One-pot protocol to synthesis *N*-(β-nitro)aimides by tandem Henry/Ritter reaction

Wensi Ai [b], Ronghua Shi [b], Liyan Zhu [a], Dehong Jiang [b], Xiaobo Ma[a],

Jilan Yuan [a], Zhouyu Wang* [a]

[a] *Department of Chemistry, Xihua University, Chengdu, 610039, China*

[b] *Department of Pharmaceutics Engineering, Xihua University, Chengdu, 610039, China*

China Tel.: +86-28-87723006

zhouyuwang77@gmail.com, zhouyuwang@mail.xhu.edu.cn

(Supporting Information)

General: All starting materials were of the commercially available (analytical grade) and used without further purification. All the solvents are used after redistillation. Reactions were monitored by thin layer chromatography using silica gel HSGF254 plates. Flash chromatography was performed using silica gel HG/T2354-92. Melting points were measured with SGW X-4 melting point apparatus. ^{1}H NMR (300, 400 or 600 MHz) spectra were recorded in $CDCl_3$. ^{1}H NMR chemical shifts are reported in ppm (δ) relative to tetramethylsilane (TMS) with the solvent resonance employed as the internal standard ($CDCl_3$, δ 7.26 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, q = quartet, m = multiplet), coupling constants (Hz) and integration.^{13}C NMR chemical shifts are reported in ppm from tetramethylsilane (TMS) with the solvent resonance as the internal standard ($CDCl_3$, 77.0ppm).

Experimental Section

General procedures for the synthesis of 2-nitro-1-phenyl-ethanol

The mixture of benzaldehyde (1.0 mmol), nitromethane (4.0 mmol) and base were stirred in the solvent at designed temperature for designed time. Then the solvent was removed under reduced pressure and the residue was purified by silicagel column chromatography (petroleum ether/ethyl acetate = 10/1) to give the corresponding 2-nitro-1-phenylethanol.

General procedures for the synthesis of N-(β-nitroalkyl) amides

The 2-nitro-1-arylethanol (1.0mmol), nitrile (4 mmol), and 1,4-diazabicyclo[2.2.2]octane (DABCO, 0.5 mmol) were dissolved in nitrile (0.5 mL). The reaction mixture was stirred at 0℃ for 24h. Then the trifluoromethanesulfonic acid (3 mmol) was added and the mixture was stirred at 40℃ for 24h. The reaction was then quenched by the addition of sodium bicarbonate at room temperature. The solvent was removed under reduced pressure and the residue was purified by silicagel column chromatography (petroleum ether/ethyl acetate = 10/1) to give the corresponding *N*-(β-nitroalkyl) amides.

The procedures for the synthesis of 7

To a well-stirred mixture of *N*-(2-nitro-1-phenylethyl) benzamide (130.1 mg, 0.5mmol) and Nickel

chloride hexahydrate (119mg, 0.5mmol) in absolute ethyl alcohol (5mL) at 0℃, sodium borohydride (90mg, 5mmol) was added. The mixture was stirred at 0℃ for 2 hours and then quenched with saturated aqueous NH_4Cl. The mixture was diluted with dichloromethane. The organic layer was separated and aqueous layer was extracted with CH_2Cl_2 (10mL×3). The combined extracts were washed with water (10mL×2), dried over magnesium sulfate and concentrated under vacuum to afford crude amine intermediate **6**. The crude amine **6** was dissolved in absolute ethyl alcohol (5mL). Sodium hydroxide was introduced slowly which made the pH exceed 12. The mixture was stirred at 90℃ for 5h and then concentrated under reduced pressure. After purification by flash chromatography with neutral alumina (dichloromethane/methyl alcohol = 10/1), the product **7** was obtained (82% yield).

The procedures for the synthesis of 8

To a well-stirred mixture of *N*-(2-nitro-1-phenylethyl) benzamide (130.1 mg, 0.5mmol) and Nickel chloride hexahydrate (119mg, 0.5mmol) in absolute ethyl alcohol (5mL) at 0℃, sodium borohydride (90mg, 5mmol) was added. The mixture was stirred at 0℃ for 2 hours and then quenched with saturated aqueous NH_4Cl. The mixture was diluted with dichloromethane. The organic layer was separated and aqueous layer was extracted with CH_2Cl_2 (10mL×3). The combined extracts were washed with water, dried over magnesium sulfate and concentrated under vacuum to afford crude amine intermediate 4. The crude amine 4 and were dissolved in H_2O/ 1, 4-dioxane (1: 2 mL). The $(Boc)_2O$ (130.8mg, 0.6mmol) was added. Then sodium hydroxide was introduced slowly which made the pH exceed 12. The mixture was stirred at room temperature for 2h and then extracted with EtOAc(10mL×3). The combined organic extracts were dried over $MgSO_4$. The solvent was removed under reduced pressure. After purification by flash chromatography (petroleum ether/ethyl acetate = 5/1), the product **8** were obtained (72% yield).

***N*-(2-nitro-1-phenylethyl)acetamide (3a)** : white solid; yield: 82%; mp: 136.2-136.8℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 2.02 (s, 3H), 4.70 (dd, *J* = 5.52, 12.90 Hz, 1H), 4.87 (dd, *J* = 6.90, 12.93 Hz, 1H), 5.66 (q, J = 7.23 Hz, 1H), 6.62 (d, J = 7.23 Hz, 1H), 7.26-7.39 (m, 5H); ESI HRMS exact mass calcd. for $C_{10}H_{12}N_2O_3$+H^+ requires m/z 209.0921, found m/z 209.0918.

***N*-(2-nitro-1-phenylethyl)benzamide (3b)**: white solid; yield: 79%; mp: 125.0-125.9℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 4.84 (dd, J = 5.28, 12.99 Hz, 1H), 5.04 (dd, J = 6.30, 12.99 Hz, 1H), 7.09 (d, J = 7.32 Hz, 1H), 7.26 - 7.54 (m, 7H), 7.80 (d, = 7.14 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 51.6, 78.3,126.4, 127.1, 128.8, 128.9, 129.3, 132.2, 133.4, 136.3, 167.0; ESI HRMS exact mass calcd. for $C_{15}H_{14}N_2O_3$+H^+ requires m/z 271.1082, found m/z 271.1080.

***N*-(2-nitro-1-phenylethyl)-2-phenylacetamide (3c)** : white solid; yield: 76%; mp: 116.5-117.2℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 3.63 (s, 2H), 4.65 (dd, J = 5.19, 12.90 Hz, 1H), 4.79 (dd, J = 6.57, 12.87 Hz, 1H), 5.65 (q, J = 6.51Hz, 1H), 6.29 (d, J = 7.28Hz, 1H), 7.13-7.16 (m, 2H), 7.26 - 7.54 (m, 8H); ^{13}C NMR (100 MHz, $CDCl_3$): 43.6, 51.2, 78.2, 126.1, 127.7, 128.7, 129.2, 129.4, 134.1, 136.2, 170.1; ESI HRMS exact mass calcd. for $C_{16}H_{16}N_2O_3$ +H^+ requires m/z 285.1234, found m/z 285.1241.

***N*-(1-(4-fluorophenyl)-2-nitroethyl)acetamide (3e)** : white solid; yield: 83%; mp: 137.8-138.7℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ=4.70 (dd, J = 5.43, 12.99 Hz, 1H), 4.90 (dd, J = 6.54, 12.99 Hz, 1H), 5.66 (dd, J = 6.09, 12.87 Hz, 1H), 6.46 (bs, 1H), 7.05 - 7.10 (m, 2H), 7.27 - 7.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.2, 50.7, 78.2, 116.1, 116.4, 128.2, 128.3, 132.2, 161.5, 169.8. ESI HRMS exact mass calcd. for $C_{10}H_{11}FN_2O_3$+H^+ requires m/z 227.0826, found m/z 227.0828.

***N*-(1-(4-fluorophenyl)-2-nitroethyl)benzamide (3f)** : white solid; yield: 81%; mp: 131.2-131.9℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 4.83 (dd, J = 5.19, 13.05 Hz, 1H), 5.04 (dd, J = 6.30, 13.08 Hz, 1H), 5.86 (q, J = 6.09 Hz, 1H), 7.32 - 7.39 (m, 2H), 7.46 (t, J = 7.54 Hz, 2H), 7.56 (t, J = 7.32 Hz, 1H), 7.80 (d, J = 7.44 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 51.0, 78.3, 116.2, 116.4, 127.1, 128.2, 128.3, 128.8, 132.3, 133.3, 161.5, 167.0; ESI HRMS exact mass calcd. for $C_{15}H_{13}FN_2O_3$+H^+ requires 289.0983, found 289.0979

***N*-(1-(4-fluorophenyl)-2-nitroethyl)-2-phenylacetamide (3g)** : white solid; yield: 76%; mp: 107.0-107.8℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 3.62 (s, 2H), 4.63 (dd, J = 5.10, 12.93 Hz, 1H), 4.78 (dd, J = 6.63, 12.93 Hz, 1H), 5.62 (q, J = 6.60 Hz, 1H), 6.38 (d, J = 7.62 Hz, 1H), 7.01 (t, J = 8.43 Hz, 2H), 7.13 (d, J = 8.67 Hz, 2H), 7.31-7.41 (m, 5H); ^{13}C NMR (100 MHz, CDCl3): 43.6, 50.6, 78.2, 116.1, 116.3, 127.8, 128.0, 128.1, 129.3, 132.1, 134.0, 161.4, 170.7; ESI HRMS exact mass calcd. for $C_{15}H_{13}FN_2O_3$ +H^+ requires 289.0983, found 289.0979.

***N*-(1-(4-chlorophenyl)-2-nitroethyl)acetamide (3i)** : white solid; yield: 78%; mp: 117.6-118.4℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 2.08 (s, 3H), 4.73 (dd, J = 5.28, 13.12 Hz, 1H), 4.92 (dd, J = 6.48, 13.12 Hz, 1H), 5.68 (q, J = 6.04 Hz, 1H), 6.47 (d, J = 7.52 Hz, 1H), 7.27 (d, J = 8.48 Hz, 2H),7.38 (d, J = 8.52 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.1, 50.7, 78.0, 127.9, 129.4, 134.7, 135.0, 170.0; ESI HRMS exact mass calcd. for $C_{10}H_{11}ClN_2O_3$+H^+ requires m/z 243.0531, found m/z 243.0533.

***N*-(1-(4-chlorophenyl)-2-nitroethyl)benzamide (3j)**: white solid; yield: 72%; mp: 138.4-139.2℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 4.86 (dd, J = 5.04, 13.16 Hz, 1H), 5.04 (dd, J = 6.24, 13.16 Hz, 1H), 5.87 (q, J = 5.72 Hz, 1H),7.16 (d, J = 7.72 Hz, 1H), 7.33 - 7.35 (m, 2H), 7.38 - 7.40 (m, 2H), 7.49 (t, J = 7.80 Hz, 2H), 7.54 - 7.60 (m, 1H),7.82 (d, J = 8.56 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 51.0, 78.2, 127.1, 127.8, 128.8, 129.5, 132.3, 133.2, 134.8, 134.9, 167.0; ESI HRMS exact mass calcd. for $C_{15}H_{13}ClN_2O_3$ +H^+requires m/z 305.0687, found m/z 305.0688.

***N*-(1-(4-chlorophenyl)-2-nitroethyl)-2-phenylacetamide (3k)** : white solid; yield: 75%; mp: 119.9-120.7℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 3.66 (s, 2H), 4.66 (dd, J = 5.00, 13.04 Hz, 1H), 4.80 (dd, J = 6.48, 13.00 Hz, 1H), 5.62 (q, J = 6.20 Hz, 1H), 6.33 (d, J = 7.60 Hz, 1H), 7.10 (d, J = 8.48 Hz, 2H), 7.28 - 7.44 (m, 7H); ^{13}C NMR (100 MHz, $CDCl_3$): 43.5, 50.6, 78.0, 127.6, 127.7, 129.2, 129.3, 129.4, 134.1, 134.6, 134.8, 170.9; ESI HRMS exact masscalcd. for $C_{16}H_{15}ClN_2O_3$ +Na^+ requires m/z 341.0663, found m/z 341.0674.

***N*-(1-(4-bromophenyl)-2-nitroethyl)acetamide (3l)** : white solid; yield: 77%; mp: 134.8-135.2℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 2.03 (s, 3H), 2.05 (s, 3H), 4.71(dd, J = 13.11, 5.28 Hz, 1H), 4.87 (dd, J = 13.11, 6.48 Hz, 1H), 5.63 (q, J = 6.12 Hz, 1H), 6.47 (d, J = 7.02 Hz, 1H), 7.18 (d, J = 8.34 Hz, 2H), 7.50 (d, J = 8.43 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.2, 50.8, 78.0, 122.8, 128.2, 132.4, 135.5, 170.0. ESI HRMS exact mass calcd. for $C_{10}H_{12}BrN_2O_3$ requires m/z 287.0026, found m/z 287.0027.

***N*-(1-(4-bromophenyl)-2-nitroethyl)benzamide (3m)** : white solid; yield: 81%; mp: 160.1-161.1℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 4.84 (dd, J = 4.80, 13.04 Hz, 1H), 7.43 - 7.58 (m, 5H), 7.82 (d, J = 7.44 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 51.0, 77.8, 122.9, 127.1, 128.1, 132.3, 133.2, 135.4, 167.0. ESI HRMS exact mass calcd. for $C_{15}H_{13}$ BrN_2O_3+H^+ requires m/z 349.0182, found m/z 349.0183.

***N*-(1-(4-bromophenyl)-2-nitroethyl)-2-phenylacetamide (3n)** : white solid; yield: 72%; mp: 124.8-126.2℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 3.65 (s, 2H), 4.66 (dd, J = 5.00, 13.08 Hz, 1H), 4.80 (dd, J = 6.52, 13.04 Hz, 1H), 5.61 (q, J = 6.40, 13.20 Hz, 1H), 6.40 (d, J = 7.88 Hz, 1H), 7.04 (d, J = 8.40 Hz, 2H), 7.28 (d, J = 8.28 Hz, 2H), 7.36 - 7.49 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): 43.6, 50.6, 78.0, 122.8, 127.8, 127.9, 129.3, 132.3, 134.0, 135.3, 170.8; ESI HRMS exact mass calcd. for $C_{16}H_{15}BrN_2O_3$ +H^+requires m/z 363.0339, found m/z 363.0338.

***N*-(2-nitro-1-p-tolylethyl)acetamide (3o)** : white solid; yield: 78%; mp: 116.4-117.2℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 2.03 (s, 3H), 2.33 (s, 3H), 4.71(dd, J = 5.28, 12.84 Hz, 1H), 4.87 (dd, J = 6.48, 13.11 Hz, 1H), 5.63 (q, J = 6.54 Hz, 1H), 6.60 (bs, 1H), 7.18 - 7.26 (m, 4H); ^{13}CNMR (200MHz, $CDCl_3$): 21.1, 23.1, 51.3, 78.3, 126.5, 129.8, 133.6, 138.6, 170.2. ESI HRMS exact mass calcd. for $C_{11}H_{14}N_2O_3$ +H^+ requires m/z 223.1077, found m/z 223.1085.

***N*-(2-nitro-1-p-tolylethyl)benzamide (3p)** : white solid; yield: 70%; mp: 149.5-150.5℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 2.34 (s, 3H), 4.82 (dd, J = 5.49, 12.89 Hz, 1H), 5.02 (dd, J = 6.27, 12. 90 Hz, 1H), 5.83 (q, J = 7.50Hz, 1H), 6.99 (d, J = 7.93 Hz, 1H), 7.18 - 7.27 (m, 4H), 7.45 (t, J = 6.27 Hz, 2H), 7.51 (t, J = 6.09 Hz,, 1H), 7.78 (d, J = 7.11 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 21.1, 51.5, 78.3, 126.4, 127.1, 128.7, 129.9, 132.1, 133.4, 133.5, 138.8, 167.1. ESI HRMS exact mass calcd. for $C_{16}H_{16}N_2O_3$ +H^+ requires m/z 285.1234, found m/z 285.1240.

***N*-(2-nitro-1-p-tolylethyl)-2-phenylacetamide (3q)** : white solid; yield: 68%; mp: 116.8-117.2℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 2.31 (s, 3H), 3.62 (s, 2H), 4.63 (dd, J = 5.31, 12.75 Hz, 1H), 4.78 (dd, J = 6.51, 12.78 Hz, 1H), 5.60 (dd, J = 6.18, 13.71 Hz, 1H), 6.23 (d, J = 7.74 Hz, 1H), 7.02 (d, J = 8.07 Hz, 2H), 7.13 (d, J = 8.04 Hz, 2H), 7.25 - 7.40 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): 21.1, 43.6, 51.0, 78.3, 126.1, 127.6, 129.1, 129.4, 129.8, 133.2, 134.2, 138.6, 170.7. ESI HRMS exact mass calcd. for $C_{17}H_{18}N_2O_3$ +H^+ requires m/z 299.1390, found m/z 299.1389.

***N*-(1-(2-bromophenyl)-2-nitroethyl)acetamide (3r)** : white solid; yield: 71%; mp: 139.6-140.1℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 2.10 (s, 3H), 4.81 (dd, J = 4.72, 13.08 Hz, 1H), 4.97 (dd, J = 7.08, 13.08 Hz, 1H), 5.99- 6.03 (m, 1H),6.91 (d, J = 7.60 Hz, 1H), 7.20 - 7.27 (m, 1H), 7.28- 7.54 (m, 2H), 7.62 (d, J = 7.84 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.3, 55.3, 86.4, 126.5, 128.6, 129.1, 136.9, 169.9. ESI HRMS exact mass calcd. for $C_{10}H_{11}BrN_2O_3$+H^+ requires m/z 287.0029, found m/z 287.0028.

***N*-(1-(2-bromophenyl)-2-nitroethyl)benzamide (3s)** : white solid; yield: 65%; mp: 193.6-194.3℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 4.95 (dd, J = 4.84, 13. 00 Hz, 1H), 5.13 (dd, J = 6.48, 13.20 Hz, 1H),6.18 (q, J = 6.68 Hz, 1H), 7.23- 7.58(m, 6H), 7.65 (d, J = 8.00 Hz, 1H), 7.85 (d, J = 7.20Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 51.7, 77.3, 127.1, 128.2, 128.4, 128.8, 130.2, 130.4, 132.3, 133.9, 135.2, 166.6. ESI HRMS exact mass calcd. for $C_{15}H_{13}BrN_2O_3$ +H^+ requires m/z 349.0182, found m/z 349.0175.

