Supporting Information

An elimination/Heck coupling/allylation cascade reaction: synthesis of 2,3-dihydrobenzofurans from allenoate adducts

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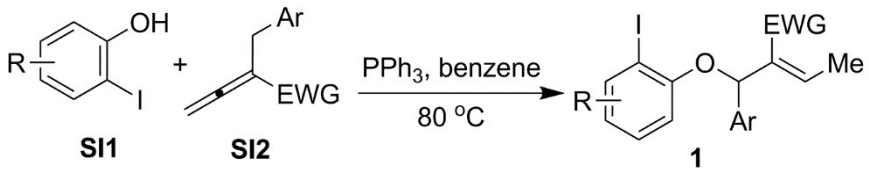
General Information

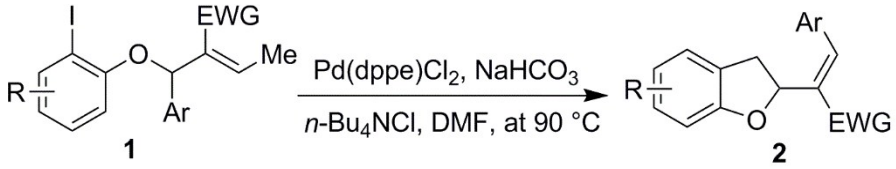
All reactions were performed under a N_2 atmosphere in oven-dried glassware with magnetic stirring. Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. Toluene and benzene were freshly distilled from CaH_2. Organic solutions were concentrated under reduced pressure on a rotary evaporator or an oil pump. Reactions were monitored through thin layer chromatography (TLC) on silica gel–precoated glass plates. Chromatograms were visualized by fluorescence quenching under UV light at 254 nm. Flash column chromatography was performed using Qingdao Haiyang flash silica gel (200–300 mesh). Infrared spectra were recorded using a Thermo Nicolet 6700 instrument. ^1H and ^{13}C NMR spectra were recorded in $CDCl_3$ using a Bruker Avance 400 MHz NMR spectrometer (referenced internally to Me_4Si). Chemical shifts (δ, ppm) are reported relative to tetramethylsilane (TMS) with the resonance of the nondeuterated solvent or TMS as the internal standard. ^1H NMR data are reported as follows: chemical shift, multiplicity (s = singlet; d = doublet; q = quartet; m = multiplet; br = broad), coupling constant (Hz), and integral. Data for ^{13}C NMR spectra are reported in terms of chemical shift. Accurate mass measurements were performed using a Varian instrument with the TOF EI-MS technique. Melting points were determined using a X-4 digital micro melting point apparatus. X-ray crystallographic data were collected using a Bruker Smart Apex CCD apparatus. All allenes were provided by Prof. Hongchao Guo (synthesized in the National Key Technologies R&D Program of China, 2015BAK45B01, CAU).

General procedure for the synthesis of substrates 1:



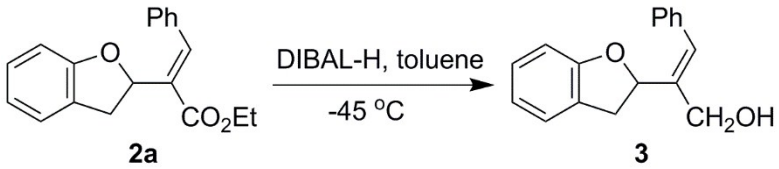
An over-dried Schlenk tube was charged with the appropriate 2-iodophenol (**SI1**) (1.0 mmol), triphenylphospine (0.2 mmol) under N_2. Distilled benzene (2 mL) was added via syringe. The mixture was stirred at 80 °C. Finally, the corresponding allene (**SI2**) (1.2 mmol) was weighed in a syringe, mixed with distilled benzene (1 mL) and added dropwise to the reaction mixture over 3 h. The reaction was left to proceed until the 2-iodophenol was consumed, typically 12 h (TLC, 40:1 Petroleum ether/EtOAc). The crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 40:1) to give the desired substrate (**1**).

General procedure for the synthesis of 2,3-dihydrobenzofuran products 2 from substrates 1:



An over-dried Schlenk tube was charged with **1** (0.5 mmol), Pd(dppe)Cl_2 (0.025 mmol), *n*-Bu_4NCl (0.5 mmol), $NaHCO_3$ (1.0 mmol) and dry DMF (5 mL) under N_2. The mixture was stirred at 90 °C for 8 h and monitored by TLC. Finally, EtOAc (5 mL) and H_2O (5 mL) were added, and the solution was partitioned. The aqueous layer was washed with EtOAc, and EtOAc extracts were washed sequentially with water and saturated NaCl solution. The combined extracts were dried (Na_2SO_4), and the crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 20:1) to give the desired product (**2**).

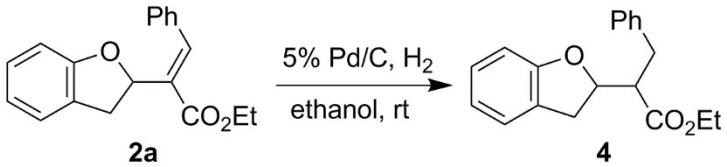
Procedure of 1,2-reduction of product 2a:



2a **3**

An over-dried Schlenk tube was charged with **6a** (1 mmol) and dry toluene(4 mL) under N_2. The solution was cooled to -45 °C in a dry alcohol bath. Finally, The 1 mL (1.5 mmol) of a 1.5 M solution of DIBAL-H in toluene was added dropwise to the reaction mixture over 0.5 h, and the solution was stirred at -45 °C for 2 h, until reduction was complete (monitored by TLC). Excess hydride was destroyed by the addtion of 1 mL of a 1 M HCl solution, and the solution was partitioned. The aqueous layer was washed with EtOAc, and EtOAc extracts were washed sequentially with water and saturated NaCl solution. The combined extracts were dried (Na_2SO_4), and the crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 3:1) to give the desired product (**3**) in 90% yield.

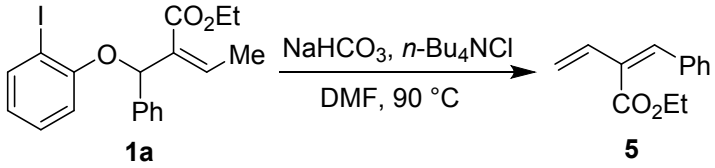
Procedure of 1,4-reduction of product 2a:



2a **4**

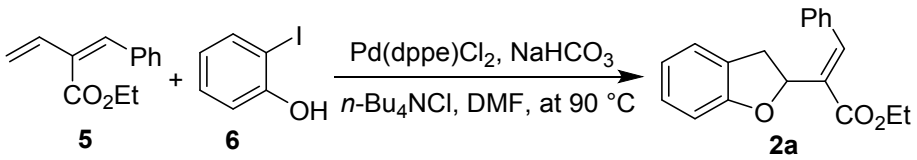
A round-bottom flask was charged with **2a** (0.5 mmol), 5% Pd/C (14.7 mg) and ethanol (50 mL) under H_2. Hydrogen gas was supplied to the reaction mixture from a balloon connected via a syringe through the septum. After stirring for 48 h at room temperature the catalyst was removed from the reaction mixture by filtration (monitored by TLC). The crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 20:1) to give the desired product (**4**) in 75% yield.

Procedure for transformation of 1a to 5:



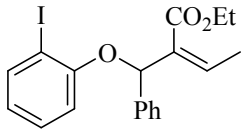
An over-dried Schlenk tube was charged with **1a** (0.5 mmol), *n*-Bu_4NCl (0.5 mmol), $NaHCO_3$ (1.0 mmol) and dry DMF (5 mL) under N_2. The mixture was stirred at 90 °C for 6 h and monitored by TLC. Finally, EtOAc (5 mL) and H_2O (5 mL) were added, and the solution was partitioned. The aqueous layer was washed with EtOAc, and EtOAc extracts were washed sequentially with water and saturated NaCl solution. The combined extracts were dried (Na_2SO_4), and the crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 20:1) to give the compound (**5**) in 82%.

Procedure for transformation of 5 and 6 to 2a:

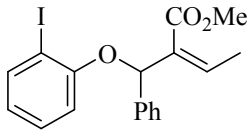


An over-dried Schlenk tube was charged with **5** (0.5 mmol), **6** (0.5 mmol), $Pd(dppe)Cl_2$ (0.025 mmol), *n*-Bu_4NCl (0.5 mmol), $NaHCO_3$ (1.0 mmol) and dry DMF (5 mL) under N_2. The mixture was stirred at 90 °C for 8 h and monitored by TLC. Finally, EtOAc (5 mL) and H_2O (5 mL) were added, and the solution was partitioned. The aqueous layer was washed with EtOAc, and EtOAc extracts were washed sequentially with water and saturated NaCl solution. The combined extracts were dried (Na_2SO_4), and the crude reaction mixture was concentrated and loaded onto a silica gel column and separated chromatographically (Petroleum ether /EtOAc, 20:1) to give the desired product (**2a**) in 92% yield.

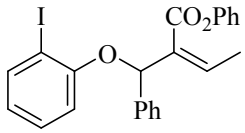
Characterization Data:



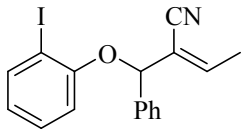
Compound 1a: 98% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.23 (t, J = 7.2 Hz, 3H), 2.02 (dd, J = 7.2, 1.2 Hz, 3H), 4.22 (q, J = 7.2 Hz, 2H), 6.19 (s, 1H), 6.40 (q, J = 7.2 Hz, 1H), 6.63 (t, J = 7.2 Hz, 1H), 6.75 (d, J = 7.6 Hz, 1H), 7.14 (t, J = 6.8 Hz, 1H), 7.22 - 7.35 (m, 3H), 7.46 (d, J = 7.2 Hz, 2H), 7.73 (d, J = 6.4 Hz,1H);^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.6, 79.6, 87.1, 113.8, 122.7, 127.2, 128.0, 128.5, 129.3, 133.0, 138.8, 139.2, 139.4, 156.2, 166.5 ppm; HRMS (TOF EI): m/z calcd for $C_{19}H_{19}IO_3^+$ (M^+) 422.0373, Found 422.0378. The stereochemistry was confirmed by NOESY (δ 6.40 and 6.19).



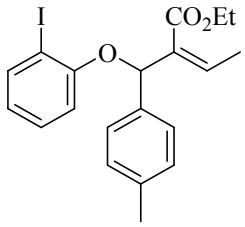
Compound 1b: 92% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.03 (d, J = 7.2 Hz, 3H), 3.77 (s, 3H), 6.18 (s, 1H), 6.43 (q, J = 7.2 Hz, 1H), 6.66 (t, J = 7.6 Hz, 1H), 6.74 (d, J = 7.2 Hz, 1H), 7.17 (t, J = 8.4 Hz, 1H), 7.29 (d, J = 7.2 Hz, 1H), 7.35 (t, J = 7.2 Hz, 2H), 7.46 (d, J = 7.2 Hz, 2H), 7.75 (d, J = 6.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 15.7, 51.6, 79.4, 87.0, 113.7, 122.7, 127.0, 128.0, 128.5, 129.2, 132.6, 139.0, 139.1, 139.4, 156.1, 166.9; HRMS (TOF EI): m/z calcd for $C_{18}H_{17}IO_3^+$ (M^+) 408.0217, Found 408.0223.



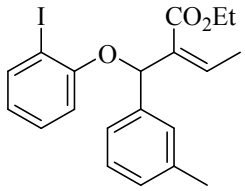
Compound 1c: 90% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.16 (d, J = 7.2 Hz, 3H), 6.32 (s, 1H), 6.66 (m, 2H), 6.80 (d, J = 7.2 Hz, 1H), 7.03 (d, J = 7.6 Hz, 2H), 7.15 - 7.23 (m, 2H), 7.29 - 7.40 (m, 5H), 7.52 (d, J = 7.2 Hz, 2H), 7.77 (dd, J = 7.6, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 16.0, 79.4, 87.1, 113.7, 121.7, 122.8, 125.9, 127.3, 128.2, 128.6, 129.3, 129.4, 132.2, 138.7, 139.5, 141.5, 150.3, 155.9, 164.7; HRMS (TOF EI): m/z calcd for $C_{23}H_{19}IO_3^+$ (M^+) 470.0373, Found 470.0369.



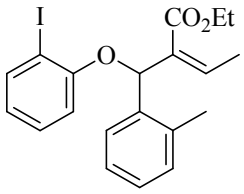
Compound 1d: 89% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.05 (t, J = 7.2 Hz, 3H), 5.74 (s, 1H), 6.67 - 6.79 (m, 3H), 7.17 (t, J = 7.2 Hz, 1H), 7.32 - 7.41 (m, 3H), 7.49 (d, J = 6.8 Hz, 2H), 7.78 (dd, J = 8.0, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.1, 32.9, 89.7, 97.1, 119.4, 120.8, 126.8, 127.1, 128.7, 128.8, 129.8, 137.8, 139.9, 153.7, 163.7; HRMS (TOF EI): m/z calcd for $C_{17}H_{14}INO^+$ (M^+) 375.0115, Found 375.0124.



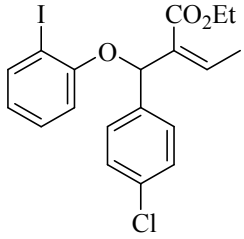
Compound 1e: 97% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.24 (t, J = 7.2 Hz, 3H), 2.02 (d, J = 7.2 Hz, 3H), 2.32 (s, 3H), 4.22 (q, J = 7.2 Hz, 2H), 6.15 (s, 1H), 6.38 (q, J = 7.2 Hz, 1H), 6.64 (t, J = 7.6 Hz, 1H), 6.76 (d, J = 8.4 Hz, 1H), 7.14 - 7.18 (m, 3H), 7.34 (d, J = 7.6 Hz, 2H), 7.73 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 21.2, 60.6, 87.1, 113.7, 122.6, 127.1, 129.2, 129.3, 133.1, 136.0, 137.7, 138.5, 139.4, 156.2, 166.5; HRMS (TOF EI): m/z calcd for $C_{20}H_{21}IO_3^+$ (M^+) 436.0530, Found 436.0539.



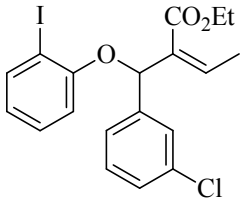
Compound 1f: 94% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.24 (t, J = 7.2 Hz, 3H), 2.03 (d, J = 7.2 Hz, 3H), 2.34 (s, 3H), 4.23 (q, J = 7.2 Hz, 2H), 6.15 (s, 1H), 6.36 (q, J = 7.2 Hz, 1H), 6.64 (t, J = 7.6 Hz, 1H), 6.76 (d, J = 8.0 Hz, 1H), 7.07 - 7.27 (m, 5H), 7.73 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.3, 15.7, 21.6, 60.6, 79.7, 87.1, 113.8, 122.7, 124.3, 127.8, 128.4, 128.8, 129.3, 133.1, 138.2, 138.8, 139.0, 139.4, 156.3, 166.5; HRMS (TOF EI): m/z calcd for $C_{20}H_{21}IO_3^+$ (M^+) 436.0530, Found 436.0538.



Compound 1g: 98% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.19 (t, J = 7.2 Hz, 3H), 2.01 (d, J = 7.2 Hz, 3H), 2.34 (s, 3H), 4.17 - 4.28 (m, 2H), 5.92 (q, J = 7.2 Hz, 1H), 6.28 (s, 1H), 6.59 - 6.68 (m, 2H), 7.12 - 7.23 (m, 4H), 7.44 (d, J = 8.8 Hz, 1H), 7.74 (d, J = 6.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.6, 19.3, 60.7, 78.2, 86.9, 113.4, 122.6, 126.4, 127.5, 128.1, 129.3, 130.6, 131.9, 135.8, 136.1, 139.1, 139.4, 156.8, 166.8; HRMS (TOF EI): m/z calcd for $C_{20}H_{21}IO_3^+$ (M^+) 436.0530, Found 436.0531.

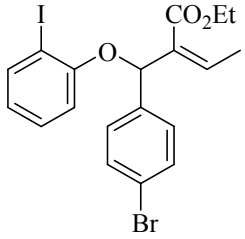


Compound 1h: 93% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.24 (t, J = 7.2 Hz, 3H), 2.04 (d, J = 7.2 Hz, 3H), 4.22 (q, J = 7.2 Hz, 2H), 6.16 (s, 1H), 6.46 (q, J = 7.2 Hz, 1H), 6.66 (t, J = 7.6 Hz, 1H), 6.73 (d, J= 8.4 Hz, 1H), 7.17 (t, J = 8.4 Hz, 1H), 7.31 (d, J = 8.4 Hz, 2H), 7.41 (d, J = 8.4 Hz, 2H), 7.74 (d, J = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.7, 78.9, 87.1, 113.8, 123.0, 128.6, 128.7, 129.3, 132.5, 133.8, 137.8, 139.2, 139.5, 155.9, 166.3; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}ClIO_3^+$ (M^+) 455.9984, Found 455.9988.

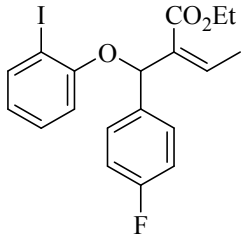


Compound 1i: 92% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.26 (t, J = 7.2 Hz, 3H), 2.06 (d, J = 7.2 Hz, 3H), 4.21 - 4.27 (m, 2H), 6.15 (s,1H), 6.47 (q, J = 7.2 Hz, 1H), 6.66 - 6.75 (m, 2H), 7.17 - 7.21 (m, 1H), 7.24 - 7.29 (m, 2H), 7.34 - 7.37 (m, 1H), 7.48 (s, 1H), 7.75 (dd, J = 6.4, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.7, 78.8, 87.1, 113.8, 123.0, 125.2, 127.3, 128.2, 129.3, 129.8, 132.3, 134.4,

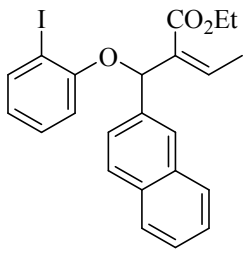
139.5, 139.6, 141.5, 155.9, 166.2; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}ClIO_3^+$ (M^+) 455.9984, Found 455.9984.



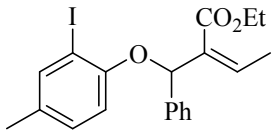
Compound 1j: 92% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, J = 7.2 Hz, 3H), 2.05 (d, J = 7.2 Hz, 3H), 4.23 (q, J = 7.2 Hz, 2H), 6.14 (s, 1H), 6.45 (q, J = 7.2 Hz, 1H), 6.66 - 6.74 (m, 2H), 7.18 (t, J = 7.2 Hz, 1H), 7.35 (d, J = 7.2 Hz, 2H), 7.46 (d, J = 8.4 Hz, 2H), 7.55 (d, J = 8.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.8, 60.8, 78.8, 87.1, 113.7, 122.0, 123.0, 128.9, 129.3, 131.7, 132.3, 138.3, 139.3, 139.5, 155.8, 166.3; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}BrIO_3^+$ (M^+) 499.9479, Found 499.9485.



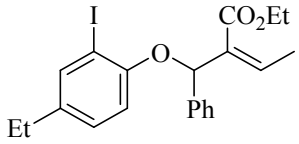
Compound 1k: 91% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, J = 6.8 Hz, 3H), 2.05 (d, J = 7.2 Hz, 3H), 4.23 (q, J = 7.2 Hz, 2H), 6.16 (s, 1H), 6.44 (q, J = 7.2 Hz, 1H), 6.67 (t, J = 7.6 Hz, 1H), 6.74 (d, J = 8.0 Hz, 1H), 7.03 (t, J = 8.0 Hz, 2H), 7.18 (t, J = 8.4 Hz, 1H), 7.42 - 7.46 (m, 2H), 7.75 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.7, 78.9, 87.1, 113.7, 115.4 (d, J = 21.4 Hz), 122.9, 128.9 (d, J = 8.2 Hz), 129.3, 132.6, 135.0 (d, J = 3.2 Hz), 138.8, 139.5, 155.9, 162.4 (d, J = 245.0 Hz), 166.3; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}FIO_3^+$ (M^+) 440.0279, Found 440.0287.



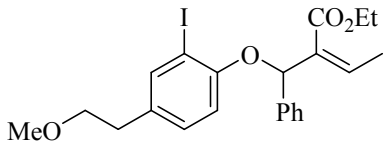
Compound 1l: 90% yield; Colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.22 (t, J = 7.2 Hz, 3H), 2.03 (d, J = 7.2 Hz, 3H), 4.22 (q, J = 7.2 Hz, 2H), 6.35 (s, 1H), 6.43 (q, J = 7.2 Hz, 1H), 6.62 (t, J = 7.6 Hz, 1H), 6.80 (d, J = 8.0 Hz, 1H), 7.12 (t, J = 7.2 Hz, 1H), 7.45 (d, J = 4.0 Hz, 2H), 7.56 (d, J = 8.4 Hz, 1H), 7.72 - 7.83 (m, 4H), 7.93 (s, 1H);^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.3, 15.8, 60.7, 79.9, 87.2, 113.9, 122.8, 124.9, 126.3, 126.5, 127.8, 128.2, 128.5, 129.3 132.9, 133.0, 133.1, 133.2, 136.5, 139.3, 139.5, 156.3, 166.5; HRMS (TOF EI): m/z calcd for $C_{23}H_{21}IO_3^+$ (M^+) 472.0530, Found 472.0534.



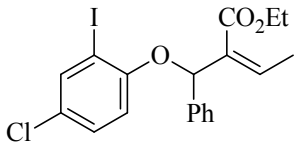
Compound 1m: 96% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, J = 7.2 Hz, 3H), 2.03 (d, J = 7.6 Hz, 3H), 2.20 (s, 3H), 4.22 (q, J = 7.2 Hz, 2H), 6.14 (s, 1H), 6.41 (q, J = 7.2 Hz, 1H), 6.63 (d, J = 8.4 Hz, 1H), 6.95 (dd, J = 8.4, 1.6 Hz, 1H), 7.27 (d, J = 7.2 Hz, 1H), 7.34 (t, J = 6.8 Hz, 2H), 7.45 (d, J = 7.2 Hz, 2H), 7.57 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 20.0, 60.6, 79.5, 86.9, 113.4, 127.2, 127.9, 128.5, 129.7, 132.2, 133.0, 138.7, 139.3, 139.7, 154.1, 166.5; HRMS (TOF EI): m/z calcd for $C_{20}H_{21}IO_3^+$ (M^+) 436.0530, Found 436.0536.



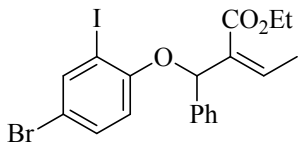
Compound 1n: 95% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.15 (t, J = 7.6 Hz, 3H), 1.25 (t, J = 7.2 Hz, 3H), 2.03 (d, J = 7.2 Hz, 3H), 2.50 (q, J = 7.6 Hz, 2H), 4.22 (q, J = 7.2 Hz, 2H), 6.41 (s, 1H), 6.40 (q, J = 7.2 Hz, 1H), 6.66 (d, J = 8.4 Hz, 1H), 6.98 (dd, J = 2.0, 8.4 Hz, 1H), 7.28 (d, J = 7.2 Hz, 1H), 7.34 (t, J = 7.2 Hz, 2H), 7.46 (d, J = 7.2 Hz, 2H), 7.58 (d, J = 2.0 Hz, 1H);^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.6, 15.7, 27.5, 60.6, 79.5, 87.0, 113.5, 127.2, 127.9, 128.5, 128.6, 133.0, 138.63, 138.67 138.7, 139.3, 154.3, 166.5; HRMS (TOF EI): m/z calcd for $C_{21}H_{23}IO_3^+$ (M^+) 450.0686, Found 450.0694.



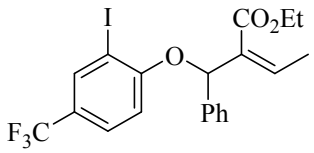
Compound 1o: 93% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.24 (t, J = 7.2 Hz, 3H), 2.02 (d, J = 7.2 Hz, 3H), 2.74 (t, J = 7.0 Hz, 2H), 3.32 (s, 3H), 3.51 (t, J = 7.0 Hz, 2H), 4.23 (q, J = 7.2 Hz, 2H), 6.14 (s, 1H), 6.38 (q, J = 7.2 Hz, 1H), 6.66 (t, J = 8.4 Hz, 1H), 7.01 (dd, J = 8.4, 1.6 Hz, 1H), 7.28 (t, J = 7.2 Hz, 1H), 7.34 (t, J = 6.8 Hz, 2H), 7.45 (d, J = 7.2 Hz, 2H), 7.61 (d, J = 2.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 34.7, 58.7, 60.6, 73.4, 79.5, 87.0, 113.4, 127.1, 127.9, 128.5, 129.6, 133.0, 133.4, 138.8, 139.2, 139.5, 154.7, 166.5; HRMS (TOF EI): m/z calcd for $C_{22}H_{25}IO_4^+$ (M^+) 480.0792, Found 480.0800.



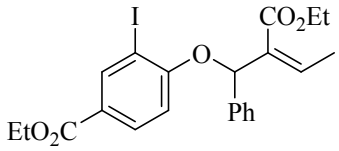
Compound 1p: 90% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, J = 7.6 Hz, 3H), 2.03 (d, J = 7.2 Hz, 3H), 4.23 (q, J = 7.2 Hz, 2H), 6.14 (s, 1H), 6.35 (q, J = 7.2 Hz, 1H), 6.66 (d, J = 8.8 Hz, 1H), 7.13 (dd, J = 8.8, 2.8 Hz, 1H), 7.29 (d, J = 7.2 Hz, 1H), 7.35 (d, J = 7.2Hz, 2H), 7.43 (d, J = 6.8 Hz, 2H), 7.71 (d, J = 2.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.3, 15.7, 60.7, 80.0, 87.2, 114.2, 126.6, 127.1, 128.2, 128.6, 129.0, 132.7, 138.5, 138.6, 139.1, 155.1, 166.4; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}ClIO_3^+$ (M^+) 455.9984, Found 455.9984.



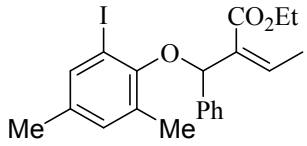
Compound 1q: 89% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.25 (t, J = 6.8 Hz, 3H), 2.03 (d, J = 7.2 Hz, 3H), 4.23 (q, J = 6.8 Hz, 2H), 6.14 (s, 1H), 6.34 (q, J = 7.2 Hz, 1H), 6.62 (d, J = 8.8 Hz, 1H), 7.27 - 7.37 (m, 2H), 7.35 (t, J = 7.2 Hz, 2H), 7.43 (d, J = 6.8 Hz, 2H), 7.85 (d, J = 2.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.7, 79.9, 87.8, 113.7, 114.7, 127.1, 128.2, 128.6, 132.0, 132.6, 138.5, 139.2, 141.1, 155.5, 166.4; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}BrIO_3^+$ (M^+) 499.9479, Found 499.9491.



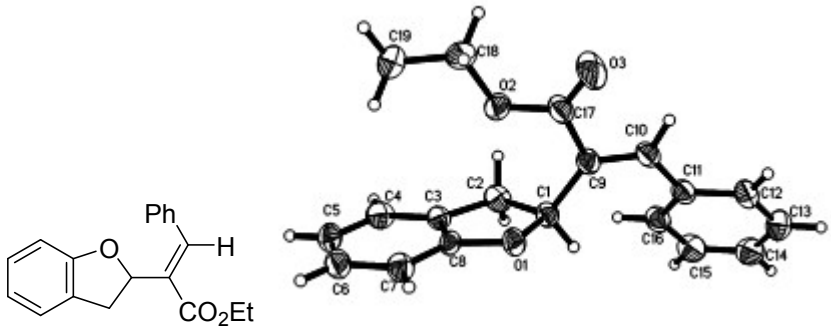
Compound 1r: 86% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.26 (t, J = 7.2 Hz, 3H), 2.04 (d, J = 7.2 Hz, 3H), 4.24 (q, J = 7.2 Hz, 2H), 6.24 (s, 1H), 6.33 (q, J = 7.2 Hz, 1H), 6.80 (d, J = 8.8 Hz, 1H), 7.31 (d, J = 6.8 Hz, 1H), 7.37 (d, J = 7.2 Hz, 2H), 7.44 (d, J = 6.8 Hz, 3H), 7.37 (d, J = 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2, 15.7, 60.8, 80.1, 86.6, 113.0, 115.8, 123.2 (q, J = 270.6 Hz), 124.7 (q, J = 32.7 Hz), 126.8 (q, J = 4.0 Hz), 128.2, 128.7, 132.5, 136.5 (q, J = 4.1 Hz), 138.2, 139.4, 158.7, 166.3; HRMS (TOF EI): m/z calcd for $C_{20}H_{18}F_3IO_3^+$ (M^+) 490.0247, Found 490.0258.



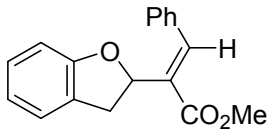
Compound 1s: 82% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.32 - 1.39 (m, 6H), 1.93 (d, J = 7.6 Hz, 3H), 4.27 - 4.37 (m, 4H), 6.69 (s, 1H), 6.89 (d, J = 8.4 Hz, 1H), 7.16 (q, J = 7.6 Hz, 1H), 7.30 (t, J = 7.2 Hz, 1H), 7.38 (t, J = 7.2 Hz, 2H), 7.57 (d, J = 8.0 Hz, 2H), 7.96 (dd, J = 8.4, 2.0 Hz, 1H), 8.48 (d, J = 2.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.3, 14.4, 15.5, 61.0, 61.3, 75.8, 85.6, 112.0, 124.8, 125.9, 127.5, 128.4, 131.5, 131.6, 139.1, 141.1, 144.8, 159.4, 165.0, 166.8; HRMS (TOF EI): m/z calcd for $C_{22}H_{23}IO_5^+$ (M^+) 494.0585, Found 494.0584.



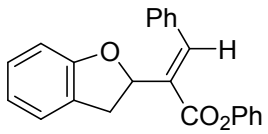
Compound 1t: 85% yield; Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.95 (t, J = 7.2 Hz, 3H), 1.67 (s, 3H), 2.09 - 2.12 (m, 6H), 3.88 - 3.94 (m, 2H), 5.75 (s, 1H), 6.72 - 6.74 (m, 2H), 7.17-7.18 (m, 5H), 7.36 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.9, 15.6, 17.3, 20.1, 60.0, 83.6, 92.0, 127.9, 128.0, 128.3, 132.0, 132.1, 132.9, 135.1, 137.9, 139.3, 139.8, 153.6, 166.0; HRMS (TOF EI): m/z calcd for $C_{21}H_{23}INaO_3^+$ ([M+Na]$^+$) 473.0584, Found 473.0584.



(*E*)-ethyl -2-(2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2a): 88% yield; White solid; M.p.: 75-76 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.41-7.35 (m, 5H), 7.15 (d, J = 7.4 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.83 (t, J = 7.6 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 5.81 (dd, J = 10.4, 8.8 Hz, 1H), 4.17-4.09 (m, 2H), 3.52 (dd, J = 15.2, 8.8 Hz, 1H), 3.42 (dd, J = 15.2, 10.4 Hz, 1H), 0.97 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 159.8, 142.5, 134.4, 131.9, 129.2, 129.0, 128.6, 127.8, 127.3, 124.4, 120.2, 109.0, 77.6, 60.8, 35.9, 13.6; IR (neat): 3019, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{18}O_3^+$ (M^+) 294.1250, Found 294.1254.

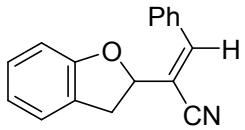


(*E*)-methyl-2-(2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2b): 86% yield; White solid; M.p.: 91-92 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.43-7.35 (m, 5H), 7.16 (dd, J = 6.8, 0.4 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.84 (td, J = 7.6, 0.4 Hz, 1H), 6.75 (d, J = 8.0 Hz, 1H), 5.79 (dd, J = 10.0, 9.0 Hz, 1H), 3.71 (s, 3H), 3.56 (dd, J = 15.2, 9.0 Hz, 1H), 3.38 (dd, J = 15.2, 10.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 159.6, 143.0, 134.3, 131.2, 129.2, 129.1, 128.6, 127.8, 127.2, 124.5, 120.3, 109.1, 77.8, 51.9, 35.7; IR (neat): 3019, 1717, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{18}H_{16}O_3^+$ (M^+) 280.1094, Found 280.1098.

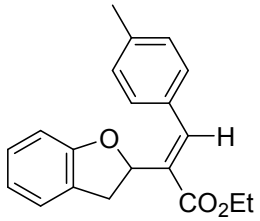


(*E*)-phenyl-2-(2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2c): 70% yield; White solid; M.p.: 149-150 °C ; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (s, 1H), 7.46-7.40

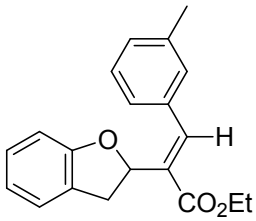
(m, 5H), 7.34-7.30 (m, 2H), 7.21-7.15 (m, 2H), 7.09 (t, J = 8.0 Hz, 1H), 7.01-6.99 (m, 2H), 6.84-6.76 (m, 2H), 5.90 (dd, J = 10.4, 8.8 Hz, 1H), 3.69 (dd, J = 15.2, 8.8 Hz, 1H), 3.49 (dd, J = 15.2, 10.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.7, 159.6, 150.6, 144.2, 134.1, 131.1, 129.4, 129.3, 129.3, 128.7, 127.9, 127.1, 125.7, 124.6, 121.4, 120.4, 109.1, 77.6, 35.8; IR (neat): 3019, 1215, 756, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{23}H_{18}O_3^+$ (M^+) 342.1250, Found 342.1259.



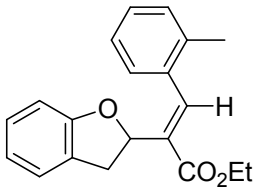
(*Z*)-2-(2,3-dihydrobenzofuran-2-yl)-3-phenylacrylonitrile (2d): 76% yield; White solid; M.p.: 93-94 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79-7.77 (m, 2H), 7.43-7.42 (m, 3H), 7.28 (s, 1H), 7.20-7.15 (m, 2H), 6.93-6.87 (m, 2H), 5.41 (t, J = 9.2 Hz, 1H), 3.56 (dd, J = 15.4, 9.2 Hz, 1H), 3.38 (dd, J = 15.4, 9.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.8, 144.2, 132.7, 130.9, 129.2, 129.0, 128.5, 125.3, 125.0, 121.5, 116.6, 111.3, 109.6, 82.5, 35.7; IR (neat): 3019, 1478, 1215, 758, 690, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{17}H_{13}NO^+$ (M^+) 247.0992, Found 247.1001.



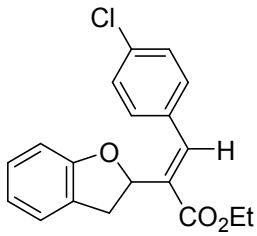
(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(p-tolyl)acrylate (2e): 82% yield; White solid; M.p.: 77-78 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.26 (d, J = 8.0 Hz, 2H), 7.20 (d, J = 8.0 Hz, 2H), 7.14 (d, J = 7.2 Hz, 1H), 7.09 (t, J = 7.6 Hz, 1H), 6.82 (t, J = 7.2 Hz, 1H), 6.73 (d, J = 7.6 Hz, 1H), 5.84 (dd, J = 10.4, 8.4 Hz, 1H), 4.16-4.08 (m, 2H), 3.51 (dd, J = 15.2, 8.4 Hz, 1H), 3.40 (dd, J = 15.2, 10.4 Hz, 1H), 2.37 (s, 3H), 0.97 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 159.8, 142.7, 139.3, 131.5, 131.1, 129.3, 129.2, 127.8, 127.4, 124.4, 120.2, 109.0, 77.6, 60.7, 35.9, 21.3, 13.6; IR (neat): 3019, 1705, 1481, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{20}H_{20}O_3$ (M^+) 308.1407, Found 308.1415.



(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(m-tolyl)acrylate (2f): 79% yield; White solid; M.p.: 85-86 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.30 (t, J = 7.6 Hz, 1H), 7.19-7.15 (m, 4H), 7.10 (t, J = 8.0 Hz, 1H), 6.83 (td, J = 7.2, 0.8 Hz, 1H), 6.74 (d, J = 8.0 Hz, 1H), 5.83 (dd, J = 10.4, 8.4 Hz, 1H), 4.16-4.10 (m, 2H), 3.51 (dd, J = 15.2, 8.4 Hz, 1H), 3.42 (dd, J = 15.2, 10.4 Hz, 1H), 2.36 (s, 3H), 0.98 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 159.8, 142.8, 138.2, 134.4, 131.6, 129.9, 129.8, 128.4, 127.8, 127.4, 126.3, 124.4, 120.2, 109.0, 77.6, 60.8, 35.9, 21.4, 13.56; IR (neat): 3019, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{20}H_{20}O_3^+$ (M^+): 308.1407, Found 308.1408.

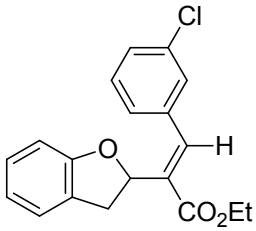


(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(*o*-tolyl)acrylate (2g): 75% yield; White solid; M.p.: 86-87 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (s, 1H), 7.29-7.06 (m, 6H), 6.81 (td, J = 7.6, 0.8 Hz, 1H), 6.71 (d, J = 7.6 Hz, 1H), 5.64 (dd, J = 10.4, 8.4 Hz, 1H), 4.19-4.08 (m, 2H), 3.50 (dd, J = 15.2, 8.4 Hz, 1H), 3.37 (dd, J = 15.2, 10.4 Hz, 1H), 2.35 (s, 3H), 0.96 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.3, 159.8, 142.3, 137.0, 133.8, 132.2, 130.2, 129.0, 128.9, 127.8, 127.4, 125.8, 124.4, 120.2, 109.0, 77.8, 60.8, 35.9, 20.1, 13.5; IR (neat): 3019, 2399, 1701, 1470, 760 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{20}H_{20}O_3^+$ (M^+): 308.1407, Found 308.1413.

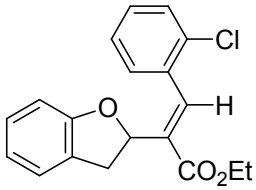


(*E*)-ethyl-3-(4-chlorophenyl)-2-(2,3-dihydrobenzofuran-2-yl)acrylate (2h): 76% yield; White solid; M.p.: 88-89 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (s, 1H), 7.37

(d, J = 8.0 Hz, 2H), 7.26 (d, J = 8.0 Hz, 2H), 7.16-7.08 (m, 2H), 6.84 (t, J = 7.2 Hz, 1H), 6.72 (d, J = 8.0 Hz, 1H), 5.74 (t, J = 9.6 Hz, 1H), 4.16-4.11 (m, 2H), 3.49 (dd, J = 15.2, 9.6 Hz, 1H), 3.41 (dd, J = 15.2, 9.6 Hz, 1H), 0.99 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 159.7, 141.1, 135.1, 132.9, 132.5, 130.5, 128.8, 127.9, 127.1, 124.4, 120.4, 109.1, 77.4, 60.9, 35.9, 13.6; IR (neat): 3019, 1717, 1481, 1215, 1015, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}ClO_3^+$ (M^+) 328.0861, Found 328.0869.

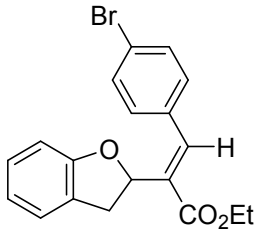


(*E*)-ethyl-3-(3-chlorophenyl)-2-(2,3-dihydrobenzofuran-2-yl)acrylate (2i): 81% yield; White solid; M.p.: 91-92 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.33-7.32 (m, 3H), 7.24-7.21 (m, 1H), 7.15 (d, J = 7.6 Hz, 1H), 7.09 (t, J = 8.0 Hz, 1H), 6.83 (t, J = 7.2 Hz, 1H), 6.72 (d, J = 8.0 Hz, 1H), 5.73 (dd, J = 10.4, 8.4 Hz, 1H), 4.18-4.10 (m, 2H), 3.50 (dd, J = 15.2, 8.4 Hz, 1H), 3.42 (dd, J = 15.2, 10.4 Hz, 1H), 0.99 (t, J =7 .2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.1, 159.7, 140.6, 136.2, 134.6, 133.3, 129.8, 129.1, 129.0, 127.9, 127.2, 127.1, 124.5, 120.4, 109.1, 77.4, 61.0, 36.0, 13.6; IR (neat): 3019, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}ClO_3^+$ (M^+) 328.0861, Found 328.0870.

