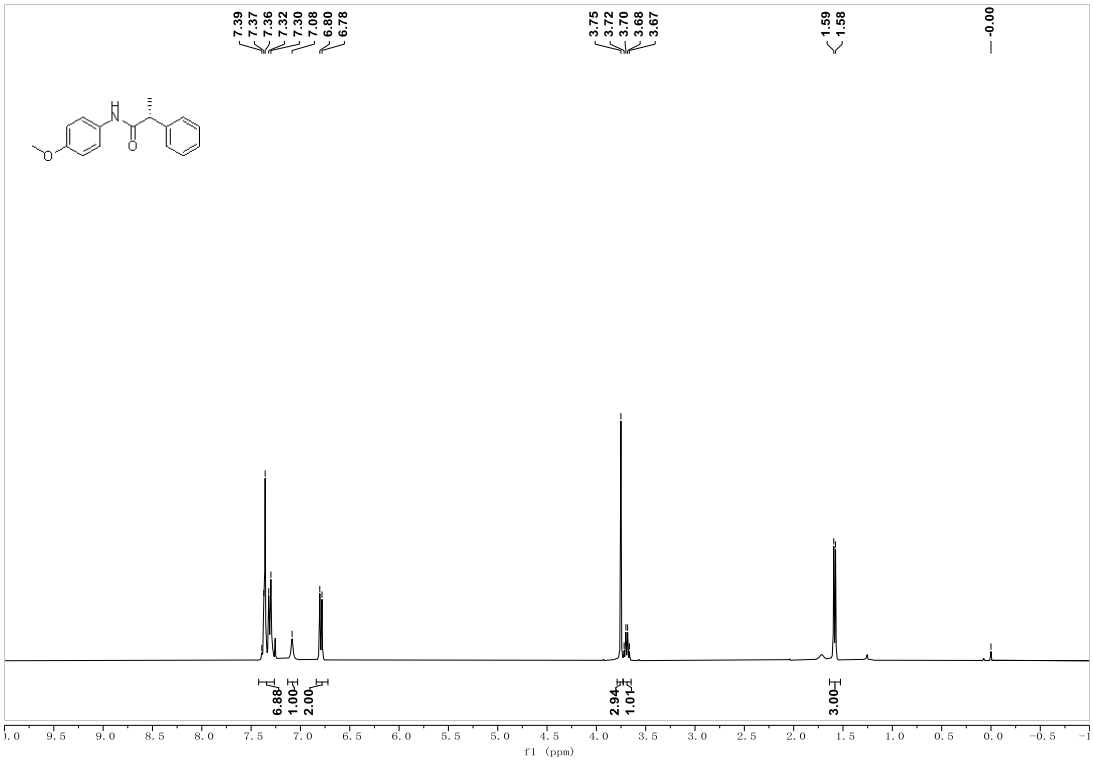
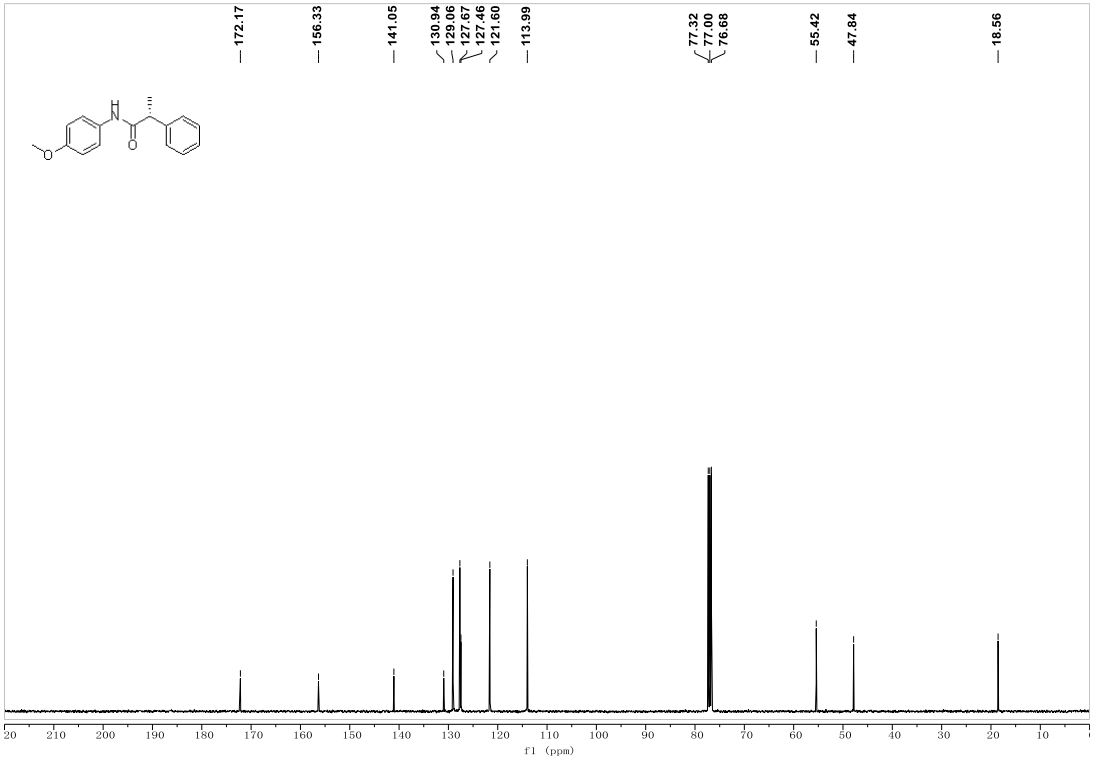



$^{13}$C NMR spectrum of compound (**3ga**)