***N*-(1-(2-bromophenyl)-2-nitroethyl)-2-phenylacetamide (3t)** : white solid; yield: 62%; mp: 167.5-168.4℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 3.65 (d, J = 1.52 Hz, 2H), 4.74 (dd, J = 4.72, 12.88 Hz, 1H), 4.85 - 4.92 (m, 1H), 5.91 - 5.96 (m, 1H), 6.60 (d, J = 7.68 Hz, 1H), 7.09 (d, J = 7.64 Hz, 1H), 7.21 (td, J = 1.60, 7.76 Hz, 1H), 7.18 - 7.54 (m, 7H),7.58 (d, J = 7.88 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 43.7, 51.3, 76.8, 122.6, 127.8, 128.1, 129.3, 129.5, 130.3, 133.8, 134.0, 135.0, 170.4. ESI HRMS exact mass calcd. for $C_{16}H_{15}BrN_2O_3$ +H^+ requires m/z 363.0339, foundm/z 363.0343.

***N*-(1-(naphthalen-1-yl)-2-nitroethyl)acetamide (3u)** : white solid; yield: 70%; mp: 162.1-163.0℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 2.05 (s, 3H), 4.92 - 5.02 (m, 2H), 6.33 (d, J = 7.44 Hz, 1H), 6.57 (q, J = 6.88 Hz, 1H), 7.46 - 7.48 (m, 2H), 7.57 - 7.64 (m, 2H), 7.87 - 7.93 (m, 2H), 8.12 (d, J = 8.44 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.1, 47.6, 77.4, 122.3, 123.2, 125.1, 126.4, 127.4, 129.2, 129.7, 130.4, 132.1, 134.1, 169.7. ESI HRMS exact mass calcd. for $C_{14}H_{14}N_2O_3$ +H^+ requires m/z 259.1077, found m/z 259.1080.

***N*-(1-(naphthalen-1-yl)-2-nitroethyl)benzamide (3v)** : white solid; yield: 62%; mp: 218.4-219.0℃; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 5.09 (dd, J = 6.00, 12.80 Hz, 1H), 5.16 (dd, J = 6.64, 12.84 Hz, 1H), 6.77 (q, J = 6.56 Hz, 1H), 6.93 (d, J = 7.32 Hz, 1H), 7.45 - 7.67 (m, 7H), 7.81 (d, J = 7.16 Hz, 2H), 7.90 (d, J = 8.08 Hz, 1H), 7.94 (d, J = 7.84 Hz, 1H), 8.18 (d, J = 8.56 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 48.1, 77.2, 122.3, 123.3, 125.1, 127.5, 128.8, 129.3, 129.8, 131.8, 132.2, 132.3, 134.4, 166.9. ESI HRMS exact mass calcd. for $C_{19}H_{18}N_2O_3$ +H^+ requires m/z 321.1234, found m/z 321.1240.

***N*-(1-(naphthalen-1-yl)-2-nitroethyl)-2-phenylacet-amide (3w)** : white solid; yield: 63%; mp: 185.5-186.0℃; ^{1}H NMR (300 MHz, $CDCl_3$): δ= 3.64 (d, J = 2.64 Hz, 1H), 4.86 (d, J = 5.97 Hz, 2H), 6.23 (bs, 1H), 6.52 (q, J = 7.08 Hz, 1H), 7.20 - 7.59 (m, 9H), 7.83 (d, J = 8.32 Hz, 1H), 7.89 (d, J = 7.70 Hz, 1H), 8.02 (d, J = 8.16 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): 43.6, 47.7, 77.2, 122.1, 123.1, 125.1, 127.4, 127.7, 129.4, 129.7, 130.2, 131.8, 134.1, 170.6; ESI HRMS exact mass calcd. for $C_{20}H_{18}N_2O_3$ +Na^+ requires m/z 357.1210, found m/z 357.1213.

***N*-(2-nitro-1-phenylpropyl)acetamide (3x)** : white solid; yield: 74%; mp: 140.2-141.1℃; diastereomeric ratio: 88%; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 1.58 (d, J = 6.76 Hz, 3H), 2.09 (s, 3H), 4.98 - 5.05 (m, 1H), 5.46-5.52 (m, 1H), 6.70 (d, J = 9.20 Hz, 1H), 7.27 - 7.41 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): 23.2, 29.7, 51.2, 122.9, 128.1, 128.2, 130.3, 133.8, 135.2, 169.6. ESI HRMS exact mass calcd. for $C_{11}H_{14}N_2O_3$ +H^+ requires m/z 223.1026, found m/z 223.1030.

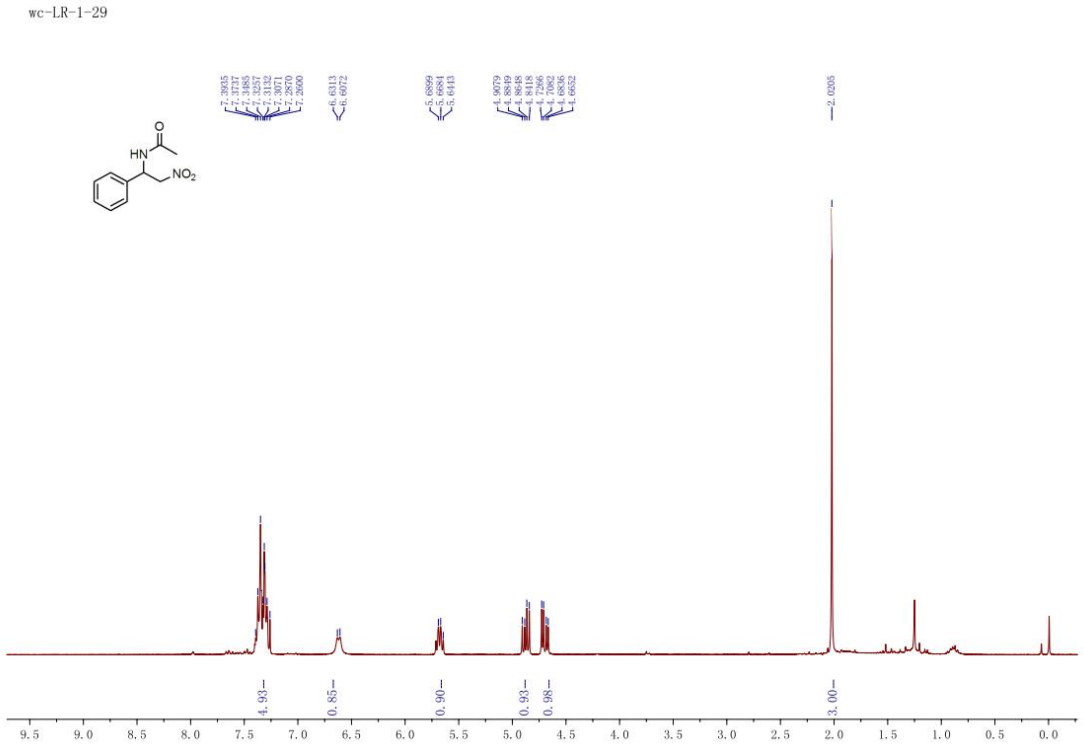
***N*-(2-nitro-1-phenylpropyl)benzamide (3y)** : white solid; yield: 73%; mp: 199.9-200.8℃; diastereomeric ratio: 69%; ^{1}H NMR (400 MHz, $CDCl_3$): δ=1.69 (d, J = 6.76 Hz, 3H), 5.10 - 5.20 (m, 1H), 5.64 - 5.72 (m, 1H), 7.33 - 7.42 (m, 5H), 7.48 - 7.60 (m, 3H), 7.87 (d, J = 7.08 Hz, 2H). ESI HRMS exact mass calcd. for $C_{16}H_{16}N_2O_3$+H^+ requires m/z 285.1234, found m/z 285.1235.

***N*-(2-nitro-1-phenylpropyl)-2-phenylacetamide (3z)** : white solid; yield: 70%; mp: 137.1-137.8℃; diastereomeric ratio: 78%; ^{1}H NMR (400 MHz, $CDCl_3$): δ=1.50 (d, J = 6.76 Hz, 3H), 3.61 - 3.77 (m, 2H), 4.87 - 4.95 (m, 1H), 5.43 (dd, J = 6.00, 9.40 Hz, 1H), 6.54 (d, J = 9.04 Hz, 1H), 7.10（d, J = 6.12 Hz, 2H）7.28 - 7.46 (m, 8H). ^{13}C NMR (100 MHz, $CDCl_3$): 17.1, 43.7, 55.1, 86.4, 126.3, 127.7, 128.5, 129.1, 129.3, 129.4, 134.3. 136.8, 170.8; ESI HRMS exact mass calcd. for $C_{17}H_{18}N_2O_3$ +H^+ requires m/z 299.1334, found m/z 285.1335.

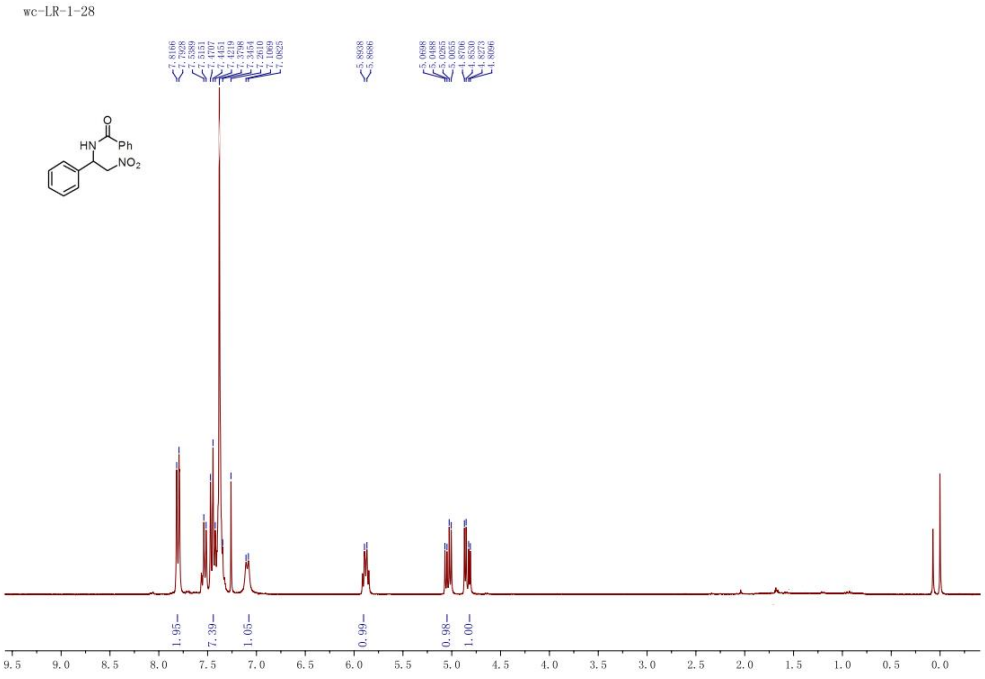
***N*-(2-nitro-1-(thiophen-2-yl)ethyl)acetamide (3aa)** : white solid; yield: 80%; ^{1}H NMR (400 MHz, $CDCl_3$): δ= 2.09 (s, 3H), 4.77 - 4.81 (dd, J = 5.4, 13.3 Hz, 1H), 4.95 - 4.99 (dd, J = 5.8, 13.3 Hz, 1H), 5.92 - 5.97 (m, 1H), 6.34 (brs, 1H), 7.00 - 7.05 (m, 2H), 7.13 - 7.3（m, 1H）. ^{13}C NMR (100 MHz, $CDCl_3$): 23.2, 47.2, 78.0, 125.6, 125.8, 127.4, 139.3, 169.6.

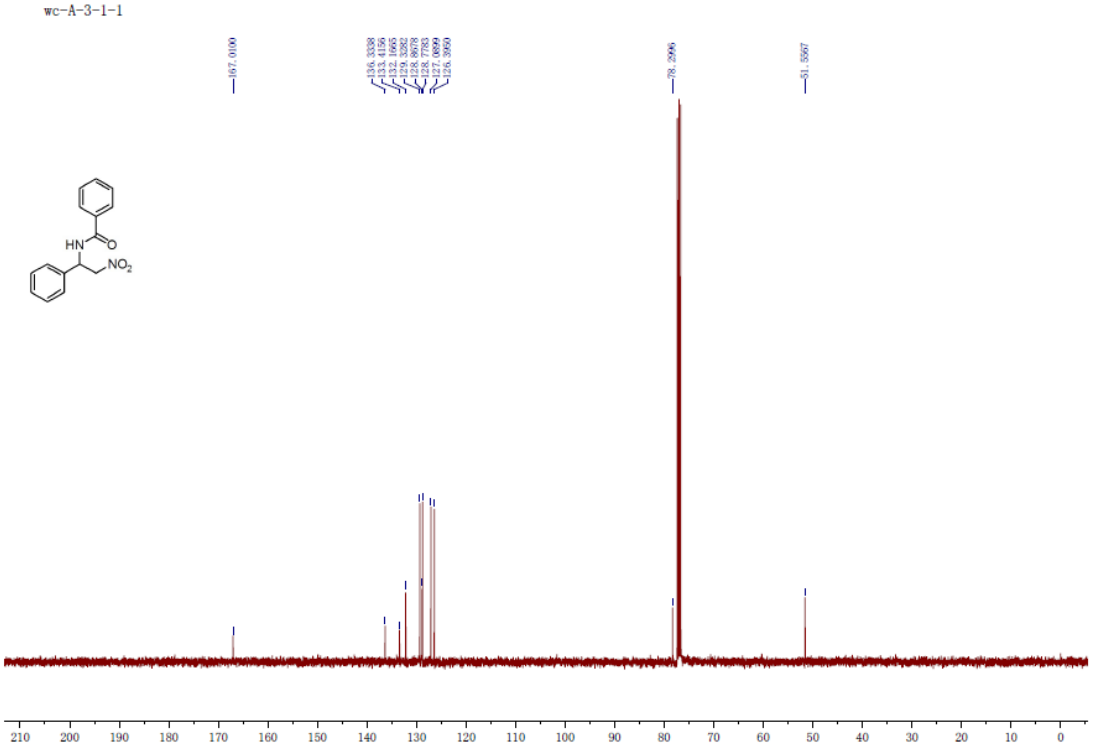
^{1}H and ^{13}C NMR Spectra:

