

Supporting Information

Palladium-catalyzed *ortho*-C-H Alkenylation of 2-benzyl-1,2,3-triazoles

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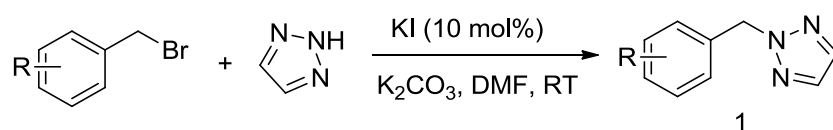
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General Experimental Details:

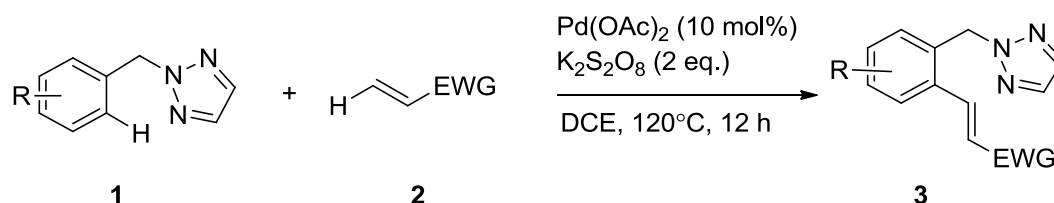
All glassware was oven or flame dried immediately prior to use. All solvents were purified and dried according to standard methods prior to use, unless stated otherwise. All reagents were obtained from commercial sources and used without further purification. Thin-layer chromatography (TLC) was performed using 60 mesh silica gel plates visualized with short-wavelength UV light (254 nm). Silica gel 60 (230-400 mesh) was used for column chromatography. ¹H NMR spectra were obtained at 400 MHz and recorded relative to the tetramethylsilane signal (0 ppm) or residual protio-solvent. ¹³C NMR spectra were obtained at 100 MHz, and chemical shifts were recorded relative to the solvent resonance (CDCl₃, 77.0 ppm). Data for ¹H NMR are recorded as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet or unresolved, br = broad singlet, coupling constant(s) in Hz, integration). Data for ¹³C NMR are reported in terms of chemical shift (δ, ppm). IR spectra were recorded on a Nicolet FT-IR spectrometer and only major peaks are reported in cm⁻¹. High resolution mass spectra were obtained using an Agilent 6210 Series TOF LC-MS equipped with electrospray ionization (ESI) probe operating in positive ion mode. Melting points were measured with SGW-4 micro melting point apparatus without further correction.

General Procedure for preparation of substrates

All of compounds in Table 2 were synthesized according to the literature, and the NMR spectroscopy were consisted with those data.^{1,2}

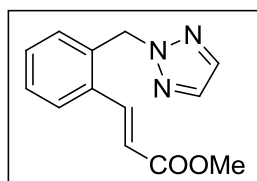


General Procedure for the alkenylation of 2-benzyl-1,2,3-triazoles



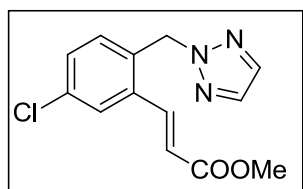
An oven-dried 15 mL screw-capped vial containing 1 (0.2 mmol, 1.0 equiv), 2 (0.4 mmol, 2.0 equiv), Pd(OAc)₂ (0.02 mmol, 0.1 equiv) and K₂S₂O₈ (0.4 mmol, 2.0 equiv) in DCE (2 mL). The reaction mixture was stirred at 120 °C for 12 h. After cooling to room temperature, the solvent was evaporated and then the residue was purified on a silica gel column using petroleum ether /ethyl acetate (10/1) as eluent to give the desired products.

The data of characterization



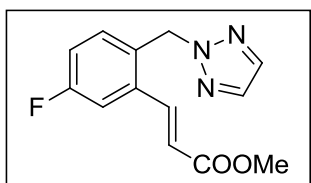
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)phenyl)acrylate (3a)

Colorless oil; ¹H NMR (400 MHz, CDCl₃) δ 8.15 (d, *J* = 15.8 Hz, 1H), 7.63 (m, 3H), 7.39 (dd, *J* = 5.1, 3.9 Hz, 2H), 7.23-7.21 (m, 1H), 6.40 (d, *J* = 15.8 Hz, 1H), 5.77 (s, 2H), 3.84 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.9, 141.1, 134.7, 134.1, 133.7, 130.3, 129.9, 129.0, 127.2, 121.0, 55.8, 51.8; IR: max (thin film) (cm⁻¹)= 2949, 1718, 1677, 1637, 1556, 1513, 1415, 1237, 1156, 1021, 962, 816, 737, 612; HRMS (ESI-TOF) *m/z*: calcd for C₁₃H₁₃N₃O₂: 243.1008 found: 243.1009



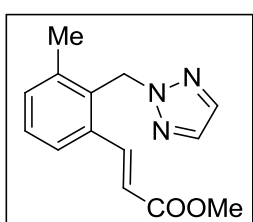
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-chlorophenyl)acrylate (3b)

Colorless oil; ¹H NMR (400 MHz, CDCl₃) δ 8.07 (d, *J* = 15.7 Hz, 1H), 7.69 - 7.55 (m, 3H), 7.35 (d, *J* = 6.4 Hz, 1H), 7.17 (d, *J* = 8.3 Hz, 1H), 6.40 (d, *J* = 15.8 Hz, 1H), 5.72 (s, 2H), 3.84 (s, 3H).); ¹³C NMR (101 MHz, CDCl₃) δ 166.5, 139.8, 135.5, 135.1, 134.8, 132.4, 131.4, 130.2, 127.1, 122.3, 55.18, 52.0; IR: max (thin film) (cm⁻¹)= 3020, 2949, 1728, 1667, 1645, 1565, 1552, 1531, 1448, 1233, 1142, 1019, 962, 816, 732, 623; HRMS (ESI-TOF) *m/z* calcd for C₁₃H₁₂ClN₃O₂: 277.0618 found: 277.0619



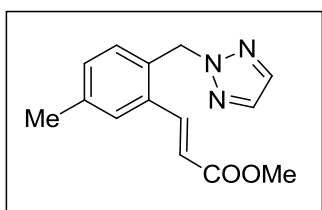
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-fluorophenyl)acrylate (3c)

Yellow oil; ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 15.8$ Hz, 1H), 7.63 (s, 2H), 7.43 (s, 1H), 7.18 (dd, $J = 21.3, 7.8$ Hz, 2H), 6.39 (d, $J = 15.8$ Hz, 1H), 5.72 (s, 2H), 3.83 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 166.5, 162.7, 140.0, 136.0, 134.7, 132.1, 129.9, 122.1, 117.2, 113.7, 55.1, 51.9; IR: max (thin film) (cm^{-1}) = 3018, 2949, 1730, 1666, 1623, 1592, 1578, 1532, 1458, 1228, 1141, 1023, 962, 888, 732, 640; HRMS (ESI-TOF) m/z : calcd for $\text{C}_{13}\text{H}_{12}\text{FN}_3\text{O}_2$: 261.0914 found: 261.0914



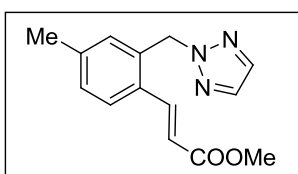
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-3-methylphenyl)acrylate (3d)

Yellow oil; ^1H NMR (400 MHz, CDCl_3) δ 8.33 (d, $J = 15.7$ Hz, 1H), 7.61 (s, 2H), 7.48 (d, $J = 7.1$ Hz, 1H), 7.32 – 7.28 (m, 2H), 6.38 (d, $J = 15.7$ Hz, 1H), 5.75 (s, 2H), 3.83 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 167.0, 142.7, 139.0, 135.7, 134.2, 133.7, 132.4, 131.7, 129.1, 125.2, 121.4, 51.8, 19.9; IR: max (thin film) (cm^{-1}) = 3060, 2941, 2790, 2358, 1745, 1687, 1621, 1558, 1435, 1125, 1060, 962, 855, 712, 610; HRMS (ESI-TOF) m/z : calcd for $\text{C}_{14}\text{H}_{15}\text{N}_3\text{O}_2$: 257.1164 found: 257.1165



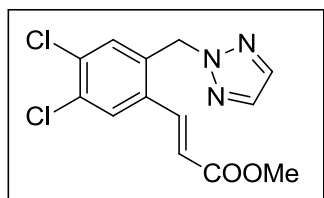
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-methylphenyl)acrylate (3e)

Yellow oil; ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 15.8$ Hz, 1H), 7.63 (s, 2H), 7.43 (s, 1H), 7.20 (d, $J = 7.8$ Hz, 1H), 7.15 (d, $J = 7.8$ Hz, 1H), 6.39 (d, $J = 15.8$ Hz, 1H), 5.72 (s, 2H), 3.83 (s, 3H), 2.37 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 167.0, 141.3, 138.9, 134.6, 133.6, 131.2, 131.2, 130.2, 127.7, 120.6, 55.6, 51.8, 21.2. IR: max (thin film) (cm^{-1}) = 3065, 2979, 2792, 2388, 1749, 1686, 1626, 1540, 1425, 1176, 1053, 962, 853, 772, 630; HRMS (ESI-TOF) m/z : calcd for $\text{C}_{14}\text{H}_{15}\text{N}_3\text{O}_2$: 257.1164 found: 257.1165



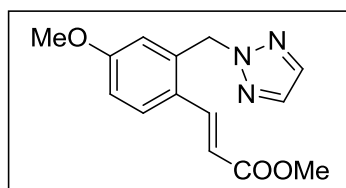
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-4-methylphenyl)acrylate (3f)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 8.12 (d, *J* = 15.7 Hz, 1H), 7.65 (s, 2H), 7.54 (d, *J* = 8.0 Hz, 1H), 7.28 (s, 1H), 7.04 (s, 1H), 6.37 (d, *J* = 15.7 Hz, 1H), 5.74 (s, 2H), 3.83 (s, 3H), 2.36 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 167.1, 141.0, 140.8, 134.6, 133.9, 130.9, 130.7, 129.9, 127.1, 119.8, 55.8, 51.8, 21.4. IR: max (thin film) (cm⁻¹) = 3055, 2994, 2796, 2384, 1753, 1675, 1632, 1552, 1435, 1180, 1037, 962, 885, 770, 632; HRMS (ESI-TOF) *m/z*: calcd for C₁₄H₁₅N₃O₂: 257.1164 found: 257.1165



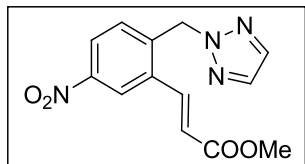
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-4,5-dichlorophenyl)acrylate (3g)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 8.01 (d, *J* = 15.8 Hz, 1H), 7.68 (d, *J* = 5.4 Hz, 2H), 7.29 (d, *J* = 7.1 Hz, 2H), 6.39 (d, *J* = 15.8 Hz, 1H), 5.70 (s, 2H), 3.84 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.3, 138.8, 135.0, 134.2, 133.7, 133.4, 131.7, 128.8, 122.6, 54.73, 52.0, 29.7; IR: max (thin film) (cm⁻¹) = 3017, 2949, 1738, 1677, 1650, 1536, 1542, 1521, 1458, 1220, 1160, 1029, 962, 817, 731, 628; HRMS (ESI-TOF) *m/z*: calcd for C₁₃H₁₁Cl₂N₃O₂: 311.0228 found: 311.0227



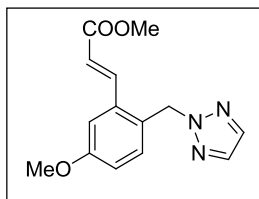
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-4-methoxyphenyl)acrylate (3h)

White solid; m.p. 125 °C; ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, *J* = 15.7 Hz, 1H), 7.65 (d, *J* = 11.8 Hz, 2H), 7.61 (d, *J* = 8.7 Hz, 1H), 6.90 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.66 (t, *J* = 6.1 Hz, 1H), 6.32 (d, *J* = 15.7 Hz, 1H), 5.76 (s, 2H), 3.81 (d, *J* = 7.8 Hz, 6H); ¹³C NMR (101 MHz, CDCl₃) δ 167.3, 161.2, 140.5, 136.0, 134.7, 128.7, 125.9, 118.4, 114.9, 114.6, 55.8, 55.4, 51.8; IR: max (thin film) (cm⁻¹) = 2949, 2918, 2846, 1716, 1637, 1604, 1574, 1500, 1435, 1294, 1288, 1238, 1194, 1178, 1036, 962, 816, 777; HRMS (ESI-TOF) *m/z*: calcd for C₁₄H₁₅N₃O₃: 273.1113 found: 273.1114



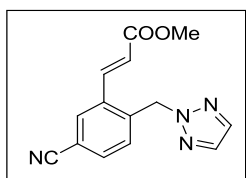
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-nitrophenyl)acrylate (3i)