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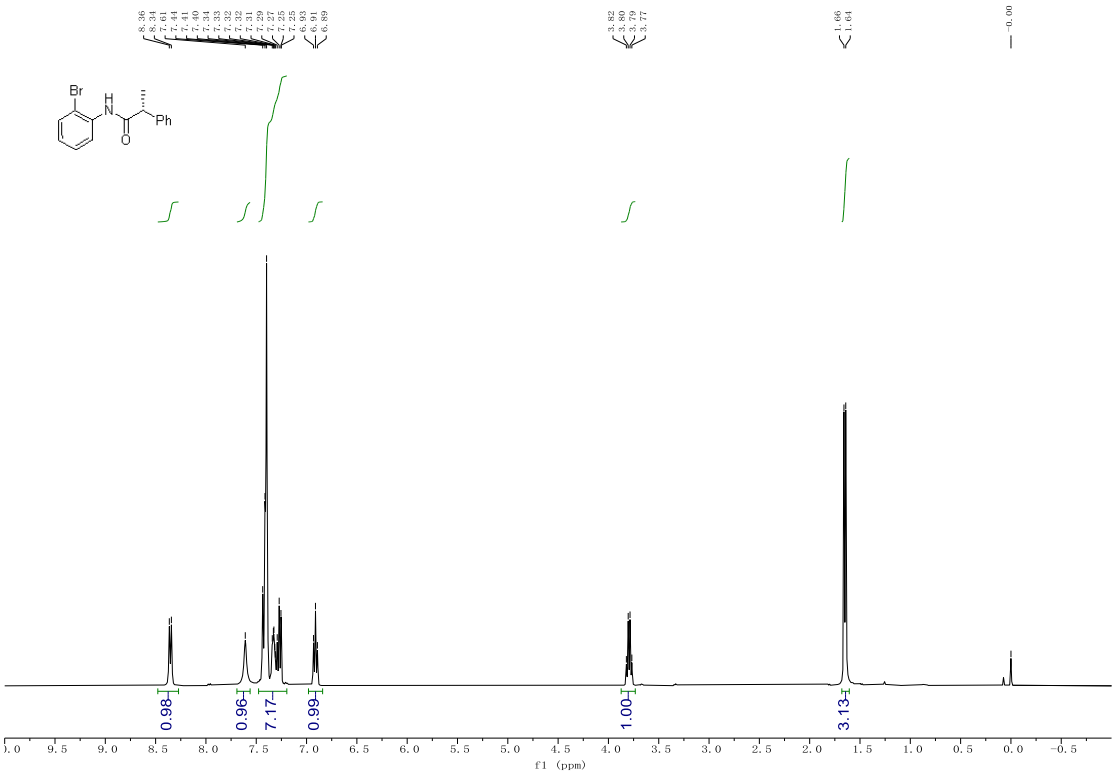


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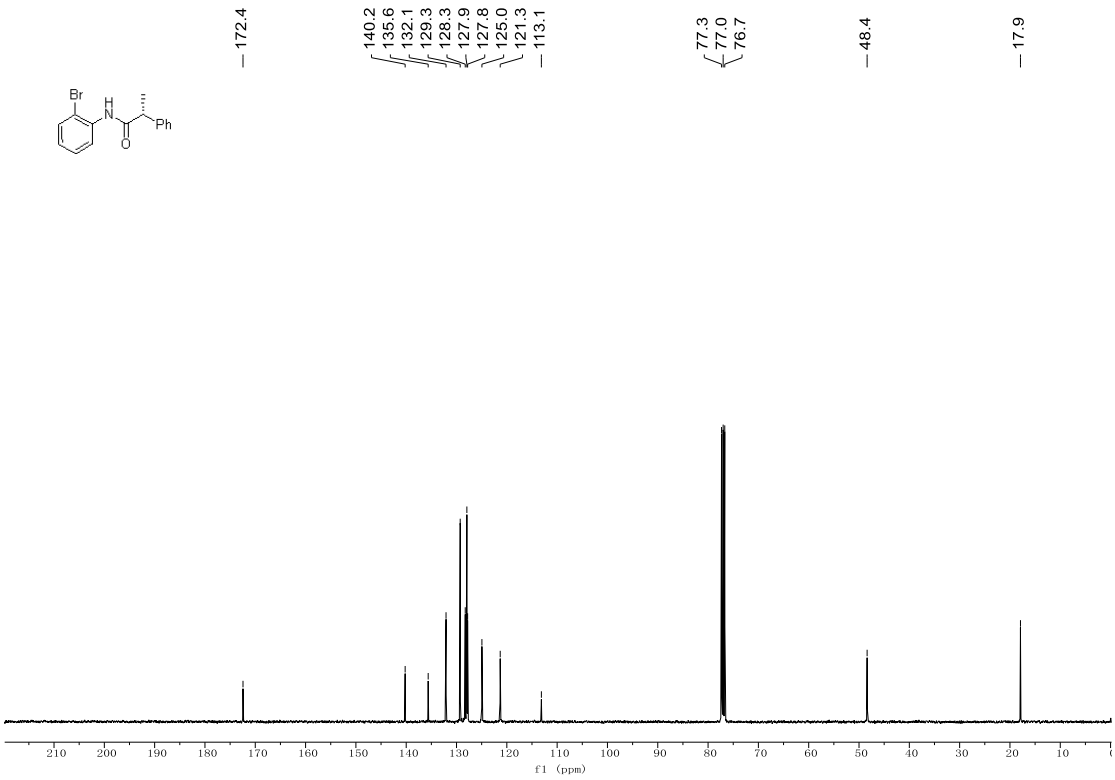

