Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Pd-catalyzed tandem C−C/C−O/C−H single bond cleavage of 3-allyloxybenzocyclobutenols

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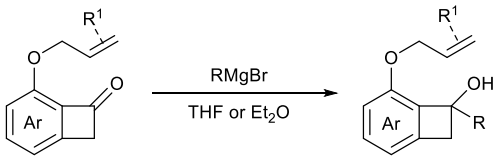
I. General Information

Unless otherwise mentioned, all reactions were carried out under an inert atmosphere. Unless otherwise noted, all of the reagents were purchased from commercial suppliers and used without further purification. THF was dried by filtration through a Solvent Purification System. Et_2O and 1,4-dioxane were dried by distillation from sodium and benzophenone and stored in the glove box.

NMR spectra were obtained on a Varian 400 M or 600 M spectrometer. The ^1H NMR (400 MHz or 600 MHz) chemical shifts were measured relative to the residual $CDCl_3$ as the internal reference ($CDCl_3$: δ = 7.26 ppm). The ^{13}C NMR (101 MHz or 151 MHz) chemical shifts were given using $CDCl_3$ as the internal standard ($CDCl_3$: δ = 77.0 ppm). Coupling constants were reported in Hertz (Hz). Data for ^1H NMR spectra were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, td = triplet of doublets, m = multiplet), coupling constant (Hz), and integration. For characterization of diastereomeric mixtures, *denotes minor diastereoisomer, $^+$denotes overlap of signals from both diastereoisomers. High-resolution mass spectra (HRMS) were obtained with a Waters Q-TOF Premier or Waters UPLC_QTof spectrometer. Elemental analysis data was obtained with Elementar UNICUBE. X-Ray single-crystal diffraction data were collected on a Rigaku XtaLAB Synergy diffractometer. Melting points were determined with SGW® X-4 apparatus.

II. Synthesis and characterization of benzocyclobutenols



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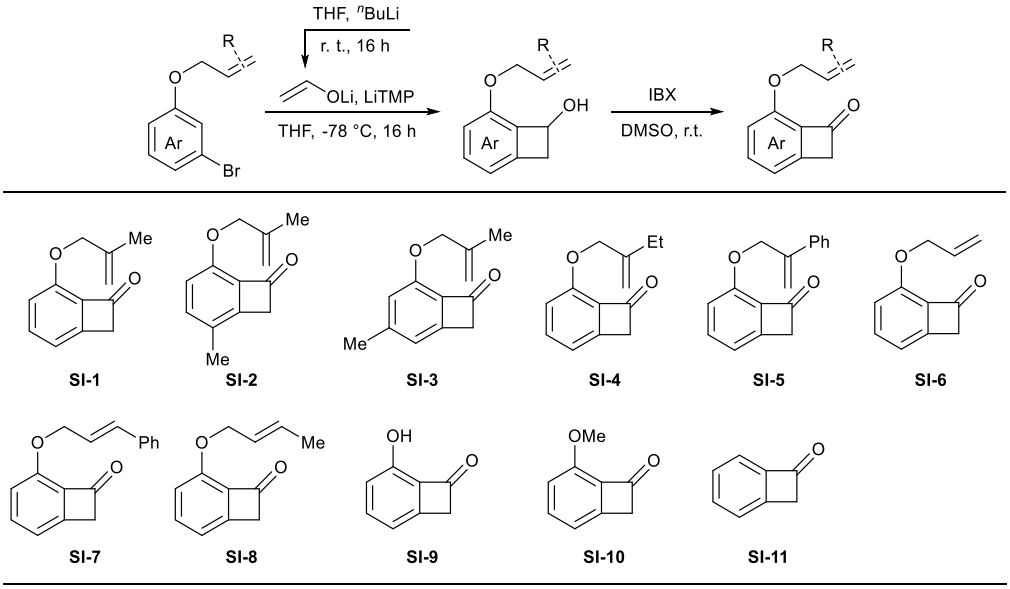
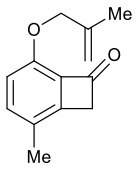
Grignard reagent was added dropwise to a solution of benzocyclobutenone in THF at 0 ℃ and the resulting solution was stirred at the indicated temperature. After the completion of the reaction as monitored by TLC, the reaction was quenched with water and extracted with EtOAc for three times. The combined organic phases were

washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired benzocyclobutenols **1**. Benzocyclobutenols **8**[1] and **11**[2] are known compounds and their characterization data are consistent with those reported in the literature.

Benzocyclobutenones were synthesized through IBX-promoted oxidation of the corresponding secondary benzocyclobutenols,[3] which were prepared according to the procedure reported by Dong.[4] Benzocyclobutenones **SI-1**, and **SI-3** to **SI-11** are known compounds and their characterization data are consistent with those reported in the literature.[4,5]

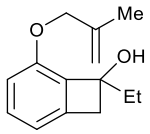


2-Methyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-one (**SI-2**)



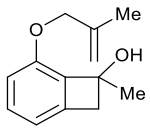
Yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, *J* = 8.4 Hz, 1H), 6.77 (d, *J* = 8.4 Hz, 1H), 5.04 (s, 1H), 4.92 (s, 1H), 4.79 (s, 2H), 3.80 (s, 2H), 2.24 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.45, 150.29, 148.51, 140.51, 138.60, 131.55, 124.61, 116.83, 112.33, 75.12, 49.81, 19.20, 16.33.