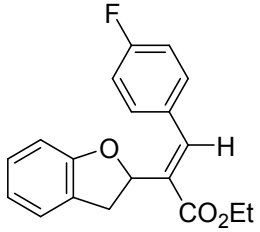


(*E*)-ethyl-3-(2-chlorophenyl)-2-(2,3-dihydrobenzofuran-2-yl)acrylate (2j): 85% yield; White solid; M.p.: 76-77 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.32-7.24 (m, 3H), 7.13 (d, J = 7.2 Hz, 1H), 7.07 (t, J = 8.0 Hz, 1H), 6.82 (t, J = 7.2 Hz, 1H), 6.69 (d, J = 8.0 Hz, 1H), 5.62 (dd, J = 10.4, 8.4 Hz, 1H), 4.19-4.13 (m, 2H), 3.49 (dd, J = 15.2, 8.4 Hz, 1H), 3.34 (dd, J = 15.2, 10.4 Hz, 1H), 1.02 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 159.7, 139.8, 134.1,

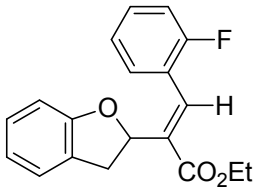
133.3, 133.2, 130.4, 130.1, 129.7, 127.8, 127.2, 126.6, 124.4, 120.3, 109.0, 77.9, 61.0, 35.8, 13.6; IR (neat): 3019, 1215, 756, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}ClO_3^+$ (M^+) 328.0861, Found 328.0866.



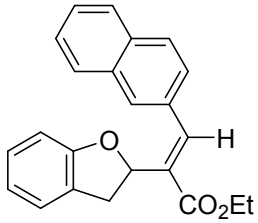
(*E*)-ethyl-3-(4-bromophenyl)-2-(2,3-dihydrobenzofuran-2-yl)acrylate (2k): 70% yield; White solid. M.p.: 90-91 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.80 (s, 1H), 7.53 (d, J = 8.4 Hz, 2H), 7.22 (d, J = 8.4 Hz, 2H), 7.15 (d, J = 7.2 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.84 (td, J = 7.6, 0.8 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 5.74 (dd, J = 8.4 Hz, 1H), 4.16-4.10 (m, 2H), 3.49 (dd, J = 15.2, 8.4 Hz, 1H), 3.41 (dd, J = 15.2, 10.4 Hz, 1H), 0.98 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 159.6, 141.2, 133.3, 132.5, 131.8, 130.8, 127.9, 127.1, 124.5, 123.4, 120.4, 109.1, 77.4, 61.0, 35.9, 13.6; IR (neat): 3019, 1715, 1636, 1481, 1215, 1011, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}BrO_3^+$ (M^+) 372.0356, Found 372.0359.



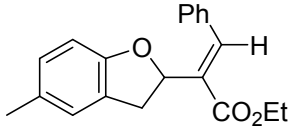
(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(4-fluorophenyl)acrylate (2l): 73% yield; White solid; M.p.: 76-77 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.84 (s, 1H), 7.37-7.33 (m, 2H), 7.15 (d, J = 7.6 Hz, 1H), 7.11-7.07 (m, 3H), 6.84 (t, J = 7.2 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 5.77 (dd, J = 10.4, 8.4 Hz, 1H), 4.16-4.10 (m, 2H), 3.50 (dd, J = 15.2, 8.4 Hz, 1H), 3.41 (dd, J = 15.2, 10.4 Hz, 1H), 0.98 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 163.0 (d, J = 248.9 Hz), 159.7, 141.4, 131.8, 131.3 (d, J = 8.2 Hz), 130.5 (d, J = 3.6 Hz), 127.9, 127.2, 124.5, 120.3, 115.7 (d, J = 22.4 Hz), 109.1, 77.4, 60.9, 35.8, 13.6; IR (neat): 3019, 2357, 1506, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}FO_3^+$ (M^+) 312.1156, Found 312.1161.



(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(2-fluorophenyl)acrylate (2m): 85% yield; White solid; M.p.: 67-68 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.38-7.31 (m, 2H), 7.19-7.07 (m, 4H), 6.83 (td, J = 7.2, 0.8 Hz, 1H), 6.71 (d, J = 7.6 Hz, 1H), 5.68 (t, J = 9.4 Hz, 1H), 4.18-4.12 (m, 2H), 3.52 (dd, J = 15.2, 9.4 Hz, 1H), 3.44 (dd, J = 15.2, 9.4 Hz, 1H), 1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 160.2 (d, J = 248.5 Hz), 159.7, 135.6 (d, J = 2.9 Hz), 133.73, 131.0 (d, J = 8.7 Hz), 130.7 (d, J = 3.9 Hz), 127.8, 127.3, 124.4, 124.1 (d, J = 3.0 Hz), 122.4 (d, J = 14.5 Hz), 120.3, 115.8 (d, J = 21.5 Hz), 109.0, 78.0, 61.0, 35.6, 13.6; IR (neat): 3019, 1717, 1481, 1215, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}FO_3^+$ (M^+): 312.1156, Found 312.1162.

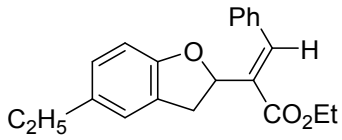


(*E*)-ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-(naphthalen-2-yl)acrylate (2n): 80% yield; White solid; M.p.: 124-125 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (s, 1H), 7.88-7.84 (m, 4H), 7.54-7.46 (m, 3H), 7.17 (d, J = 6.8 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.84 (td, J = 7.6, 0.8 Hz, 1H), 6.75 (d, J = 8.0 Hz, 1H), 5.93 (dd, J = 10.4, 8.4 Hz, 1H), 4.20-4.14 (m, 2H), 3.56 (dd, J = 15.2, 8.4 Hz, 1H), 3.47 (dd, J = 15.2, 10.4 Hz, 1H),1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 159.8, 142.7, 133.2, 132.9, 131.9, 131.8, 129.1, 128.4, 128.2, 127.8, 127.7, 127.3, 127.0, 126.7, 126.5, 124.4, 120.2, 109.1, 77.7, 60.9, 35.9, 13.6; IR (neat): 3019, 1215, 756, 669 cm^{-1}; HRMS (EI): m/z calcd for $C_{23}H_{20}O_3^+$ (M^+) 344.1407, Found 344.1409.

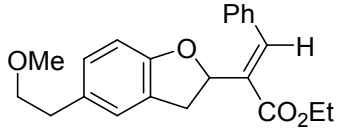


(*E*)-ethyl-2-(5-methyl-2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2o): 75%

yield; White solid; M.p.: 101-102 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.42-7.34 (m, 5H), 6.96 (s, 1H), 6.88 (d, J = 8.4 Hz, 1H), 6.61 (d, J = 8.0 Hz, 1H), 5.78 (dd, J = 10.4, 8.8 Hz, 1H), 4.20-4.09 (m, 2H), 3.49 (dd, J = 15.2, 8.8 Hz, 1H), 3.36 (dd, J = 15.2, 10.4 Hz, 1H), 2.27 (s, 3H), 1.02 (t, J = 6.8 Hz, 3H) ; ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 157.7, 142.3, 134.5, 132.0, 129.4, 129.2, 128.9, 128.5, 128.1, 127.3, 125.0, 108.5, 77.7, 60.8, 36.0, 20.8, 13.7; IR (neat): 3019, 1709, 1493, 1263, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{20}H_{20}O_3^+$ (M^+) 308.1407, Found 308.1408.

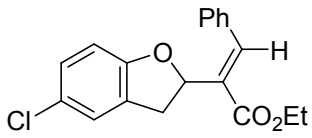


(*E*)-ethyl-2-(5-ethyl-2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2p): 74% yield; White solid; M.p.: 38-39 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (s, 1H), 7.43-7.35 (m, 5H), 6.99 (s, 1H), 6.91 (d, J = 8.4 Hz, 1H), 6.64 (d, J = 8.0 Hz, 1H), 5.79 (dd, J = 10.4, 8.4 Hz, 1H), 4.18-4.10 (m, 2H), 3.50 (dd, J = 15.2, 8.4 Hz, 1H), 3.38 (dd, J = 15.2, 10.4 Hz, 1H), 2.57(q, J = 7.6 Hz, 2H), 1.19 (t, J = 7.6 Hz, 3H), 0.99 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 157.8, 142.4, 136.2, 134.4, 131.9, 129.2, 129.0, 128.5, 127.3, 127.0, 123.9, 108.6, 77.6, 60.8, 36.0, 28.4, 16.3, 13.6; IR (neat): 3053, 2986, 2305, 1711, 1491, 1206, 895, 739 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{21}H_{22}O_3^+$ (M^+) 322.1563, Found 322.1566.

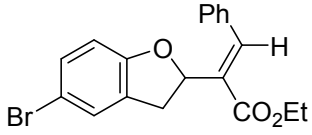


(*E*)-ethyl-2-(5-(2-methoxyethyl)-2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2q): 78% yield; White solid; M.p.: 62-63 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.43-7.35 (m, 5H), 7.02 (s, 1H), 6.94 (d, J = 8.0 Hz, 1H), 6.65 (d, J = 8.0 Hz, 1H), 5.80 (dd, J = 10.4, 8.8 Hz, 1H), 4.18-4.10 (m, 2H), 3.56-3.47 (m, 3H), 3.38 (dd, J = 15.2, 10.4 Hz, 1H), 3.35 (s, 3H), 2.81 (t, J = 7.2 Hz, 2H), 0.98 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 158.4, 142.5, 134.4, 131.8, 130.6, 129.2, 129.0, 128.6, 128.2, 127.5, 124.9, 108.7, 77.7, 74.3, 60.8, 58.6, 35.9, 35.7, 13.6; IR (neat): 3019, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{22}H_{24}O_4^+$(M^+) 352.1669,

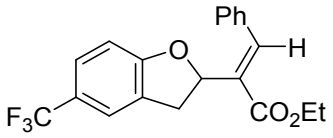
Found 352.1671.



(*E*)-ethyl-2-(5-chloro-2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2r): 75% yield; White solid; M.p.: 111-112 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (s, 1H), 7.44-7.33 (m, 5H), 7.11 (t, J = 0.8 Hz, 1H), 7.06 (dd, J = 8.4. 2.0 Hz, 1H), 6.64 (d, J = 8.4 Hz, 1H), 5.83 (dd, J = 10.4, 8.4 Hz, 1H), 4.18-4.12 (m, 2H), 3.50 (dd, J = 15.2, 8.4 Hz, 1H), 3.40 (dd, J = 15.2, 10.4 Hz, 1H), 1.03 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 158.6, 143.0, 134.2, 131.3, 129.4, 129.2, 129.1, 128.6, 127.7, 124.8, 124.6, 109.8, 78.3, 60.9, 35.8, 13.7; IR (neat): 3019, 1215, 758, 669 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}ClO_3^+$ (M^+) 328.0861, Found 328.0864.

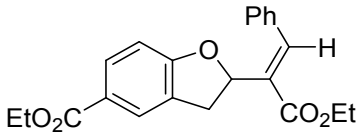


(*E*)-ethyl-2-(5-bromo-2,3-dihydrobenzofuran-2-yl)-3-phenylacrylate (2s): 71% yield; White solid; M.p.: 109-110 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (s, 1H), 7.42-7.33 (m, 5H), 7.25 (s, 1H), 7.19 (dd, J = 8.4, 1.6 Hz, 1H), 6.60 (d, J = 8.4 Hz, 1H), 5.83 (dd, J = 10.4, 8.4 Hz, 1H), 4.18-4.11 (m, 2H), 3.51 (dd, J = 15.2, 8.4 Hz, 1H), 3.40 (dd, J = 15.2, 10.4 Hz, 1H), 1.03 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 159.1, 143.0, 134.2, 131.3, 130.6, 130.0, 129.2, 129.1, 128.6, 127.4, 111.9, 110.5, 78.2, 60.9, 35.7, 13.7; IR (neat): 3019, 1707, 1477, 1215, 756 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{17}BrO_3^+$ (M^+): 372.0356, Found 372.0361.

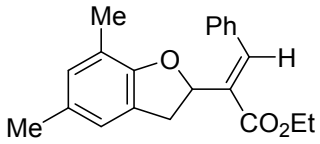


(*E*)-ethyl-3-phenyl-2-(5-(trifluoromethyl)-2,3-dihydrobenzofuran-2-yl)acrylate (2t): 70% yield; White solid; M.p.: 91-92 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.45-7.25 (m, 7H), 6.78 (d, J = 8.0 Hz, 1H), 5.90 (dd, J = 10.4, 8.4 Hz, 1H), 4.20-4.08 (m, 2H), 3.54 (dd, J = 15.6, 8.4 Hz, 1H), 3.46 (dd, J = 15.6, 8.4 Hz, 1H), 0.99 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.1, 162.5, 143.4, 134.2, 131.1, 129.2,

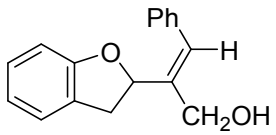
129.1, 128.7, 128.4, 125.9 (q, J = 3.8 Hz), 125.0 (q, J = 300.0 Hz), 123.0 (q, J = 32.0 Hz), 121.8 (q, J = 3.5 Hz), 108.9, 78.6, 61.0, 35.4, 13.6; IR (neat): 3019, 2359, 1717, 1327, 1163, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{20}H_{17}F_3O_3^+$ (M^+): 362.1124, Found 362.1129.



(*E*)-ethyl-2-(3-ethoxy-3-oxo-1-phenylprop-1-en-2-yl)-2,3-dihydrobenzofuran-5-carboxylate (2u): 70% yield; White solid; M.p.: 82-83 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.89-7.87 (m, 2H), 7.45-7.31 (m, 5H), 6.74 (d, J = 8.8 Hz, 1H), 5.91 (dd, J = 10.4, 8.4 Hz, 1H), 4.34 (q, J = 7.2 Hz, 2H), 4.17-4.08 (m, 2H), 3.55-3.42 (m, 2H), 1.38 (t, J = 7.2 Hz, 3H), 0.97 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 166.1, 163.9, 143.2, 134.2, 131.2, 131.0, 129.2, 128.7, 128.0, 126.2, 122.8, 108.6, 78.8, 60.9, 60.6, 35.2, 14.4, 13.6; IR (neat): 3019, 1705, 1275, 1215, 758 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{22}H_{22}O_5^+$ (M^+) 366.1462, Found 366.1465.

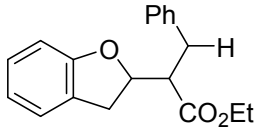


(*E*)-ethyl-3-phenyl-2-(5-(trifluoromethyl)-2,3-dihydrobenzofuran-2-yl)acrylate (2v): 72% yield; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (s, 1H), 7.39-7.35 (m, 5H), 6.80 (s, 1H), 6.71 (s, 1H), 5.77 (dd, J = 10.4, 9.2 Hz, 1H), 4.21-4.08 (m, 2H), 3.51 (dd, J = 15.2, 8.8 Hz, 1H), 3.40 (dd, J = 15.2, 10.4 Hz, 1H), 2.24 (s, 3H), 2.09 (s, 3H), 1.01 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 156.1, 141.8, 134.6, 132.4, 129.5, 129.3, 129.2, 128.9, 128.5, 126.4, 122.3, 118.5, 77.4, 60.7, 36.5, 20.8, 15.3, 13.7; IR (neat): 3018, 2922, 1716, 1483, 1254, 698 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{21}H_{22}NaO_3^+$ ([M+Na]$^+$) 345.1461, Found 345.1442.

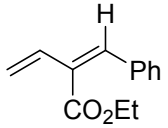


(*Z*)-2-(2,3-dihydrobenzofuran-2-yl)-3-phenylprop-2-en-1-ol (3): 90% yield; White solid; M.p.: 81-82 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.34 (m, 2H), 7.30-7.22 (m,

3H), 7.16 (d, J = 7.6 Hz, 1H), 7.11 (t, J = 7.6 Hz, 1H), 6.88-6.84 (m, 2H), 6.78 (d, J = 8.0 Hz, 1H), 5.75 (t, J = 9.6 Hz, 1H), 4.45 (d, J = 13.2Hz, 1H), 4.29 (d, J = 13.2 Hz, 1H), 3.39 (dd, J = 15.6, 9.6 Hz, 1H), 3.30 (dd, J = 15.6, 9.6 Hz, 1H), 2.14 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.3, 139.6, 136.1, 130.4, 128.7, 128.4, 128.2, 127.4, 126.6, 124.8, 120.9, 109.4, 80.7, 63.2, 35.8; IR (neat): 3053, 2986, 1479, 1265, 895, 739, 704 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{17}H_{16}O_2^+$ (M^+): 252.1145, Found 252.1147.

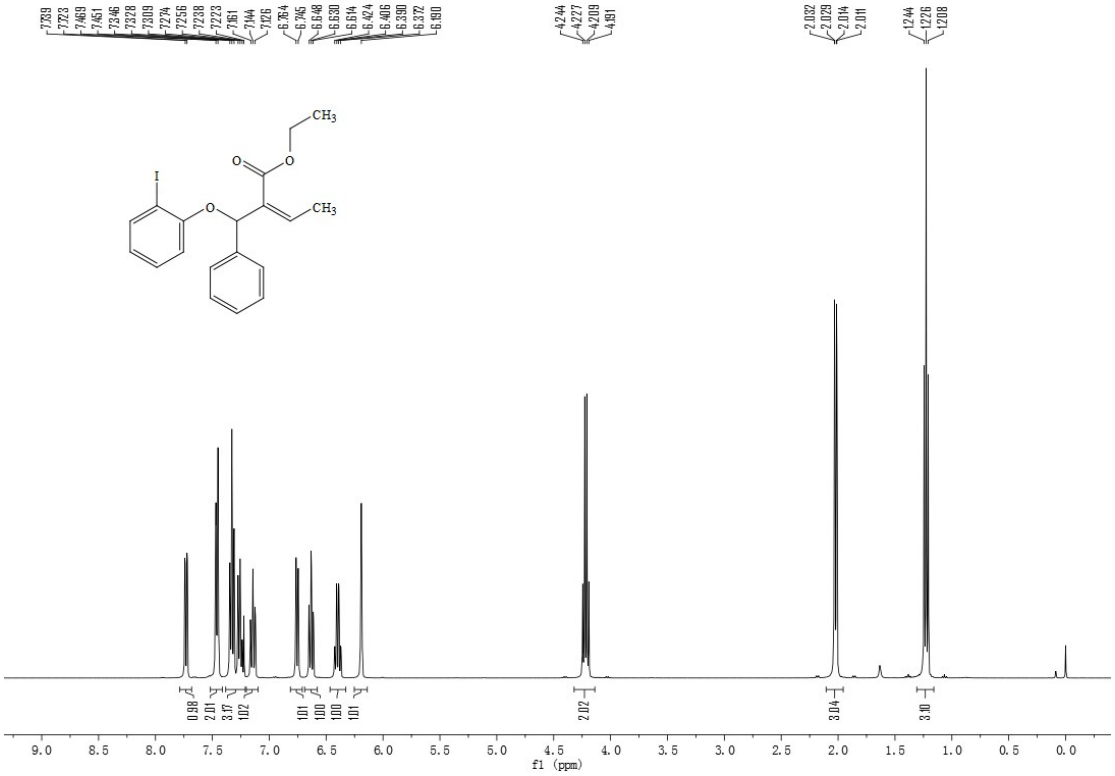


Ethyl-2-(2,3-dihydrobenzofuran-2-yl)-3-phenylpropanoate (4): 75% yield; Colorless liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29-7.25 (m, 2H), 7.20-7.18 (m, 3H), 7.15 (d, J = 7.6 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.83 (t, J = 7.2 Hz, 1H), 6.78 (d, J = 8.0 Hz, 1H), 5.02-4.96 (m, 1H), 4.02 (q, J = 7.2 Hz, 2H), 3.30 (dd, J = 15.6, 9.2 Hz, 1H), 3.11 (dd, J = 15.6, 7.2 Hz, 1H), 3.01-2.90 (m, 3H), 1.04 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.6, 159.3, 138.3, 129.0, 128.5, 128.2, 126.6, 126.1, 124.8, 120.6, 109.6, 82.7, 60.6, 53.1, 34.3, 33.5, 14.0; IR (neat): 3052, 2934, 1732, 1599, 1157, 858, 565 cm^{-1}; HRMS (TOF EI): m/z calcd for $C_{19}H_{20}O_3^+$ (M^+): 296.1407, Found 296.1413.



(*Z*)-ethyl 2-benzylidenebut-3-enoate (5): 82% yield; Colorless liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.43-7.32 (m, 5H), 6.64 (ddd, J = 18.0, 11.6, 0.8 Hz, 1H), 5.86 (dd, J = 18.0, 1.6 Hz, 1H), 5.44 (dt, J = 11.6, 1.2 Hz, 1H), 4.31 (q, J = 7.2 Hz, 2H), 1.37 (t, J = 7.2 Hz, 3H) ; ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.4, 139.1, 135.3, 130.4, 130.0, 129.7, 128.7, 128.3, 120.9, 61.0, 14.3; HRMS (TOF EI): m/z calcd for $C_{13}H_{14}O_2^+$ (M^+): 202.0988, Found 202.0992. *Z* stereochemistry was confirmed by NOESY (δ 7.54 and 6.64).

1a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6.406
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6.190
4.244
4.227
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4.191
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1.244
1.226
1.208
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1.101
1.010
1.000
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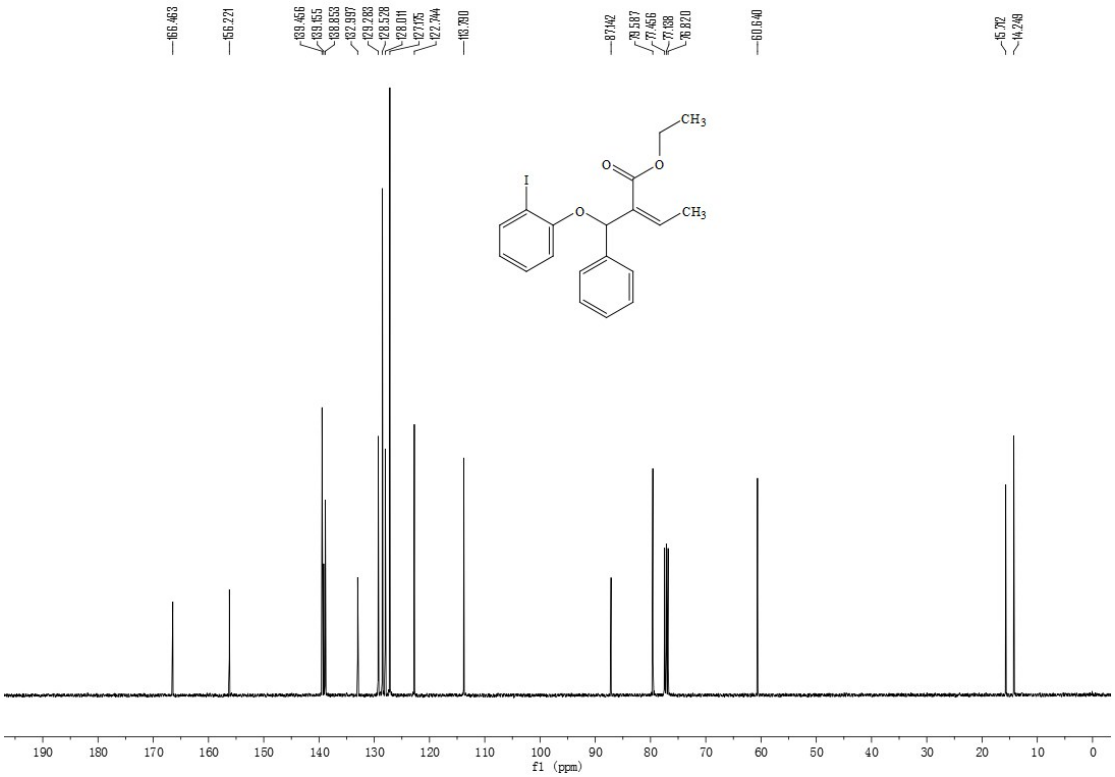
2.012
3.014
3.110
f1 (ppm)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77.466
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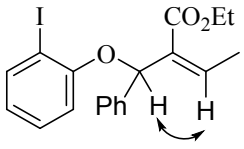
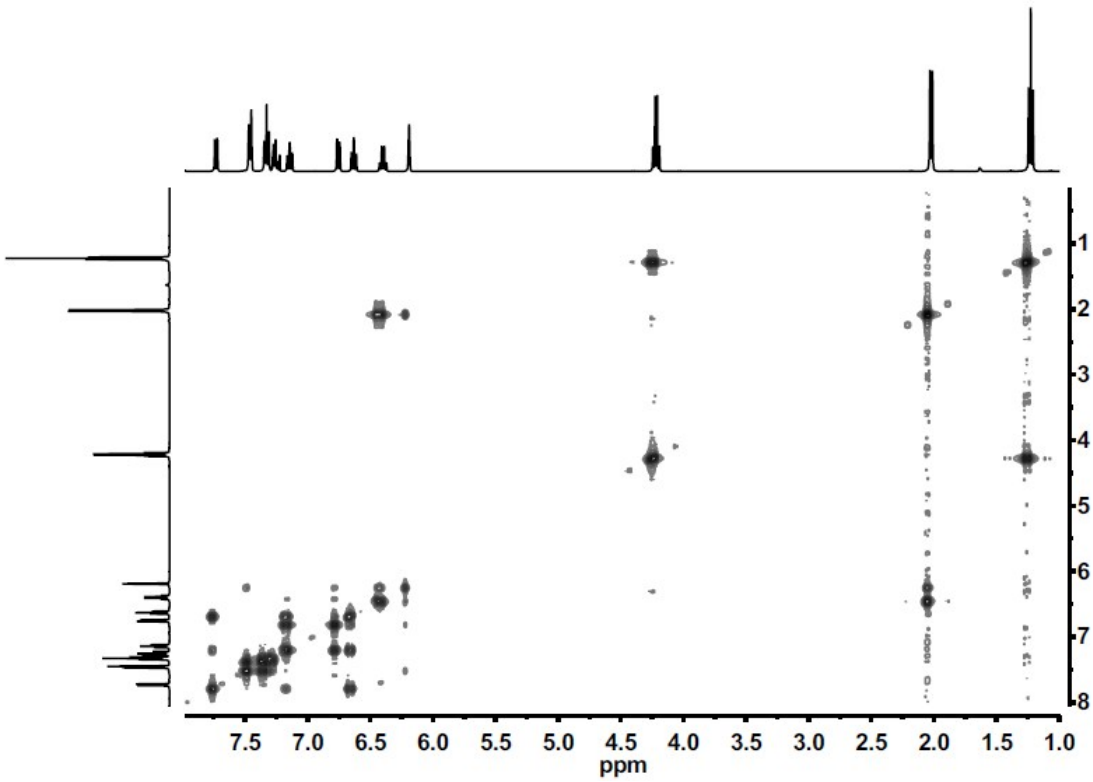
14.248
f1 (ppm)



NOESY (δ 6.40 and 6.19)



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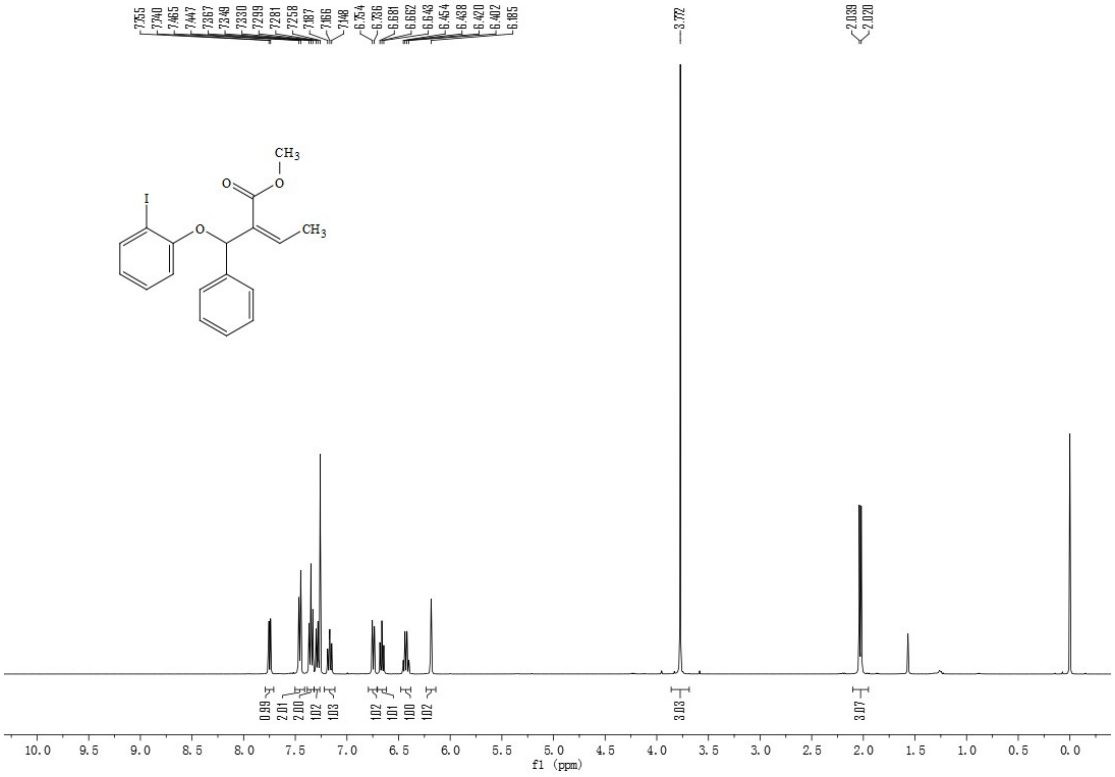
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6.6662
6.6643
6.6454
6.6438
6.6420
6.6402
6.6185
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1.03
1.02
1.01
1.00
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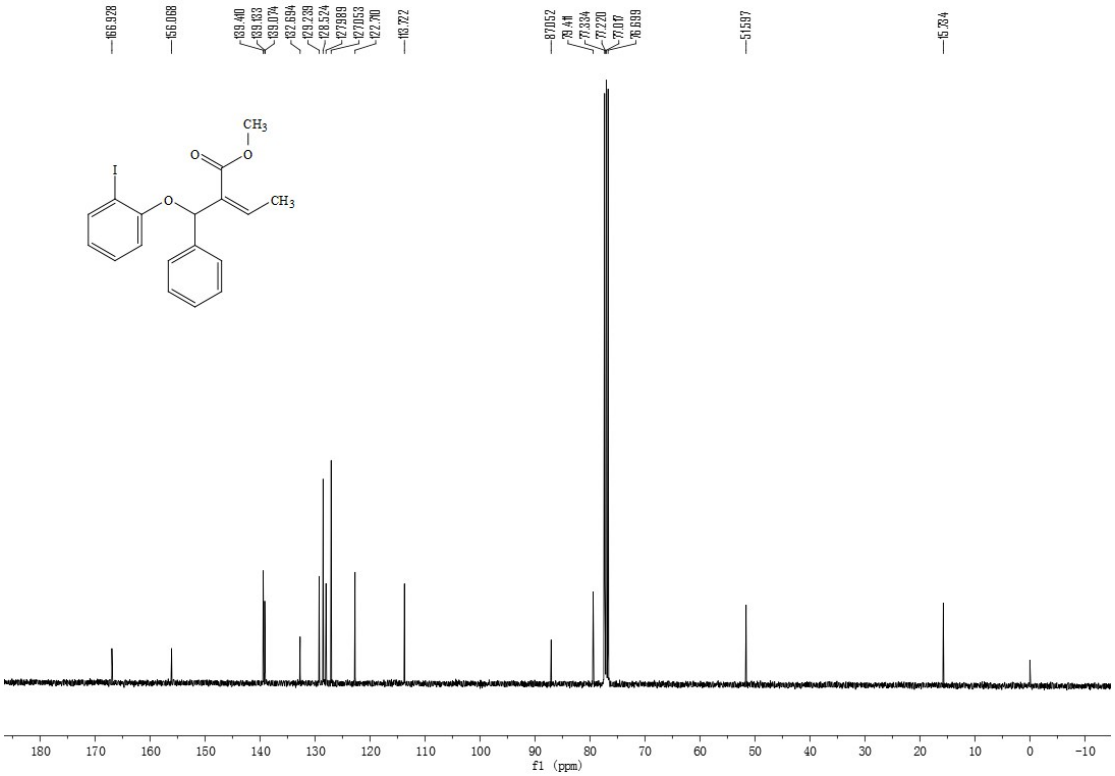
3.07
f1 (ppm)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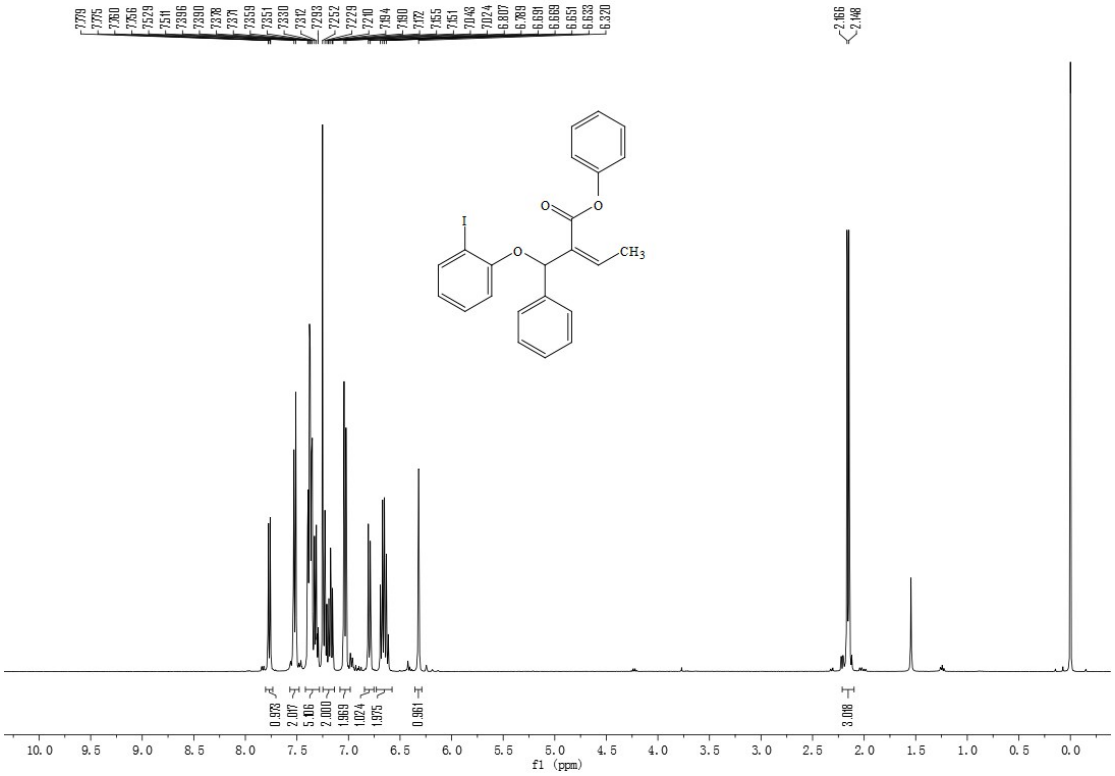
f1 (ppm)

1c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7.330
7.312
7.293
7.252
7.229
7.210
7.194
7.180
7.172
7.155
7.151
7.143
7.024
6.807
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6.668
6.651
6.633
6.320
2.166
2.148
0.978
2.017
5.106
2.000
1.969
1.024
1.975
0.961
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I
O
O
O
CH3
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9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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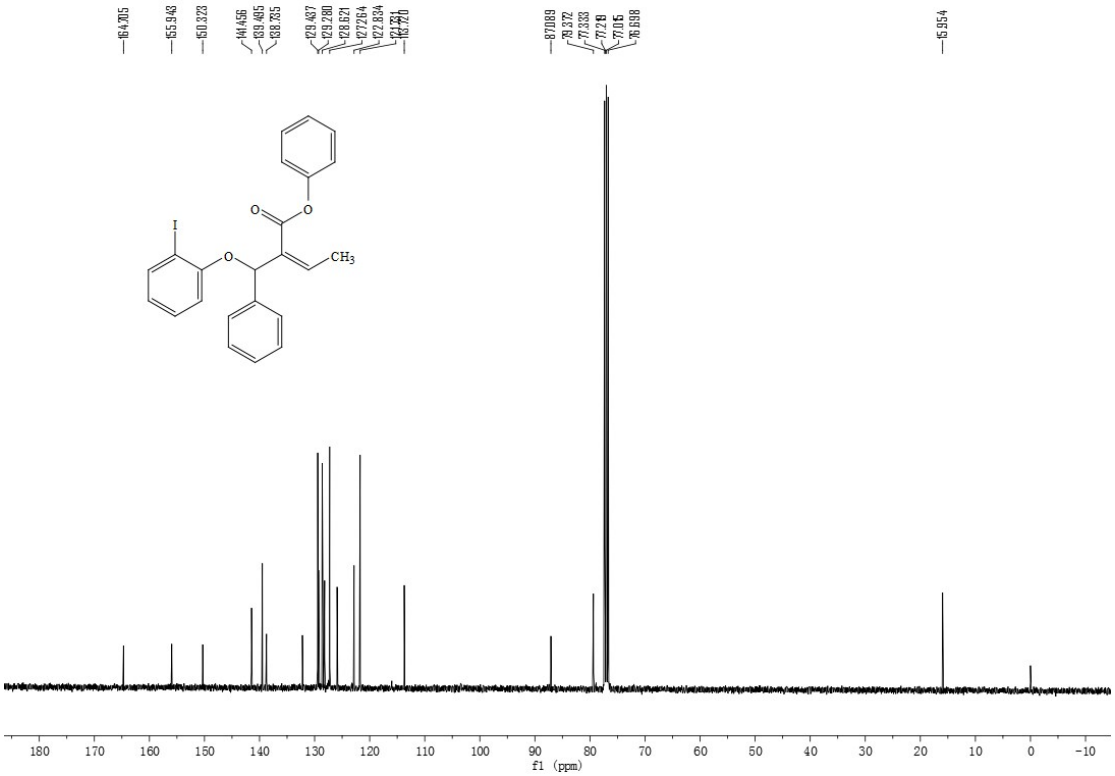
f1 (ppm)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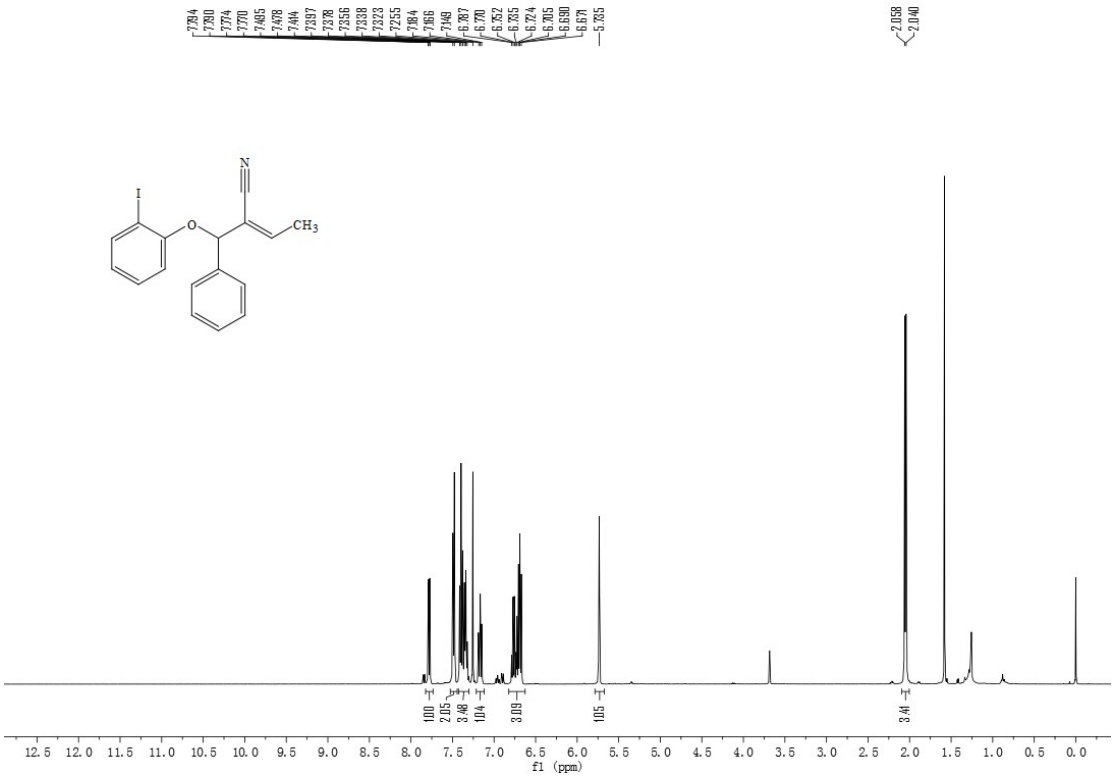
77.228
77.015
76.698
15.954
I
O
O
O
CH3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