Yellow solid; m.p. 82 °C; ¹H NMR (400 MHz, CDCl₃) δ 8.45 (d, *J* = 2.1 Hz, 1H), 8.24 – 8.17 (m, 1H), 8.09 (d, *J* = 15.7 Hz, 1H), 7.69 (s, 2H), 7.29 (d, *J* = 2.6 Hz, 1H), 6.54 (d, *J* = 15.8 Hz, 1H), 5.84 (s, 2H), 3.87 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.1, 148.2, 140.4, 138.7, 135.2, 130.7, 128.7, 124.4, 124.0, 122.1, 55.1, 52.1; IR: max (thin film) (cm⁻¹) = 2949, 1718, 1637, 1525, 1435, 1348, 1281, 1172, 1174, 962, 817, 731; HRMS (ESI-TOF) *m/z*: calcd for C₁₃H₁₂N₄O₄: 288.0859 found: 288.0859



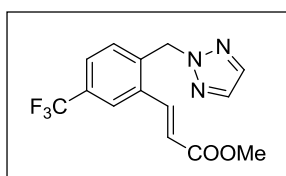
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-methoxyphenyl)acrylate (3j)

Yellow solid; m.p. 113 °C; ¹H NMR (400 MHz, CDCl₃) δ 8.13 (d, *J* = 15.8 Hz, 1H), 7.63 (s, 2H), 7.26 (d, *J* = 8.5 Hz, 1H), 7.12 (d, *J* = 2.6 Hz, 1H), 6.94 (d, *J* = 8.5, 2.6 Hz, 1H), 6.38 (d, *J* = 15.7 Hz, 1H), 5.69 (s, 2H), 3.84 (d, *J* = 1.4 Hz, 6H); ¹³C NMR (101 MHz, CDCl₃) δ 166.9, 159.9, 141.3, 135.1, 134.5, 131.8, 129.6, 126.4, 121.1, 116.1, 112.1, 55.3, 51.9. IR: max (thin film) (cm⁻¹)= 2949, 2922, 2843, 1730, 1628, 1600, 1576, 1498, 1433, 1292, 1286, 1240, 1200, 1177, 1045, 962, 816, 767; HRMS (ESI-TOF) *m/z*: calcd for C₁₄H₁₅N₃O₃: 273.1113 found: 273.1115



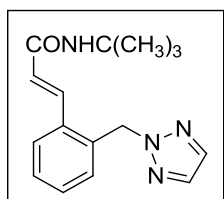
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-cyanophenyl)acrylate (3k)

Brown solid; m.p. 124 °C; ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, *J* = 15.8 Hz, 1H), 7.87 (s, 1H), 7.69 (s, 2H), 7.64 (d, *J* = 8.1 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 1H), 6.44 (d, *J* = 15.8 Hz, 1H), 5.80 (s, 2H), 3.86 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.2, 138.8, 138.7, 135.2, 135.0, 133.1, 130.8, 130.3, 123.7, 117.8, 113.3, 55.3, 52.1. IR: max (thin film) (cm⁻¹)= 2355, 2330, 1699, 1683, 1653, 1558, 1506, 1456, 1123, 962, 667; HRMS (ESI-TOF) *m/z*: calcd for C₁₄H₁₂N₄O₂: 268.0960 found: 268.0961



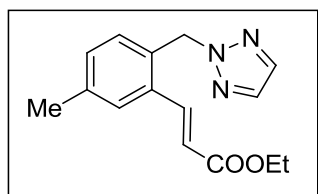
(E)-methyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-(trifluoromethyl)phenyl)acrylate (3l)

White solid; m.p. 109 °C; ¹H NMR (400 MHz, CDCl₃) δ 8.14 (d, *J* = 15.8 Hz, 1H), 7.86 (s, 1H), 7.70 (s, 2H), 7.64 (d, *J* = 8.0 Hz, 1H), 7.31 (s, 1H), 6.49 (d, *J* = 15.8 Hz, 1H), 5.83 (s, 2H), 3.88 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.39, 139.60, 137.57, 134.99, 134.52, 131.52, 131.20, 130.24, 126.69, 124.13, 122.95, 55.34, 52.03. IR: max (thin film) (cm⁻¹)= 3080, 2978, 2360, 2346, 1680, 1663, 1654, 1620, 1558, 1523, 1433, 1120, 962, 663; HRMS (ESI-TOF) *m/z*: calcd for C₁₄H₁₂F₃N₃O₂: 311.0882 found: 311.0881



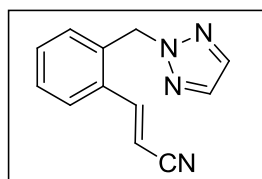
(E)-3-(2-((2H-1,2,3-triazol-2-yl)methyl)phenyl)-N-(tert-butyl)acrylamide (3m)

Yellow solid; m.p. 141 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.95 (d, *J* = 15.4 Hz, 1H), 7.64 (s, 2H), 7.53 (dd, *J* = 5.2, 3.9 Hz, 1H), 7.35 – 7.30 (m, 2H), 7.16 – 7.08 (m, 1H), 6.27 (d, *J* = 15.4 Hz, 1H), 5.76 (s, 2H), 1.44 (d, *J* = 13.6 Hz, 9H); ¹³C NMR (101 MHz, CDCl₃) δ 164.9, 136.3, 134.6, 134.5, 133.8, 129.6, 129.5, 128.8, 127.0, 125.8, 56.0, 51.6, 28.9. IR: max (thin film) (cm⁻¹) = 3288, 2927, 2924, 1659, 1620, 1547, 1452, 1342, 1223, 1130, 962, 762, 727; HRMS (ESI-TOF) *m/z*: calcd for C₁₆H₂₀N₄O: 284.1637 found: 284.1639



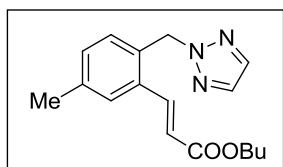
(E)-ethyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-methylphenyl)acrylate (3n)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, *J* = 15.8 Hz, 1H), 7.63 (s, 2H), 7.44 (s, 1H), 7.20 (d, *J* = 7.8 Hz, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 6.38 (d, *J* = 15.7 Hz, 1H), 5.73 (s, 2H), 4.29 (q, *J* = 7.1 Hz, 2H), 2.37 (s, 3H), 1.36 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 166.6, 141.0, 138.9, 134.5, 133.6, 131.1, 131.1, 130.1, 127.7, 121.1, 60.6, 55.6, 21.2, 14.3. IR: max (thin film) (cm⁻¹) = 3065, 2979, 2792, 2388, 1749, 1686, 1626, 1540, 1425, 1176, 1053, 962, 853, 772, 630; HRMS (ESI-TOF) *m/z*: calcd for C₁₅H₁₇N₃O₂: 271.1321 found: 271.1321



(E)-3-(2-((2H-1,2,3-triazol-2-yl)methyl)phenyl)acrylonitrile (3o)

Yellow solid; m.p. 110 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.96 (d, *J* = 16.4 Hz, 1H), 7.64 (d, *J* = 6.8 Hz, 2H), 7.54 (d, *J* = 7.5 Hz, 1H), 7.48 – 7.36 (m, 3H), 5.86 (d, *J* = 16.4 Hz, 1H), 5.70 (s, 2H); ¹³C NMR (126 MHz, CDCl₃) δ 147.4, 134.8, 133.6, 133.3, 131.2, 130.8, 129.4, 126.5, 117.7, 99.5, 55.8. IR: max (thin film) (cm⁻¹) = 3130, 2916, 2846, 2220, 1618, 1485, 1421, 1419, 1346, 1130, 962, 845, 752; HRMS (ESI-TOF) *m/z*: calcd for C₁₂H₁₀N₄: 210.0905 found: 210.0905



(E)-butyl 3-(2-((2H-1,2,3-triazol-2-yl)methyl)-5-methylphenyl)acrylate (3p)

Colorless oil. ¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 15.8 Hz, 1H), 7.63 (s, 2H), 7.44 (s, 1H), 7.20 (d, *J* = 7.8 Hz, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 6.38 (d, *J* = 15.8 Hz, 1H), 5.72 (s, 2H), 4.23 (t, *J* = 6.6 Hz, 2H), 2.37 (s, 3H), 1.76 – 1.64 (m, 2H), 1.47 (m, 2H), 0.99 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 166.6, 140.8, 134.6, 134.1, 133.8, 130.3, 130.0, 129.0, 127.1, 121.5, 64.6, 55.9, 30.8, 21.2,

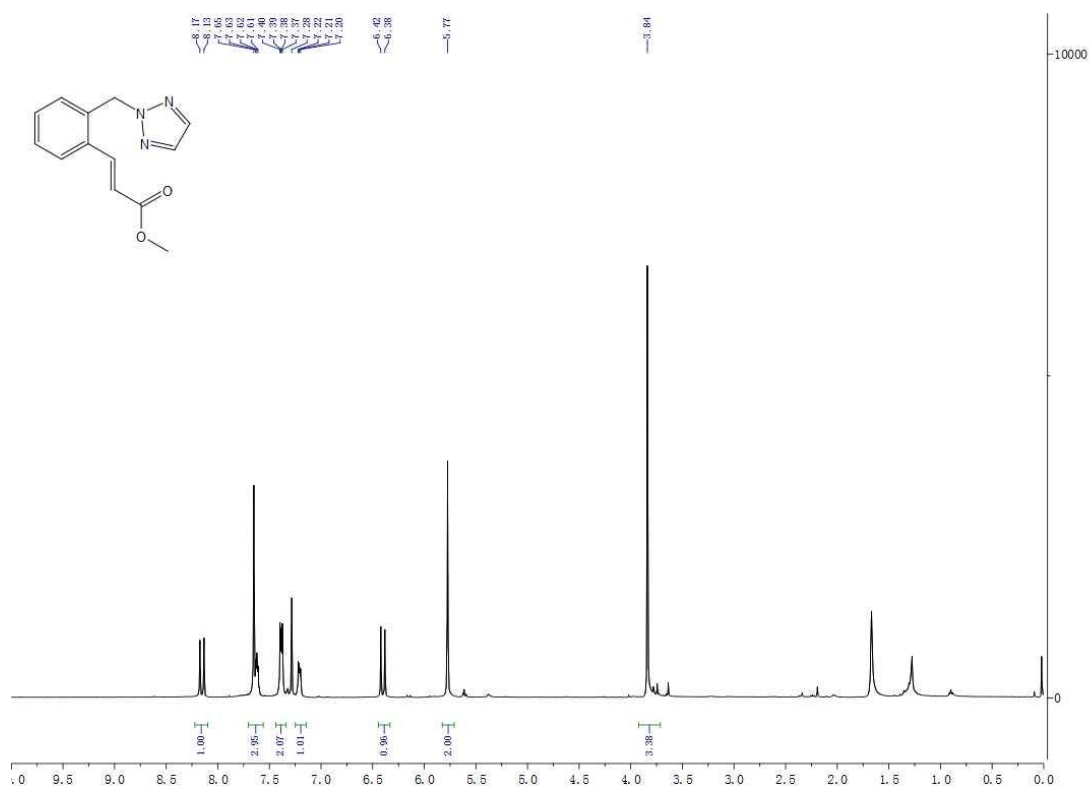
19.1, 13.8; IR: max (thin film) (cm⁻¹)= 3056, 2983, 2779, 2384, 1750, 1689, 1628, 1543, 1424, 1178, 1052, 962, 853, 772, 630; HRMS (ESI-TOF) m/z: calcd for C₁₇H₂₁N₃O₂: 299.1634 found: 299.1635

Reference:

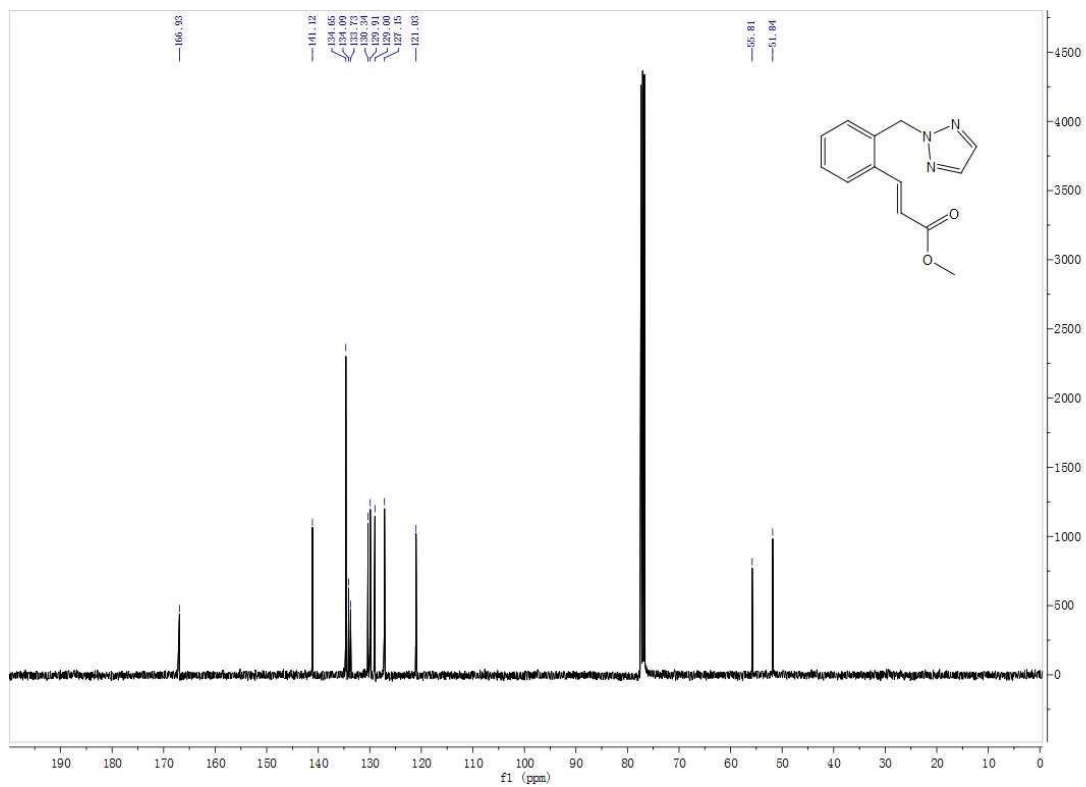
1. J. Doiron, A. H. Sultana, R. Richard, M. M. Toure, N. Picot, R. Richard, M. C. Culf, G. A. Robichaud, M. Touaibia, *Eur. J. Med. Chem.*, 2011, **46**, 4010.
2. H. Wolfgang, B. Bettina, J. Christine, K. Michael, L. Thierry, B. Wayne, *Scientia Pharmaceutica*, 2004, **72**, 197.