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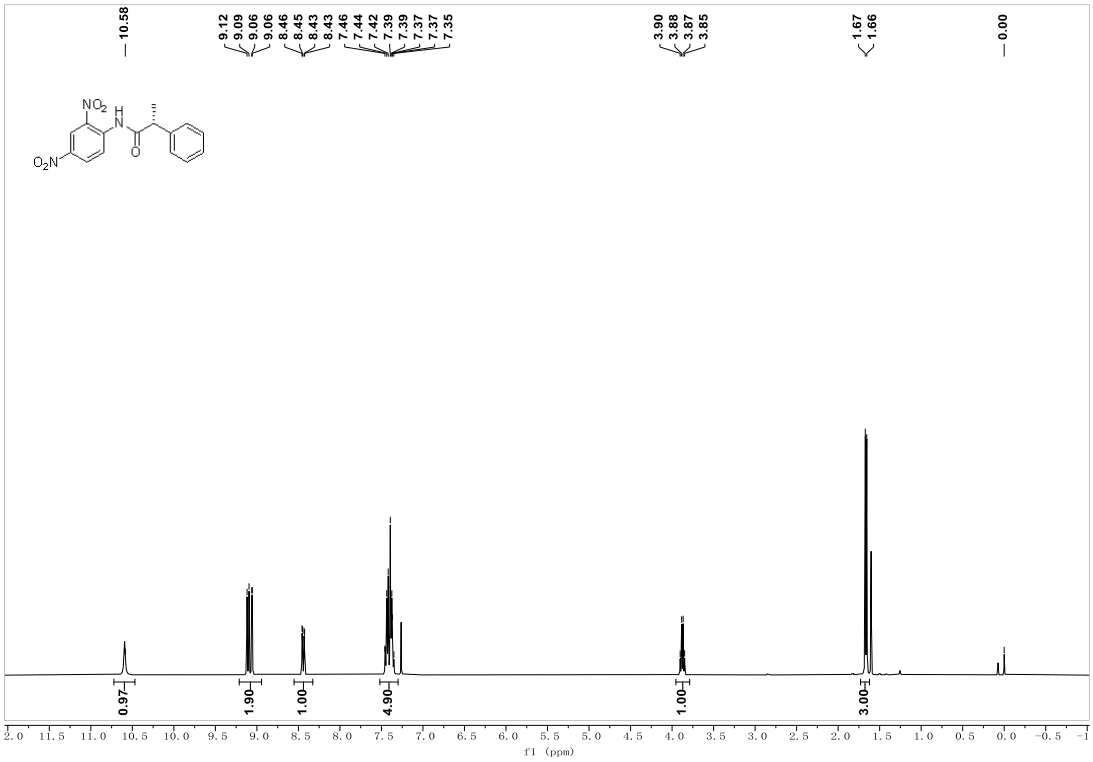


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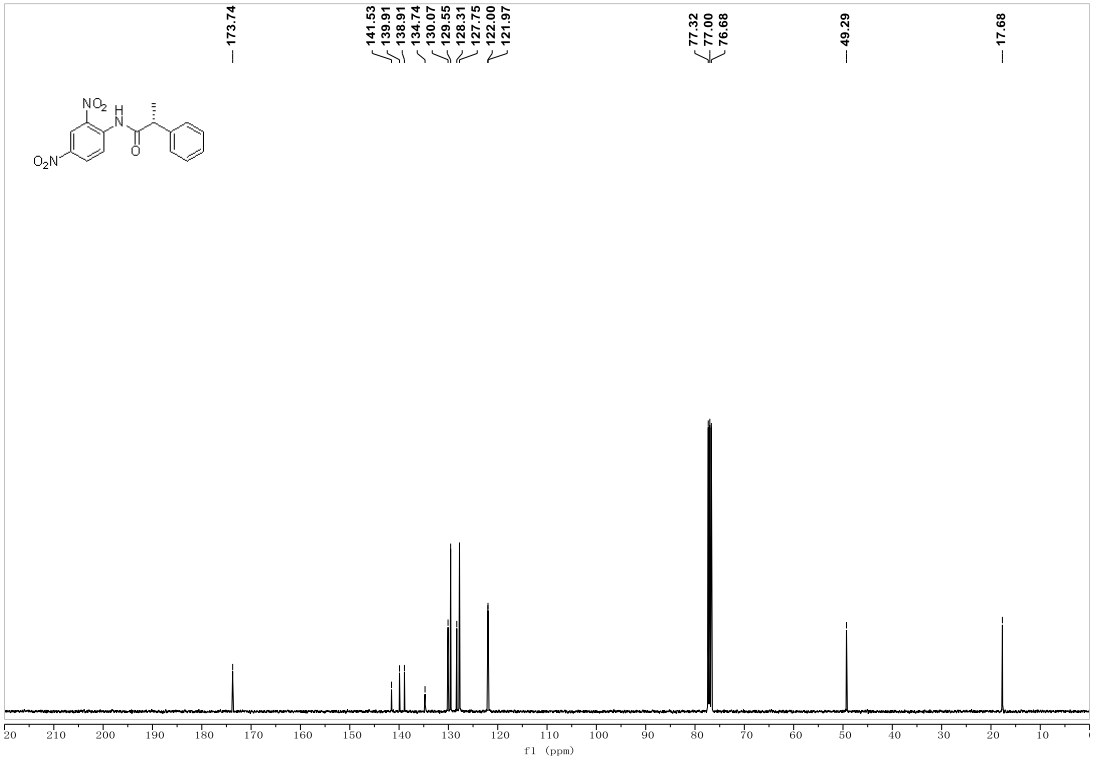