7-Ethyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1a)



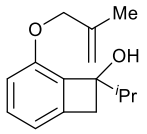
Following the general procedure, benzocyclobutenone **SI-1** (1.88 g, 10.0 mmol), EtMgBr (1.0 M in THF, 15.0 mL, 15.0 mmol) and THF (50.0 mL) were used. The reaction was stirred at room temperature for 3 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1a** as a yellow liquid (1.61 g, 74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (dd, *J* = 8.4, 7.2 Hz, 1H), 6.75 (d, *J* = 7.0 Hz, 1H), 6.71 (d, *J* = 8.4 Hz, 1H), 5.09 (s, 1H), 4.96 (s, 1H), 4.53 (d, *J* = 12.7 Hz, 1H), 4.45 (d, *J* = 12.6 Hz, 1H), 3.28 (d, *J* = 14.1 Hz, 1H), 3.03 (d, *J* = 14.1 Hz, 1H), 2.82 (brs, 1H), 2.07 – 1.97 (m, 1H), 1.95 – 1.86 (m, 1H), 1.82 (s, 3H), 1.03 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.70, 143.19, 140.84, 134.36, 130.58, 116.14, 112.74, 112.28, 80.97, 72.26, 44.92, 32.09, 19.34, 9.22. HRMS (ESI^+) for $C_{14}H_{18}NaO_2$ $[M + Na]^+$: calcd 241.1199; found 241.1207.

7-Methyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1b)



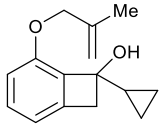
Following the general procedure, benzocyclobutenone **SI-1** (0.19 g, 1.0 mmol), CH_3MgBr (3.0 M in THF, 0.5 mL, 1.5 mmol) and THF (3.0 mL) were used. The reaction was stirred at 0 ^{o}C for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1b** as a light yellow liquid (0.09 g, 40% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (dd, *J* = 7.1, 7.2 Hz, 1H), 6.74-6.70 (m, 2H), 5.09 (s, 1H), 4.96 (s, 1H), 4.61 (d, *J* = 12.6 Hz, 1H), 4.52 (d, *J* = 12.6 Hz, 1H), 3.28 (d, *J* = 14.1 Hz, 1H), 3.16 (d, *J* = 14.1 Hz, 1H), 2.73 (s, 1H), 1.83 (s, 3H), 1.72 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.74, 142.72, 141.03, 134.77, 130.84, 116.27, 113.75, 112.33, 77.76, 72.66, 47.98, 26.52, 19.40. HRMS (ESI^+) for $C_{13}H_{16}NaO_2$ $[M + Na]^+$: calcd 227.1043; found 227.1051.

7-Isopropyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1c)



Following the general procedure, benzocyclobutenone **SI-1** (0.19 g, 1.0 mmol), ^{i}PrMgBr (1.0 M in THF, 1.5 mL, 1.5 mmol) and THF (5.0 mL) were used. The reaction was stirred at room temperature for 2.5 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1c** as a yellow liquid (0.21 g, 90% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (dd, *J* = 8.3, 7.2 Hz, 1H), 6.76 (d, *J* = 7.1 Hz, 1H), 6.71 (d, *J* = 8.4 Hz, 1H), 5.09 (s, 1H), 4.96 (s, 1H), 4.50 (d, *J* = 12.7 Hz, 1H), 4.45 (d, *J* = 12.7 Hz, 1H), 3.31 (d, *J* = 14.1 Hz, 1H), 2.93 (d, *J* = 14.1 Hz, 1H), 2.50 (s, 1H), 2.19 – 2.09 (m, 1H), 1.82 (s, 3H), 1.14 (d, *J* = 6.7 Hz, 3H), 0.96 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.61, 143.74, 140.83, 134.73, 130.51, 116.20, 112.33, 111.89, 84.16, 72.01, 42.95, 35.55, 19.38, 17.87, 17.66. HRMS (ESI^+) for $C_{15}H_{20}NaO_2$ $[M + Na]^+$: calcd 255.1356; found 255.1348.

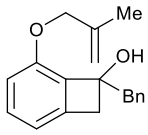
7-Cyclopropyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1d)



Following the general procedure, benzocyclobutenone **SI-1** (0.19 g, 1.0 mmol), cyclopropylmagnesium bromide (1.0 M in THF, 1.5 mL, 1.5 mmol) and THF (5.0 mL) were used. The reaction was stirred at room temperature for 2 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1d** as a yellow liquid (0.11 g, 47% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (dd, *J* = 8.3, 7.3 Hz, 1H), 6.74 (d, *J* = 7.2 Hz, 1H), 6.69 (d, *J* = 8.4 Hz, 1H), 5.08 (s, 1H), 4.96 (s, 1H), 4.51 (s, 2H), 3.26 (d, *J* = 14.0 Hz, 1H), 3.08 (d, *J* = 13.9 Hz, 1H), 2.67 (brs, 1H), 1.83 (s, 3H), 1.47 – 1.40 (m, 1H), 0.74 – 0.67 (m, 1H), 0.56 – 0.47 (m, 2H), 0.29 – 0.22 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.60, 143.66, 140.86,

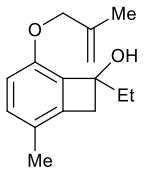
133.11, 130.69, 116.14, 112.34, 112.21, 81.39, 72.17, 45.18, 19.38, 18.95, 2.32, 2.16. HRMS (ESI$^+$) for $C_{15}H_{18}NaO_2$ [M + Na]$^+$: calcd 253.1199; found 253.1206.