1d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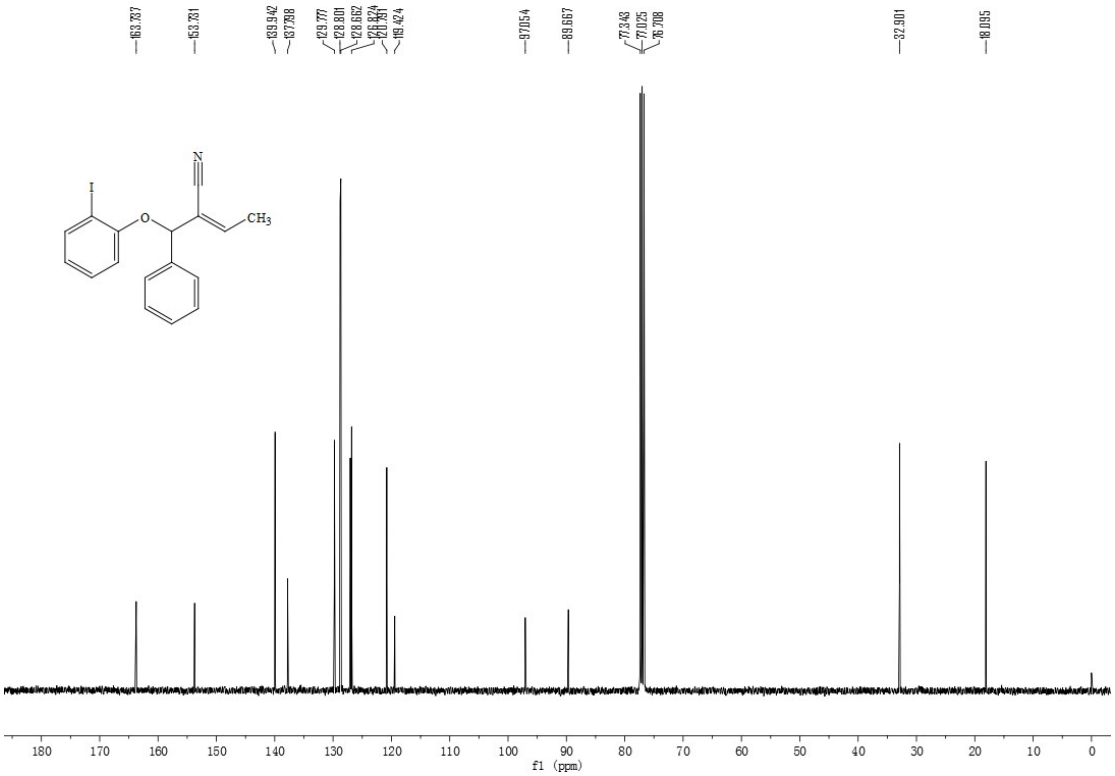
7.7166
7.7148
6.7387
6.7370
6.7352
6.7335
6.7274
6.7255
6.6580
6.6571
5.7335
2.0358
2.0340
N
I
O
CH3
1.00
2.05
3.48
1.04
3.19
1.05
3.41
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.662
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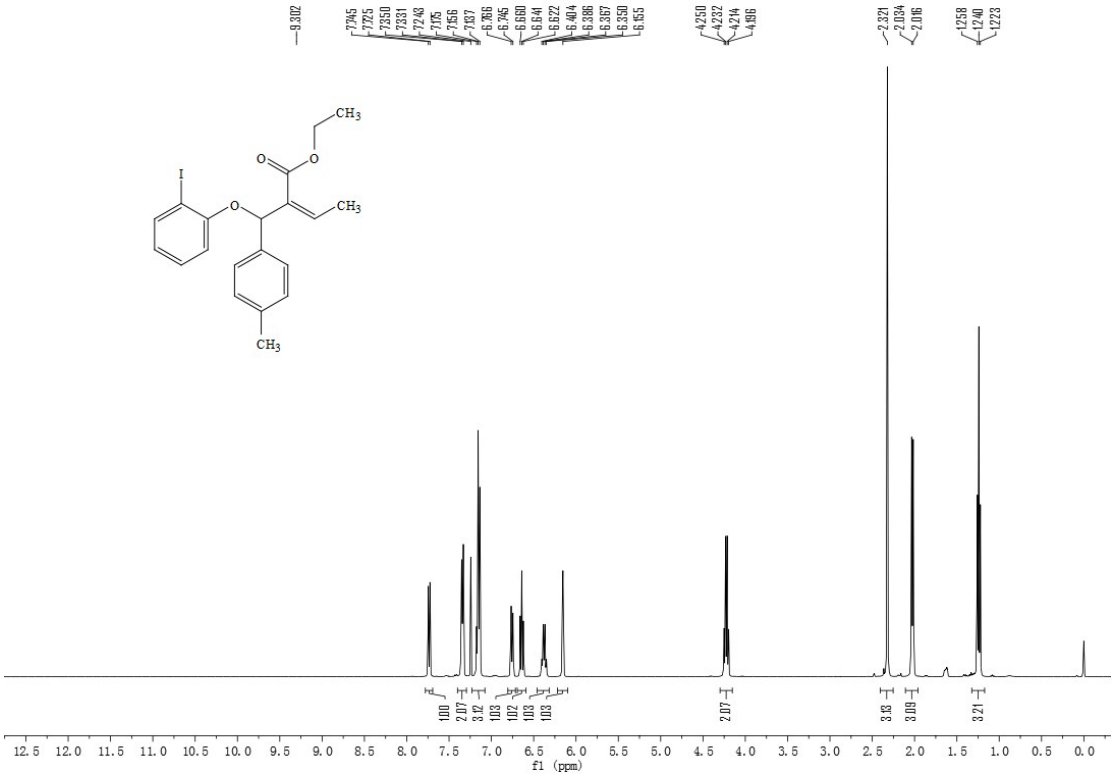
120.781
118.424
97.015
89.667
77.343
77.025
76.708
32.901
18.095
N
I
O
CH3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

1e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6.644
6.622
6.404
6.386
6.367
6.350
6.155
4.250
4.232
4.214
4.196
2.321
2.034
2.016
1.258
1.240
1.223
1.00
2.07
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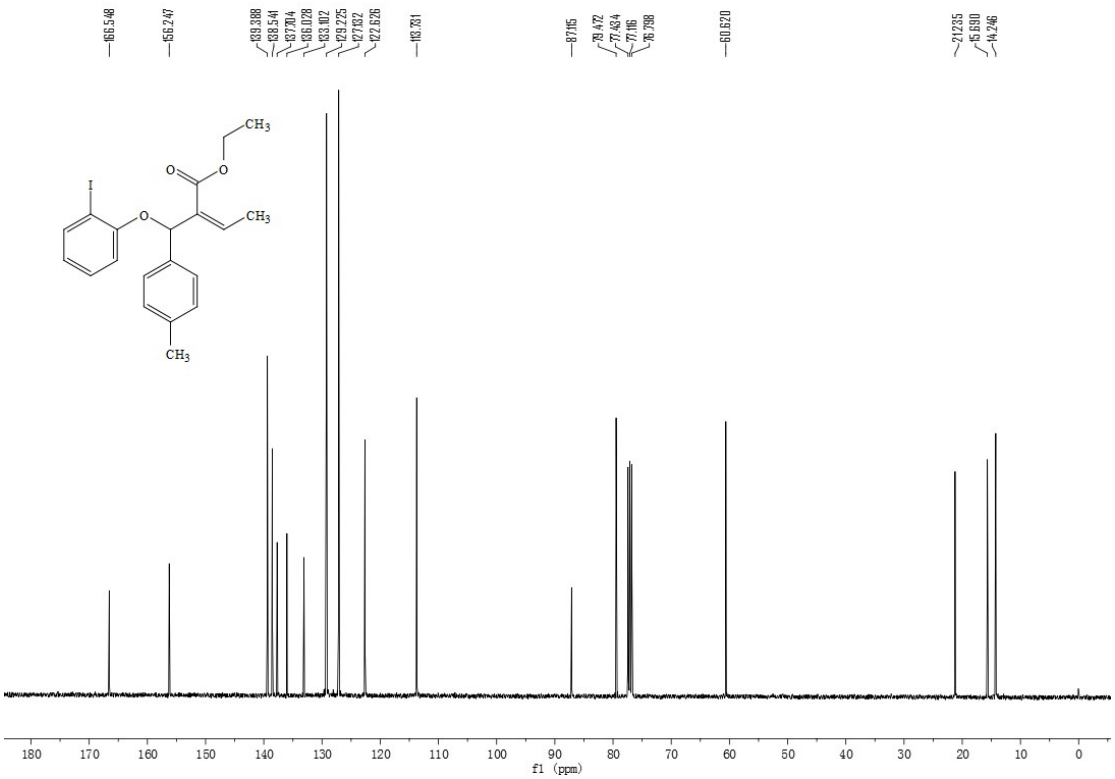
2.07
3.63
3.09
3.21
f1 (ppm)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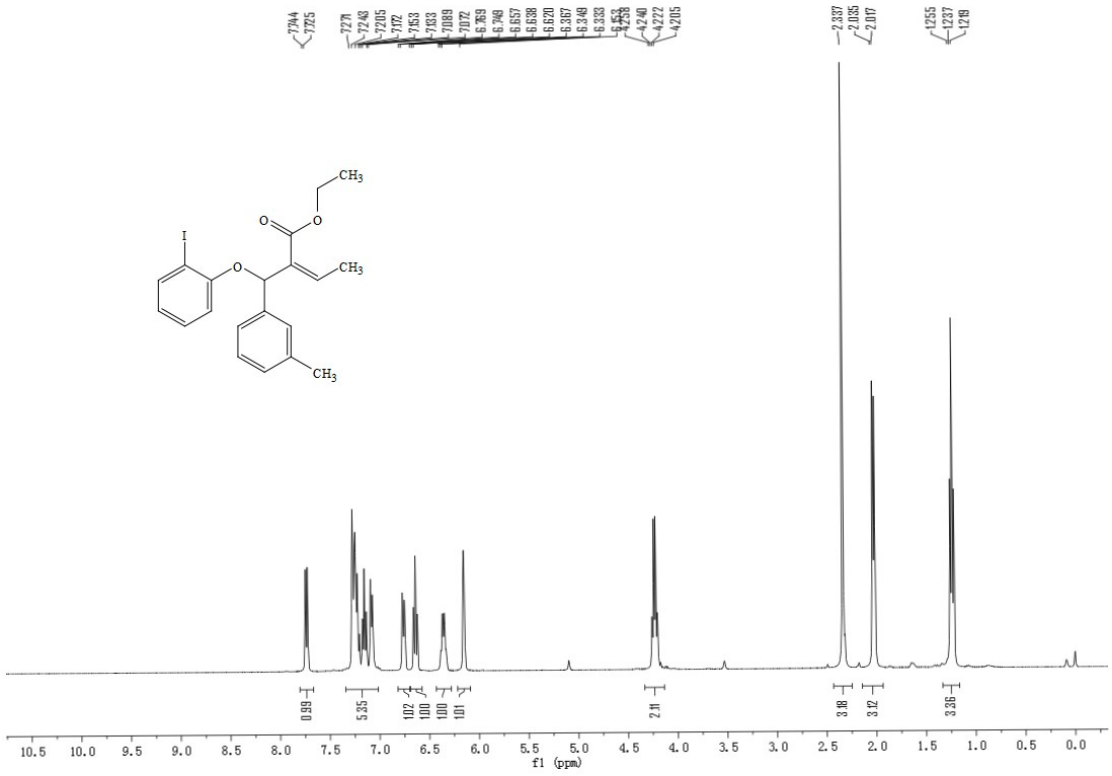
f1 (ppm)

1f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7.133
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7.072
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6.387
6.349
6.333
4.240
4.222
4.205
2.337
2.035
2.017
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1.237
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1.00
1.00
1.01
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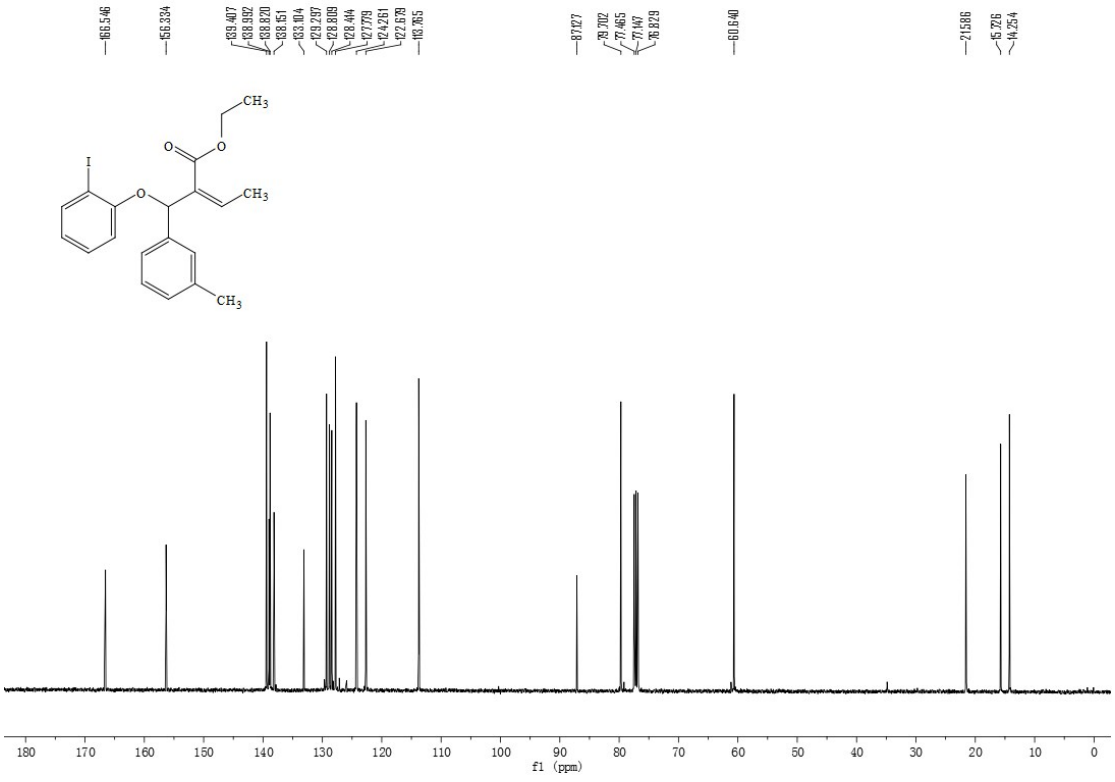
3.18
3.12
3.36
f1 (ppm)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122.878
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77.147
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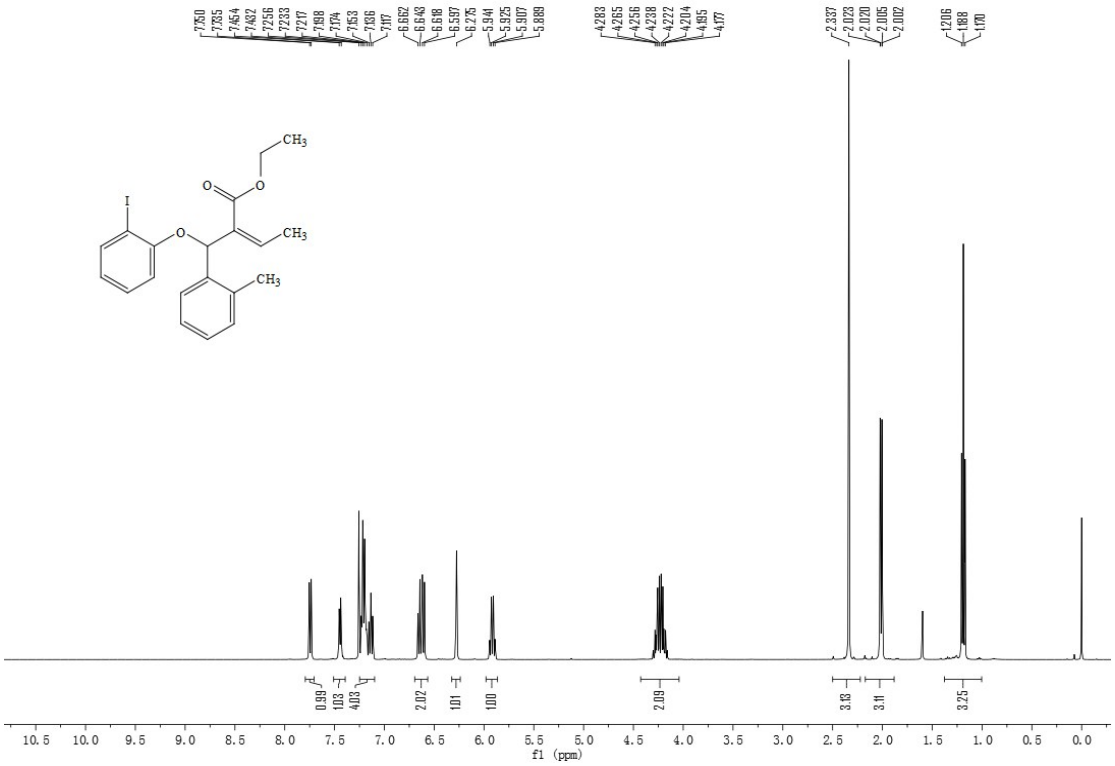
f1 (ppm)

1g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6.618
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5.907
5.888
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4.265
4.256
4.238
4.222
4.204
4.185
4.177
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2.005
2.002
1.206
1.188
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1.00
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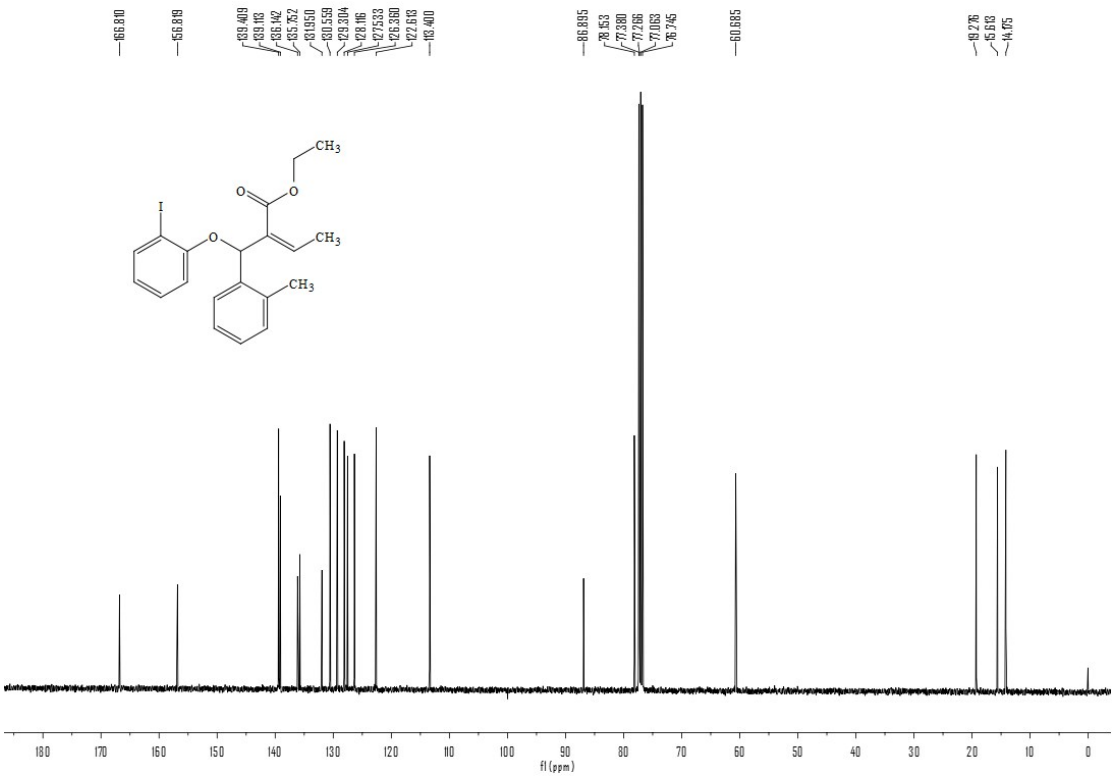
3.25
f1 (ppm)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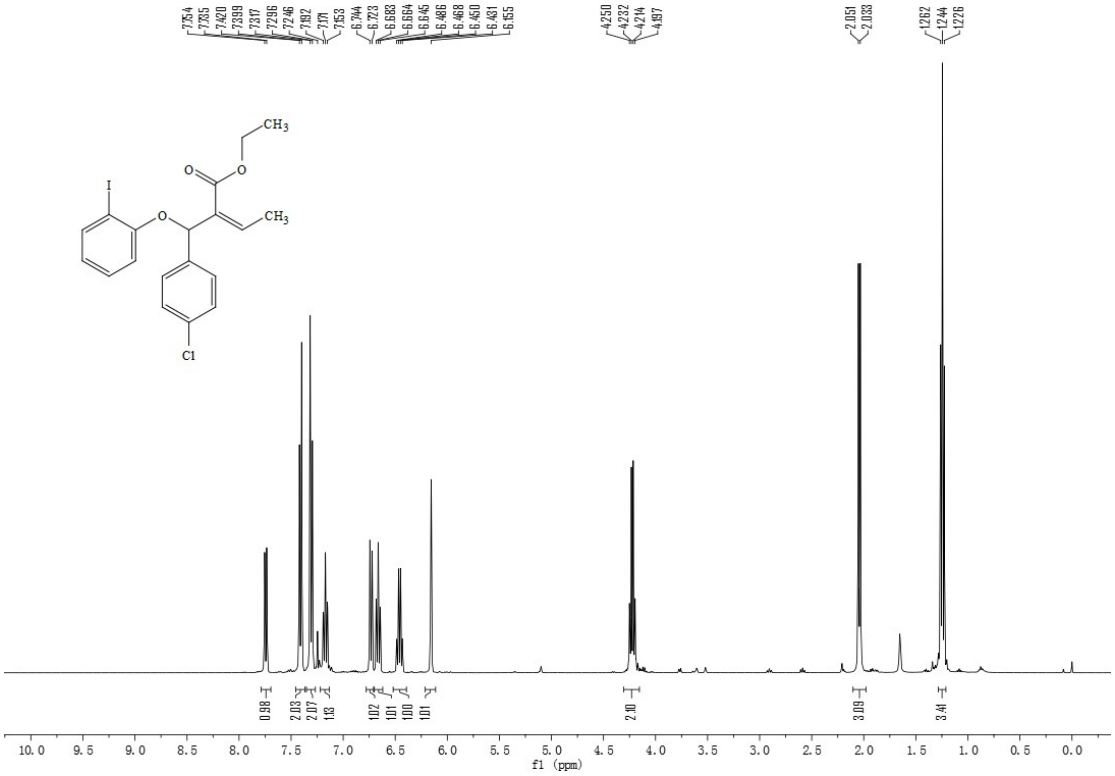
f1 (ppm)

1h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6.664
6.645
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6.468
6.450
6.431
6.655
4.250
4.232
4.214
4.197
2.051
2.033
1.262
1.244
1.226
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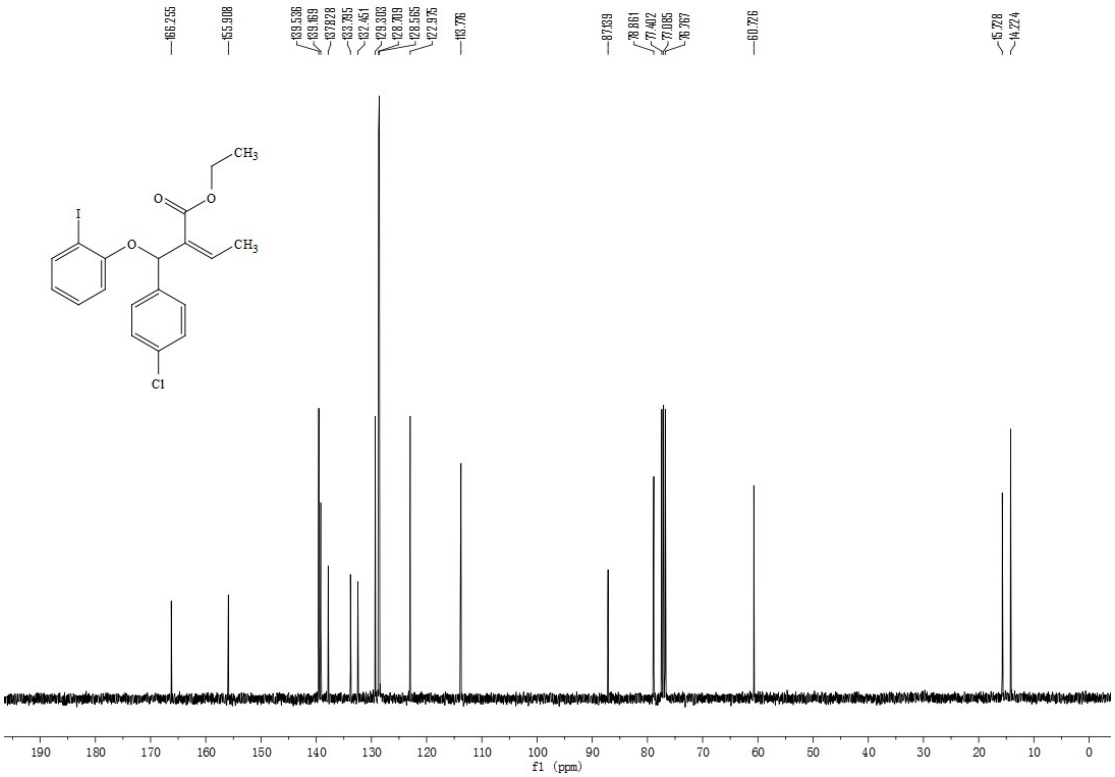
1.13
1.02
1.01
1.00
1.01
2.00
3.09
3.41
f1 (ppm)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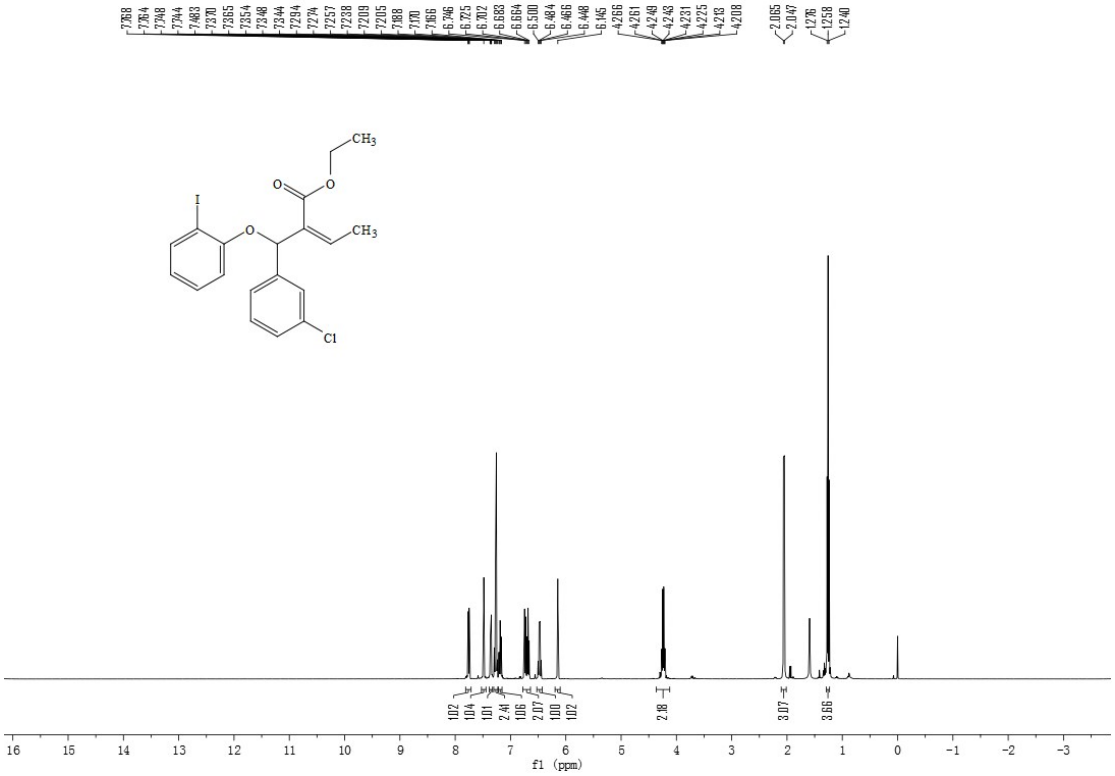
1i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6.4465
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4.2861
4.2749
4.2743
4.2231
4.2225
4.2218
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2.0147
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1.2758
1.2740
I
O
O
O
CH3
CH3
Cl
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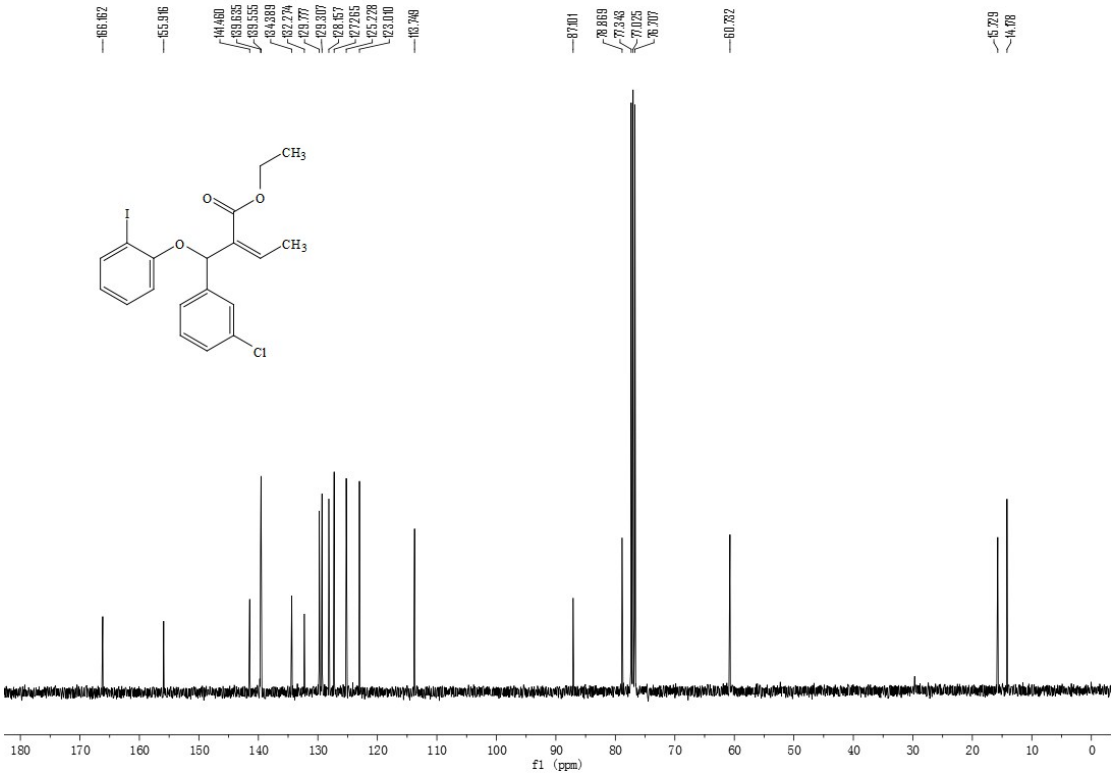
f1 (ppm)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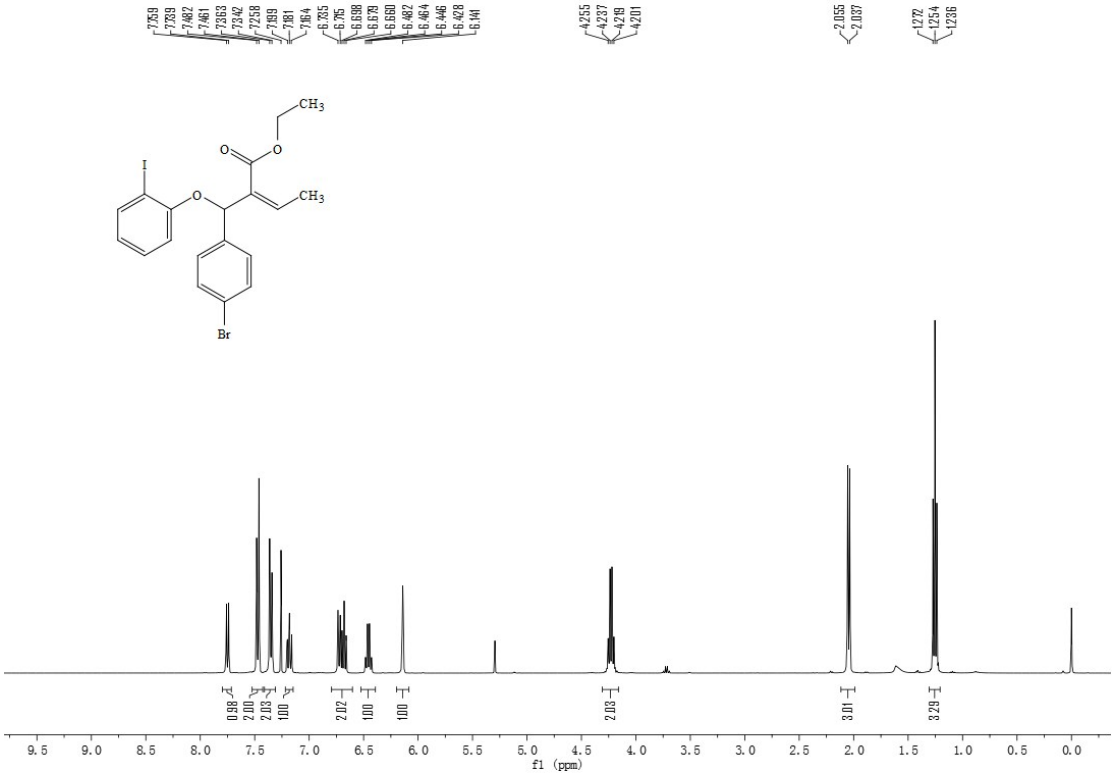
O
O
CH3
CH3
Cl
f1 (ppm)

1j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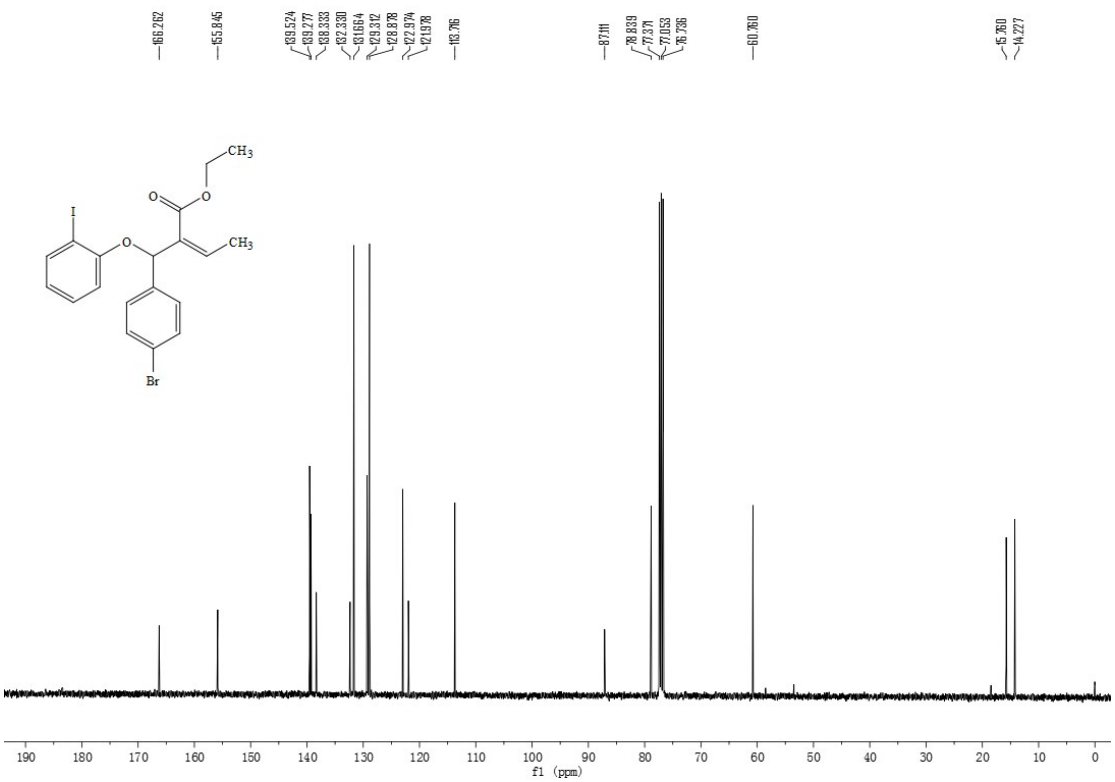
6.660
6.482
6.464
6.446
6.428
6.141
4.255
4.237
4.218
4.201
2.055
2.037
1.272
1.254
1.236
CH3
O
O
I
O
CH3
Br
0.98
2.10
2.13
1.00
2.12
1.00
1.00
2.03
3.01
3.29
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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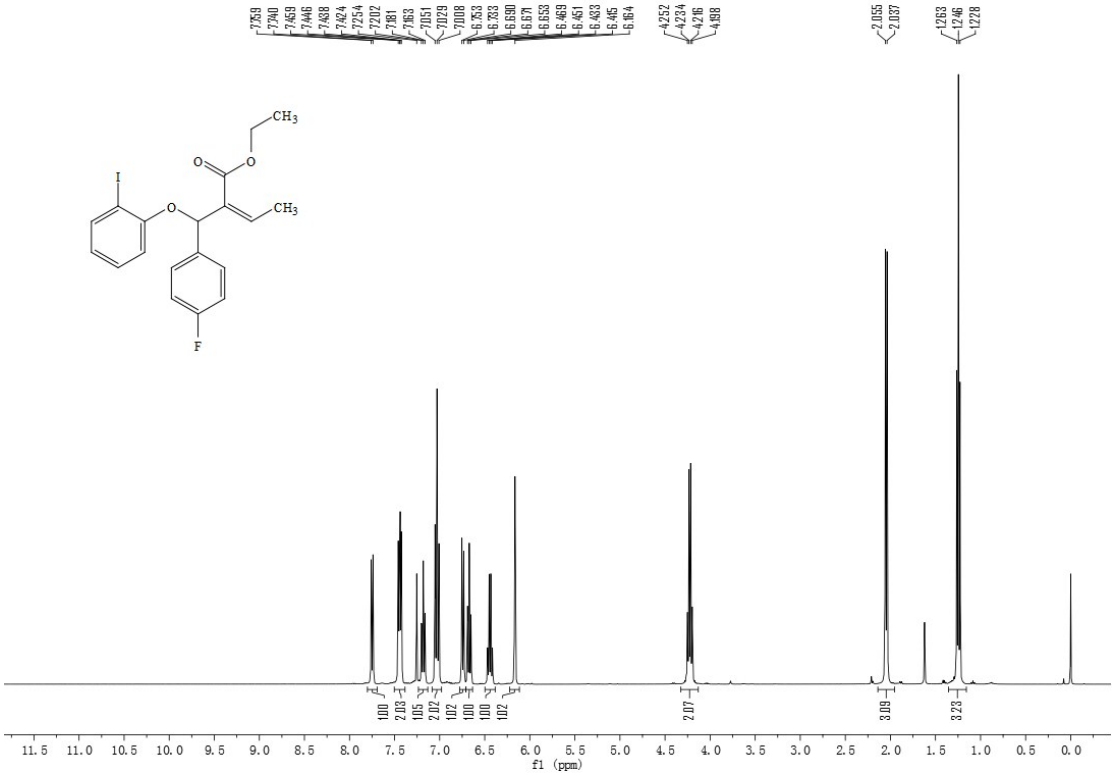
155.845
139.524
139.277
138.333
132.330
131.664
129.312
128.878
122.974
121.978
113.766
87.111
78.839
77.371
77.053
76.736
60.760
15.760
14.227
CH3
O
O
I
O
CH3
Br
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