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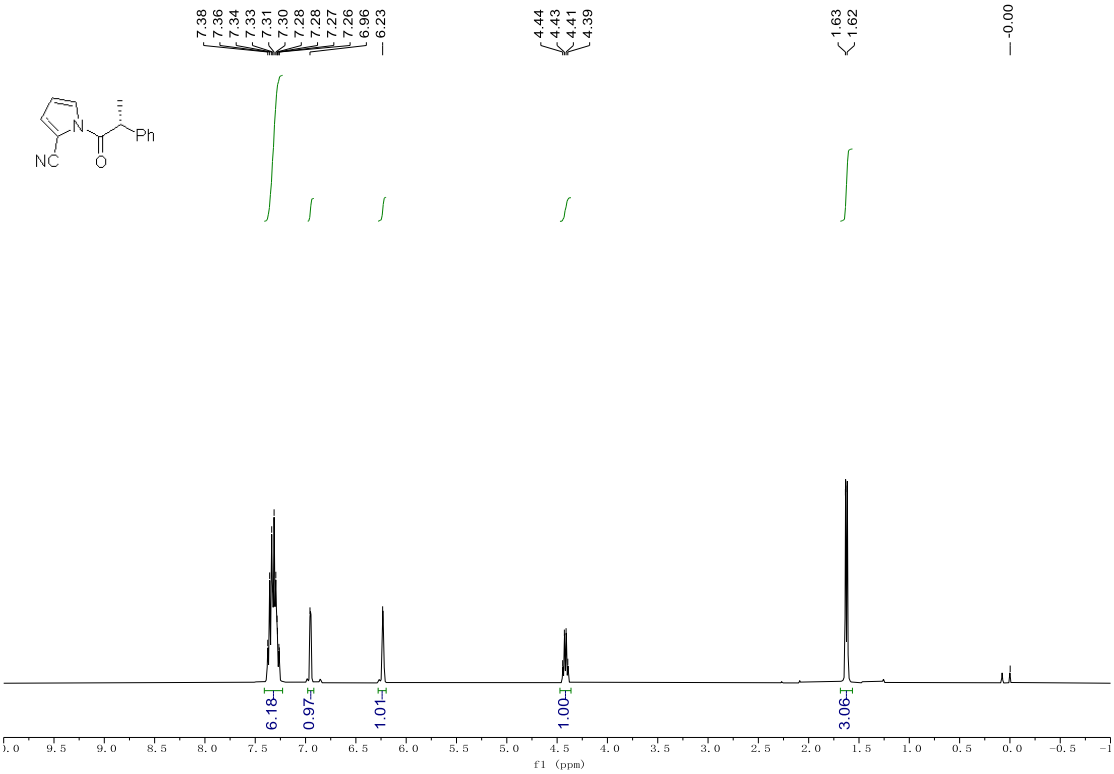


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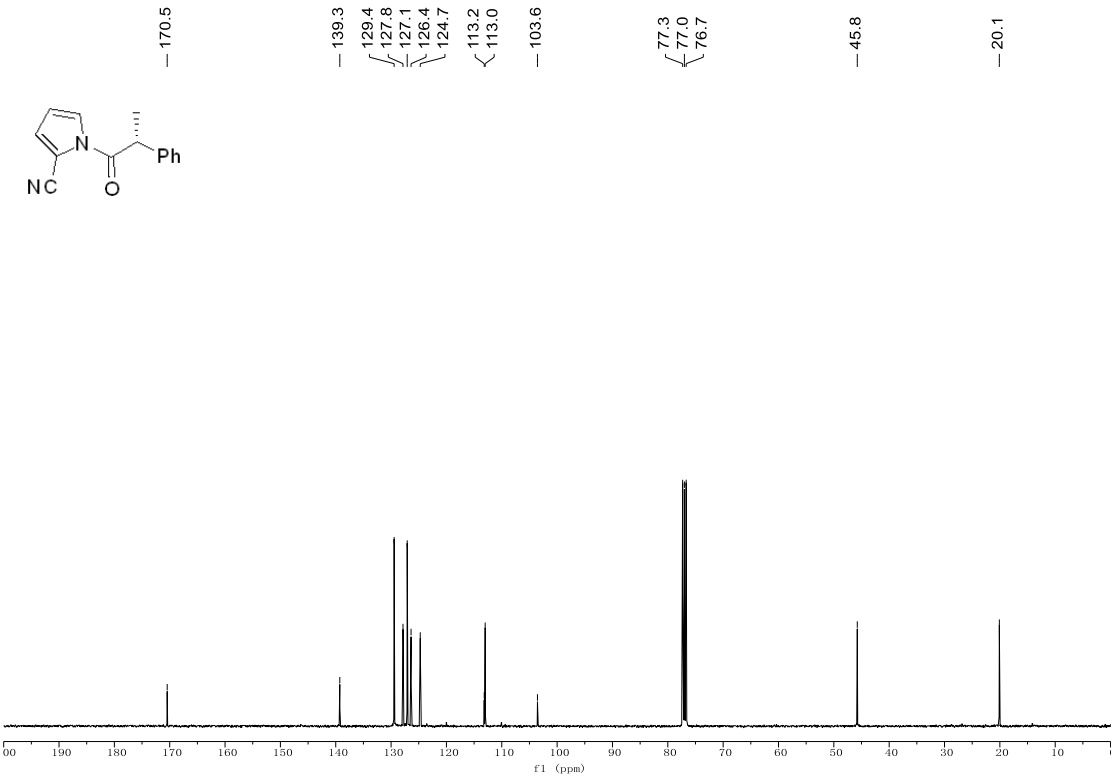

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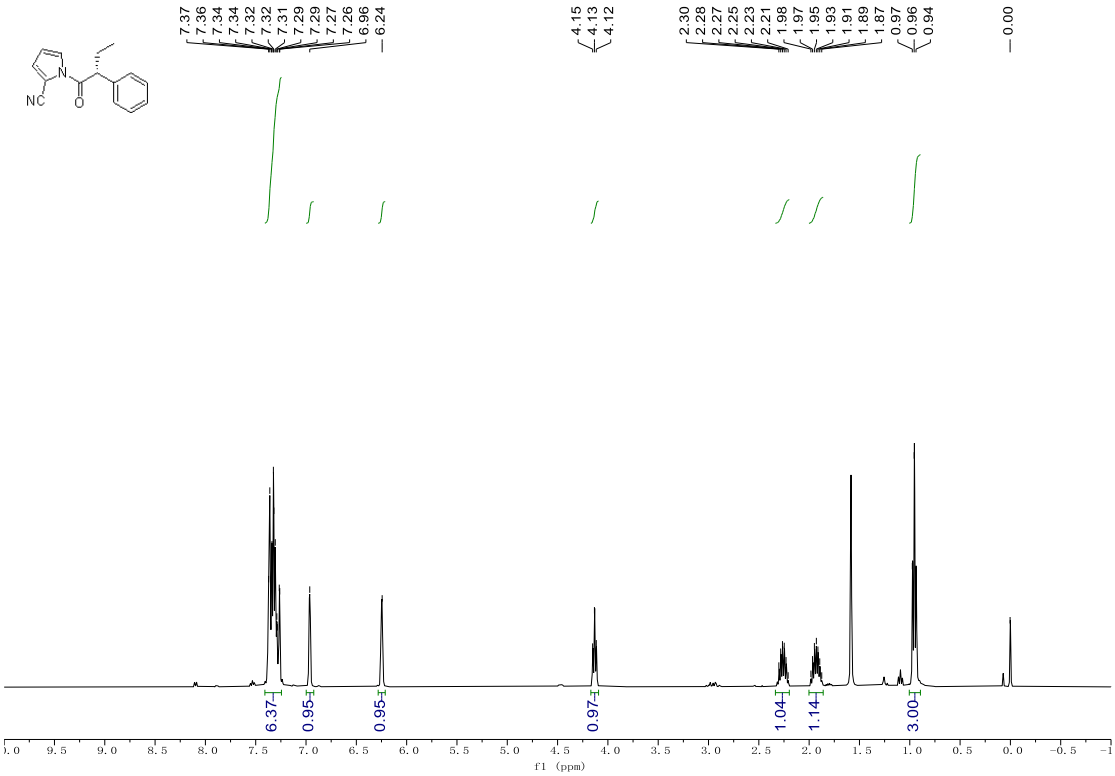