NMR Spectra of compounds

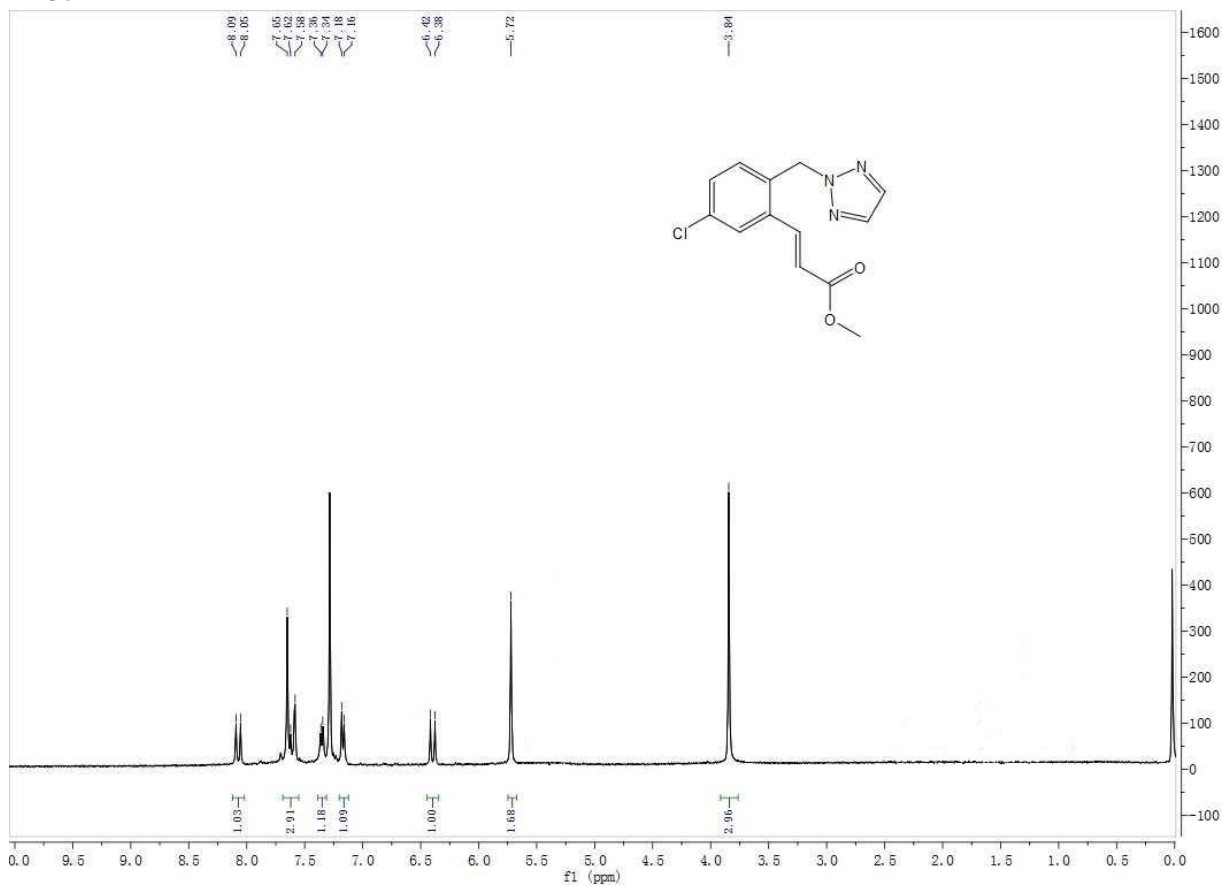
¹H-3a



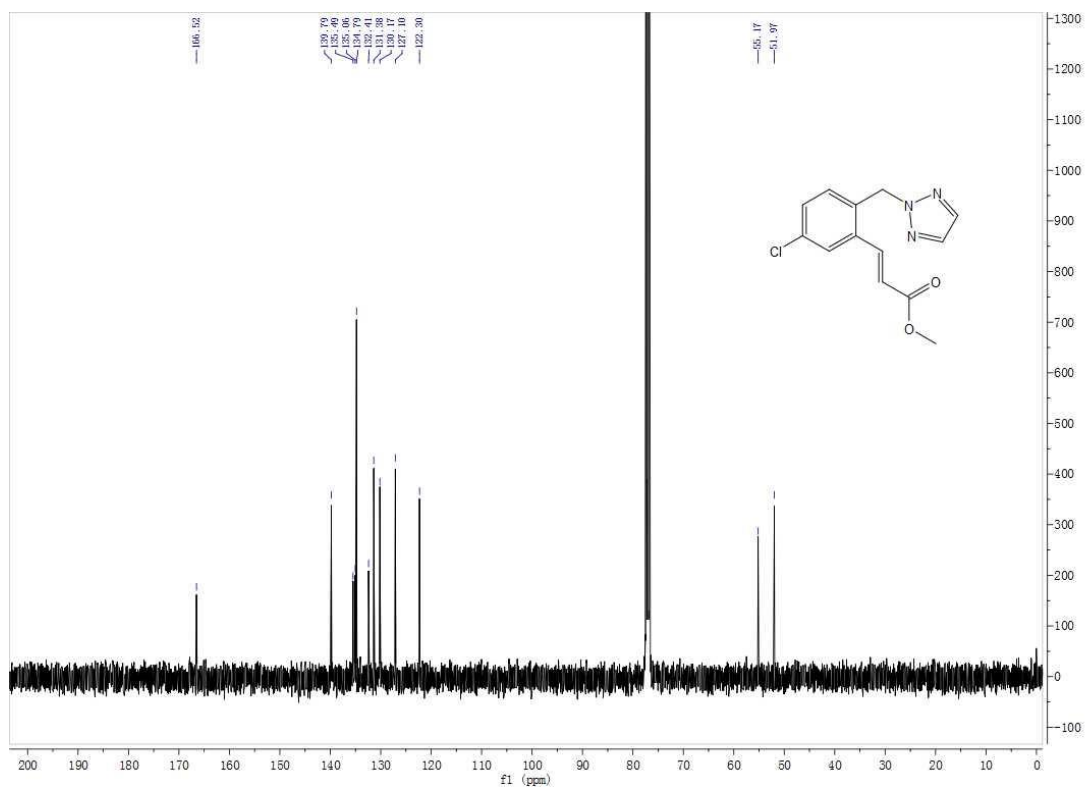
¹³C-3a



¹H-3b



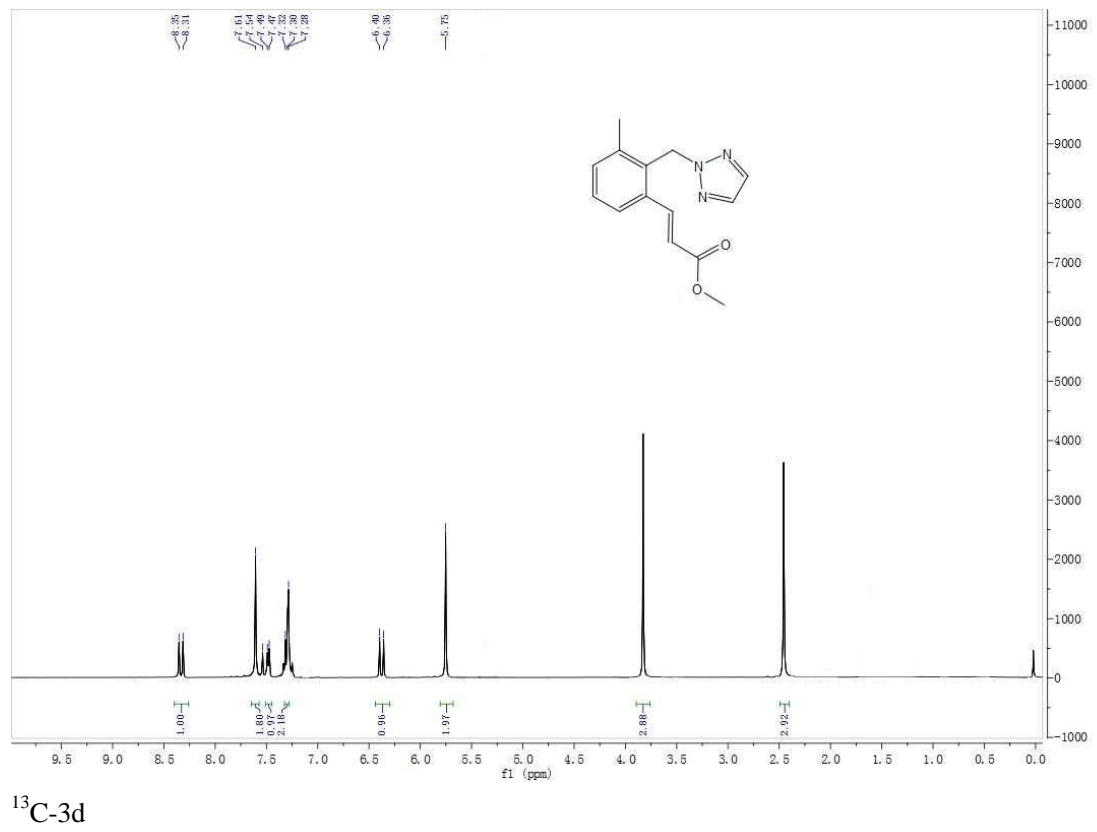
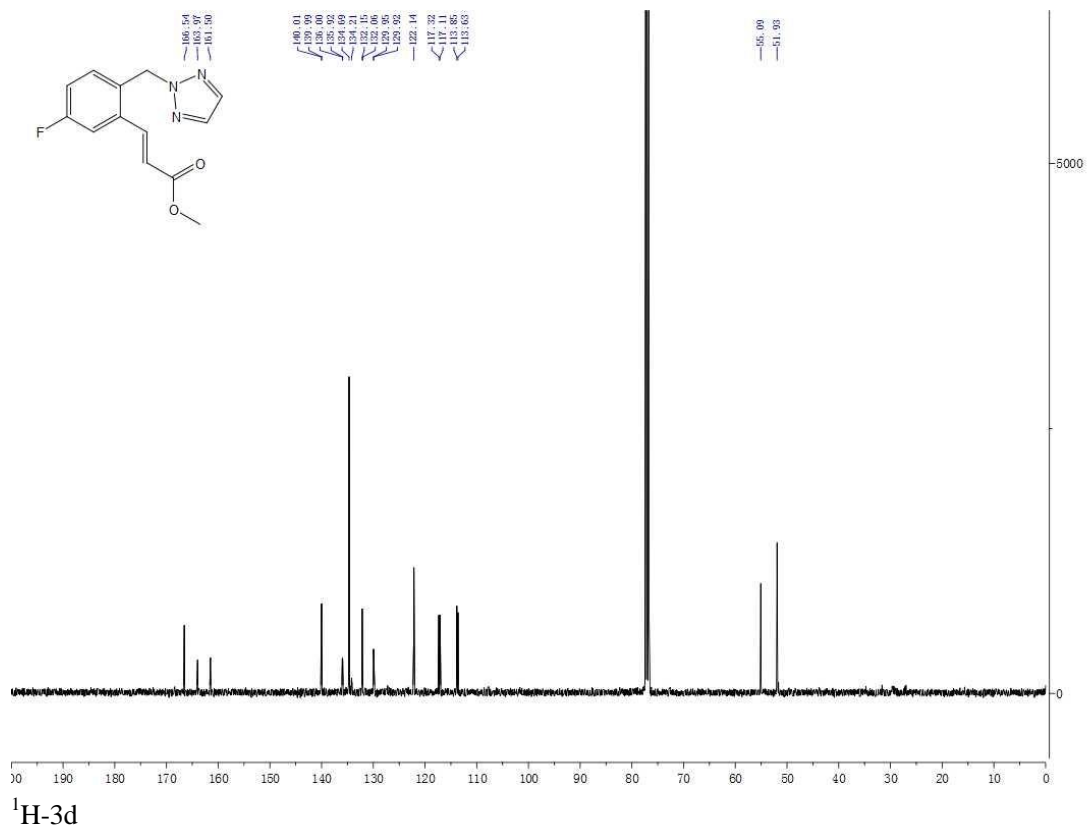
¹³C-3b

