SYNTHESIS OF *CIS* OR *TRANS* 4-HETEROAROMATIC SUBSTITUTE FURANO AND PYRANO [3,2-*c*]TETRAHYDROQUINOLINES BY ONE POT IMINO DIELS-ALDER REACTIONS

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Supporting Information

1.Experimental section

Melting points (not corrected) were determined using a Reichert Thermovar apparatus. Proton nuclear magnetic resonance (^{1}H NMR, 400 MHz) spectra and carbon nuclear magnetic resonance (^{13}C NMR, 100 MHz) spectra were recorded on a Bruker Avance III NMR spectrometer. Chemical shifts for protons are reported in parts per million downfield from tetramethylsilane and are referenced to residual protium in the NMR solvent ($CHCl_3$: δ 7.26; DMSO-d_6: δ 2.50). Chemical shifts for carbon are reported in parts per million downfield from tetramethylsilane and are referenced to the carbon resonances of the solvent ($CHCl_3$: δ 77.0; DMSO-d_6: δ 39.5). Mass spectra were run using a Waters ESI-QTOF mass spectrometer (Waters, USA) equipped with an interchangeable ESI Z-spray source. Samples were dissolved in methanol which were infused by a syringe pump at a flow rate of 5 mL/min. Nitrogen was used as nebulizing gas, desolvation gas and cone curtain gas. The QTOF-MS source parameters were set as follows: spray voltage, 2800V in the positive mode; sample cone, 40 V; extract cone, 4 V; source temperature, 90 ℃; desolvation temperature; 25 ℃; cone gas flow, 100L/h; and desolvation gas flow, 500L/h. The micro-channel

plate detector was operated at 2100V. The m/z range of 50 to 800 was recorded at every 1.0s with an interscan time of 0.02s for QTOF-MS analysis. Chemicals received from commercial sources were used without further purification.

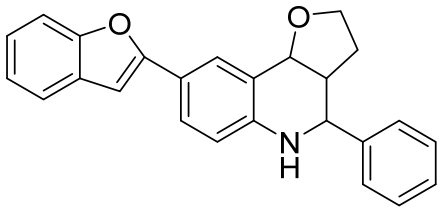
Typical procedure for the preparation of Compound **10-13**

Add 4-Benzofuran-2-yl-phenylamine (209 mg; 1.00 mmol) and $InCl_3$ (43.8 mg; 20 mol%) into CH_3CN (8 mL),then the aldehyde(1.10mmol)was added to the mixture. After 5 min stirring at room temperature, DHP/DHF (105μL, 1.30mmol) was added. This mixture was stirred for the appropriate time and at the temperature, as indicated in Tables 1, 2 and 3. After complete conversion, as indicated by TLC, the solvent was removed under reduced pressure, diluted with ethyl acetate and filtered. The organic layer was washed with water and brine and dried over Na_2SO_4. The mixture was filtered, evaporated to dryness, and the residue was purified by column chromatography (silica, eluent: PE:EA=20:1) to afford the products. For some of the products, the isomers were separated by column chromatography, using a mixture of petroleum ether and ethyl acetate as eluent. In case, the isomers were not separated. The ^1H NMR data of both isomers were assigned by comparison with previously synthesized compounds and based on the relative ratio between both isomers.

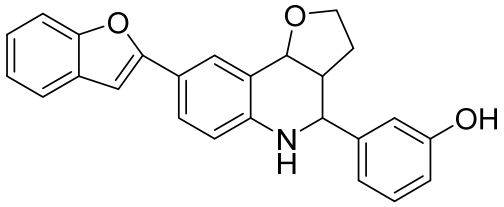
Typical procedure for the preparation of Compound **14a-c**

First substituted aniline(1.00 mmol) and DHF(2.00 mmol) were dissolved in MeCN(10 ml),then $InCl_3$ (20% mmol)was added to the mixture. This mixture was stirred for the appropriate time and at the temperature, as indicated in Tables 4. After complete conversion, as indicated by TLC, the solvent was removed under reduced pressure, diluted with ethyl acetate and filtered. The organic layer was washed with water and brine and dried over Na_2SO_4. The mixture was filtered, evaporated to dryness, and the residue was purified by column chromatography (silica, eluent: PE:EA=3:1) to afford the products.

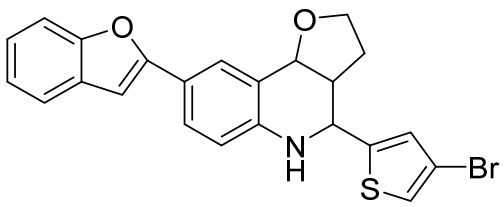
2. ^{1}H, ^{13}C-NMR and HRMS Spectra



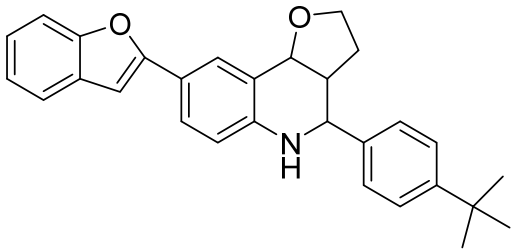
Compound **11a**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 1H),7.64 (d, *J* = 8.4 Hz, 1H), 7.58 (d, *J* = 7.8 Hz, 1H), 7.53 (m, 1H), 7.46 (m, 3H), 7.40 (m, 2H), 7.20 (m, 2H), 6.84 (s, 1H), 6.69 (d, *J* = 8.4 Hz, 1H), 4.68 (d, *J* = 5.0 Hz, 1H), 4.08 (m, 1H), 3.82 (t, *J* = 6.2 Hz, 1H),3.11 (t, *J* = 6.3 Hz, 1H), 2.51 (m, 1H), 2.07 (m, 1H), 1.76 (m, 1H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 18.4, 29.7, 43.2, 57.6, 65.3, 98.6, 110.8, 111.2, 114.9, 120.0, 120.3, 120.8, 122.7, 123.3, 126.0, 128.2, 128.3, 128.5, 128.8, 128.9, 129.7, 141.3, 145.8, 154.5, 156.6; HRMS (ESI): $[M+H]^+$ 368.1630 founded, $[C_{25}H_{22}NO_2]^+$ calculated 368.1645. Mp: 171-174 °C.



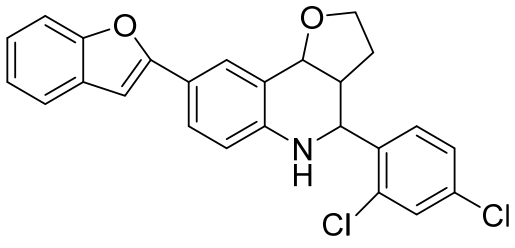
Compound **10b**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.64 (d, *J* = 8.4 Hz, 1H), 7.54 (m, 2H), 7.20 (m, 3H), 7.01(m, 2H), 6.84 (s, 1H), 6.71 (d, *J* = 9.7 Hz, 1H), 6.55 (d, *J* = 8.7 Hz, 1H), 5.32 (d, *J* = 7.6 Hz, 1H), 4.09 (d, *J* = 6.7 Hz, 1H), 3.90 (m, 1H), 3.79 (m, 1H), 2.81 (m, 1H), 2.16 (m, 2H); ^{13}C NMR (400 MHz,$CDCl_3$) δ: 19.0, 27.4, 29.6, 34.0, 34.3, 36.6, 50.1, 61.2, 61.8, 71.4, 80.2, 102.9, 115.5, 118.5, 119.4, 120.1, 122.3, 125.1, 126.9, 127.6, 128.0, 131.3, 134.2, 134.5, 159.0, 161.6, 162.4; HRMS (ESI): $[M+H]^+$ 384.1586 founded, $[C_{25}H_{22}NO_3]^+$ calculated 384.1594. Mp: 162-165 °C.



Compound **11c**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 1H), 7.67 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.62 (d, *J* = 7.7 Hz, 1H),7.42 (s,1H), 7.22(m, 2H), 7.17 (s, 1H),7.06 (s, 1H), 6.86 (s, 1H), 6.74 (d, *J* = 8.4 Hz, 1H), 4.68 (d, *J* = 5.1 Hz, 1H), 4.15 (d, *J* = 10.7 Hz, 1H), 3.31 (t, *J* = 6.4 Hz, 2H), 2.47 (m, 1H), 2.19 (m, 1H),1.87 (m, 1H); ^{13}C NMR (400 MHz,$CDCl_3$) δ: 14.2, 28.7, 29.7, 43.3, 57.3, 65.3, 76.0, 98.8, 110.9, 111.3, 105.0, 120.0, 120.4, 122.7, 123.4, 124.9, 126.1, 126.6, 128.2, 128.3, 128.5, 130.0, 143.4, 156.5; HRMS (ESI): $[M+H]^+$ 452.0314 founded, $[C_{23}H_{19}BrNO_2S]^+$ calculated 452.0314. Mp: 183-186 °C.

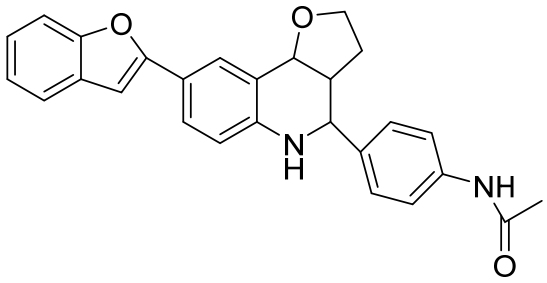


Compound **11d**: cis:^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (s, 1H), 7.39 (d, *J* = 7.5 Hz, 1H), 7.35 (m, 2H), 7.30 (d, *J* = 8.3 Hz, 2H),7.12 (m, 4H), 6.76 (s, 1H), 6.59 (d, *J* = 8.4 Hz, 1H), 4.60 (d, *J* = 4.9 Hz, 1H), 3.99 (m, 1H), 3.05 (t, *J* = 6.5 Hz, 2H), 2.43 (m, 1H),1.99 (m, 2H, H_{10}), 1.30 (s, 12H); ^{13}C NMR (400 MHz,$CDCl_3$) δ: 21.7, 28.7, 30.9, 42.1, 56.2, 64.2, 97.5, 109.8, 110.2, 113.8, 119.3, 120.2, 121.6, 122.2, 124.5, 124.6, 125.0, 126.9, 127.2, 127.8, 144.9, 150.3, 153.5, 154.1, 155.6; HRMS (ESI): $[M+H]^+$ 424.2265 founded, $[C_{29}H_{30}NO_2]^+$ calculated 424.2271. Mp: 177-180 °C.

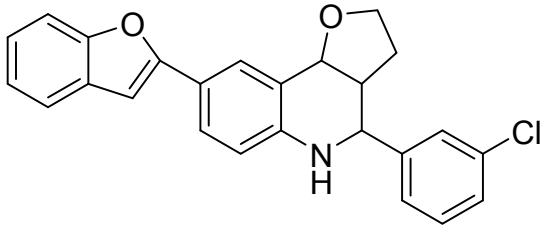


Compound **11e**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.64 (m, 2H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.45 (m, 2H), 7.33 (s, 1H), 7.20 (m, 2H), 6.86 (s, 1H), 6.74 (d, *J* = 12.0 Hz, 1H), 4.79 (d, *J* = 4.8 Hz, 1H), 4.09 (m, 1H), 3.81(m, 1H), 2.50 (m, 1H), 2.14 (m, 1H), 1.48 (m, 1H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 24.6, 28.5, 43.5, 53.2, 66.8, 98.8, 99.0, 110.8, 110.9, 115.1, 120.4, 120.5, 122.7,

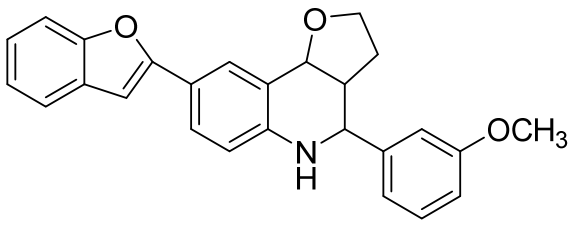
123.4, 123.5, 125.4, 126.1, 127.0, 127.5, 128.6, 129.4, 129.7, 130.2, 145.4, 154.6, 156.4; HRMS (ESI): $[M+H]^+$ 436.0862 founded, $[C_{25}H_{20}Cl_2NO_2]^+$ calculated 436.0866. M. p. : 176-179 ℃.



Compound **11f**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (s, 1H),7.66 (d, *J* = 8.4 Hz, 1H), 7.49 (d, *J* = 7.1 Hz, 2H), 7.43 (t, *J* = 7.5 Hz, 2H), 7.25 – 7.17 (m, 4H), 6.86 (s, 1H), 6.71 (d, *J* = 8.4 Hz, 1H), 4.68 (d, *J* = 5.0 Hz, 1H), 4.09 (m, 1H), 3.76 (dt, *J* = 18.6, 7.2 Hz, 2H), 2.49 (m, 1H), 2.22 (s, 3H), 2.07 (m, 2H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 15.8, 33.6, 58.8, 72.6, 73.0, 79.0, 102.4, 115.4, 119.1, 124.5, 124.9, 127.6, 127.9, 130.9, 132.8, 133.5, 134.6, 135.9, 137.1, 143.7, 151.0, 158.9, 161.8, 172.3, 173.6 ; HRMS (ESI): $[M+H]^+$ 425.1852 founded, $[C_{27}H_{25}N_2O_3]^+$ calculated 425.1860. M. p. : 190-193 ℃.

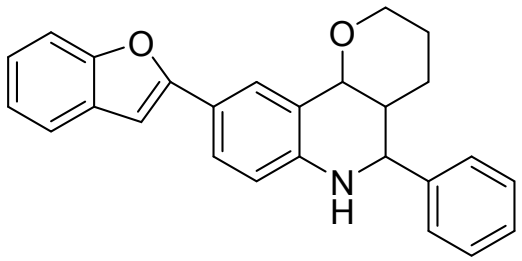


Compound **11g**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 1H), 7.64 (d, *J* = 8.4 Hz, 1H), 7.58 (d, *J* = 7.8 Hz, 1H), 7.53(m, 1H), 7.47 (m, 2H), 7.40 (m, 2H), 7.20 (m, 2H), 6.84 (s, 1H), 6.69 (d, *J* = 8.4 Hz, 1H), 4.68 (d, *J* = 5.0 Hz, 1H), 4.34 (brs, 1H), 4.08 (m, 1H), 3.82 (t, *J* = 6.2 Hz, 1H), 3.11 (t, *J* = 6.3 Hz, 1H), 2.51 (m, 1H), 2.07 (m, 1H), 1.76 (m, 1H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 28.7, 43.3, 57.3, 66.8, 98.8, 98.9, 110.9, 115.1, 120.4, 122.7, 123.4, 126.1, 126.6, 128.3, 128.5, 130.0, 134.6, 134.7, 143.5, 144.0, 144.8, 145.5, 154.6, 156.5; HRMS (ESI): $[M+H]^+$ 402.1233 founded, $[C_{25}H_{21}ClNO_2]^{l+}$ calculated 402.1255. M. p. : 170-172 ℃.

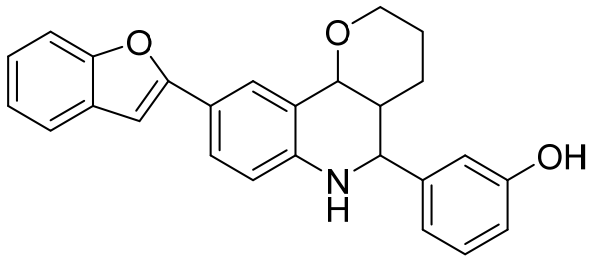


Compound **11h**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 1H), 7.64 (d, *J* = 9.8 Hz, 1H), 7.53 (d, *J* = 6.9 Hz, 1H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.31(t, J = 7.9 Hz, 1H), 7.19 (m, 2H), 7.07 – 7.00 (m, 3H), 6.83 (s, 1H), 6.69 (d, *J* = 8.4 Hz, 1H), 4.67 (d, *J* = 4.9 Hz, 1H), 4.06 (m, 1H), 3.88 (m, 2H), 3.84 (s, 3H), 2.49 (m, 1H), 2.06 (m, 1H), 1.78(m, 1H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 28.8, 35.7, 43.3, 55.3, 55.4, 57.6, 65.3, 98.6, 102.9, 110.9, 111.3, 113.7, 114.9, 120.0, 120.4, 120.7, 121.2, 122.7, 123.3, 124.9, 126.0 128.2, 129.7, 142.9, 145.8, 156.6, 160.0 ; HRMS (ESI): $[M+H]^+$ 398.1755 founded, $[C_{26}H_{24}NO_3]^+$ calculated 398.1751. Mp: 148-153 °C.

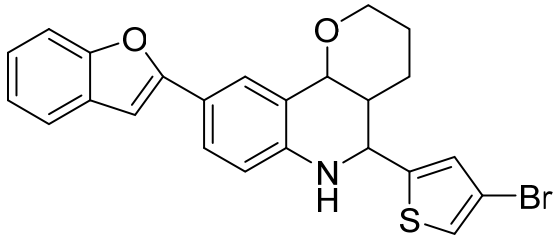
Compound **10h**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (s, 1H, H_8), 7.58 (d, *J* = 8.5 Hz, 1H), 7.53 (d, *J* = 6.9 Hz, 1H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.31 (t, *J* = 7.9 Hz, 1H), 7.19 (m, 2H), 6.90 (m, 3H), 6.83 (s, 1H), 6.66 (d, *J* = 8.5 Hz, 1H), 5.32 (d, *J* = 7.8 Hz, 1H), 4.06 (m, 1H), 3.84 (s, 3H), 3.75 (m, 2H), 3.10 (t, *J* = 6.6 Hz, 1H), 2.81 (m, 1H), 2.09(m, 1H). Mp : 191-196 °C



Compound **13a**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.62-7.56 (m, 3H), 7.55 – 7.45 (m, 5H), 7.21 (m, 2H), 6.85 (s, 1H), 6.66 (d, *J* = 8.4 Hz, 1H), 5.37 (d, *J* = 5.4 Hz, 1H), 4.74 (d, *J* = 2.5 Hz, 1H), 3.67 (m, 1H), 3.58 (d, *J* = 6.2 Hz, 1H), 2.22 (s, 1H), 1.80 (m, 2H), 1.60 – 1.50 (m, 2H) ; ^{13}CNMR (400MHz,$CDCl_3$) δ: 11.0, 14.1, 23.0, 23.7, 28.9, 29.1, 29.7, 30.4, 33.3, 38.7, 62.0, 68.2, 102.7, 111.3, 121.2, 122.6, 123.2, 124.8, 126.3, 127.8, 128.5, 128.8, 129.2, 130.9, 134.0, 155.2; HRMS (ESI): $[M+H]^+$ 382.1797 founded, $[C_{26}H_{24}NO_2]^+$ calculated 382.1802. Mp: 145-150 °C.

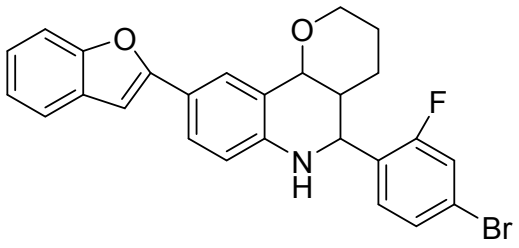


Compound **12b**: trans: ^{1}H NMR (400 MHz,$CDCl_3$) δ: 7.76 (d, J = 1.8 Hz, 1H), 7.60 (m, 1H), 7.51 (m, 1H), 7.47 (d, J = 8.6 Hz, 1H), 6.58 (d, J = 8.4 Hz, 1H), 6.79 (m, 2H), 7.21 (m, 3H), 6.97 (t, J = 6.6Hz, 1H), 6.90 (s, 1H), 4.70 (d, J = 10.8 Hz, 1H), 4.48 (d, J = 2.4 Hz, 1H), 4.10 (t, J=10.8,1 H), 3.77 (m, 1H), 2.08 (m, 1H), 1.86 (m, 1H), 1.70 (m, 1H), 1.42 (m, 1H); ^{13}C NMR (400 MHz,$CDCl_3$) δ: 14.1, 14.2, 23.0, 24.0, 29.0, 29.8, 30.4, 38.7, 39.0, 54.3, 68.2, 68.7, 74.3, 98.4, 110.8, 115.6, 115.8, 120.3, 122.7, 123.3, 126.5, 127.9, 128.8, 129.3, 129.4, 130.9, 154.5,156.7, 167.8; HRMS (ESI): $[M+H]^+$ 398.1748 founded, $[C_{26}H_{24}NO_3]^+$ calculated 398.1751. Mp: 153-156 °C.



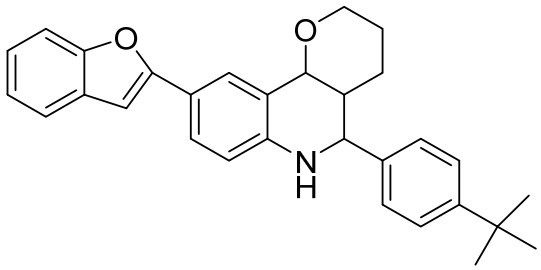
Compound **12c**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.76 (d, J = 1.6 Hz, 1H), 7.62 (m, 1H), 7.53 (m, 1H), 7.47 (d, J = 7.4 Hz, 1H), 7.20 (m, 3H), 7.02 (s, 1H), 6.82 (s, 1H), 6.63 (d, J = 8.4 Hz, 1H), 5.04 (d, J = 10.4 Hz, 1H), 4.49 (d, J = 2.6 Hz, 1H), 4.12 (m, 1H),3.78 (m, 1H), 2.07 (m, 1H), 1.80 (m, 2H), 1.43(m, 2H); Mp: 151-154 °C.

Compound **13c**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.29 (s, 1H), 7.6 2(m, 1H,), 8.1 3(s, 1H), 7.94 (s, 1H), 7.70 (s, 1H), 7.53 (m, 2H), 7.1 7(s, 1H), 7.02 (s, 1H), 6.68 (d, J = 8.4 Hz,1H), 5.31 (d, J = 5.6 Hz, 1H), 4.97 (d, J = 1.6 Hz, 1H), 4.21 (m, 2H), 3.80 (t, J = 6.0 Hz, 1H), 3.49 (t, J = 7.2 Hz, 1H), 3.18 (t, J = 8.0 Hz, 1H), 2.25 (m, 1H), 2.02 (m, 2H), 1.43 (m, 2H); ^{13}C NMR (400 MHz ,$CDCl_3$) δ: 22.7, 24.3, 32.0, 38.3, 68.1, 73.7, 98.5, 110.8, 114.6, 119.3, 120.3, 120.6, 121.8, 122.7, 123.3, 126.4, 127.6, 128.1, 129.7, 130.2, 154.5, 156.6, 159.5,162.0; HRMS (ESI): $[M+H]^+$ 466.0466 founded, $[C_{24}H_{21}BrNO_2S]^+$ calculated 466.0471. Mp: 162-166 °C.



Compound **12d**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.78 (d, *J* = 1.4 Hz, 1H), 7.62 (m, 1H), 7.52 (m, 1H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.31 (m, 2H), 7.20 (m, 2H), 6.82 (s, 1H), 6.63 (d, *J* = 8.3 Hz, 1H), 5.12 (d, *J* = 10.1 Hz, 1H), 4.49 (d, *J* = 2.3 Hz, 1H), 4.08 (d, *J* = 10.9 Hz, 1H), 3.75 (m, 1H), 2.16 (s, 1H), 1.87 (m, 1H), 1.76 (m, 1H), 1.46 (m, 2H); Mp: 149-153 °C.