7-Benzyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1e)



Following the general procedure, benzocyclobutenone **SI-1** (0.38 g, 2.0 mmol), benzylmagnesium bromide (1.0 M in THF, 3.0 mL, 3.0 mmol) and THF (7.0 mL) were used. The reaction was stirred at 0 ^oC for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1e** as a yellow liquid (0.28 g, 50% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.34-7.32 (m, 4H), 7.31-7.27 (m, 1H), 7.24 (dd, *J* = 8.4, 7.1 Hz, 1H), 6.79 (d, *J* = 8.4 Hz, 1H), 6.74 (d, *J* = 7.1 Hz, 1H), 5.12 (s, 1H), 5.01 (s, 1H), 4.58 (d, *J* = 12.8 Hz, 1H), 4.48 (d, *J* = 12.9 Hz, 1H), 3.44 (d, *J* = 14.1 Hz, 1H), 3.37 (d, *J* = 13.7 Hz, 1H), 3.24 (d, *J* = 13.7 Hz, 1H), 3.03 (d, *J* = 14.1 Hz, 1H), 2.81 (s, 1H), 1.86 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.88, 142.66, 140.92, 137.31, 134.26, 130.85, 130.04, 128.06, 126.47, 116.15, 113.15, 112.21, 79.79, 72.51, 45.30, 44.92, 19.33. HRMS (ESI$^+$) for $C_{19}H_{20}NaO_2$ [M + Na]$^+$: calcd 303.1356; found 303.1355.

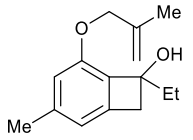
7-Ethyl-2-methyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1f)



Following the general procedure, benzocyclobutenone **SI-2** (0.61 g, 3.0 mmol), EtMgBr (2.0 M in THF, 2.3 mL, 4.5 mmol) and THF (9.0 mL) were used. The reaction was stirred at room temperature for 3 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1f** as a colorless liquid (0.31 g, 44% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 6.98 (d, *J* = 8.4 Hz, 1H), 6.64 (d, *J* = 8.4 Hz, 1H), 5.07 (s, 1H), 4.95 (s, 1H), 4.51 (d, *J* = 12.7 Hz, 1H),

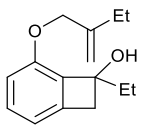
4.45 (d, *J* = 12.7 Hz, 1H), 3.23 (d, *J* = 13.9 Hz, 1H), 2.96 (d, *J* = 13.9 Hz, 1H), 2.51 (brs, 1H), 2.13 (s, 3H), 2.07 – 1.97 (m, 1H), 1.95 – 1.86 (m, 1H), 1.81 (s, 3H), 1.04 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.64, 141.34, 140.94, 133.80, 130.81, 125.48, 113.33, 112.01, 80.09, 72.30, 43.60, 32.09, 19.23, 15.68, 9.16. HRMS (ESI^+) for $C_{15}H_{20}NaO_2$ $[M + Na]^+$: calcd 255.1356; found 255.1347.

7-Ethyl-3-methyl-5-((2-methylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1g)



Following the general procedure, benzocyclobutenone **SI-3** (0.22 g, 1.1 mmol), EtMgBr (2.0 M in THF, 0.9 mL, 1.8 mmol) and THF (3.6 mL) were used. The reaction was stirred at room temperature for 3 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1g** as a colorless liquid (0.21 g, 82% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.60 (s, 1H), 6.56 (s, 1H), 5.10 (s, 1H), 4.96 (s, 1H), 4.55 (d, *J* = 12.6 Hz, 1H), 4.46 (d, *J* = 12.6 Hz, 1H), 3.26 (d, *J* = 14.1 Hz, 1H), 3.00 (d, *J* = 14.1 Hz, 1H), 2.77 (brs, 1H), 2.33 (s, 3H), 2.06 – 1.97 (m, 1H), 1.95 – 1.86 (m, 1H), 1.83 (s, 3H), 1.03 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.69, 143.05, 141.03, 140.99, 131.19, 116.86, 113.84, 112.13, 80.64, 72.43, 44.71, 32.22, 21.97, 19.35, 9.26. HRMS (ESI^+) for $C_{15}H_{20}NaO_2$ $[M + Na]^+$: calcd 255.1356; found 255.1349.

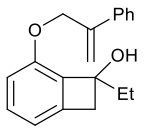
7-Ethyl-5-(2-methylenebutoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1h)



Following the general procedure, benzocyclobutenone **SI-4** (2.02 g, 10.0 mmol), EtMgBr (2.0 M in THF, 7.5 mL, 15 mmol) and THF (30.0 mL) were used. The reaction was stirred at room temperature for 1.5 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 10 : 1) afforded **1h** as a light yellow liquid (1.71 g, 73% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (dd, *J* =

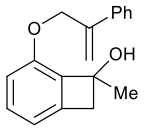
7.8 Hz, 7.8 Hz, 1H), 6.78 – 6.68 (m, 2H), 5.12 (s, 1H), 4.97 (s, 1H), 4.59 (d, *J* = 12.5 Hz, 1H), 4.51 (d, *J* = 12.5 Hz, 1H), 3.29 (d, *J* = 14.1 Hz, 1H), 3.04 (d, *J* = 14.1 Hz, 1H), 2.73 (brs, 1H), 2.16 (q, *J* = 7.4 Hz, 2H), 2.10 – 1.84 (m, 2H), 1.11 (t, *J* = 7.4 Hz, 3H), 1.03 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.86, 146.46, 143.21, 134.41, 130.64, 116.13, 112.82, 110.40, 81.05, 71.62, 45.00, 32.15, 25.77, 11.92, 9.23. HRMS (ESI^+) for $C_{15}H_{20}NaO_2$ $[M + Na]^+$: calcd 255.1356; found 255.1358.