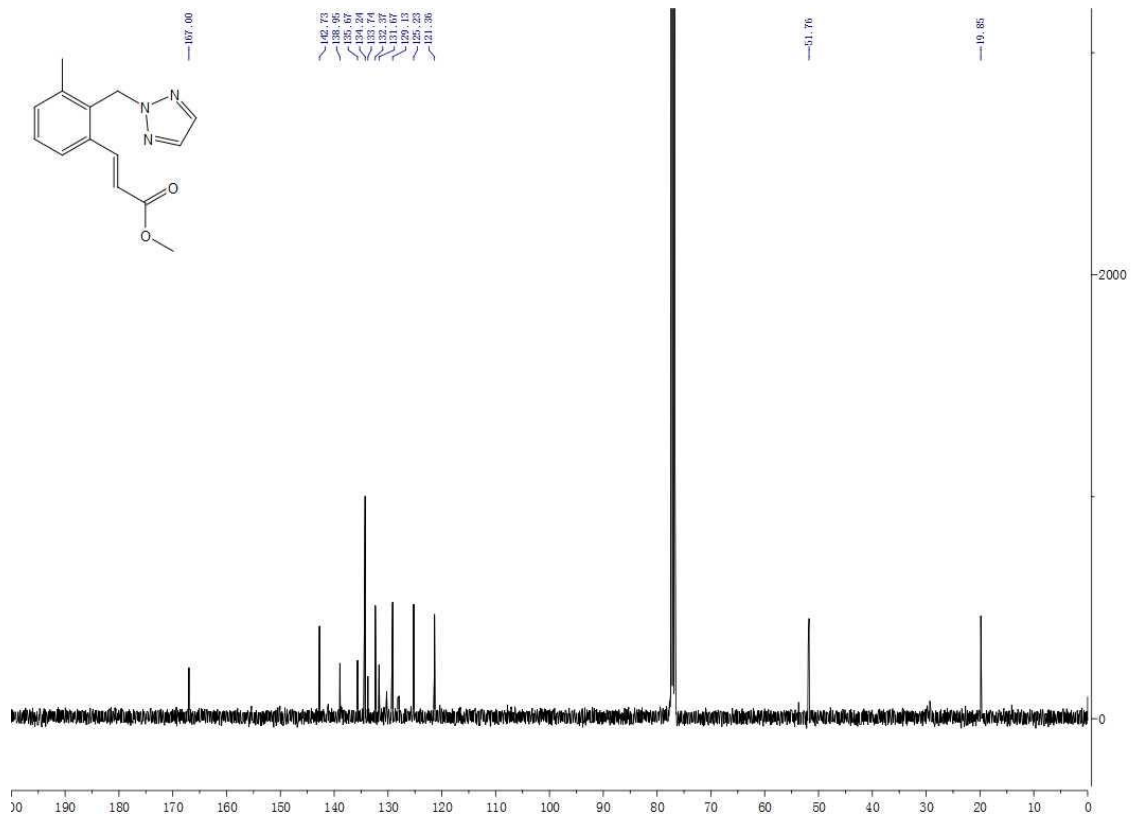


¹H-3c

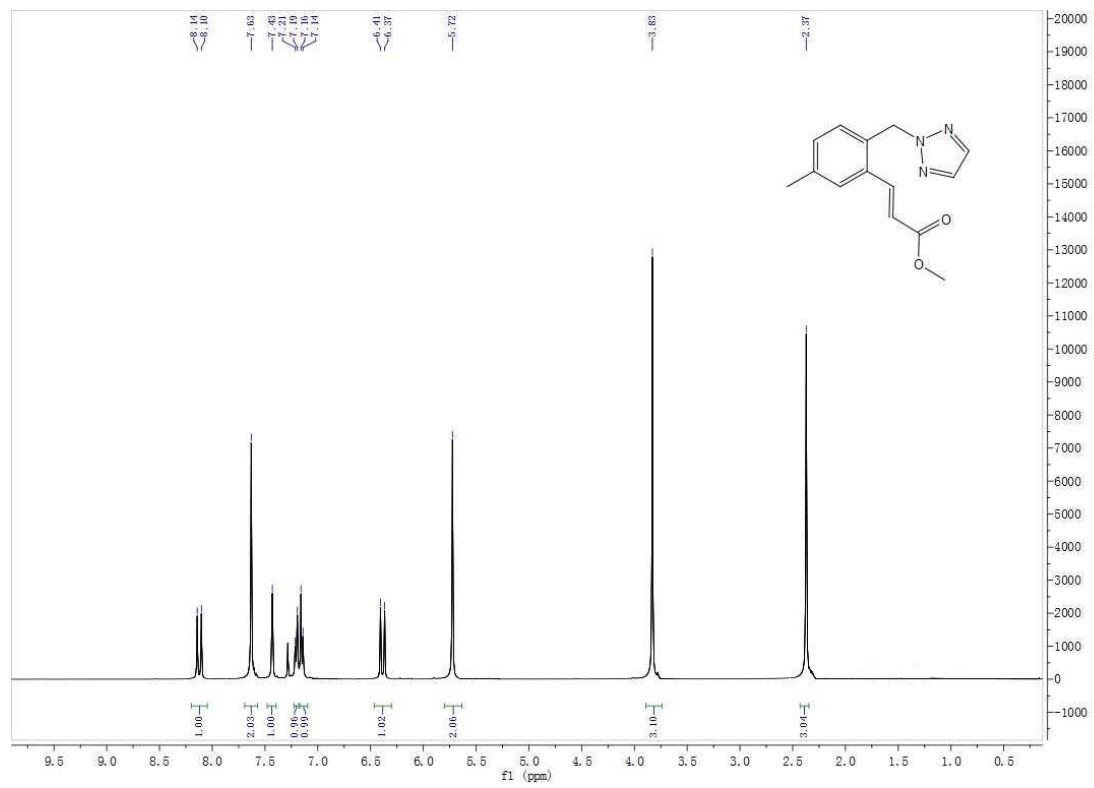


¹³C-3c

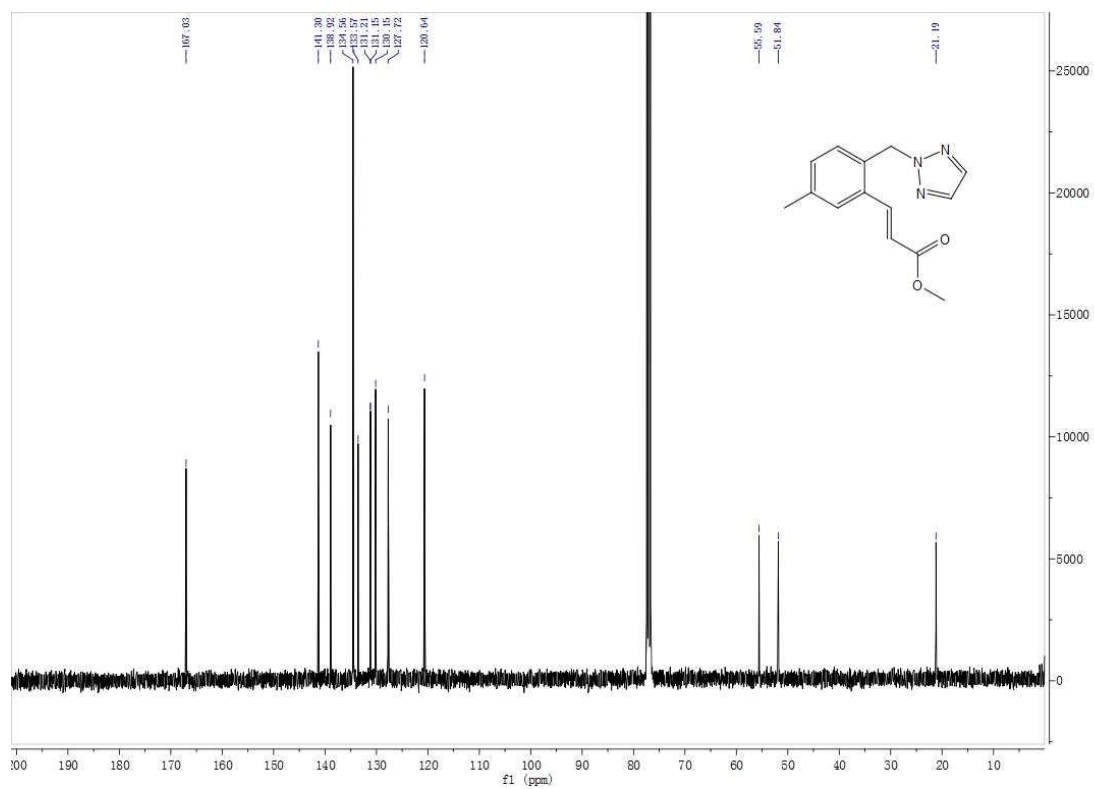




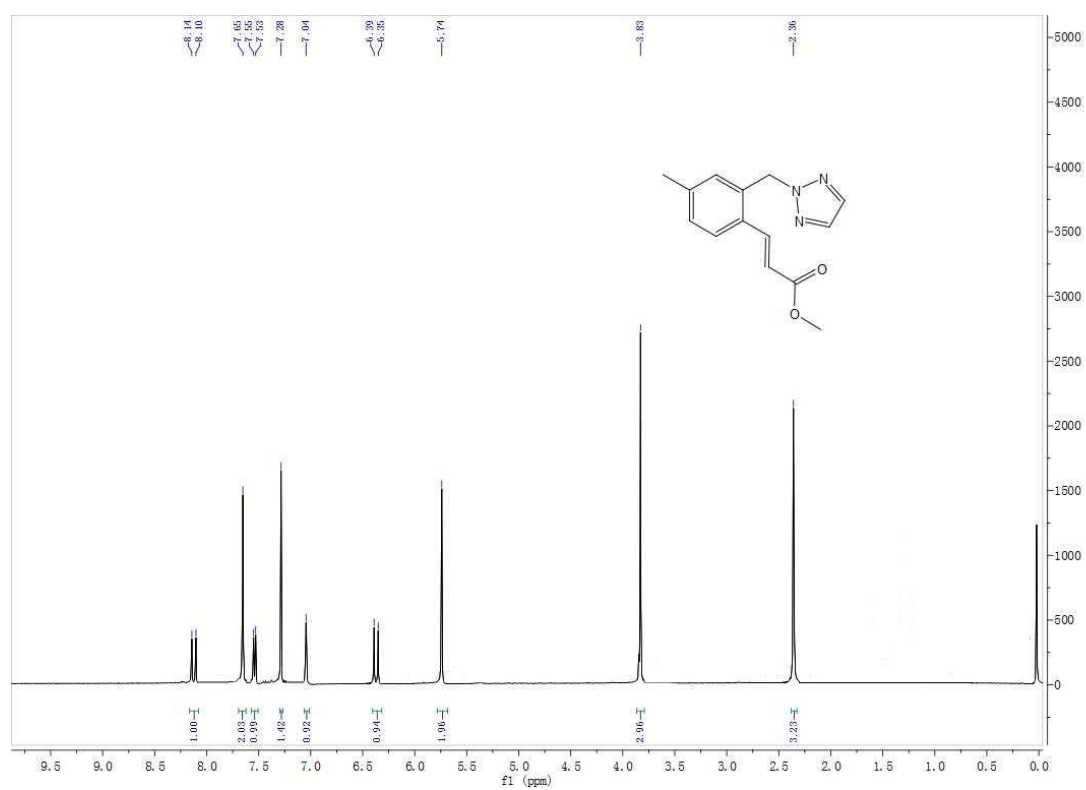
¹H-3e



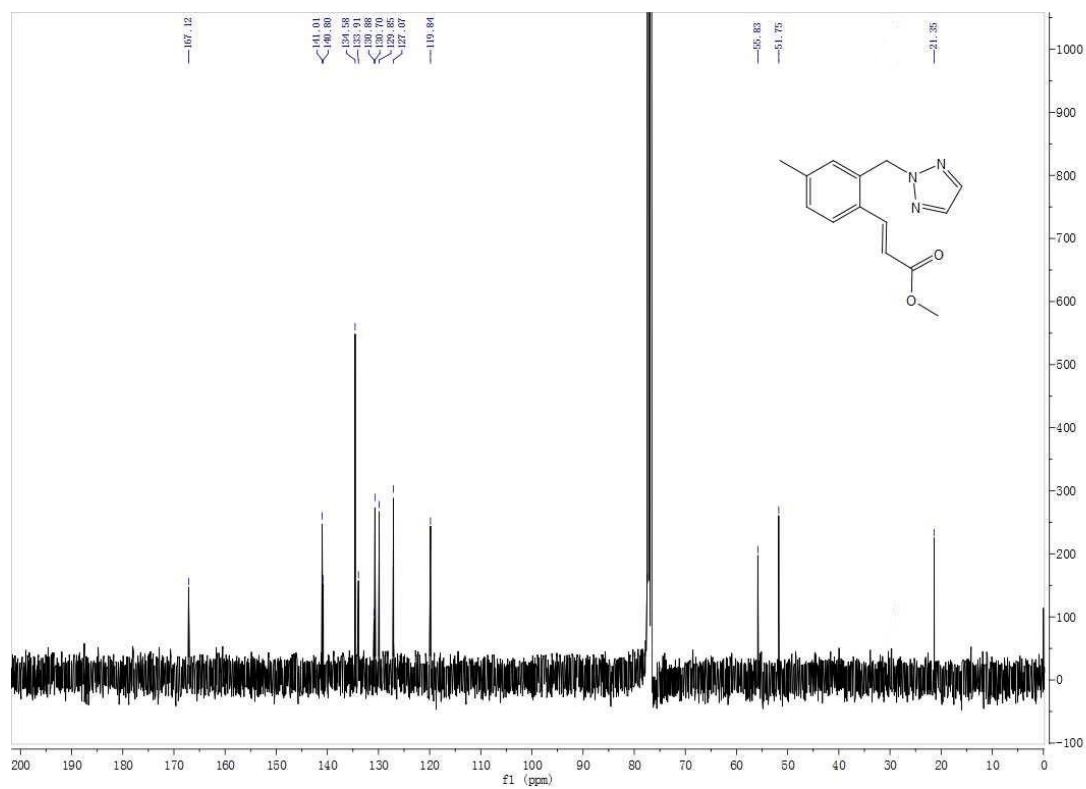