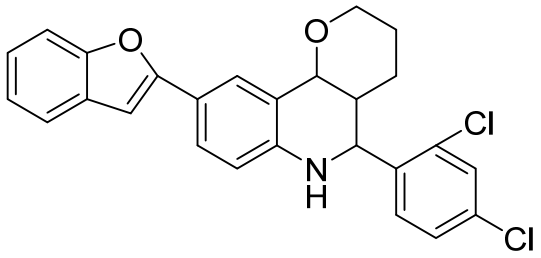
Compound **13d**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.78 (d, *J* = 1.4 Hz, 1H), 7.62 (m, 1H), 7.52 (m, 1H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.31 (m, 2H), 7.20 (m, 2H), 6.82 (s, 1H), 6.63 (d, *J* = 8.3 Hz, 1H), 5.12 (d, *J* = 10.1 Hz, 1H), 4.49 (d, *J* = 2.3 Hz, 1H), 4.08 (d, *J* = 10.9 Hz, 1H), 3.75 (m, 1H), 2.16 (s, 1H), 1.87 (m, 1H), 1.76 (m, 1H), 1.46 (m, 2H); ^{13}C NMR (400 MHz, $CDCl_3$) δ: 14.1, 22.2, 22.7, 24.3, 24.5, 29.4, 29.7, 32.0, 38.3, 68.1, 73.7, 98.5, 110.8, 119.1, 120.3, 120.6, 121.7, 122.7, 123.3, 126.4, 127.6, 128.1, 129.7, 131.1, 154.5, 156.6; HRMS (ESI): $[M+Na]^+$ 500.0644 founded, $[C_{26}H_{21}BrFNNaO_2]^+$ calculated 500.0632. M.p: 165-170 °C.



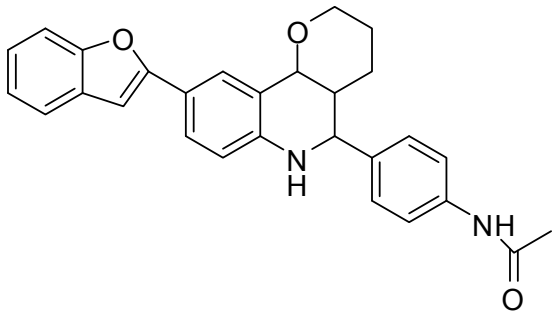
Compound **12e**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (s, 1H), 7.60 (d, *J* = 8.3 Hz, 1H), 7.51 (m, 1H), 7.47 (d, *J* = 7.6 Hz, 1H), 7.41 (d, *J* = 8.2 Hz, 2H), 7.35 (d, *J* = 8.2 Hz, 2H), 7.19 (m, 2H), 6.79 (s, 1H), 6.57 (d, *J* = 8.4 Hz, 1H), 4.75 (d, *J* = 10.7 Hz, 1H), 4.48 (d, *J* = 2.0 Hz, 1H), 4.24 (m, 1H), 4.14 (d, *J* = 10.4 Hz, 1H), 3.77 (m, 1H), 2.14 (t, *J* = 11.8 Hz, 1H), 1.89 (m, 1H), 1.69 (m, 1H), 1.55 (m, 2H), 1.34 (s, 9H); Mp : 166-171 °C.

Compound **13e**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.60 (m, 1H), 7.52(m, 1H), 7.48 (m, 1H), 7.48 (m, 1H), 7.41 (m, 1H), 7.34 (m, 1H), 7.20 (m, 2H), 6.85 (s, 1H), 6.64 (d, *J* = 8.8 Hz, 1H), 5.36 (d, *J* = 5.6 Hz, 1H,), 4.72 (d, *J* = 2.0 Hz, 1H), 4.22 (m, 1H), 4.06 (m, 1H), 3.65 (m, 1H), 3.51

(m, 1H), 2.55 (m, 1H), 2,20 (m, 2H), 1.34 (s, 9H); ^{13}C NMR (400 MHz,$CDCl_3$) δ: 14.1, 22.1, 23.0, 24.1, 31.4, 34.6, 38.7, 54.5, 68.2, 68.7, 74.5, 98.1, 110.8, 114.2, 119.5, 120.2, 120.5, 122.6, 123.1, 125.6, 126.4, 127.4, 127.9, 129.8, 138.9, 145.2, 151.1, 154.5, 156.9; HRMS(ESI): $[M+Na]^+$ 460.2173 founded, $[C_{30}H_{31}NNaO_2]^+$ calculated 460.2247. Mp: 175-179 °C.

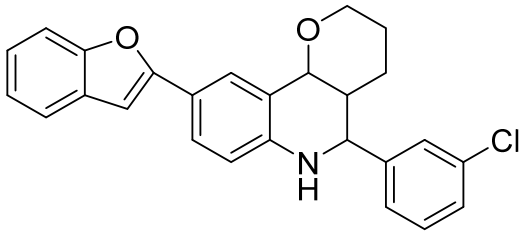


Compound **13f**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (s, 1H), 7.61 (m, 2H), 7.52 (m, 2H), 7.44 (d, *J* = 2.0 Hz, 1H), 7.32-7.19 (m, 3H), 6.87 (s, 1H), 6.69 (d, *J* = 8.4 Hz, 1H), 5.15 (d, *J* = 5.6 Hz, 1H), 4.51 (d, *J* = 2.2 Hz, 1H), 4.19 (m, 1H), 4.01 (m, 1H), 3.70 (m, 1H), 2.21 (m, 1H), 1.91 (m, 1H), 1.72 (m, 1H), 1.48 (m, 1H); ^{13}C NMR (400 MHz, $CDCl_3$) δ: 22.9, 28.0, 41.3, 51.0, 61.6, 65.6, 97.5, 109.8, 113.6, 113.9, 119.3, 119.5, 120.0, 121.6, 122.2, 124.2, 124.8, 125.9, 126.9, 127.8, 128.7, 129.9, 144.1, 144.3, 153.5, 155.6; HRMS (ESI): $[M+Na]^+$ 472.2161 founded, $[C_{26}H_{21}Cl_2NNaO_2]^+$ calculated 472.0842. Mp: 155-158 °C.



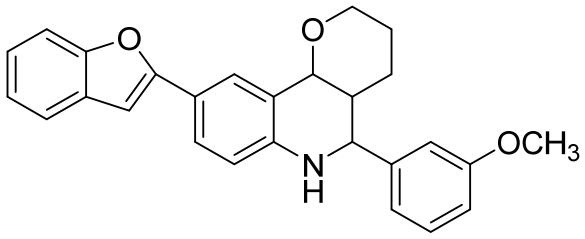
Compound **12g**: trans: ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.97 (s, 1H), 7.62 (s, 1H), 7.60 (m, 2H), 7.55 (m, 2H), 7.35 (m, 2H), 7.21 (m, 2H), 7.05 (d, *J* = 9.0 Hz, 1H), 6.72 (d, *J* = 8.5 Hz, 1H), 6.60 (s, 1H), 4.55 (d, *J* = 10.5 Hz, 1H), 4.39 (d, *J* = 2.2 Hz, 1H), 3.94 (d, *J* = 9.2 Hz, 1H), 3.66 (m, 1H), 2.05 (s, 3H), 1.94 (d, *J* = 8.9 Hz, 1H), 1.86 – 1.48(m,4H); ^{13}C NMR (400 MHz, $CDCl_3$) δ: 15.8, 27.7, 28.4, 33.6, 35.0, 43.4, 58.8, 72.6, 79.0, 102.4, 115.4, 119.1, 124.5, 124.9, 127.6, 127.8, 130.9, 132.8, 133.5, 134.6, 135.9, 143.7, 151.0, 161.8, 173.6; HRMS(ESI):$[M+Na]^+$ 461.1750 founded,

$[C_{28}H_{26}N_2NaO_2]^+$ calculated 461.1836. Mp: 157-163 °C.



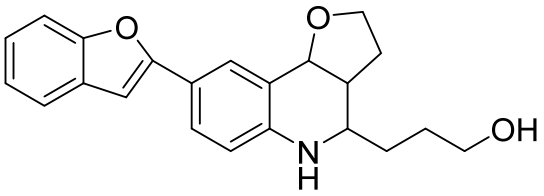
Compound **12h**: trans: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 1.8 Hz, 1H), 7.62 (m, 1H), 7.52 (m, 1H), 7.46 (m, 2H), 7.38-7.28 (m, 3H), 7.20 (m, 2H), 6.81 (s, 1H), 6.61 (d, *J* = 8.4 Hz, 1H), 4.75 (d, *J* = 10.6 Hz, 1H), 4.48 (d, *J* = 2.6 Hz, 1H), 4.25 (brs, 1H), 4.14 (d, *J* = 11.2 Hz, 1H), 3.78 (m, 1H), 2.11 (m, 1H), 1.94-1.79 (m, 1H), 1.78-1.67 (m, 1H), 1.51-1.35 (m, 2H). ^{13}C NMR (400 MHz, $CDCl_3$) δ: 22.8, 24.5, 43.3, 57.3, 65.2, 98.8, 110.8, 110.9, 115.1, 120.4, 122.7, 123.4, 126.1, 128.2, 128.3, 129.7, 130.0, 143.5, 145.5, 154.6, 156.5; HRMS (ESI): $[M+Na]^+$ 438.1220 founded, $[C_{26}H_{22}ClNNaO_2]^+$ calculated 438.1231. Mp: 160-163 °C.

Compound **13h**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 1H), 7.67 (d, *J* = 8.7 Hz, 1H), 7.61 (m, 1H), 7.43 (s, 1H), 7.30 (m, 3H), 7.20 (td, *J* = 7.2, 1.4 Hz, 3H), 6.85 (s, 1H), 6.67(m, 1H), 5.34 (d, *J* = 5.5 Hz, 1H), 4.70 (d, *J* = 2.3 Hz, 1H), 4.02 (brs,1H), 3.66 (d, *J* = 11.1 Hz, 1H), 3.50 (t, *J* = 11.3 Hz, 1H), 2.20 (m, 1H), 1.63-1.54 (m, 2H), 1.52-1.44 (m, 2H) ; Mp: 174-179 °C.

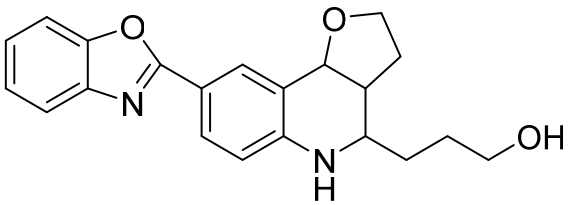


Compound **13i**: cis: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.61 (m, 1H), 7.53 (m, 1H), 7.49 (m, 1H), 7.31 (t, *J* = 7.9 Hz, 1H), 7.21 (m, 2H), 7.00 (d, J = 7.7 Hz, 1H), 6.97 (s, 1H), 6.87 (d, *J* = 2.3 Hz, 1H), 6.85 (s, 1H) , 6.67 (d, *J* = 8.4 Hz, 1H), 5.37 (d, *J* = 5.5 Hz, 1H), 4.72 (d, *J* = 2.4 Hz, 1H), 3.84 (s, 3H), 3.66 (m, 1H), 3.51 (t, *J* = 11.4 Hz, 1H), 2.22 (d, *J* = 2.4 Hz, 1H), 1.53-1.42 (m, 2H), 1.36 (m, 2H); ^{13}C NMR (400 MHz, $CDCl_3$) δ: 28.8, 29.7, 35.7, 43.3, 55.3, 57.6, 65.3, 98.7, 102.9, 110.5, 113.6, 114.9, 120.0, 120.4, 121.2, 122.7, 123.3, 124.9, 126.0, 128.2, 129.6, 129.7,

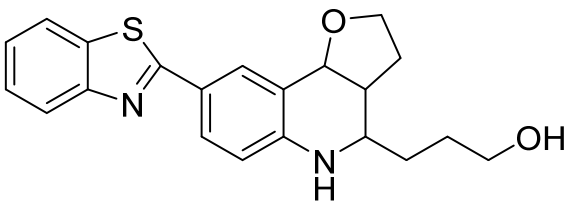
142.9, 145.8, 154.6, 156.6, 160.0; HRMS (ESI): $[M+H]^+$ 412.1901 founded, $[C_{27}H_{26}N_2O_3]^+$ calculated 412.1907. Mp: 169-17 °C.



Compound **14a**: ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.63 (s, 1H), 7.54 (m, 2H), 7.20 (m, 3H), 7.04 (s, 1H), 6.70 (d, J = 8.5 Hz, 1H), 5.05 (d, J = 5.6 Hz, 1H), 4.48 (m, 1H), 3.44 (m, 4H), 2.72 (d, J = 8.5 Hz, 1H), 1.88 – 1.75 (m, 4H), 1.57 (m, 2H); ^{13}C NMR (400 MHz, DMSO-d_6) δ: 23.5, 28.6, 30.1, 50.6, 60.7, 64.6, 65.7, 74.2, 114.1, 119.0, 120.2, 121.0, 121.6, 121.8, 121.9, 124.4, 126.2, 127.2, 128.8, 130.2, 133.7, 148.2, 153.8, 167.9; HRMS (ESI): $[M+H]^+$ 372.1579 founded, $[C_{22}H_{23}NNaO_3]^+$ calculated 372.1570. Mp: 110-116 °C.



Compound **14b**: ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.94 (s, 1H), 7.77 (d, J = 8.4 Hz, 1H), 7.68 (m, 2H), 7.33 (d, J = 4.8 Hz, 2H), 6.75 (d, J = 8.4 Hz, 1H), 5.07 (d, J = 5.2 Hz, 1H), 4.51 (s, 1H), 3.47 (d, J = 4.1 Hz, 4H), 2.57 (d, J = 7.7 Hz, 1H), 1.92 – 1.68 (m, 4H), 1.48(m,2H) ; ^{13}CNMR (400MHz, DMSO-d_6) δ: 23.5, 28.6, 30.1, 50.5, 50.6, 60.0, 60.8, 65.7, 74.1, 74.4, 110.3, 113.6, 114.1, 118.8, 121.5, 124.1, 124.4, 127.2, 129.1, 142.0, 148.5, 149.9, 163.3; HRMS (ESI): $[M+H]^+$ 402.1233 founded, $[C_{25}H_{21}ClNO_2]^{+}$ calculated 402.1255. M. p. : 115-119 ℃..



Compound **14c**: ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.08 (d, J = 7.7 Hz, 1H), 7.96 (d, J = 7.9 Hz, 1H), 7.87 (s, 1H), 7.72 (d, J = 8.4 Hz, 1H), 7.52 (t, J = 7.4 Hz, 1H), 7.40 (t, J = 7.3 Hz, 1H), 6.78 (d, J =

8.4 Hz, 1H), 5.12 (d, *J* = 5.2 Hz, 1H), 4.56 (s, 1H), 3.52 (m, 4H), 2.62 (d, *J* = 8.5 Hz, 1H), 1.81 (m, 2H), 1.31(m, 4H) ; ^{13}C NMR (400 MHz, DMSO-d_6) δ: 23.5, 28.6, 30.1, 50.6, 60.7, 65.7, 74.2, 74.5, 114.1, 121.0, 121.6, 121.8, 121.9, 124.4, 126.2, 127.2, 127.7, 128.8, 130.2, 133.7, 148.2, 153.8, 167.9; HRMS (ESI): $[M+H]^+$ 367.1470 founded, $[C_{21}H_{23}N_2O_2S]^+$ calculated 367.1475. Mp: 108-113 °C.

3. Coupling constants between protons H_a, H_b and H_c,

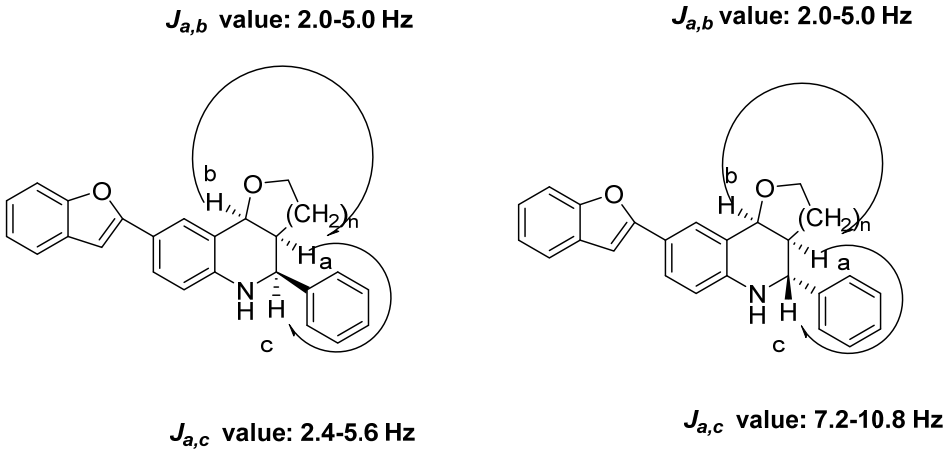
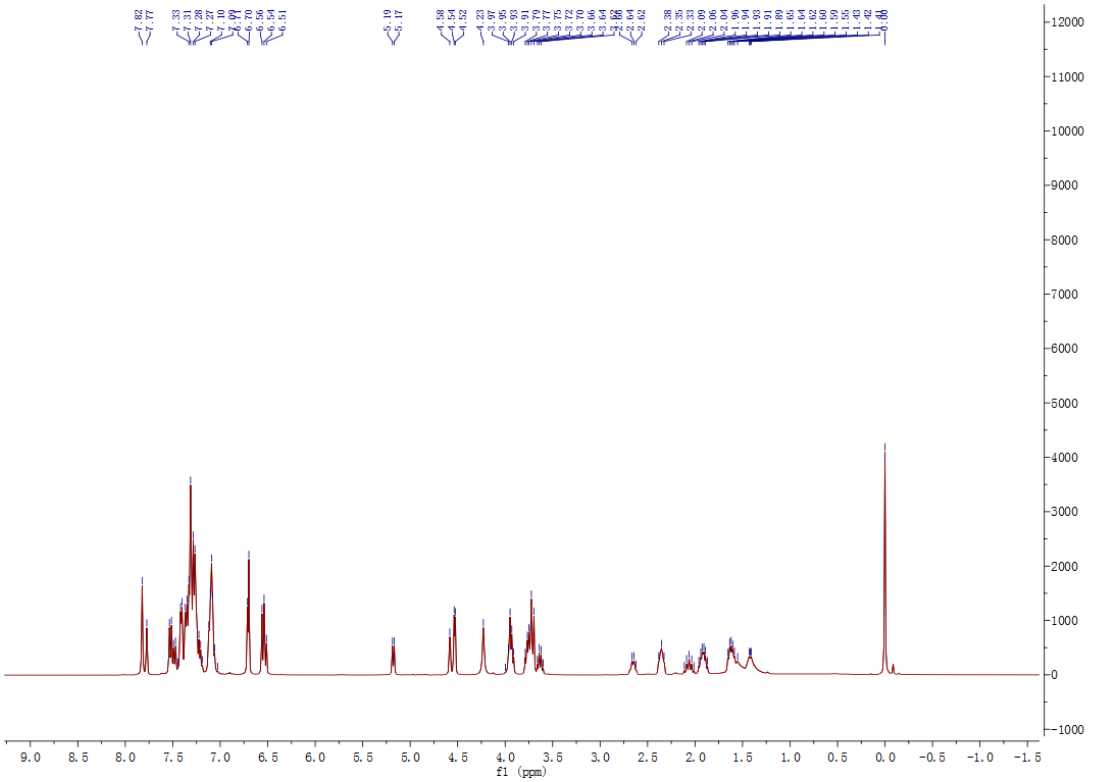


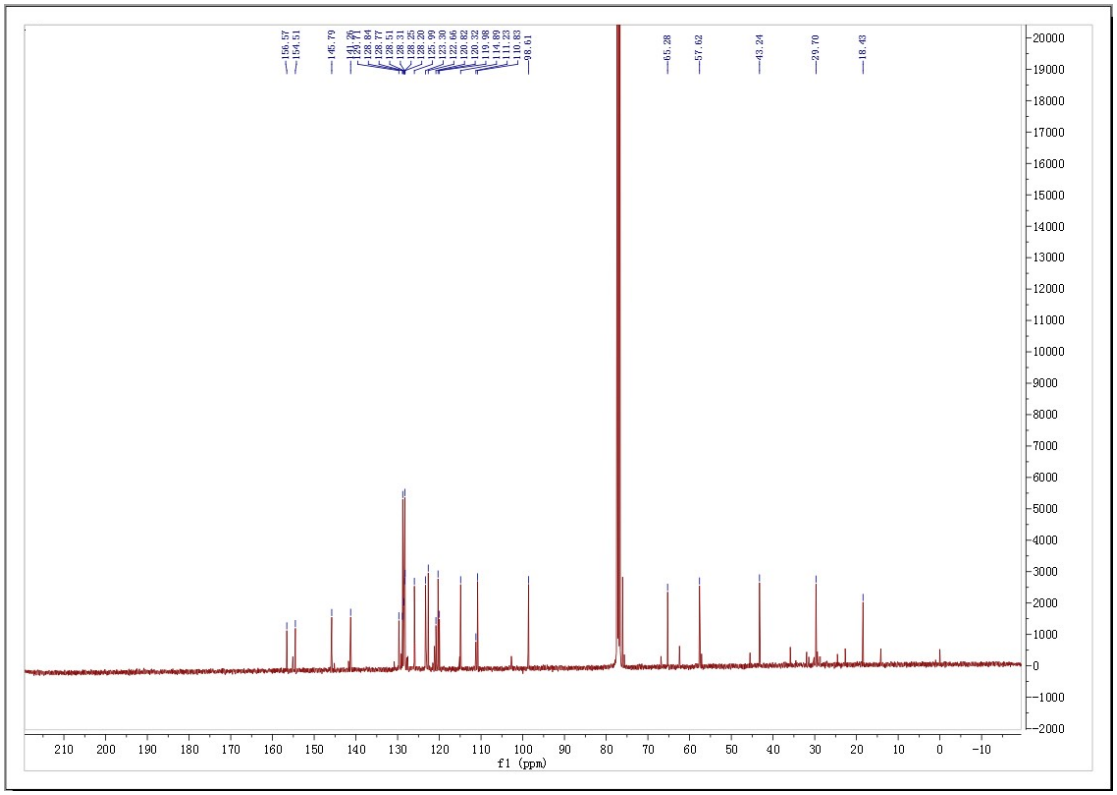
Figure S1. Coupling constant for determining stereo-chemistry

This imino Diels-Alder reaction always forms two pairs of diastereomers (wavy bond in Table 1), in which the phenyl-substituent is situated *cis* or *trans* towards protons H_a, H_b of the furan ring (Figure 2). Both protons always take a *cis* configuration, since the enol ether approaches the diene *endo* or *exo*.[13] Moreover, the presence of small coupling constants for protons H_a and H_b (2.0 Hz –5.0 Hz) proves the *cis* ring junction between the furan and the quinoline rings. The relative ratio between both isomers was obtained from ^{1}H NMR spectral data, and assigned by comparison with NMR literature. In compound **14**, the small coupling constant (5.2 Hz–5.6 Hz) for proton H_c also shows that the furan and quinoline rings are *cis* fused, whereas protons H_a and H_c have *cis* configurations. However, coupling constants for protons H_a and H_b were not obtained from the ^{1}H NMR spectrum, making isomer configuration determination difficult. By referring to NMR literature, the *cis* and *trans* configurations were assigned by comparing the coupling constants for proton H_a with other analogues. The *cis* isomer shows a coupling constant of 5.6 Hz, depicting the *cis* configuration between both protons H_a and H_c. In this case, the phenyl group is in a *cis* configuration with the pyran ring.