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

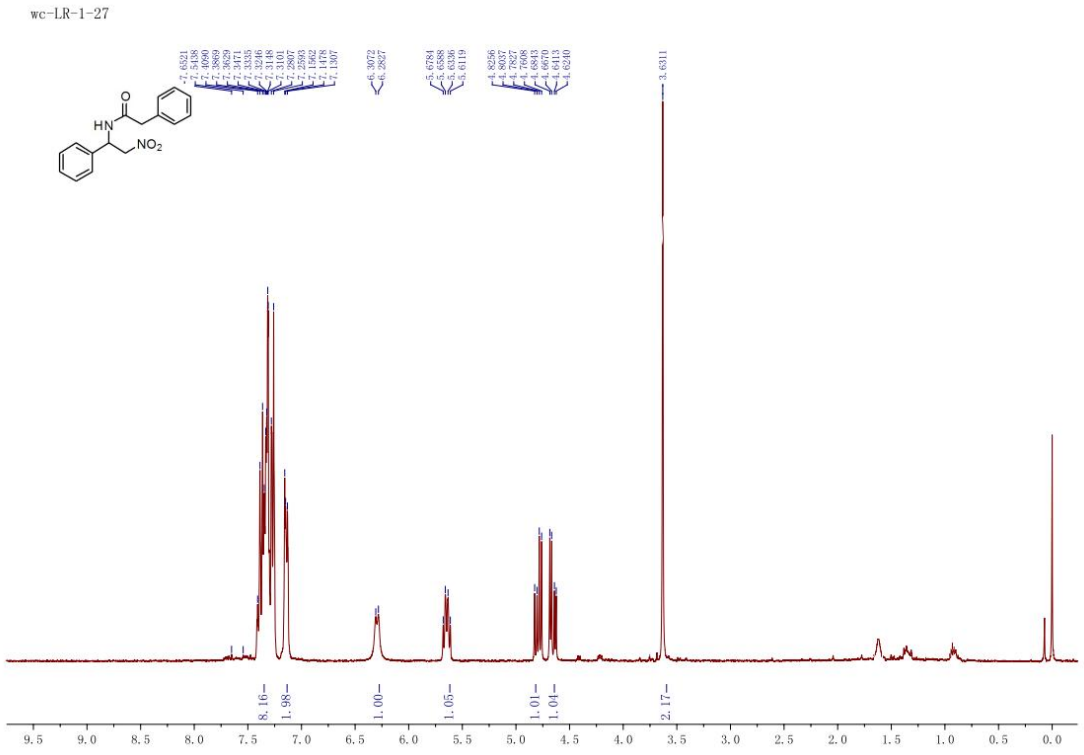


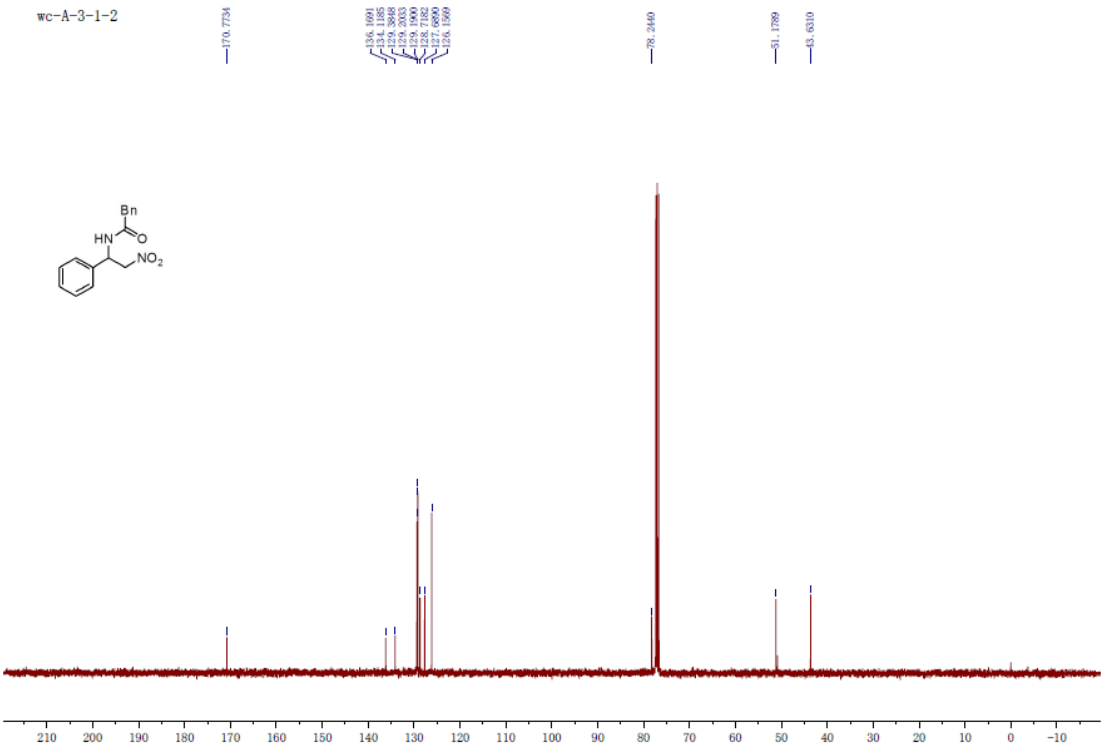
The ^{1}H and ^{13}C NMR Spectra of 3b



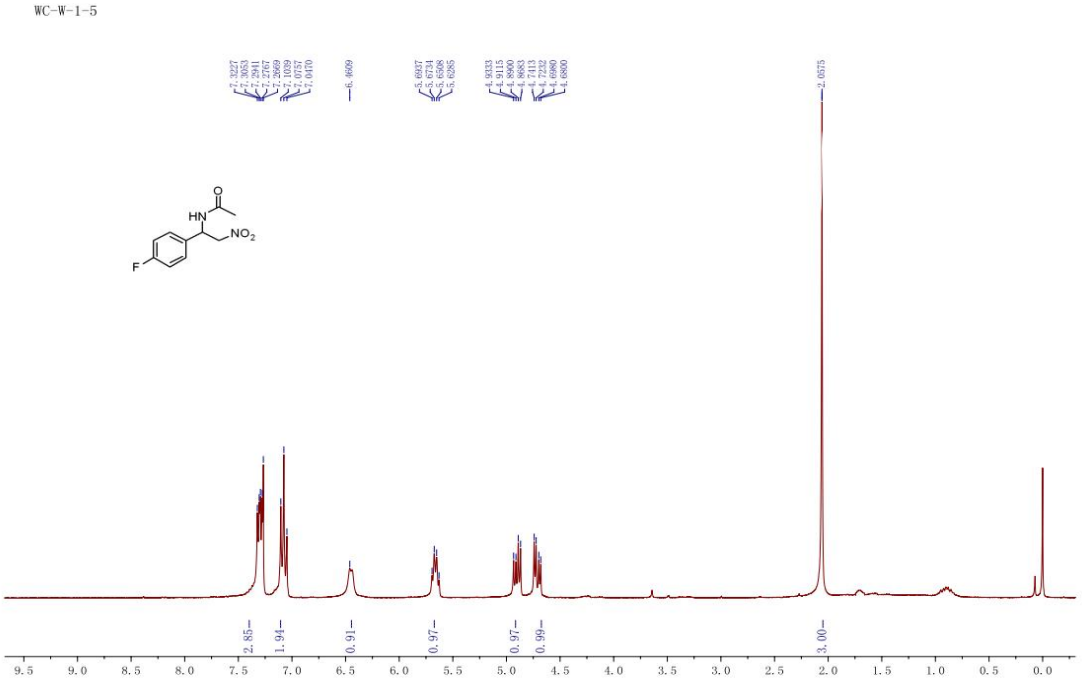


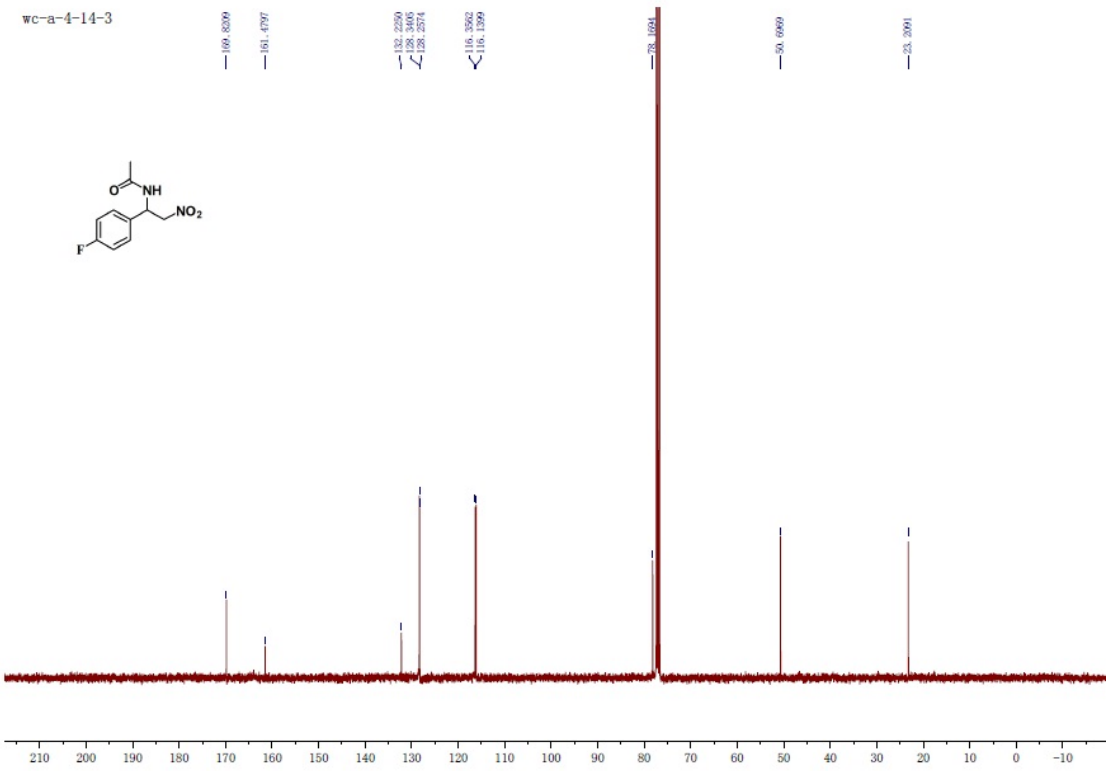
The ^{1}H and ^{13}C NMR Spectra of 3c



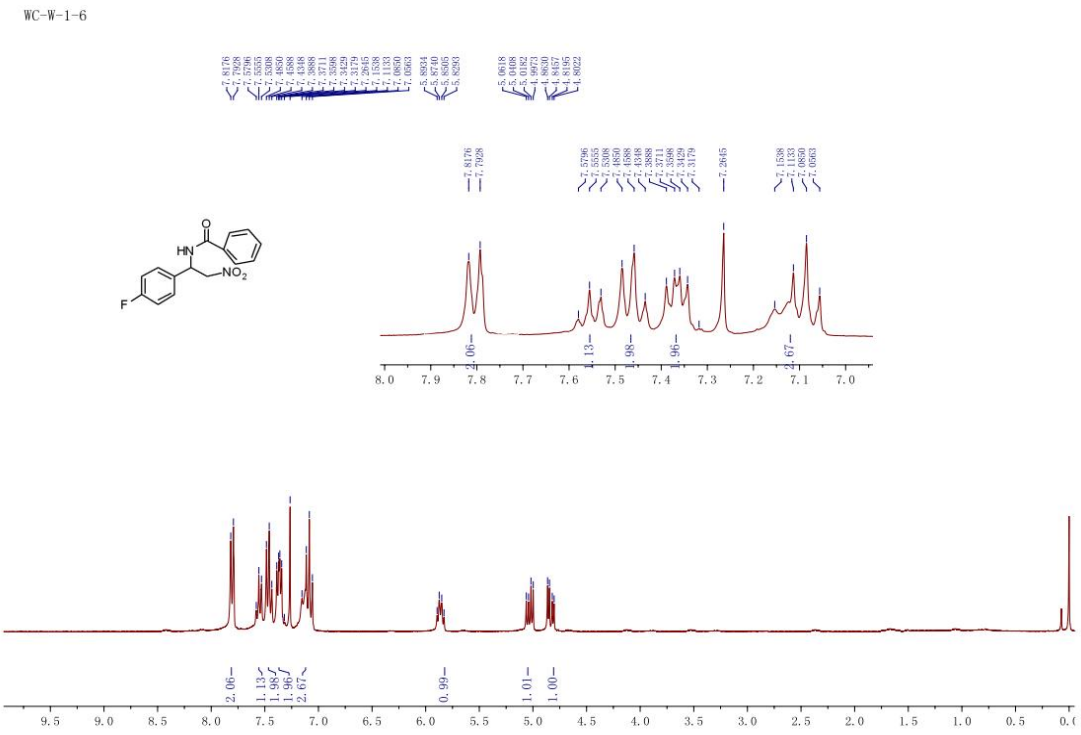


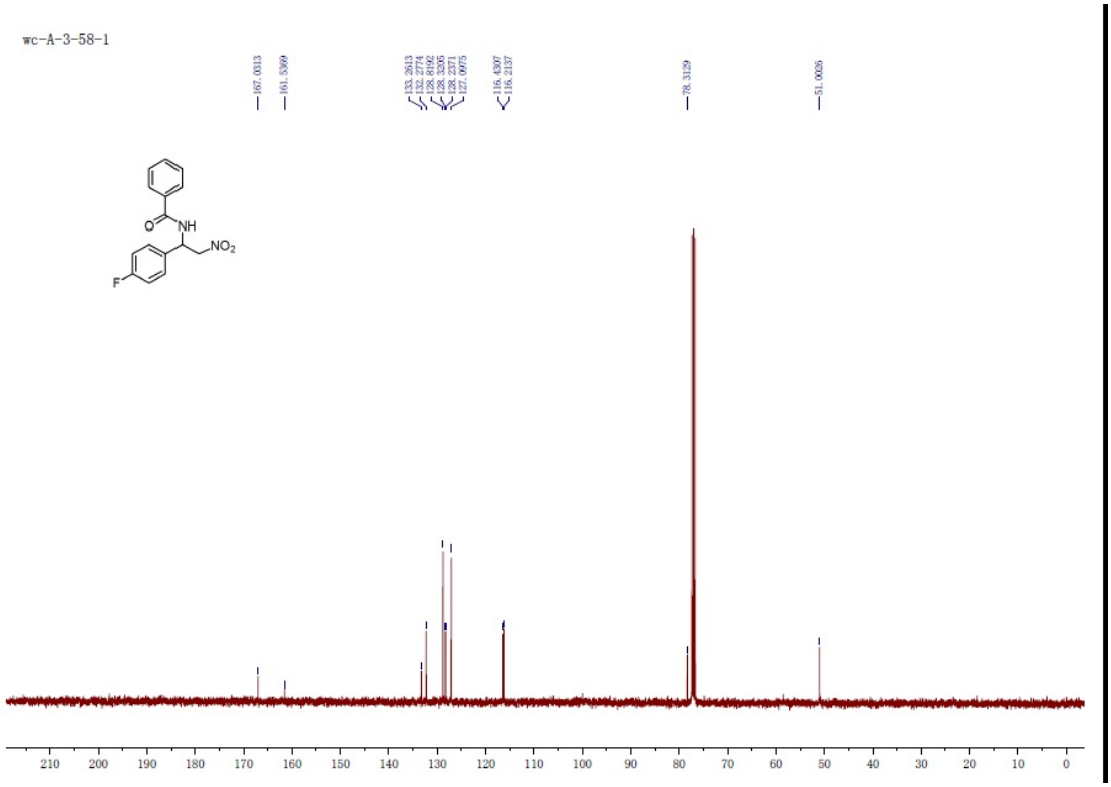
The ^{1}H and ^{13}C NMR Spectra of 3e



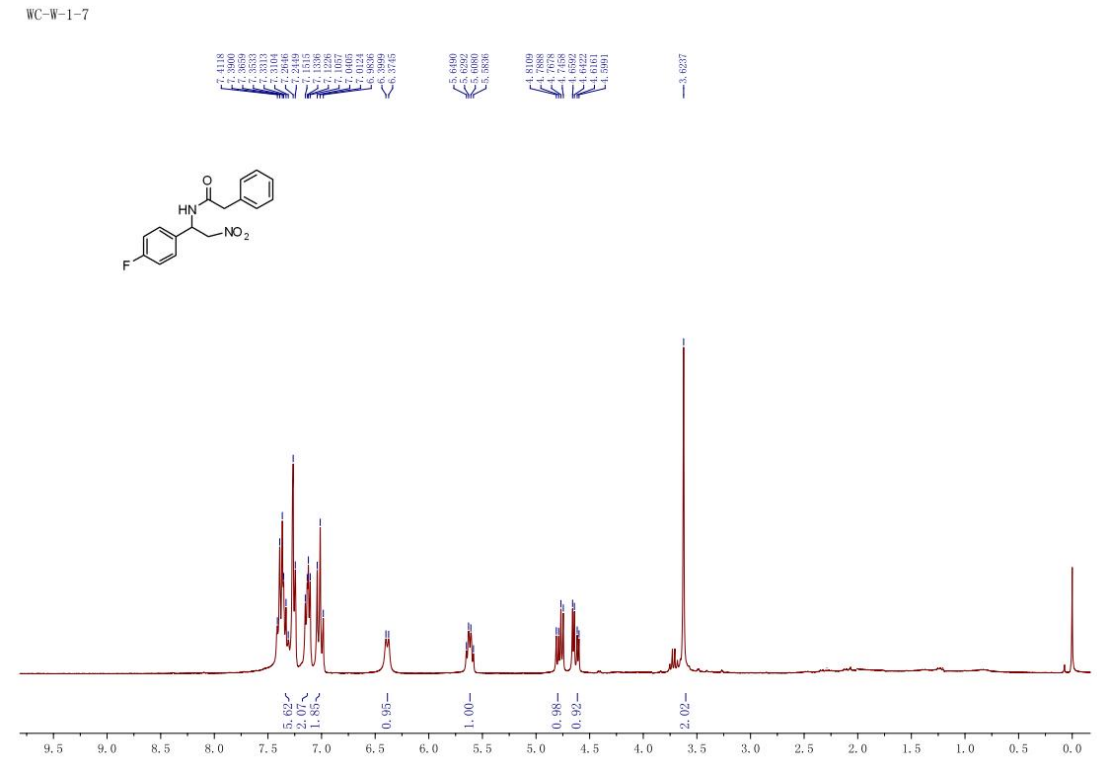