¹³C-3e



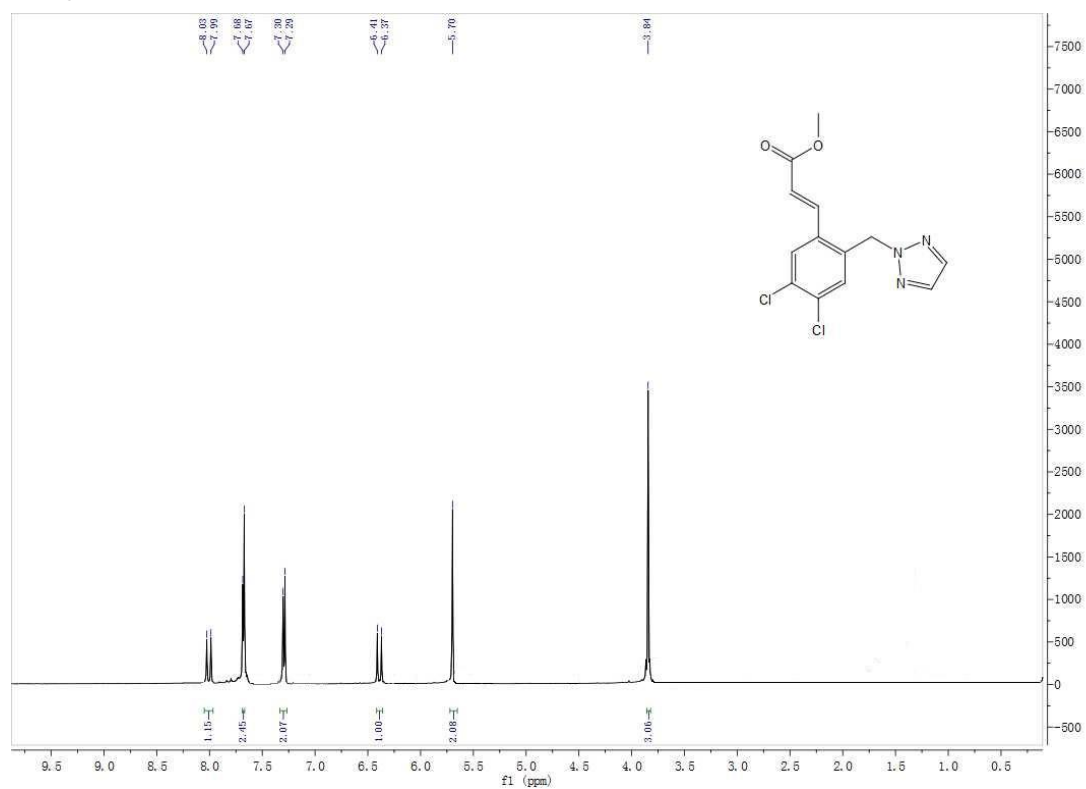
¹H-3f



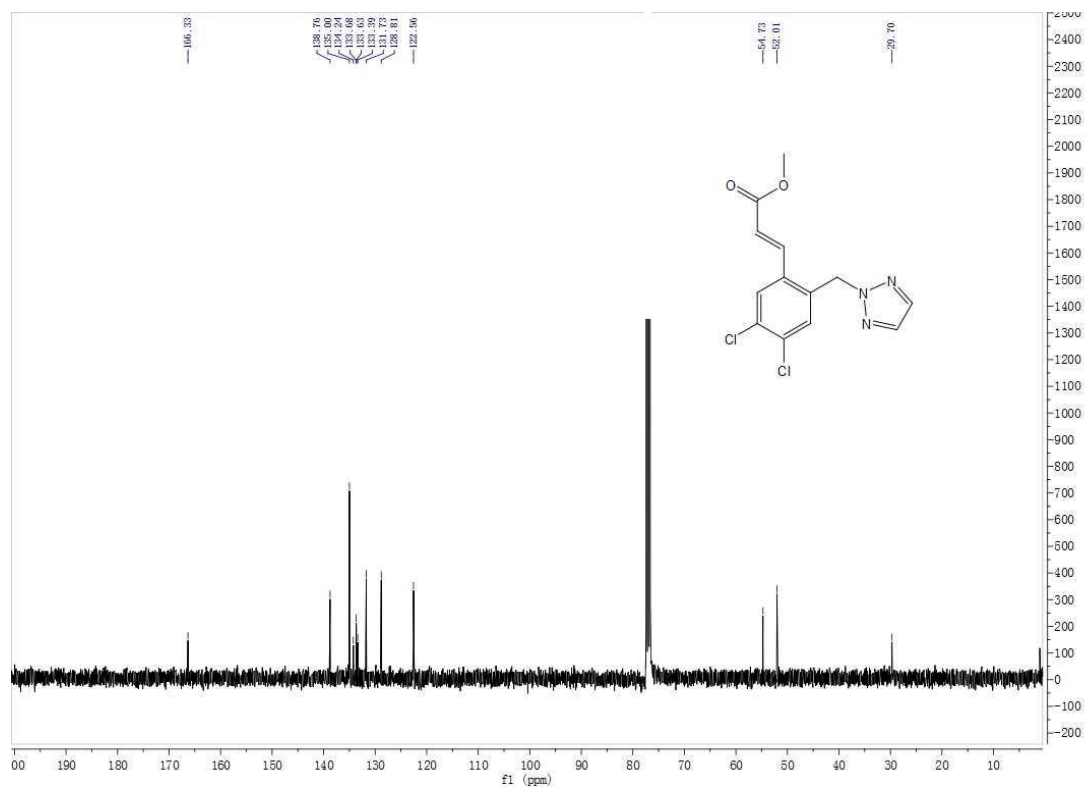
¹³C-3f



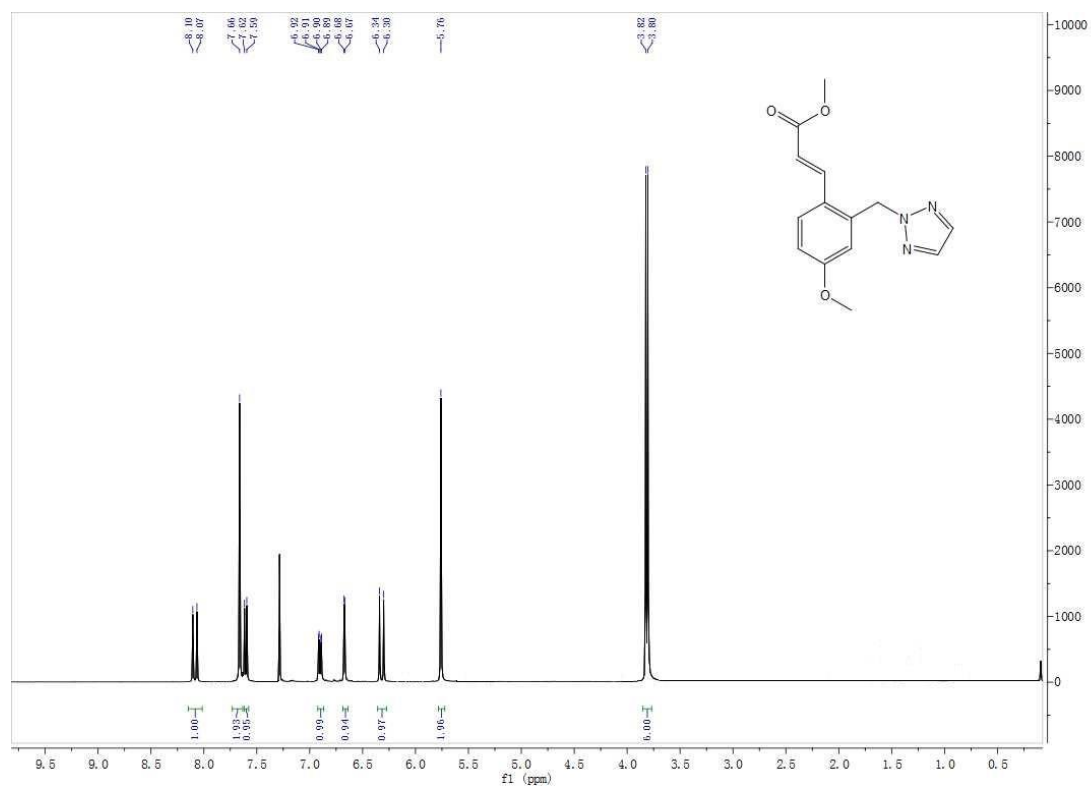
¹H-3g



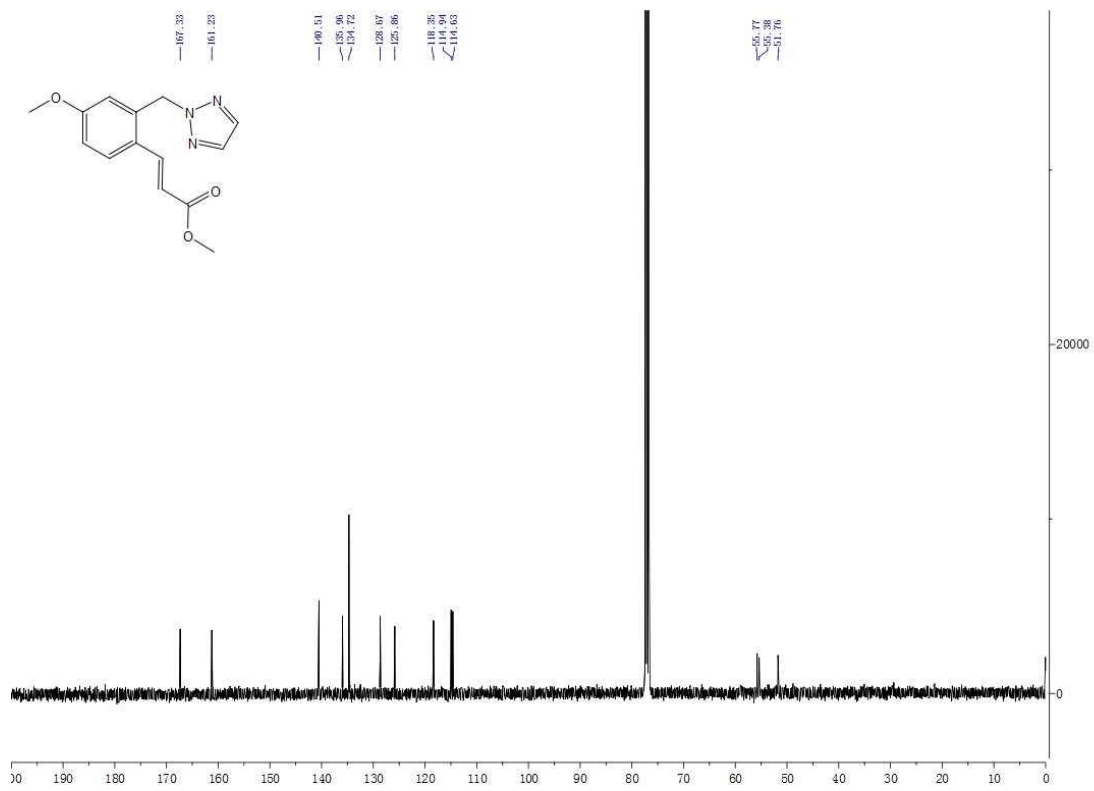
¹³C-3g



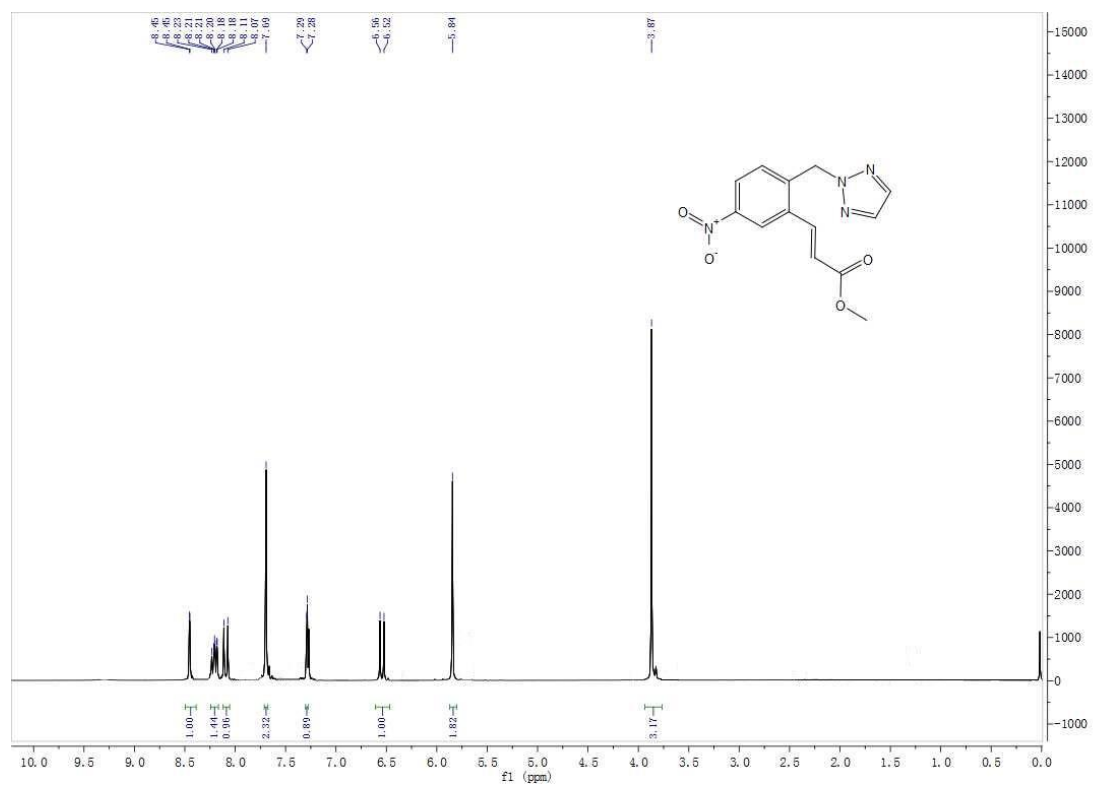