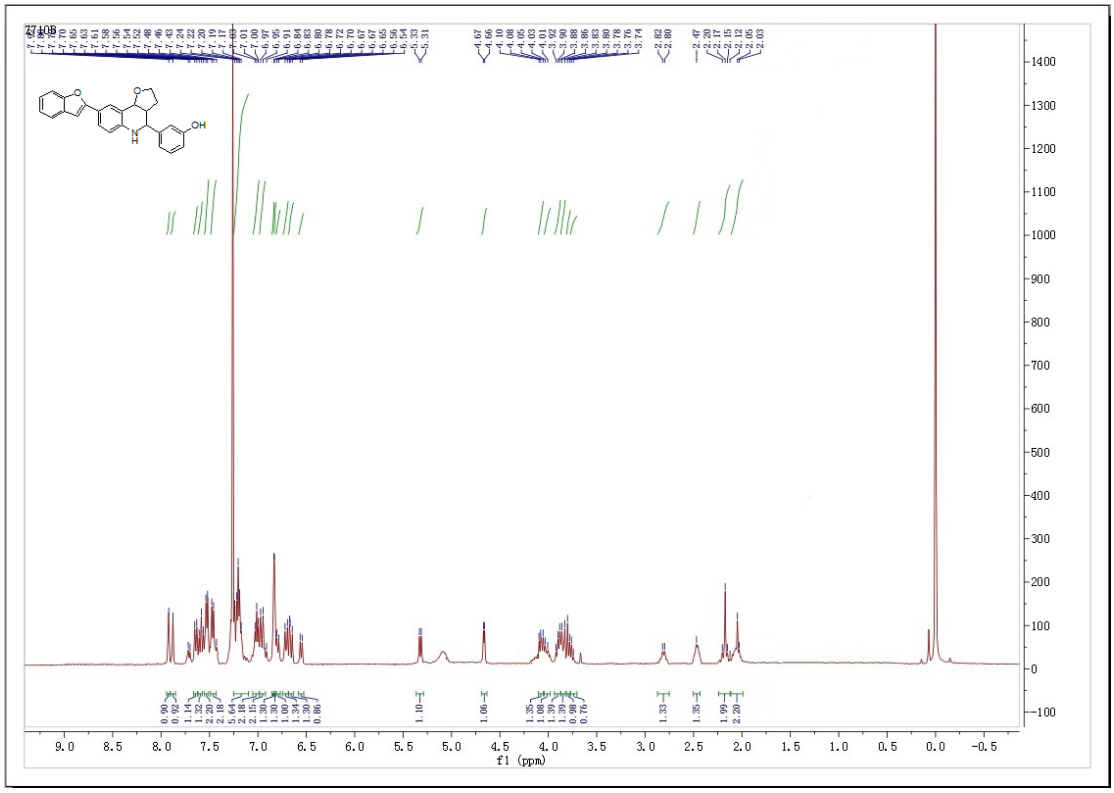
3. ^{1}H and ^{13}C-NMR Spectra

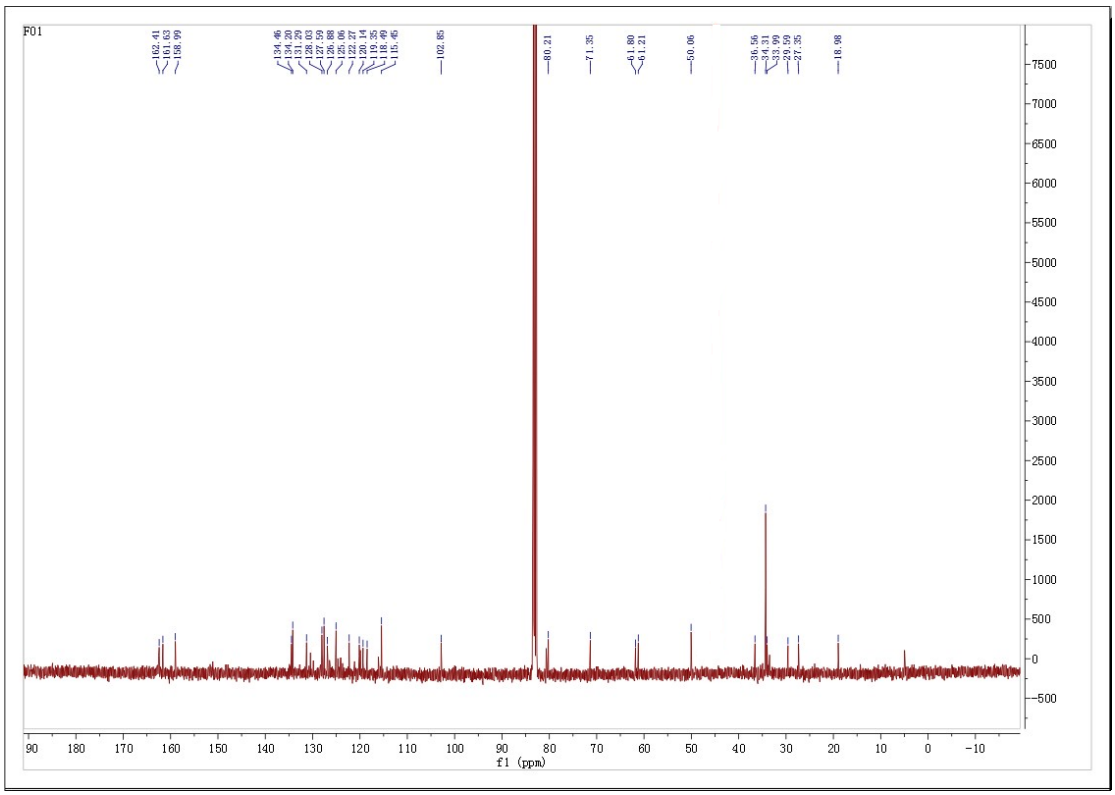
Compound 10a+11a



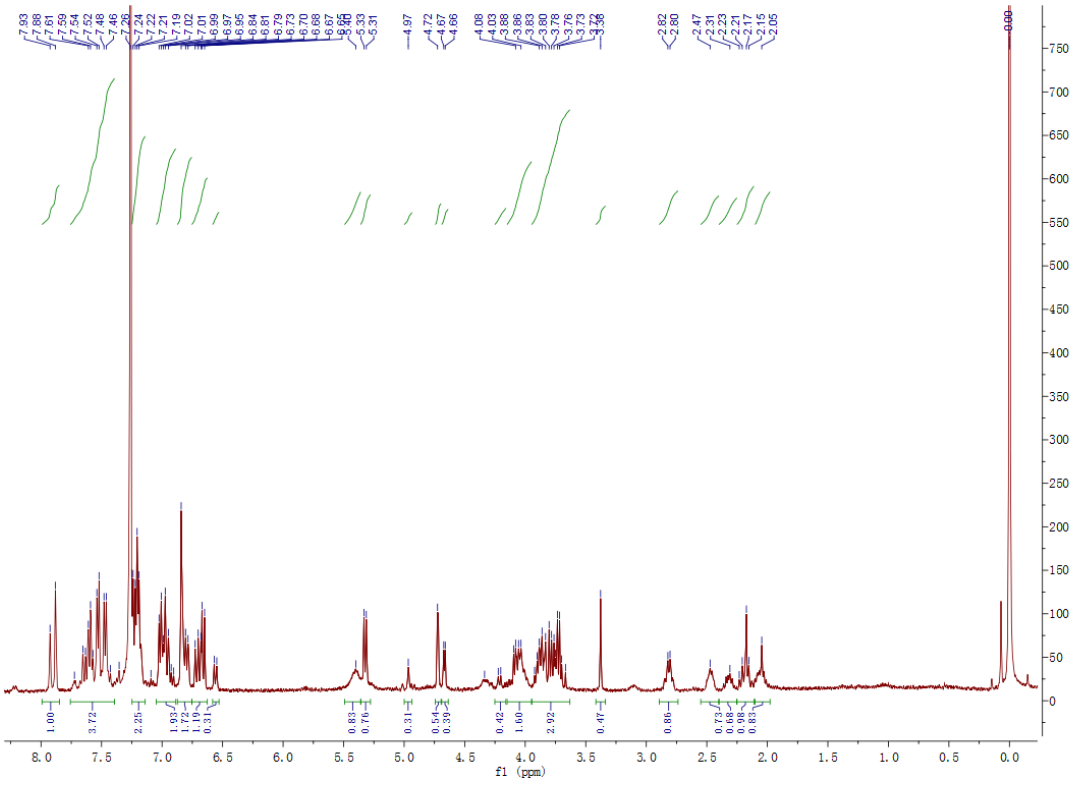


Compound 10b

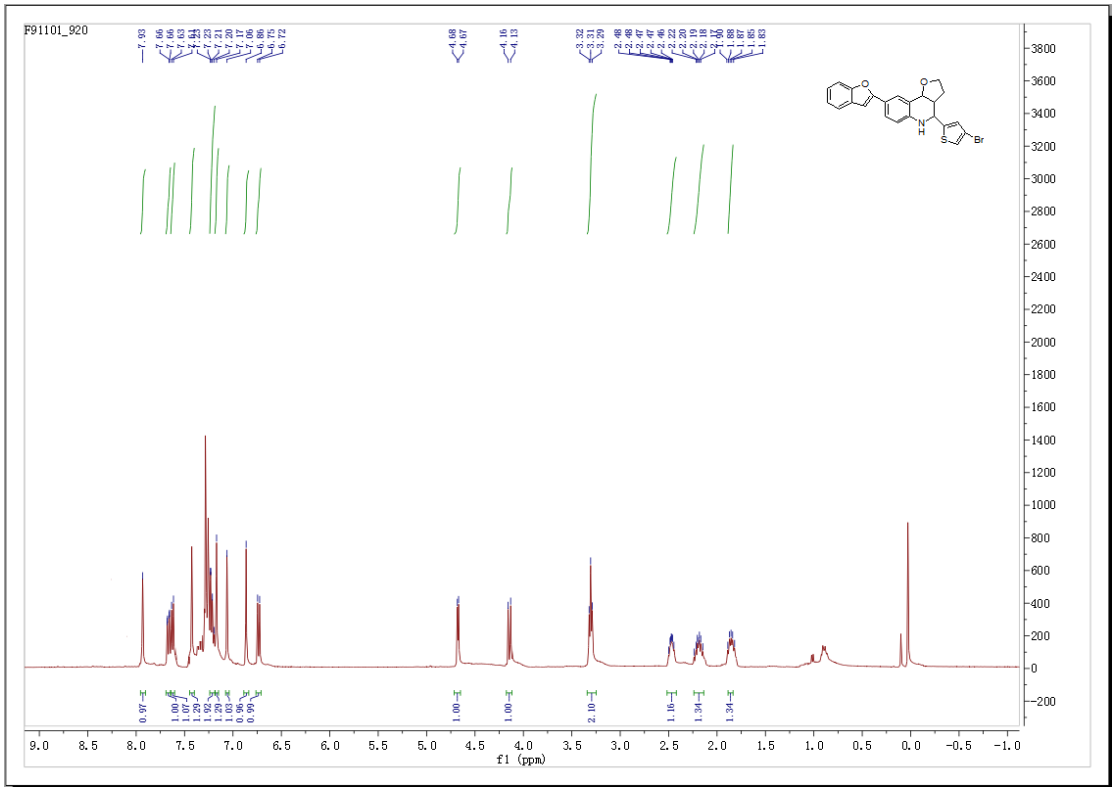


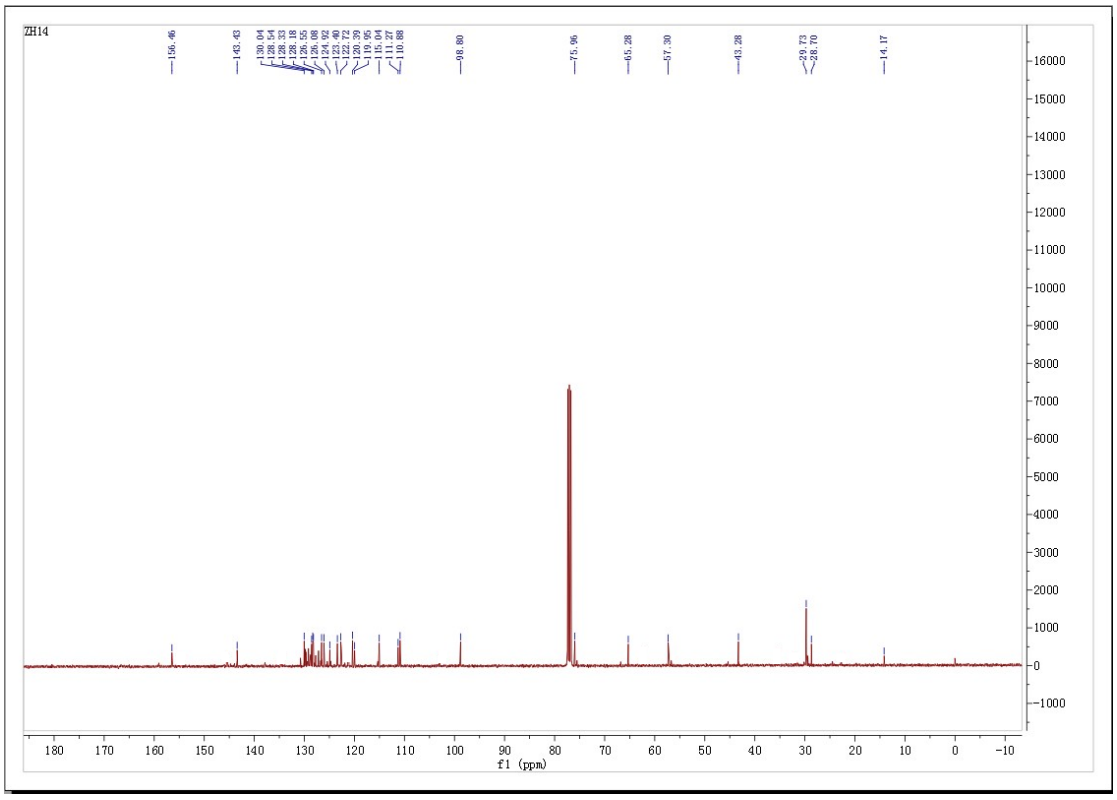


Crude mixture of 10b and 11b

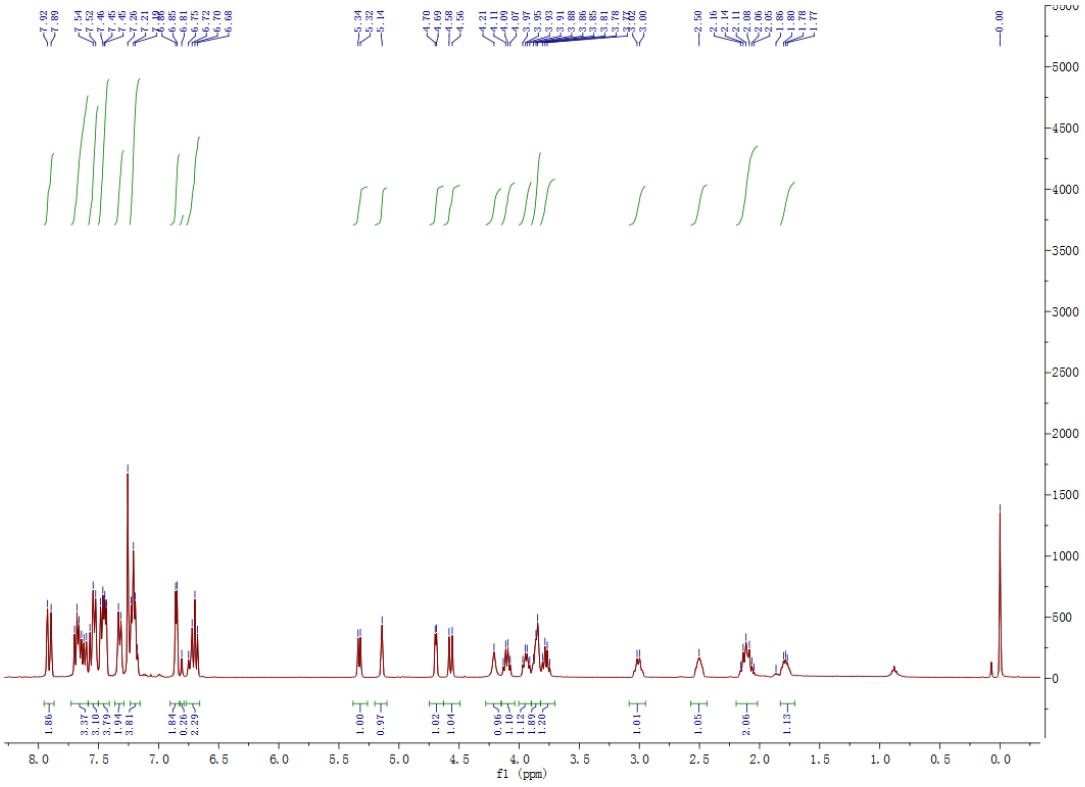


Compound 11c

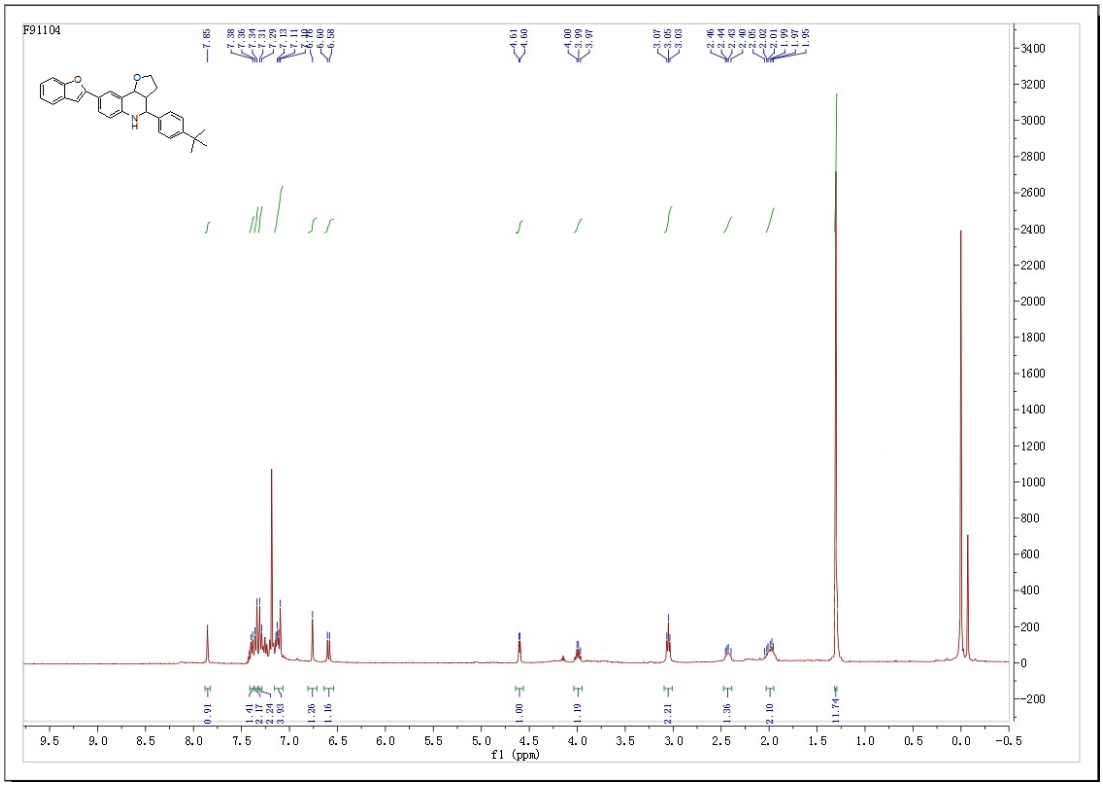


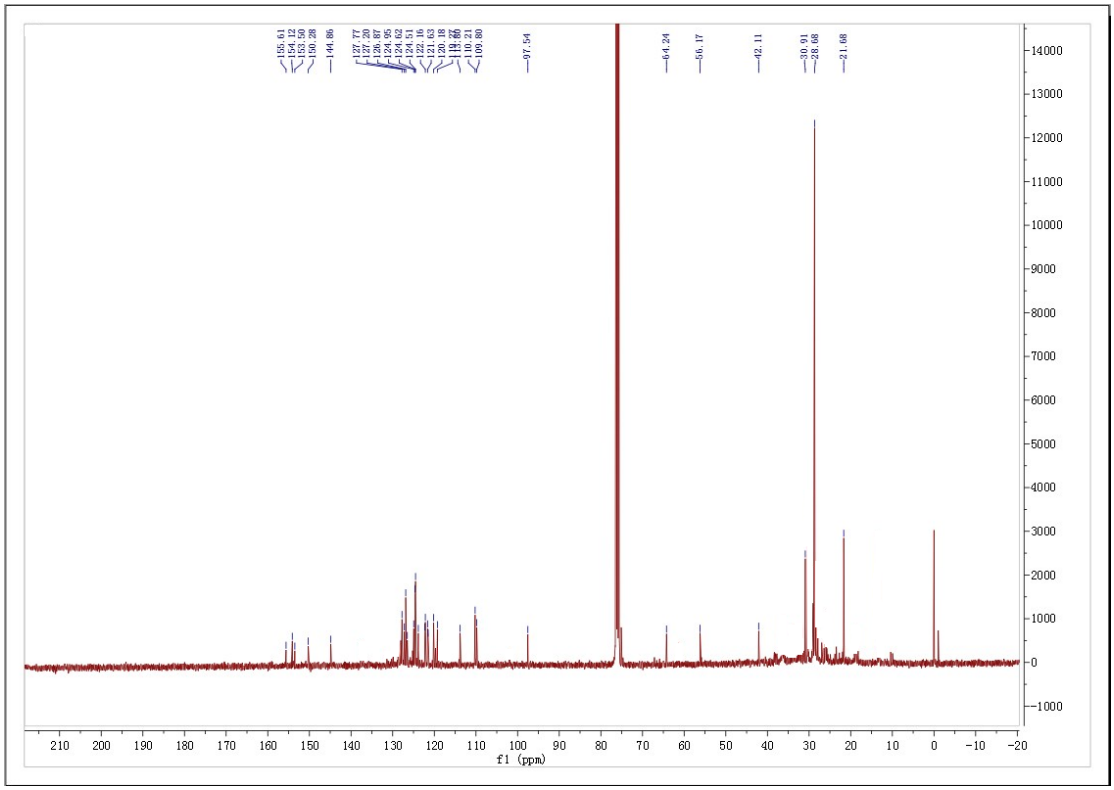


Crude mixture of 10c and 11c

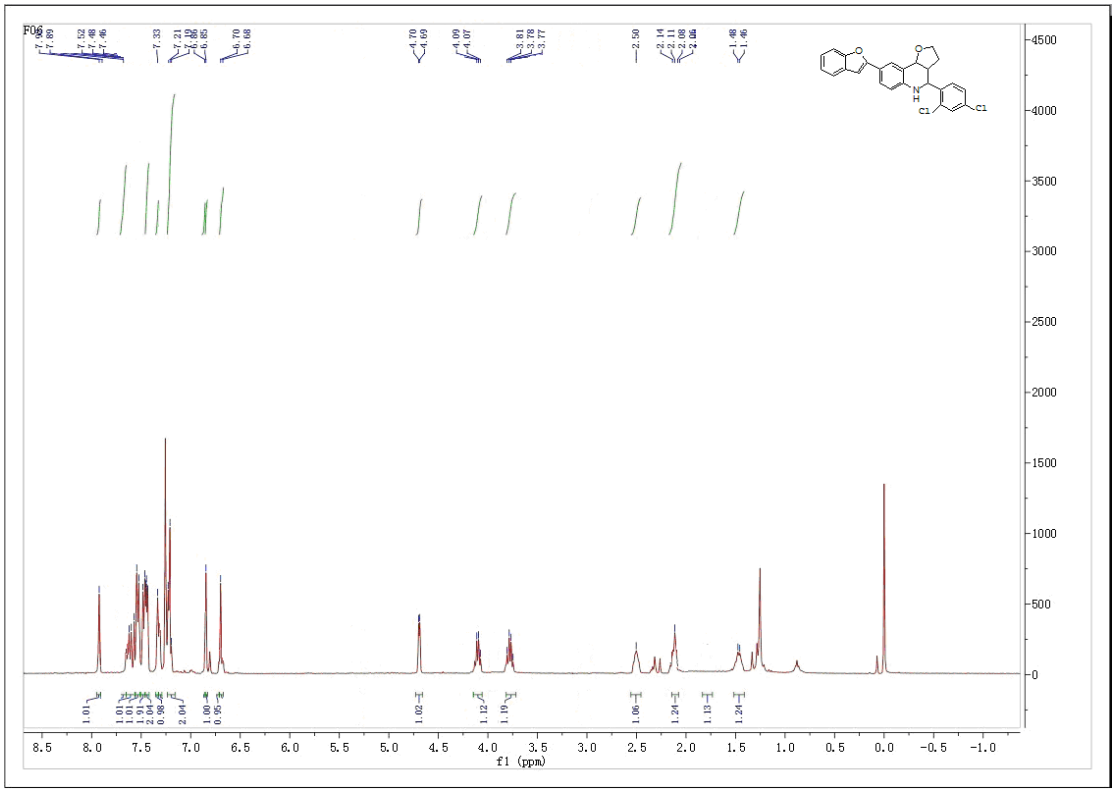


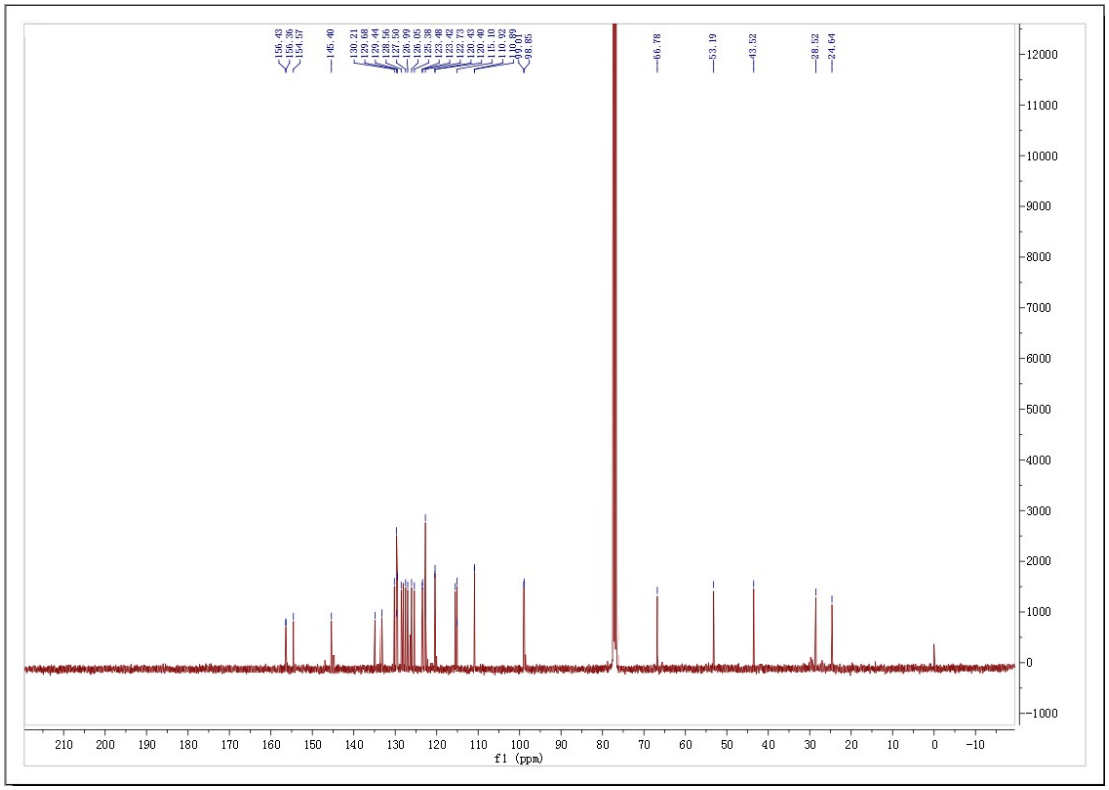
Compound 11d



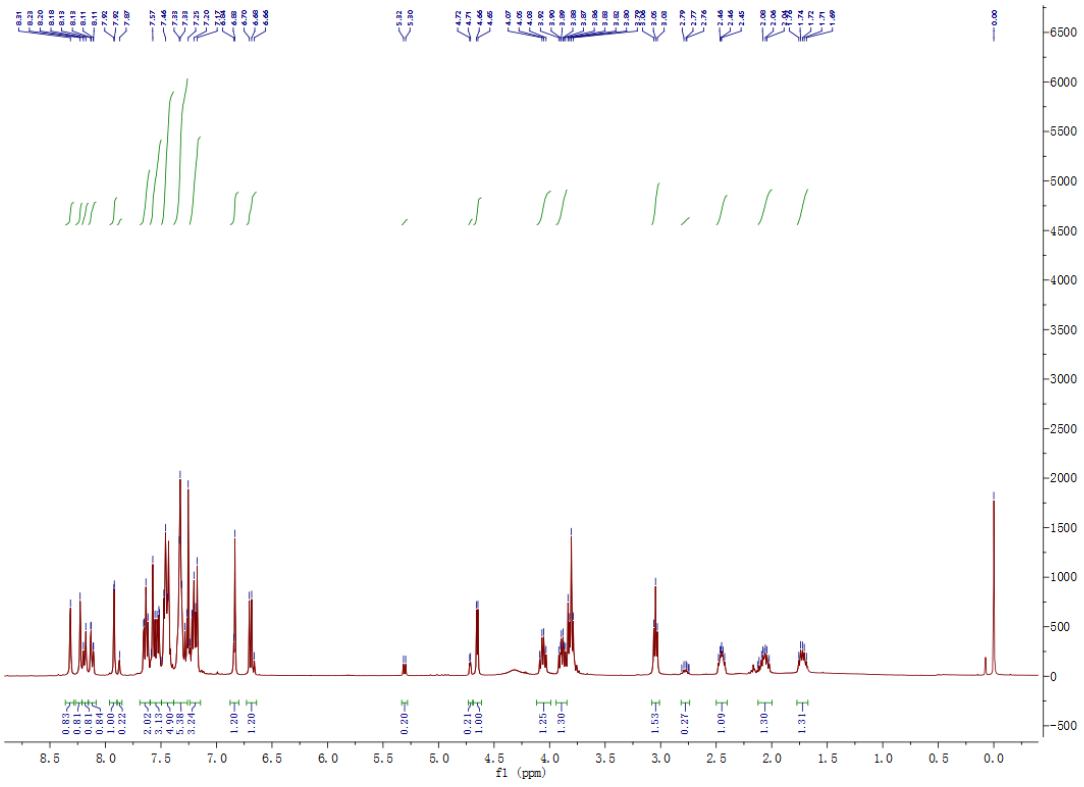


Compound 11e

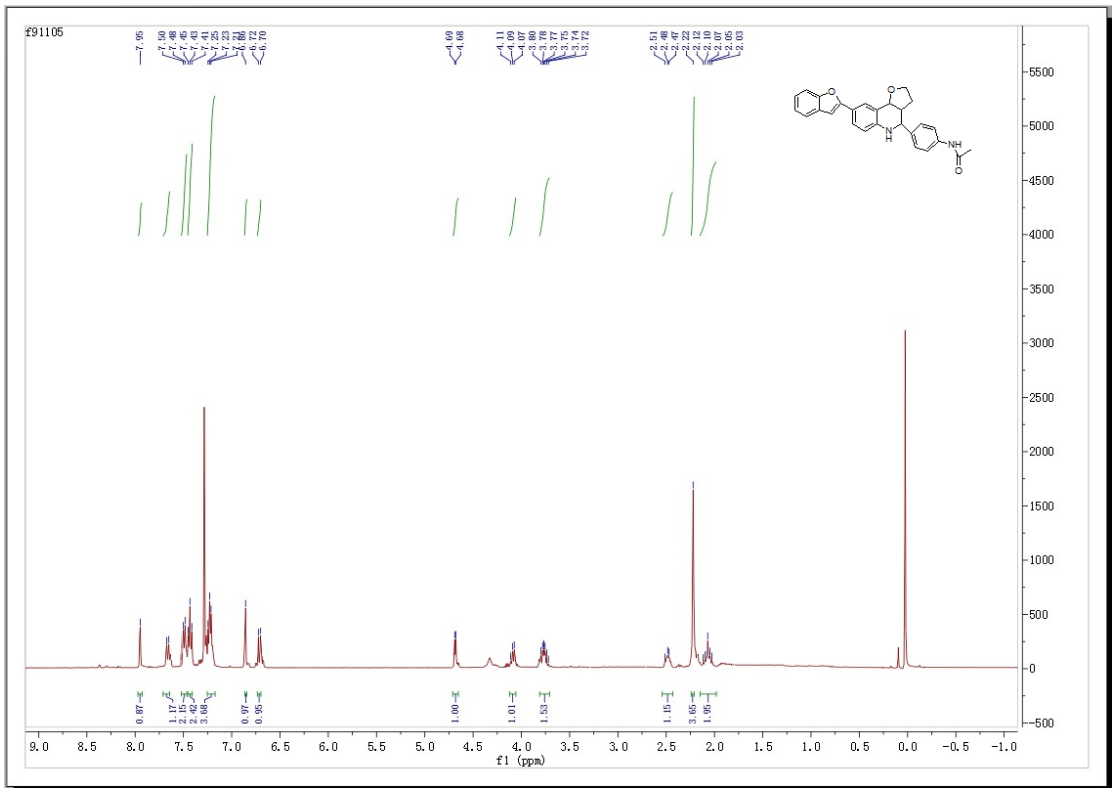


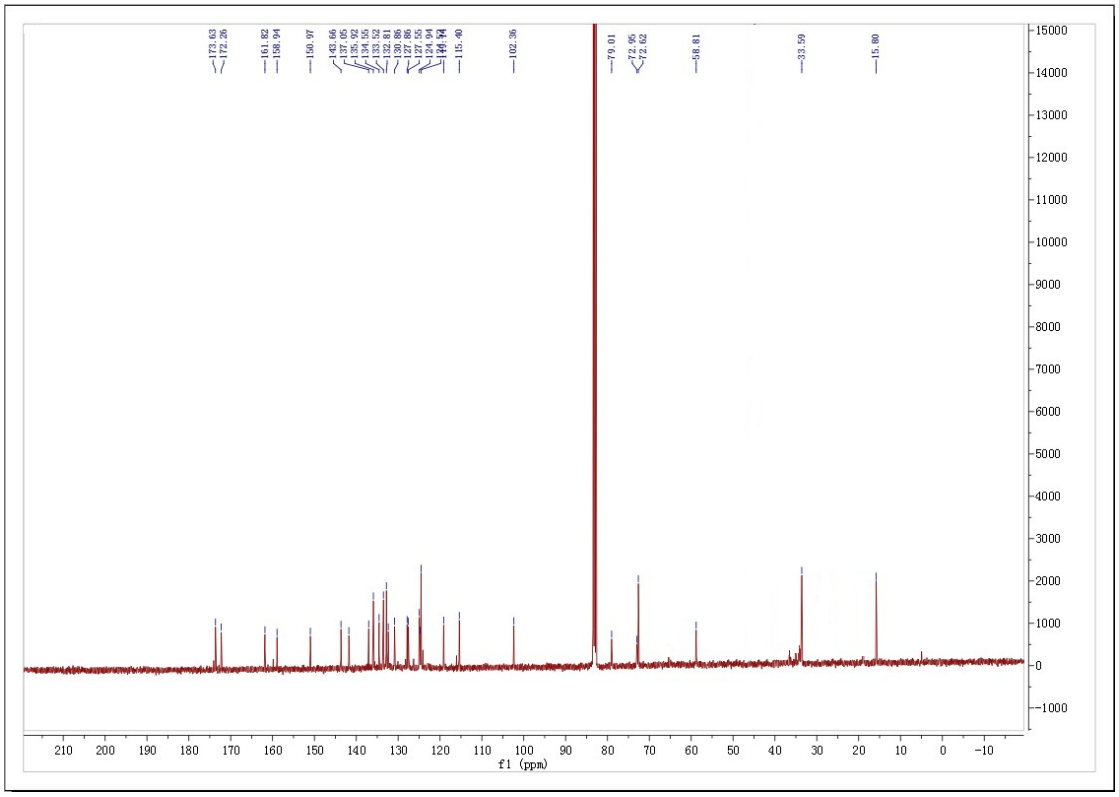


Crude mixture of 10e and 11e

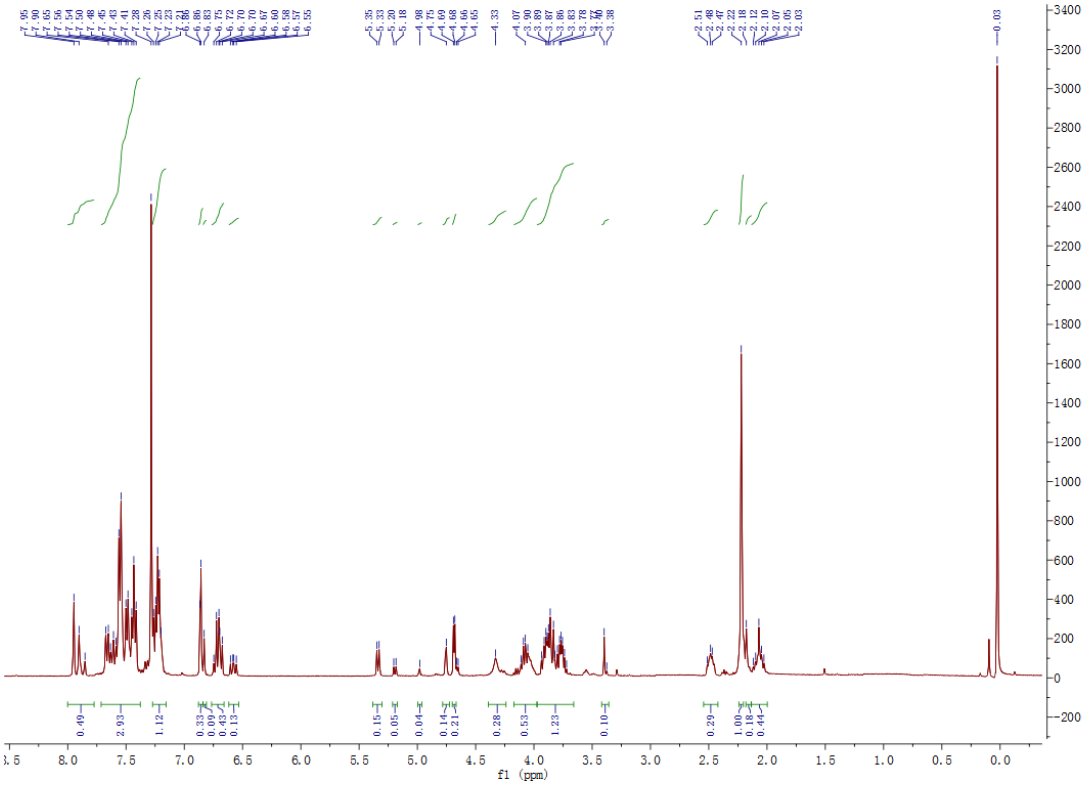