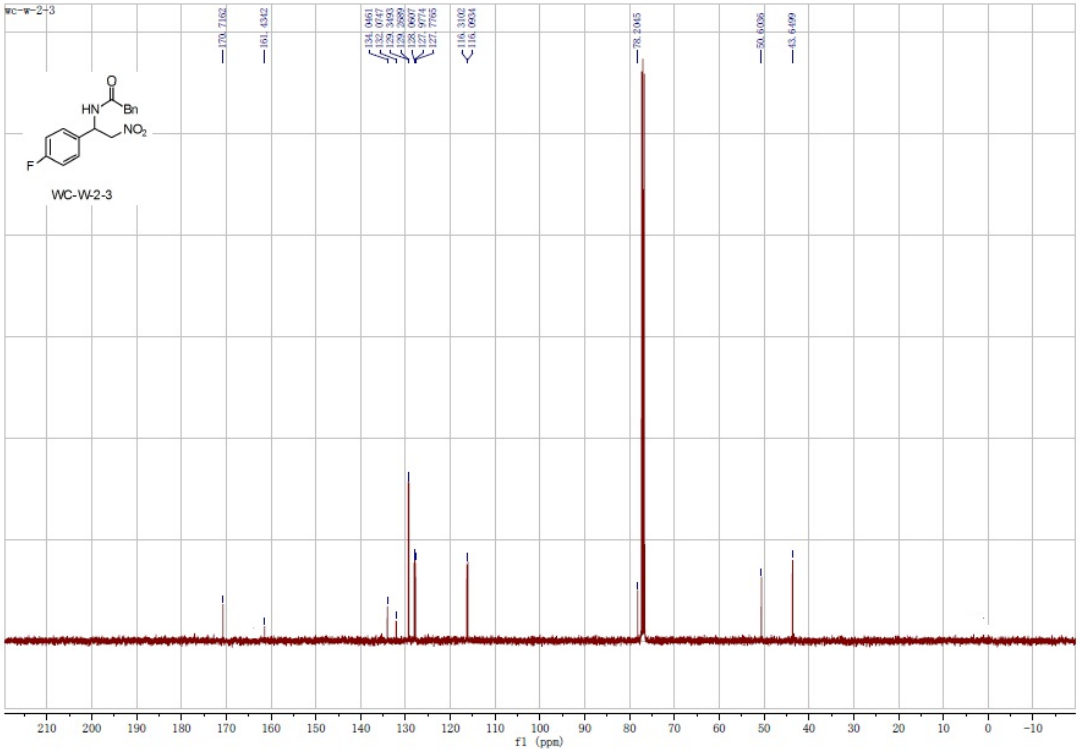
The ^{1}H and ^{13}C NMR Spectra of 3f



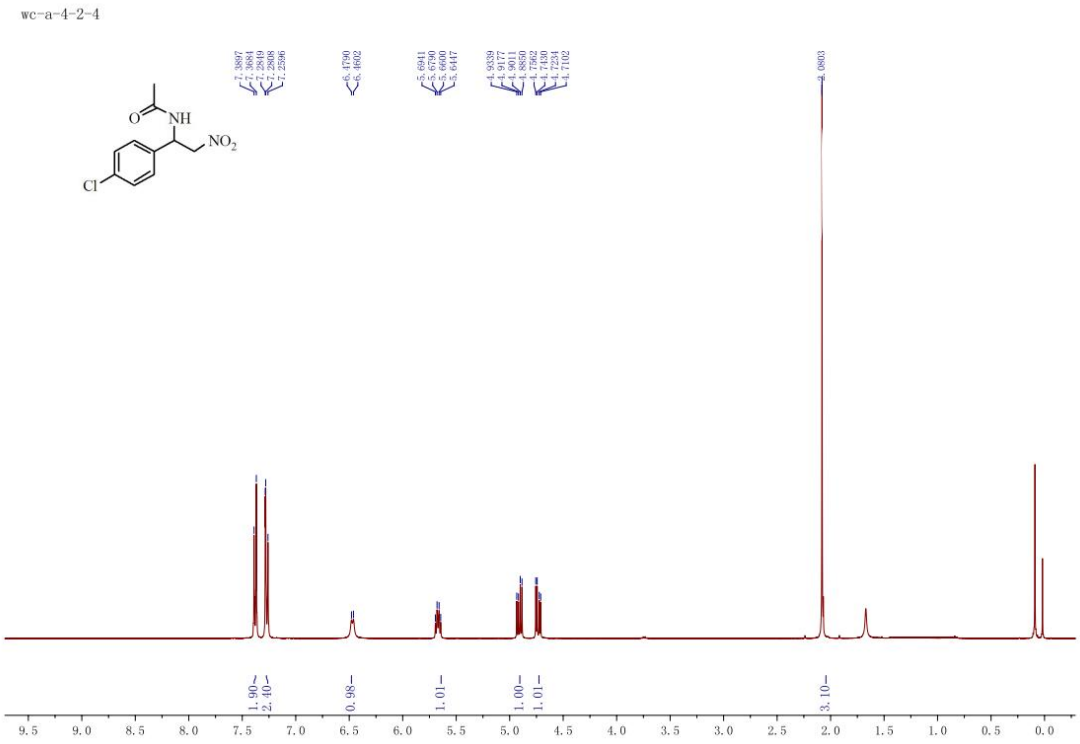


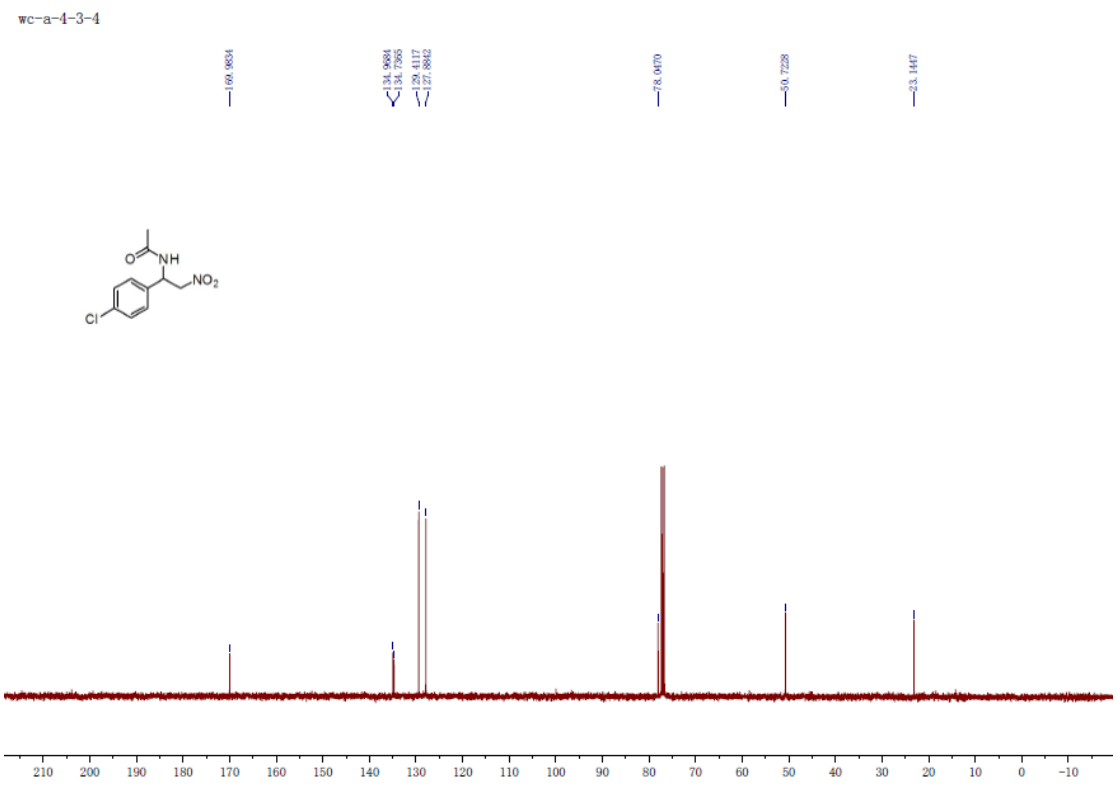
The ^{1}H and ^{13}C NMR Spectra of 3g



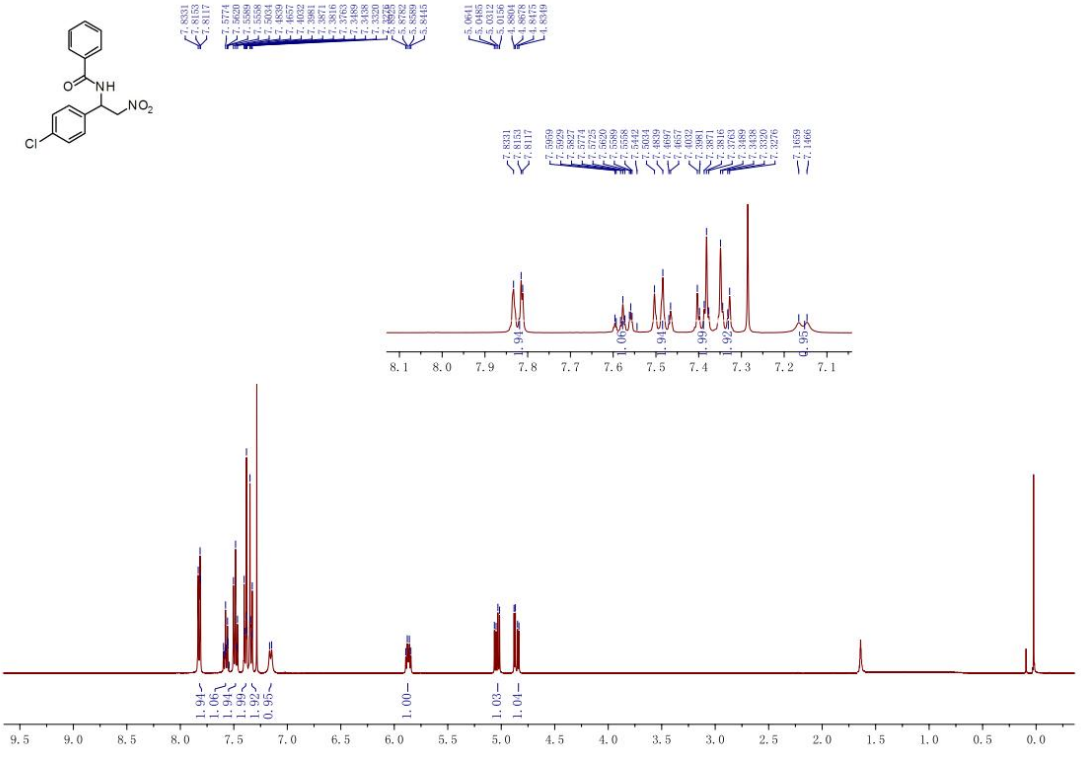


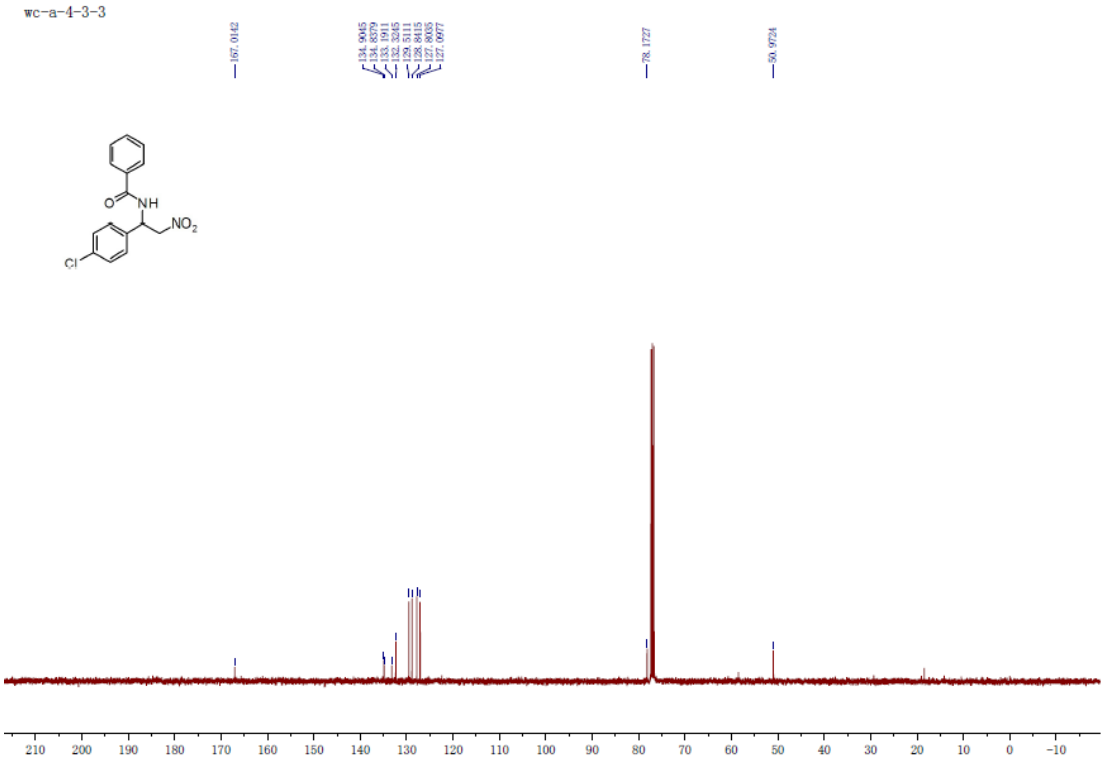
The ^{1}H and ^{13}C NMR Spectra of 3i



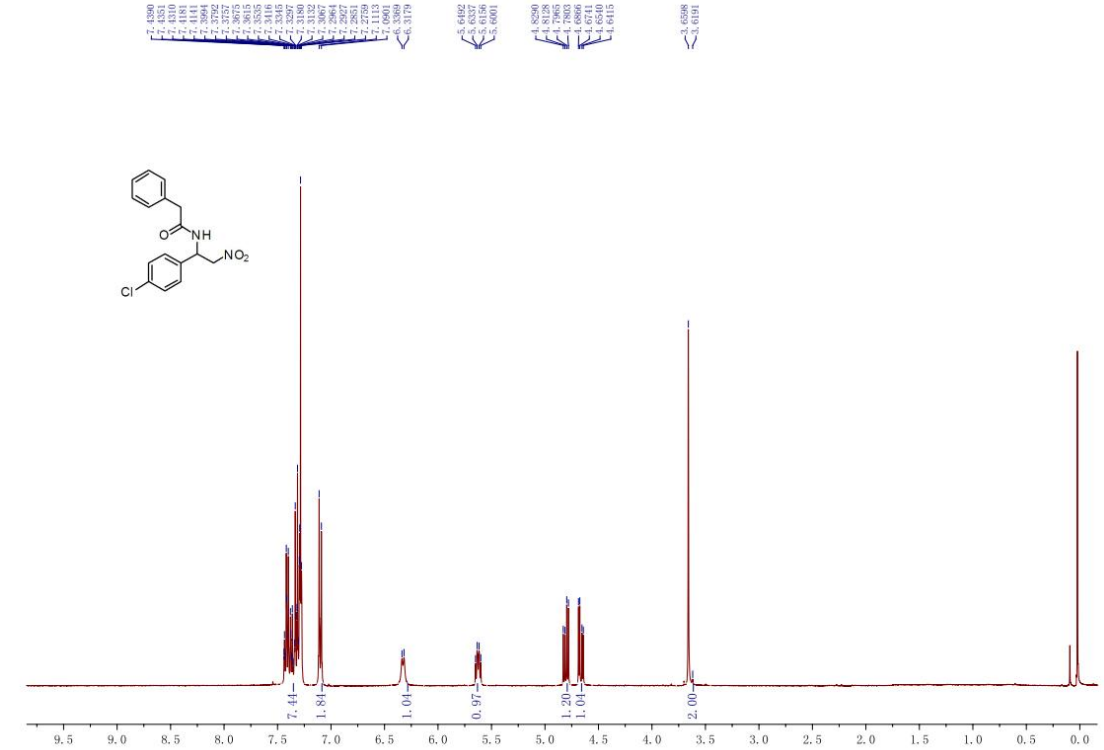


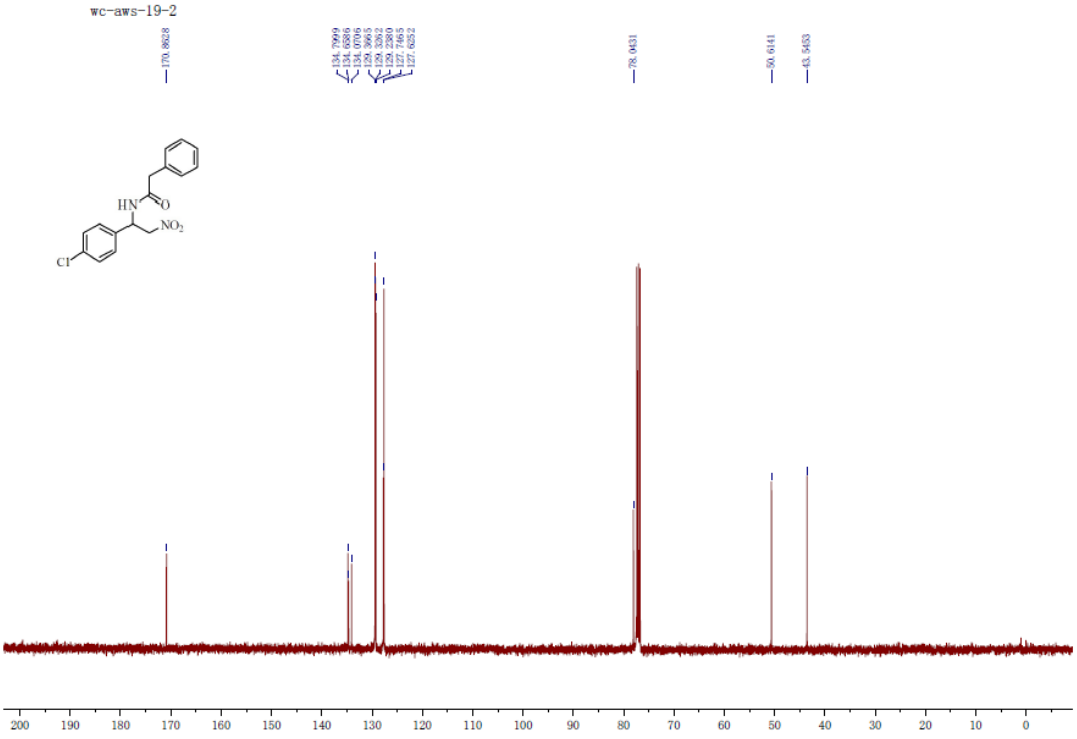
The ^{1}H and ^{13}C NMR Spectra of 3j