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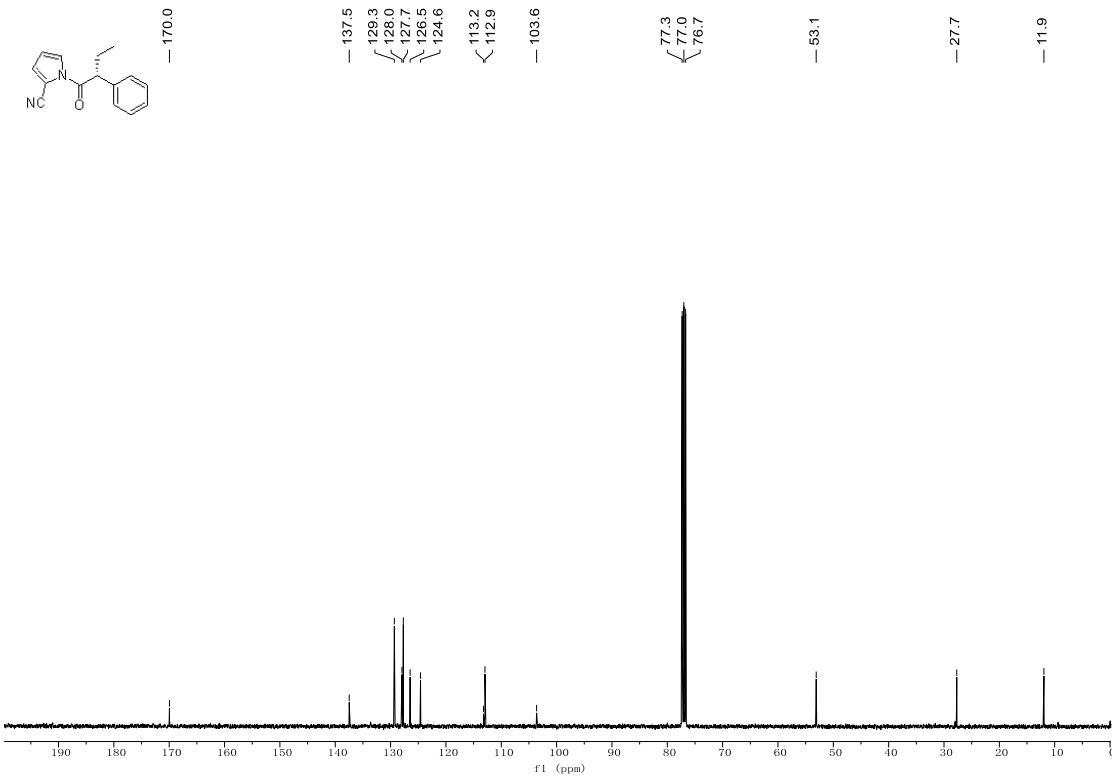

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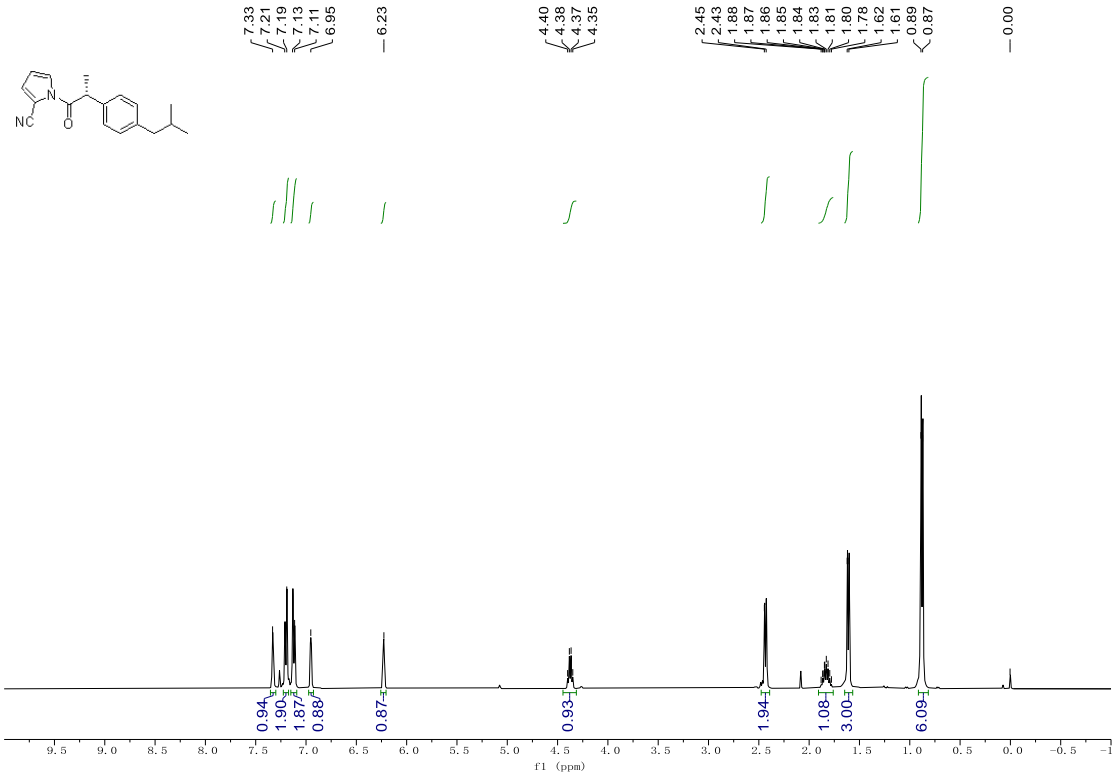