Compound 11f

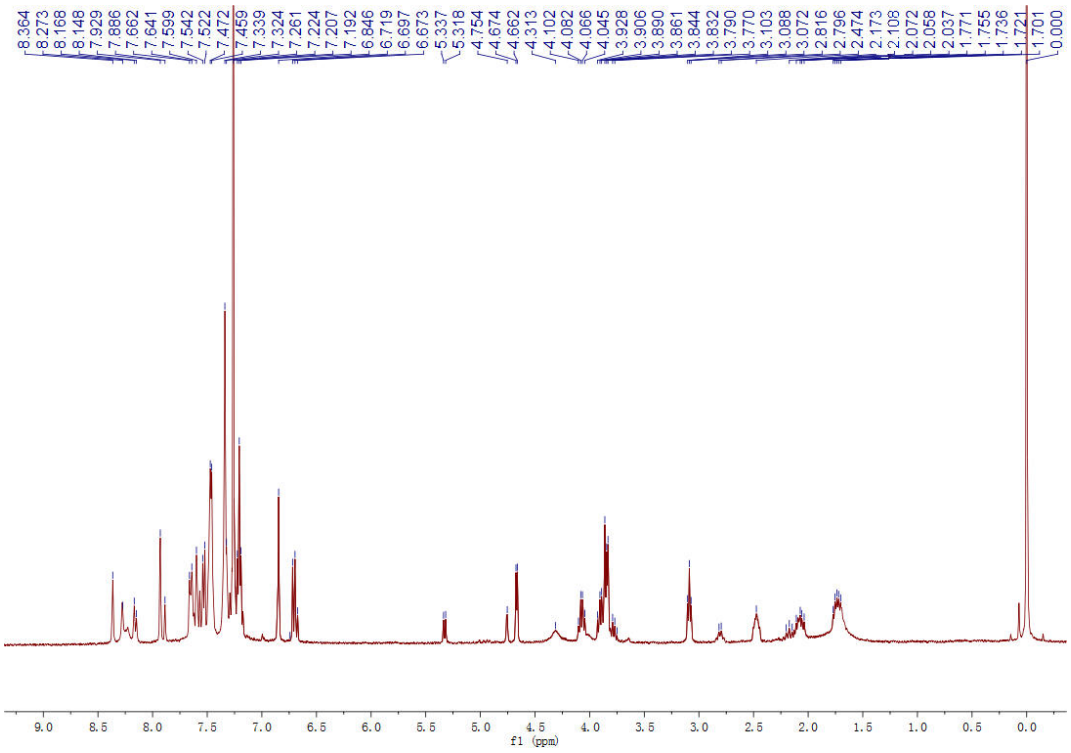


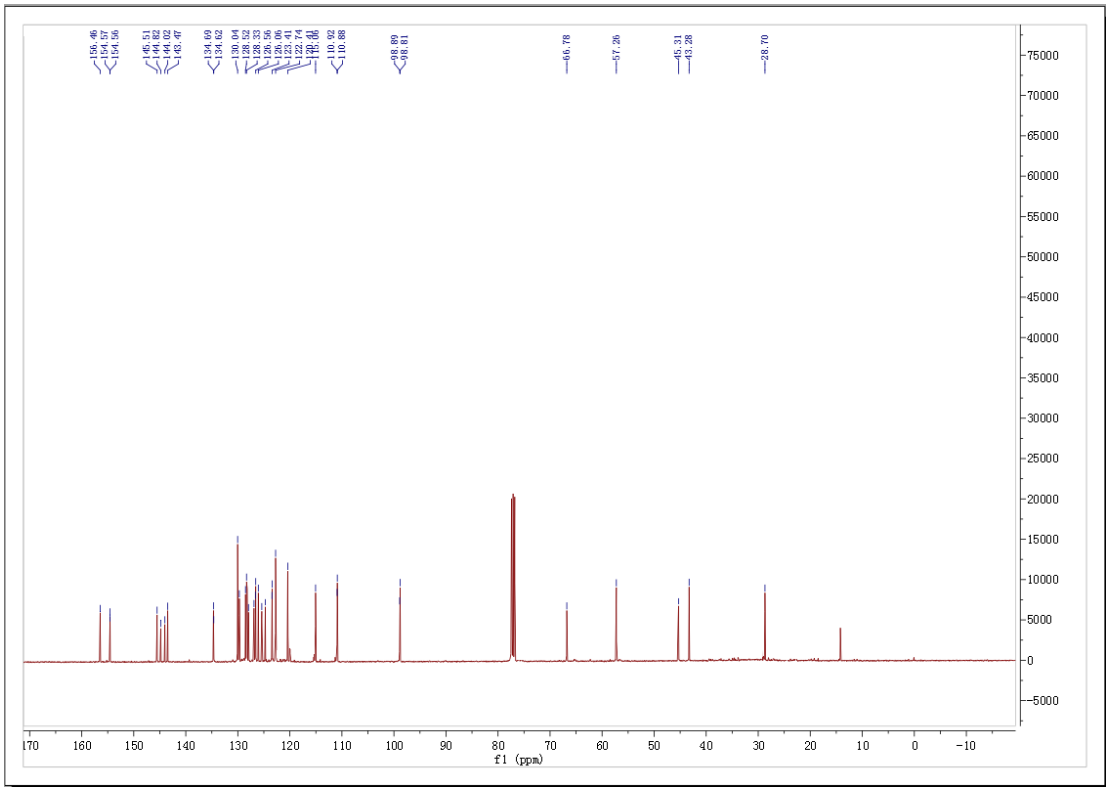


Crude mixture of 10f and 11f

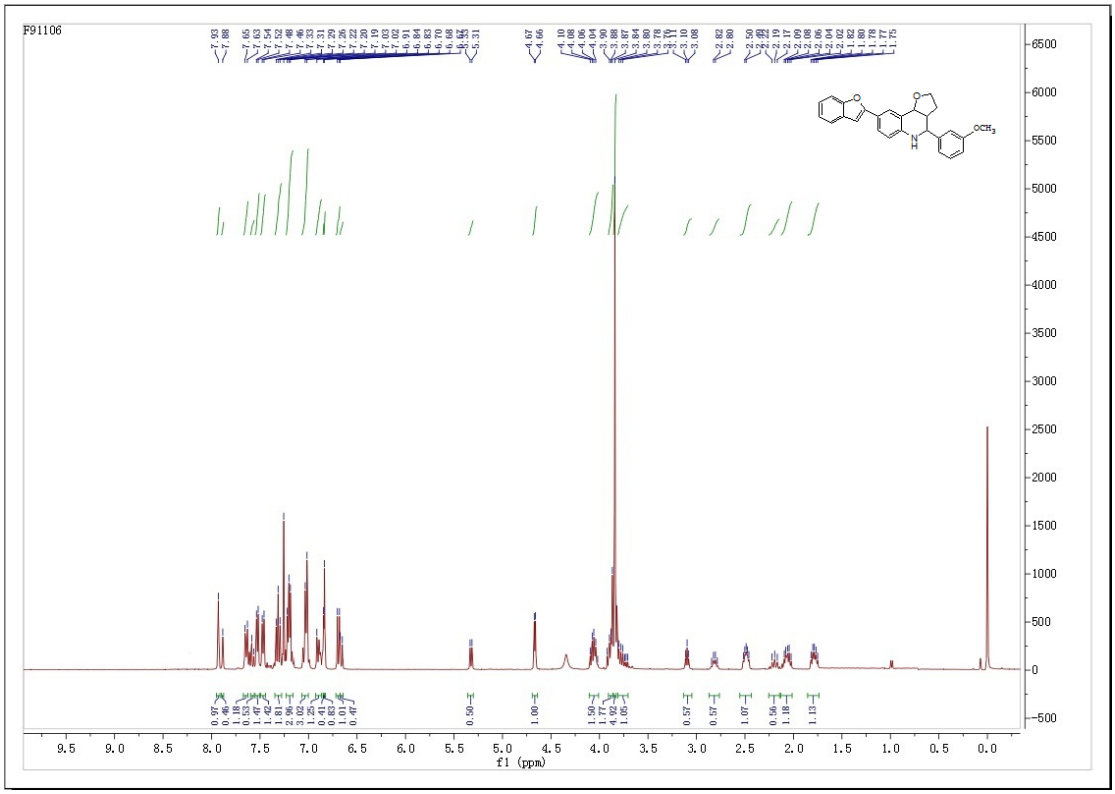


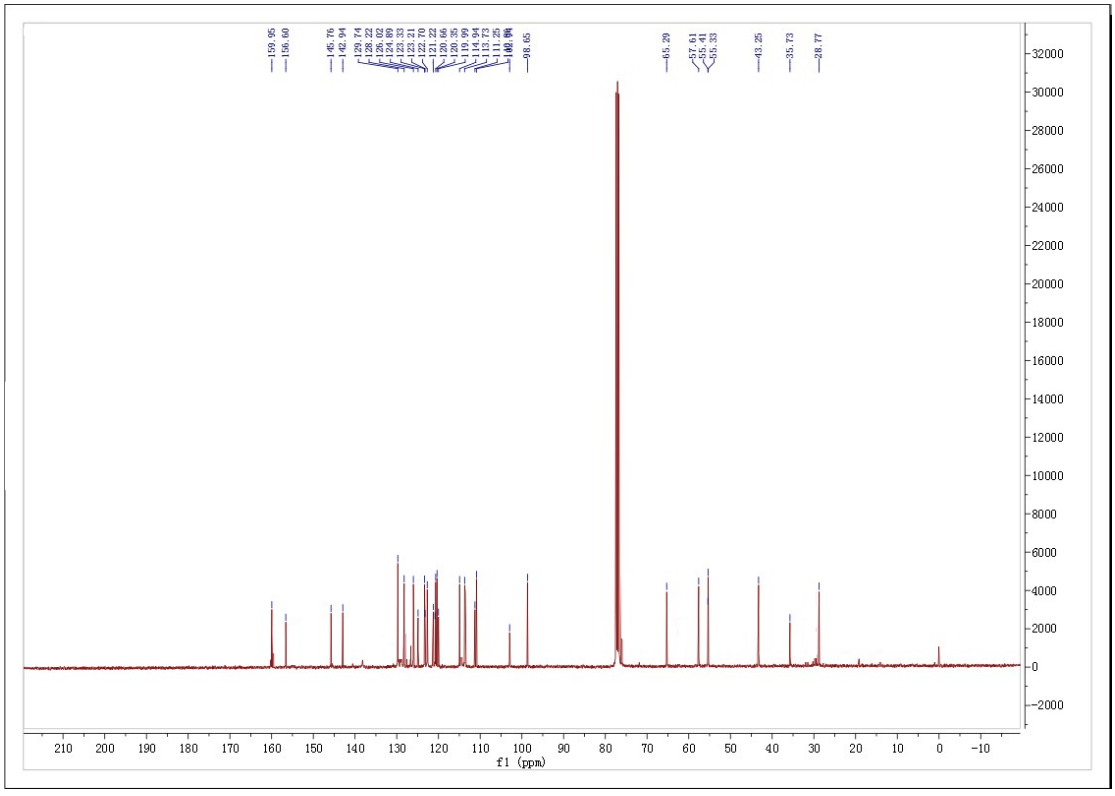
Compound 10g+11g



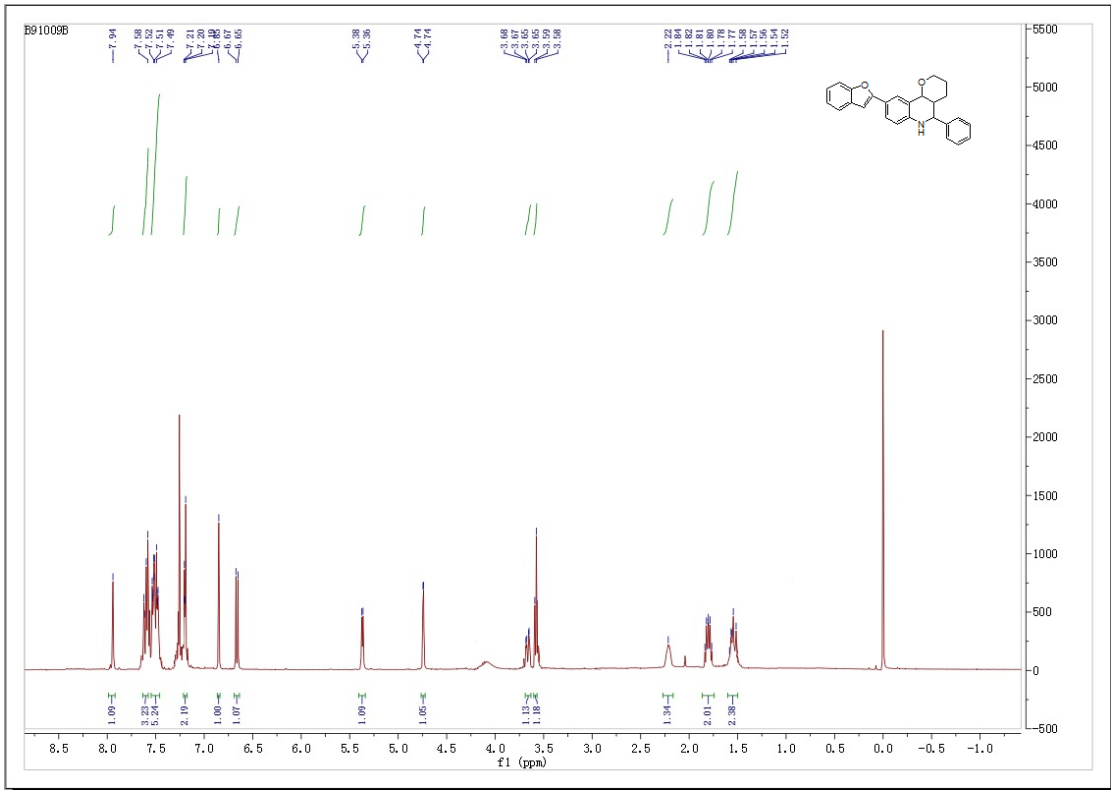


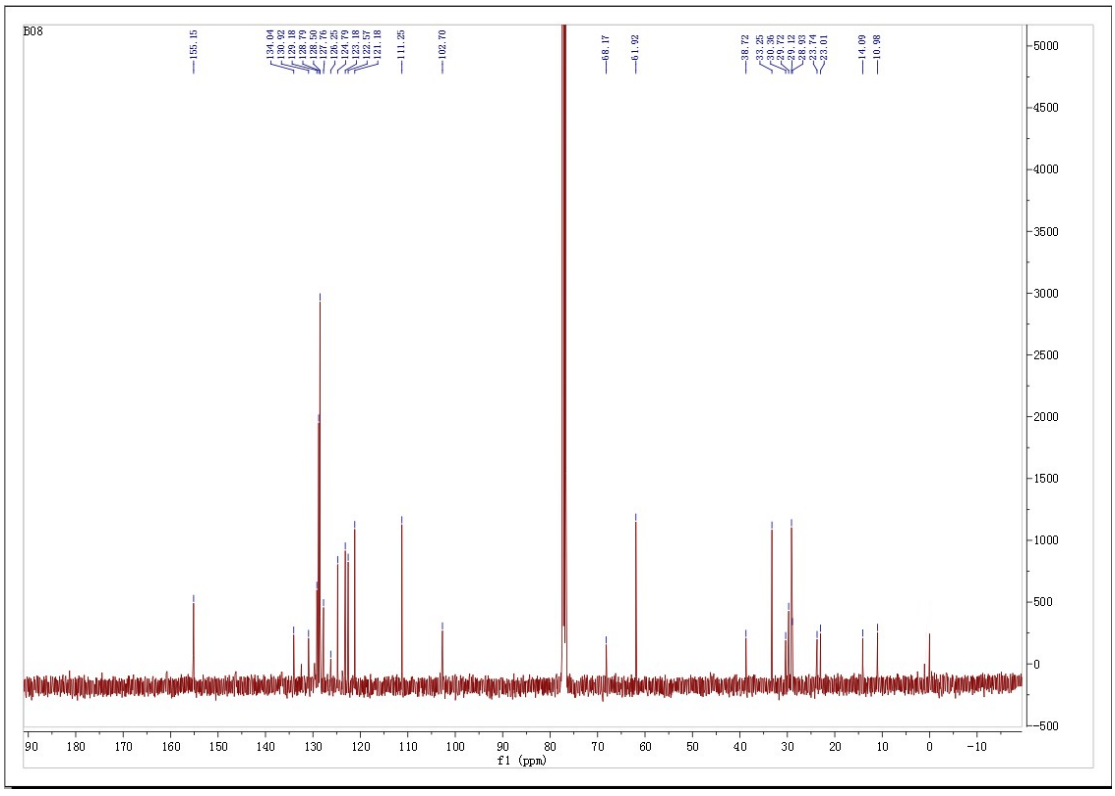
Compound 10h+11h



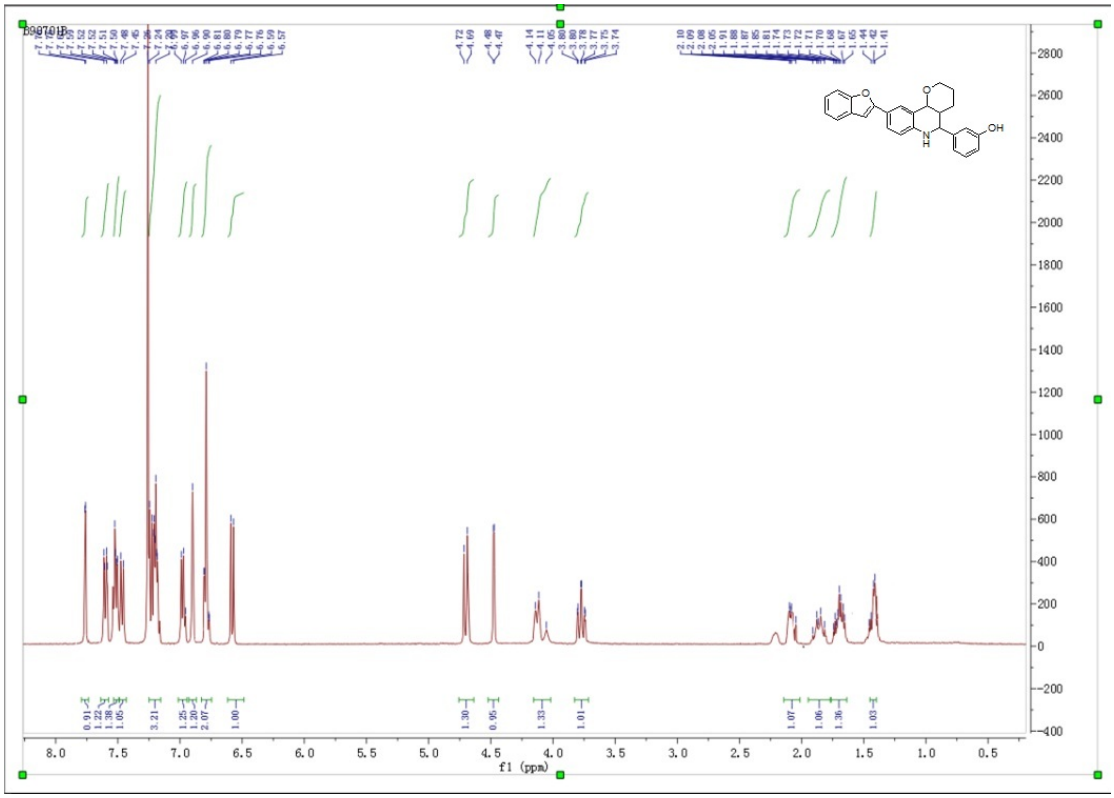


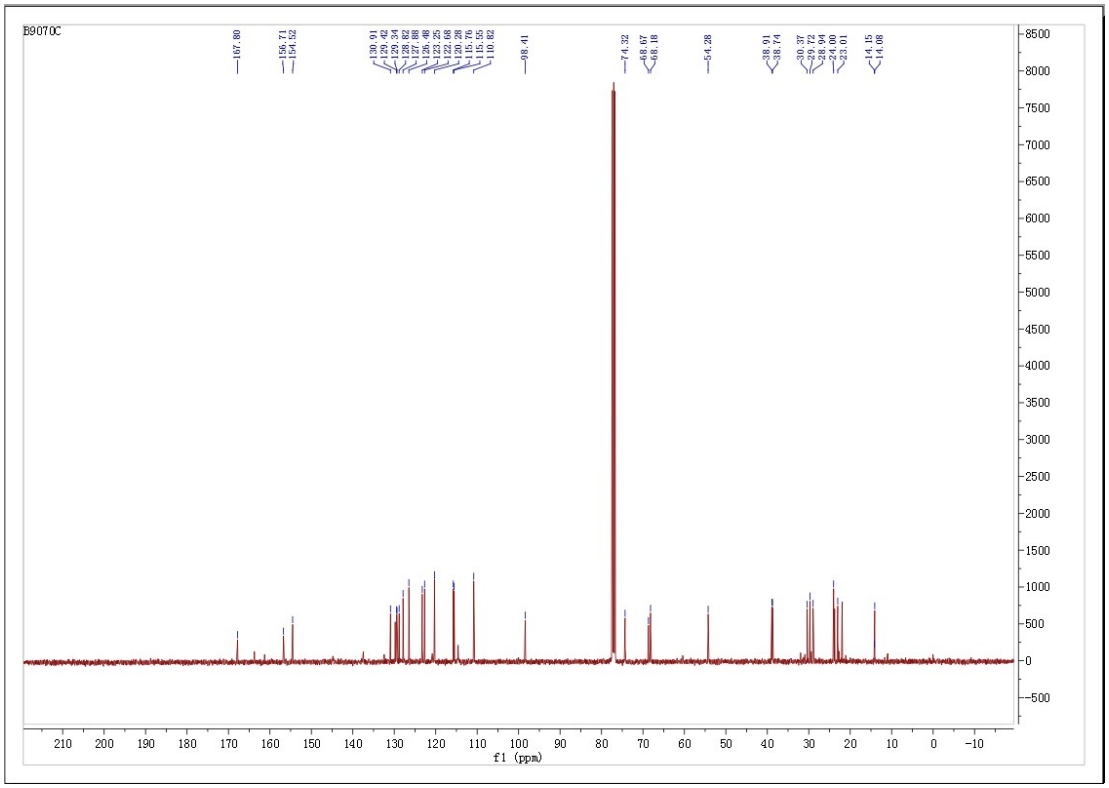
Compound 13a



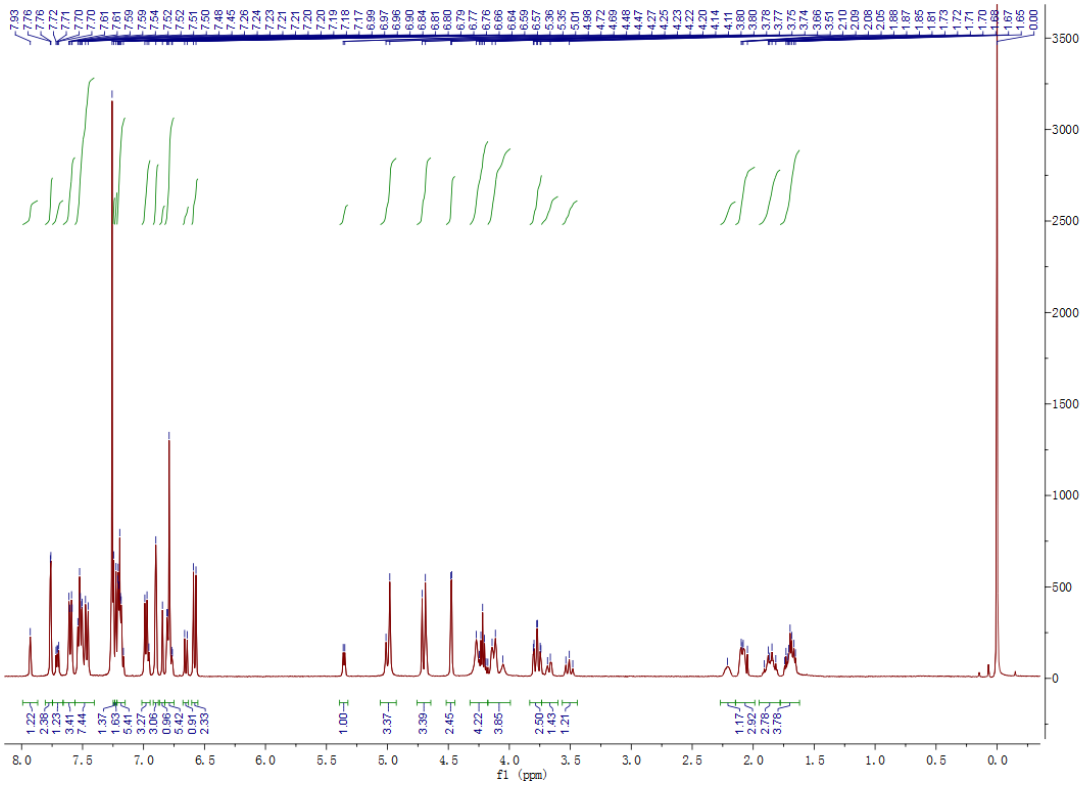


Compound 12b

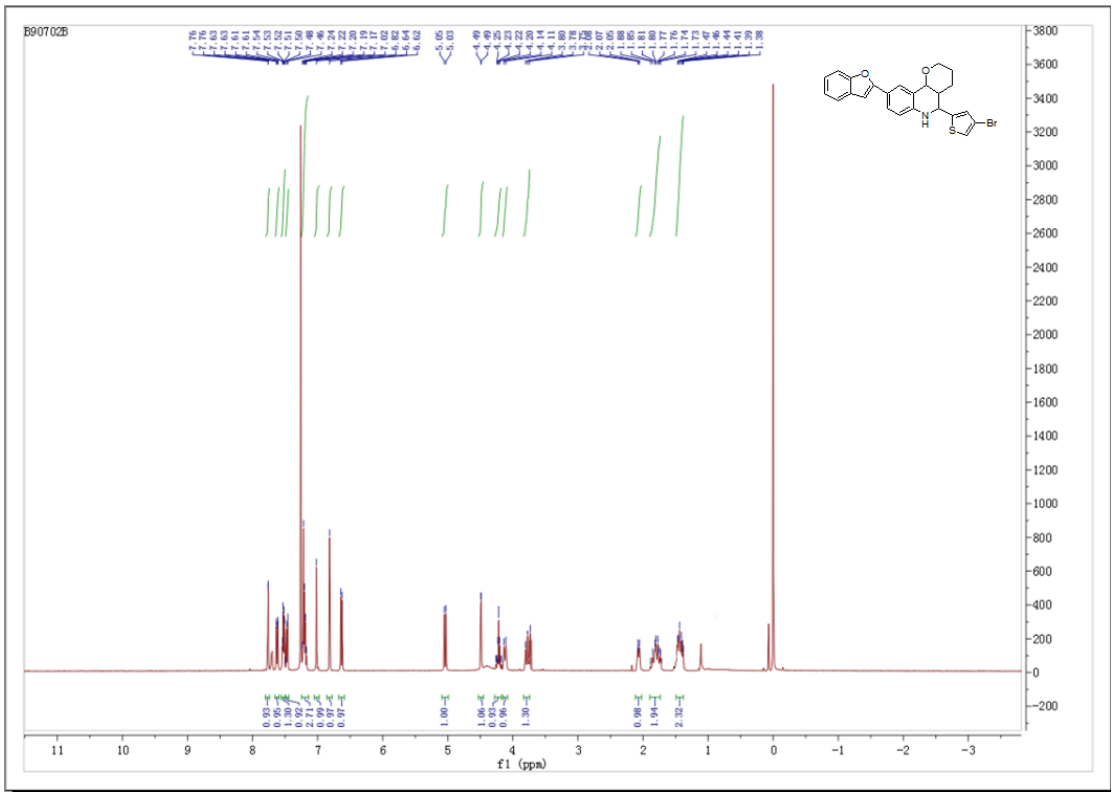




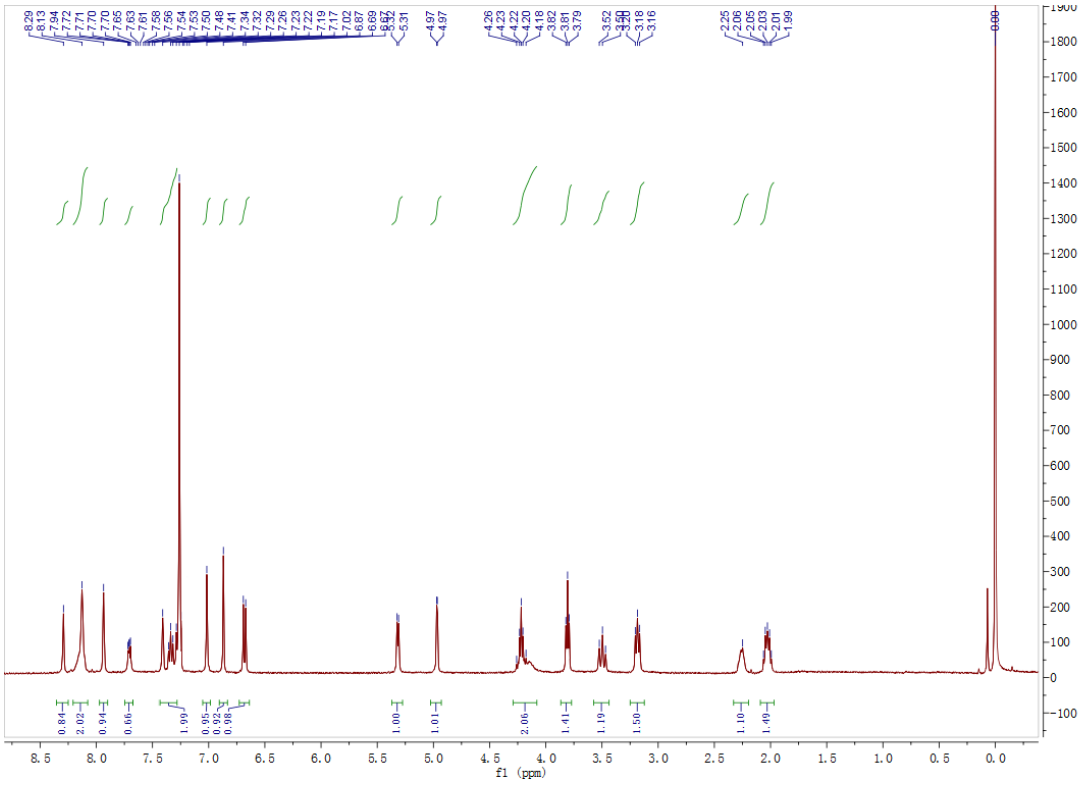
Crude mixture of 12b and 13b

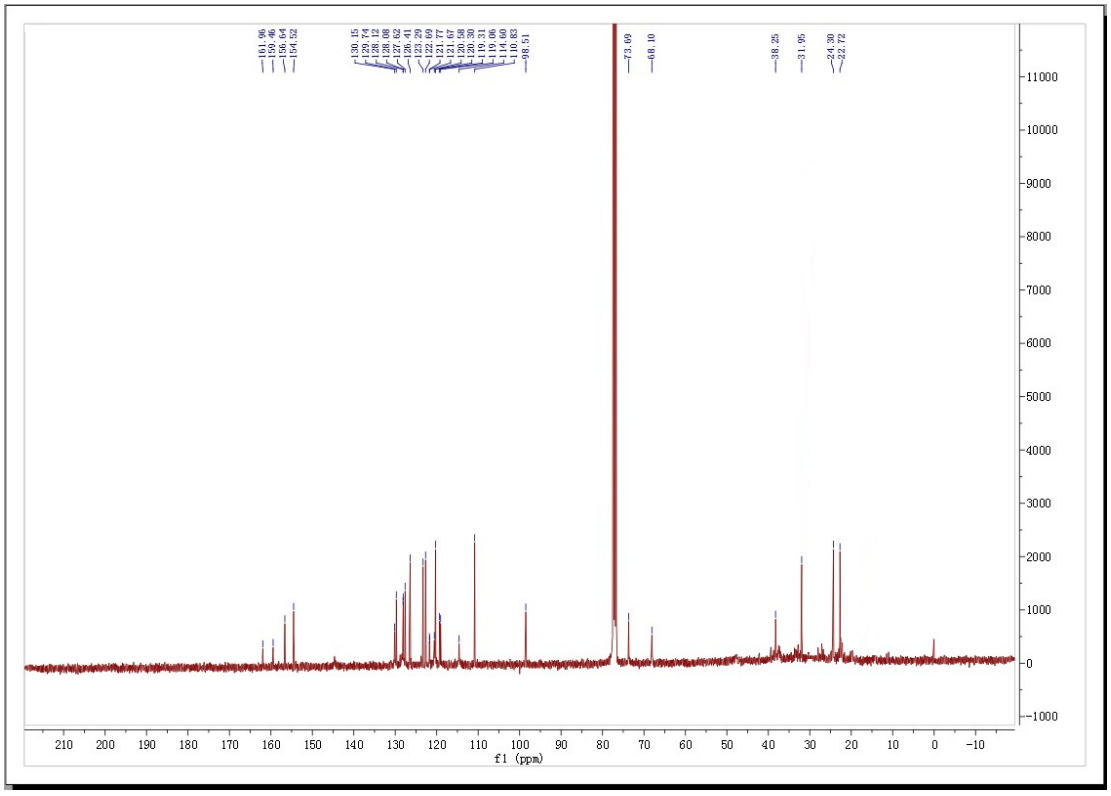


Compound 12c

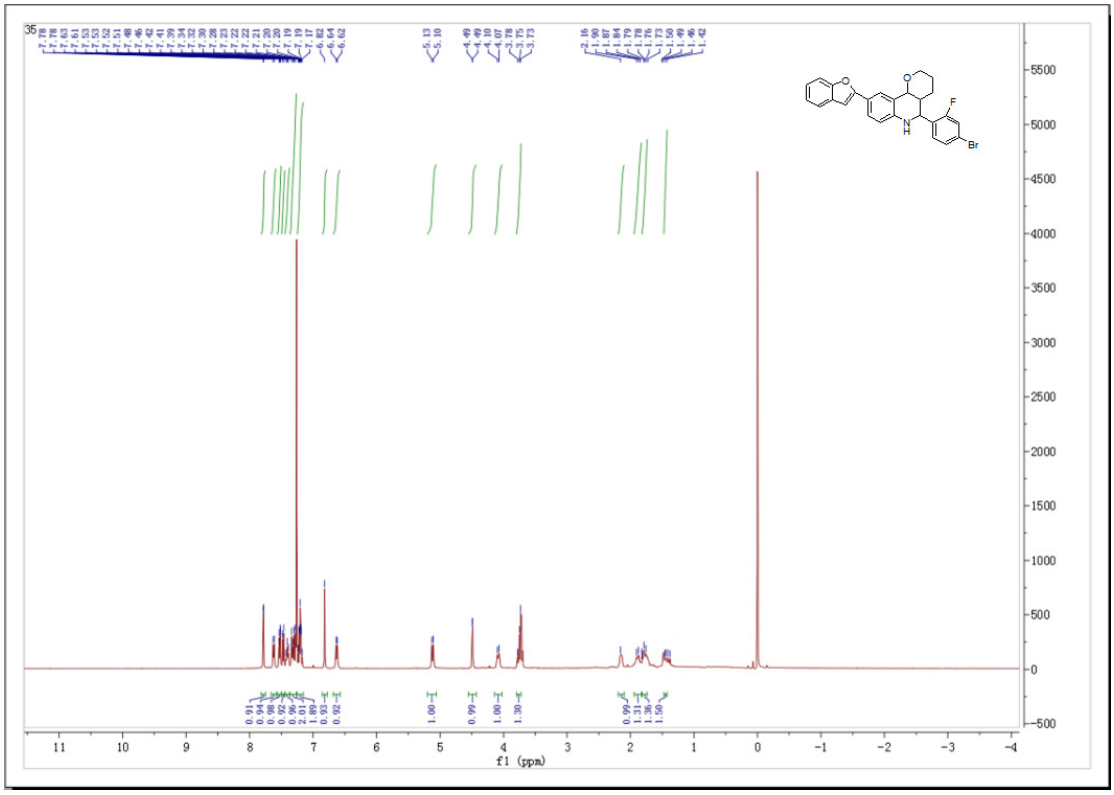


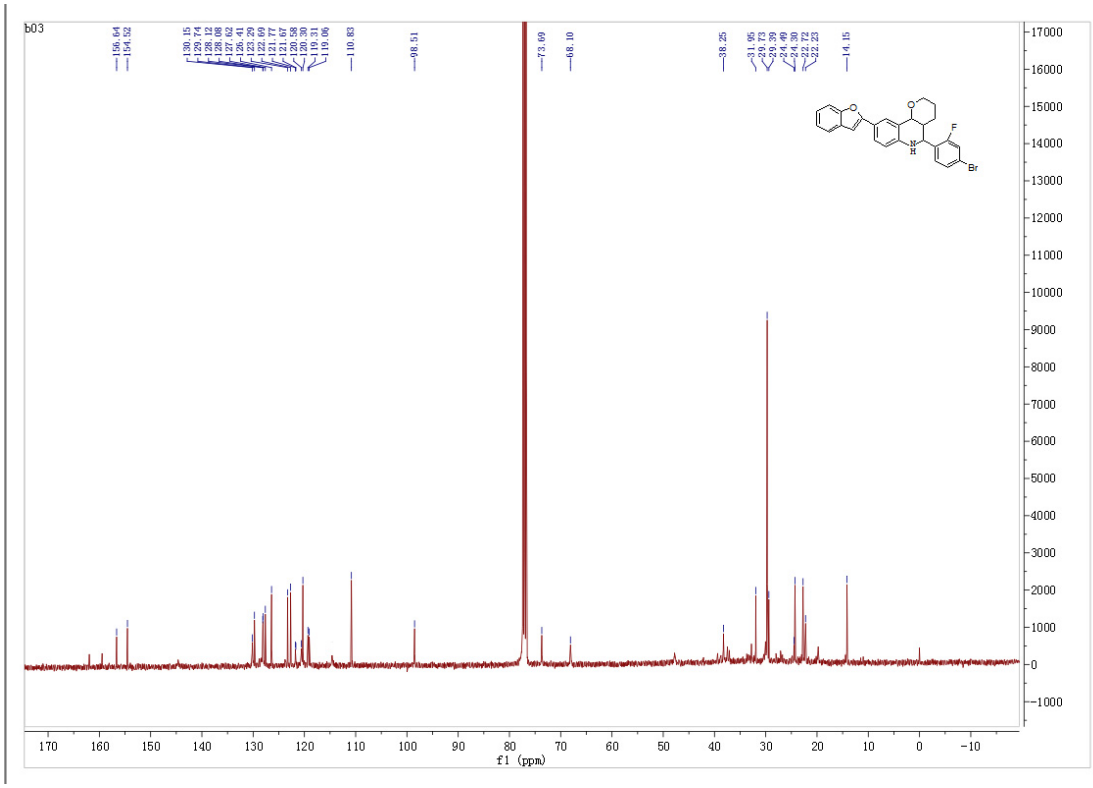
Compound 13c