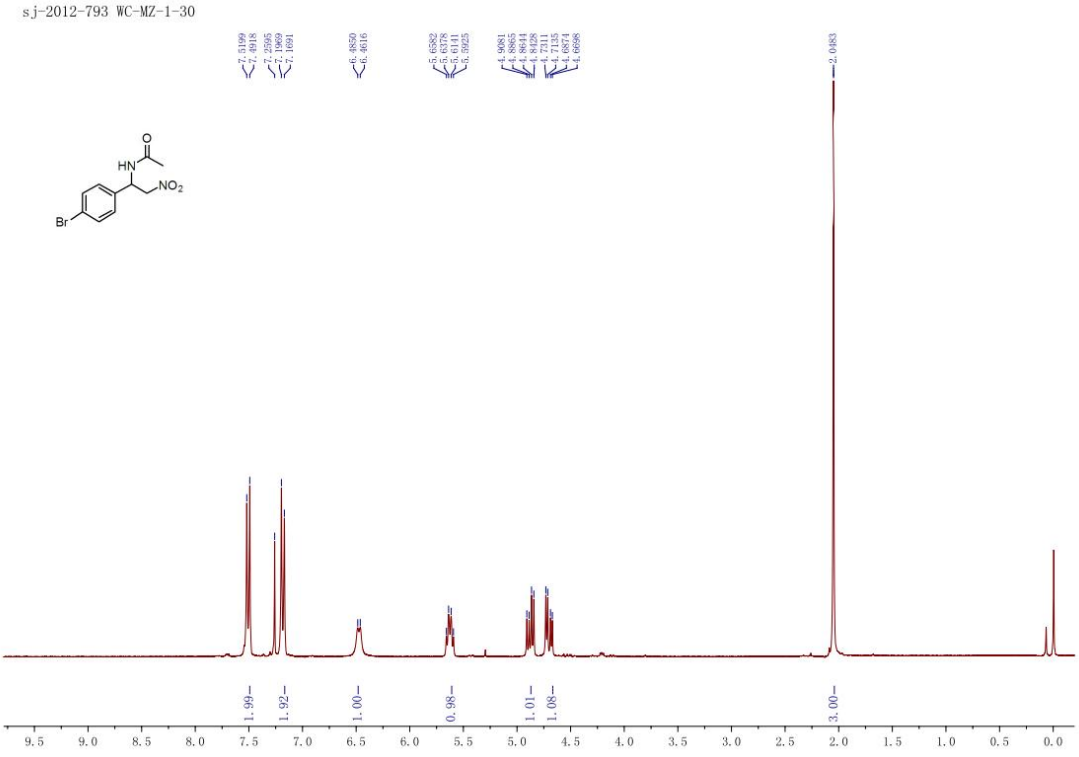


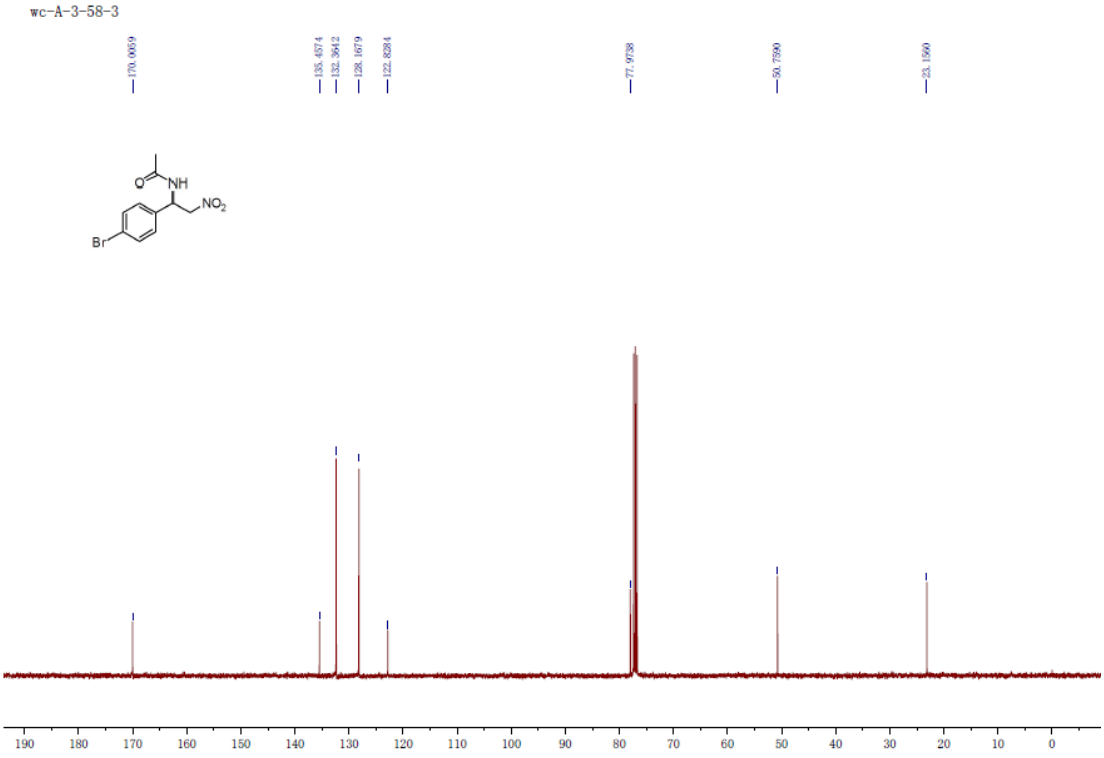
The ^{1}H and ^{13}C NMR Spectra of 3k



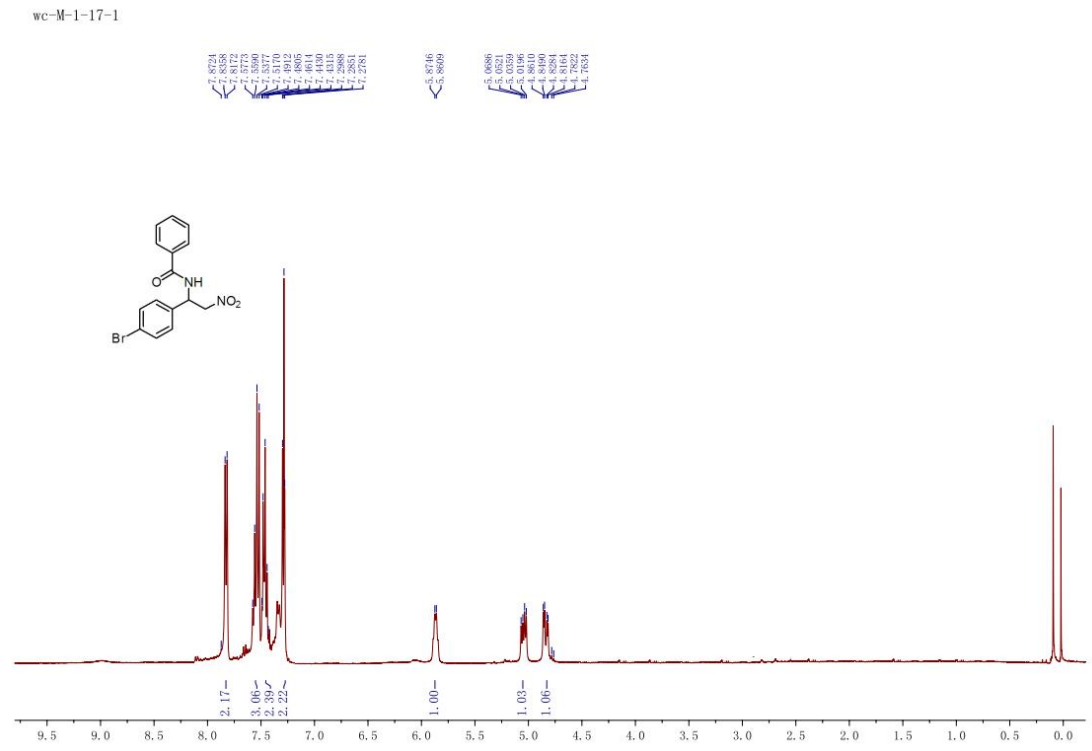


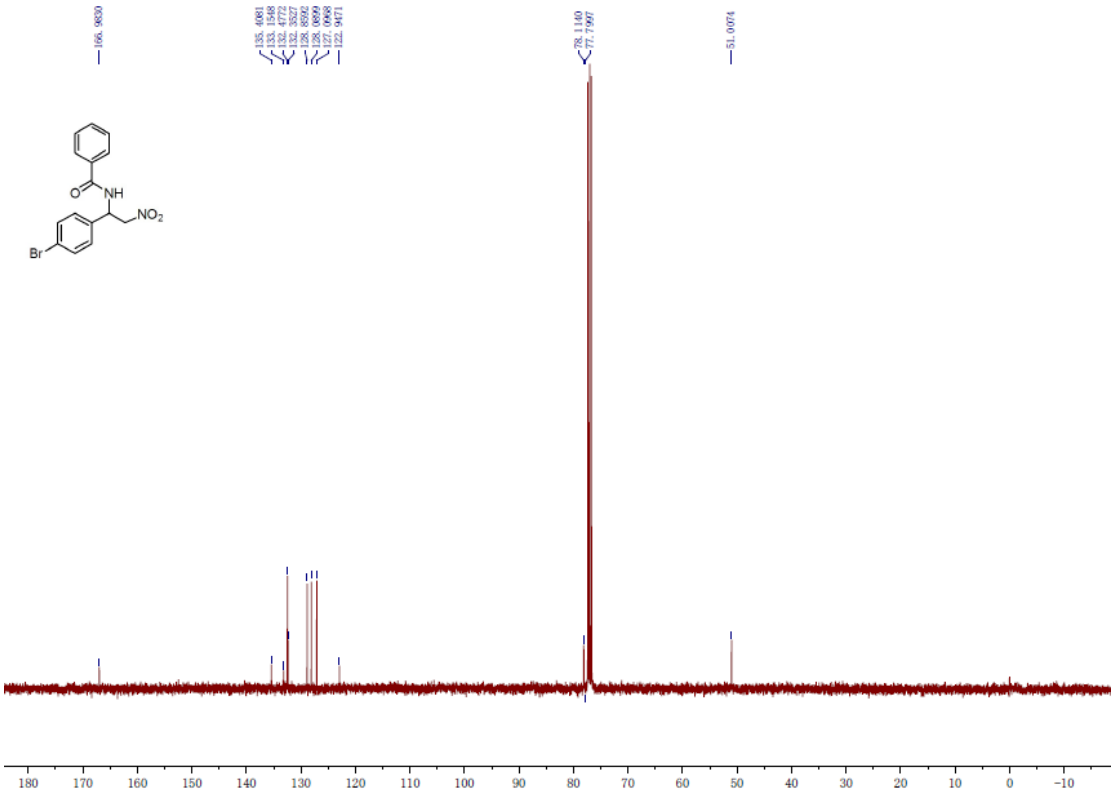
The ^{1}H and ^{13}C NMR Spectra of 3l



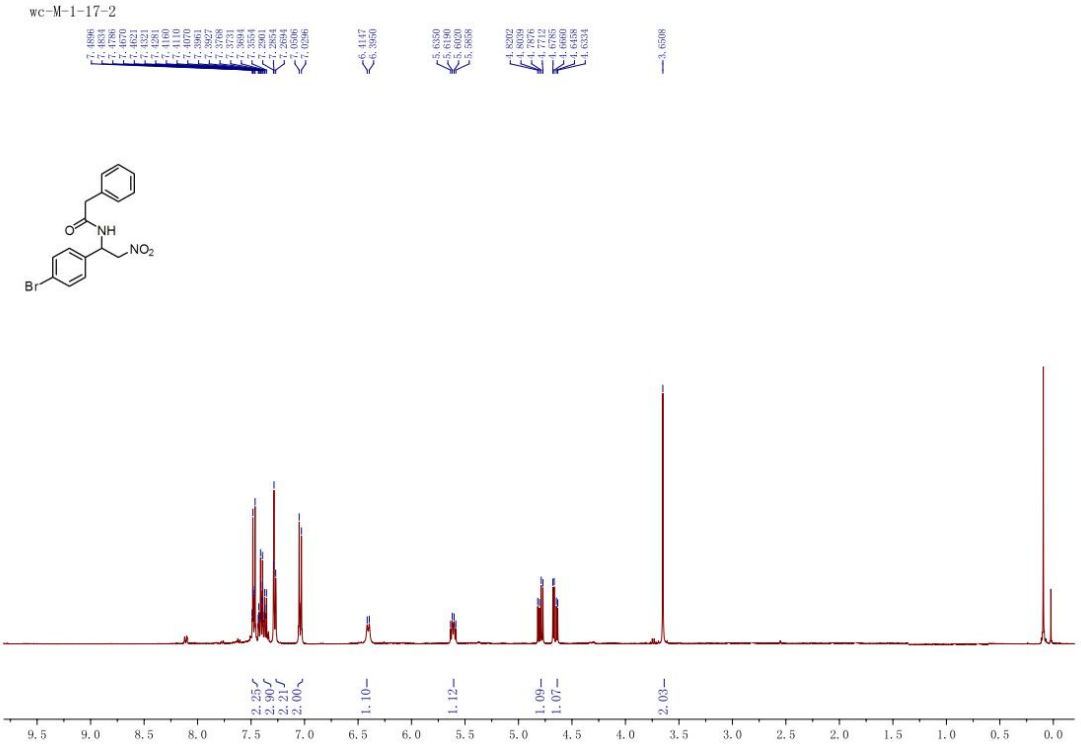


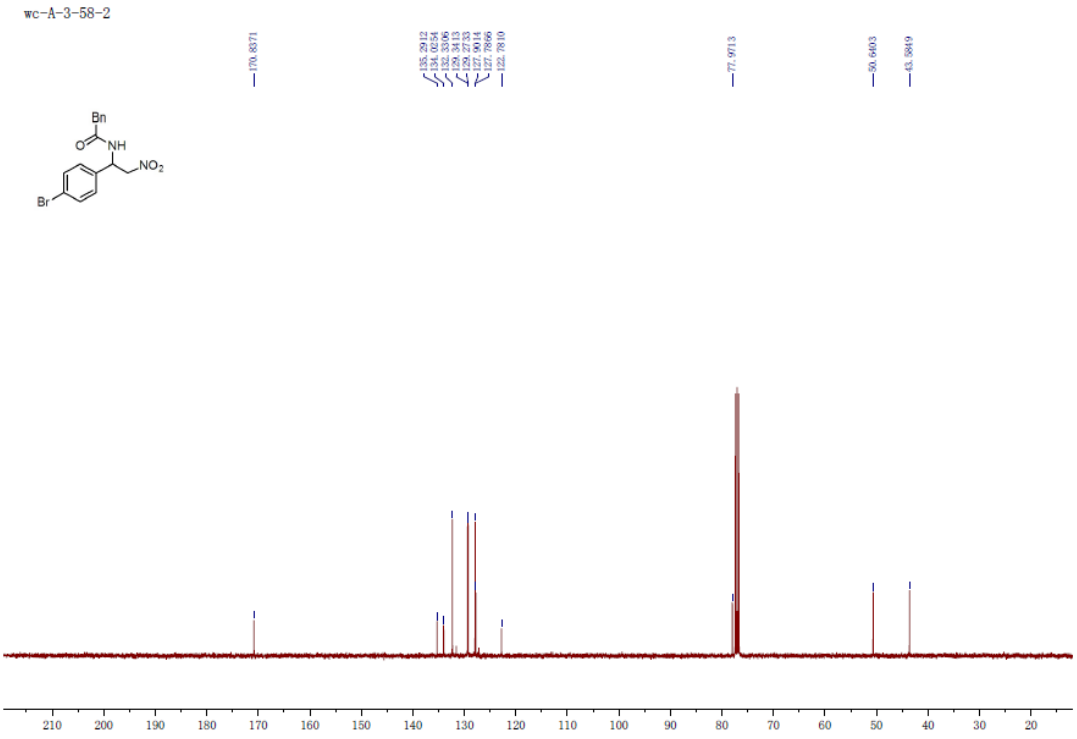
The ^{1}H and ^{13}C NMR Spectra of 3m



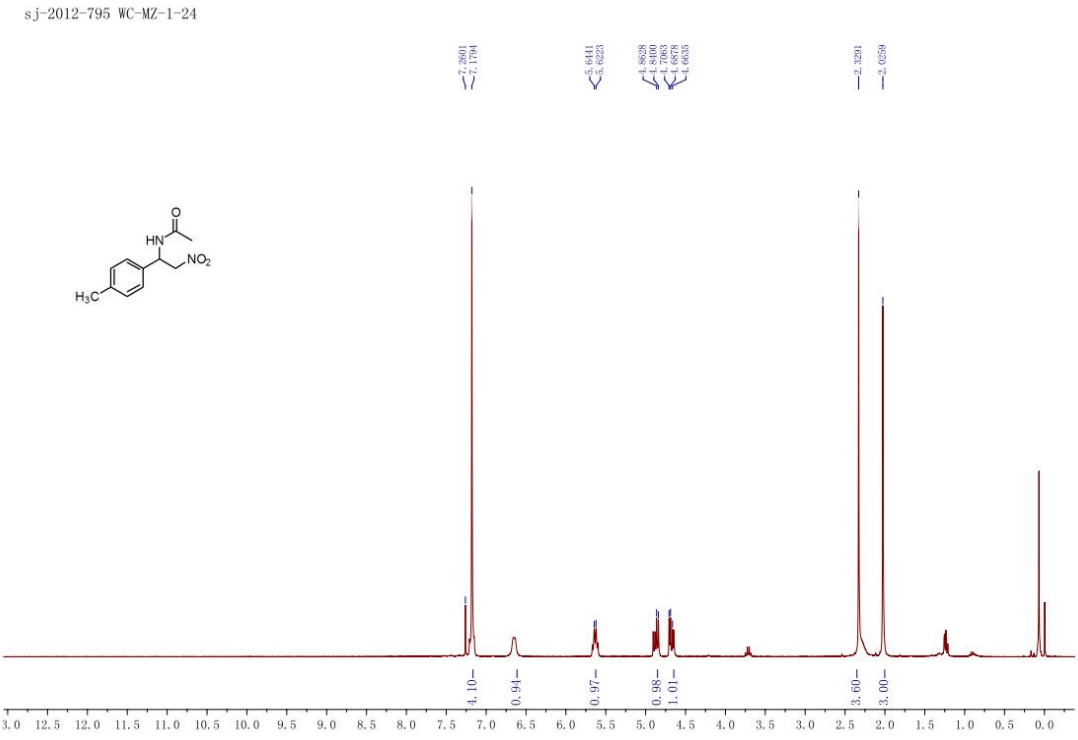


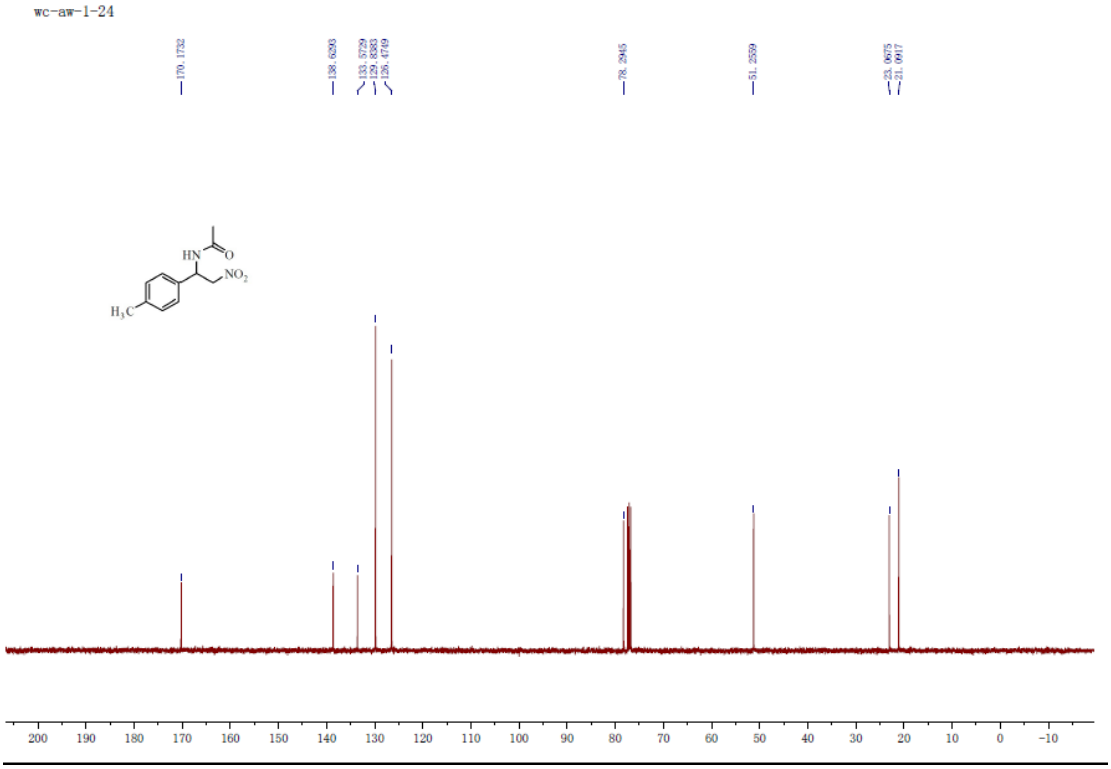
The ^{1}H and ^{13}C NMR Spectra of 3n