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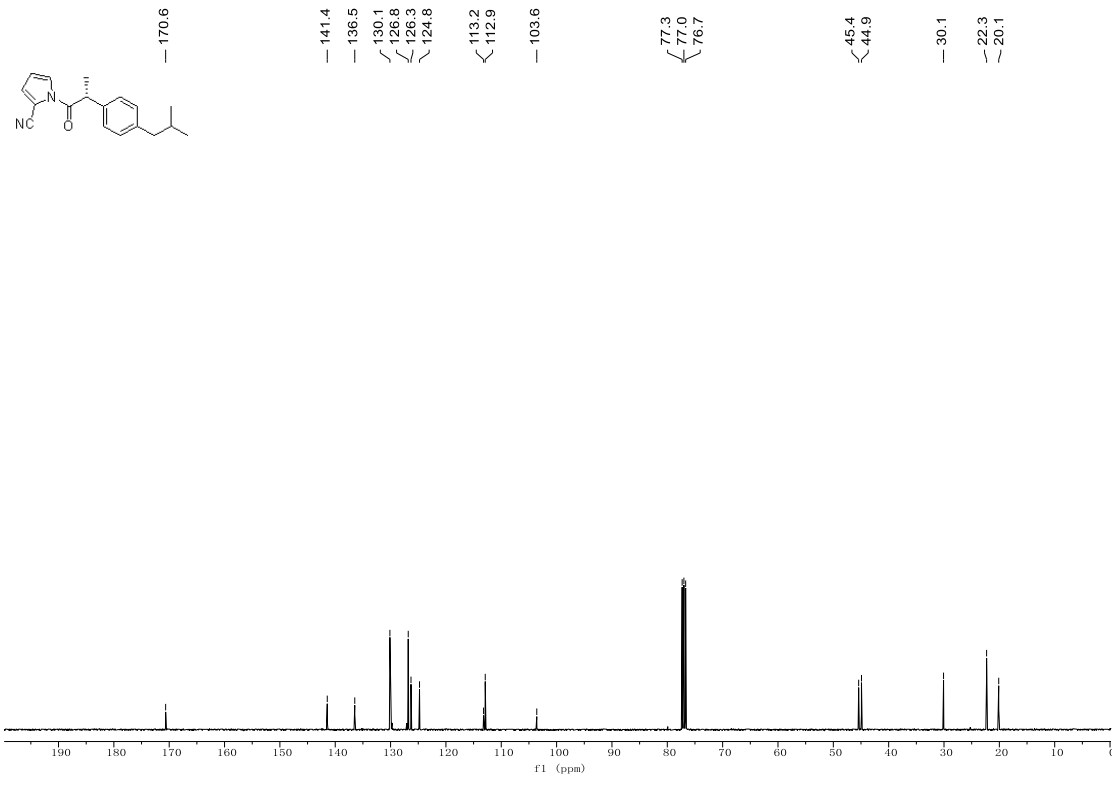
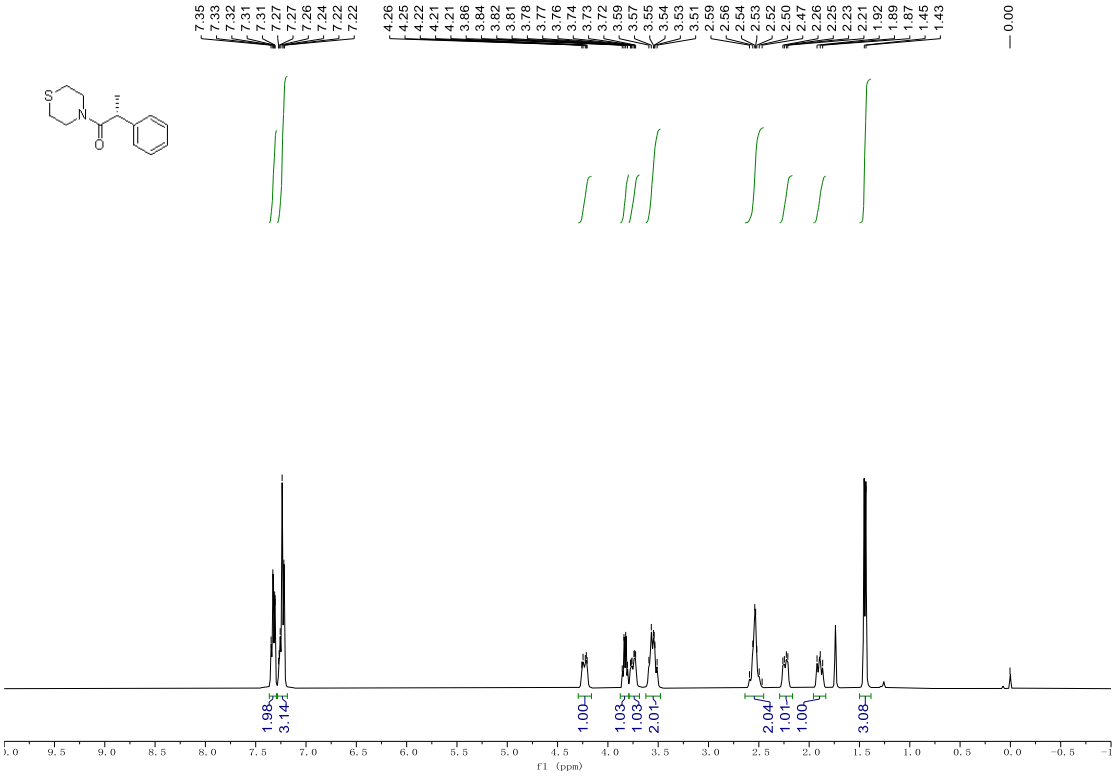
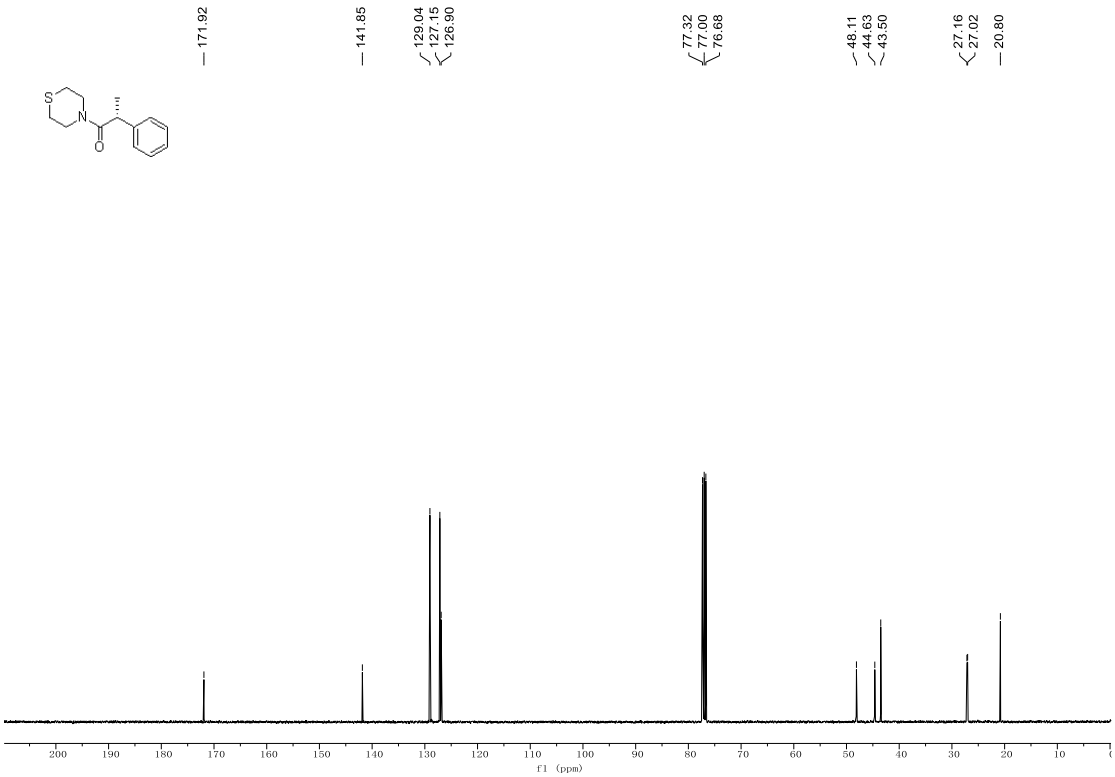