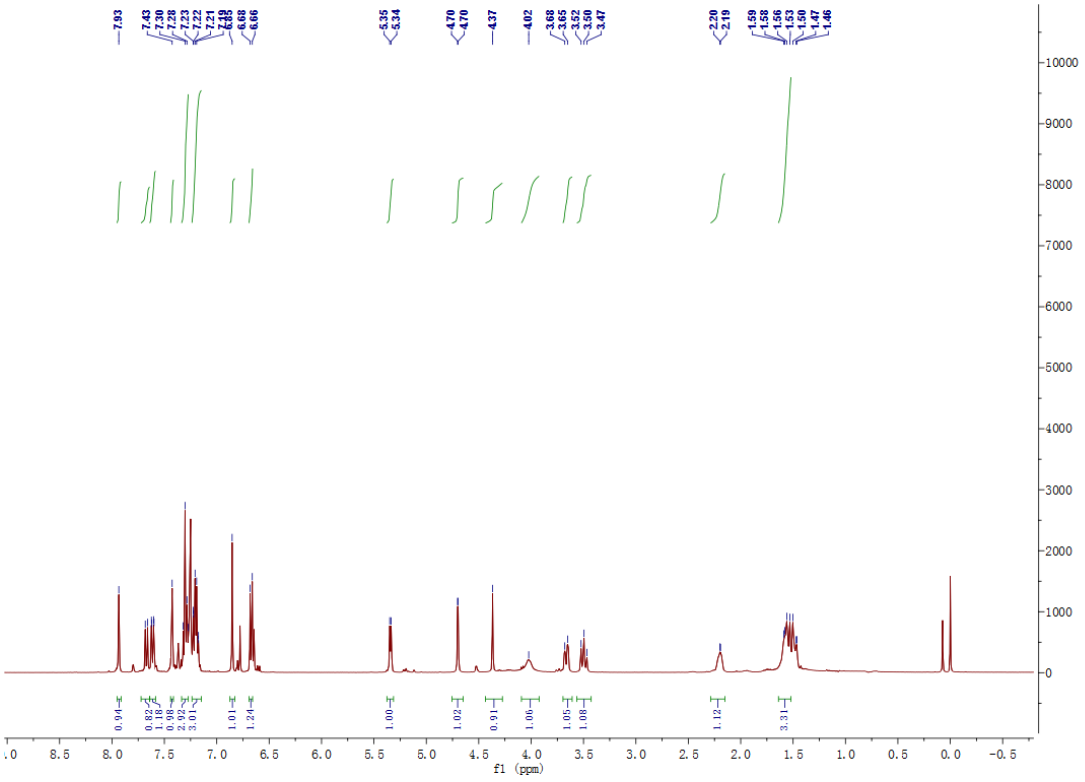


Compound 12d

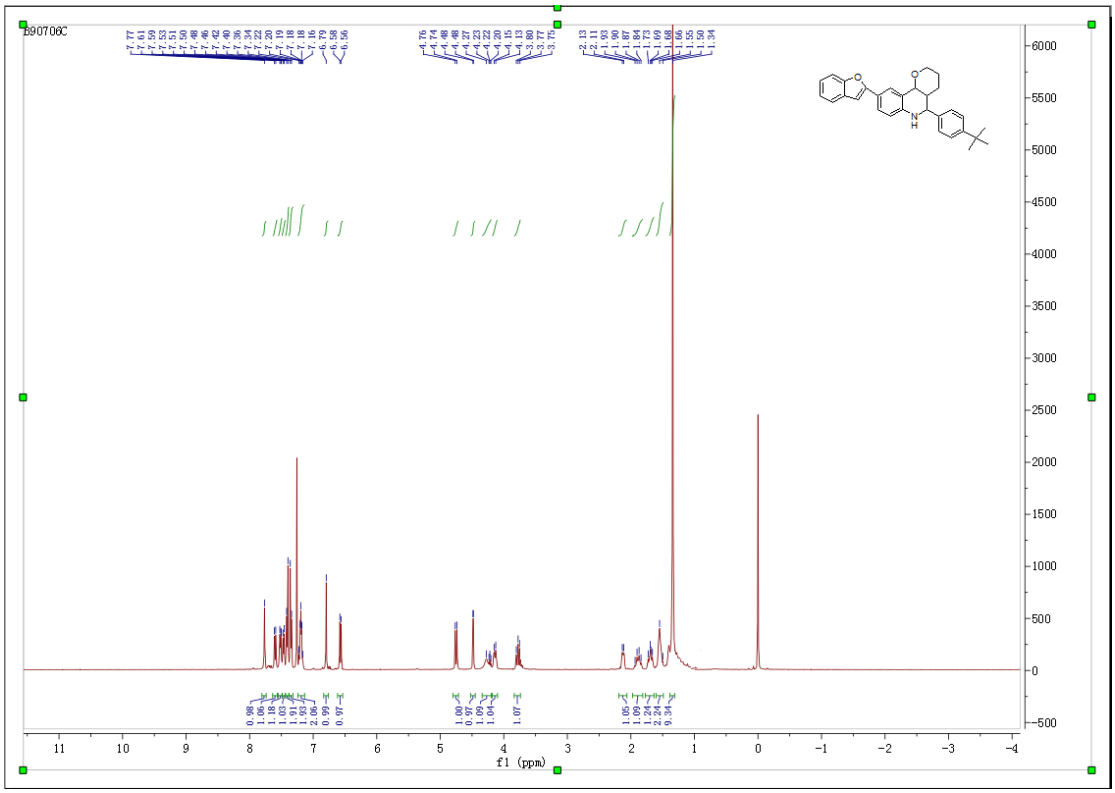


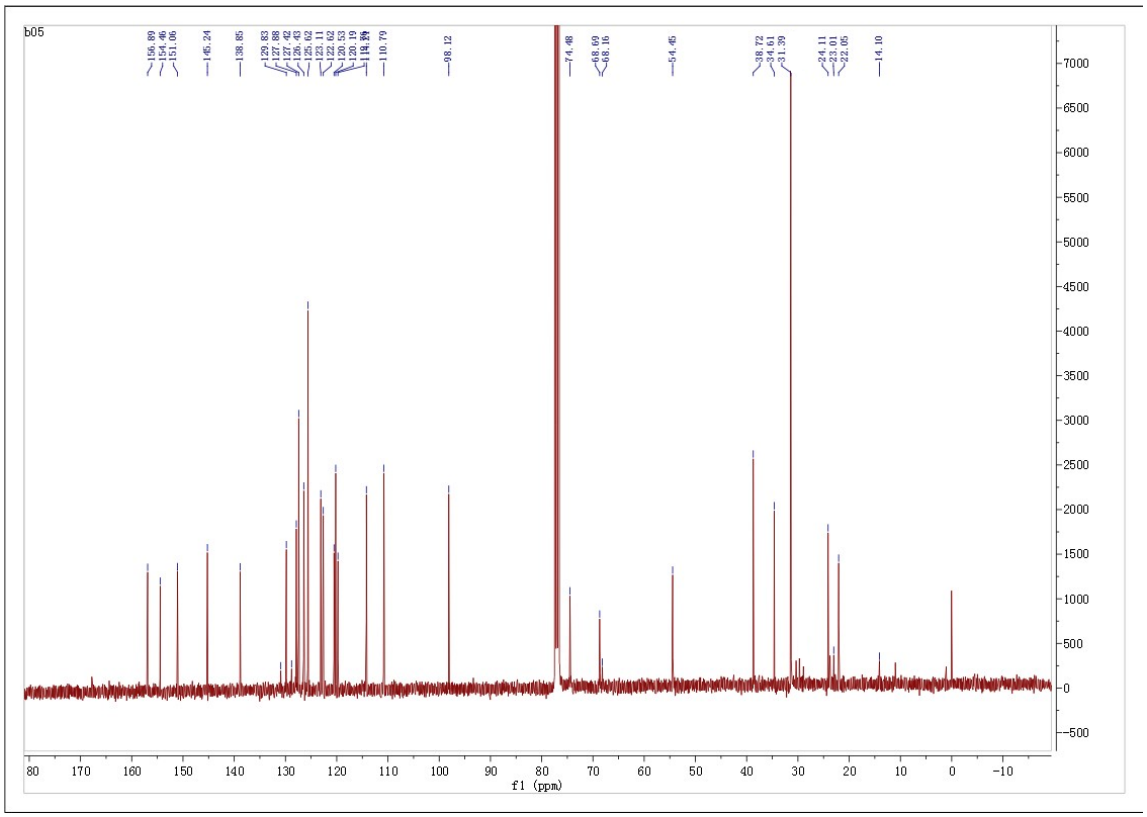


Compound 13d

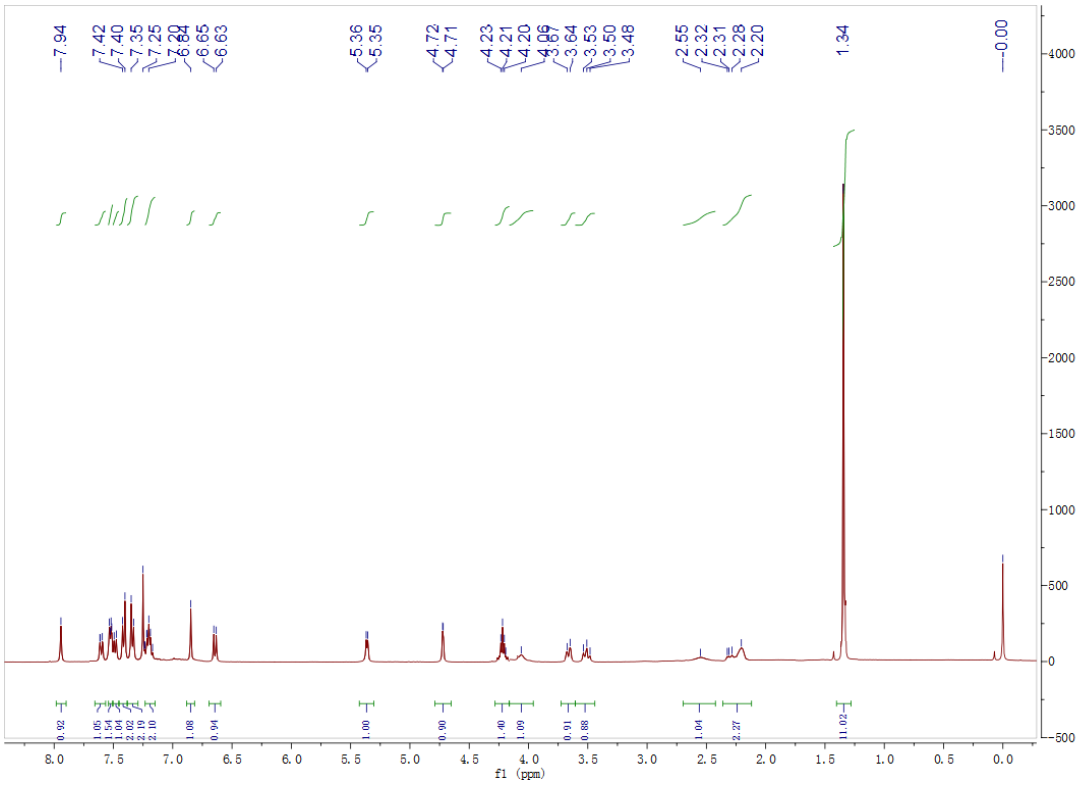


Compound 12e

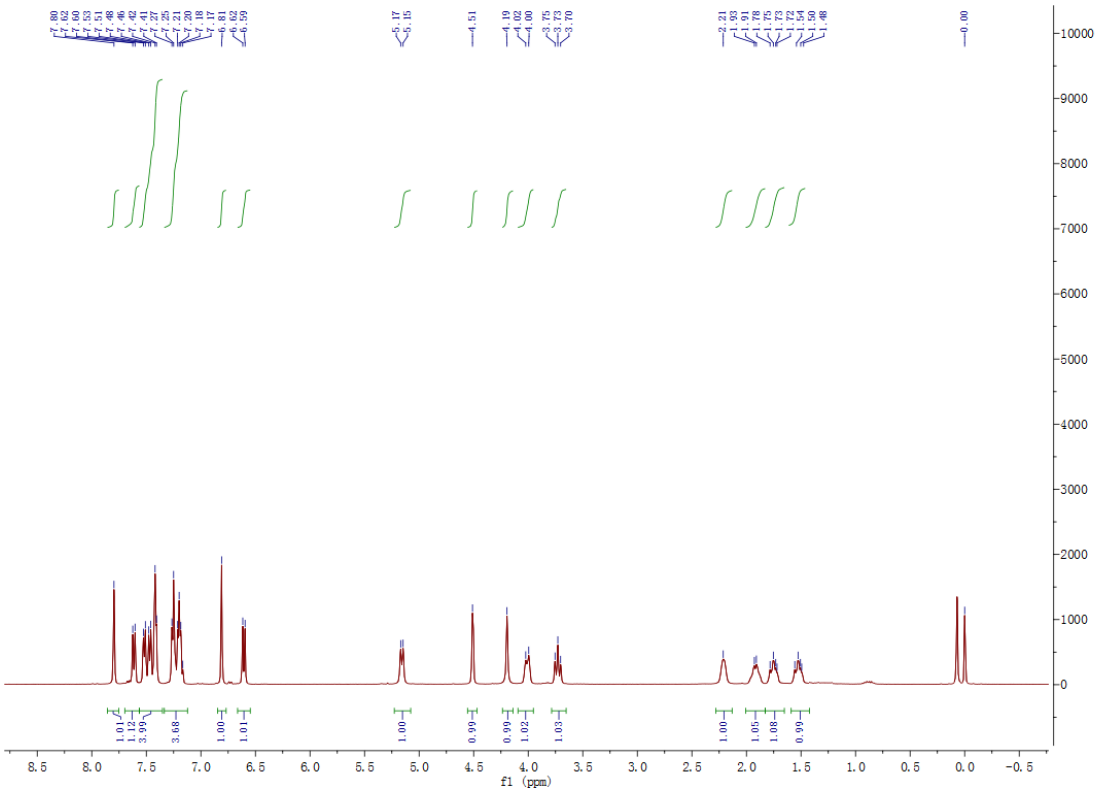


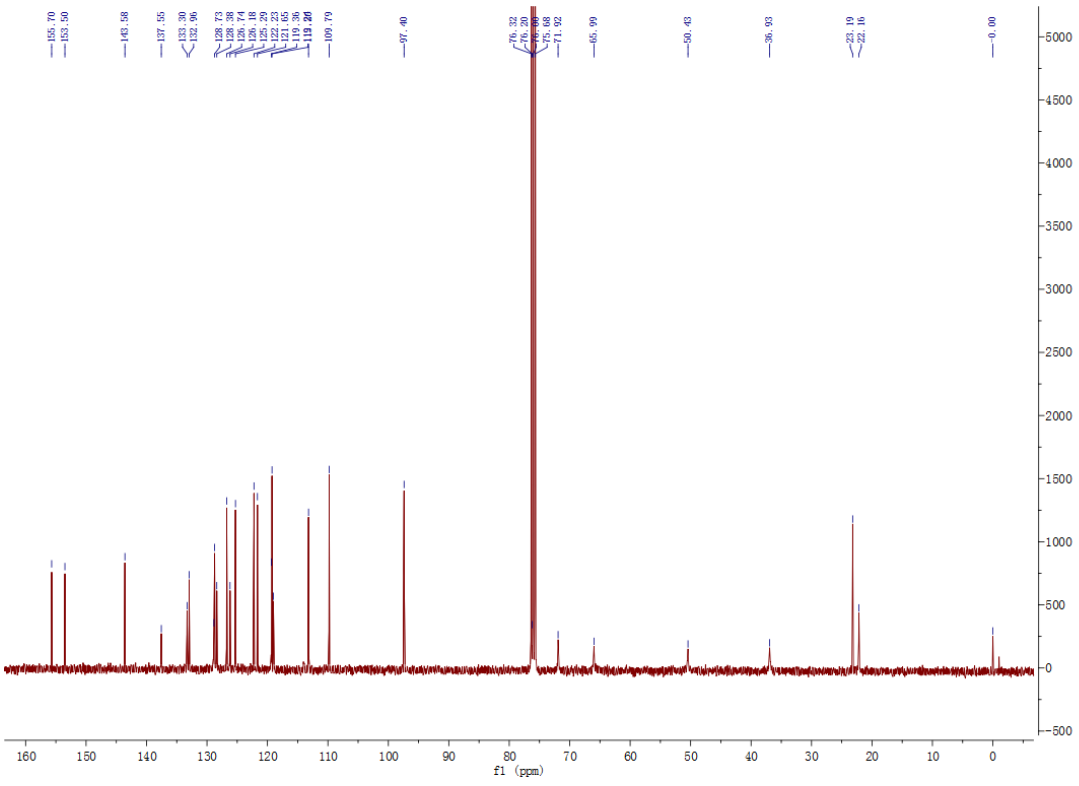


Compound 13e

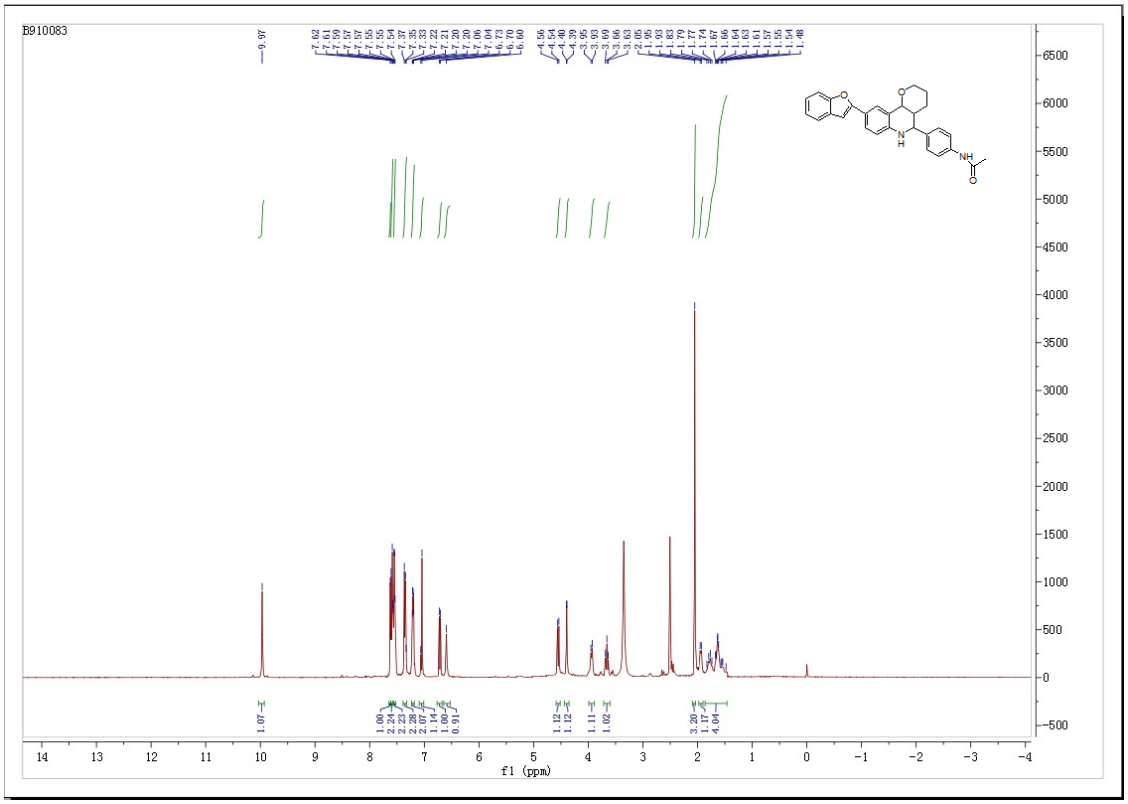


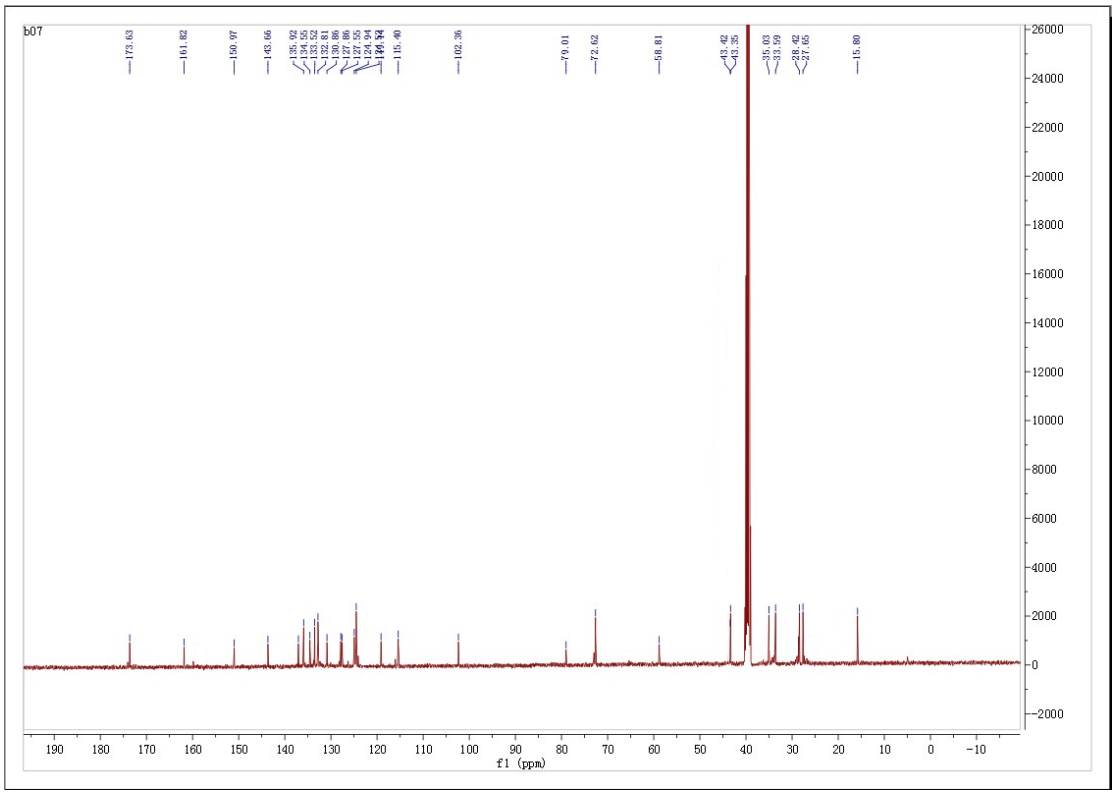
Compound 13f



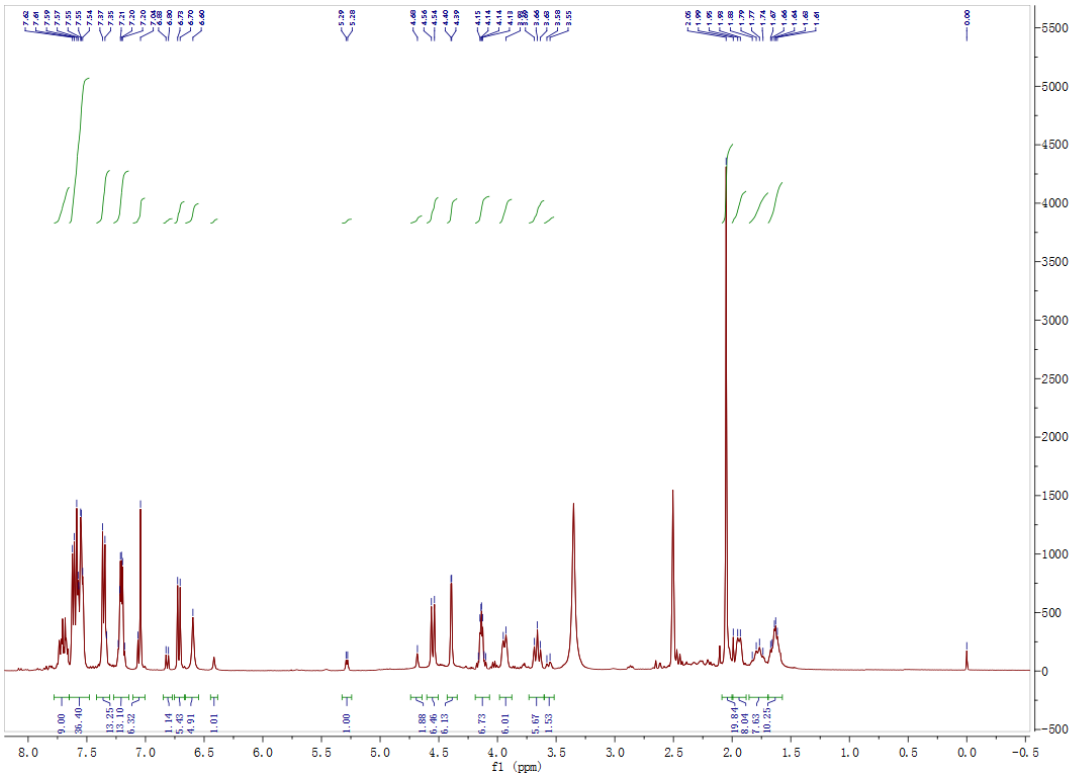


Compound 12g

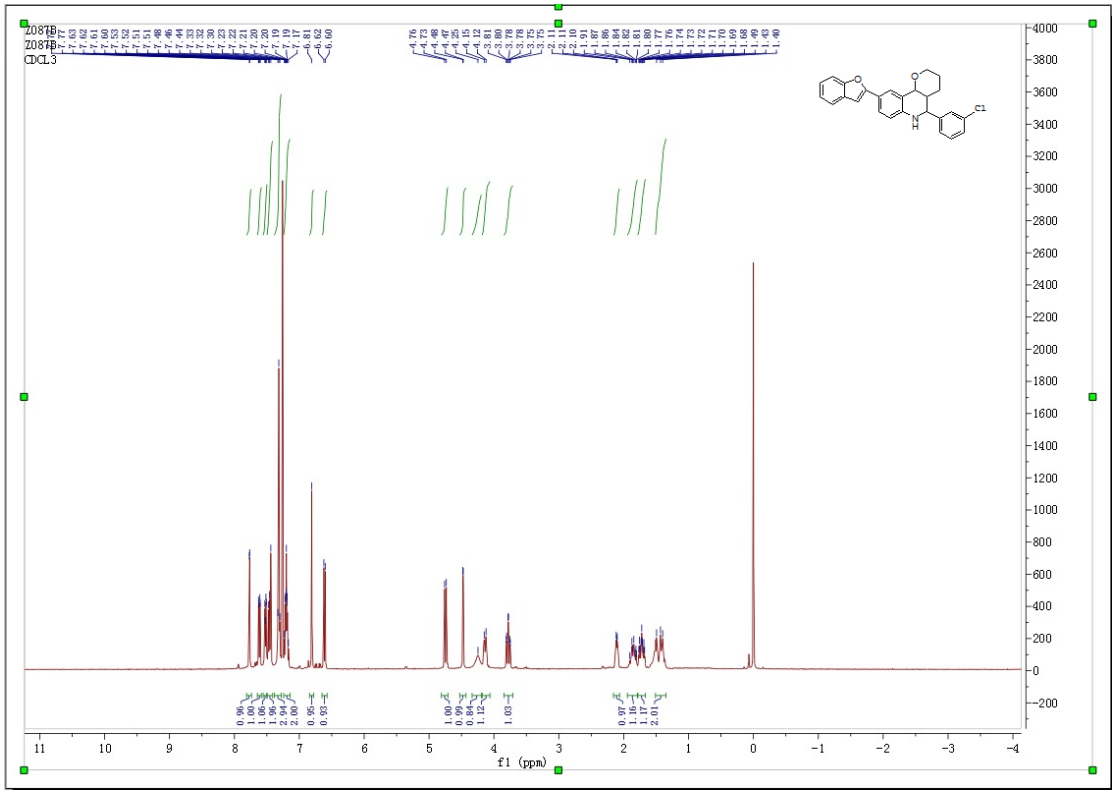


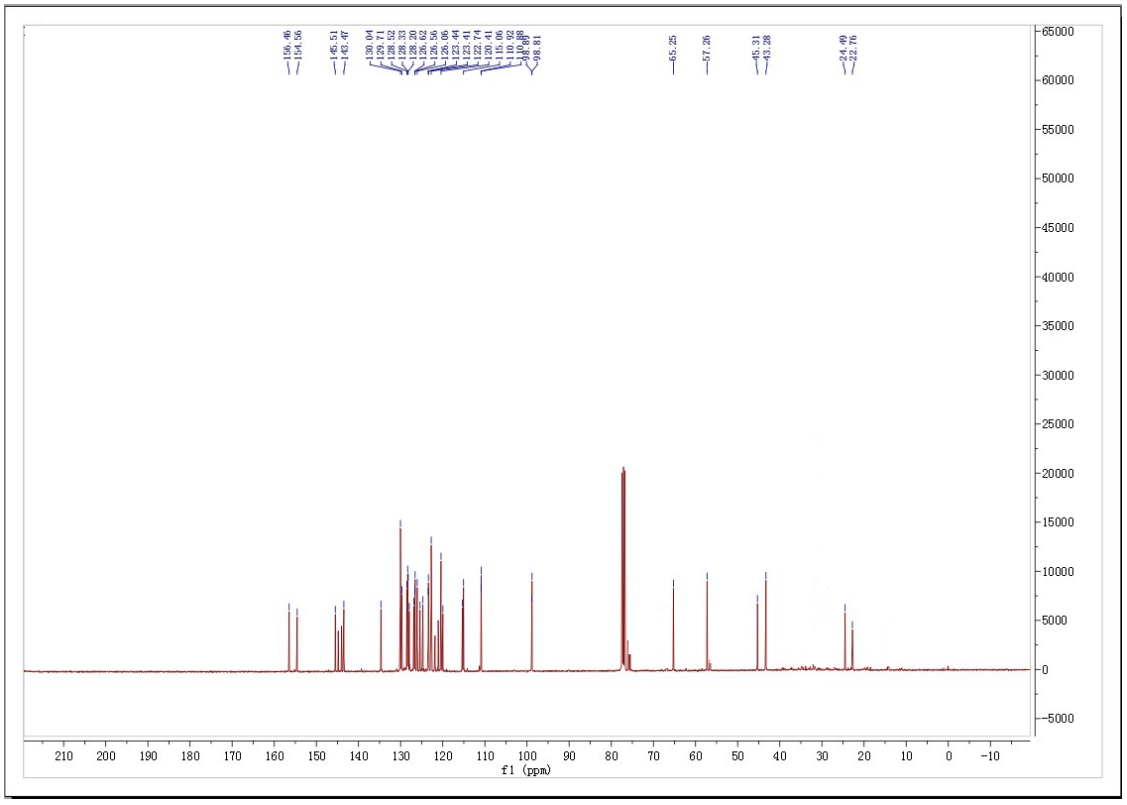


Crude mixture of 12g and 13g

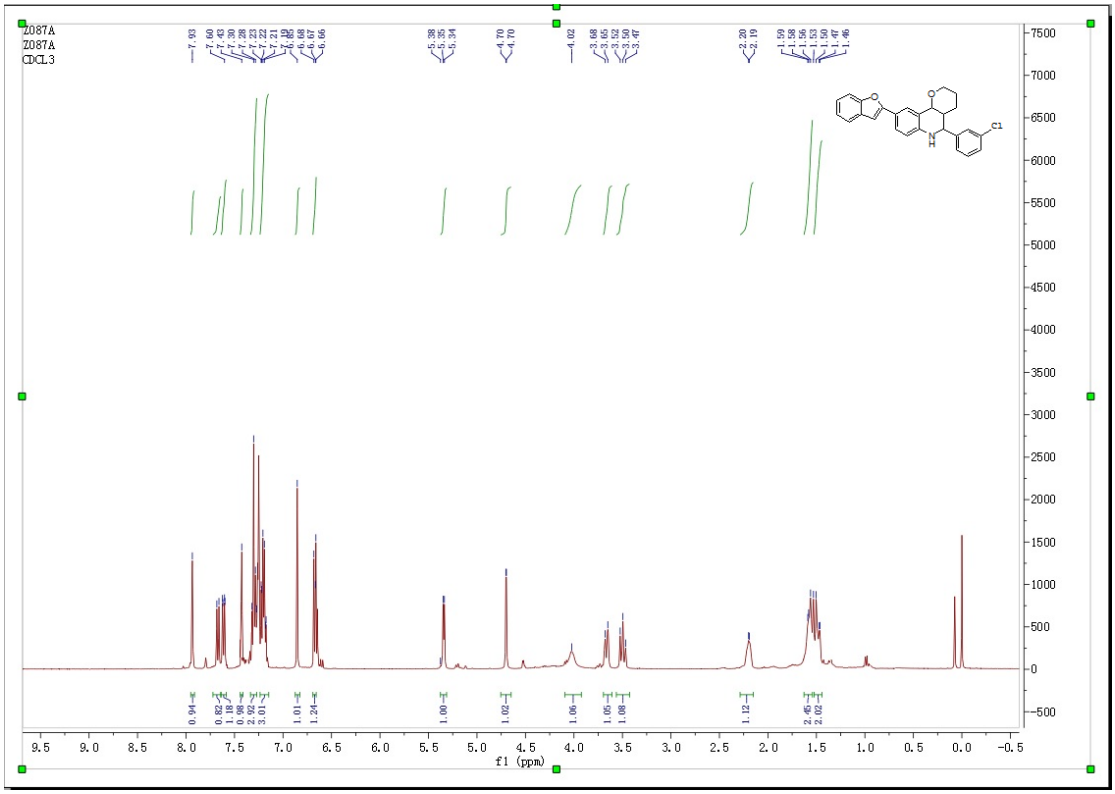


Compound 12h

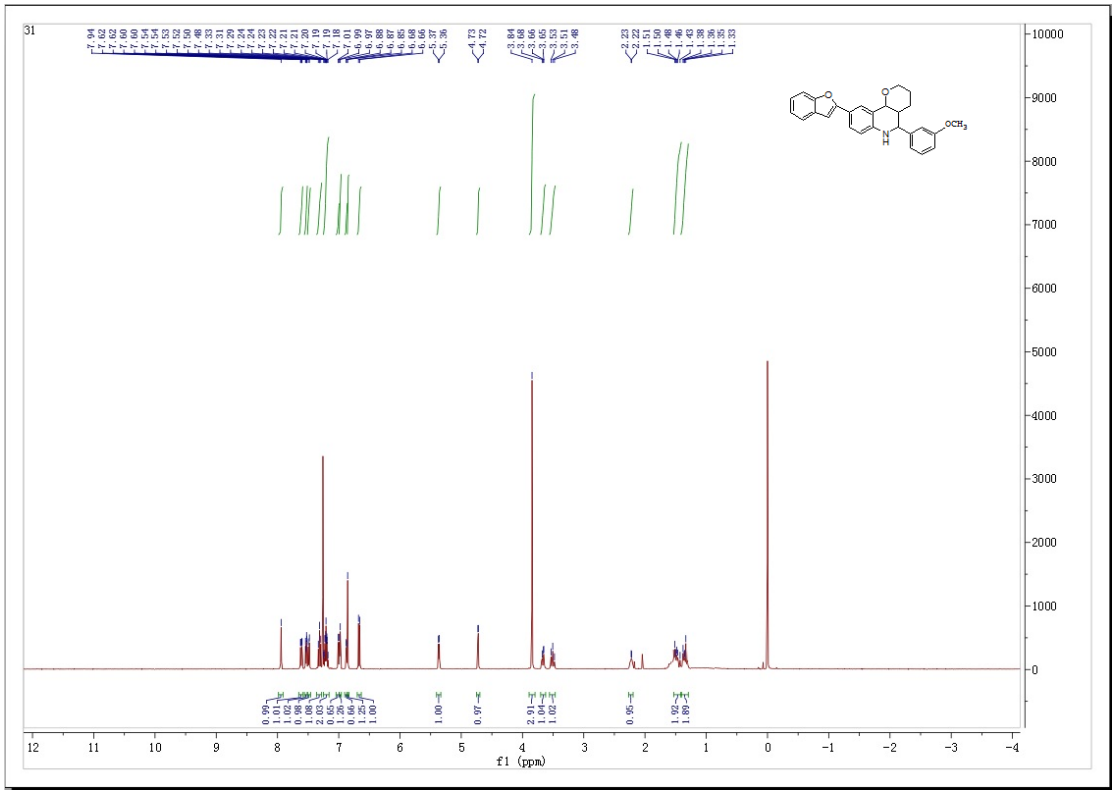


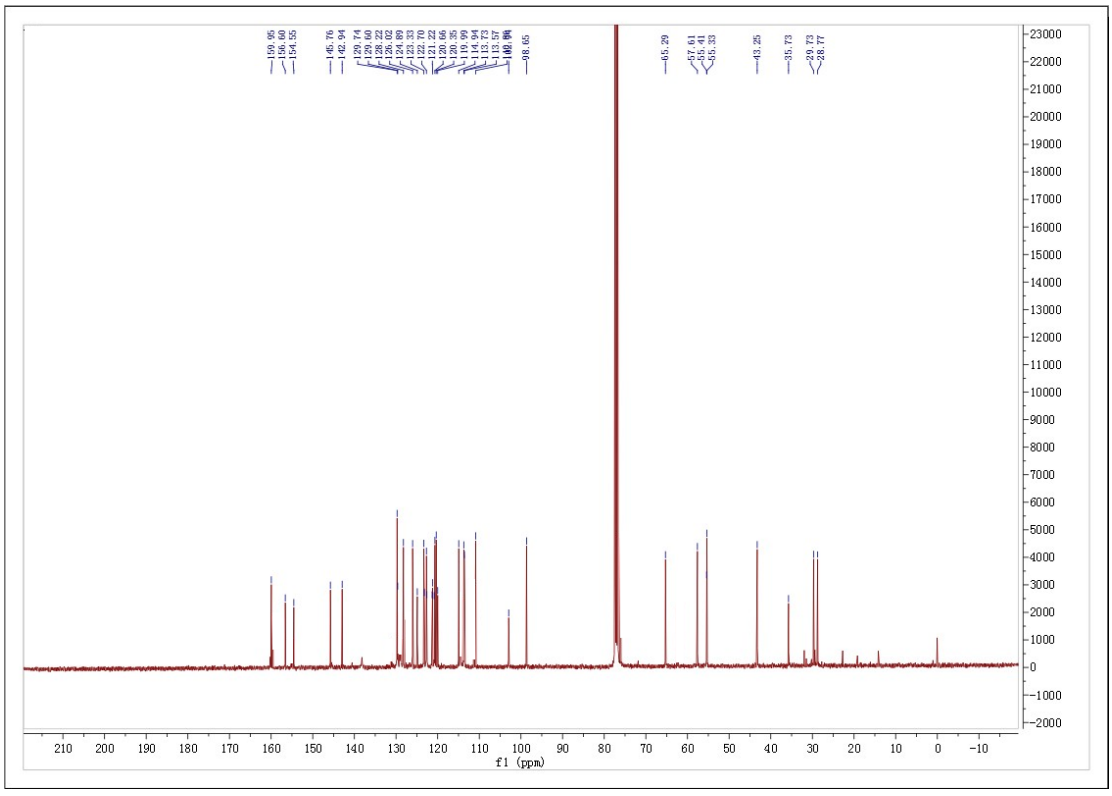


Compound 13h

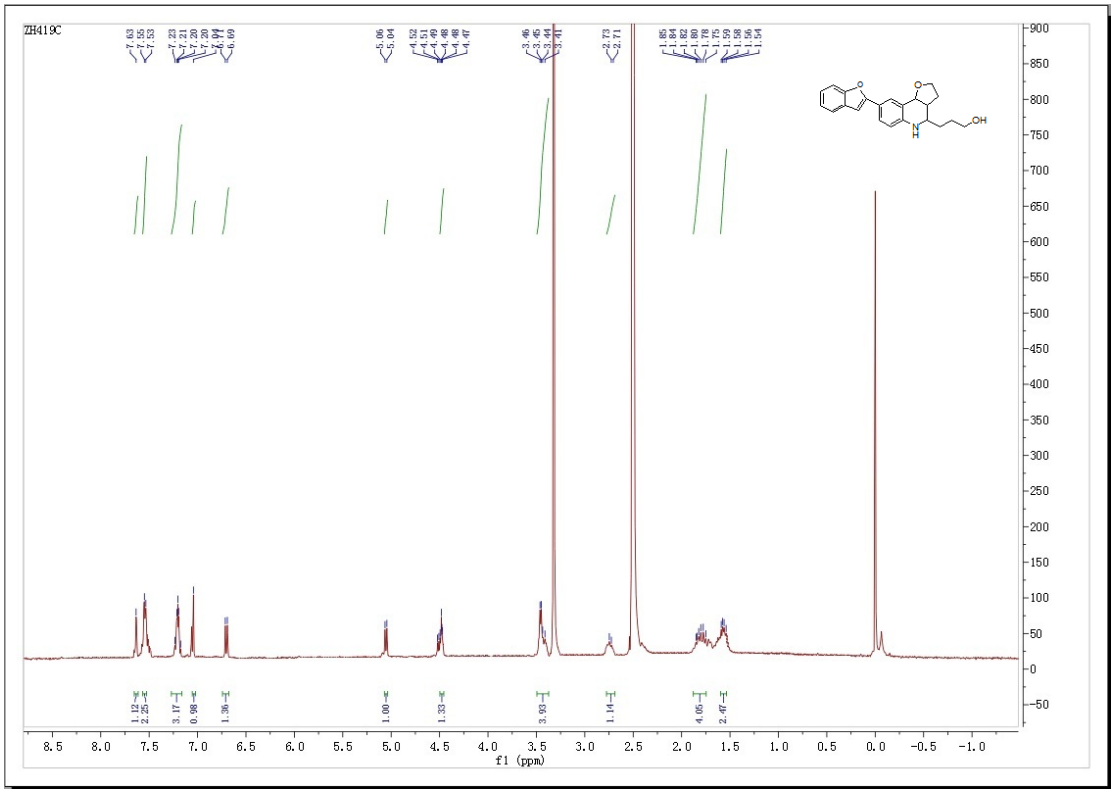