1k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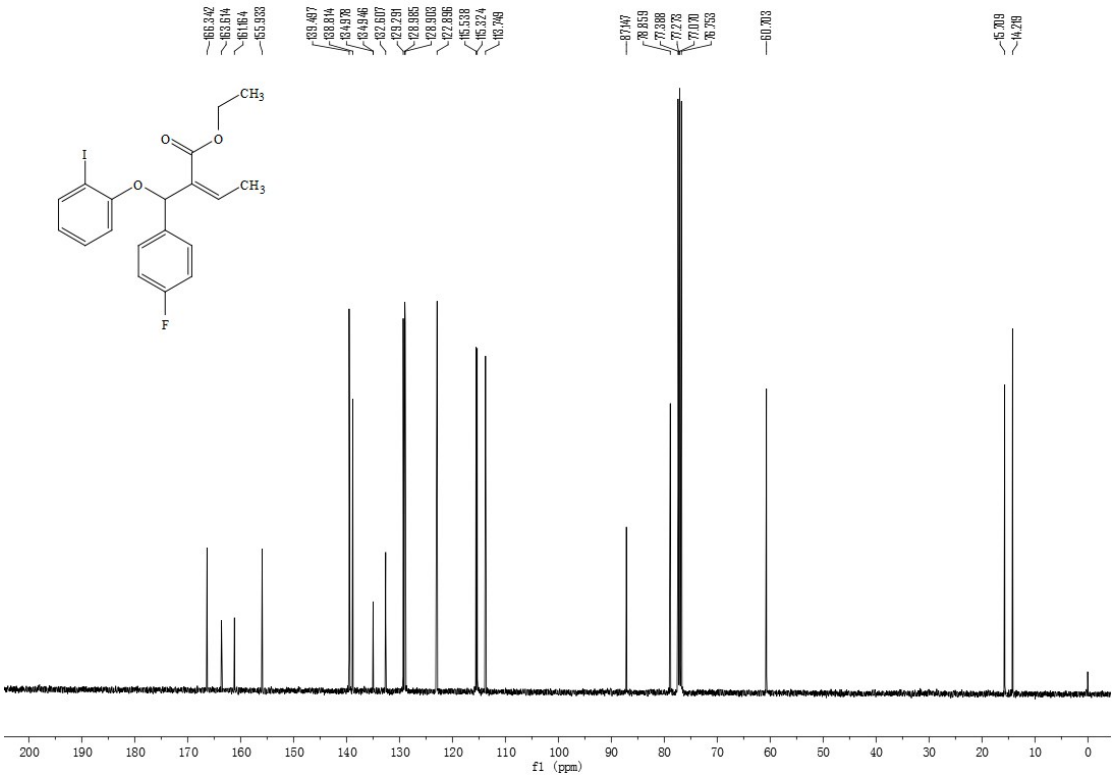
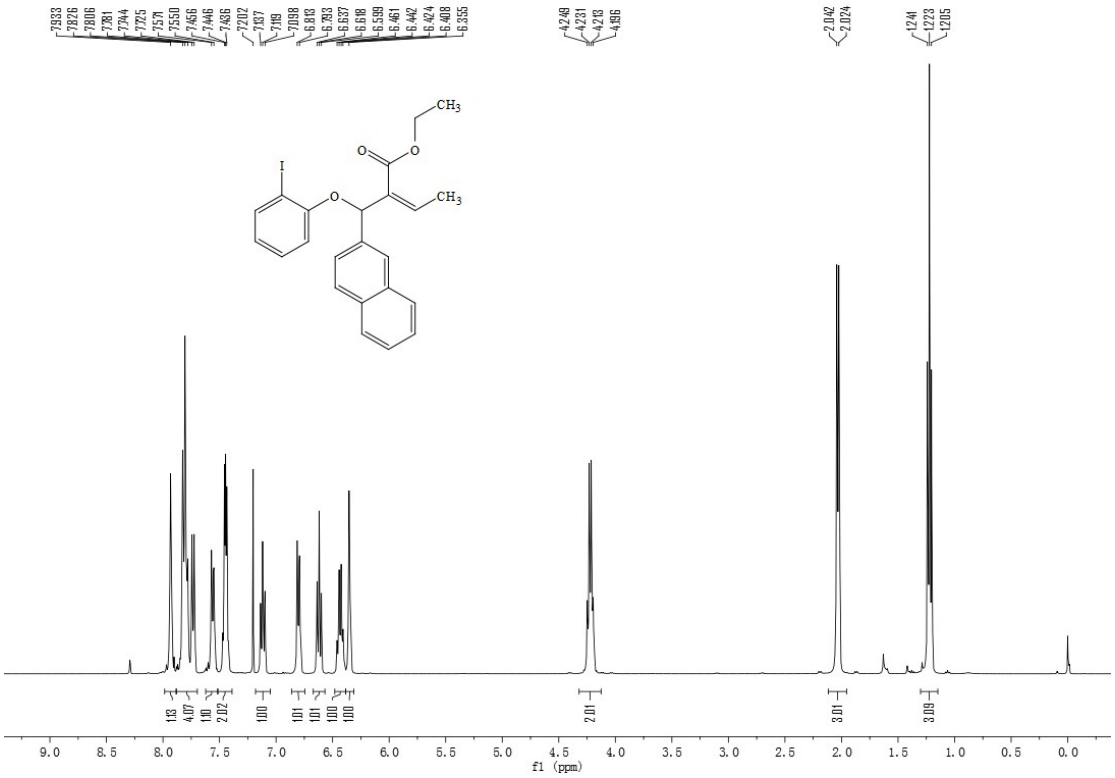
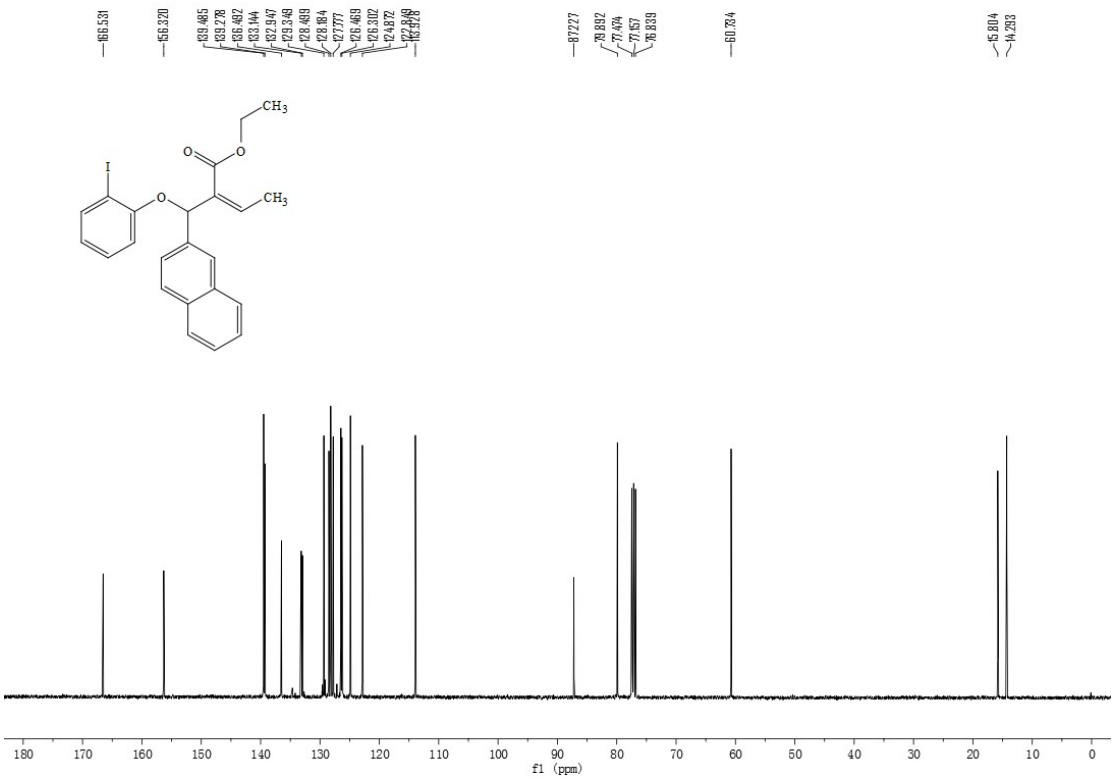
7.740
7.459
7.446
7.438
7.424
7.254
7.202
7.181
7.163
7.051
7.029
7.008
6.753
6.733
6.690
6.677
6.653
6.469
6.451
6.433
6.405
6.164
4.252
4.234
4.216
4.198
2.055
2.037
1.263
1.246
1.228
1.00
2.03
1.05
2.02
1.02
1.00
1.00
1.02
2.07
3.09
3.23
f1 (ppm)

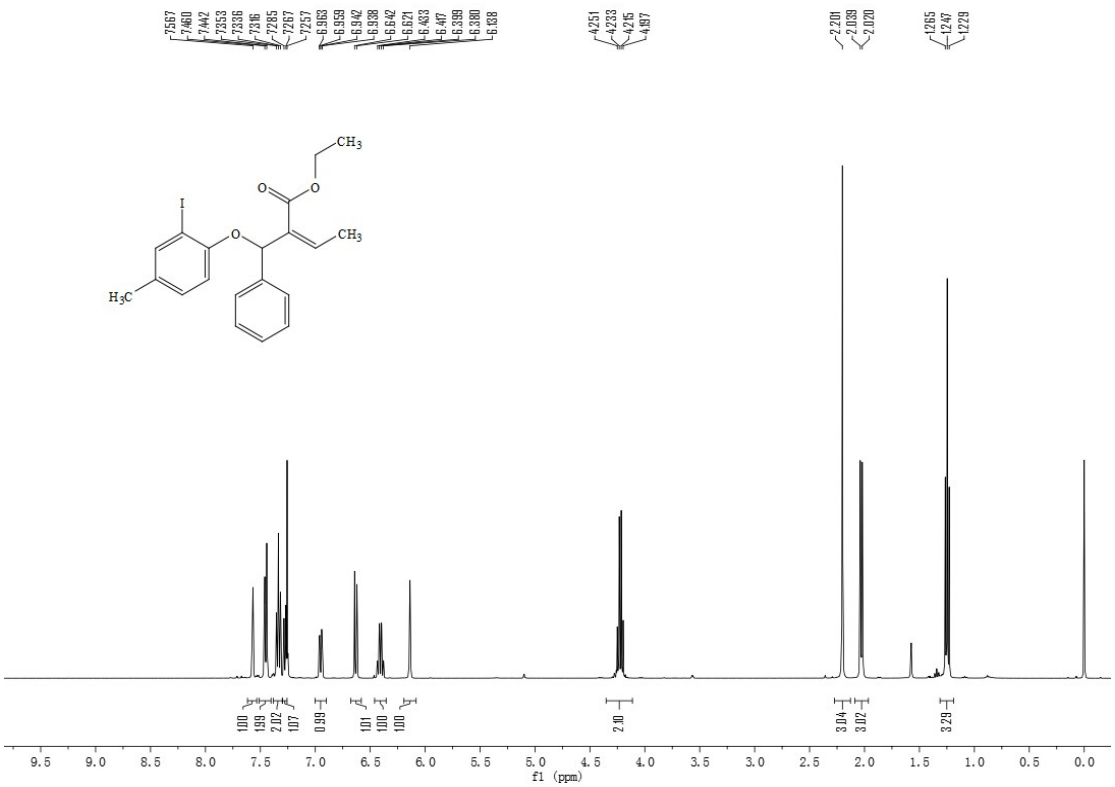

166.342
163.614
161.164
155.933
139.497
138.814
134.978
134.946
132.607
129.291
128.985
128.903
122.896
115.538
115.324
113.749
87.147
78.859
77.388
77.273
77.070
76.753
60.703
15.709
14.298
f1 (ppm)

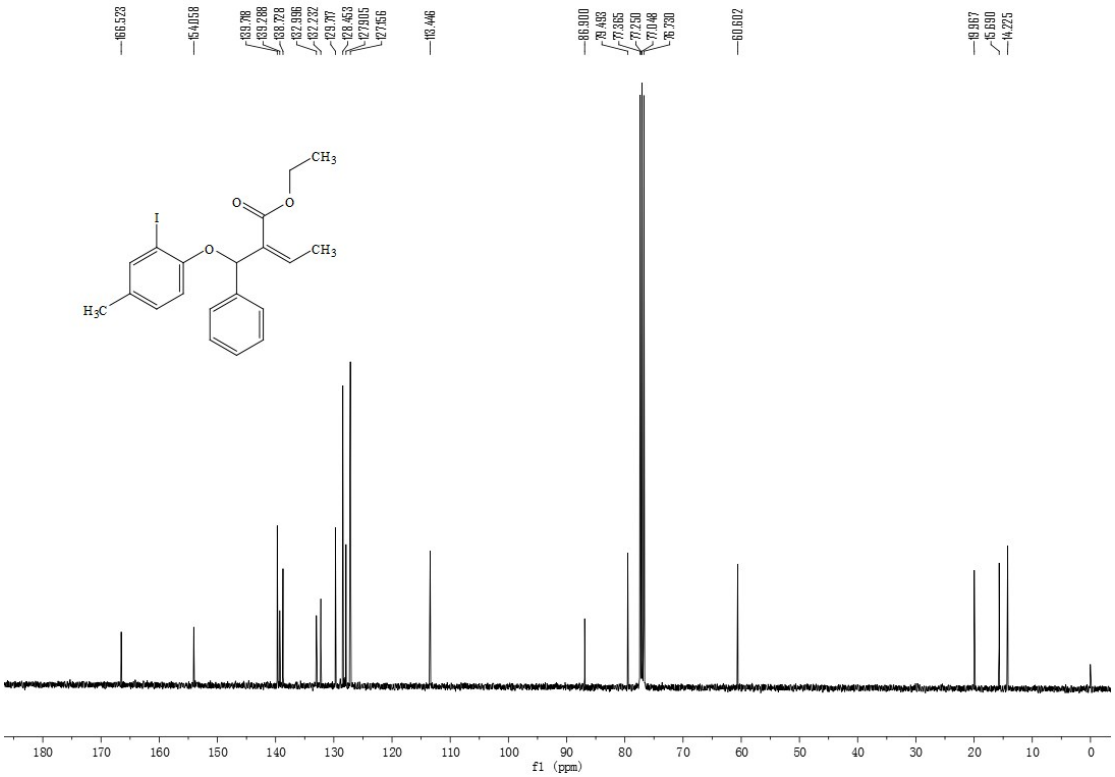
1l


7.9333
7.9226
7.8086
7.7981
7.7944
7.7725
7.7571
7.7550
7.7456
7.7446
7.7436
7.7202
7.7137
7.7119
7.7098
6.8163
6.7983
6.7637
6.6718
6.6598
6.6461
6.6442
6.6424
6.6408
6.6355
4.2749
4.2731
4.2713
4.2695
2.1042
2.1024
1.2441
1.2223
1.2205
1.63
4.07
1.40
2.12
1.00
1.01
1.01
1.00
1.00
2.01
3.01
3.09
f1 (ppm)

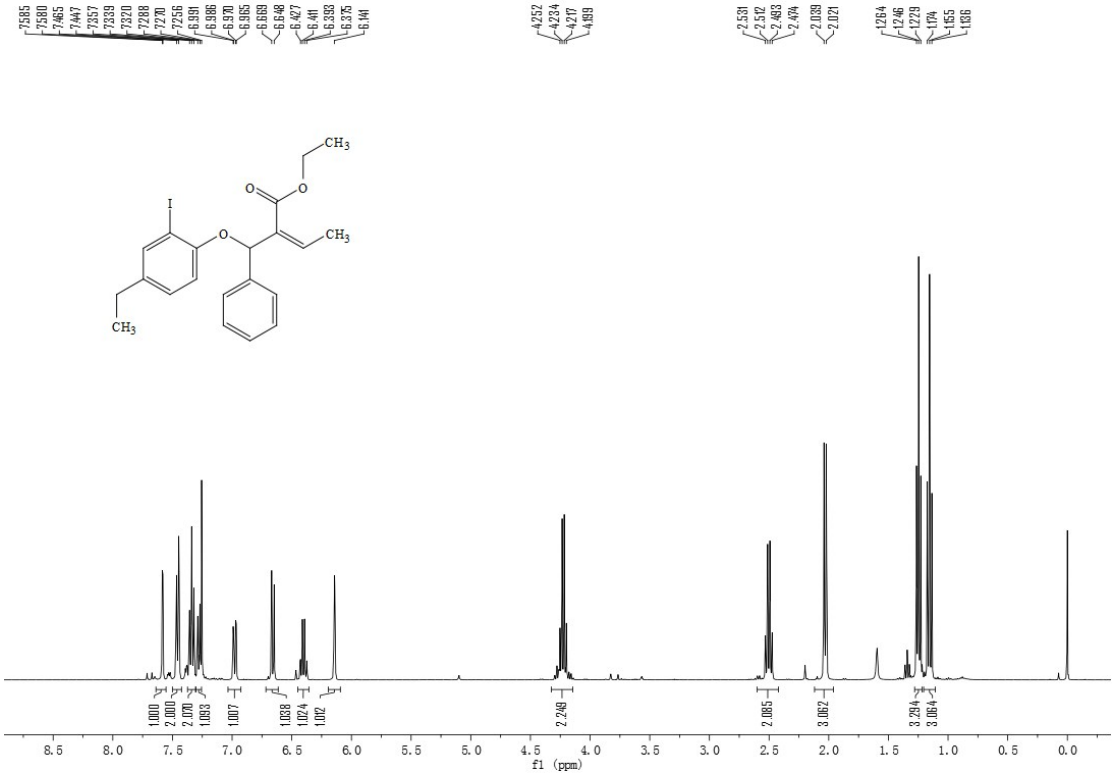

165.531
156.320
139.485
139.278
135.492
133.144
132.947
129.349
128.489
128.184
127.777
126.469
126.302
124.872
122.849
122.678
87.227
78.852
77.474
77.157
76.839
60.734
15.804
14.293
f1 (ppm)

1m


7.587
7.460
7.442
7.353
7.336
7.316
7.265
7.257
7.257
6.963
6.959
6.942
6.938
6.642
6.621
6.403
6.397
6.389
6.380
6.938
4.251
4.233
4.215
4.197
2.201
2.039
2.020
1.265
1.247
1.229
CH3
O
O
I
O
CH3
H3C
100
1.99
2.02
1.07
0.99
1.01
1.00
1.00
2.00
3.04
3.12
3.29
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


166.523
154.058
139.788
139.288
138.728
132.936
132.232
129.707
128.453
127.905
127.156
113.446
86.910
79.483
77.365
77.250
77.048
76.730
60.607
19.957
15.690
14.225
CH3
O
O
I
O
CH3
H3C
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

1n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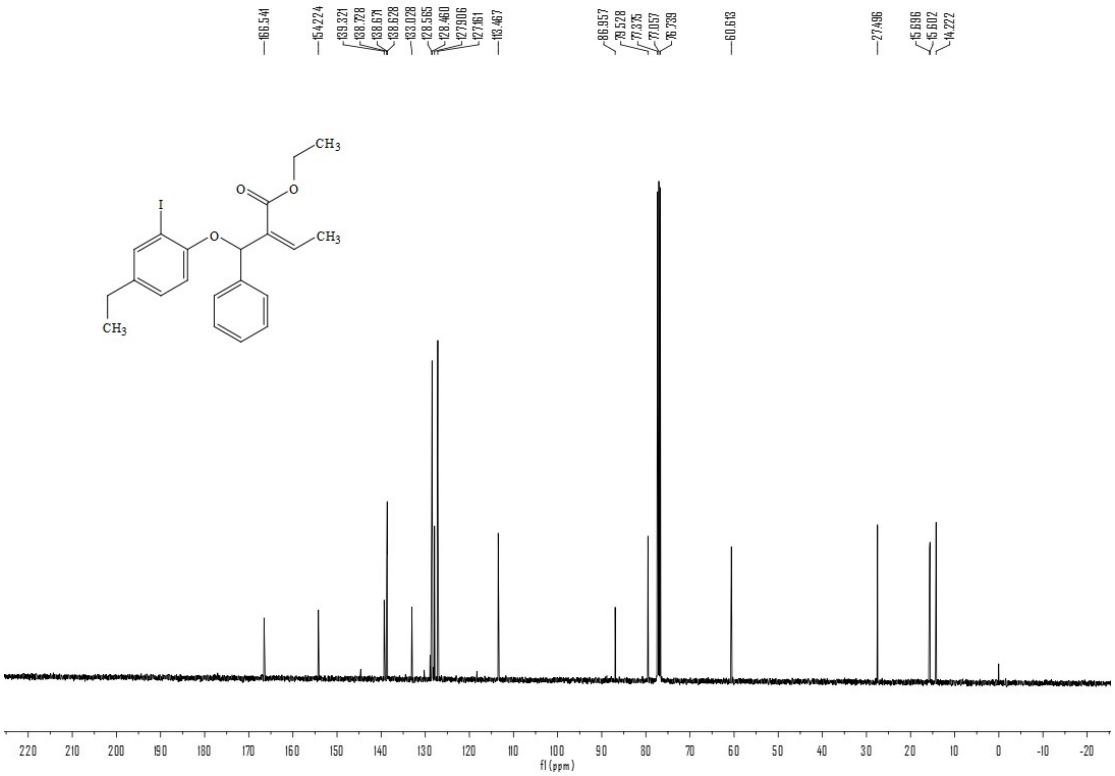
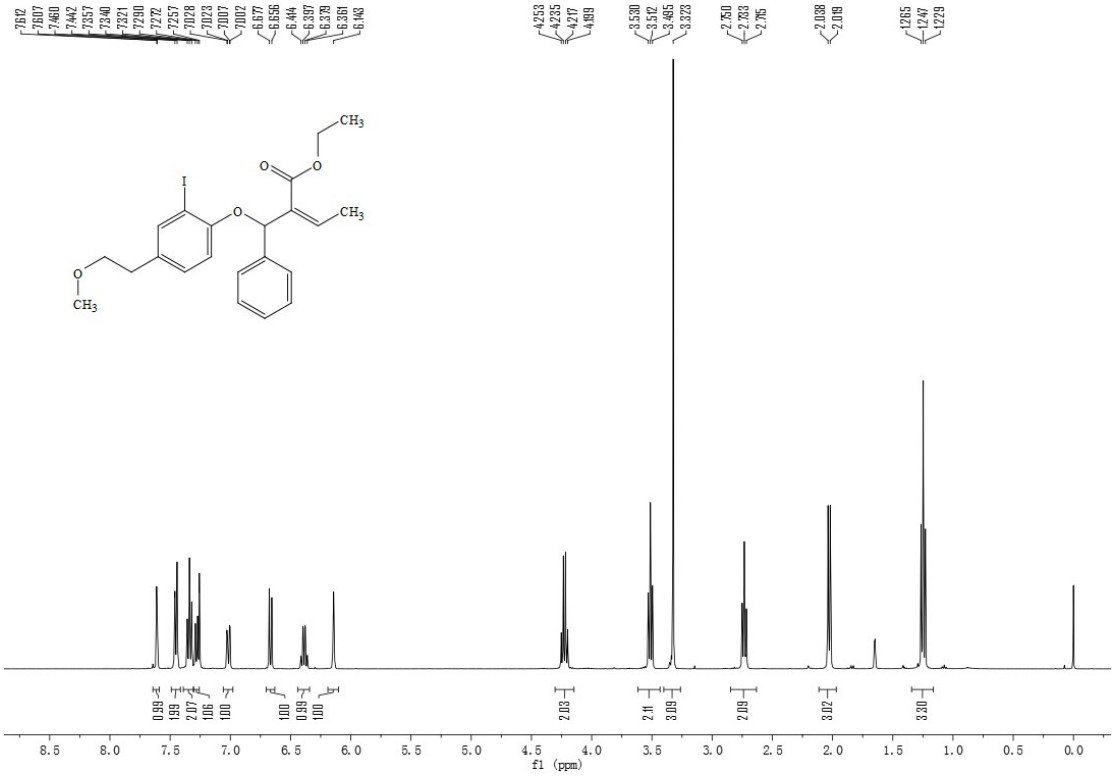
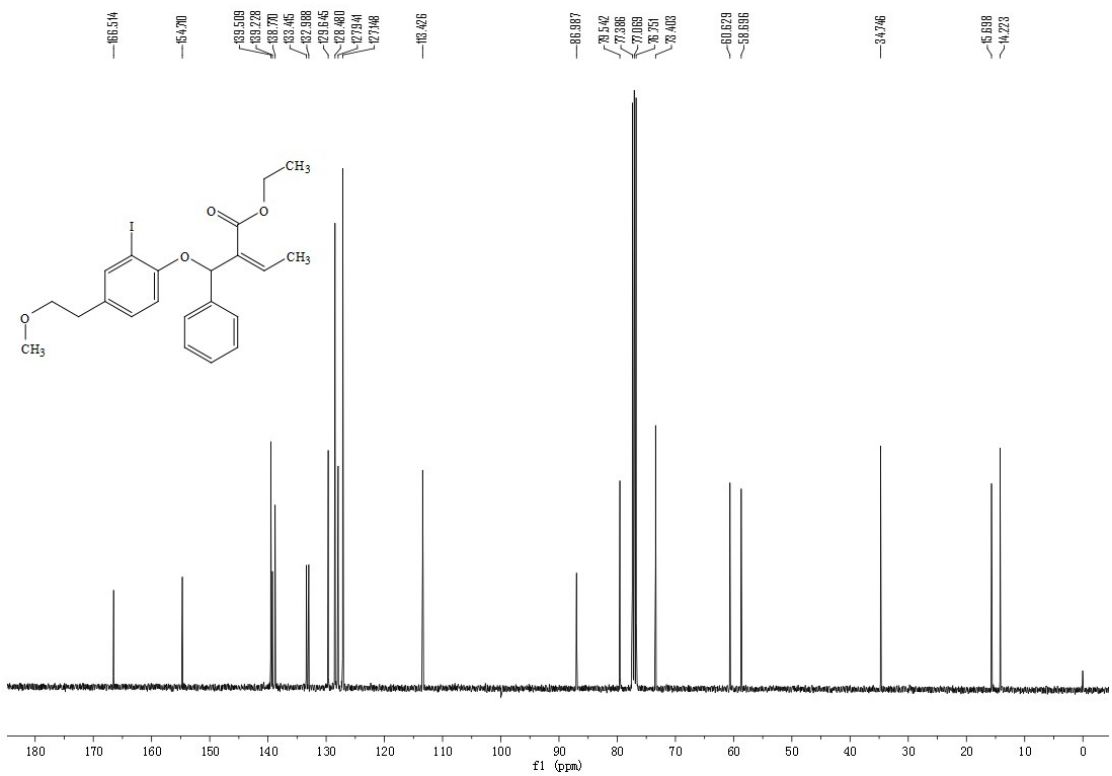
7.580
7.465
7.447
7.357
7.339
7.320
7.288
7.270
7.256
6.991
6.986
6.970
6.965
6.669
6.648
6.427
6.411
6.393
6.375
6.141
4.252
4.234
4.217
4.199
2.531
2.512
2.493
2.474
2.039
2.021
1.264
1.246
1.229
1.174
1.155
1.136
1.000
2.000
2.070
1.093
1.007
1.038
1.024
1.012
2.248
2.085
3.062
3.294
3.064
f1 (ppm)

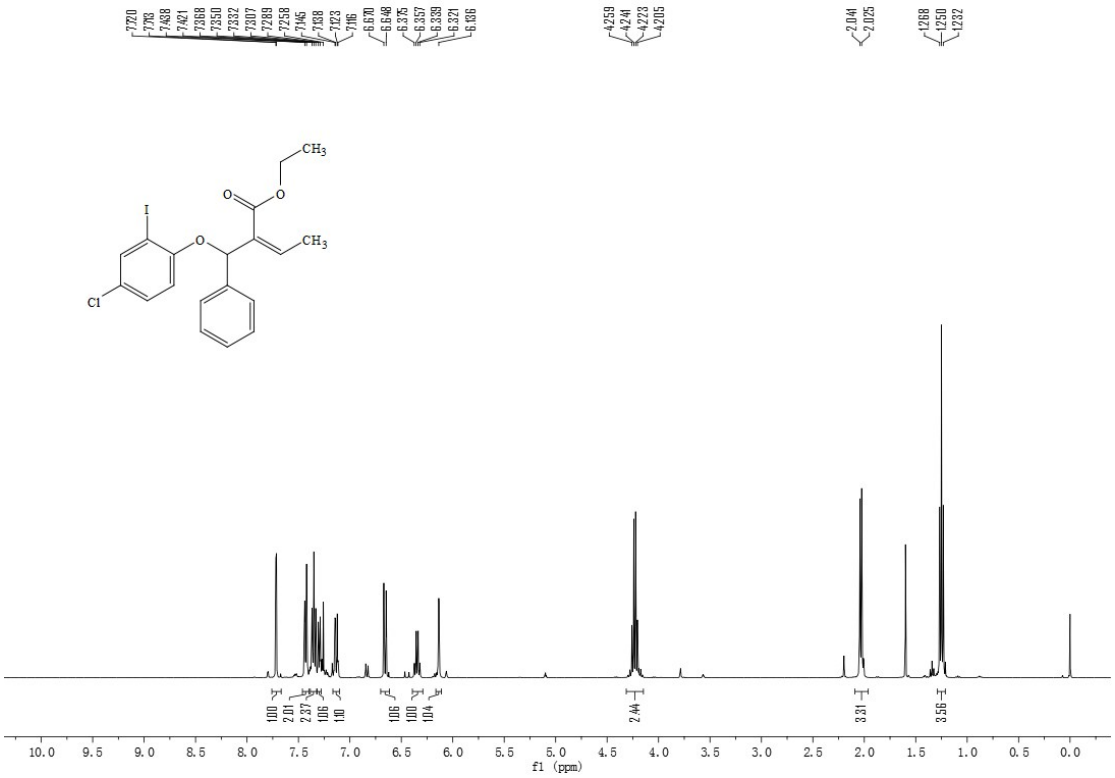

166.541
154.274
139.321
138.728
138.671
138.628
133.028
129.565
128.460
127.906
127.161
118.467
86.957
79.528
77.375
77.057
76.739
60.613
27.496
15.696
15.602
14.222
f1 (ppm)

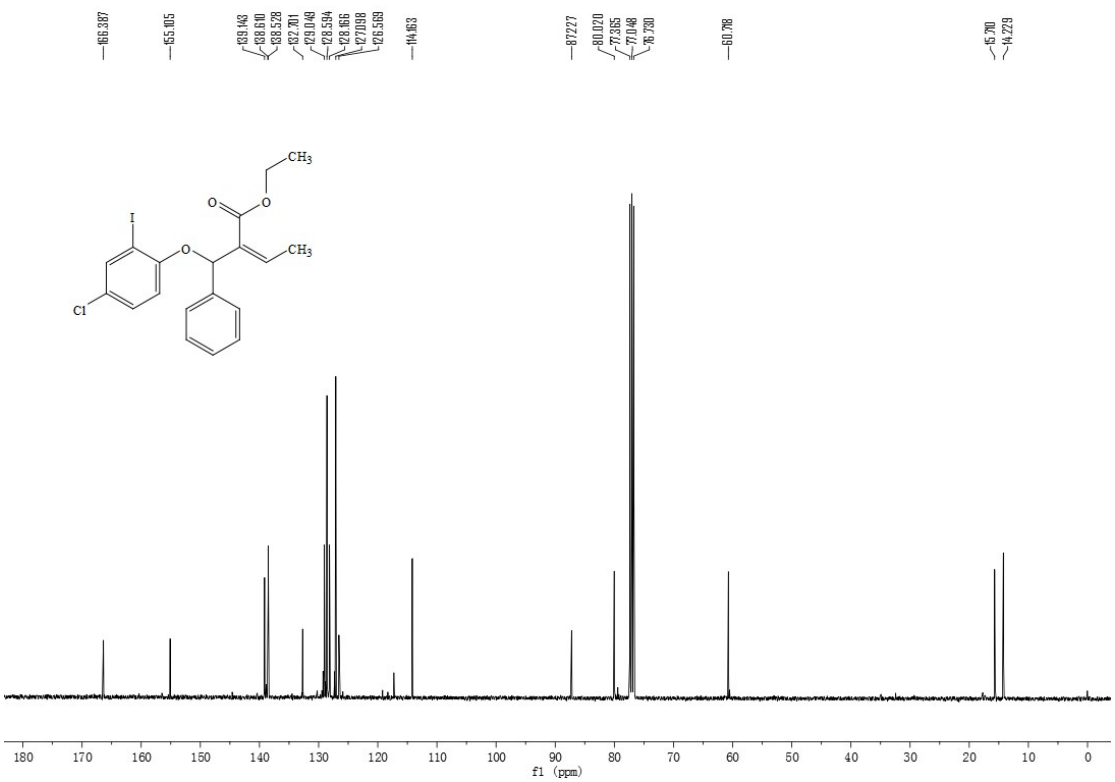
1o


7.612
7.607
7.460
7.442
7.357
7.340
7.321
7.290
7.272
7.257
7.028
7.023
7.007
7.002
6.677
6.656
6.444
6.397
6.378
6.361
6.143
4.253
4.235
4.217
4.199
3.530
3.512
3.495
3.323
2.750
2.733
2.715
2.038
2.019
1.265
1.247
1.229
0.93
1.39
2.07
1.16
1.00
1.00
0.93
1.00
2.03
2.11
3.19
2.19
3.02
3.30
f1 (ppm)


166.514
154.700
139.508
139.228
138.770
133.445
132.988
129.645
128.460
127.944
127.948
102.426
86.987
79.542
77.386
77.069
76.751
73.403
60.623
58.696
34.746
15.698
14.223
f1 (ppm)

1p


7.720
7.703
7.438
7.421
7.368
7.350
7.332
7.317
7.289
7.258
7.145
7.138
7.123
7.116
6.670
6.648
6.375
6.357
6.339
6.321
6.136
4.259
4.241
4.223
4.205
2.044
2.025
1.268
1.250
1.232
CH3
O
O
I
O
CH3
Cl
1.00
2.01
2.37
1.06
1.50
1.06
1.00
1.04
2.44
3.31
3.56
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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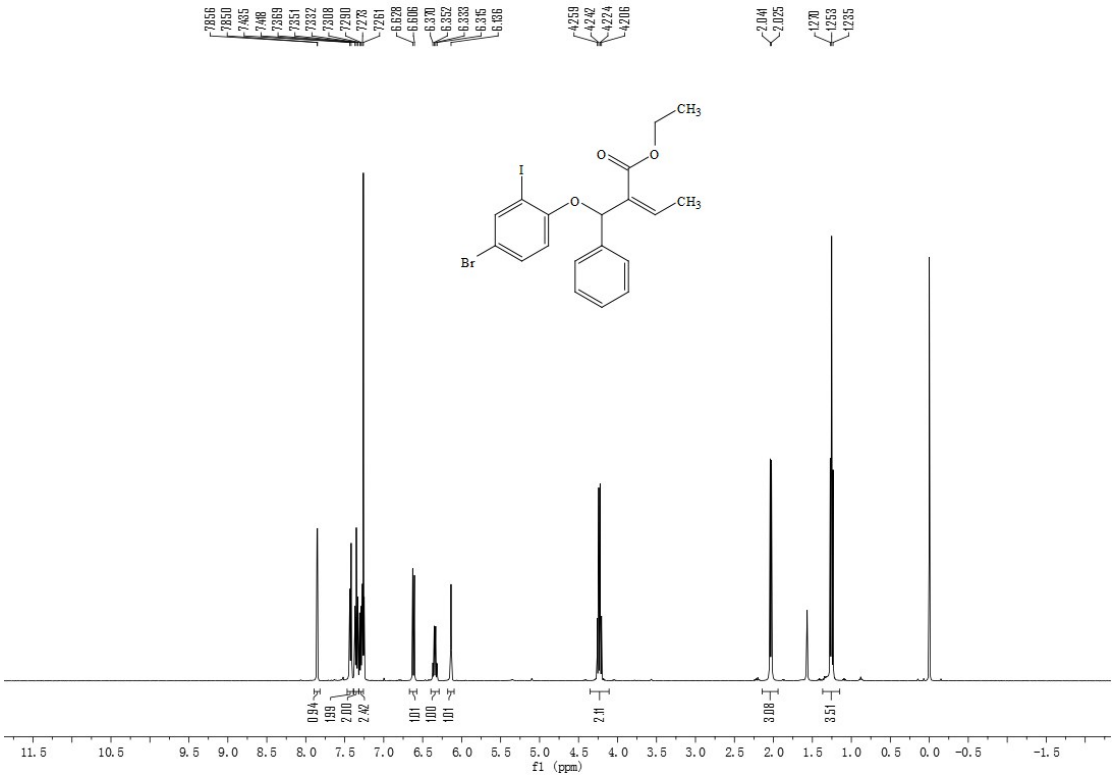
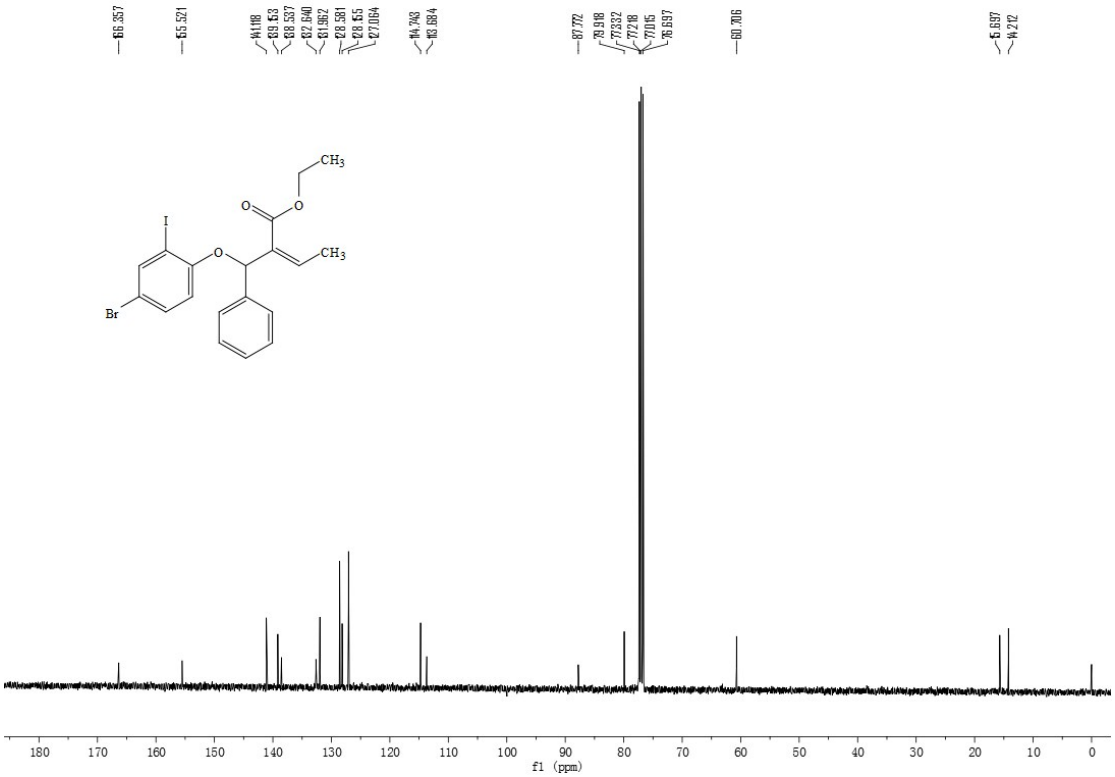
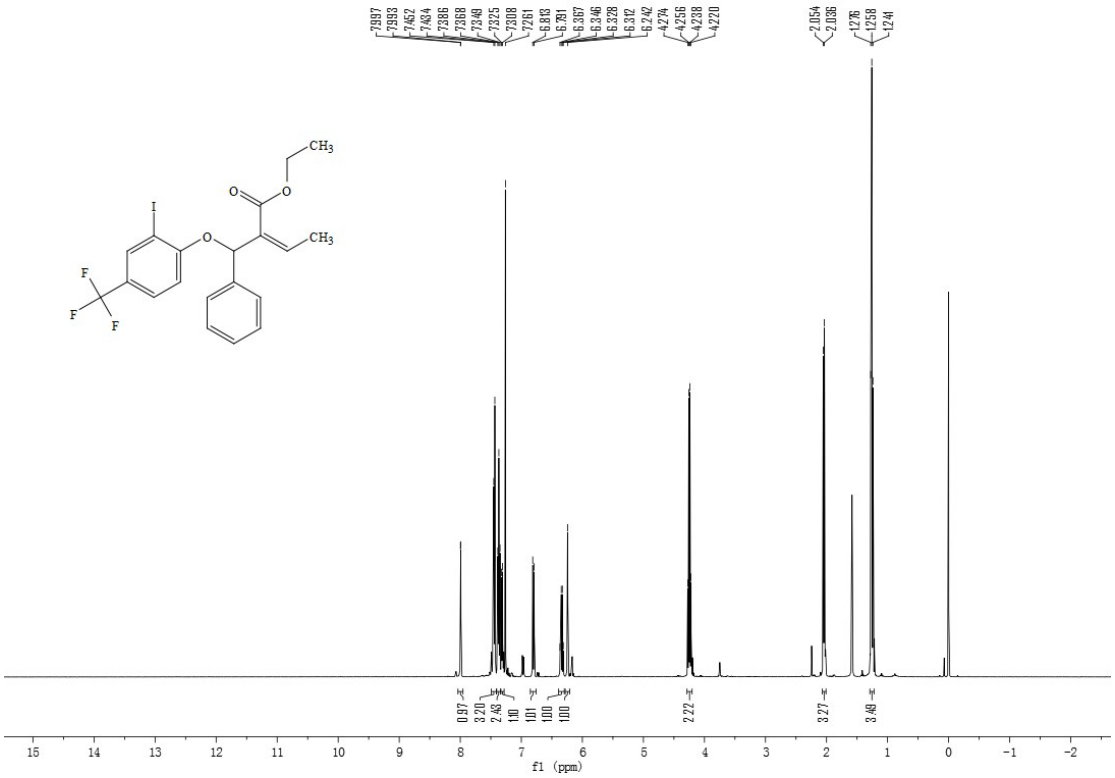
139.143
138.610
138.528
132.701
129.040
128.534
128.166
127.098
126.568
114.853
87.227
80.020
77.365
77.048
76.730
60.708
15.700
14.229
CH3
O
O
I
O
CH3
Cl
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