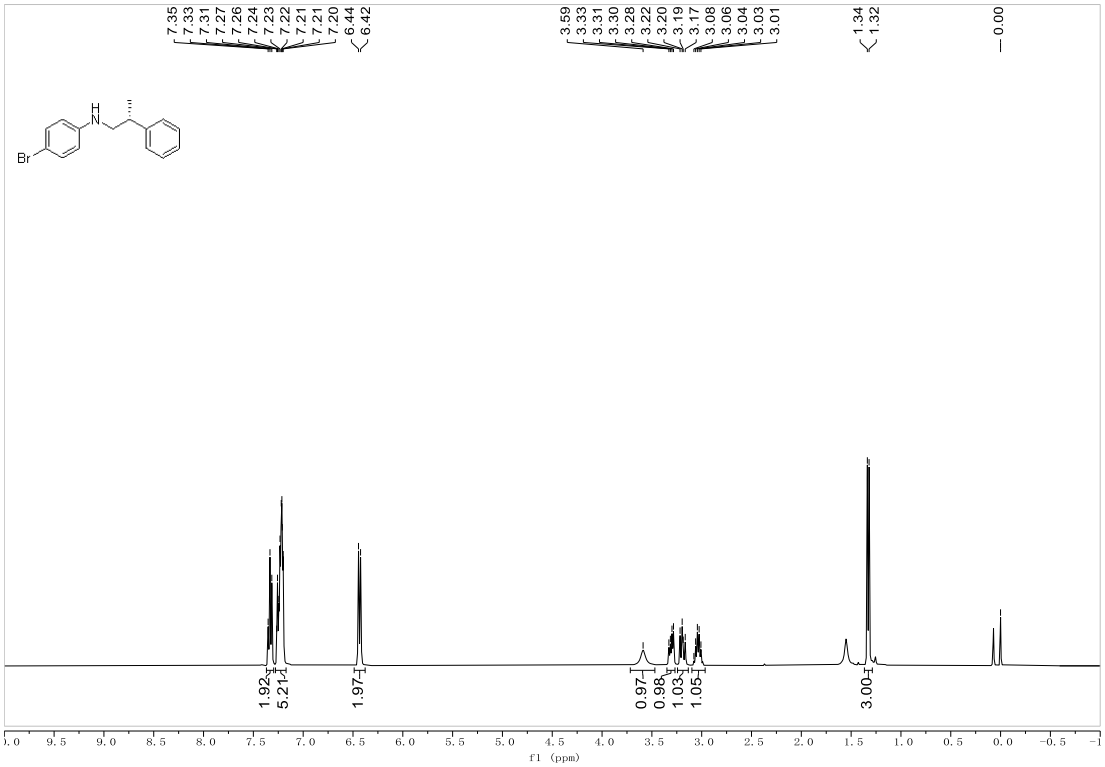
$^{1}$H NMR spectrum of compound (**3ka**)