7-Ethyl-5-((2-phenylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1i)



Following the general procedure, benzocyclobutenone **SI-5** (0.83 g, 3.3 mmol), EtMgBr (1.0 M in THF, 5.0 mL, 5.0 mmol) and THF (10.0 mL) were used. The reaction was stirred at -20 ^{o}C for 12 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1i** as a yellow liquid (0.80 g, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.0 Hz, 2H), 7.40 – 7.28 (m, 3H), 7.22 (t, *J* = 7.8 Hz, 1H), 6.78 (d, *J* = 7.8 Hz, 2H), 5.59 (s, 1H), 5.48 (s, 1H), 5.07 (d, *J* = 12.9 Hz, 1H), 4.96 (d, *J* = 12.8 Hz, 1H), 3.32 (d, *J* = 14.1 Hz, 1H), 3.06 (d, *J* = 14.1 Hz, 1H), 2.35 (brs, 1H), 2.06 – 1.97 (m, 1H), 1.94 – 1.85 (m, 1H), 0.98 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.70, 143.26, 143.21, 138.32, 134.49, 130.76, 128.43, 127.93, 126.01, 116.43, 114.33, 113.30, 81.17, 70.60, 45.08, 32.23, 9.20. HRMS (ESI^+) for $C_{19}H_{20}NaO_2$ $[M + Na]^+$: calcd 303.1356; found 303.1360.

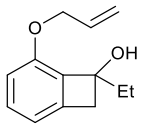
7-Methyl-5-((2-phenylallyl)oxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1j)



Following the general procedure, benzocyclobutenone **SI-5** (0.50 g, 2.0 mmol), MeMgBr (3.0 M in 2-MeTHF, 1.0 mL, 3.0 mmol) and THF (6.0 mL) were used. The reaction was stirred at 0 ^{o}C for 2 h. Purification by column chromatography on silica

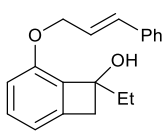
gel (petroleum ether : dichloromethane = 2 : 3) afforded **1j** as a yellow liquid (0.22 g, 41% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.6 Hz, 2H), 7.36 (t, *J* = 7.5 Hz, 2H), 7.32 (d, *J* = 7.2 Hz, 1H), 7.25 – 7.21 (m, 1H), 6.81 – 6.75 (m, 2H), 5.61 (s, 1H), 5.49 (s, 1H), 5.14 (d, *J* = 12.8 Hz, 1H), 5.01 (d, *J* = 12.8 Hz, 1H), 3.32 (d, *J* = 14.0 Hz, 1H), 3.20 (d, *J* = 14.0 Hz, 1H), 2.44 (brs, 1H), 1.73 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.58, 143.21, 142.75, 138.28, 134.86, 130.89, 128.46, 127.95, 125.98, 116.49, 114.32, 114.14, 77.85, 70.86, 48.04, 26.72. HRMS (ESI+) for $C_{18}H_{18}NaO_2$ $[M + Na]^+$: calcd 289.1199; found 289.1202.

5-(Allyloxy)-7-ethylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1k)



Following the general procedure, benzocyclobutenone **SI-6** (0.10 g, 0.6 mmol), EtMgBr (2.0 M in THF, 0.5 mL, 1.0 mmol) and THF (2.5 mL) were used. The reaction was stirred at 0 ^{o}C for 2 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1k** as a yellow liquid (0.10 g, 82% yield). δ 7.20 (dd, *J* = 8.3, 7.2 Hz, 1H), 6.75 (d, *J* = 7.1 Hz, 1H), 6.72 (d, *J* = 8.4 Hz, 1H), 6.08 – 5.99 (m, 1H), 5.43 – 5.38 (m, 1H), 5.27 – 5.24 (m, 1H), 4.68 – 4.56 (m, 2H), 3.30 (d, *J* = 14.1 Hz, 1H), 3.04 (d, *J* = 14.1 Hz, 1H), 2.60 (brs, 1H), 2.08 – 1.99 (m, 1H), 1.95 – 1.86 (m, 1H), 1.02 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.72, 143.23, 134.39, 133.37, 130.72, 117.19, 116.26, 113.09, 81.11, 69.65, 45.08, 32.20, 9.23. HRMS (ESI^+) for $C_{13}H_{16}NaO_2$ $[M + Na]^+$: calcd 227.1043; found 227.1050.

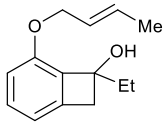
5-(Cinnamyloxy)-7-ethylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1l)



Then following the general procedure, compound **SI-7** (0.13 g, 0.5 mmol), EtMgBr (2.0 M in THF, 0.4 mL, 0.8 mmol) and THF (3.0 mL) were used. The reaction was

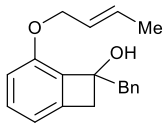
stirred at -20 ^{o}C for 2 h. Purification by column chromatography on neutral aluminum oxide (petroleum ether : ethyl acetate = 20 : 1) afforded **1l** as a light yellow liquid (0.10 g, 72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, *J* = 7.5 Hz, 2H), 7.33 (dd, *J* = 7.5 Hz, 2H), 7.28 – 7.21 (m, 2H), 6.79 – 6.71 (m, 3H), 6.44 – 6.37 (m, 1H), 4.86 – 4.75 (m, 2H), 3.33 (d, *J* = 14.1 Hz, 1H), 3.07 (d, *J* = 14.1 Hz, 1H), 2.49 (brs, 1H), 2.12 – 2.03 (m, 1H), 1.99 – 1.90 (m, 1H), 1.05 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.79, 143.26, 136.43, 134.37, 132.61, 130.81, 128.54, 127.81, 126.52, 124.62, 116.32, 113.28, 81.18, 69.62, 45.14, 32.25, 9.29.