1q


7.856
7.850
7.435
7.348
7.339
7.331
7.322
7.308
7.290
7.278
7.261
6.628
6.606
6.370
6.352
6.333
6.315
6.136
4.259
4.242
4.224
4.206
2.041
2.025
1.270
1.253
1.235
CH3
O
O
I
O
CH3
Br
0.94
1.39
2.10
2.42
1.01
1.00
1.01
2.11
3.18
3.51
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.5
f1 (ppm)


166.357
155.521
141.108
139.153
138.537
127.840
121.962
128.381
128.155
127.016
94.743
82.684
67.772
70.918
77.332
77.218
77.015
76.697
60.706
15.697
14.272
CH3
O
O
I
O
CH3
Br
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

1r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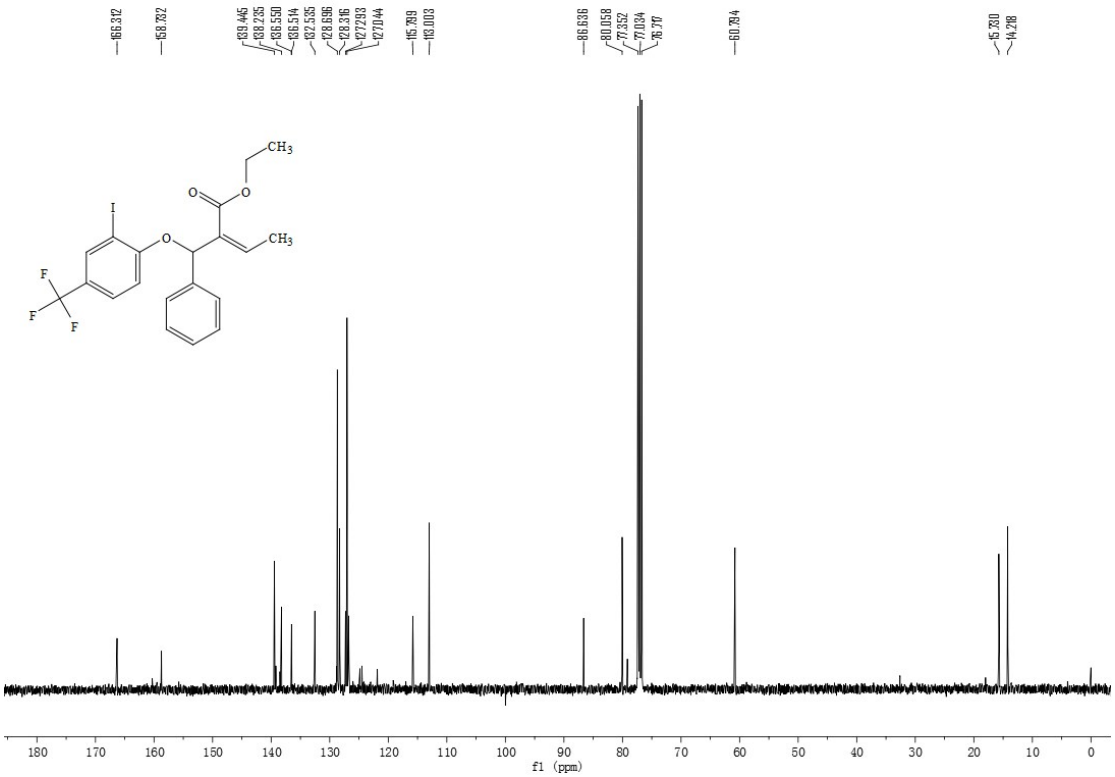
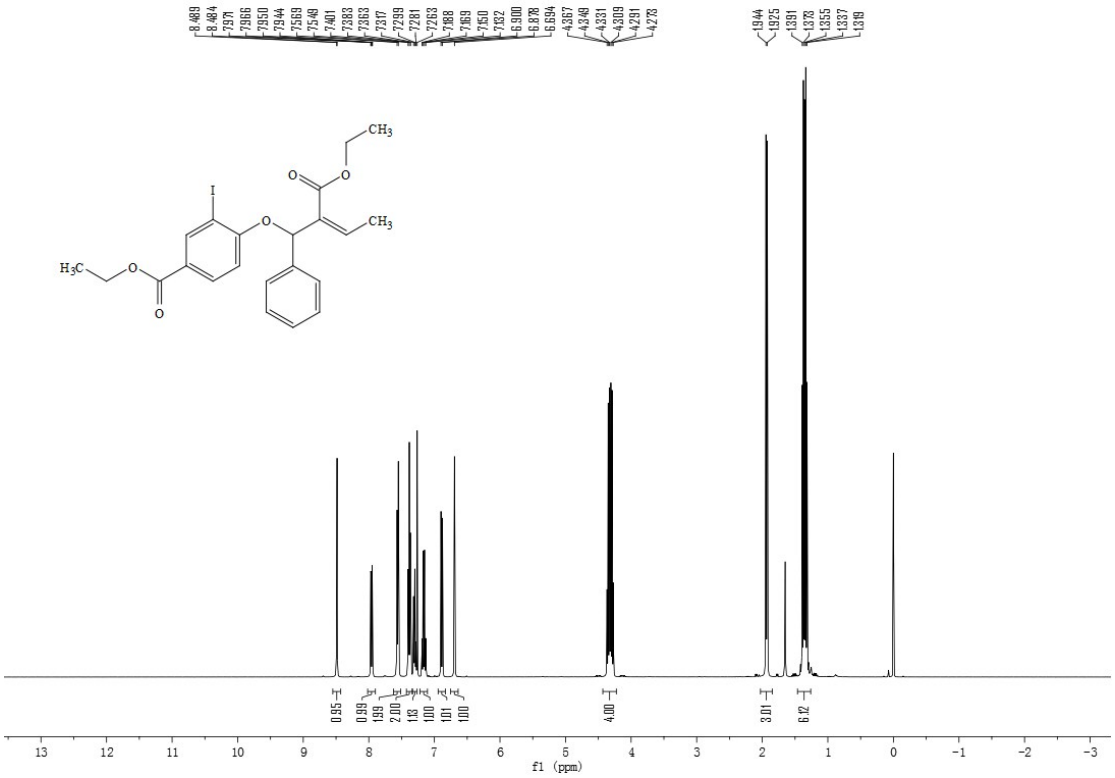
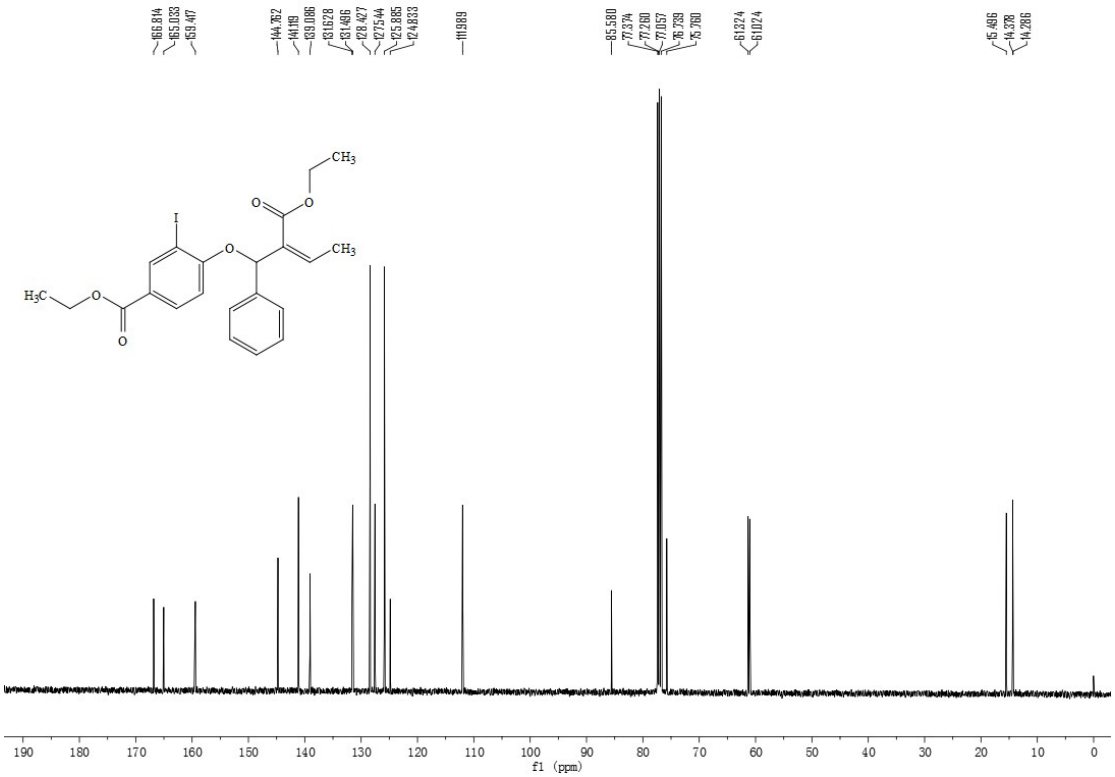
7.7993
7.7452
7.7434
7.7386
7.7368
7.7340
7.7325
7.7308
7.7281
6.8153
6.7911
6.3367
6.3346
6.3328
6.3312
6.2742
4.2794
4.2556
4.2238
4.2220
2.1054
2.1036
1.2785
1.2758
1.2741
0.937
3.201
2.483
1.410
1.011
1.000
1.000
2.222
3.277
3.483
f1 (ppm)


166.312
158.782
139.445
138.235
136.550
136.514
127.535
128.636
128.316
127.293
127.044
115.789
113.013
86.638
80.058
77.352
77.034
76.717
60.784
15.230
14.298
f1 (ppm)

1s


8.489
8.484
7.971
7.966
7.950
7.944
7.569
7.548
7.401
7.383
7.363
7.317
7.299
7.281
7.263
7.188
7.169
7.150
7.132
6.900
6.878
6.594
4.367
4.346
4.331
4.309
4.291
4.273
1.944
1.925
1.391
1.378
1.355
1.337
1.318
0.95
0.99
1.99
2.10
1.18
1.00
1.01
1.00
4.00
3.01
6.12
f1 (ppm)


166.814
165.033
159.417
144.762
141.199
139.098
131.628
131.496
128.427
127.544
125.885
124.833
111.989
85.580
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77.057
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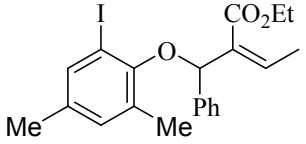
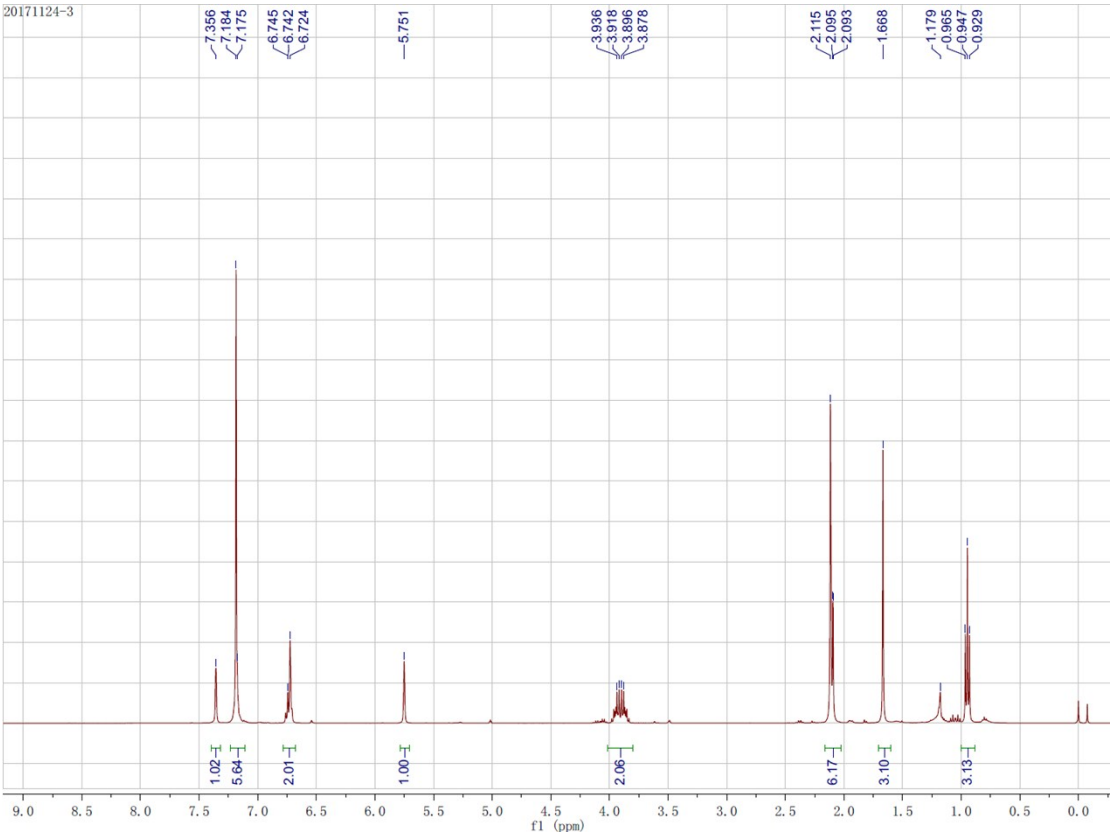
61.024
15.496
14.378
14.266
f1 (ppm)


I
CO_2Et
O
Ph
Me
Me

1t


20171124-3
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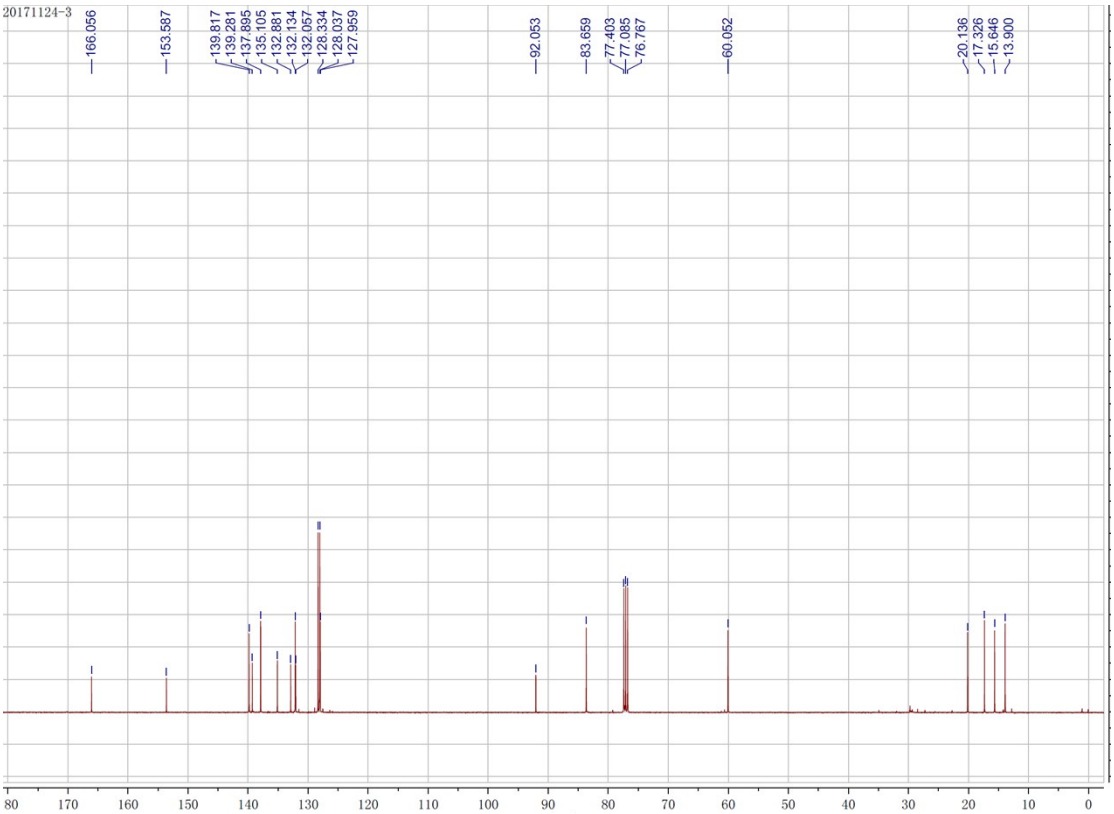
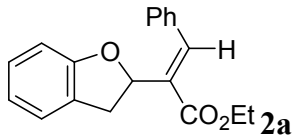
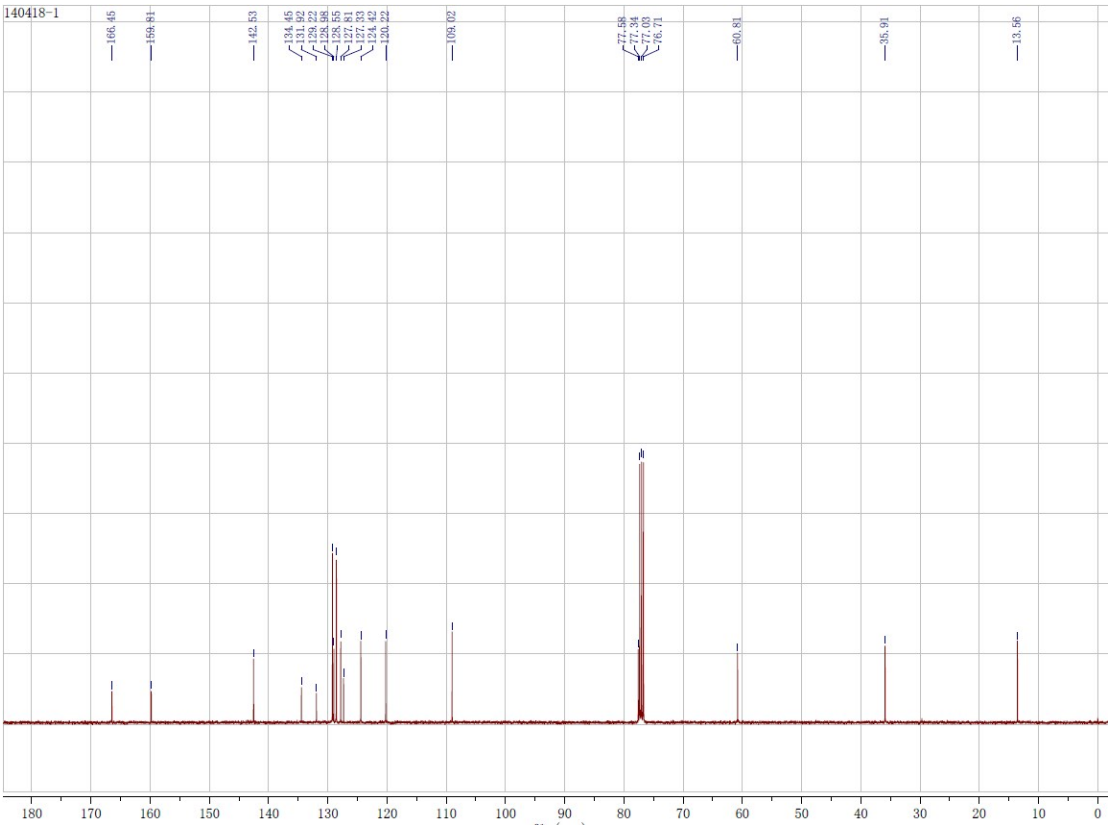
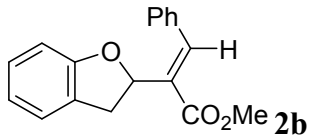
7.184
7.175
6.745
6.742
6.724
5.751
3.936
3.918
3.896
3.878
2.115
2.095
2.093
1.668
1.179
0.965
0.947
0.929
1.02
5.64
2.01
1.00
2.06
6.17
3.10
3.13
f1 (ppm)


20171124-3
166.056
153.587
139.817
139.281
137.895
135.105
132.881
132.134
132.057
128.334
128.037
127.959
92.053
83.659
77.403
77.085
76.767
60.052
20.136
17.326
15.646
13.900

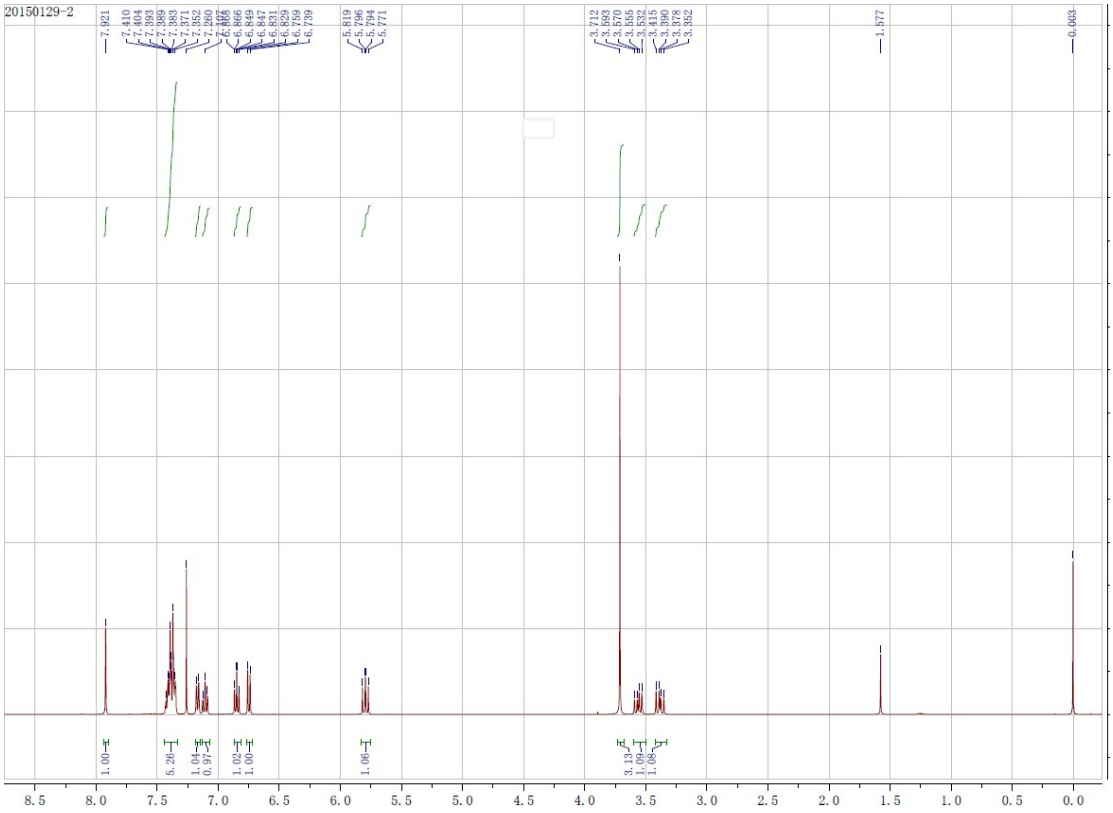


2a




Ph
H
O
CO2Me

2b


20150129-2
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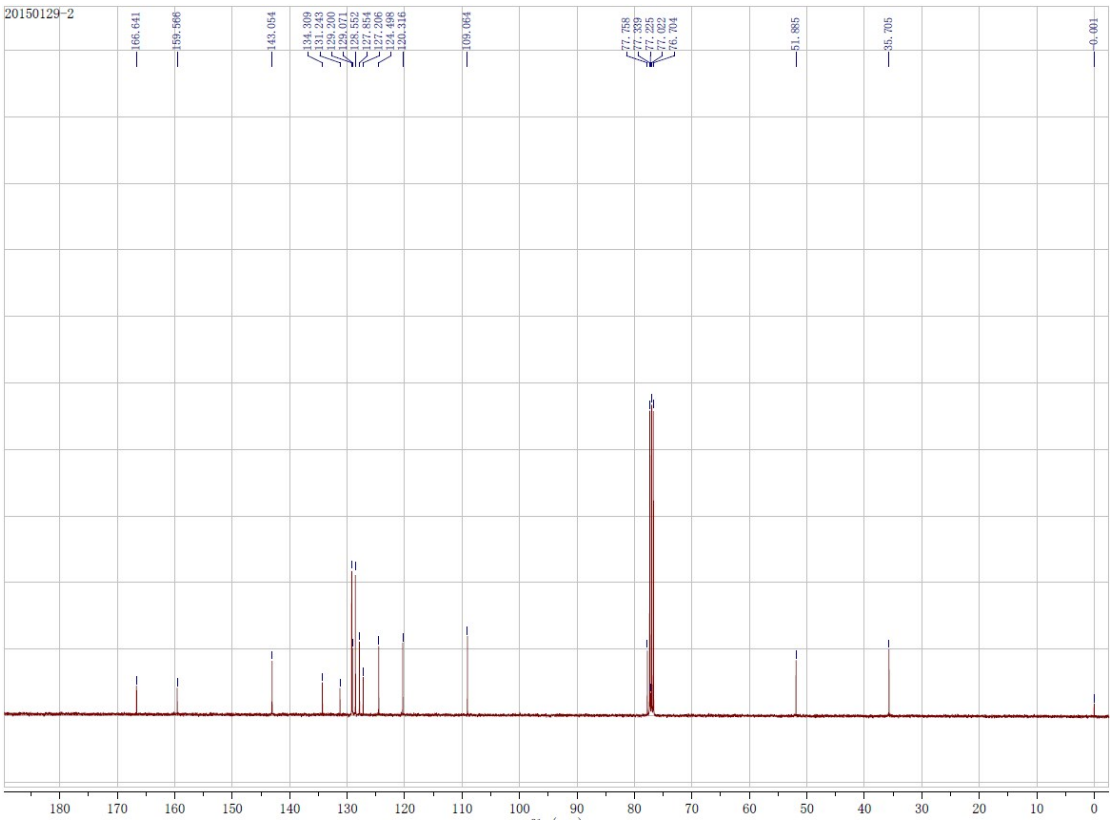
7.410
7.404
7.393
7.389
7.383
7.371
7.352
7.280
6.866
6.849
6.847
6.831
6.829
6.799
6.799
5.819
5.796
5.794
5.771
3.712
3.693
3.670
3.555
3.532
3.415
3.390
3.378
3.352
1.577
0.003
1.00
5.26
1.04
0.97
1.02
1.00
1.06
3.13
1.09
1.08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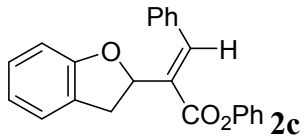
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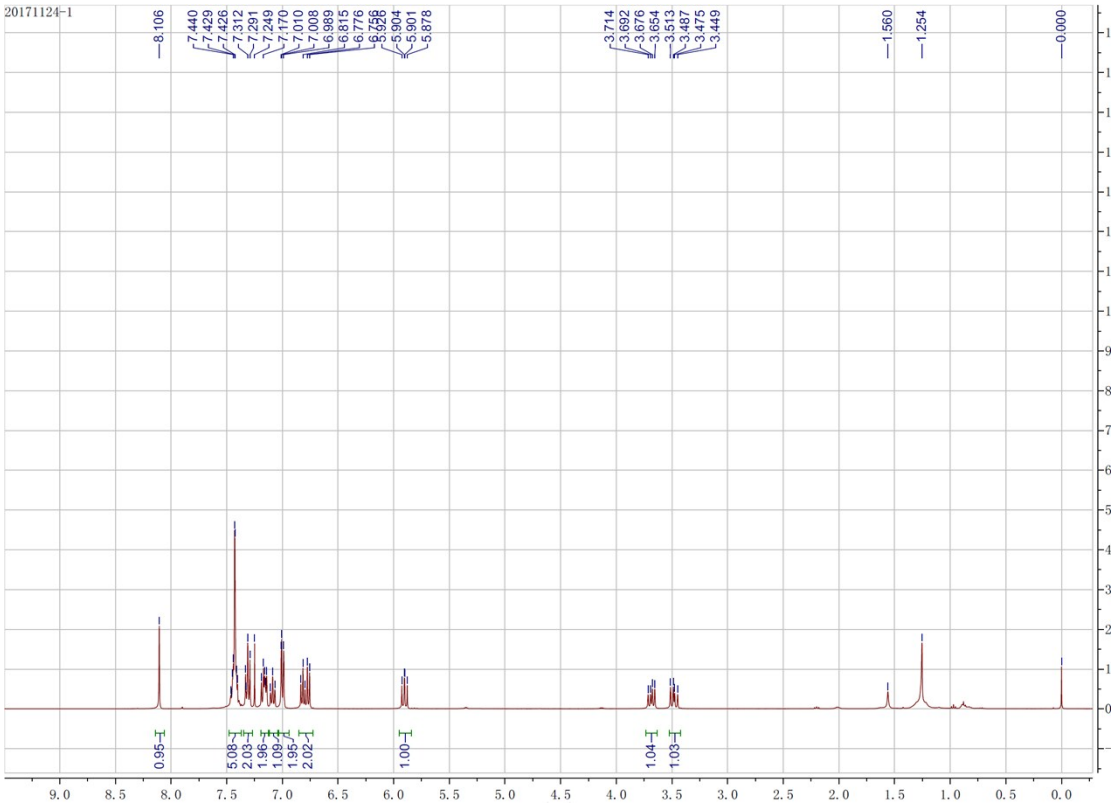
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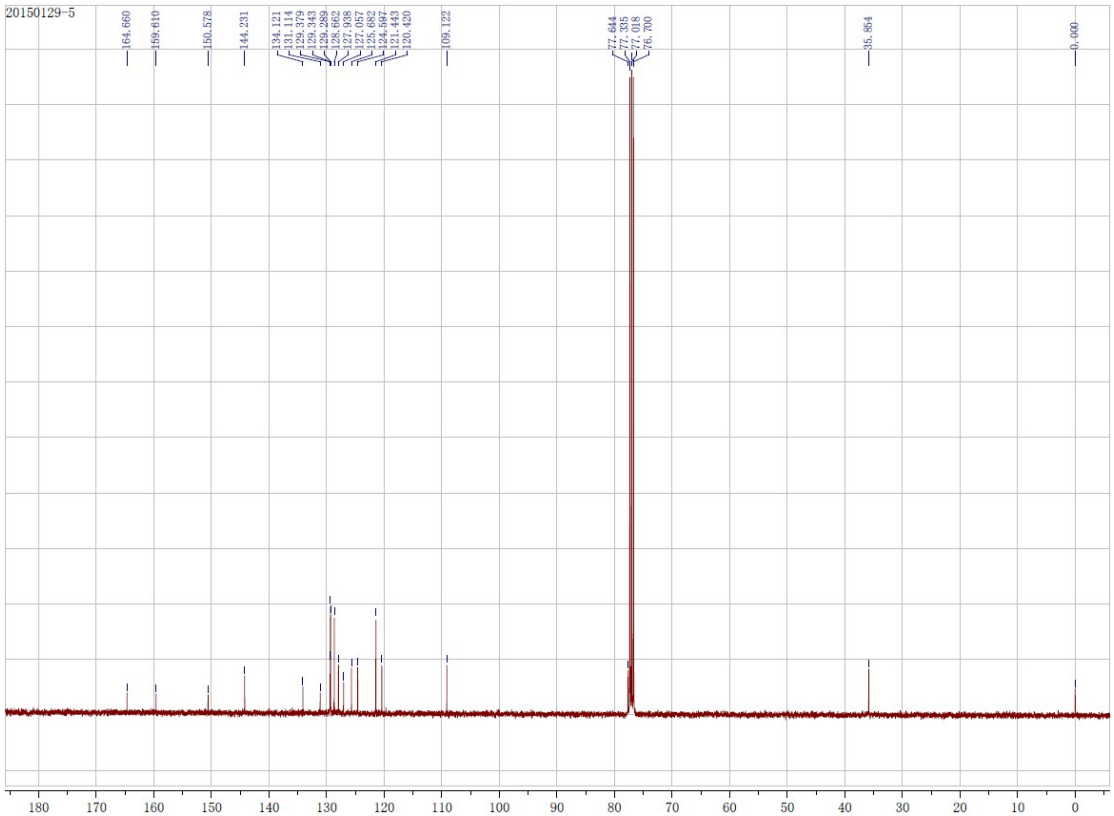
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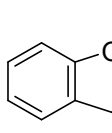

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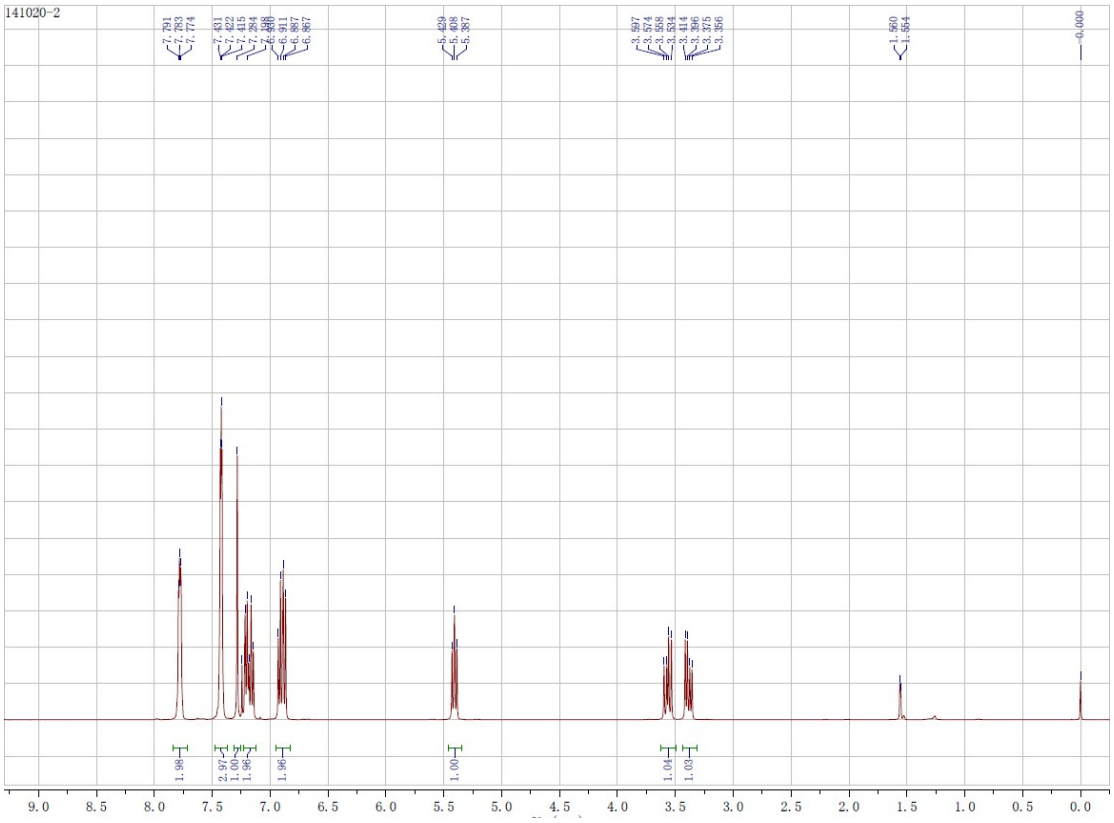

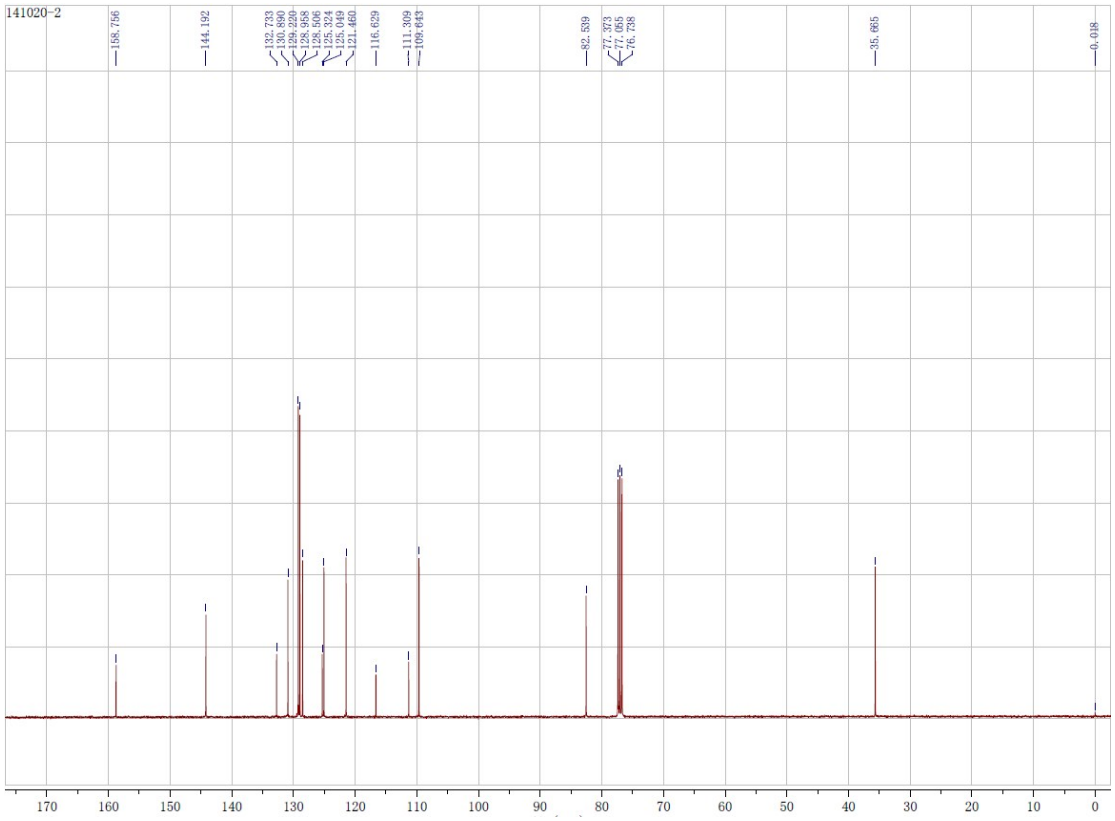

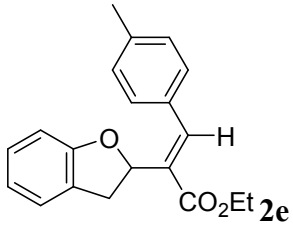

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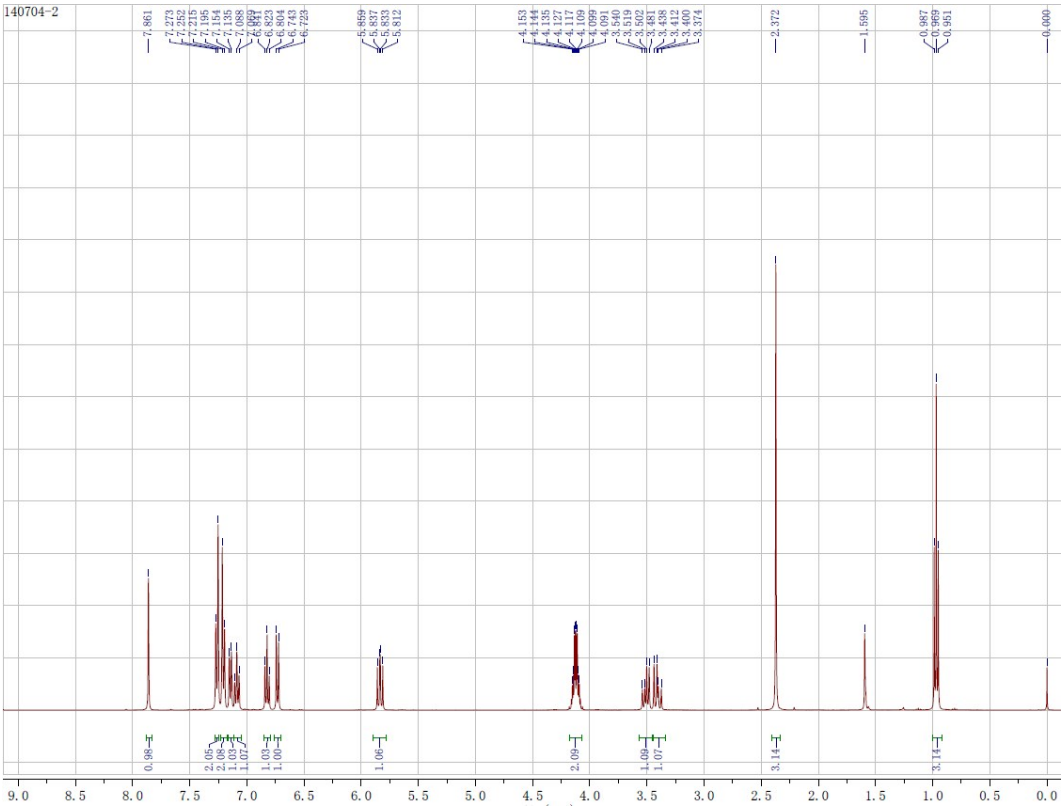