^1H -3h



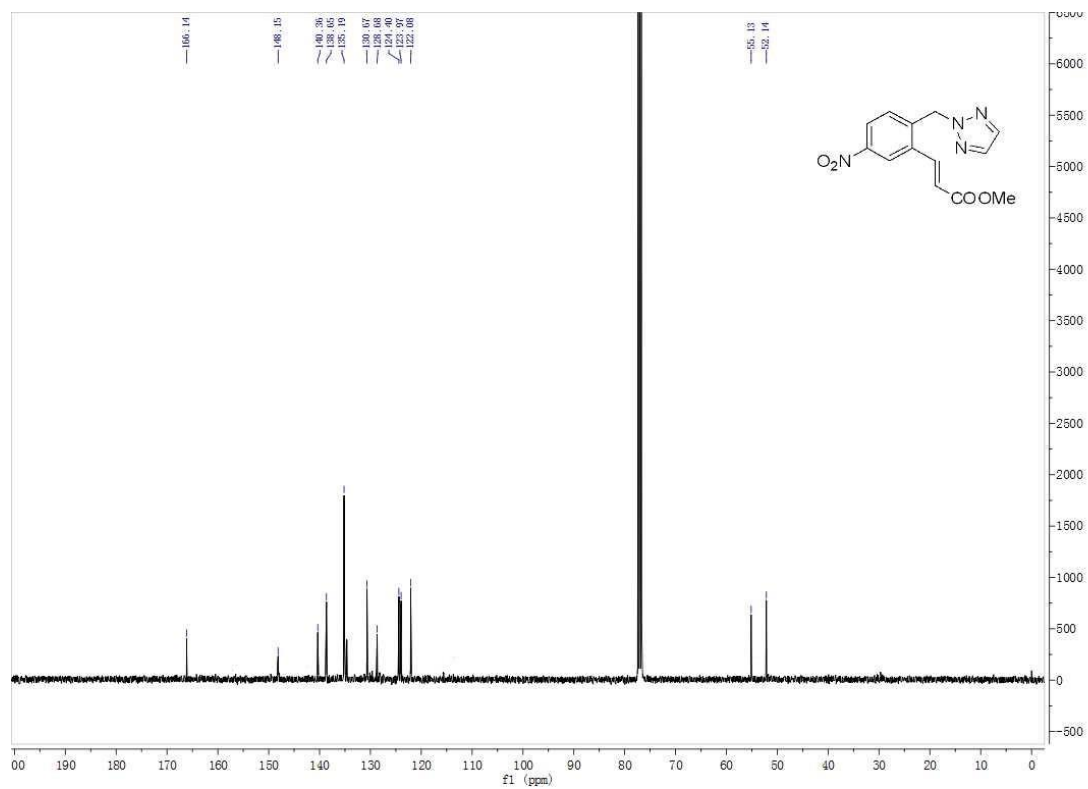
^{13}C -3h



¹H-3i



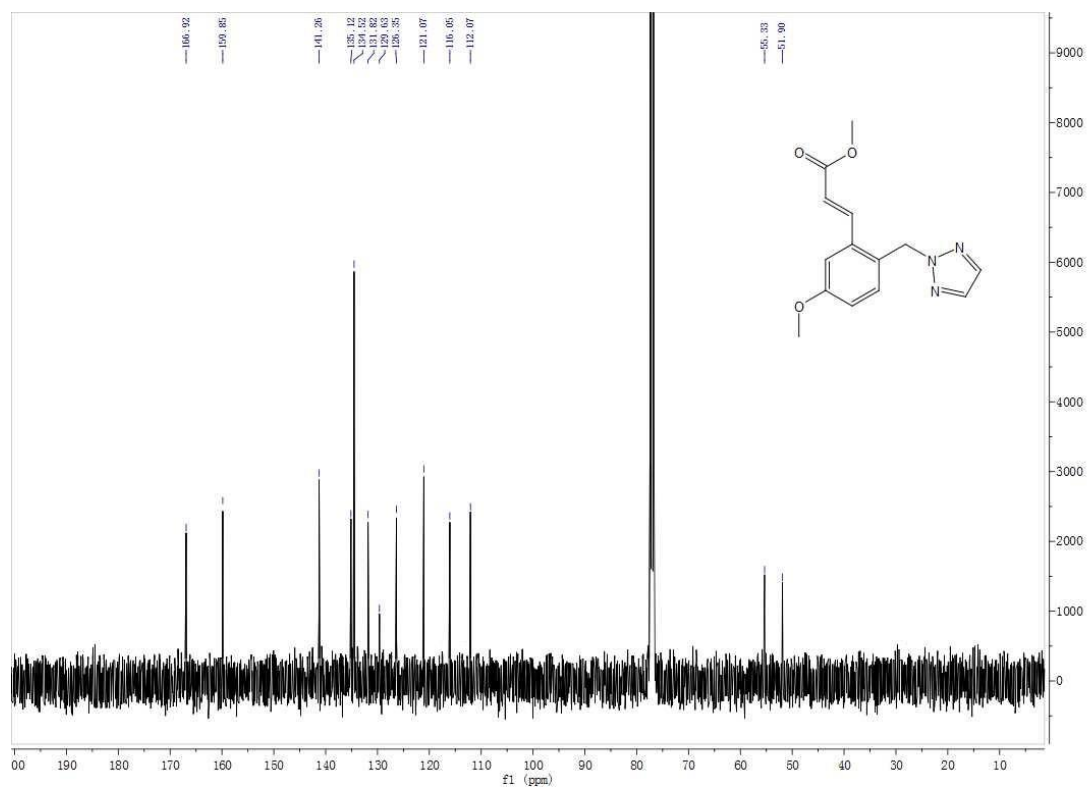
¹³C-3i



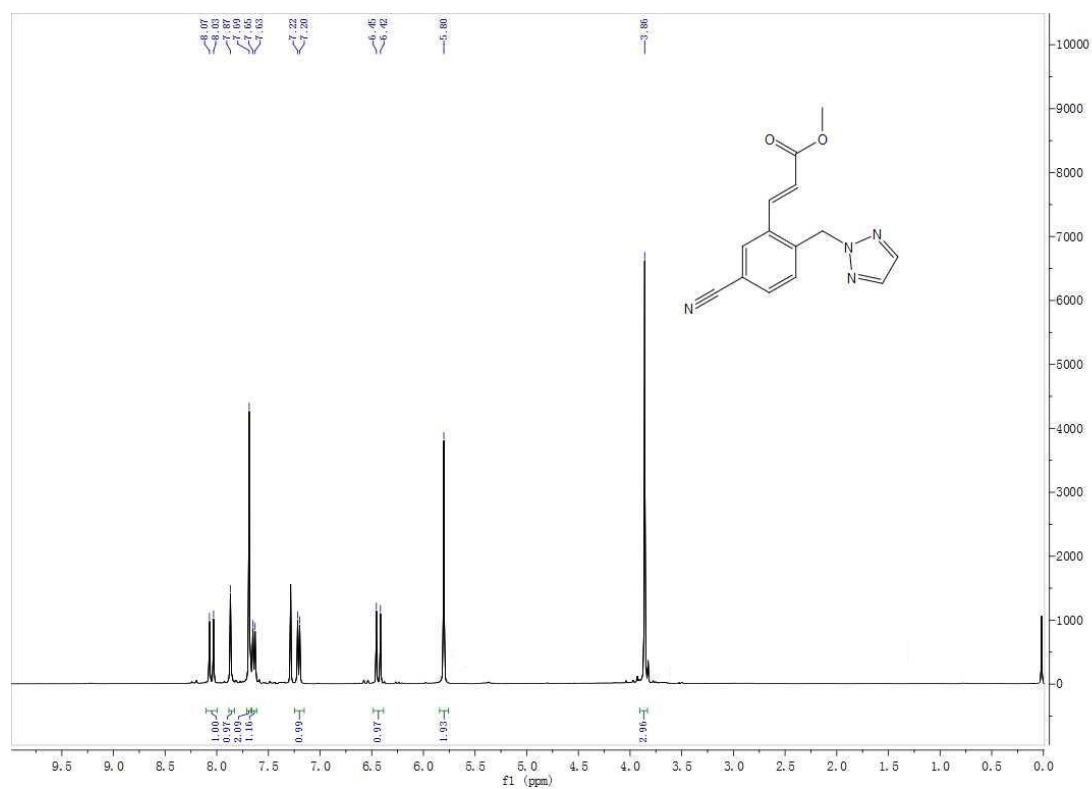
¹H-3j



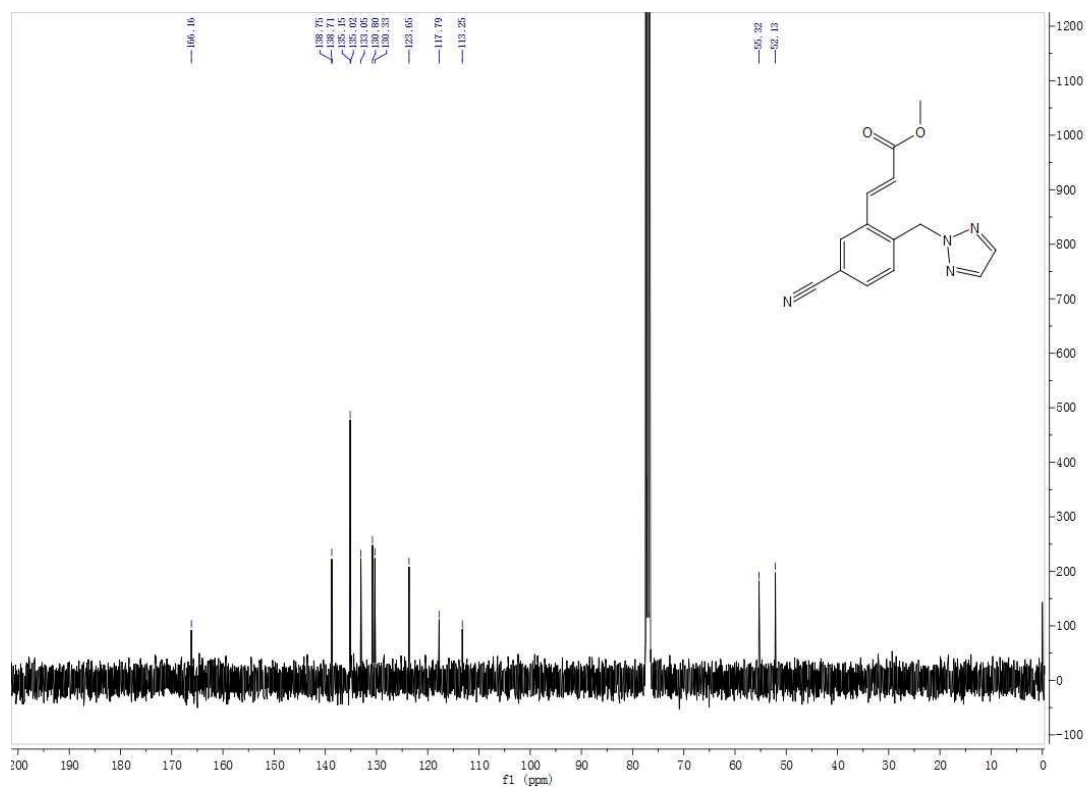
¹³C-3j