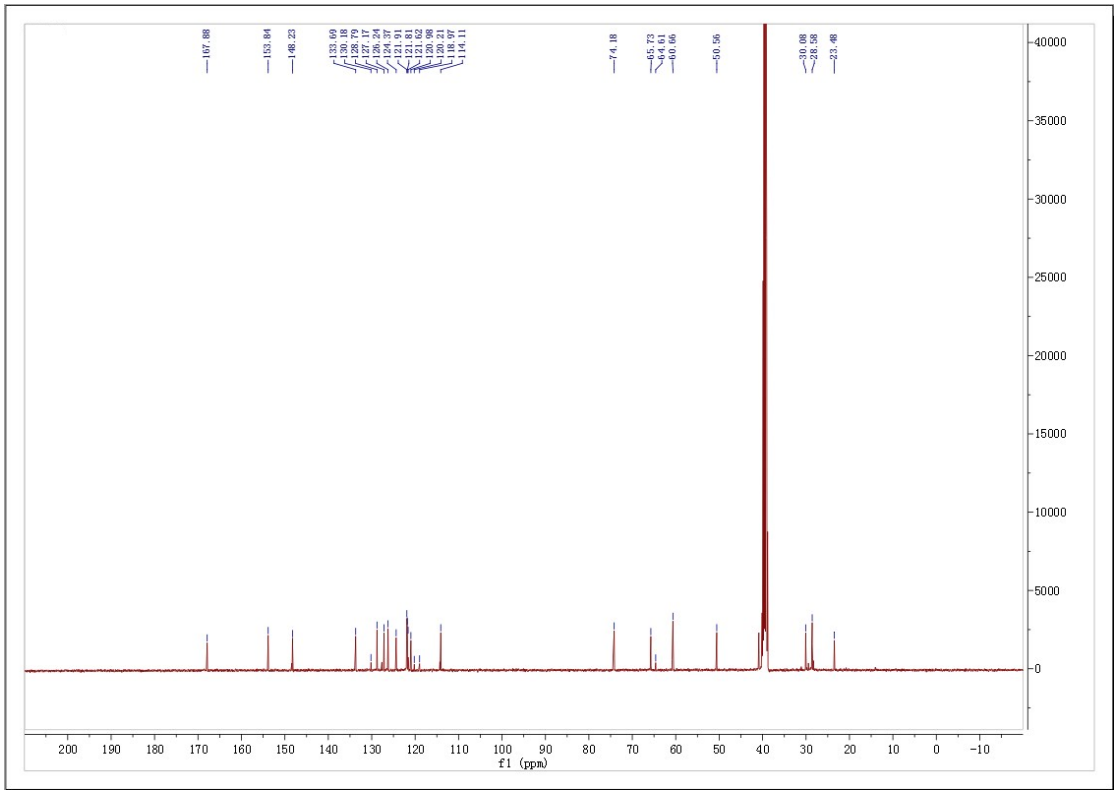
Compound 13i



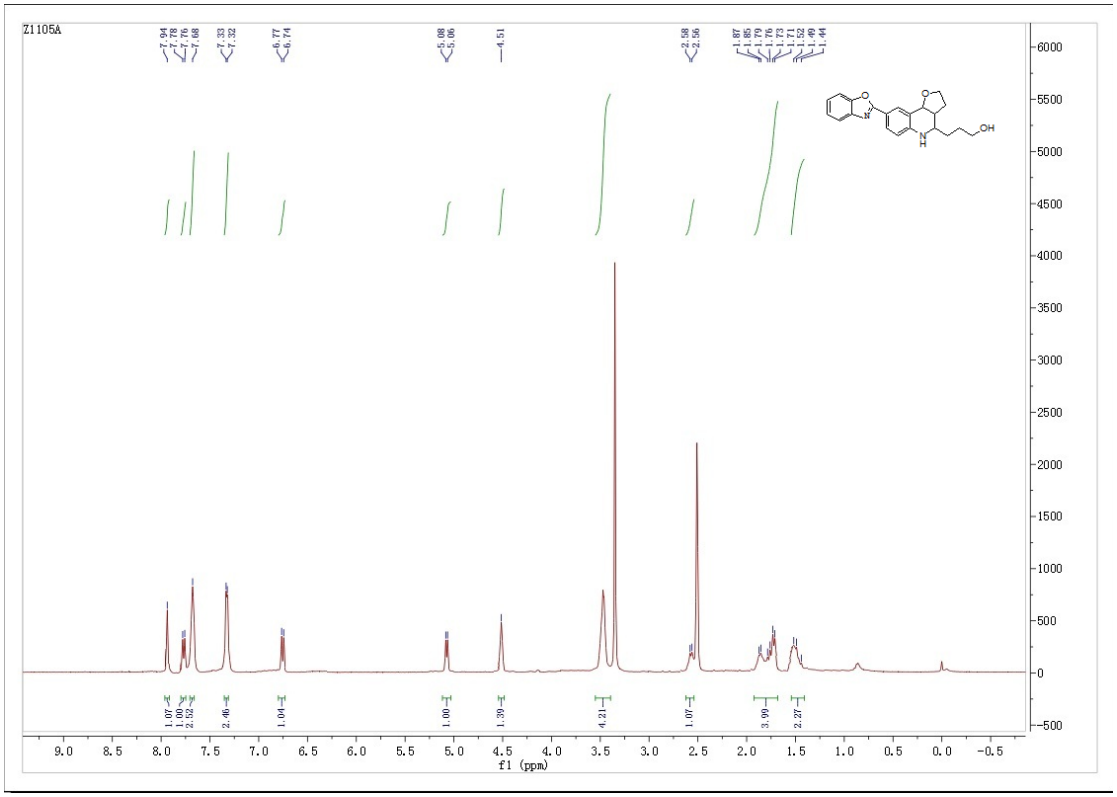


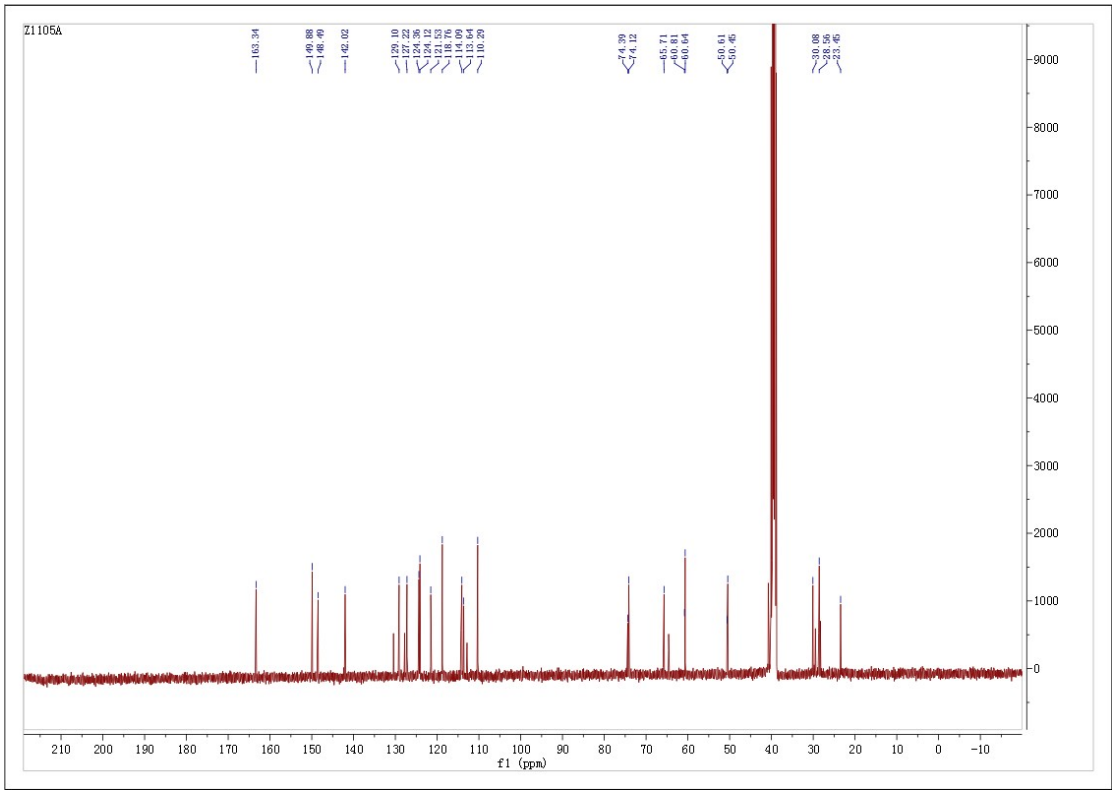
Compound 14a



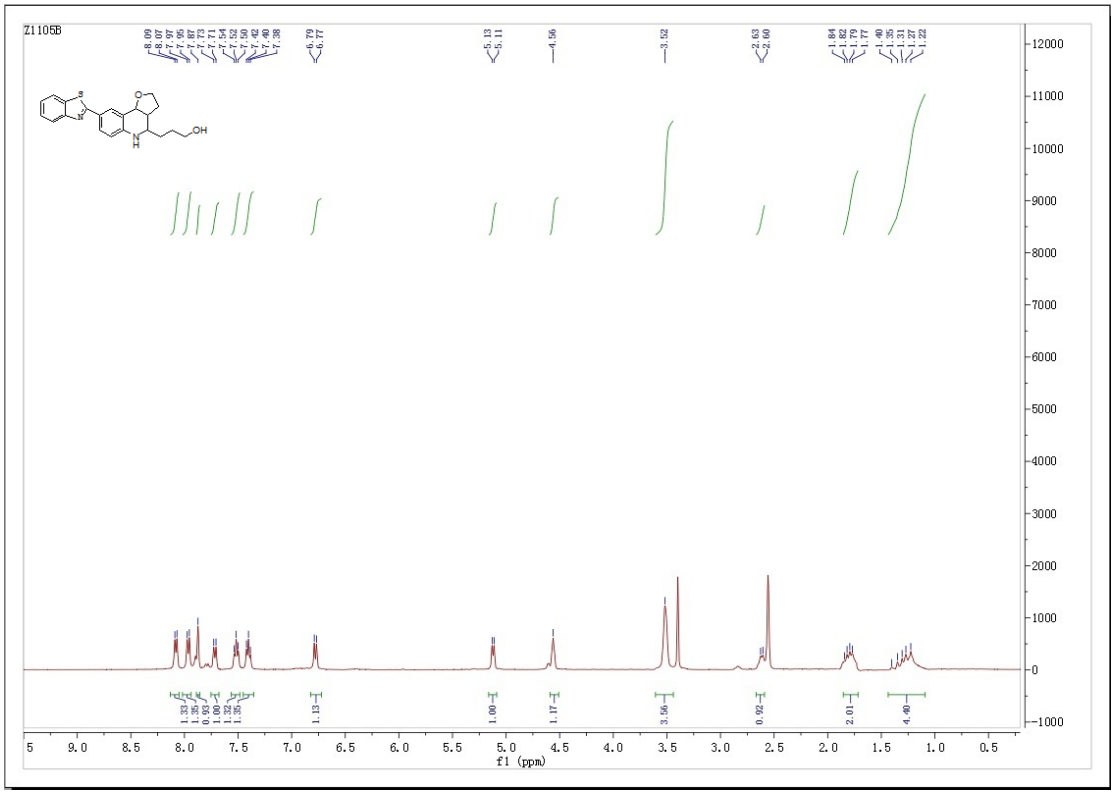


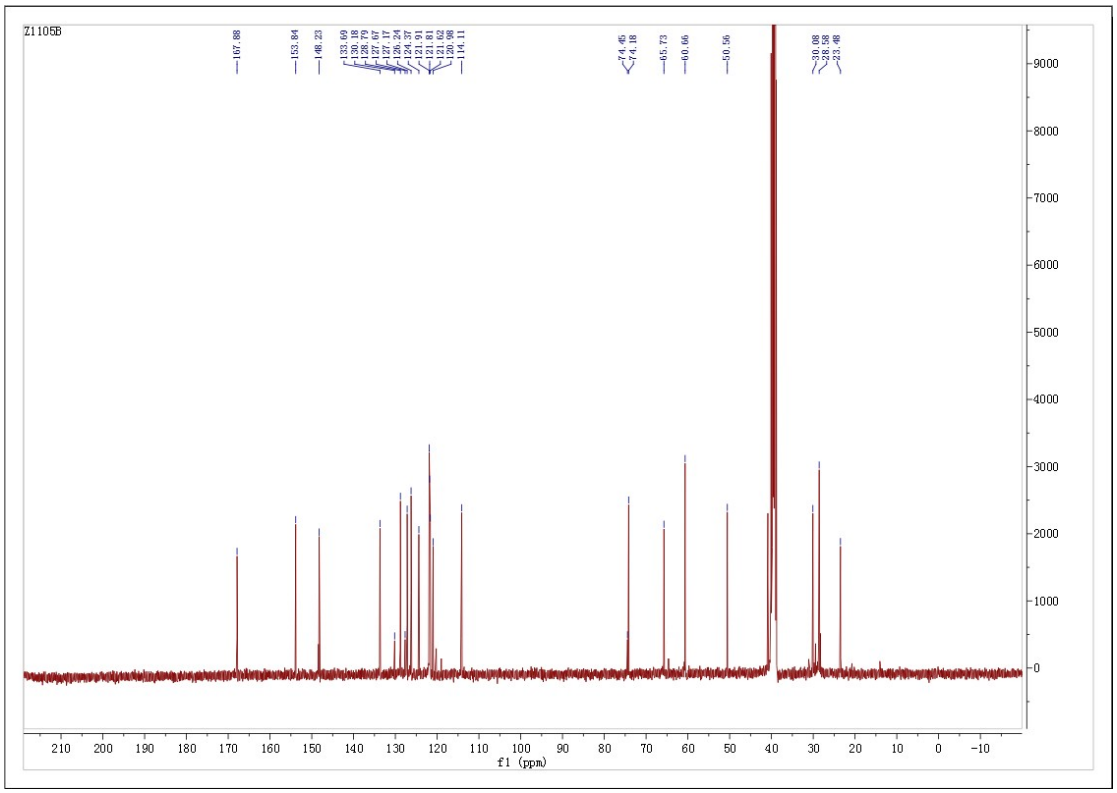
Compound 14b



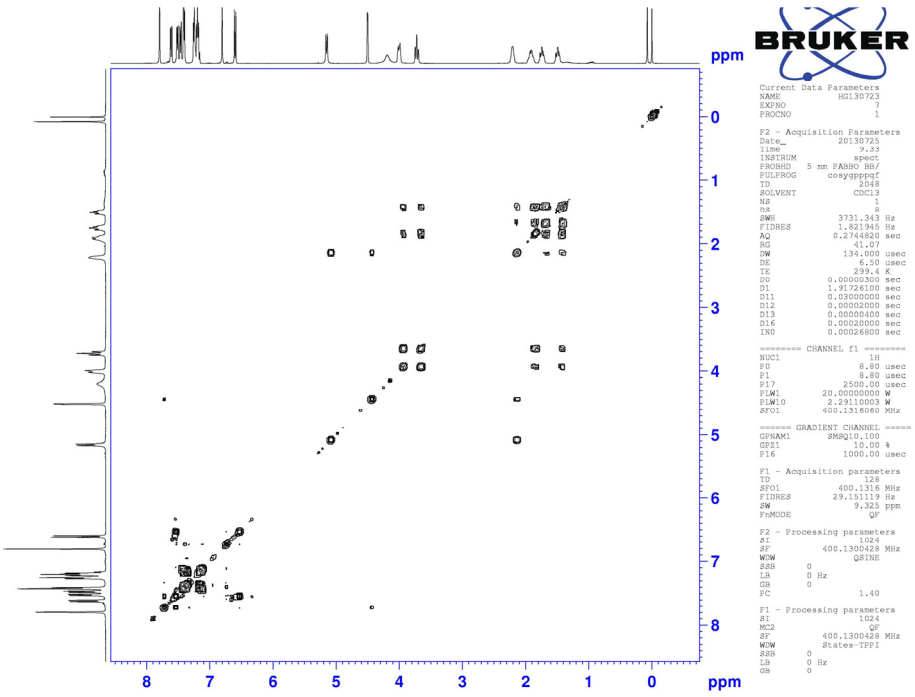


Compound 14c





COSY Spectrum of 13f



BRUKER

Current Data Parameters
NAME HG130723
EXPNO 7
PROCNO 1

F2 - Acquisition Parameters
Date_ 20130725
Time 9.33
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG cosygpppqf
TD 2048
SOLVENT CDCl3
NS 1
DS 8
SWH 3731.343 Hz
FIDRES 1.821945 Hz
AQ 0.2744820 sec
RG 41.07
DW 134.000 usec
DE 6.50 usec
TE 299.4 K
D0 0.00000300 sec
D1 1.91726100 sec
D11 0.03000000 sec
D12 0.00002000 sec
D13 0.00000400 sec
D16 0.00020000 sec