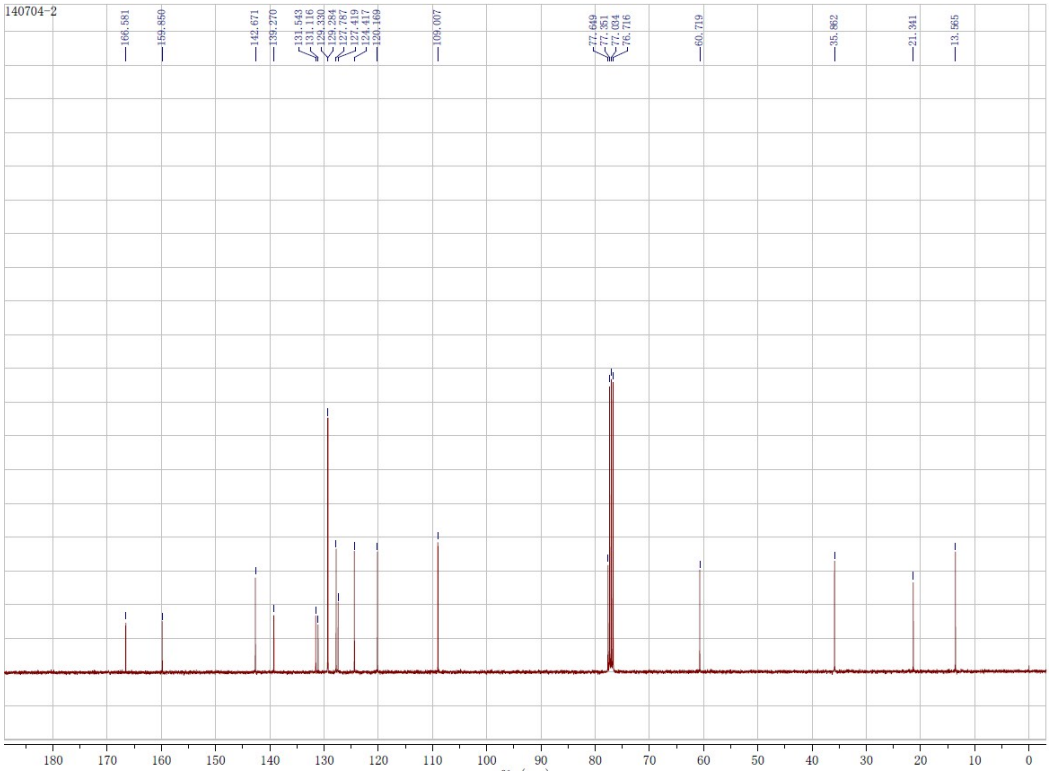

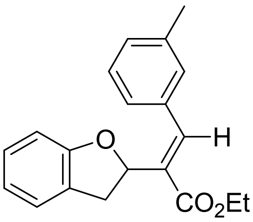
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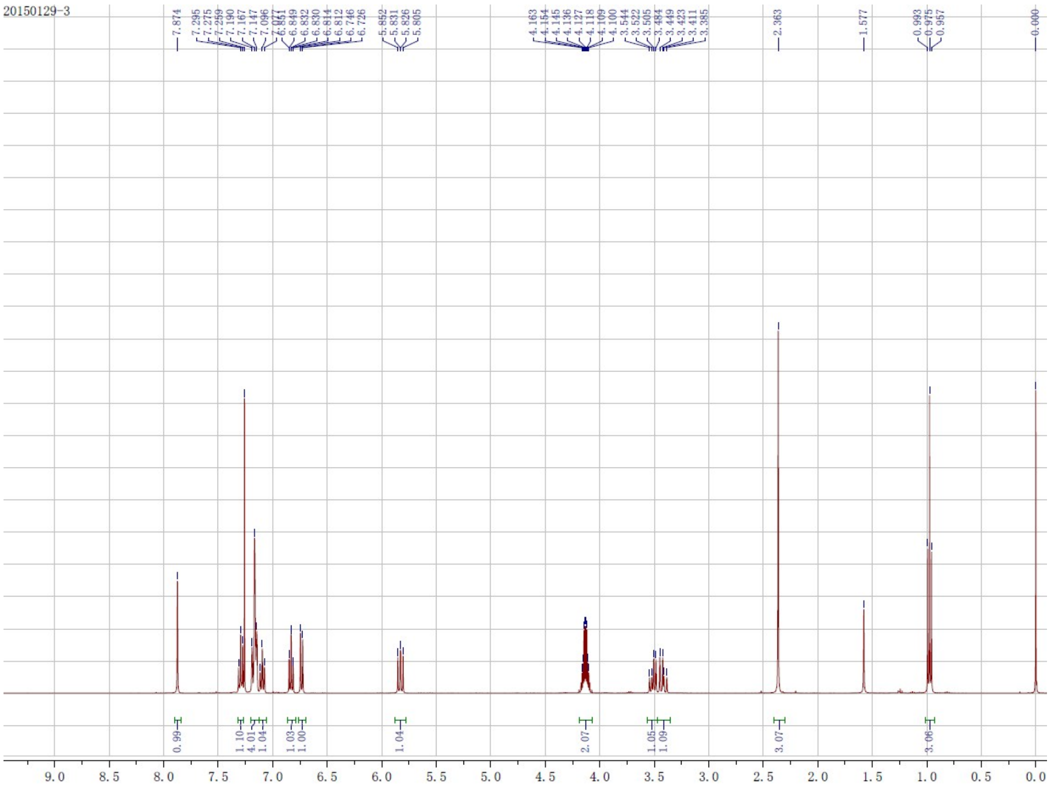
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6.812
6.746
6.726
5.852
5.831
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4.154
4.145
4.136
4.127
4.118
4.109
4.100
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3.522
3.505
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0.957
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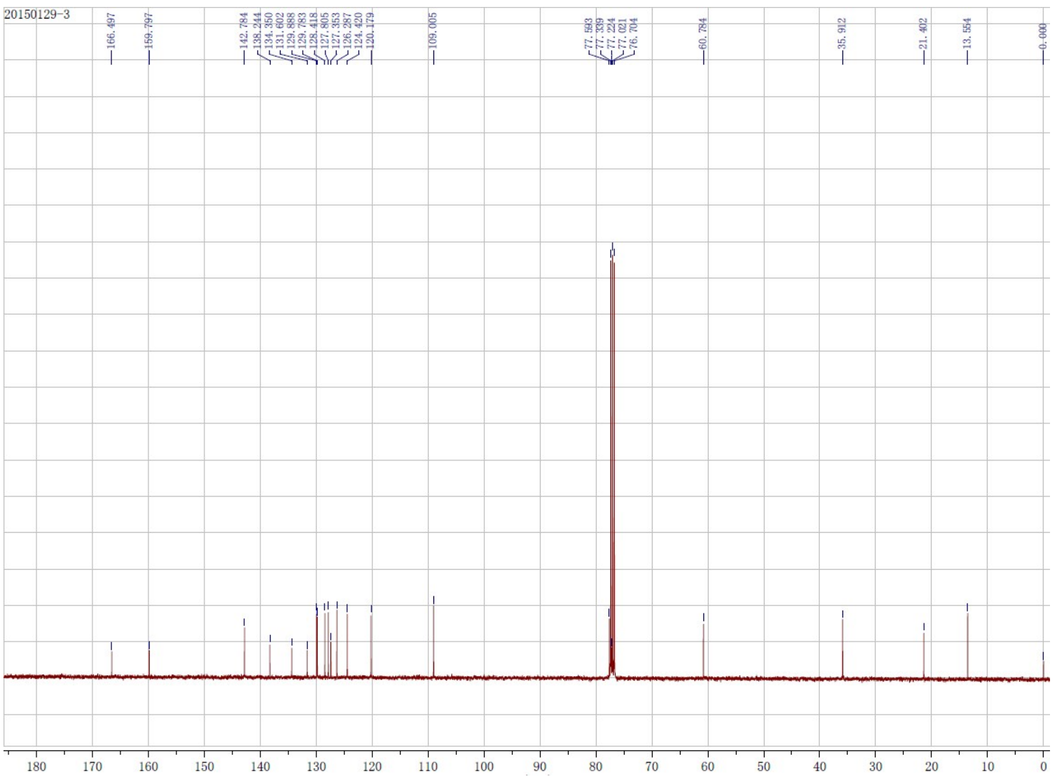
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77.224
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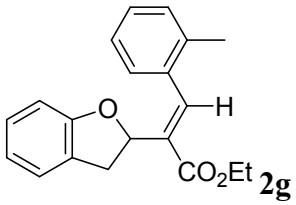

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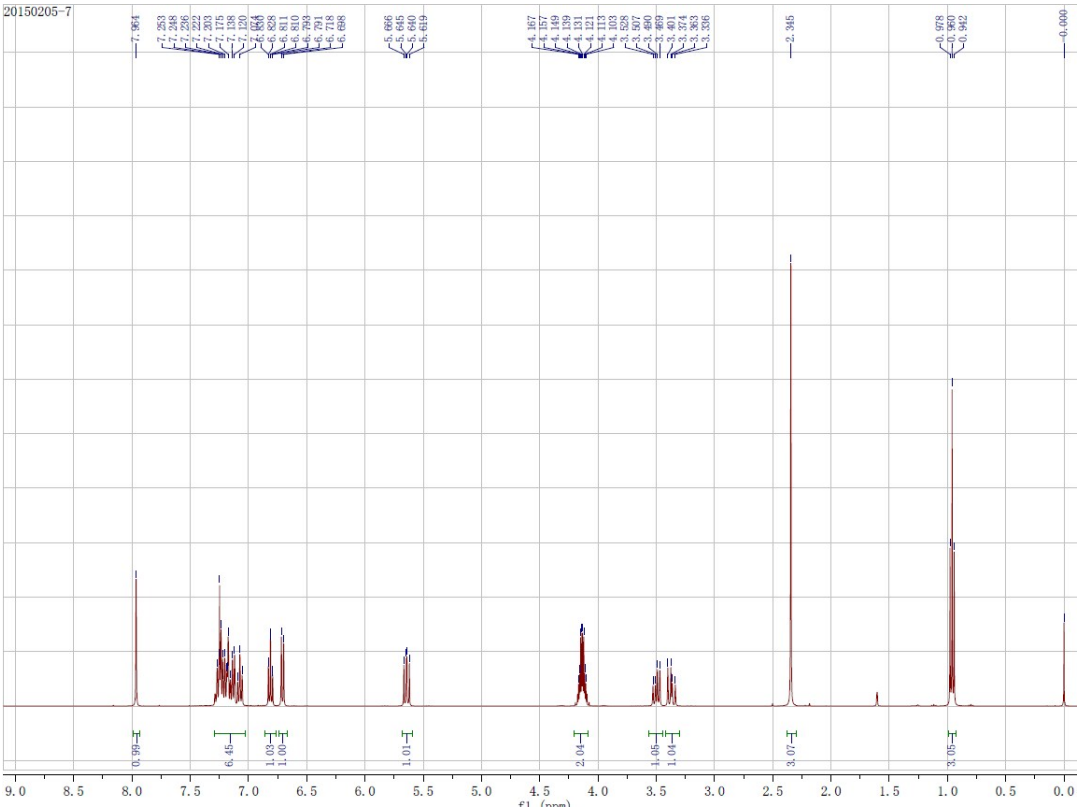

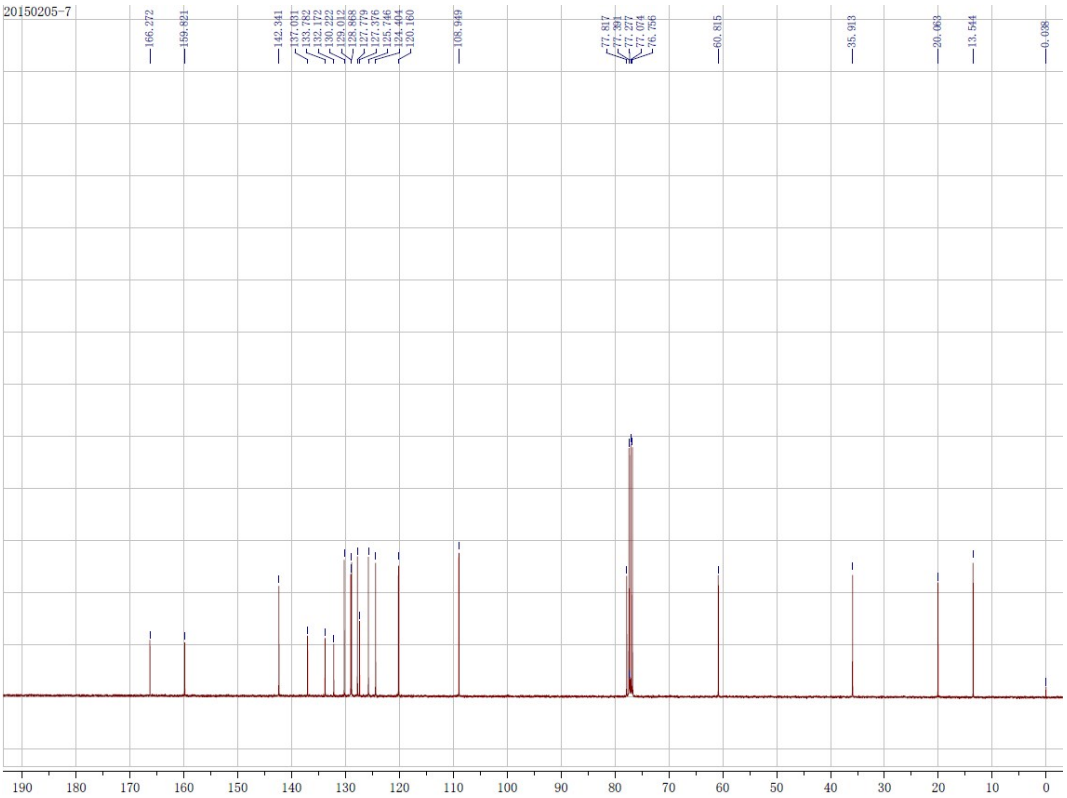

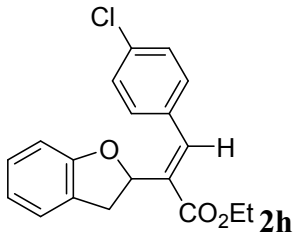

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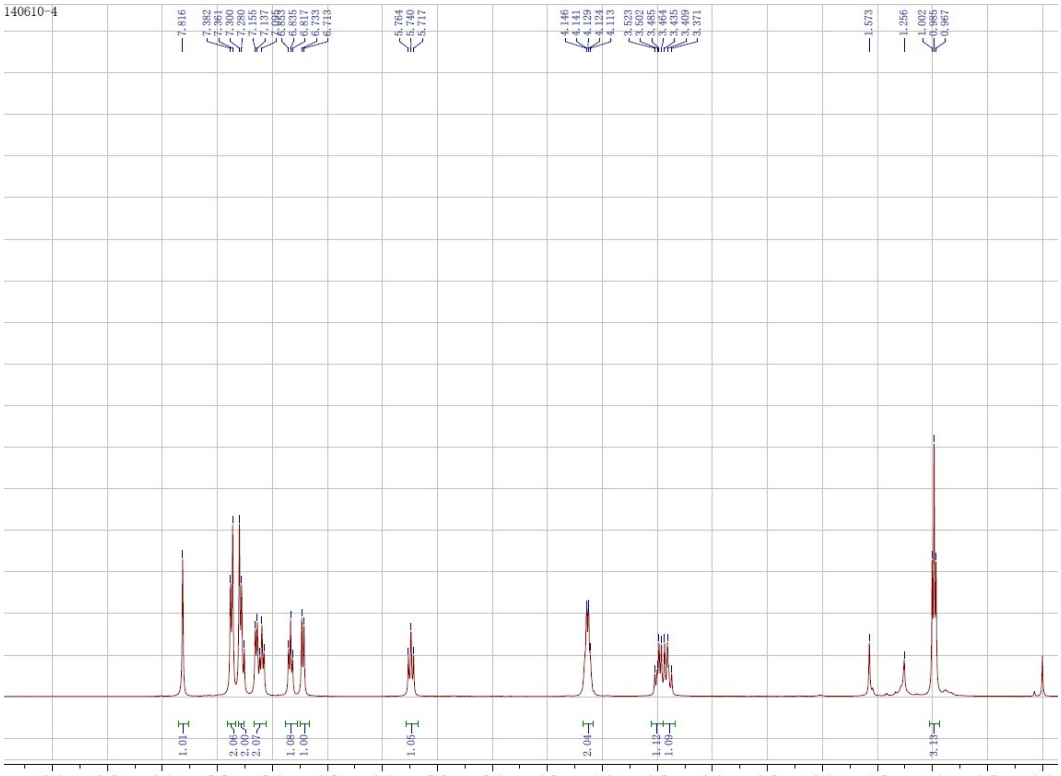

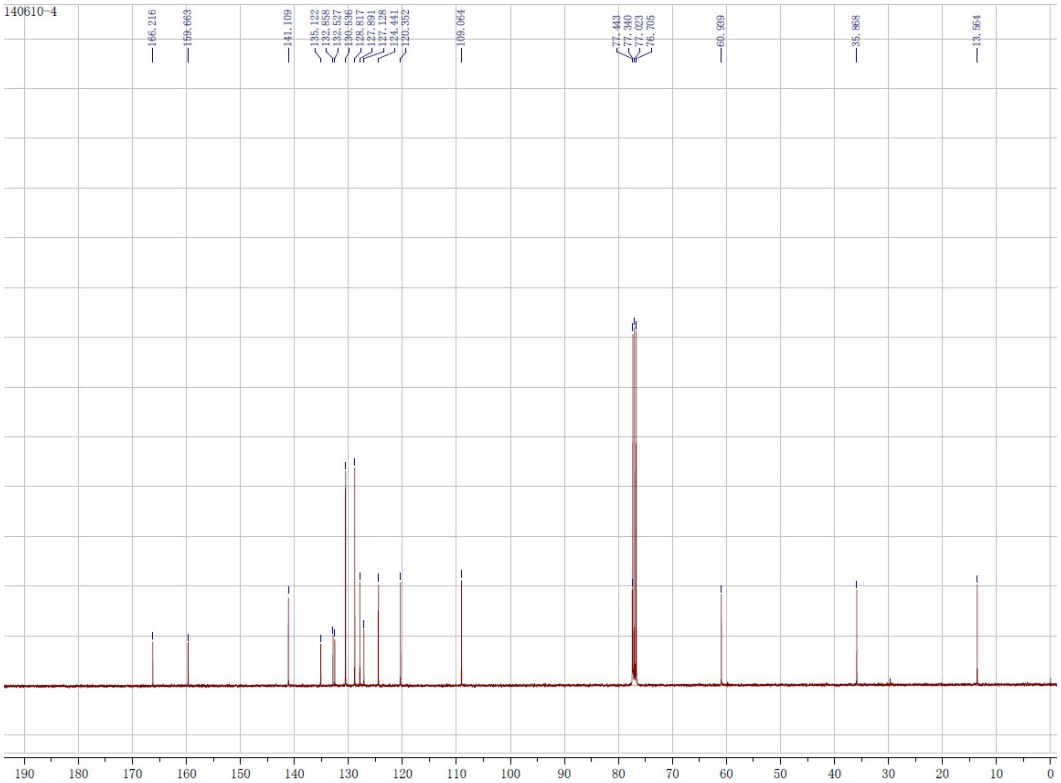

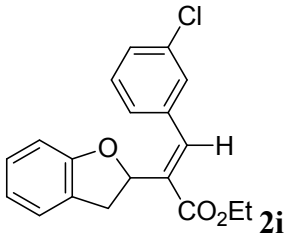

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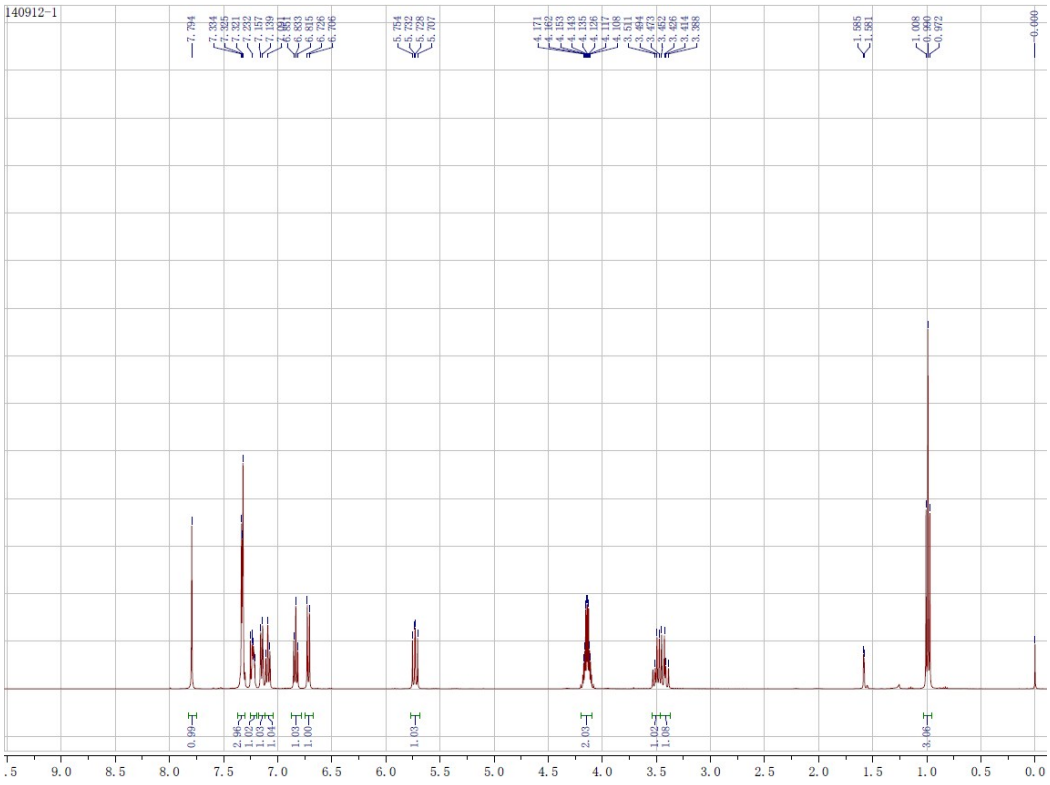

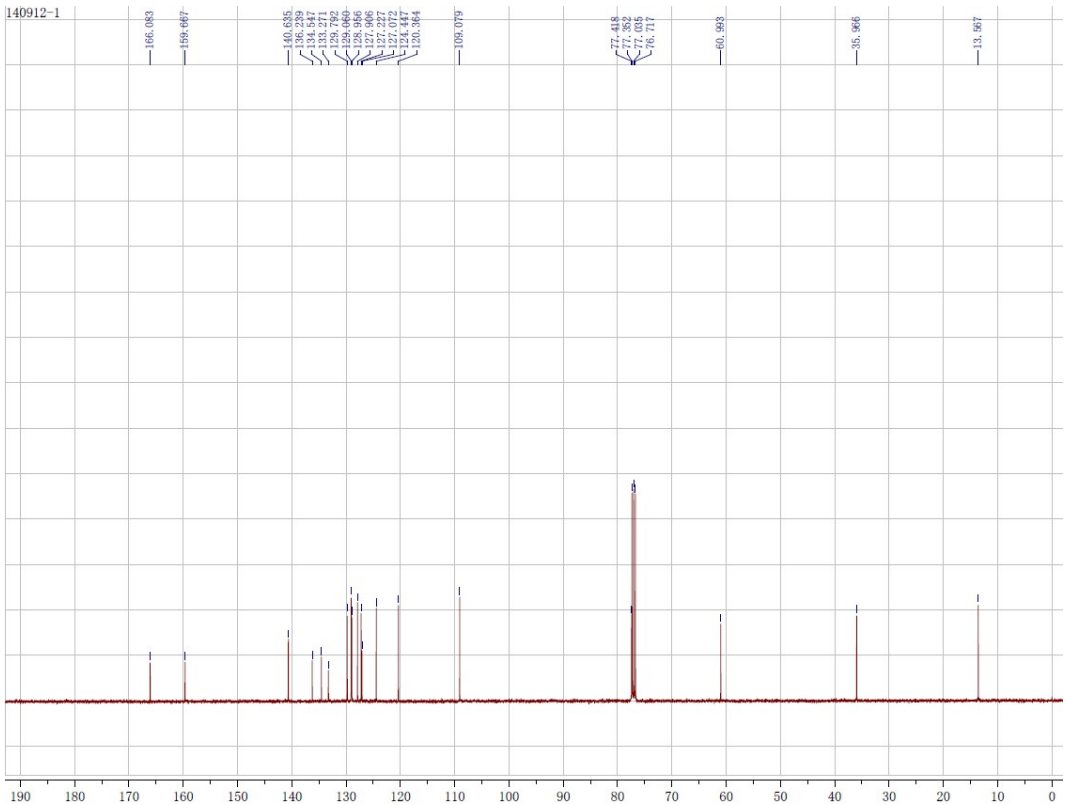

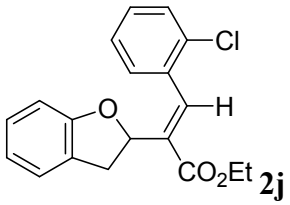

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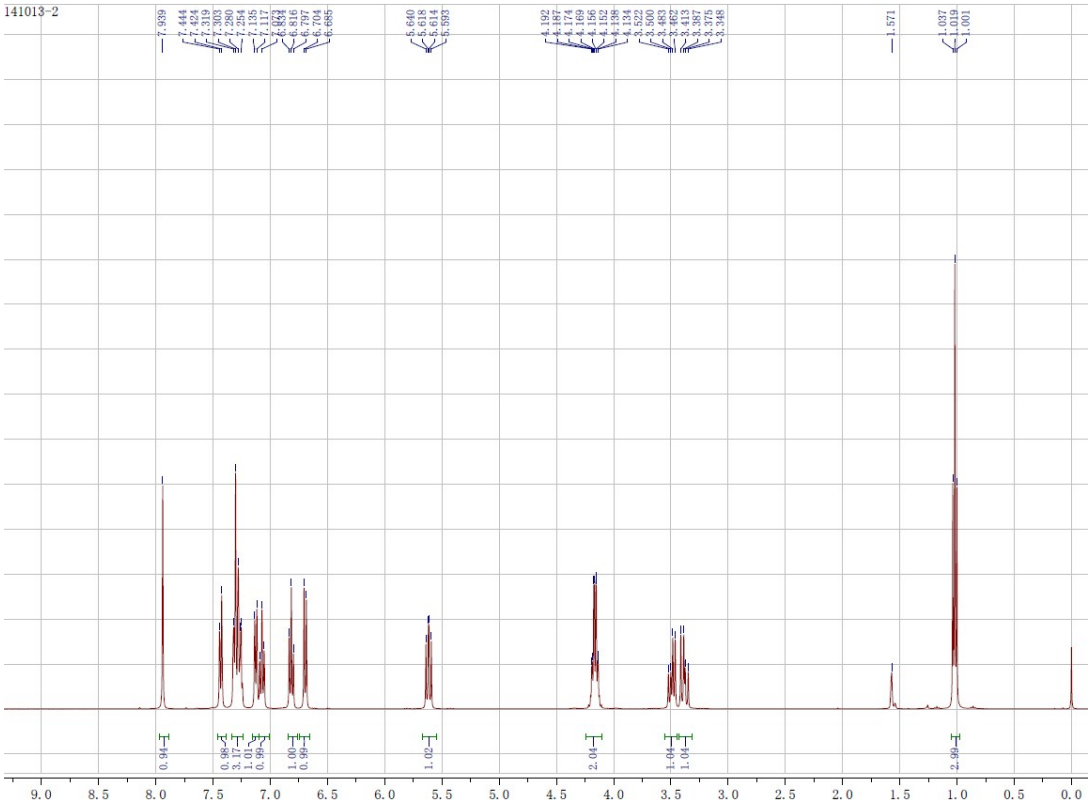

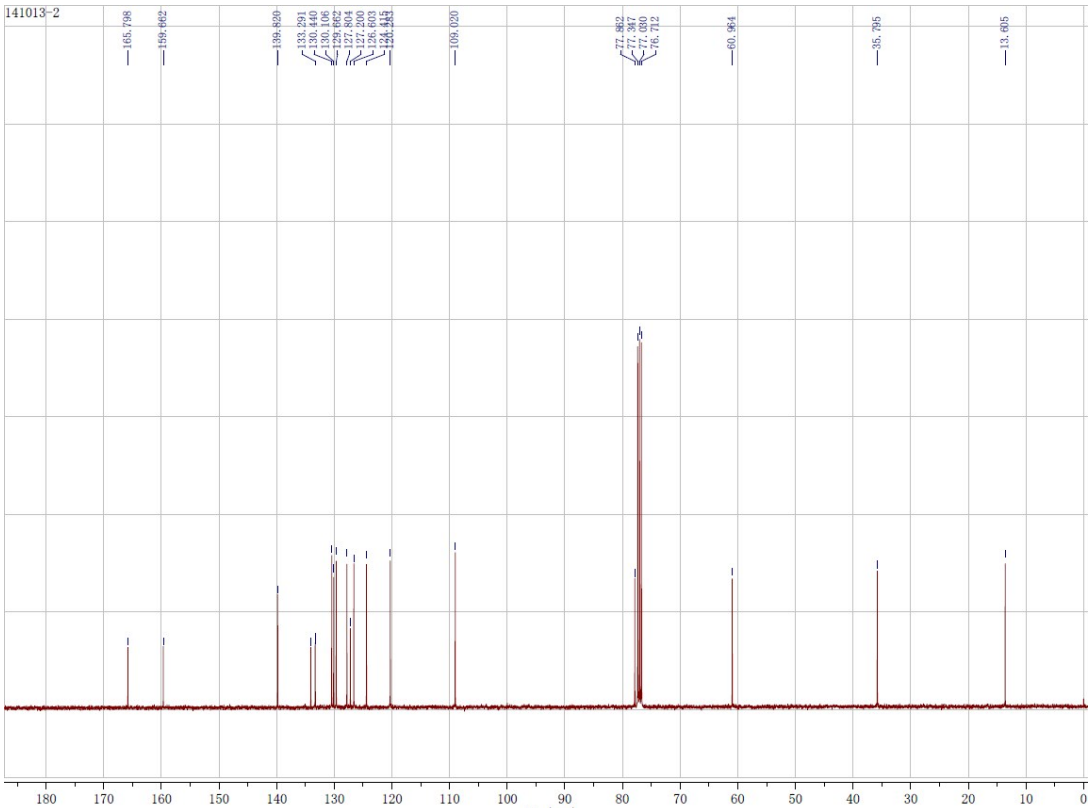

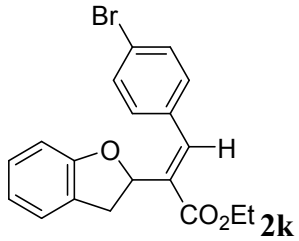

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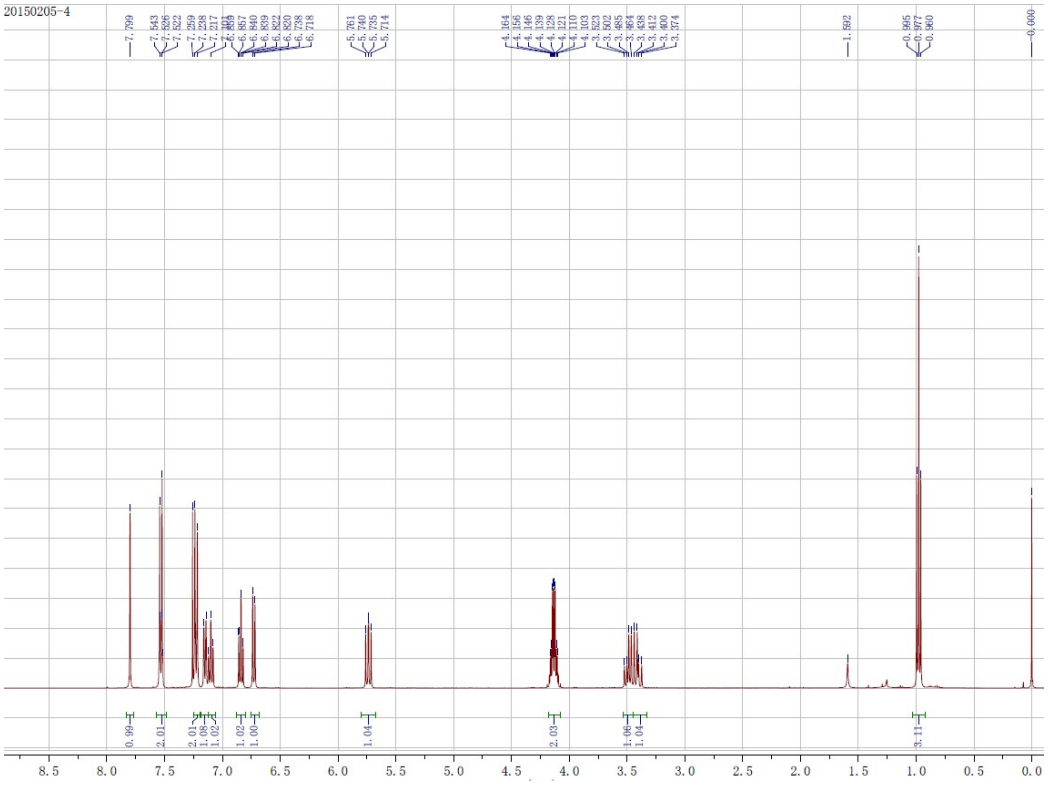

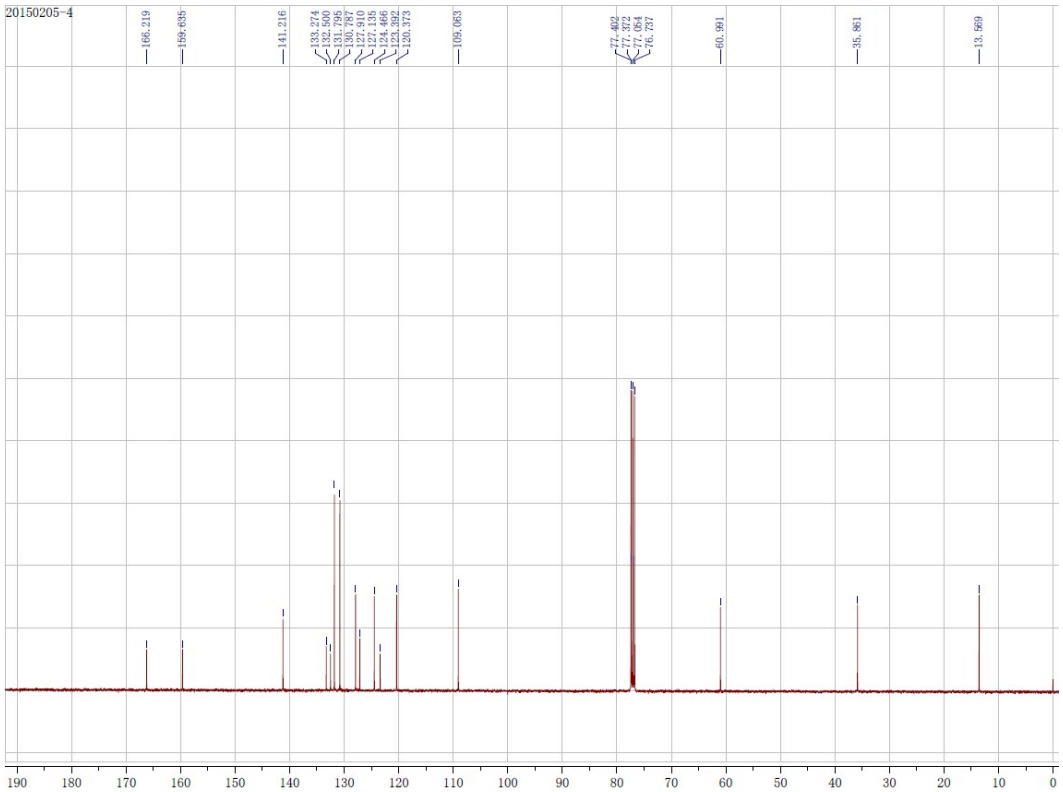

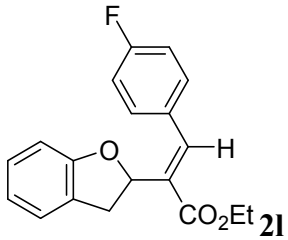
F
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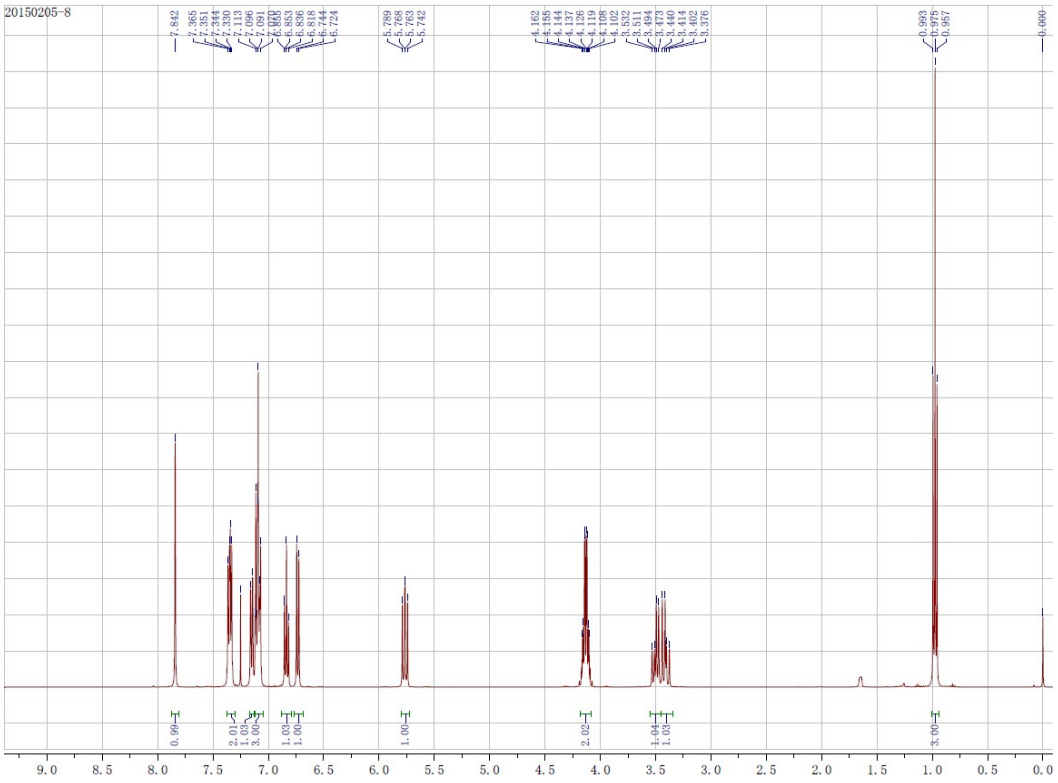
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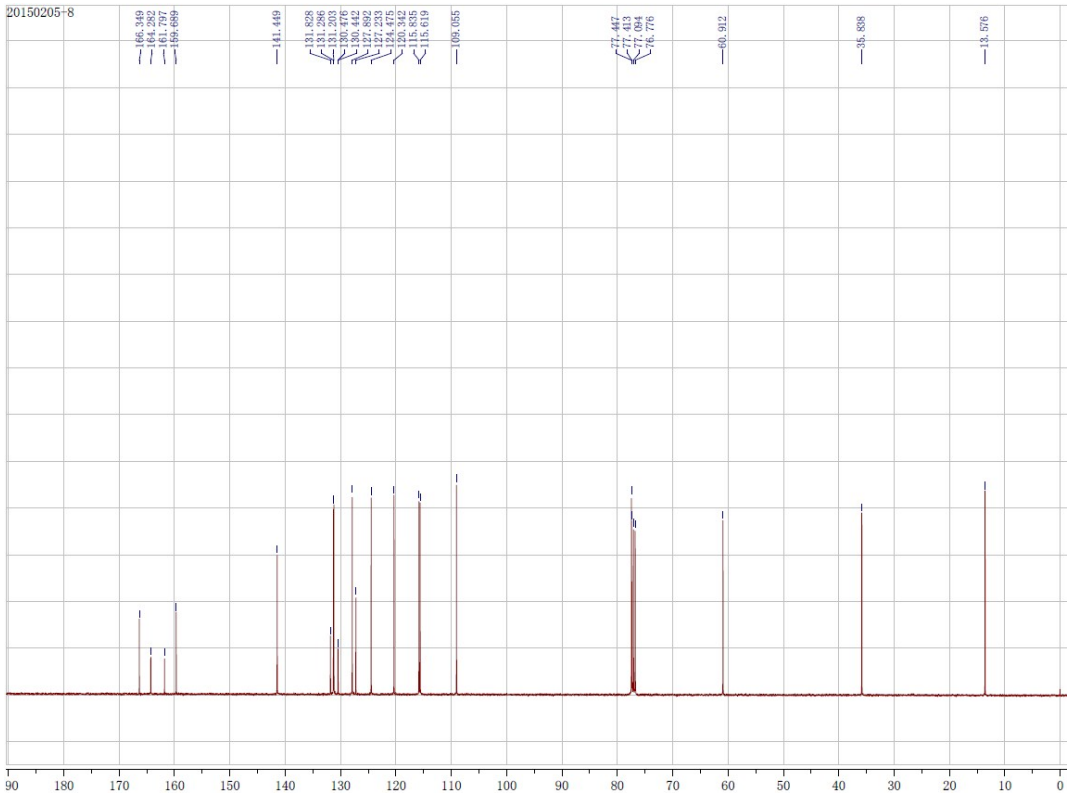
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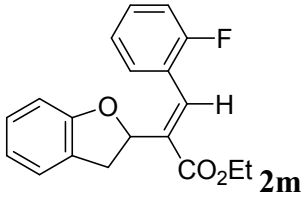