(*E*)-5-(But-2-en-1-yloxy)-7-ethylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1m)



Following the general procedure, benzocyclobutenone **SI-8** (0.56 g, 3.0 mmol), EtMgBr (1.0 M in THF, 4.5 mL, 4.5 mmol) and THF (15.0 mL) were used. The reaction was stirred at room temperature for 1.5 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1m** as a yellow liquid (0.40 g, 61% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (dd, *J* = 8.4, 7.2 Hz, 1H), 6.74 (d, *J* = 7.1 Hz, 1H), 6.71 (d, *J* = 8.4 Hz, 1H), 5.89 – 5.79 (m, 1H), 5.73 – 5.66 (m, 1H), 4.60 – 4.56 (m, 1H), 4.54 – 4.49 (m, 1H), 3.30 (d, *J* = 14.1 Hz, 1H), 3.04 (d, *J* = 14.1 Hz, 1H), 2.49 (brs, 1H), 2.08 – 1.99 (m, 1H), 1.95 – 1.86 (m, 1H), 1.75 (dd, *J* = 6.4, 1.2 Hz, 3H), 1.02 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.90, 143.19, 134.32, 130.71, 130.12, 126.22, 116.07, 113.23, 81.15, 69.75, 45.05, 32.24, 17.83, 9.24. HRMS (ESI^+) for $C_{14}H_{18}NaO_2$ $[M + Na]^+$: calcd 241.1199; found 241.1205.

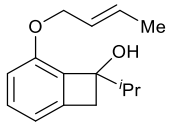
(*E*)-7-Benzyl-5-(but-2-en-1-yloxy)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1n)



Following the general procedure, benzocyclobutenone **SI-8** (0.38 g, 2.0 mmol),

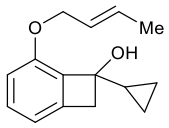
benzylmagnesium bromide (1.0 M in THF, 3.0 mL, 3.0 mmol) and THF (10.0 mL) were used. The reaction was stirred at room temperature for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1n** as a yellow liquid (0.67 g, >99% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.22 (m, 6H), 6.78 (d, *J* = 8.4 Hz, 1H), 6.74 (d, *J* = 7.1 Hz, 1H), 5.91 – 5.82 (m, 1H), 5.76 – 5.69 (m, 1H), 4.60 (dd, *J* = 11.6, 5.8 Hz, 1H), 4.52 (dd, *J* = 11.7, 6.1 Hz, 1H), 3.43 (d, *J* = 14.1 Hz, 1H), 3.36 (d, *J* = 13.7 Hz, 1H), 3.24 (d, *J* = 13.7 Hz, 1H), 3.03 (d, *J* = 14.1 Hz, 1H), 2.99 (brs, 1H), 1.81 (d, *J* = 6.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.77, 142.64, 137.35, 134.26, 130.77, 130.05, 130.02, 127.97, 126.36, 126.18, 115.98, 113.08, 79.81, 69.70, 45.36, 44.79, 17.74. HRMS (ESI^+) for $C_{19}H_{20}NaO_2$ $[M + Na]^+$: calcd 303.1356; found 303.1360.

(*E*)-5-(But-2-en-1-yloxy)-7-isopropylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1o)



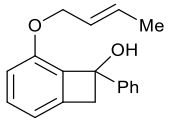
Following the general procedure, benzocyclobutenone **SI-8** (0.38 g, 2.0 mmol), ^{i}PrMgBr (1.0 M in THF, 3.0 mL, 3.0 mmol) and THF (10.0 mL) were used. The reaction was stirred at room temperature for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **1o** as a yellow liquid (0.34 g, 72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (dd, *J* = 8.4, 7.2 Hz, 1H), 6.74 (d, *J* = 7.1 Hz, 1H), 6.70 (d, *J* = 8.4 Hz, 1H), 5.87 – 5.78 (m, 1H), 5.72 – 5.64 (m, 1H), 4.55 – 4.46 (m, 2H), 3.30 (d, *J* = 14.1 Hz, 1H), 2.92 (d, *J* = 14.1 Hz, 1H), 2.61 (s, 1H), 2.19 – 2.09 (m, 1H), 1.74 (dd, *J* = 6.4, 1.3 Hz, 3H), 1.12 (d, *J* = 6.7 Hz, 3H), 0.92 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.70, 143.69, 134.63, 130.53, 129.93, 126.17, 116.06, 112.33, 84.18, 69.33, 42.78, 35.55, 17.93, 17.83, 17.64. HRMS (ESI^+) for $C_{15}H_{20}NaO_2$ $[M + Na]^+$: calcd 255.1356; found 255.1354.

(*E*)-5-(But-2-en-1-yloxy)-7-cyclopropylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1p)



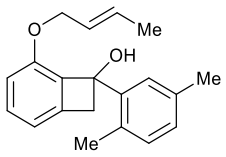
Following the general procedure, benzocyclobutenone **SI-8** (0.38 g, 2.0 mmol), cyclopropylmagnesium bromide (1.0 M in THF, 3.0 mL, 3.0 mmol) and THF (10.0 mL) were used. The reaction was stirred at 0 ^{o}C for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 8 : 1) afforded **1p** as a yellow liquid (0.39 g, 84% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (t, *J* = 7.8 Hz, 1H), 6.72 (d, *J* = 7.1 Hz, 1H), 6.68 (d, *J* = 8.4 Hz, 1H), 5.88 – 5.79 (m, 1H), 5.73 – 5.66 (m, 1H), 4.55 (d, *J* = 5.8 Hz, 2H), 3.24 (d, *J* = 14.0 Hz, 1H), 3.06 (d, *J* = 14.0 Hz, 1H), 2.66 (brs, 1H), 1.74 (d, *J* = 6.4 Hz, 3H), 1.46 – 1.40 (m, 1H), 0.70 – 0.64 (m, 1H), 0.55 – 0.46 (m, 2H), 0.25 – 0.20 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.67, 143.61, 133.11, 130.69, 130.03, 126.20, 116.01, 112.53, 81.42, 69.50, 45.06, 19.02, 17.80, 2.34, 2.23. HRMS (ESI^+) for $C_{15}H_{18}NaO_2$ $[M + Na]^+$: calcd 253.1199; found 253.1194.