IN0 0.00026800 sec

======== CHANNEL f1 ========
NUC1 1H
P0 8.80 usec
P1 8.80 usec
P17 2500.00 usec
PLW1 20.00000000 W
PLW10 2.29110003 W
SFO1 400.1316060 MHz

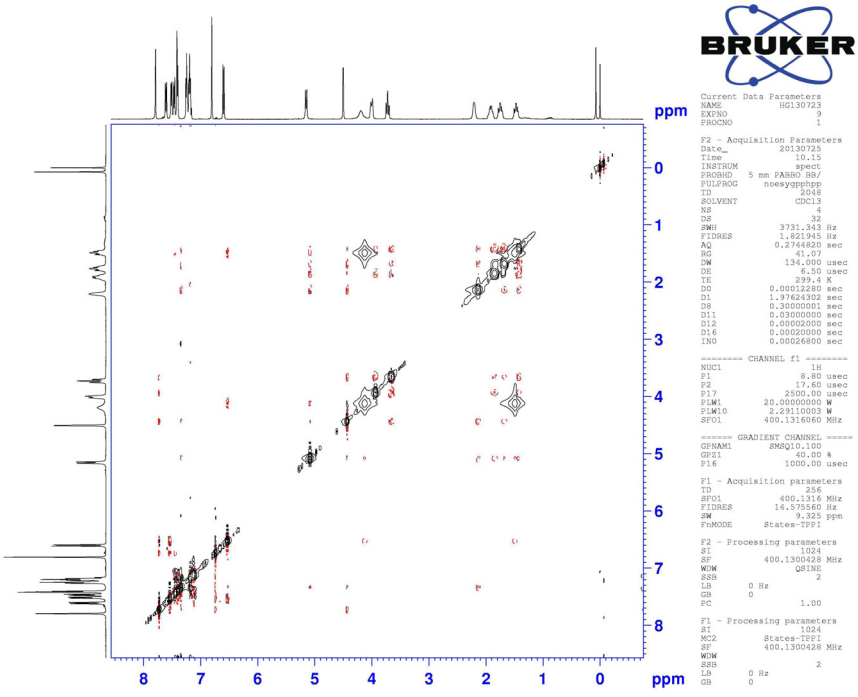
====== GRADIENT CHANNEL =====
GPNAM1 SMSQ10.100
GPZ1 10.00 %
P16 1000.00 usec

F1 - Acquisition parameters
TD 128
SFO1 400.1316 MHz
FIDRES 29.151119 Hz
SW 9.325 ppm
FnMODE QF

F2 - Processing parameters
SI 1024
SF 400.1300428 MHz
WDW QSINE
SSB 0
LB 0 Hz
GB 0
PC 1.40

F1 - Processing parameters
SI 1024
MC2 QF
SF 400.1300428 MHz
WDW States-TPPI
SSB 0
LB 0 Hz
GB 0

NOESY Spectrum of 13f



BRUKER

Current Data Parameters
NAME HG130723
EXPNO 9
PROCNO 1

F2 - Acquisition Parameters
Date_ 20130725
Time 10.15
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG noesygpphpp
TD 2048