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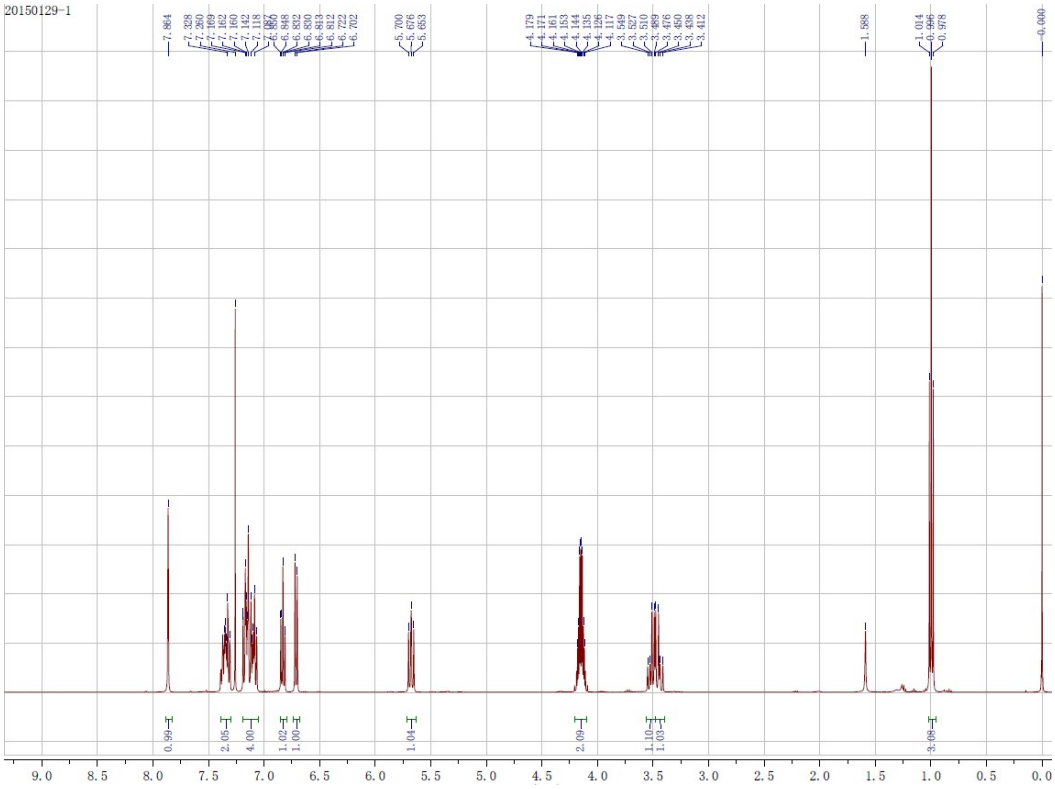

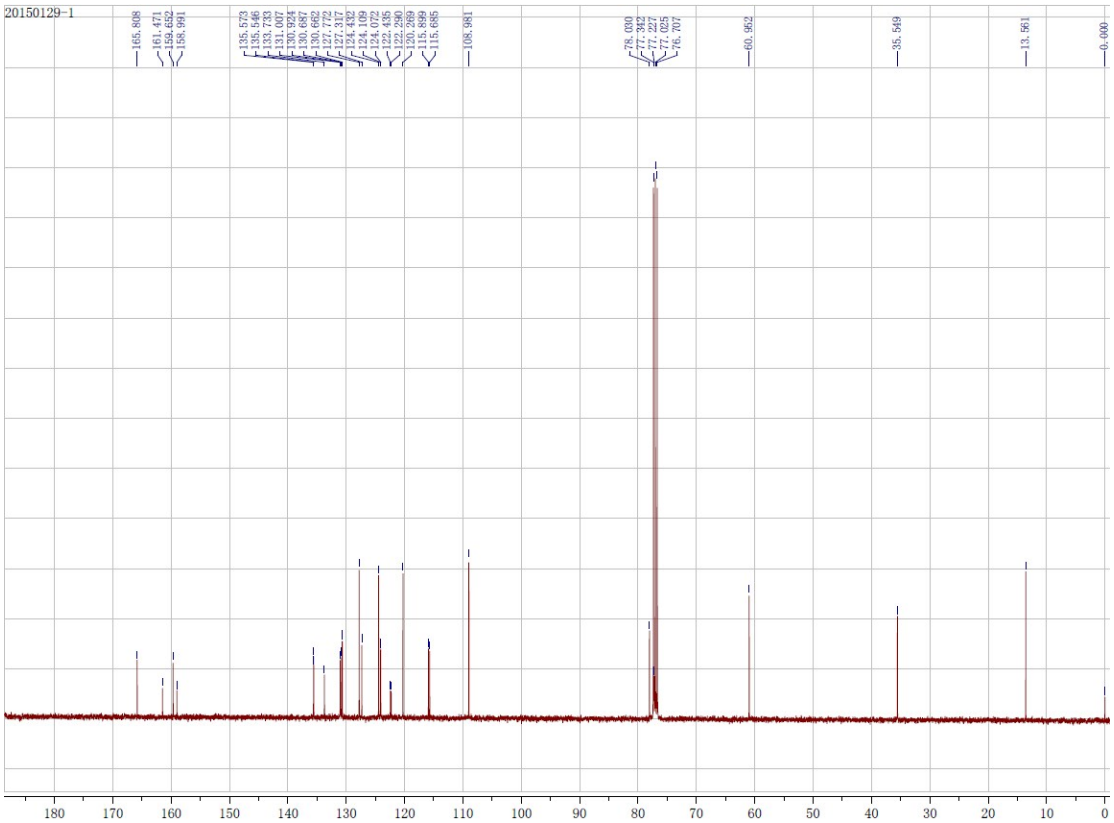

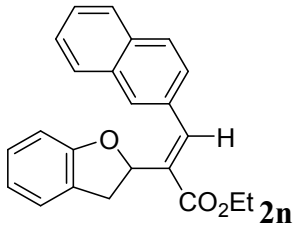

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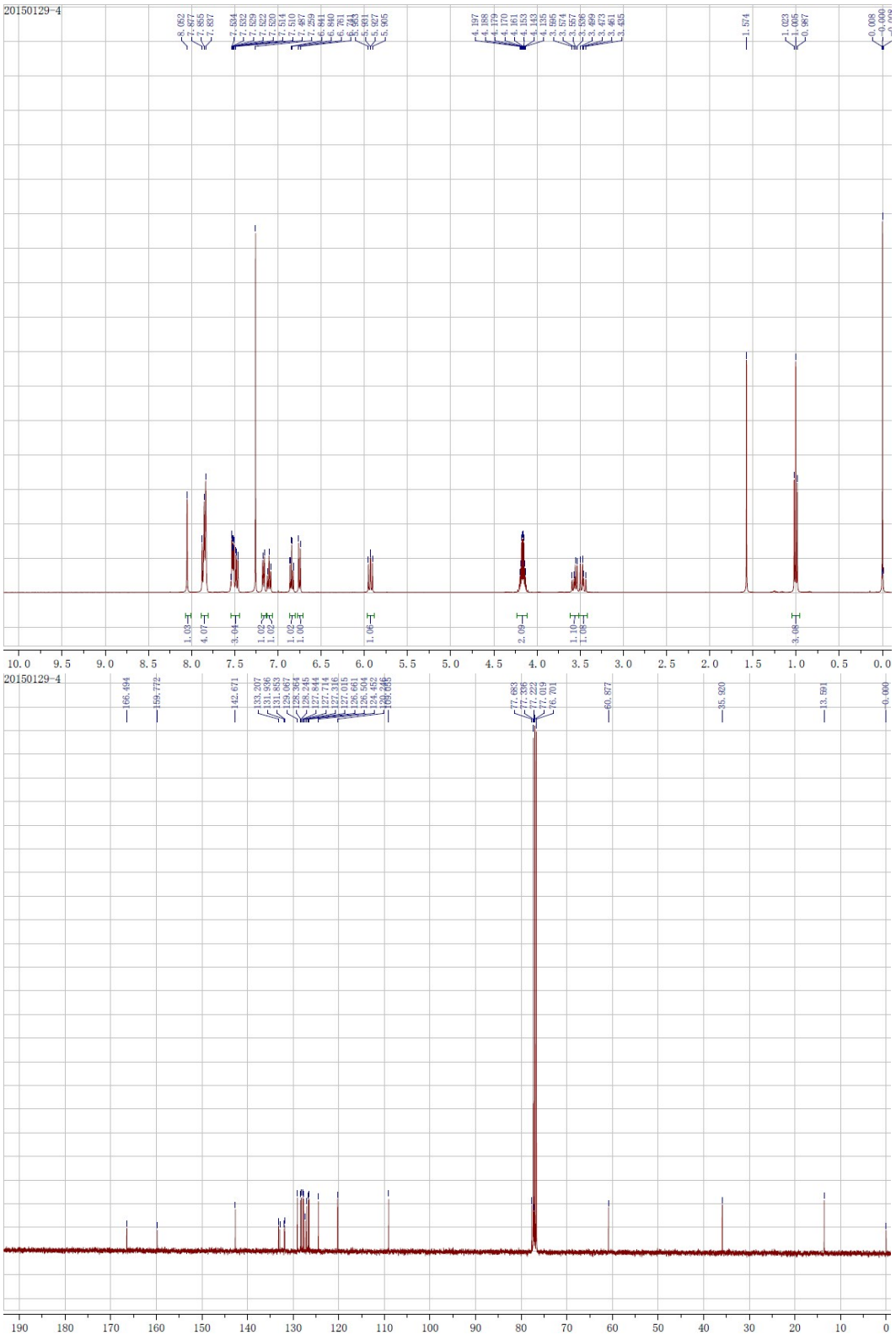

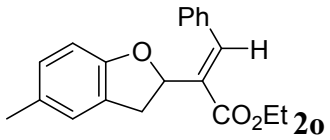
Ph
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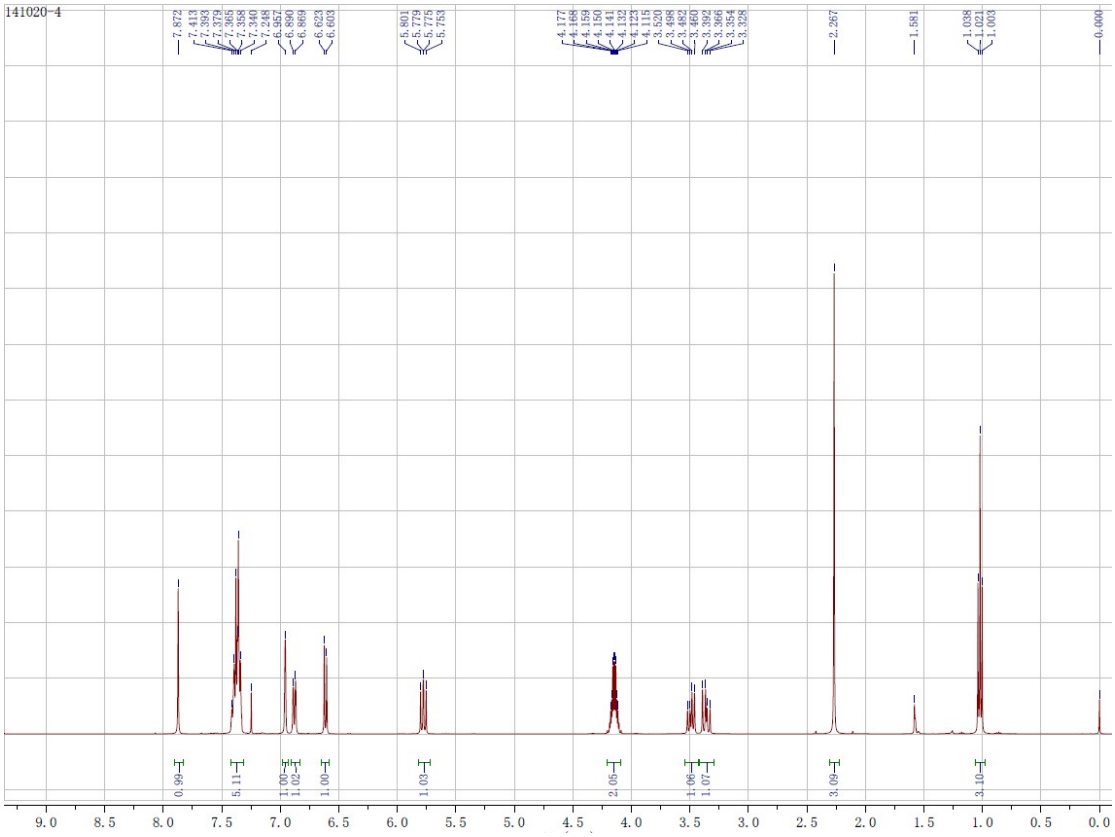
CO2Et

2o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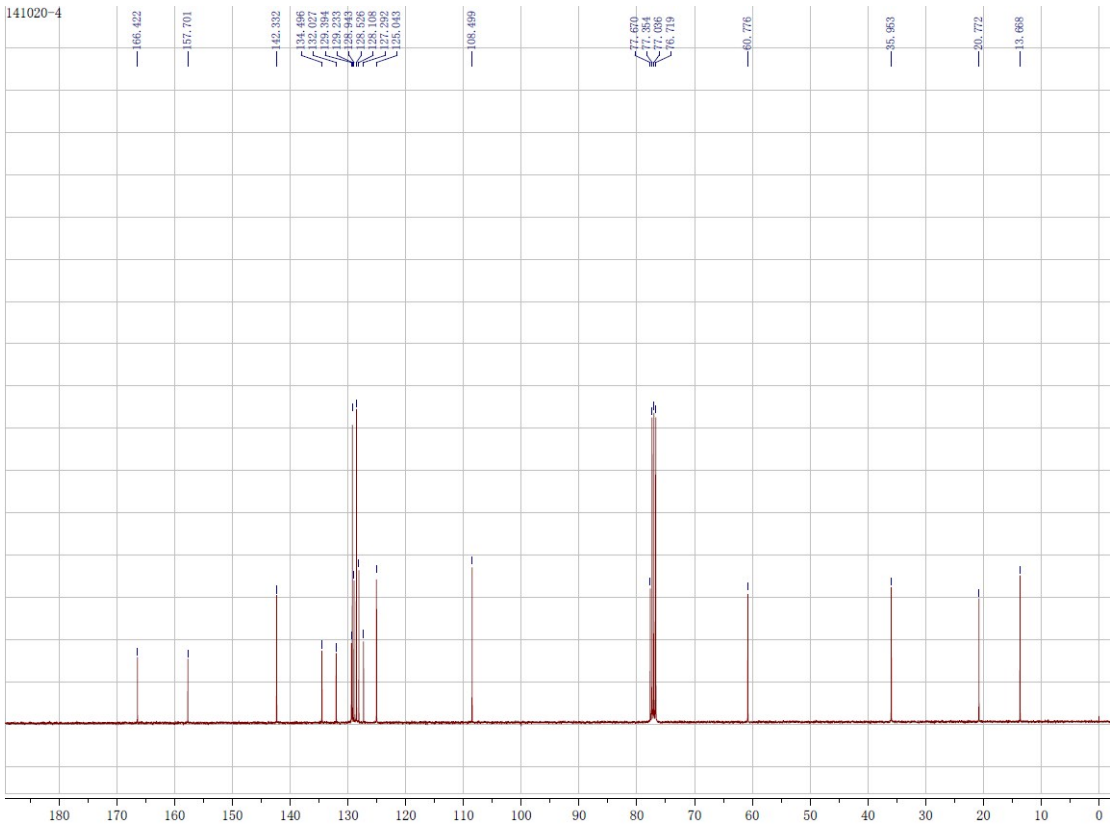
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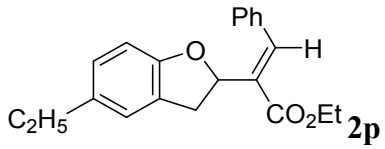
20.772
13.668



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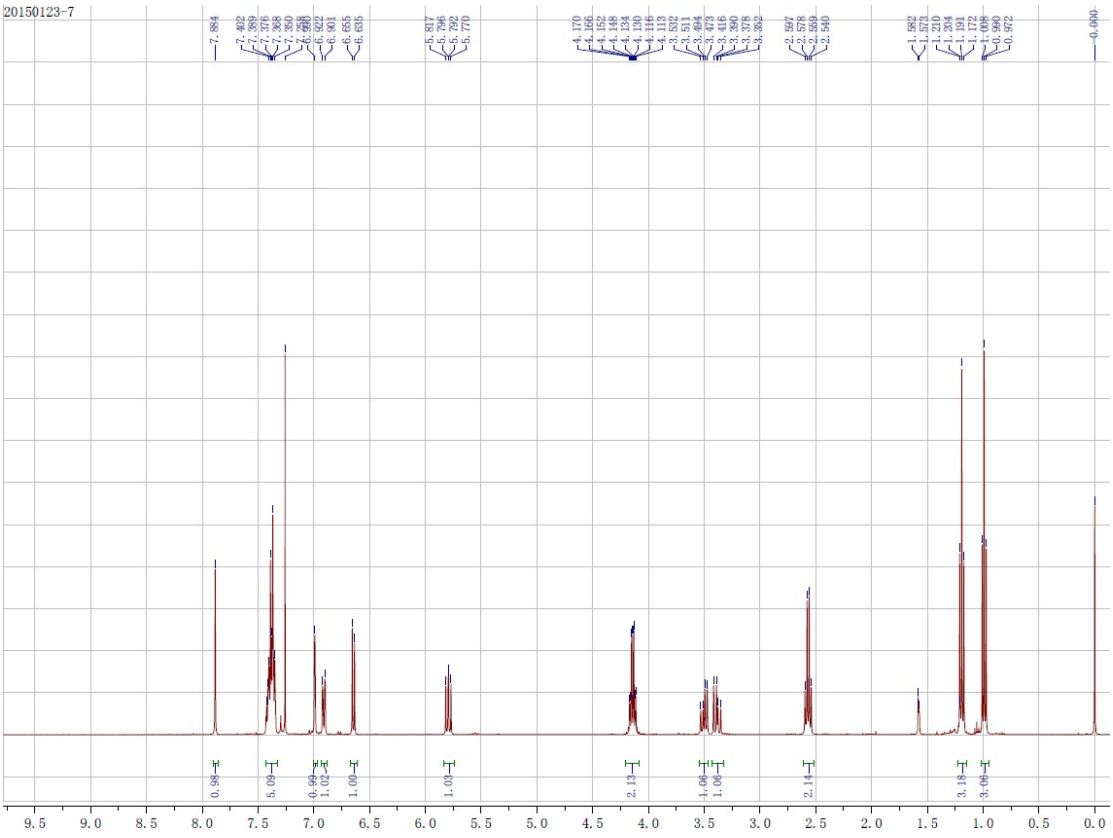

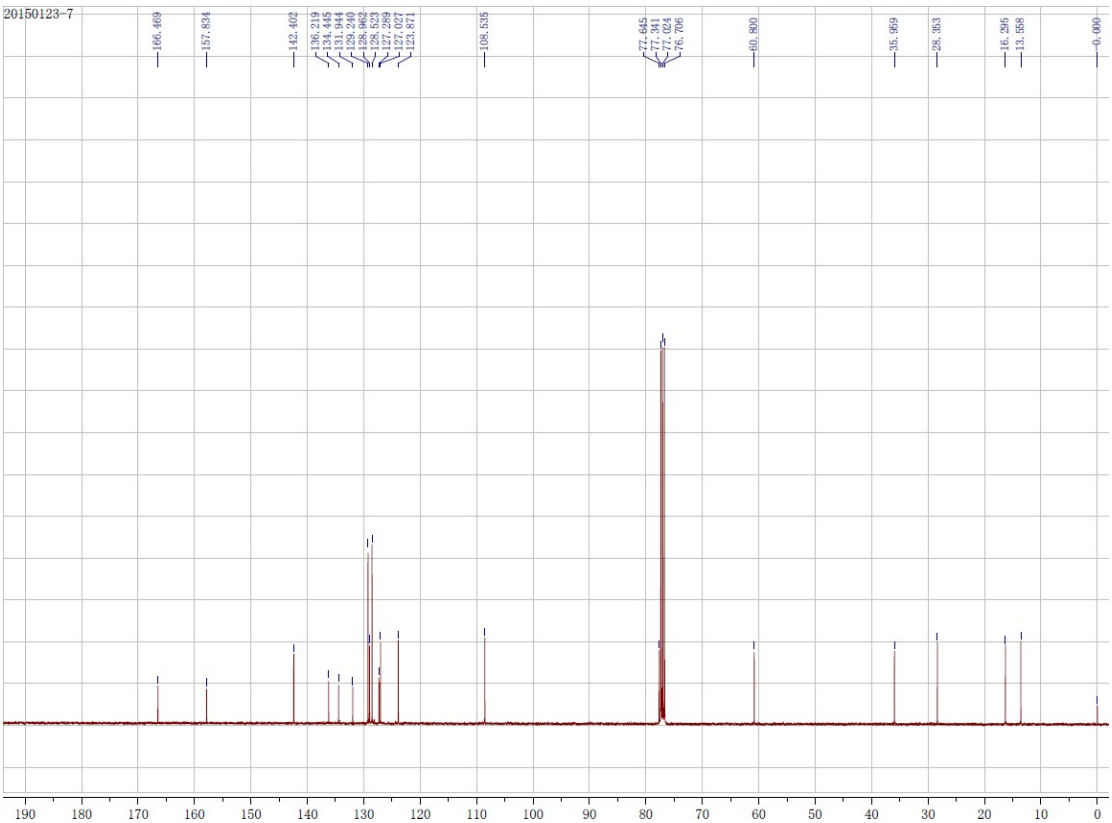

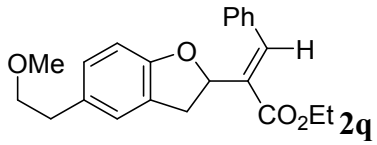

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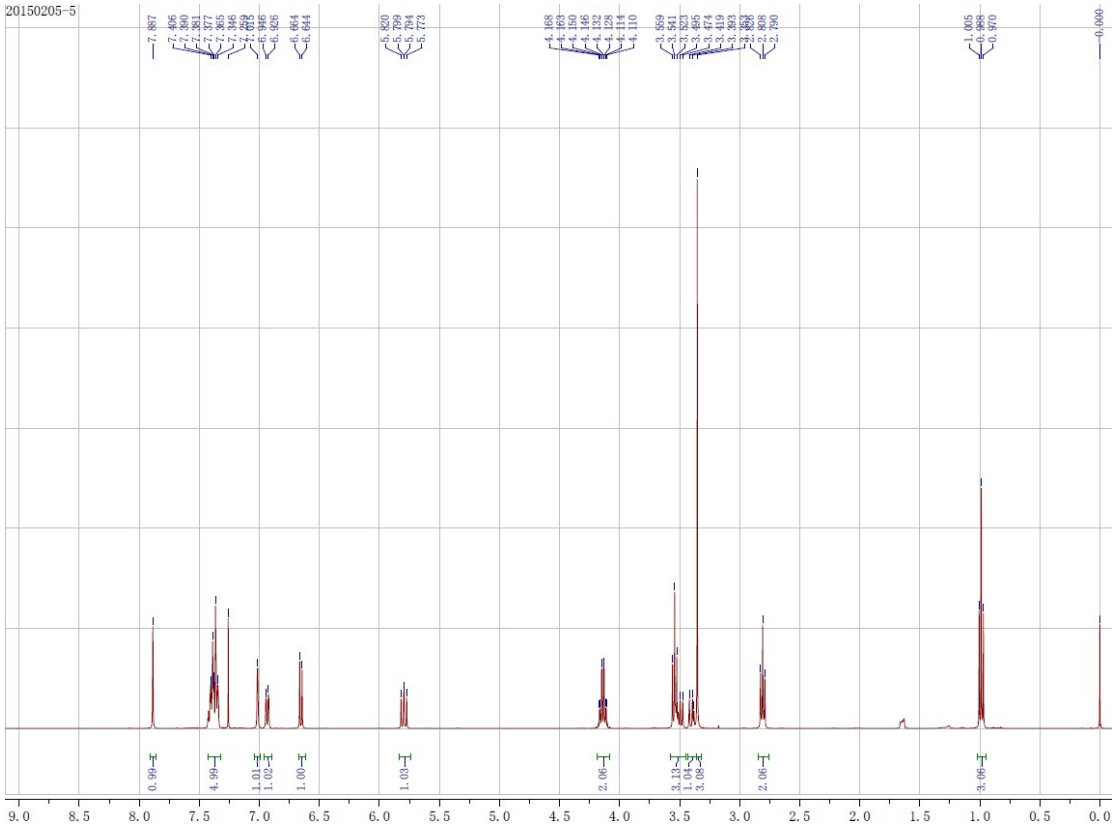
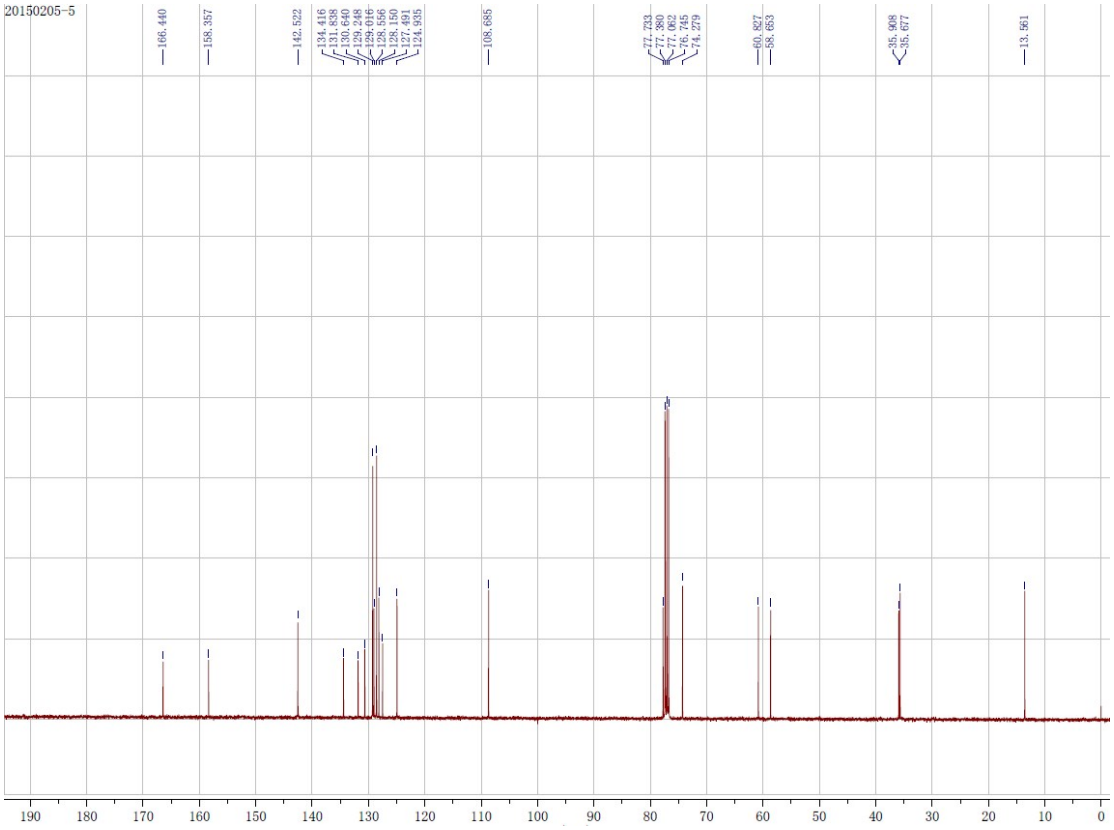
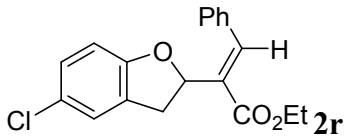
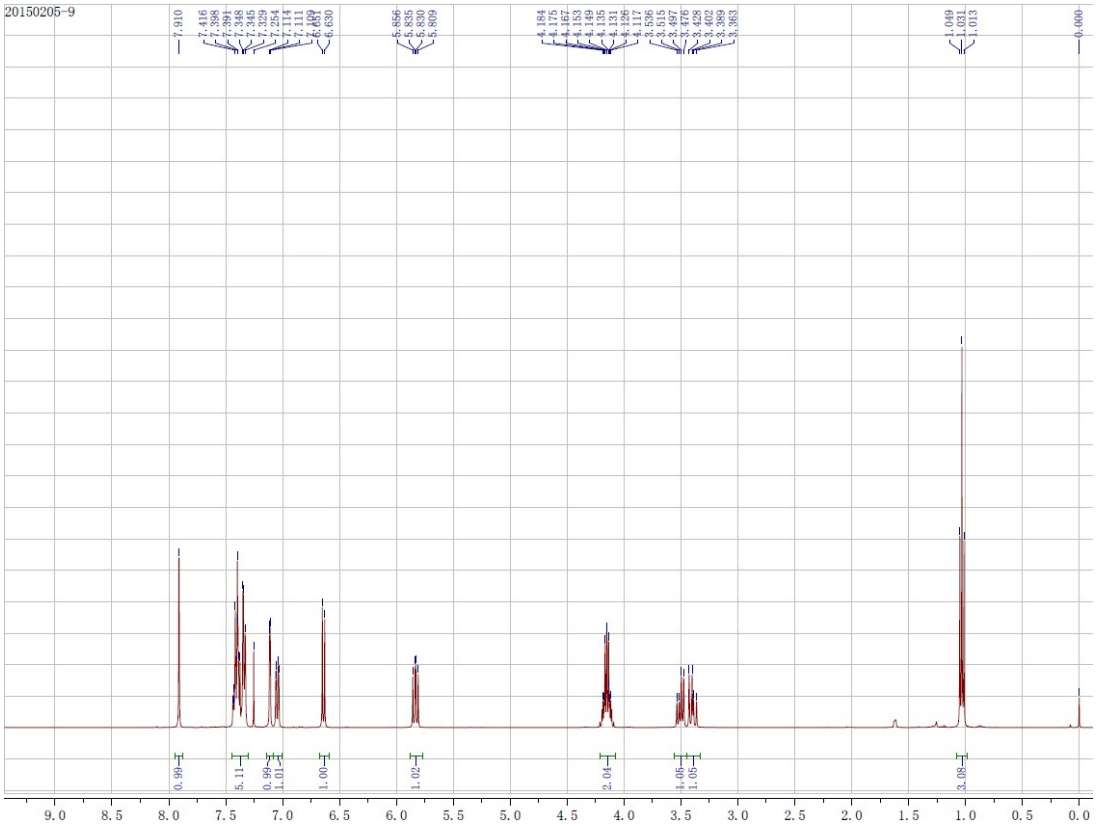
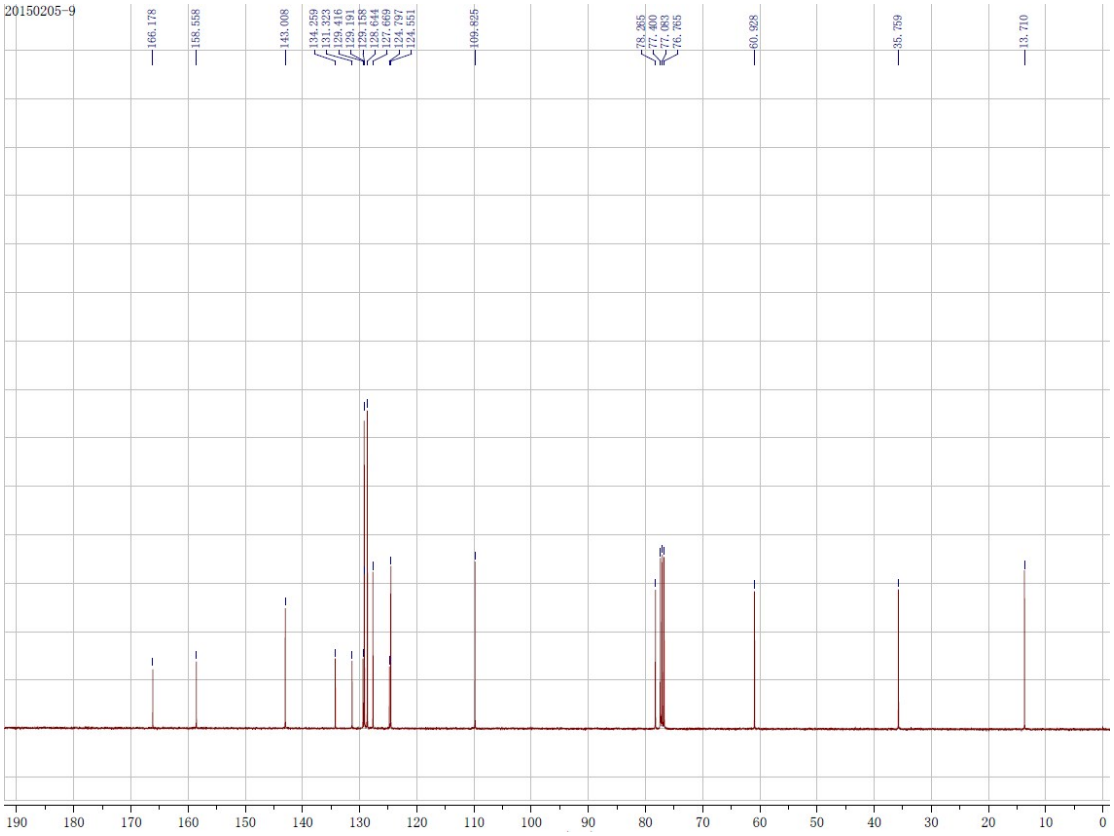


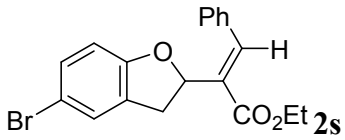



Ph
H
O
Cl
CO2Et

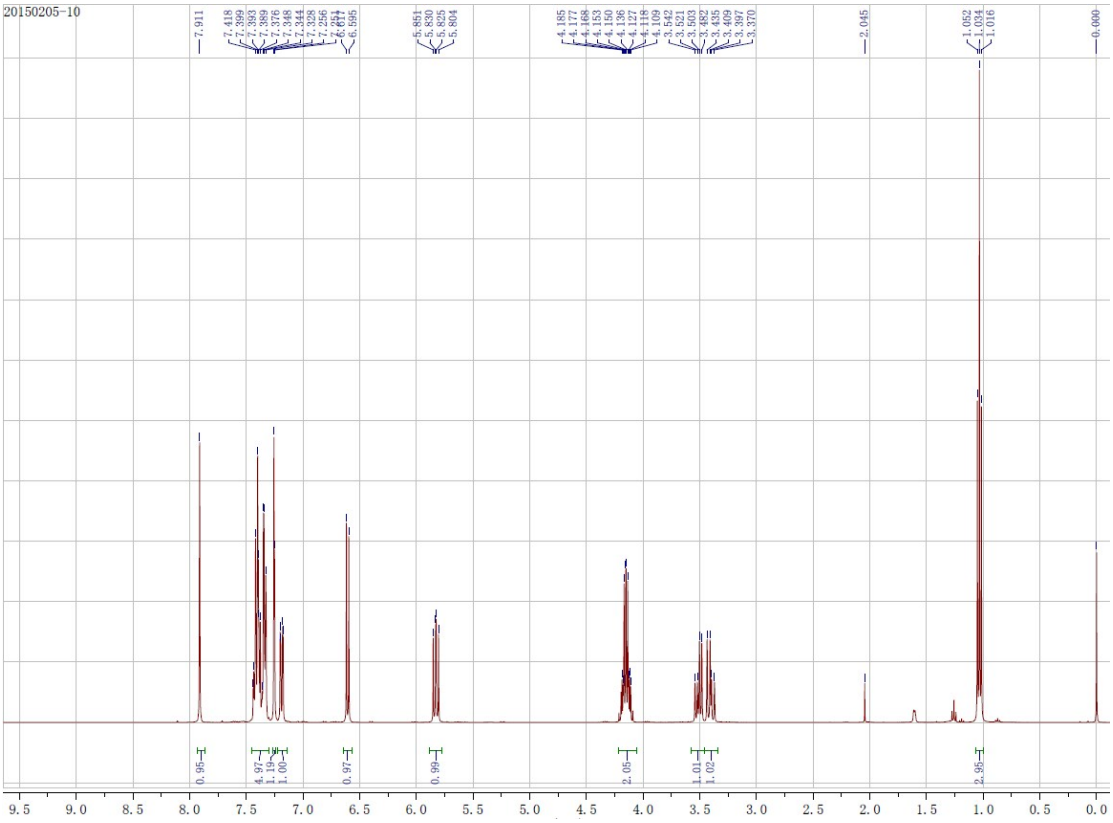
2r

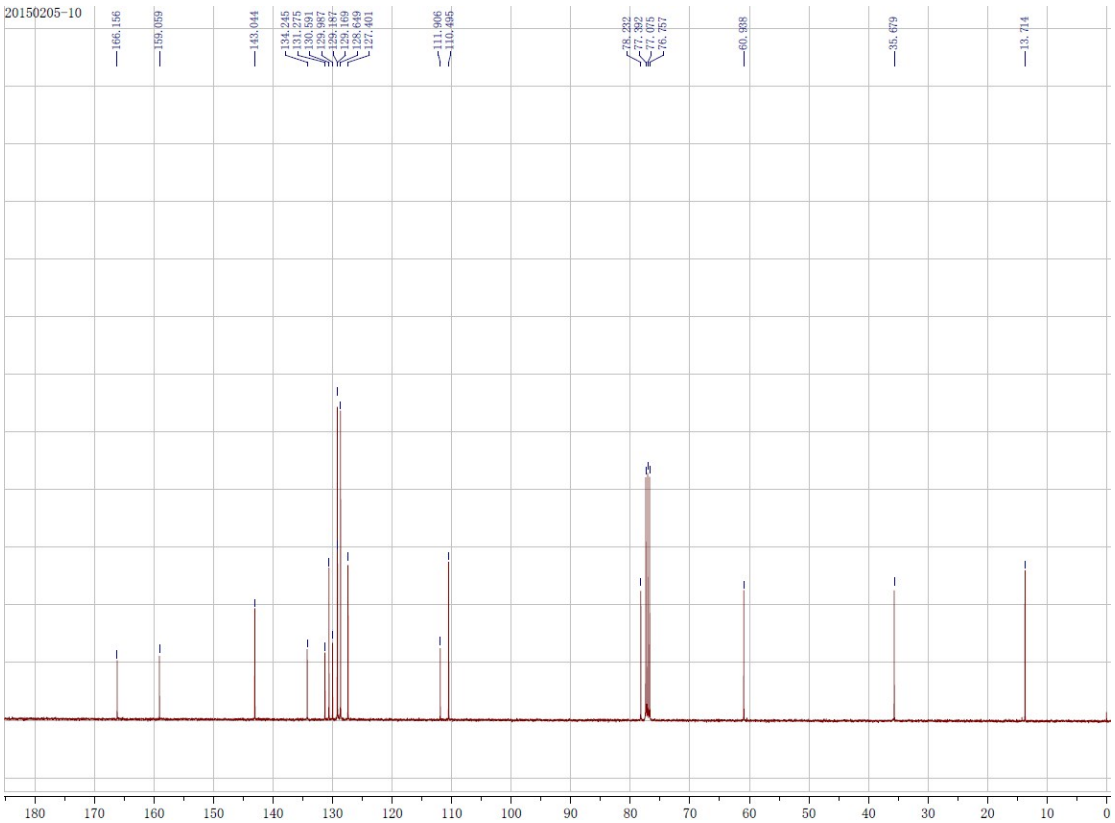

20150205-9
7.910
7.416
7.398
7.391
7.348
7.345
7.329
7.254
7.114
7.111
6.634
6.630
5.866
5.835
5.830
5.809
4.184
4.175
4.167
4.153
4.149
4.135
4.131
4.126
4.117
3.536
3.515
3.497
3.476
3.428
3.402
3.389
3.363
1.049
1.031
1.013
0.000
0.99
5.11
0.99
1.01
1.00
1.02
2.04
1.06
1.06
3.08
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