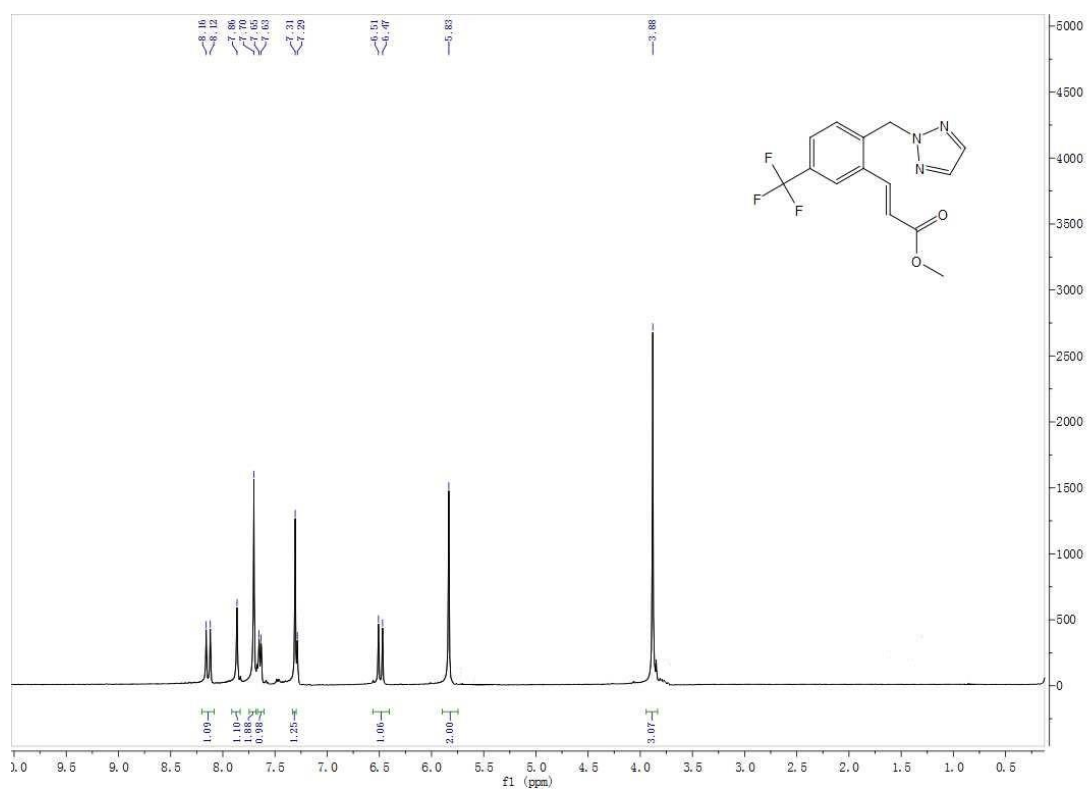
1H-3k



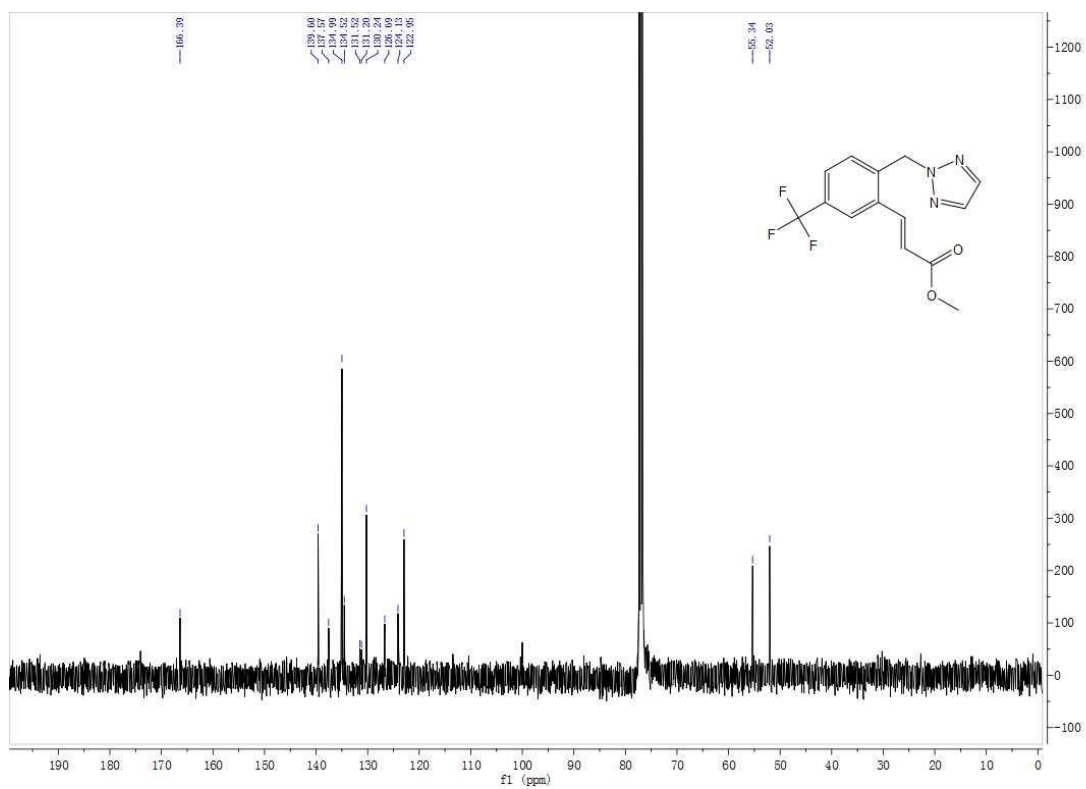
¹³C-3k



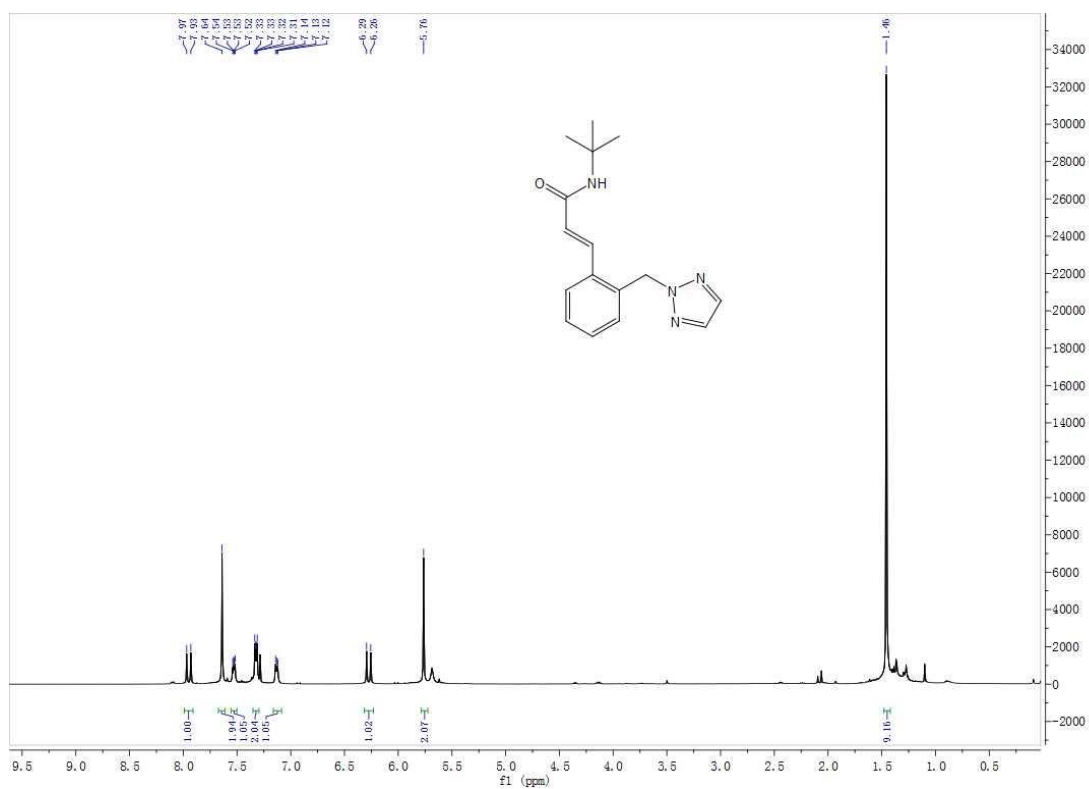
¹H-31



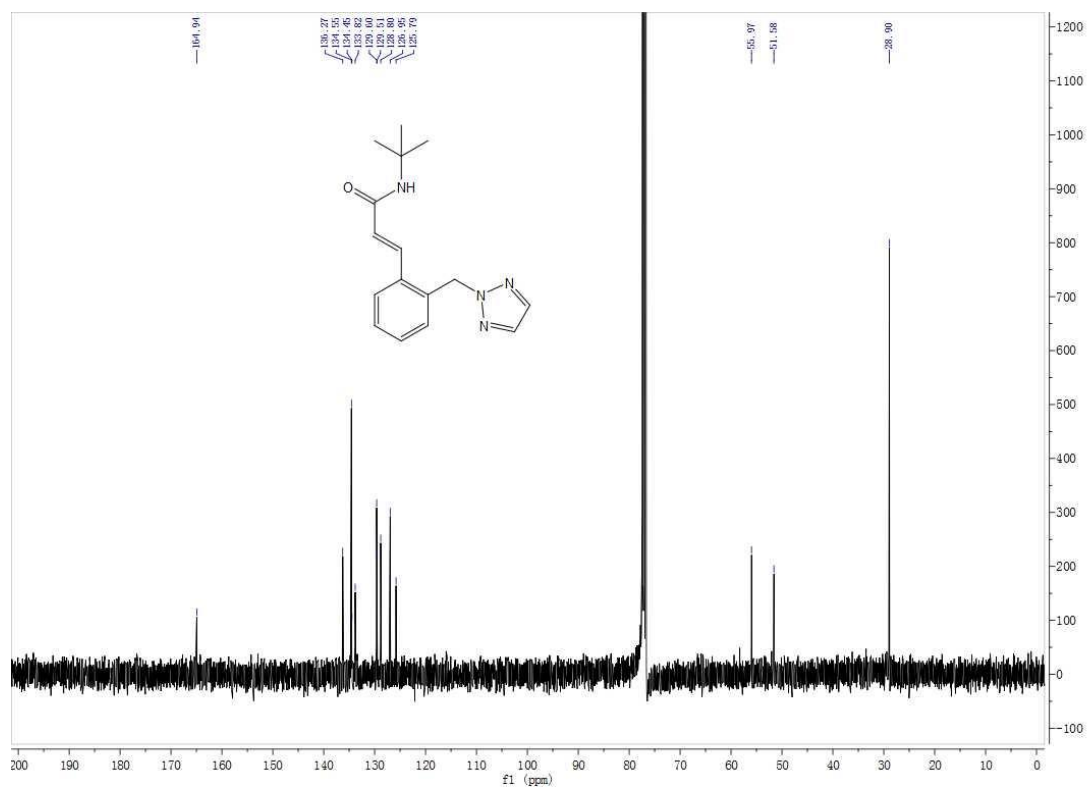
¹³C-31



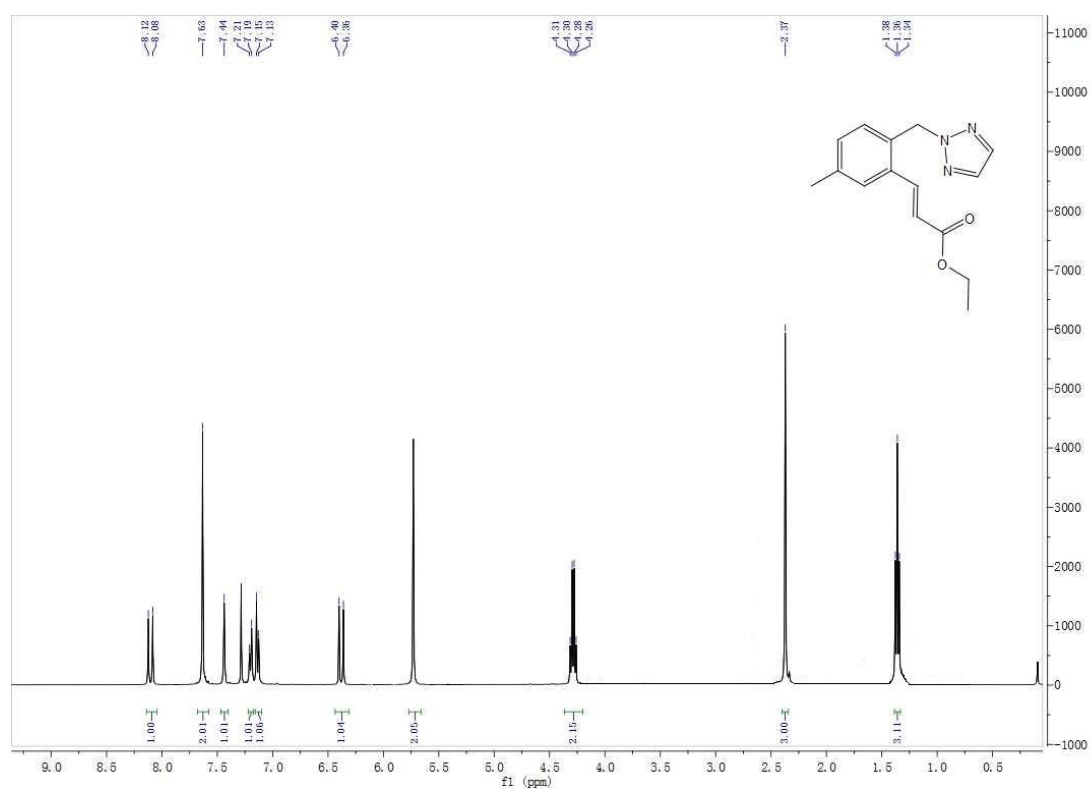