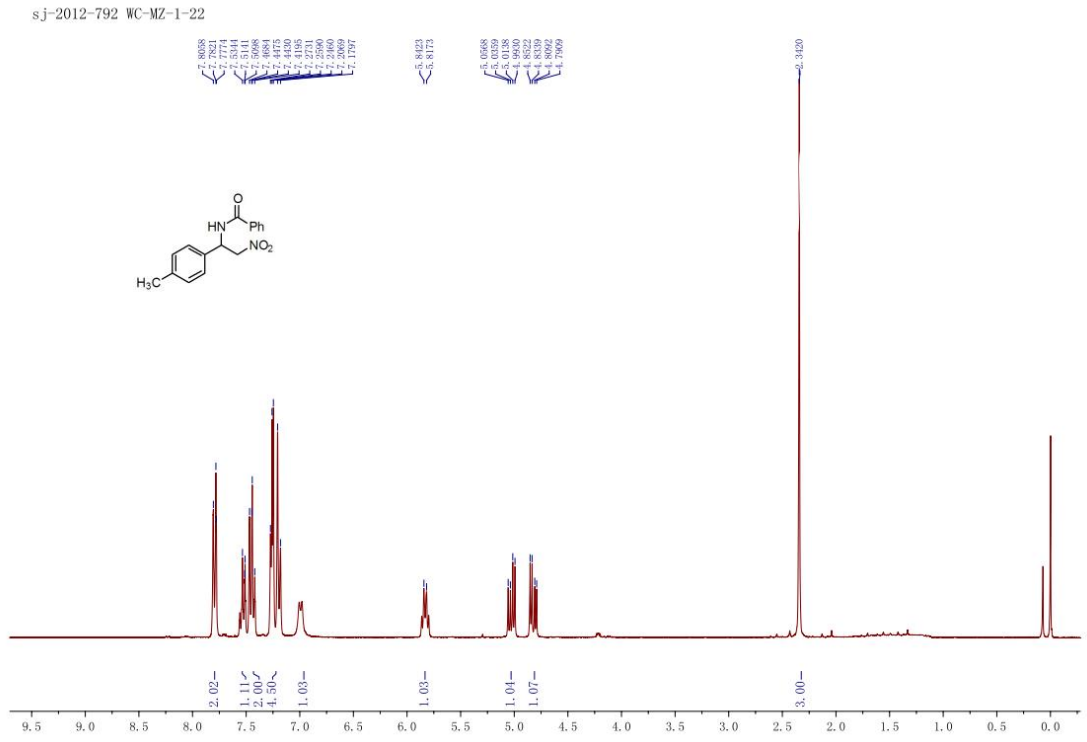


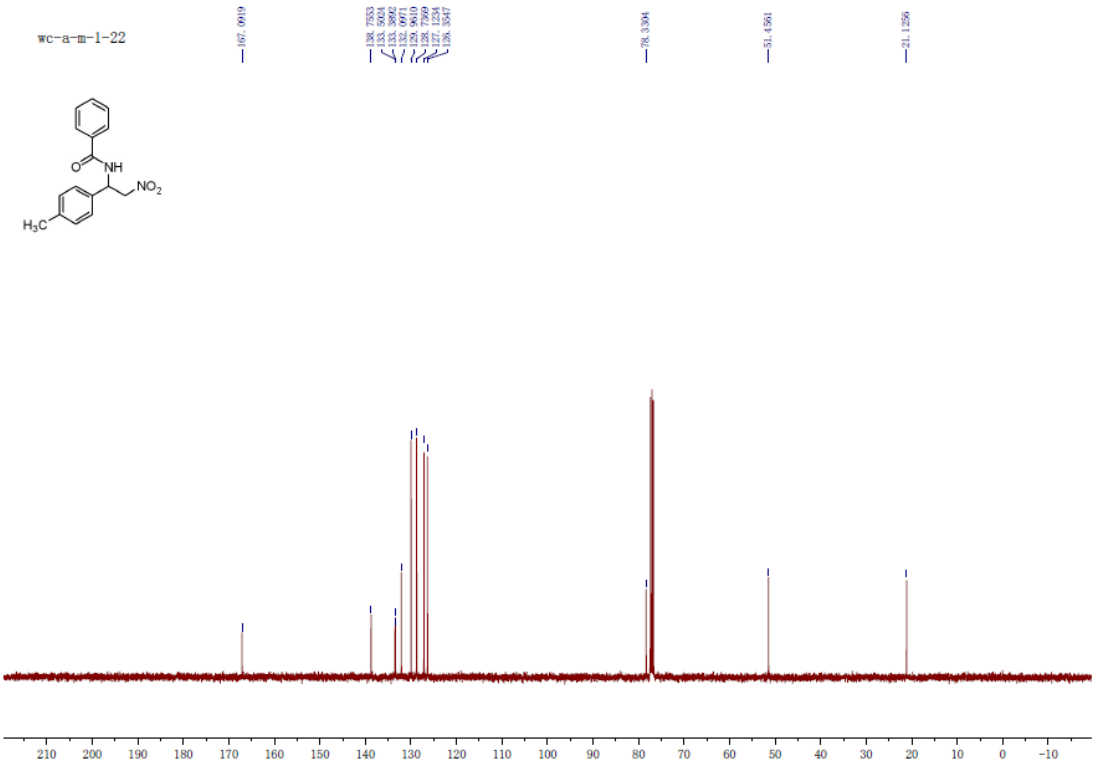
The ^{1}H and ^{13}C NMR Spectra of 3o



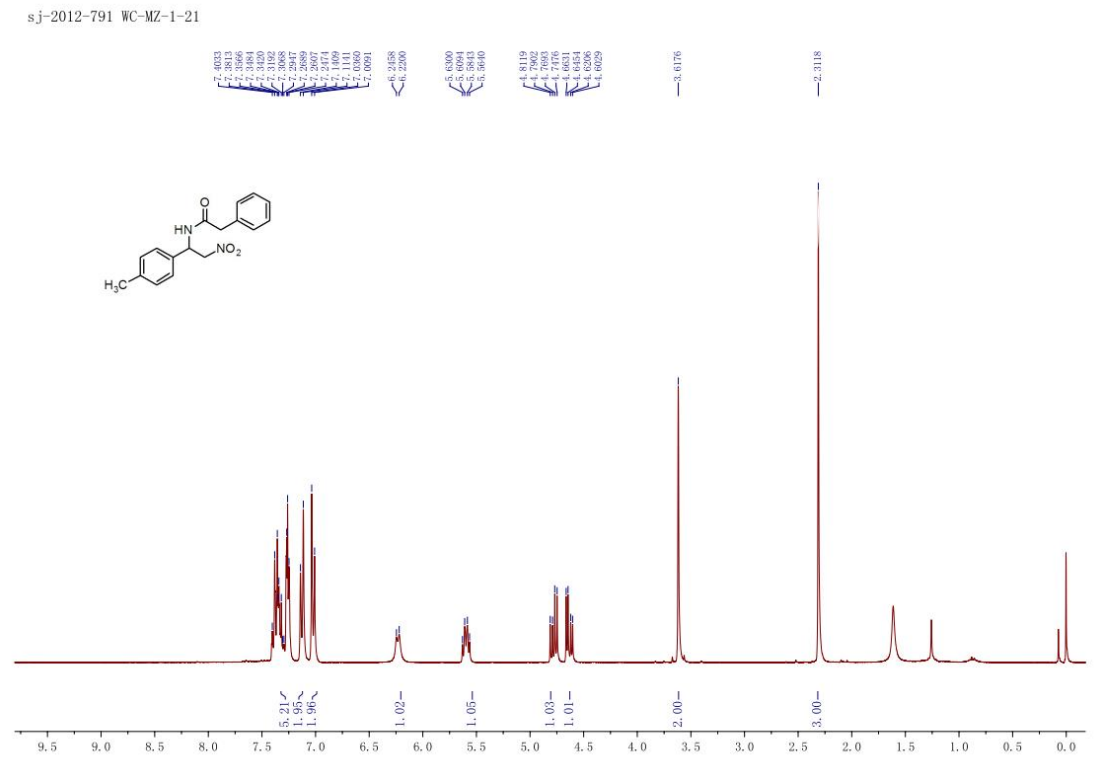


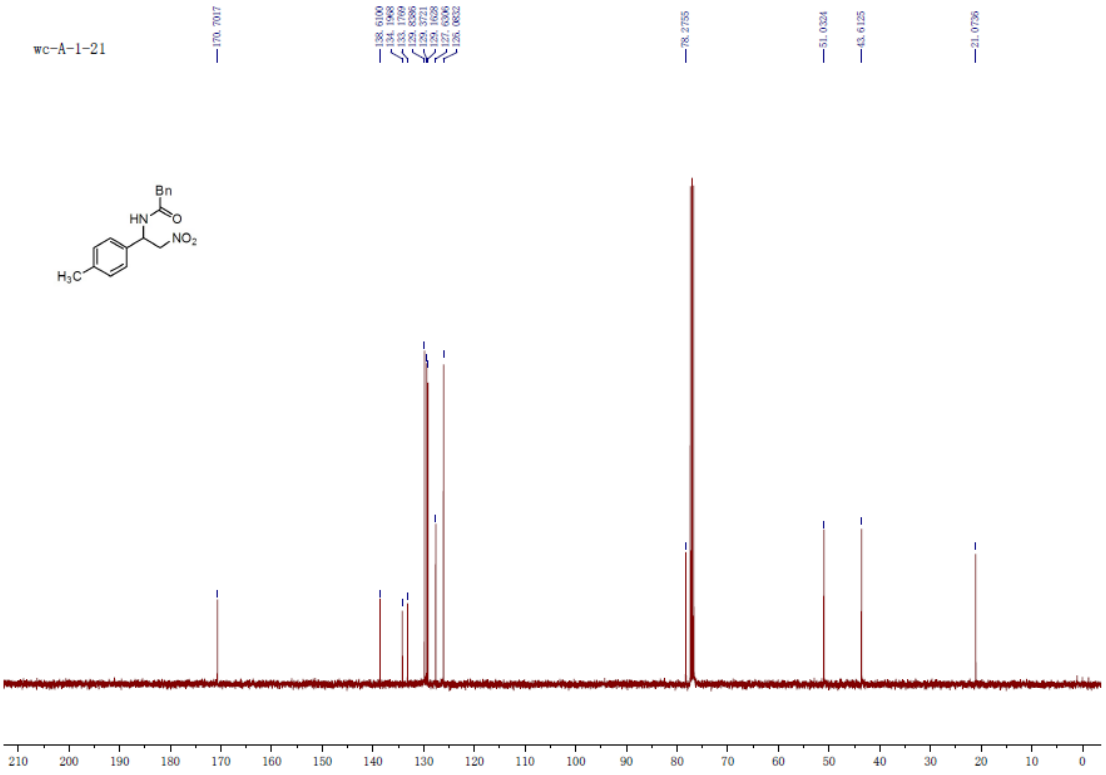
The ^{1}H and ^{13}C NMR Spectra of 3p



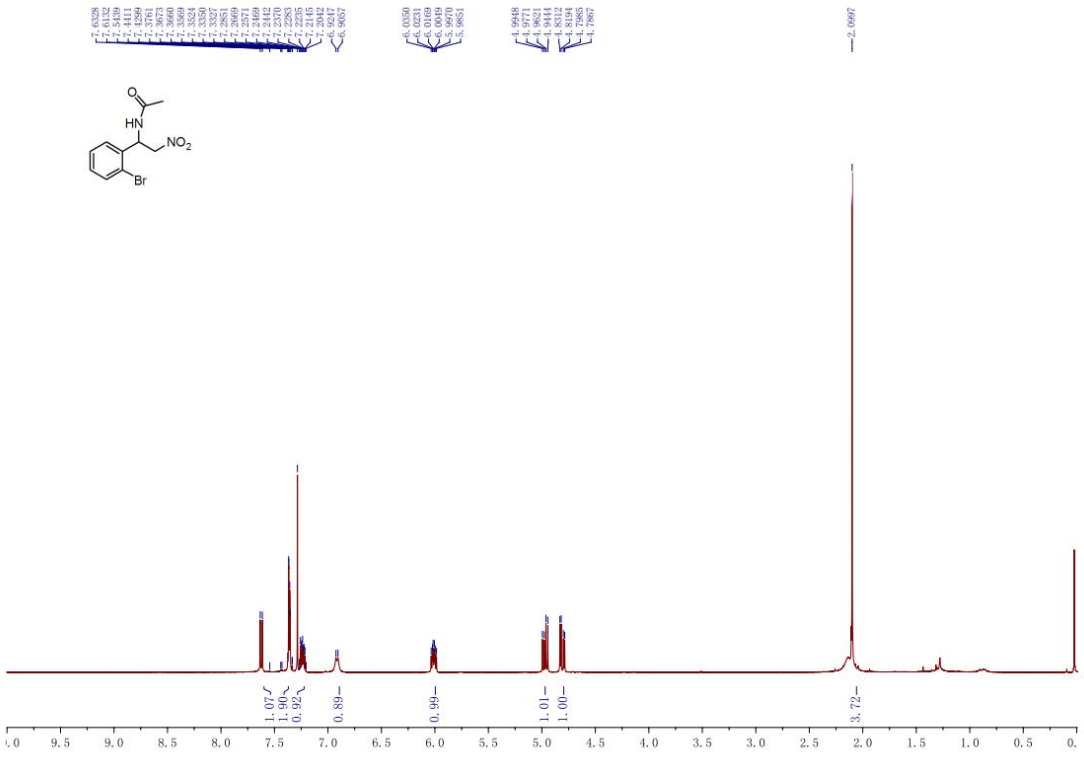


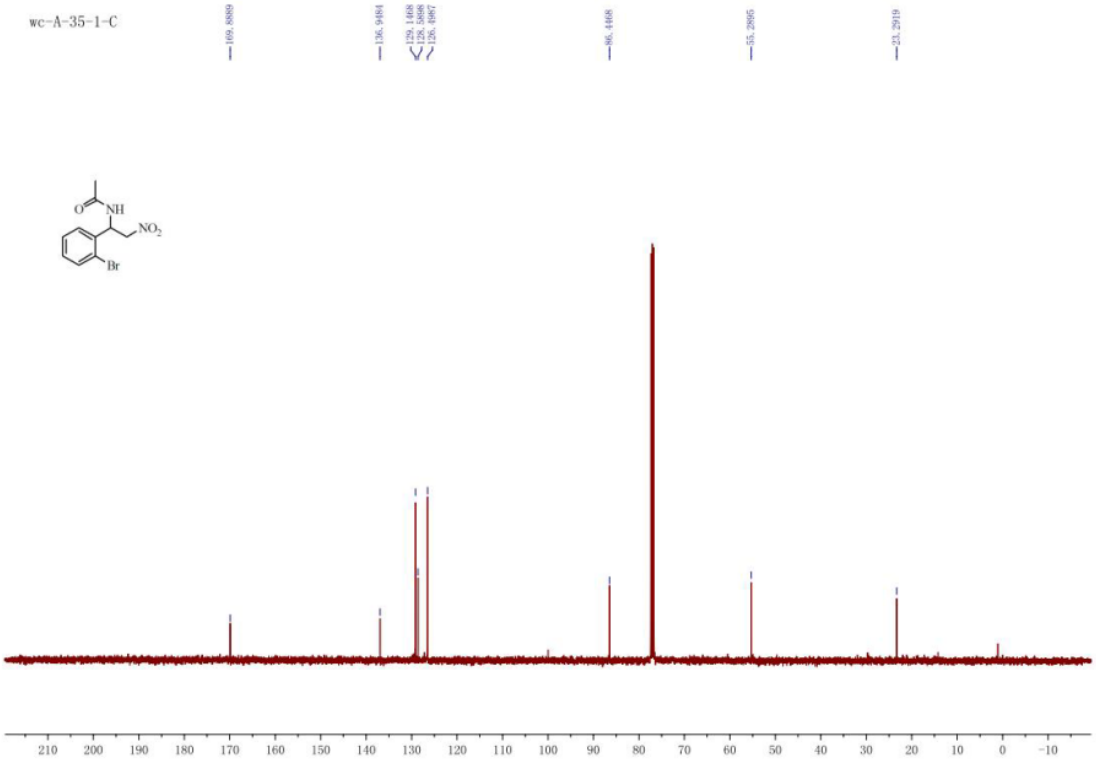
The ^{1}H and ^{13}C NMR Spectra of 3q



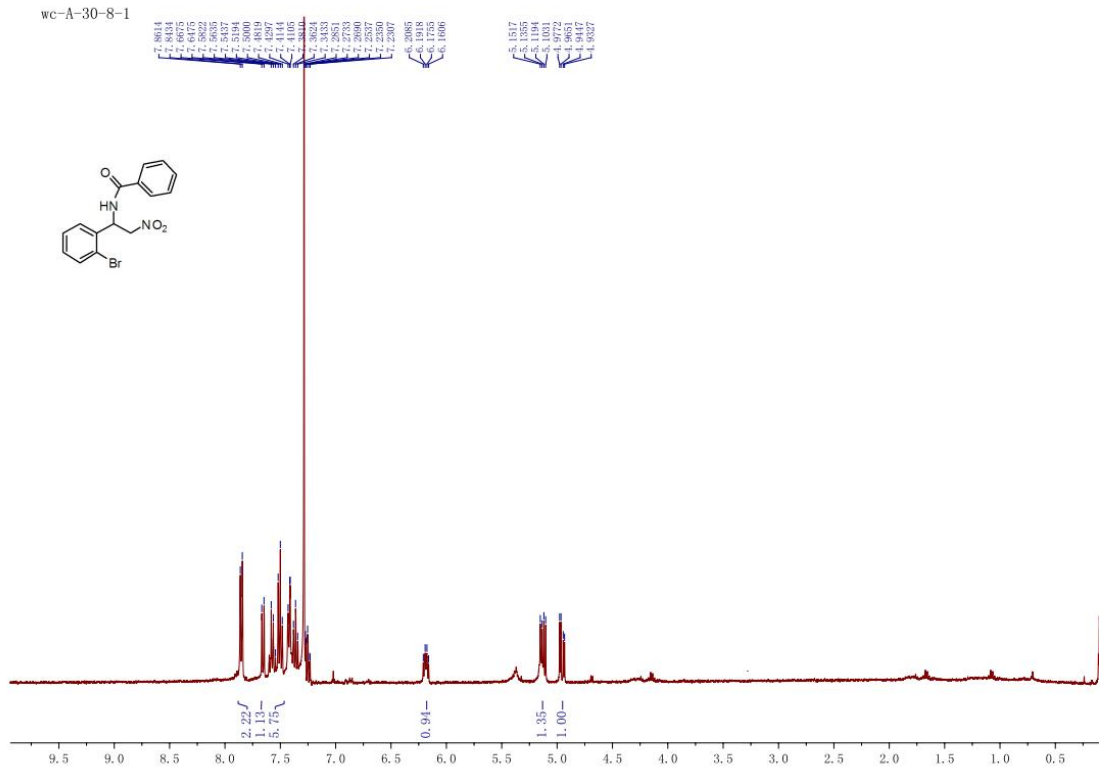


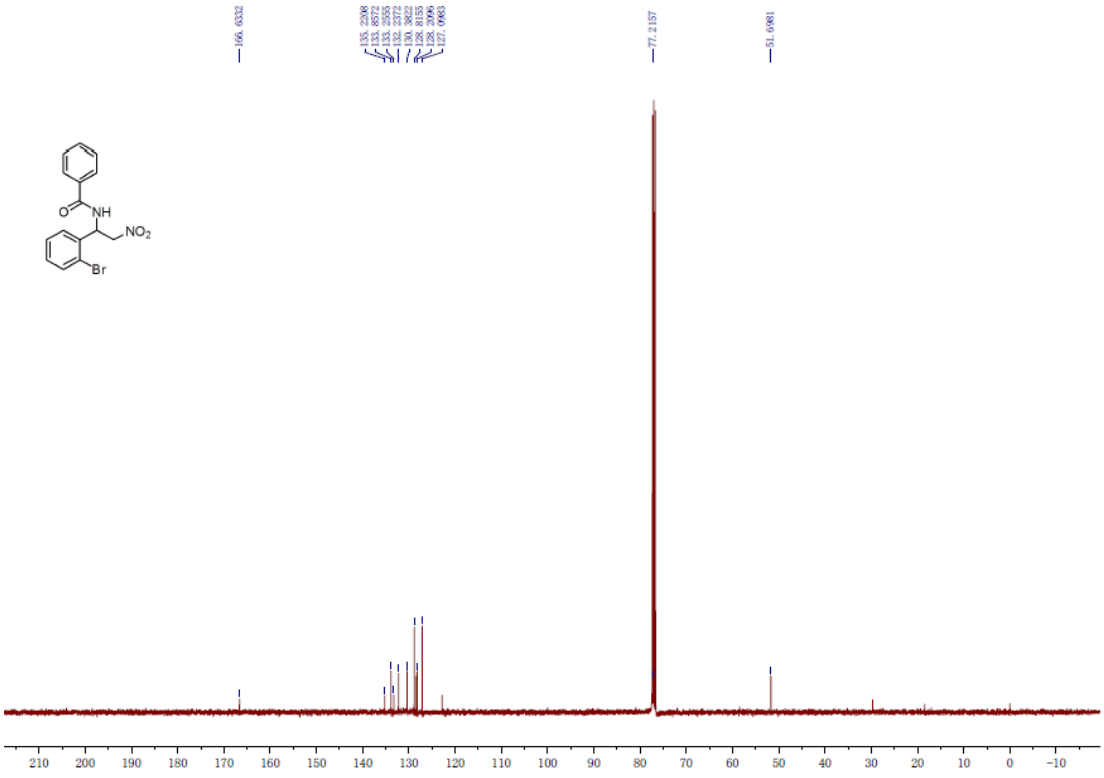