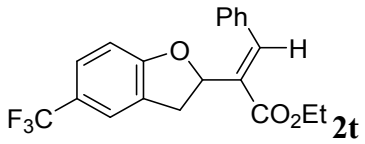

20150205-9
166.178
158.558
143.008
134.259
131.323
129.416
129.191
129.158
128.644
127.669
124.797
124.551
109.825
78.265
77.400
77.083
76.765
60.928
35.759
13.710
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0



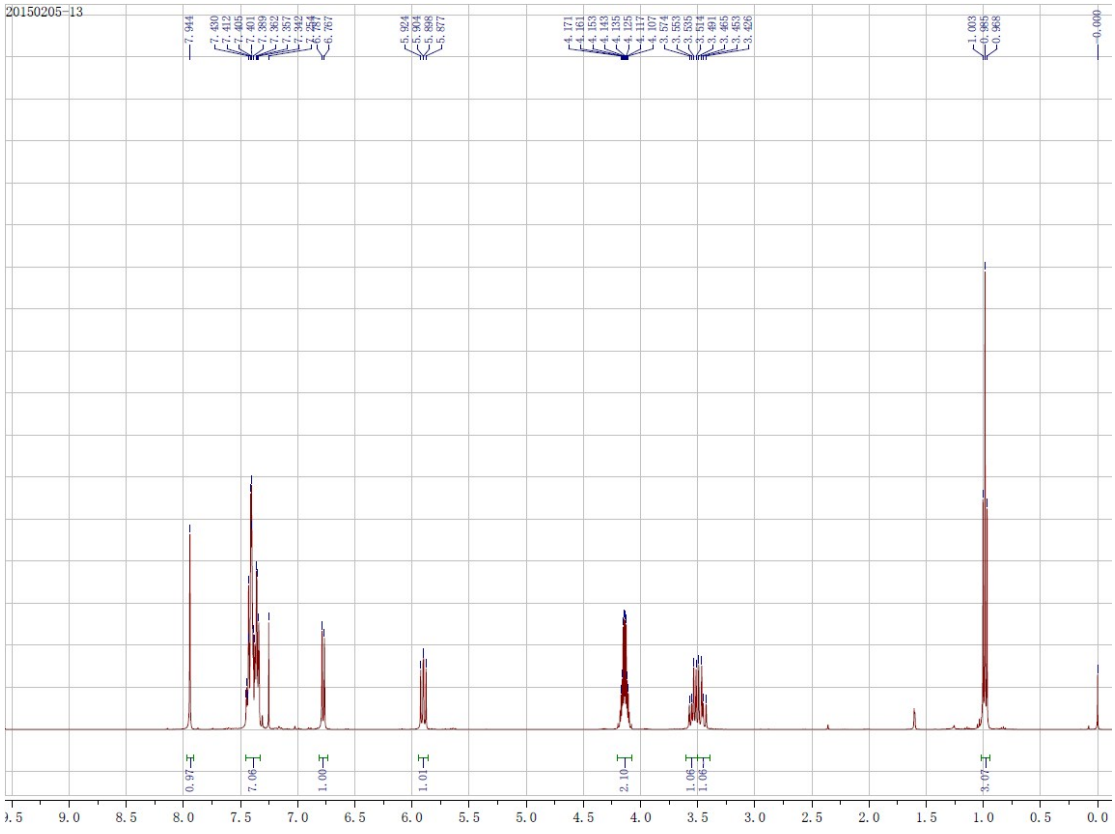
2s






Ph
H
O
F3C
CO2Et

2t


20150205-13
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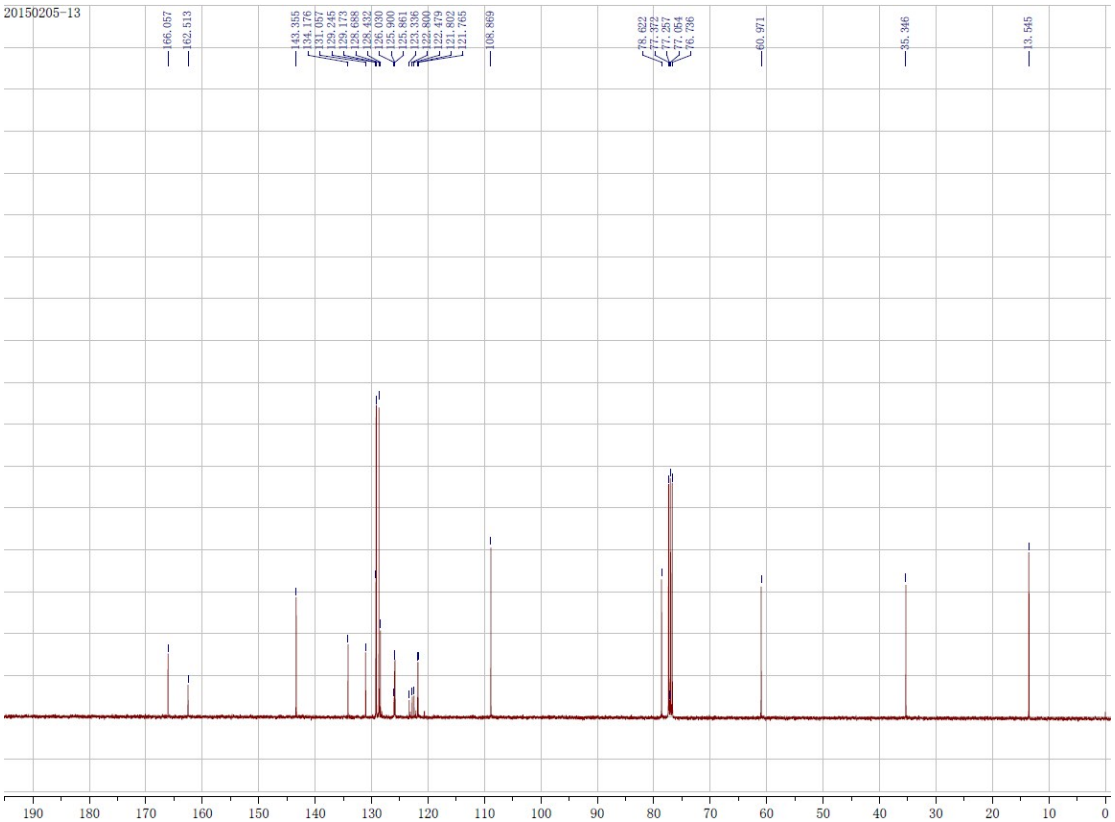
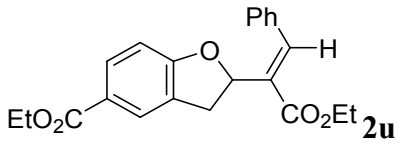
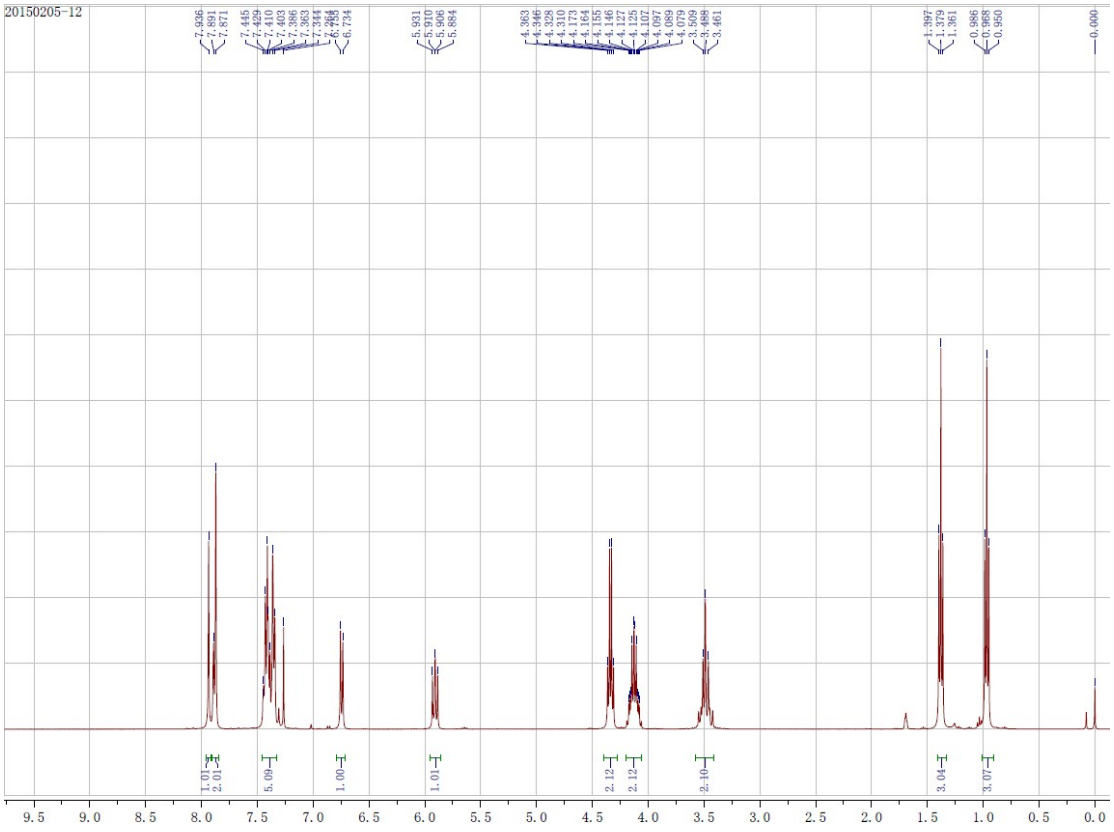
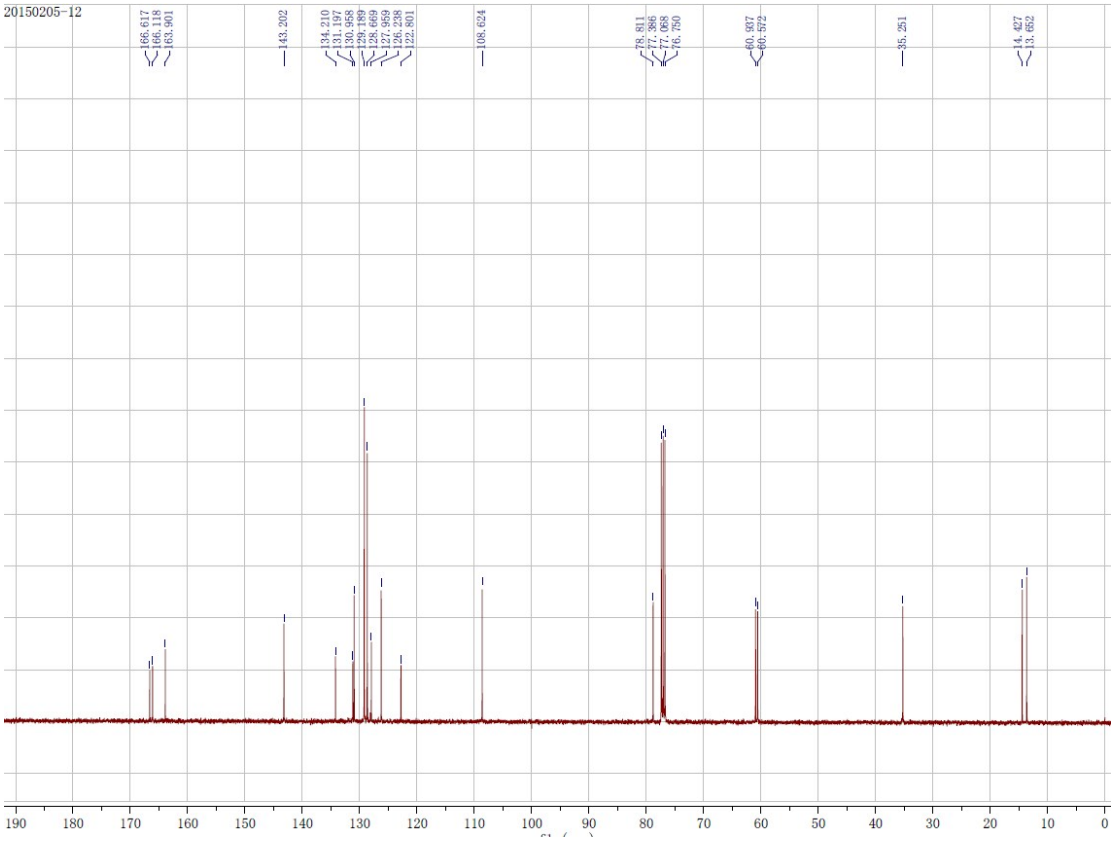
7.430
7.412
7.401
7.389
7.382
7.357
5.924
5.904
5.898
5.877
4.171
4.161
4.153
4.143
4.135
4.125
4.117
4.107
3.574
3.553
3.535
3.491
3.465
3.453
3.426
1.003
0.985
0.966
0.000
0.97
7.06
1.00
1.01
2.10
1.06
1.06
3.07

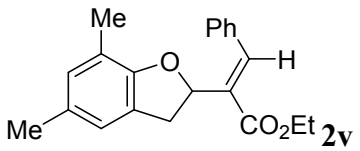

20150205-13
166.057
162.513
143.355
134.176
131.057
129.245
129.173
128.688
128.432
126.600
125.900
125.861
123.336
122.800
122.479
121.802
121.765
108.869
78.622
77.372
77.257
77.054
76.736
60.971
35.346
13.545



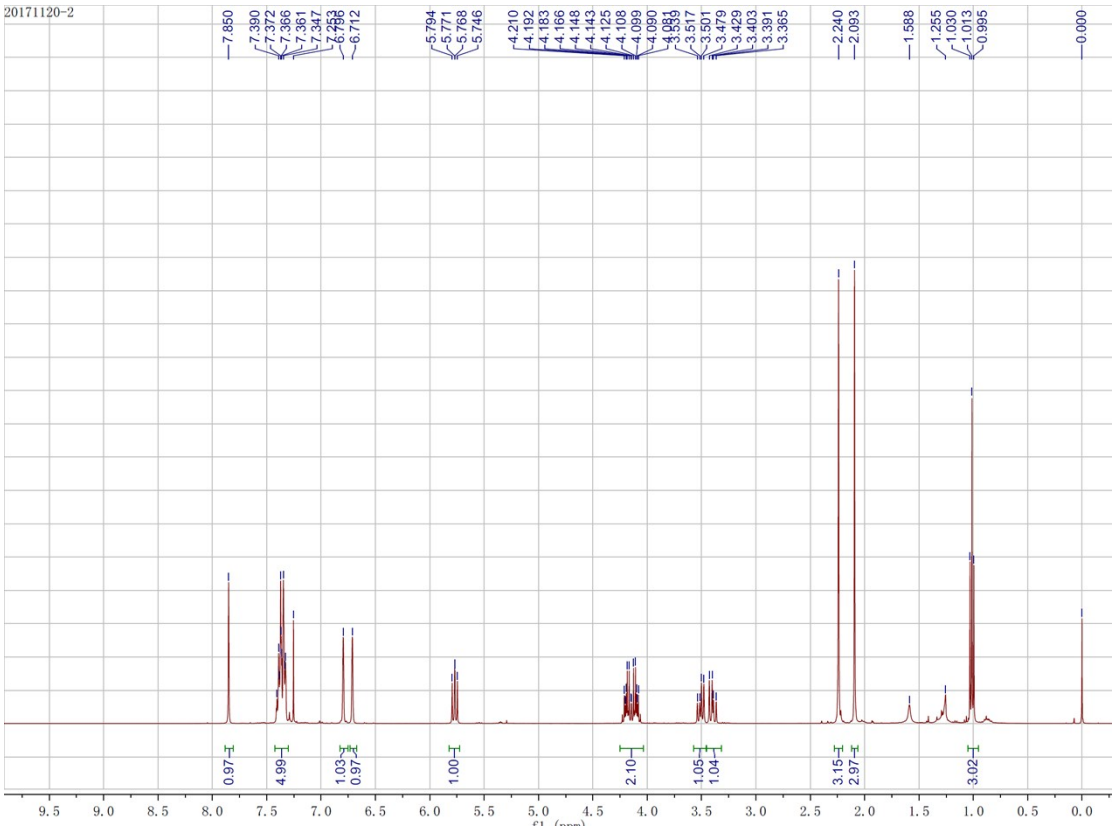
2u

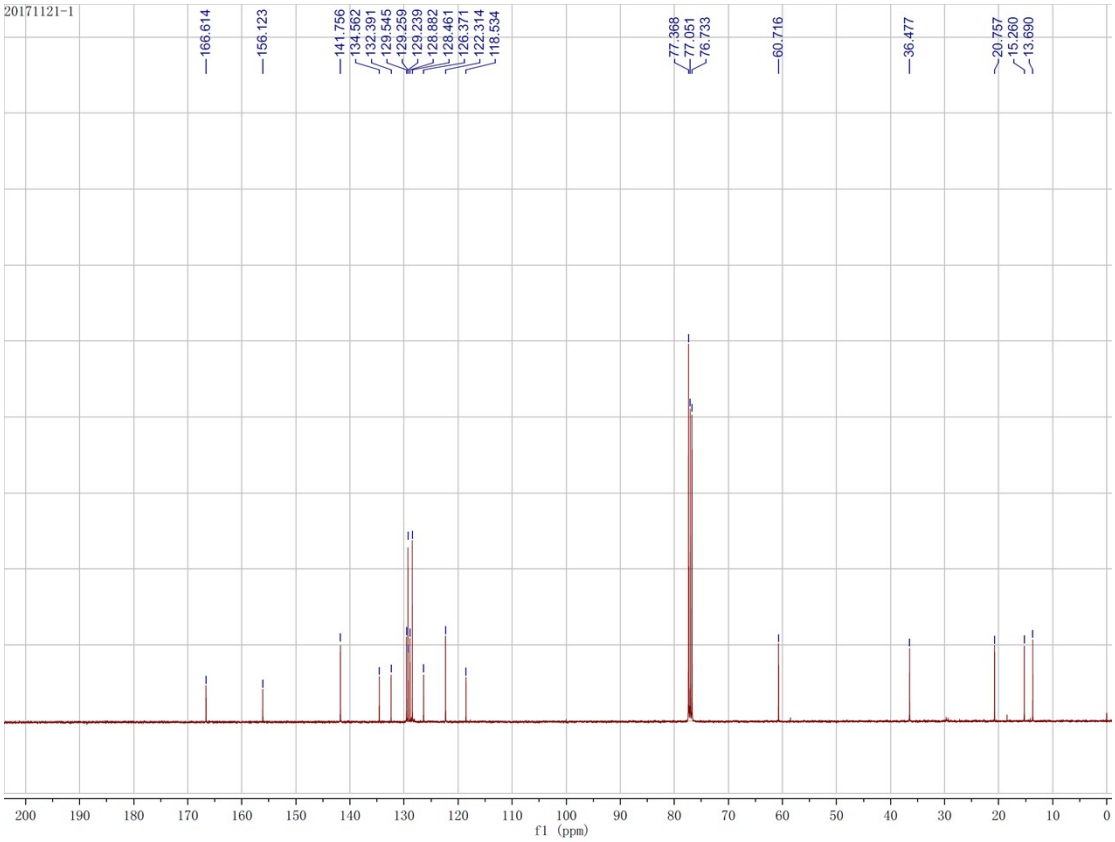


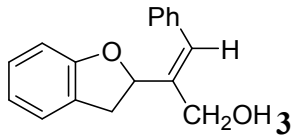



Me
Ph
O
H
Me
CO2Et

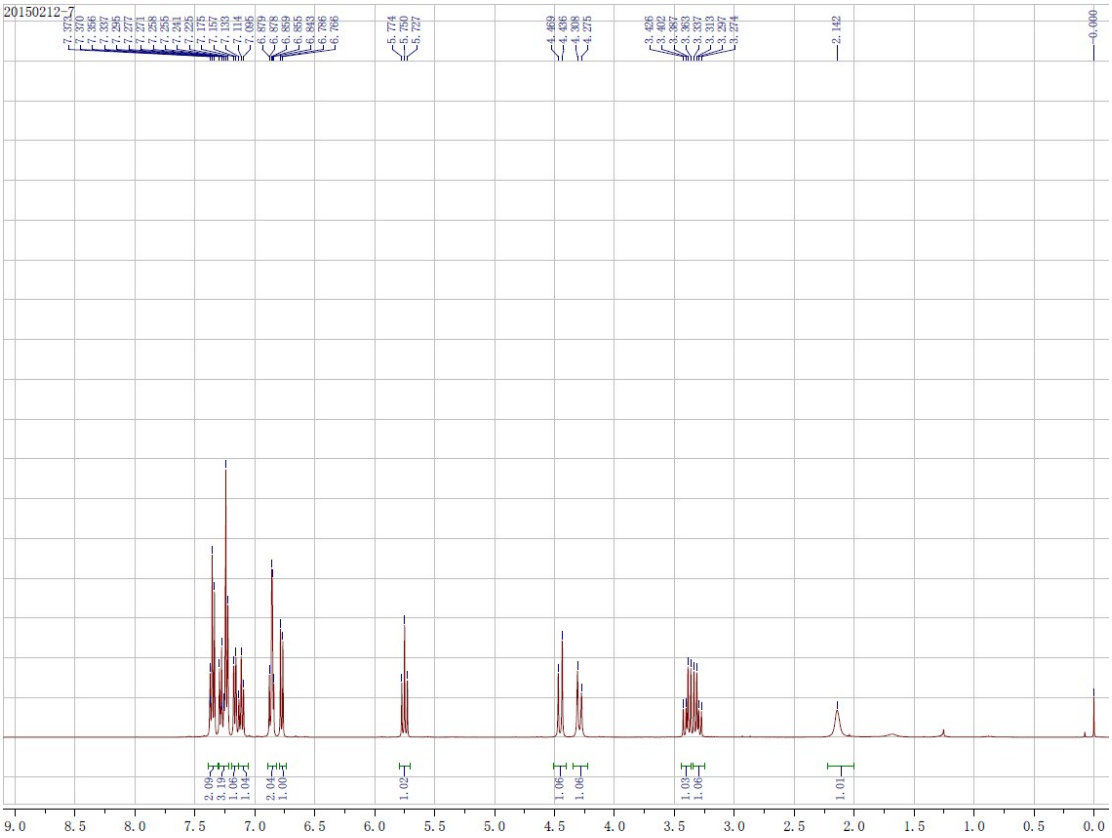
2v

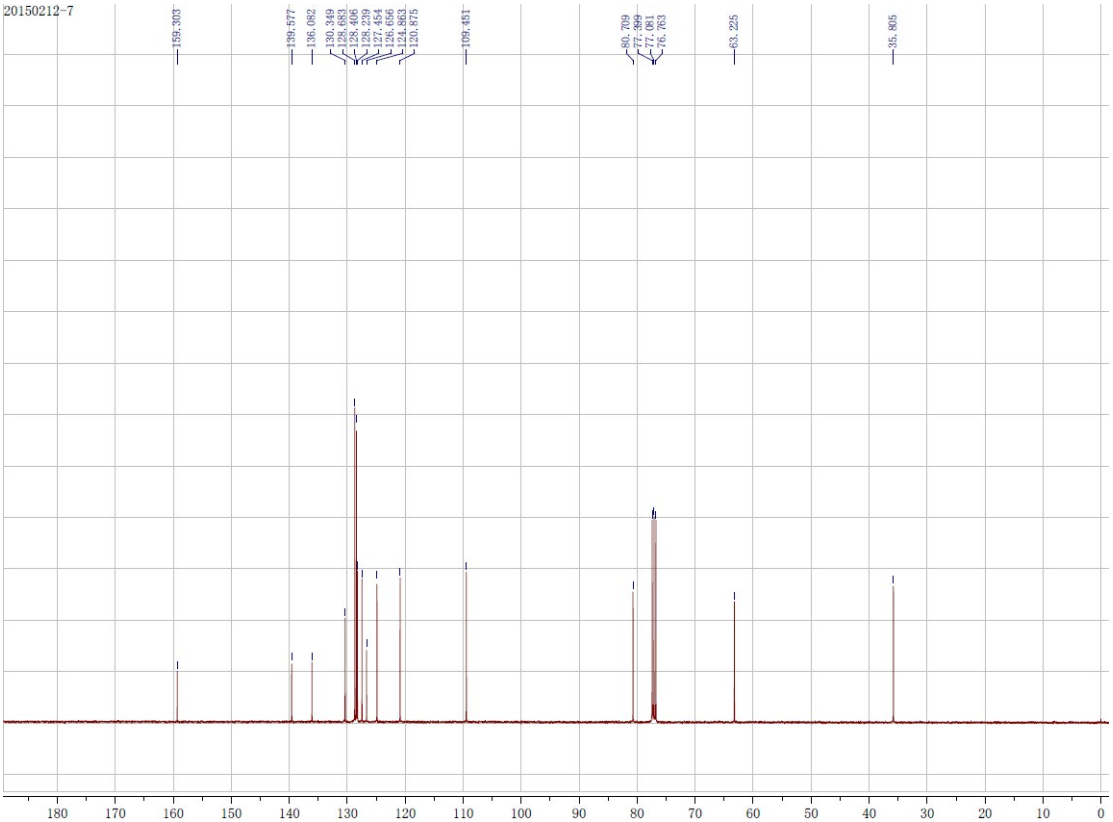

20171120-2
7.850
7.390
7.372
7.366
7.361
7.347
6.798
6.712
5.794
5.771
5.768
5.746
4.210
4.192
4.183
4.166
4.148
4.143
4.125
4.108
4.099
4.090
3.517
3.501
3.479
3.429
3.403
3.391
3.365
2.240
2.093
1.588
1.255
1.030
1.013
0.995
0.000
0.97
4.99
1.03
0.97
1.00
2.10
1.05
1.04
3.15
2.97
3.02

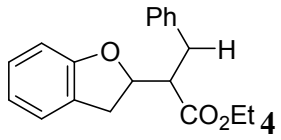

20171121-1
166.614
156.123
141.756
134.562
132.391
129.545
129.259
129.239
128.882
128.461
128.371
122.314
118.534
77.368
77.051
76.733
60.716
36.477
20.757
15.260
13.690
f1 (ppm)


Ph
H
O
CH2OH

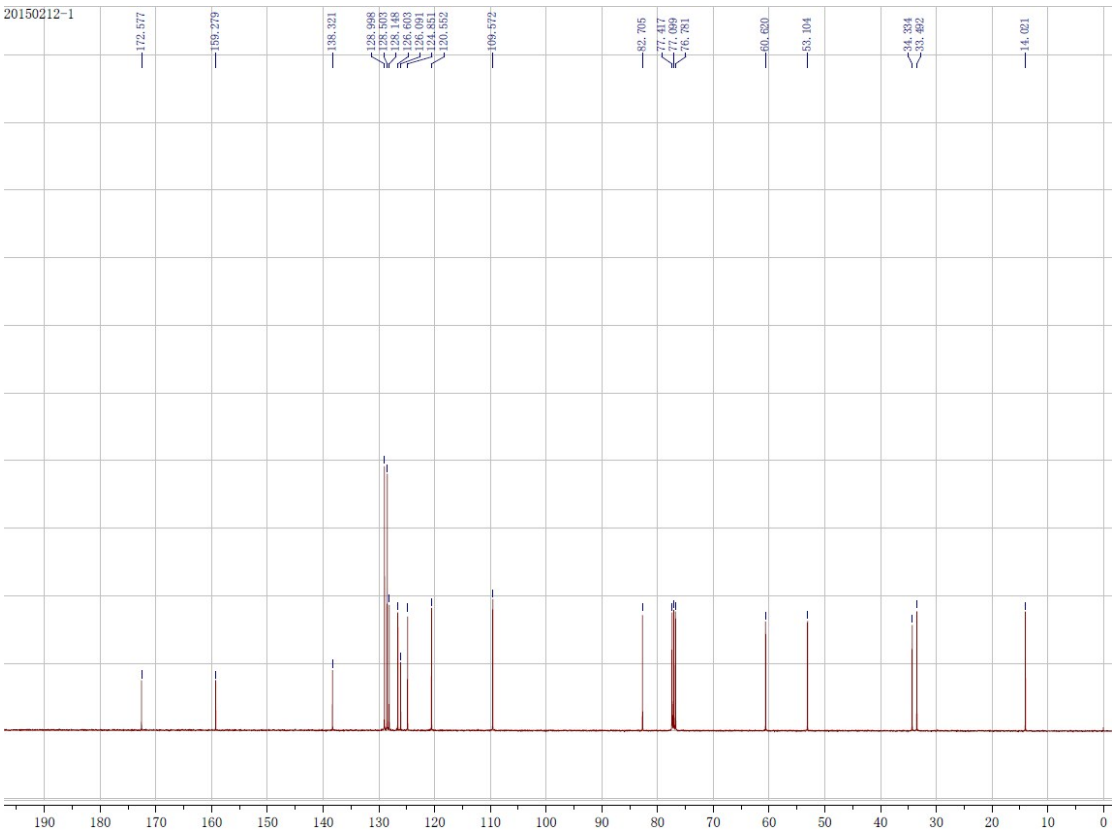
3

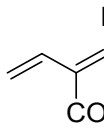

20150212-7
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


20150212-7
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

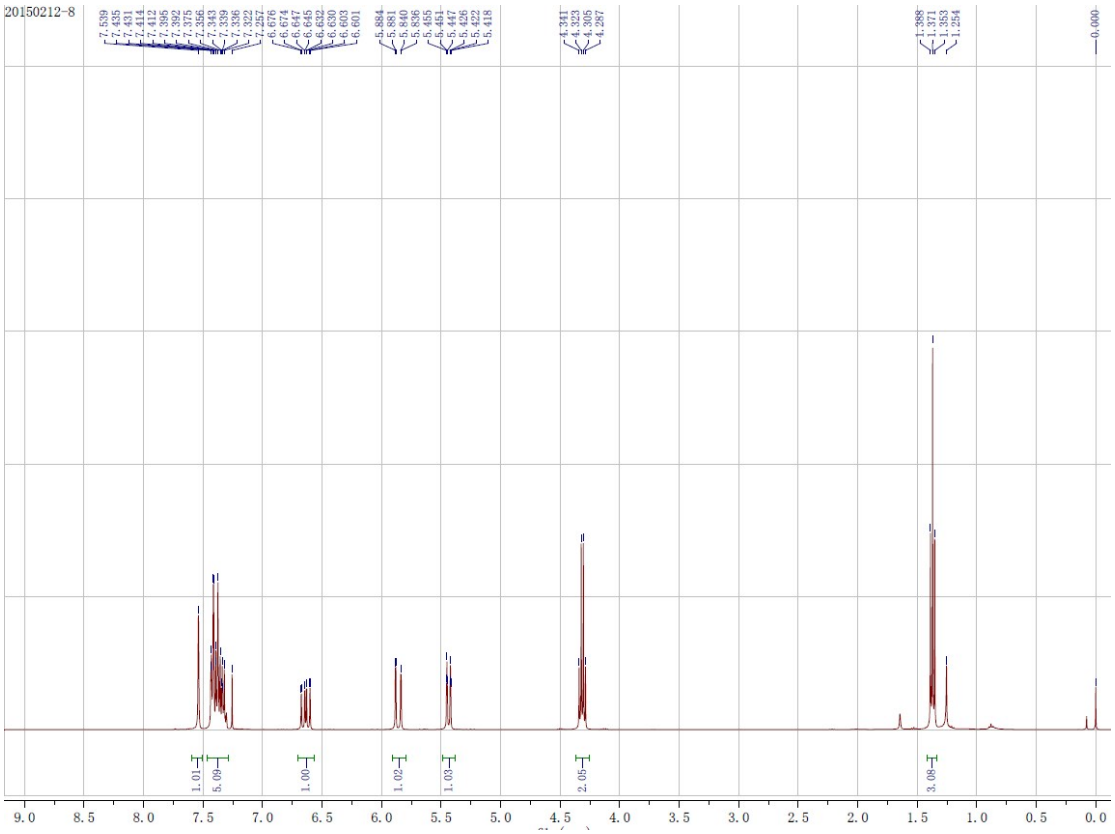


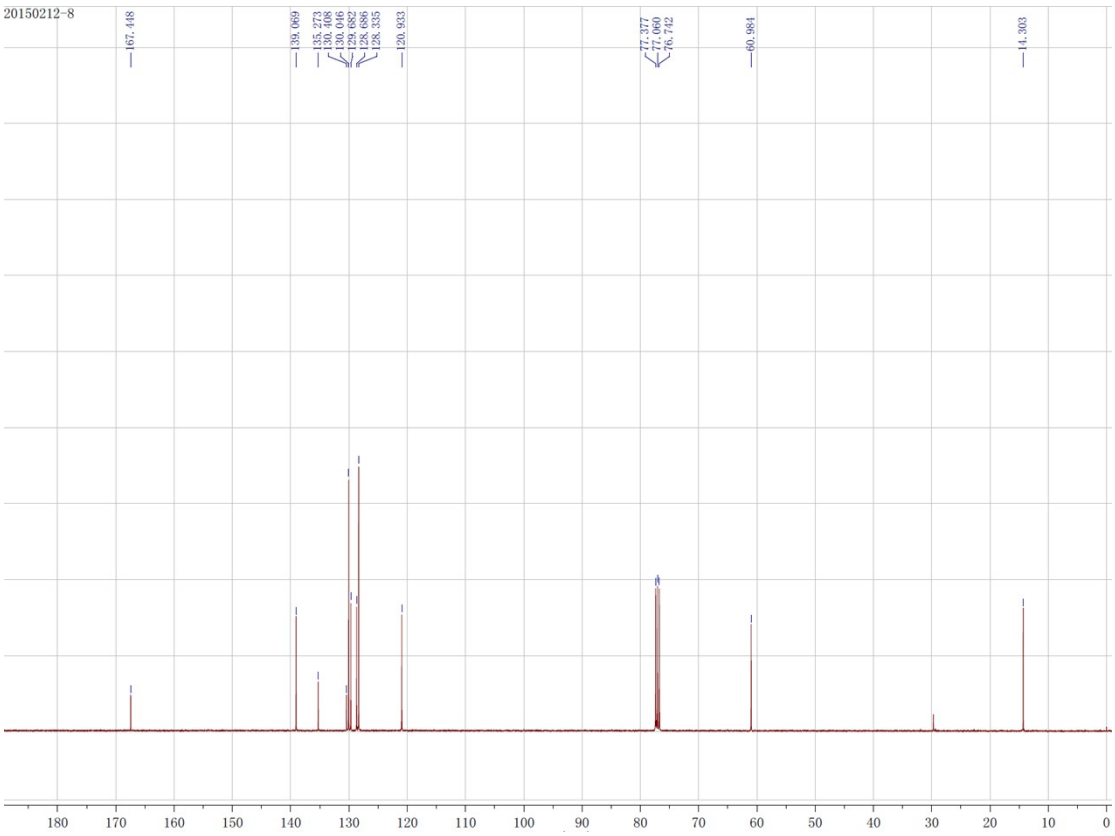
4

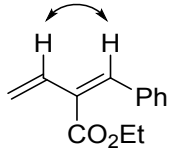



H
Ph
CO2Et

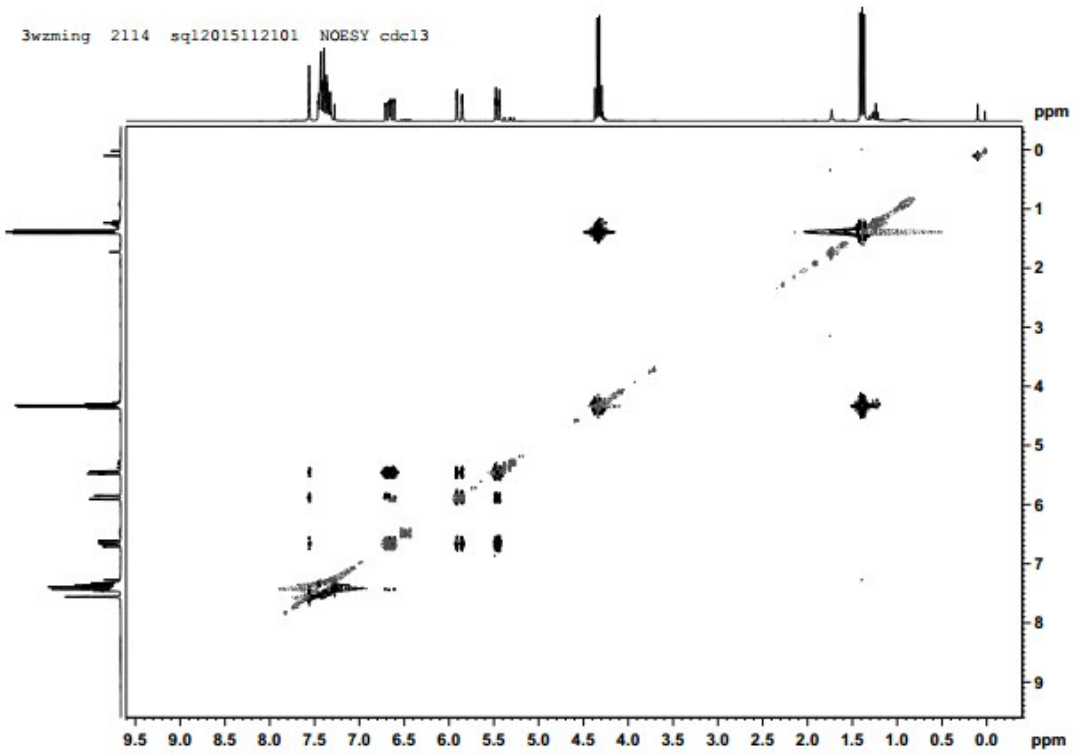
5


20150212-8
7.539
7.435
7.431
7.414
7.412
7.395
7.392
7.375
7.356
7.343
7.339
7.336
7.322
7.257
6.676
6.674
6.647
6.645
6.632
6.630
6.603
6.601
5.884
5.881
5.840
5.836
5.455
5.451
5.447
5.436
5.422
5.418
4.341
4.323
4.305
4.287
1.388
1.371
1.353
1.254
0.000
1.01
5.09
1.00
1.02
1.03
2.05
3.08
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


20150212-8
167.448
139.069
135.273
130.408
130.046
129.682
128.686
128.335
120.933
77.377
77.060
76.742
60.984
14.303
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0



NOESY (δ 7.54 and 6.64)



2a : **2o** = 0.8 : 1