SOLVENT CDCl3
NS 4
DS 32
SWH 3731.343 Hz
FIDRES 1.821945 Hz
AQ 0.2744820 sec
RG 41.07
DW 134.000 usec
DE 6.50 usec
TE 299.4 K
D0 0.00012280 sec
D1 1.97624302 sec
D8 0.30000001 sec
D11 0.03000000 sec
D12 0.00002000 sec
D16 0.00020000 sec
IN0 0.00026800 sec

======== CHANNEL f1 ========
NUC1 1H
P1 8.80 usec
P2 17.60 usec
P17 2500.00 usec
PLW1 20.00000000 W
PLW10 2.29110003 W
SFO1 400.1316060 MHz

====== GRADIENT CHANNEL =====
GPNAM1 SMSQ10.100
GPZ1 40.00 %
P16 1000.00 usec

F1 - Acquisition parameters
TD 256
SFO1 400.1316 MHz
FIDRES 14.575560 Hz
SW 9.325 ppm
FnMODE States-TPPI

F2 - Processing parameters
SI 1024
SF 400.1300428 MHz
WDW QSINE
SSB 2
LB 0 Hz
GB 0
PC 1.00

F1 - Processing parameters
SI 1024
MC2 States-TPPI
SF 400.1300428 MHz
WDW
SSB 2
LB 0 Hz
GB 0

HMBC Spectrum of 13f