The ^{1}H and ^{13}C NMR Spectra of 3r



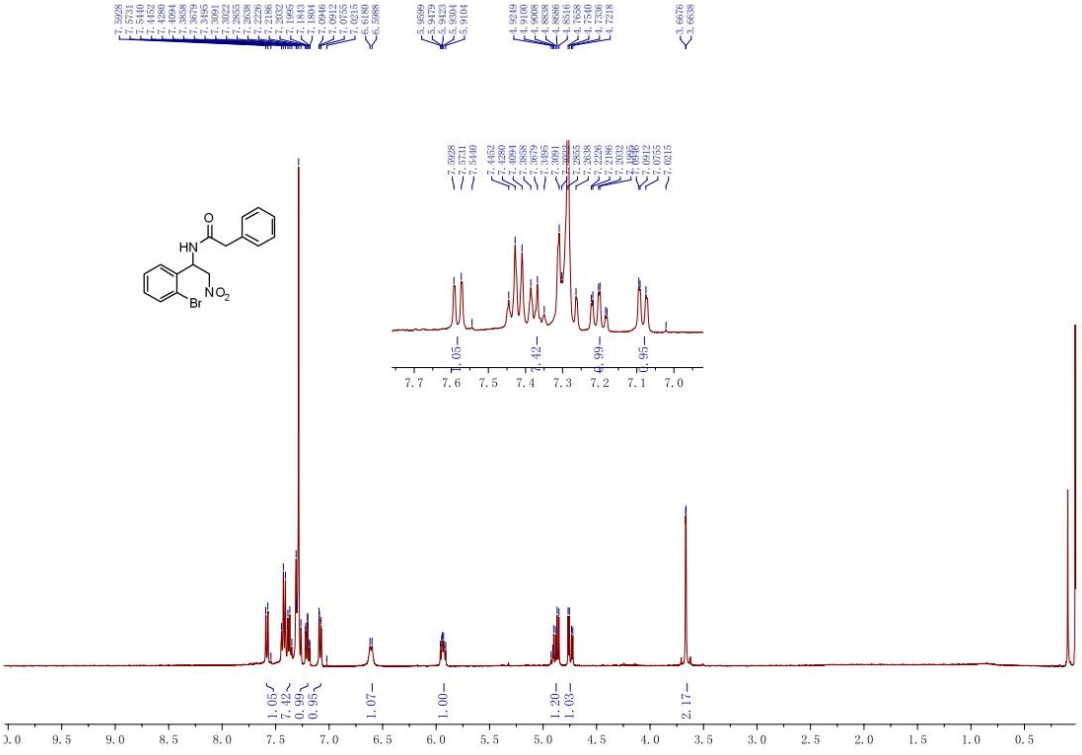


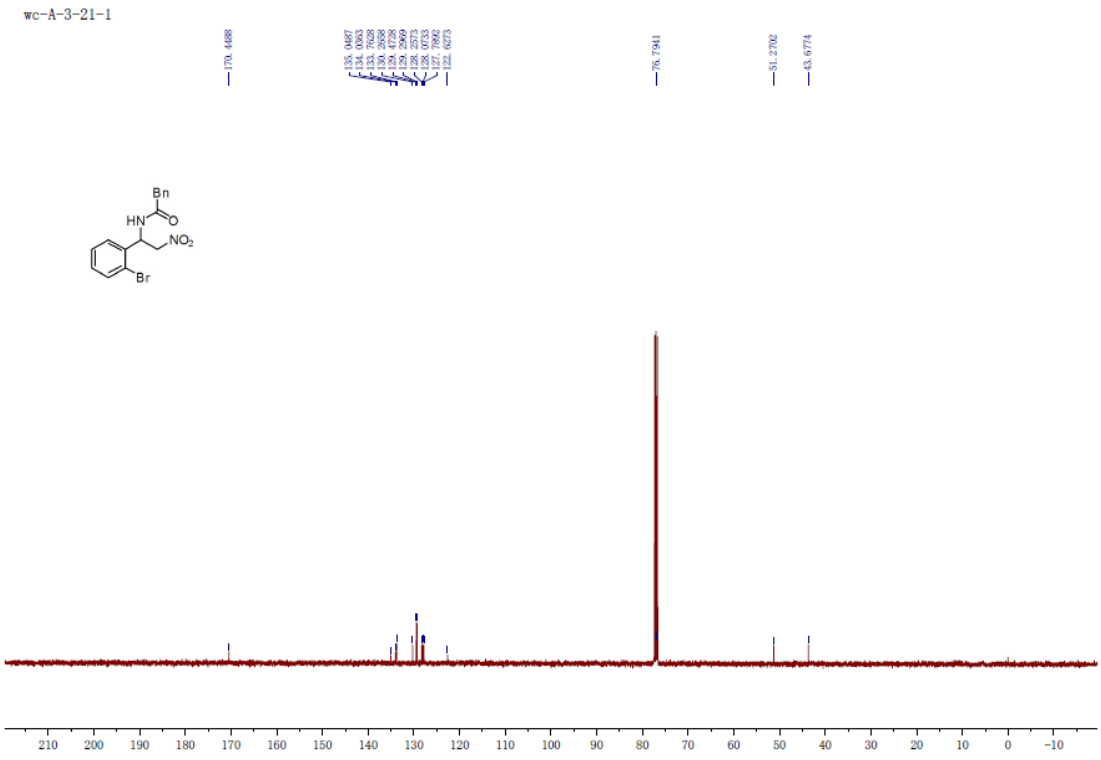
The ^{1}H and ^{13}C NMR Spectra of 3s



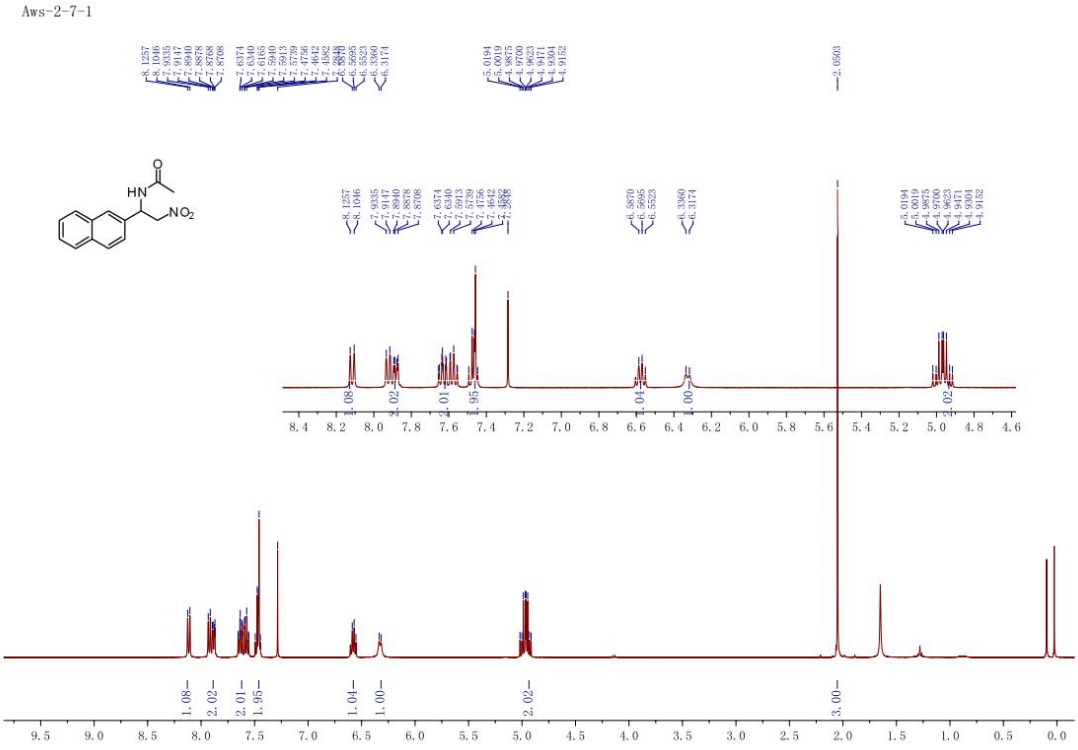


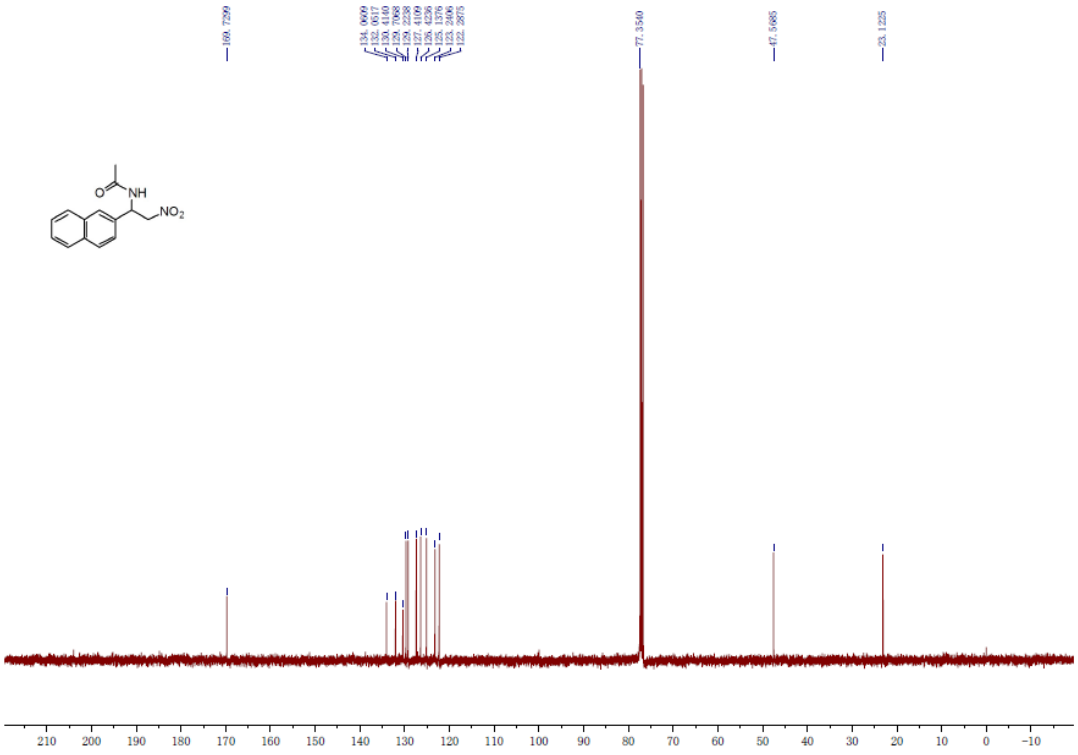
The ^{1}H and ^{13}C NMR Spectra of 3t



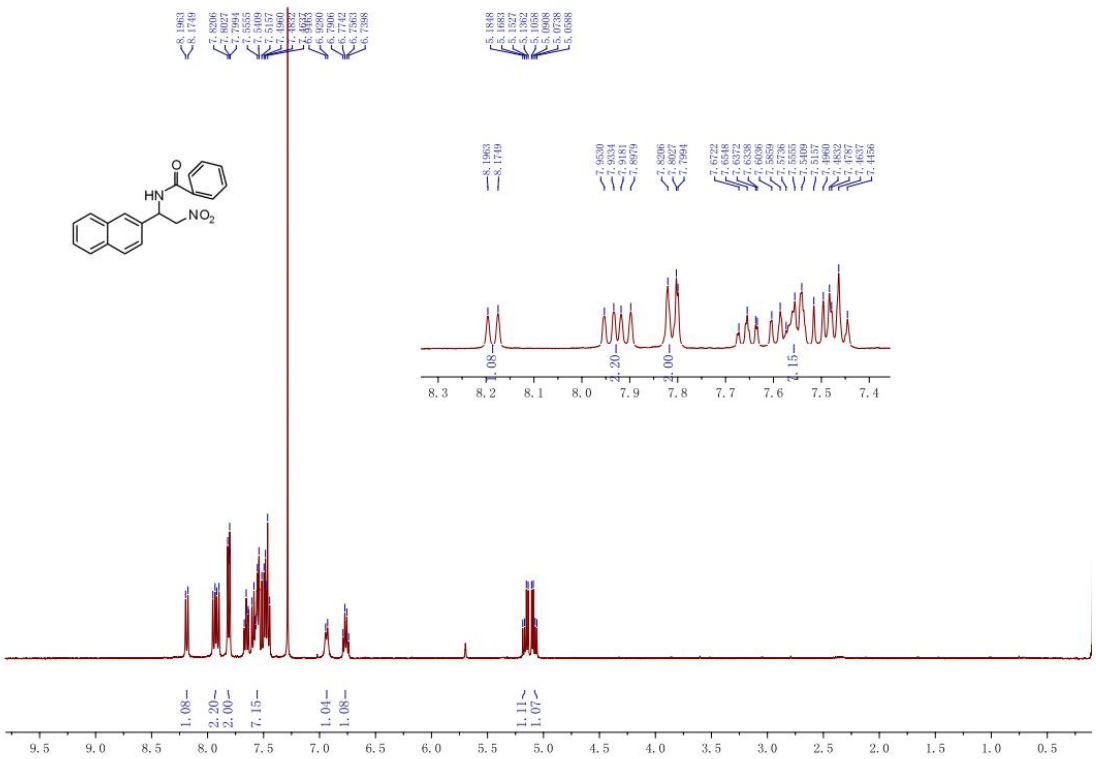


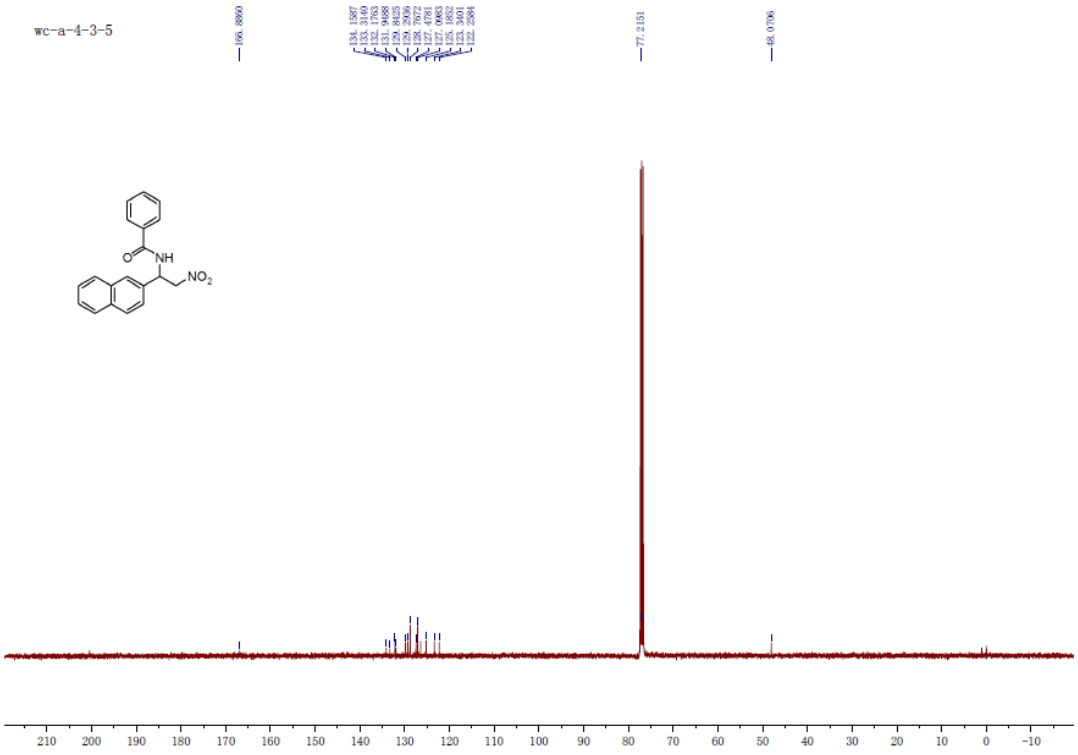
The ^{1}H and ^{13}C NMR Spectra of 3u



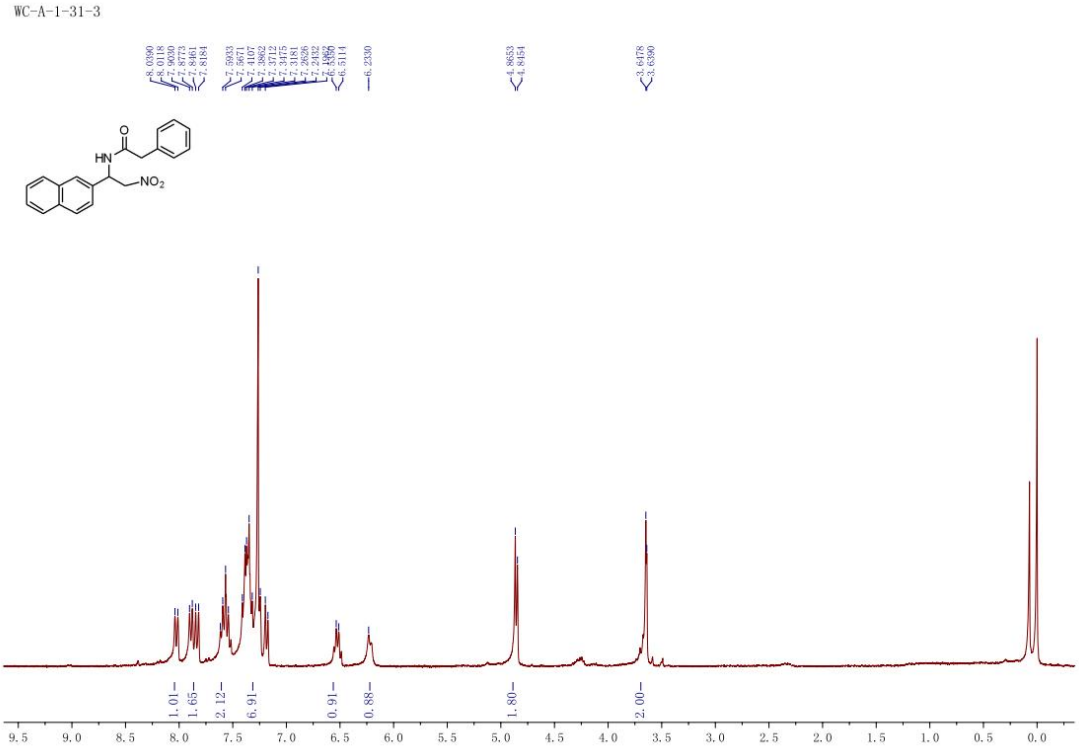