(*E*)-5-(But-2-en-1-yloxy)-7-phenylbicyclo[4.2.0]octa-1,3,5-trien-7-ol (1q)



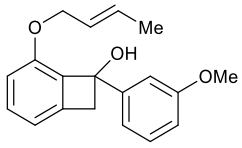
Following the general procedure, benzocyclobutenone **SI-8** (0.56 g, 3.0 mmol), PhMgBr (1.0 M in THF, 4.5 mL, 4.5 mmol) and THF (15.0 mL) were used. The reaction was stirred at room temperature for 1.5 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1q** as a yellow liquid (0.55 g, 69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.43 (m, 2H), 7.38 – 7.21 (m, 4H), 6.84 – 6.81 (m, 2H), 5.71 – 5.63 (m, 1H), 5.58 – 5.51 (m, 1H), 4.54 – 4.50 (m, 1H), 4.29 – 4.17 (m, 1H), 3.57 – 3.45 (m, 2H), 3.19 (brs, 1H), 1.68 (dd, *J* = 6.3, 1.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.66, 144.20, 143.72, 133.18, 131.33, 130.16, 128.25, 127.25, 126.08, 125.30, 116.12, 114.51, 81.14, 70.06, 50.44, 17.73. HRMS (ESI^+) for $C_{18}H_{18}NaO_2$ $[M + Na]^+$: calcd 289.1199; found 289.1198.

(*E*)-5-(But-2-en-1-yloxy)-7-(2,5-dimethylphenyl)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1r)



Following the general procedure, benzocyclobutenone **SI-8** (0.38 g, 2.0 mmol), 2,5-dimethylphenylmagnesium bromide (1.0 M in THF, 3.0 mL, 3.0 mmol) and Et_2O (6.0 mL) were used. The reaction was stirred at 0 ^oC for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1r** as a yellow liquid (0.39 g, 53% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.27 (m, 2H), 7.12 (d, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 6.86 (d, *J* = 8.4 Hz, 1H), 6.80 (d, *J* = 7.1 Hz, 1H), 5.90 – 5.81 (m, 1H), 5.76 – 5.69 (m, 1H), 4.64 – 4.63 (m, 2H), 3.62 (d, *J* = 13.9 Hz, 1H), 3.58 (d, *J* = 13.9 Hz, 1H), 2.64 (s, 1H), 2.51 (s, 3H), 2.25 (s, 3H), 1.74 (dd, *J* = 6.3, 1.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.93, 143.43, 140.37, 134.59, 133.85, 133.67, 131.35, 131.18, 130.21, 128.51, 128.48, 126.08, 116.44, 112.58, 83.10, 69.55, 48.35, 20.94, 19.69, 17.84. HRMS (ESI^+) for $C_{20}H_{22}NaO_2$ $[M + Na]^+$: calcd 317.1512; found 317.1506.

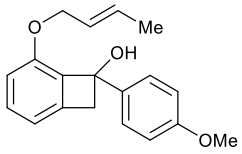
(*E*)-5-(But-2-en-1-yloxy)-7-(3-methoxyphenyl)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1s)



Following the general procedure, benzocyclobutenone **SI-8** (0.56 g, 3.0 mmol), 3-methoxyphenylmagnesium bromide (1.0 M in THF, 4.5 mL, 4.5 mmol) and THF (15.0 mL) were used. The reaction was stirred at 0 ^oC for 3 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **1s** as a yellow liquid (0.59 g, 67% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.21 (m, 2H), 7.11 – 7.10 (m, 1H), 7.01 (dd, *J* = 7.7, 1.0 Hz, 1H), 6.82 – 6.78 (m, 3H), 5.72 – 5.64

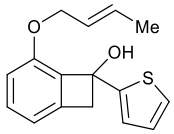
(m, 1H), 5.61 – 5.52 (m, 1H), 4.54 – 4.49 (m, 1H), 4.30 – 4.25 (m, 1H), 3.78 (s, 3H), 3.50 (q, *J* = 14.1 Hz, 2H), 3.05 (brs, 1H), 1.67 (dd, *J* = 6.4, 1.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.56, 152.57, 145.91, 143.69, 133.05, 131.33, 130.20, 129.29, 126.08, 117.75, 116.11, 114.34, 112.85, 111.03, 81.07, 69.96, 55.15, 50.31, 17.74.

(*E*)-5-(But-2-en-1-yloxy)-7-(4-methoxyphenyl)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1t)



Following the general procedure, benzocyclobutenone **SI-8** (0.56 g, 3.0 mmol), 4-methoxyphenylmagnesium bromide (1.0 M in THF, 4.5 mL, 4.5 mmol) and THF (15.0 mL) were used. The reaction was stirred at 0 ^{o}C for 1 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 25 : 1) afforded **1t** as a yellow liquid (0.49 g, 56% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 8.7 Hz, 2H), 7.29 – 7.25 (m, 1H), 6.86 (d, *J* = 8.8 Hz, 2H), 6.82 – 6.78 (m, 2H), 5.74 – 5.63 (m, 1H), 5.62 – 5.53 (m, 1H), 4.55 – 4.51 (m, 1H), 4.31 – 4.27 (m, 1H), 3.80 (s, 3H), 3.51 (s, 2H), 2.75 (s, 1H), 1.68 (dd, *J* = 6.3, 1.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.78, 152.70, 143.66, 136.52, 133.37, 131.28, 130.16, 126.66, 126.16, 116.16, 114.41, 113.57, 81.01, 70.10, 55.25, 50.41, 17.77. HRMS (ESI^+) for $C_{19}H_{20}NaO_3$ [M + Na]$^+$: calcd 319.1305; found 319.1307.