¹H-3m



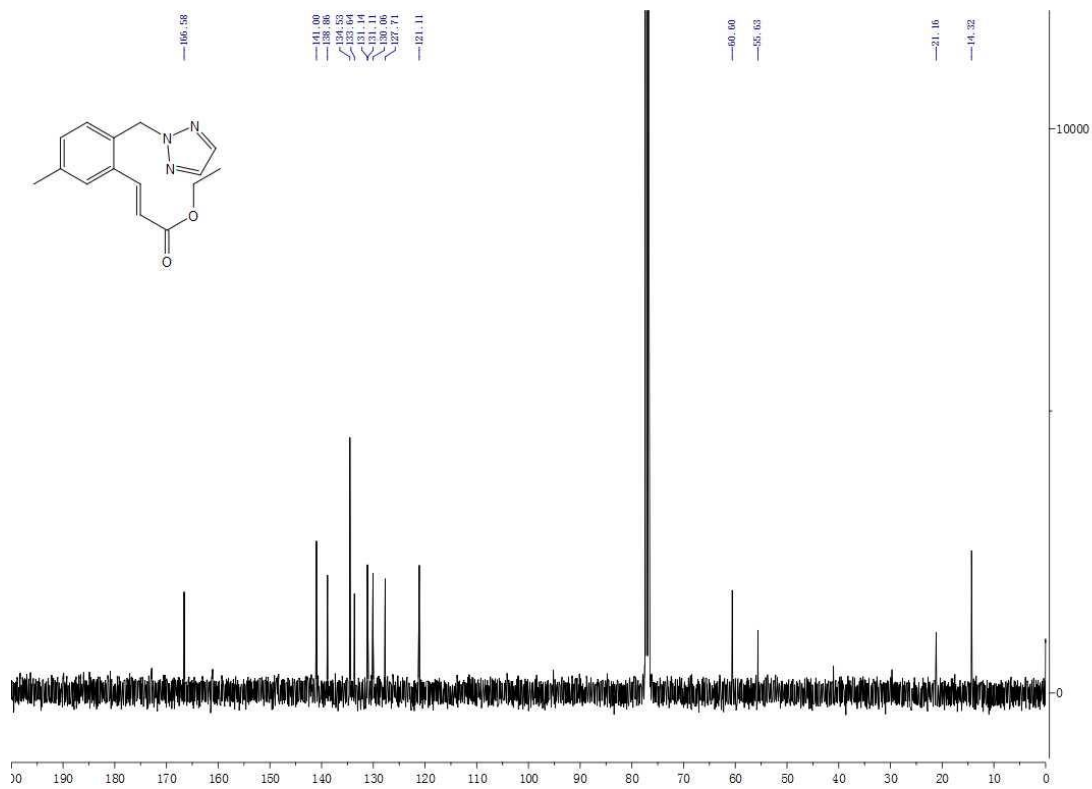
¹³C-3m



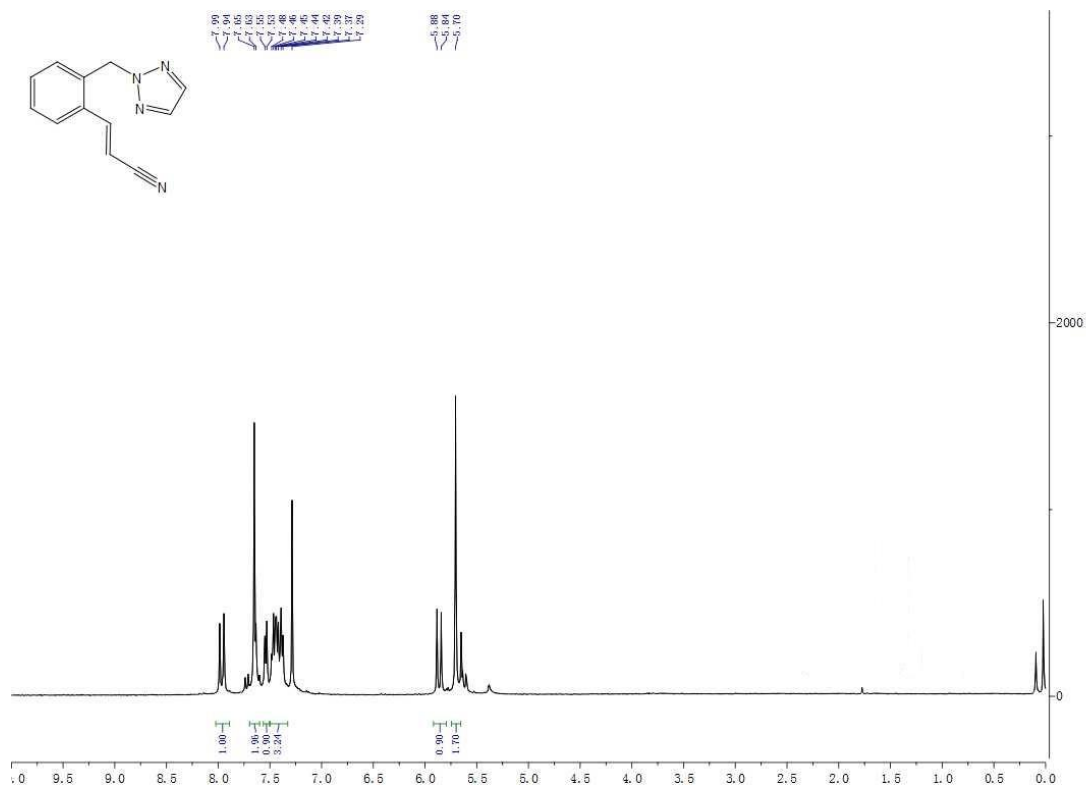
¹H-3n



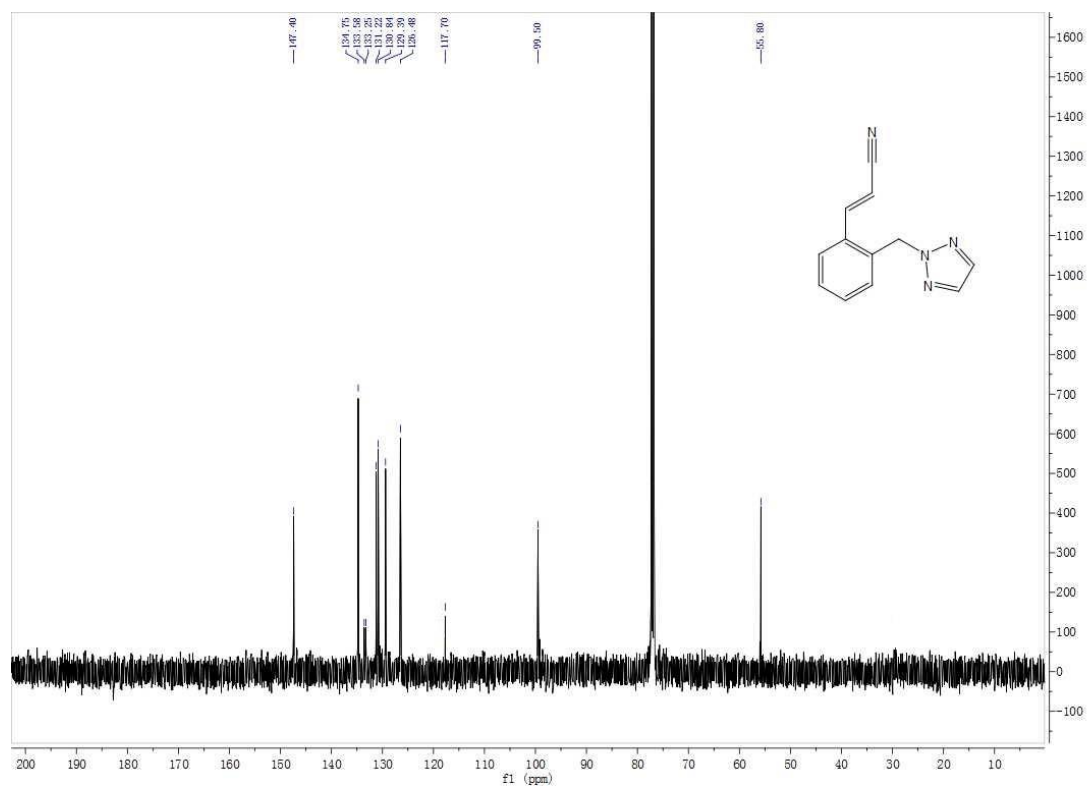
¹³C-3n



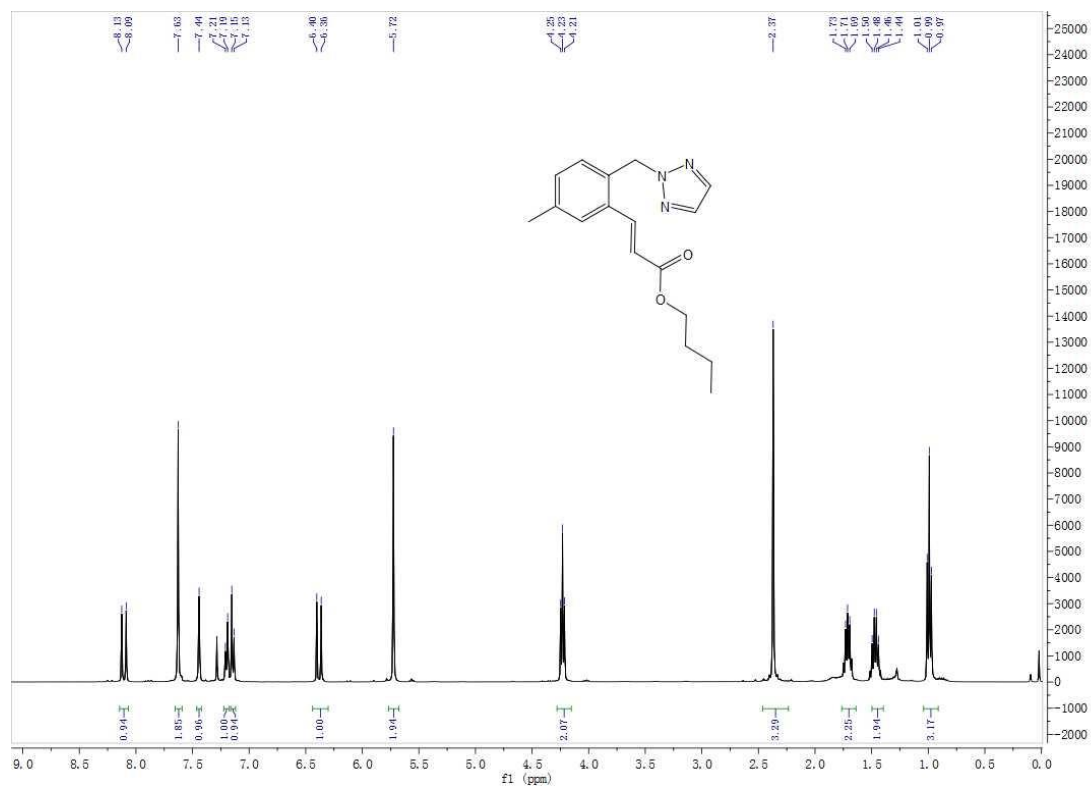
¹H-3o



^{13}C -3o



^1H -3p



¹³C-3p