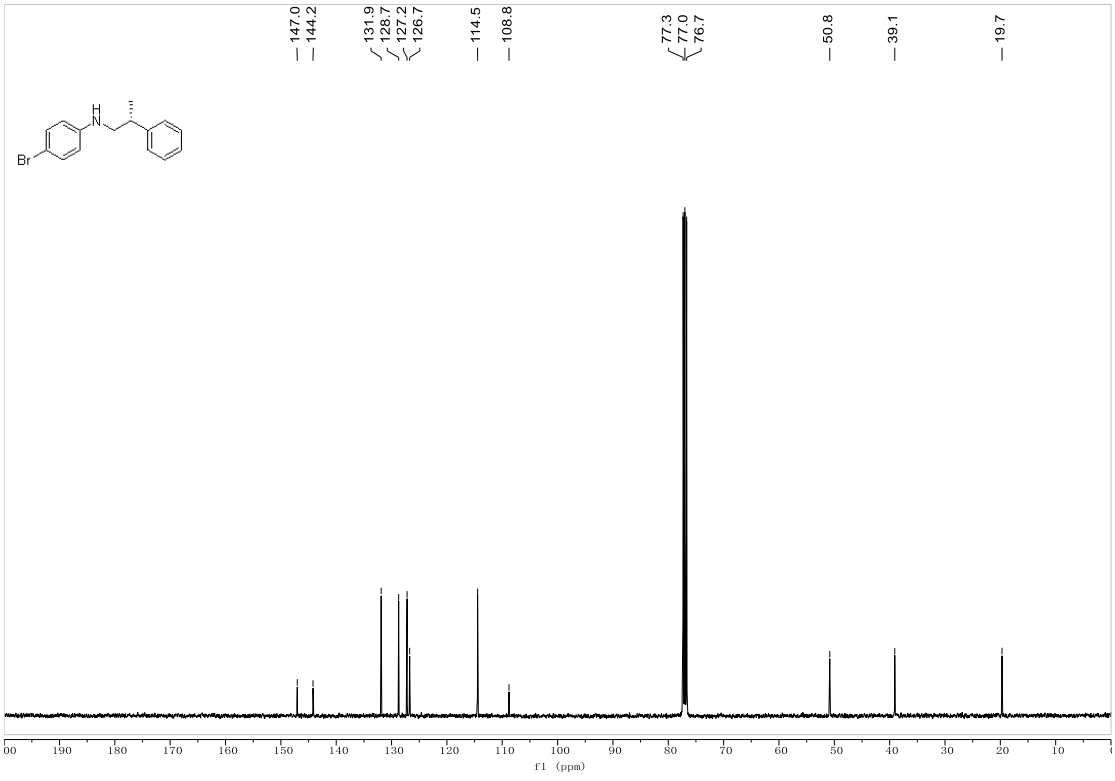

$^{13}$C NMR spectrum of compound (**3ka**)



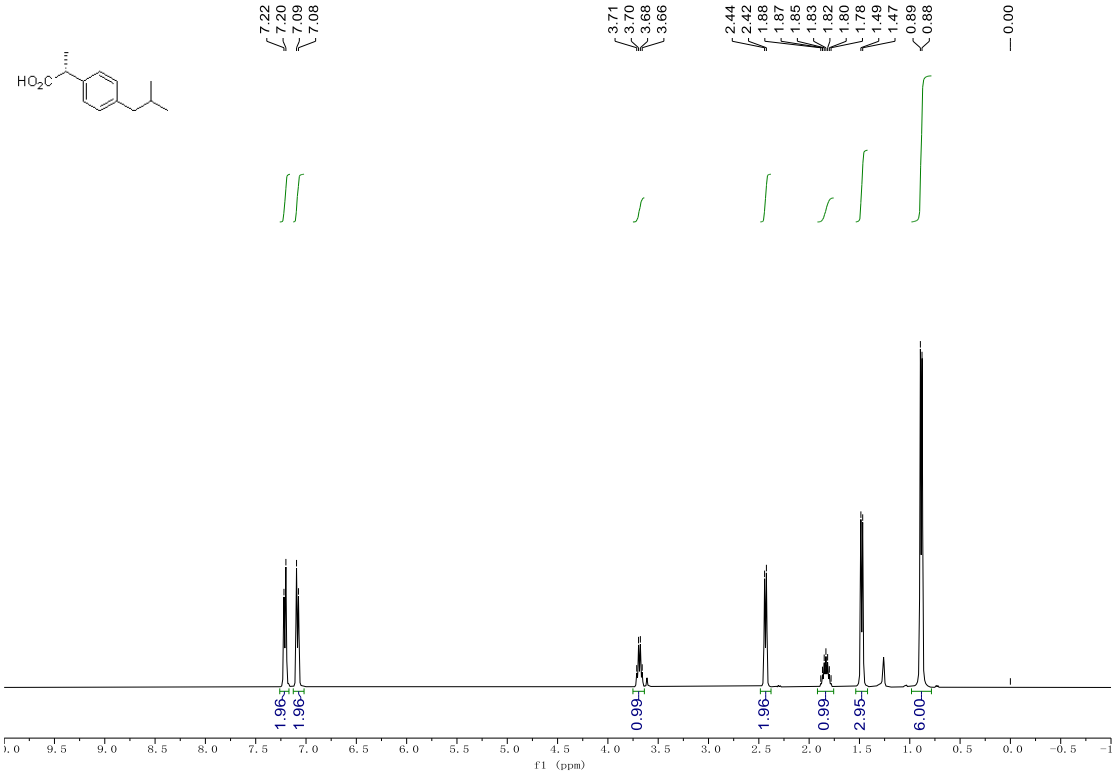
$^{1}$H NMR spectrum of compound (**4**)




$^{13}$C NMR spectrum of compound (**4**)



$^{1}$H NMR spectrum of compound (**5**)




$^{13}$C NMR spectrum of compound (**5**)