(*E*)-5-(But-2-en-1-yloxy)-7-(thiophen-2-yl)bicyclo[4.2.0]octa-1,3,5-trien-7-ol (1u)[6]



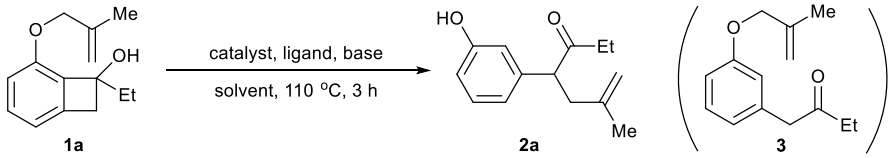
^{n}BuLi (2.5 M in THF, 1.2 mL, 3.0 mmol) was added dropwise to a solution of *o*-bromothiophene (0.29 mL, 3.0 mmol) in Et_2O (6.0 mL) at -78 ^{o}C. The solution was warmed to and stirred at room temperature for 1h. The mixture was re-cooled to -78 ^{o}C after the appearance of white solid. A solution of benzocyclobutenone **SI-8** (0.38 g, 2.0 mmol) in Et_2O (6.0 mL) was then added dropwise. After stirring at -78 ^{o}C for another 1 h, the reaction was warmed to room temperature and quenched with

saturated aqueous NH_4Cl solution. The aqueous phase was extracted with EtOAc for three times. The combined organic phases were washed with brine, dried over anhydrous $MgSO_4$, filtered, and evaporated. The residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) to afford benzocyclobutenol **1u** as an orange liquid (0.38 g, 70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 8.2 Hz, 1H), 7.23 (d, *J* = 4.9 Hz, 1H), 6.95 – 6.91 (m, 2H), 6.82 – 6.78 (m, 2H), 5.77 – 5.69 (m, 1H), 5.64 – 5.57 (m, 1H), 4.56 (dd, *J* = 11.7, 5.7 Hz, 1H), 4.39 (dd, *J* = 11.6, 6.0 Hz, 1H), 3.62 (d, *J* = 14.1 Hz, 1H), 3.56 (d, *J* = 14.1 Hz, 1H), 3.15 (s, 1H), 1.70 (d, *J* = 6.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.54, 148.85, 143.17, 133.15, 131.65, 130.26, 126.63, 126.08, 124.72, 123.81, 116.21, 114.40, 78.75, 70.13, 51.12, 17.77. HRMS (ESI^+) for $C_{16}H_{16}NaO_2S$ $[M + Na]^+$: calcd 295.0763; found 295.0761.

III. Optimization of the reaction of benzocyclobutenol 1a

To an oven-dried Schlenk tube with a stirring bar was successively added catalyst, ligand, base, and benzocyclobutenol **1a** (43.7 mg, 0.2 mmol). The tube was evacuated and backfilled with inert gas for three times and solvent (1.0 mL) was then added. The tube was directly placed in an oil bath at 110 ^{o}C and stirred for 3 h. The reaction mixture was then quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the crude product was analyzed by ^{1}H NMR spectrometer.

Table S1. Optimization of the reaction of benzocyclobutenol 1a.



1a **2a** **3**

Entry	Catalyst	Ligand	Base	Solvent	Yield (%)[a]
1	4 mol% $Pd(OAc)_2$	8 mol% PPh_3	1.5 equiv Cs_2CO_3	1,4-dioxane	63
2	4 mol% $Pd(OAc)_2$	8 mol% (p-$MeOC_6H_4)_3P$	1.5 equiv Cs_2CO_3	1,4-dioxane	57
3	4 mol% $Pd(OAc)_2$	8 mol% dppm	1.5 equiv Cs_2CO_3	1,4-dioxane	0 (62)[b]
4	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv Cs_2CO_3	1,4-dioxane	79
5	4 mol% $Pd(OAc)_2$	8 mol% dppp	1.5 equiv Cs_2CO_3	1,4-dioxane	69
6	4 mol% $Pd(OAc)_2$	8 mol% dppb	1.5 equiv Cs_2CO_3	1,4-dioxane	60
7	4 mol% $Pd(OAc)_2$	8 mol% dppf	1.5 equiv Cs_2CO_3	1,4-dioxane	62
8	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv Cs_2CO_3	DMF	64
9	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv Cs_2CO_3	CH_3CN	74
10	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv Cs_2CO_3	THF	57
11	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv Na_2CO_3	1,4-dioxane	0 (85)[c]
12	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv K_2CO_3	1,4-dioxane	73
13	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv $KHCO_3$	1,4-dioxane	48 (14)[b]
14	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv $NaHCO_3$	1,4-dioxane	41(18)[b]
15	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv CsF	1,4-dioxane	38 (16)[b]
16	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv K_3PO_4	1,4-dioxane	81
17[d]	4 mol% $Pd(OAc)_2$	8 mol% dppe	1.5 equiv K_3PO_4	1,4-dioxane	12 (41)[b]
18	4 mol% $Pd(OAc)_2$	8 mol% dppe	3.0 equiv K_3PO_4	1,4-dioxane	74
19	4 mol% $Pd(OAc)_2$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	85
20	4 mol% $Pd(acac)_2$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	79
21	4 mol% $PdCl_2$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	0 (78)[b]
22	4 mol% $Pd(PPh_3)_4$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	84
23	4 mol% $Pd_2(dba)_3$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	83
24	4 mol% $Pd(OCOCF_3)_2$	8 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	4 (66)[b]
25	2 mol% $Pd(OAc)_2$	4 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	85 (86)[e]
26	1 mol% $Pd(OAc)_2$	2 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	49
27	2 mol% $Pd(OAc)_2$	2 mol% dppe	0.5 equiv K_3PO_4	1,4-dioxane	30 (16)[b]
28	2 mol% $Pd(OAc)_2$	4 mol% dppe	none	1,4-dioxane	unrepeatable
29	2 mol% $Pd(OAc)_2$	none	0.5 equiv K_3PO_4	1,4-dioxane	0 (74)[b]
30	none	none	0.5 equiv K_3PO_4	1,4-dioxane	0 (78)[b]
31	none	none	none	1,4-dioxane	0