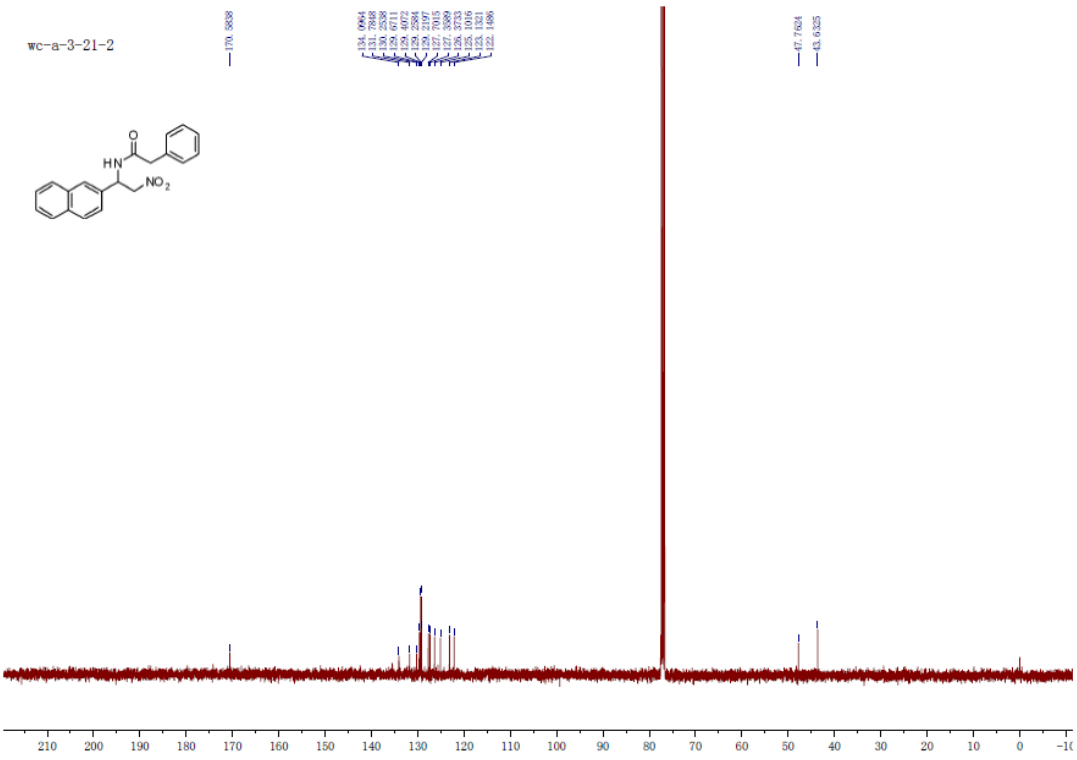
The ^{1}H and ^{13}C NMR Spectra of 3v



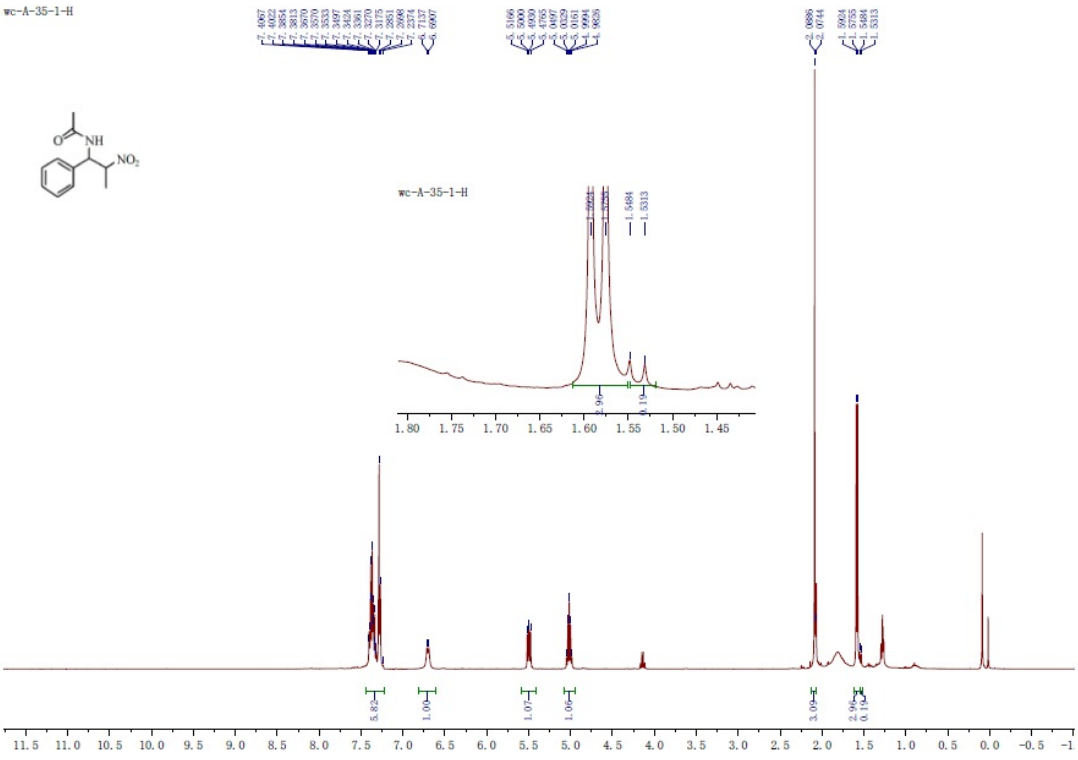


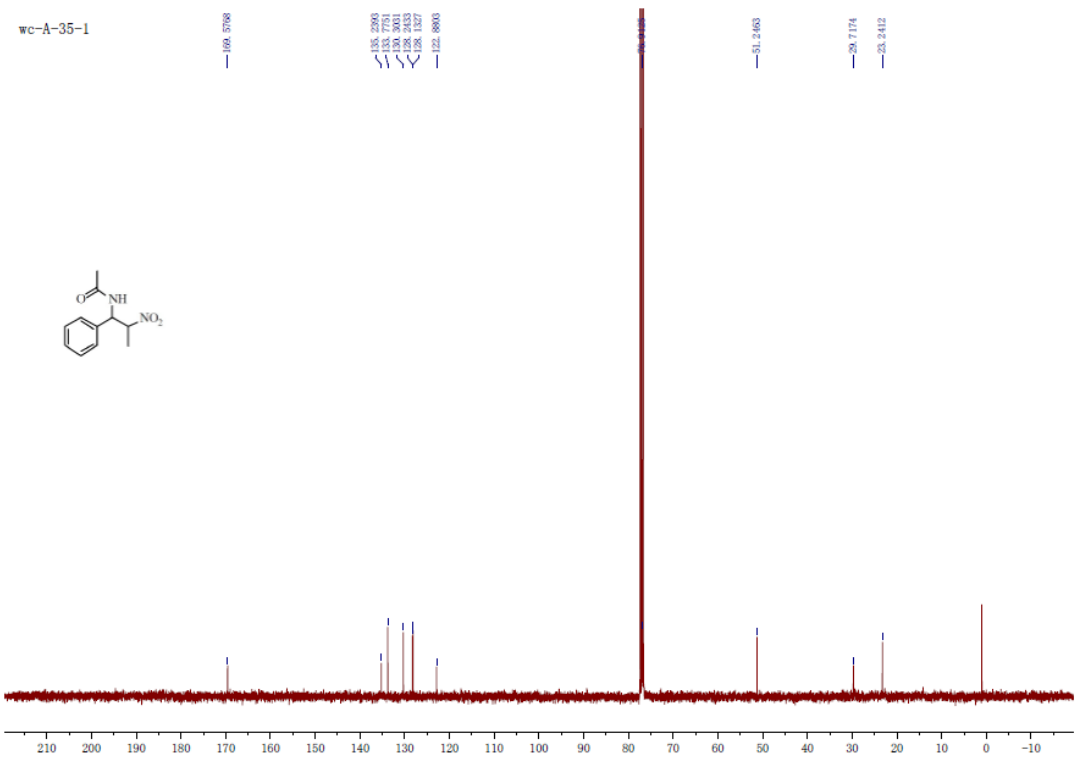
The ^{1}H and ^{13}C NMR Spectra of 3w



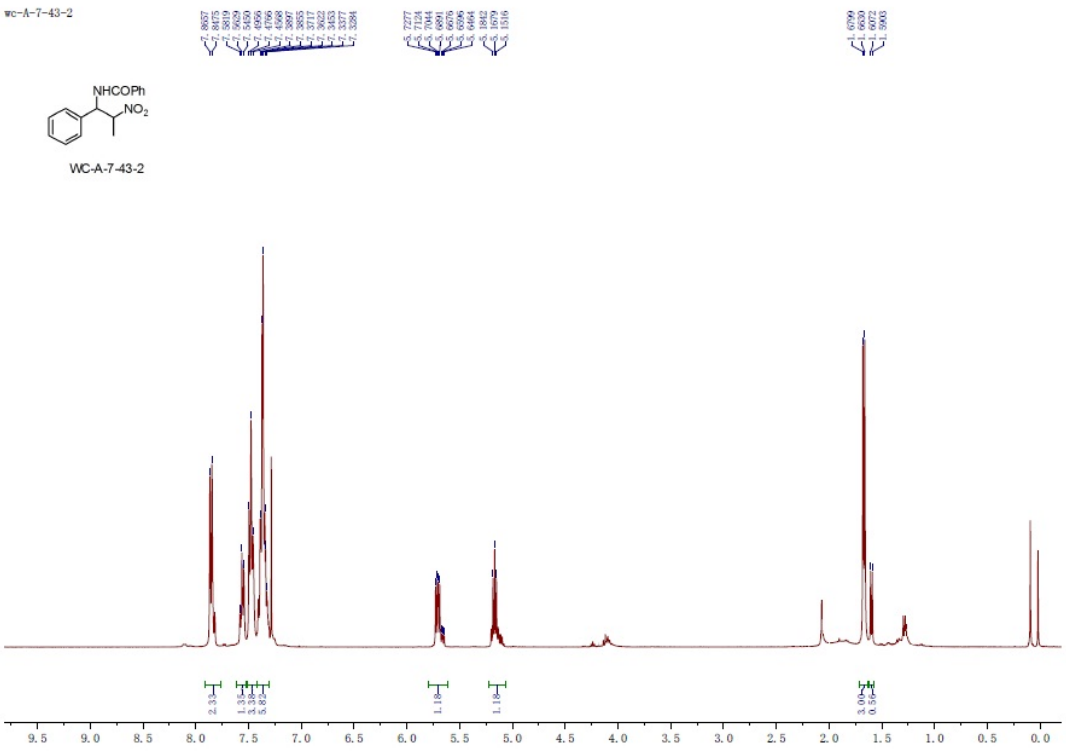


The ^{1}H and ^{13}C NMR Spectra of 3x

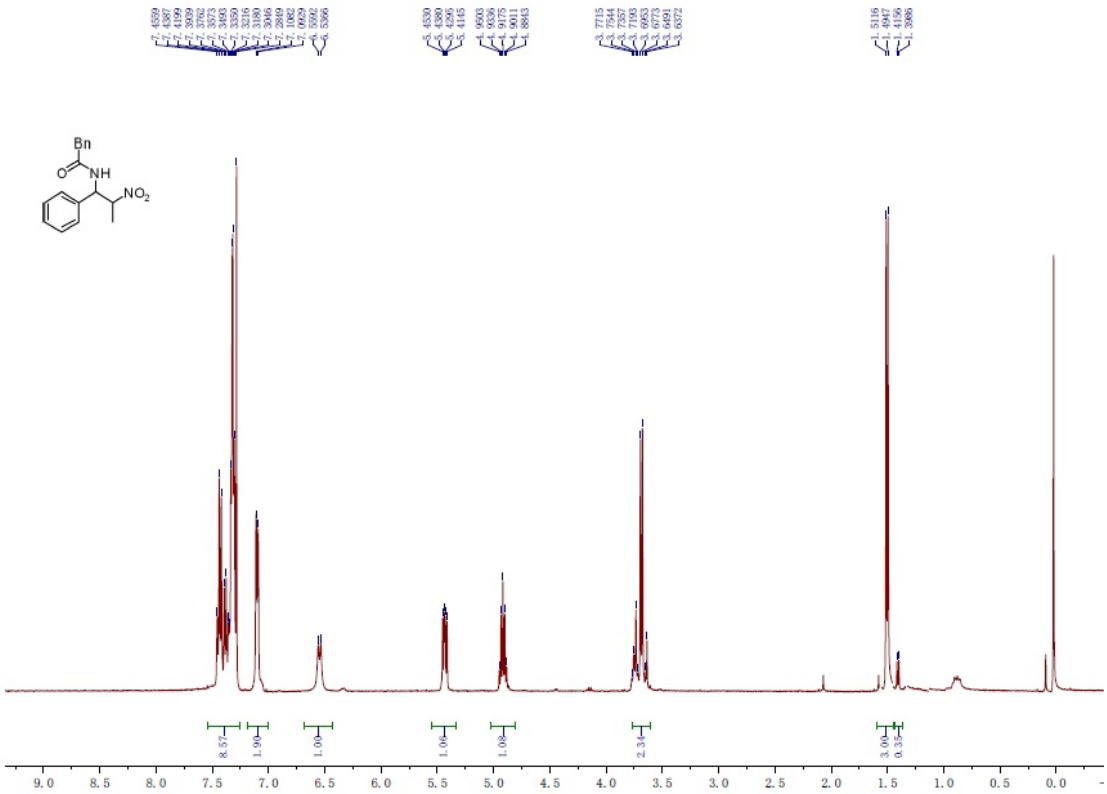


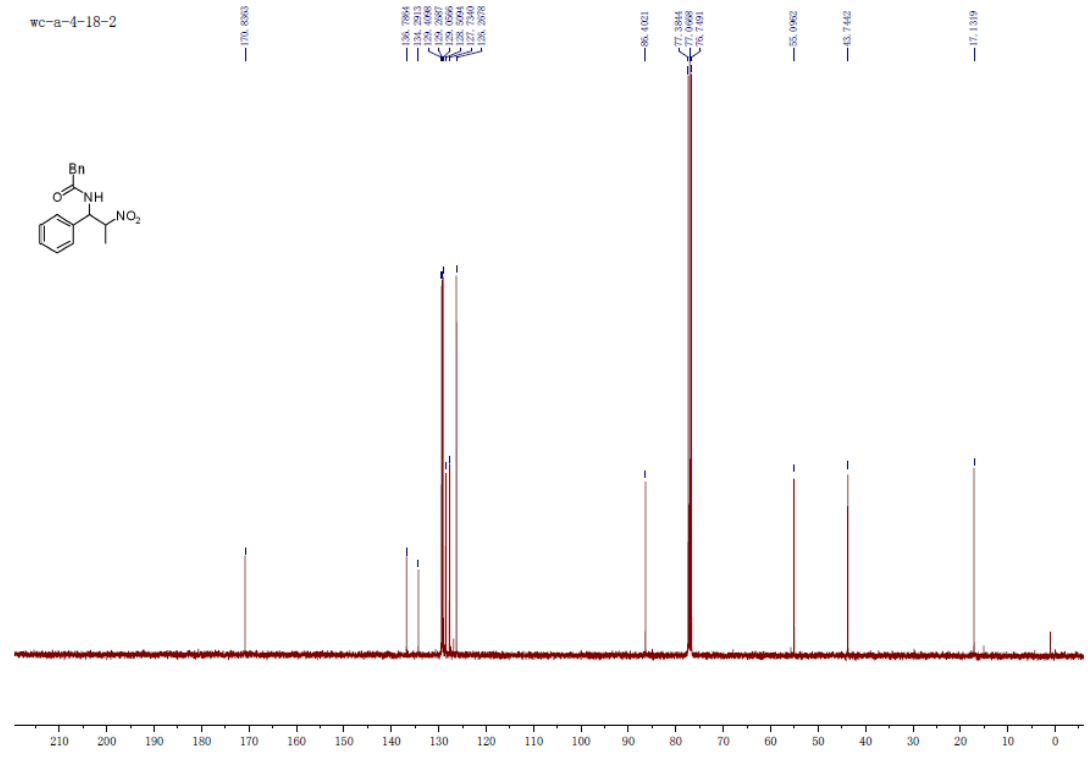


The ^{1}H NMR Spectra of 3y



The ^{1}H and ^{13}C NMR Spectra of 3z





The ^{1}H and ^{13}C NMR Spectra of 3aa