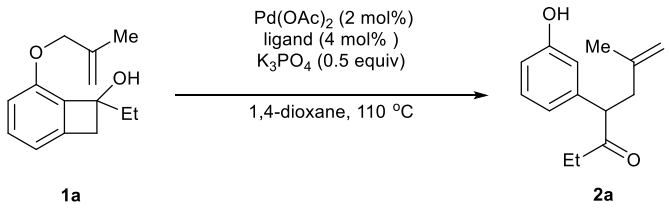
[a] Yields were determined by ^{1}H NMR spectroscopy using 1,1,2,2-tetrachloroethane as the internal standard. [b] NMR yield of **3** was given in the parenthesis. [c] 85% of **1a** was unreacted as determined by crude ^{1}H NMR spectroscopy. [d] At 80 °C. [e] Isolated yield was given in the parenthesis. dppm = bis(diphenylphosphino)methane, dppe = 1,2-bis(diphenylphosphino)ethane, dppp = 1,3-bis(diphenylphosphino)propane, dppb = 1,4-bis(diphenylphosphino)butane, dppf = 1,1'-Bis(diphenylphosphino)ferrocene.

IV. Optimization of the asymmetric synthesis of 2a

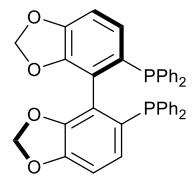
A solution of $Pd(OAc)_2$ in 1,4-dioxane (4.0 mM) was prepared, stored in the glove box and used for the catalytic reaction. To an oven-dried Schlenk tube with a stirring

bar was successively added ligand (8.0 μmol), K_3PO_4 (21.2 mg, 0.1 mmol), and benzocyclobutenol **1a** (43.7 mg, 0.2 mmol). The tube was evacuated and backfilled with inert gas for three times. After the addition of $Pd(OAc)_2$ (1.0 mL, 4.0 μmol), the tube was directly placed in an oil bath at 110 ^oC and stirred for 3 h. The mixture was then quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) to afford **2**a. Pure **2a** was then analyzed by chiral HPLC to determine the enantiopurity.

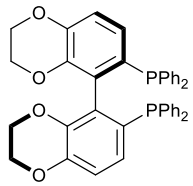
Table S2. Optimization of the asymmetric synthesis of 2a[a]



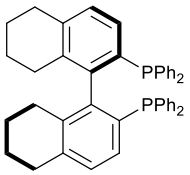
1a **2a**



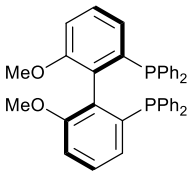
(*R*)-segphos,
58% yield, <1% ee



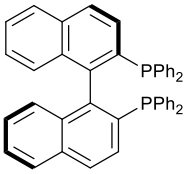
(*R*)-synphos
78% yield, <1% ee



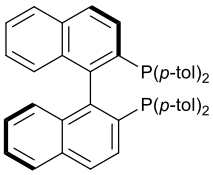
(*R*)-H8-binap
64% yield, <1% ee



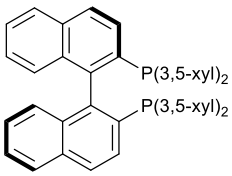
(*R*)-MeO-biphep
72% yield, <1% ee



(*R*)-binap
77% yield, <1% ee

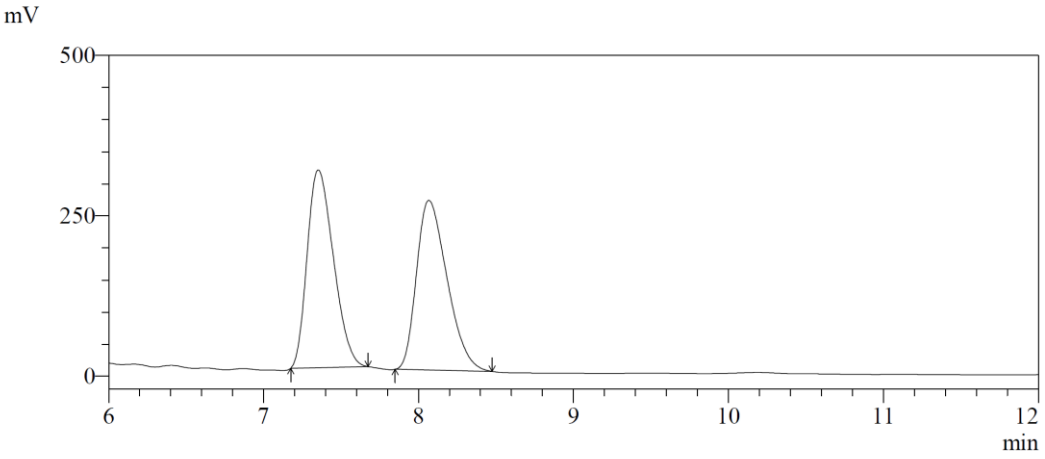


(*R*)-tol-binap
87% yield, <1% ee



(*R*)-dm-binap
63% yield, <1% ee

[a] HPLC analysis: Chiracel OD, eluent hexane:*i*-propanol 95%:5%, flow rate 1.0 mL/min, 25 ^oC, 254 nm, t_{R1} = 7.4 min and t_{R2} = 8.1 min.

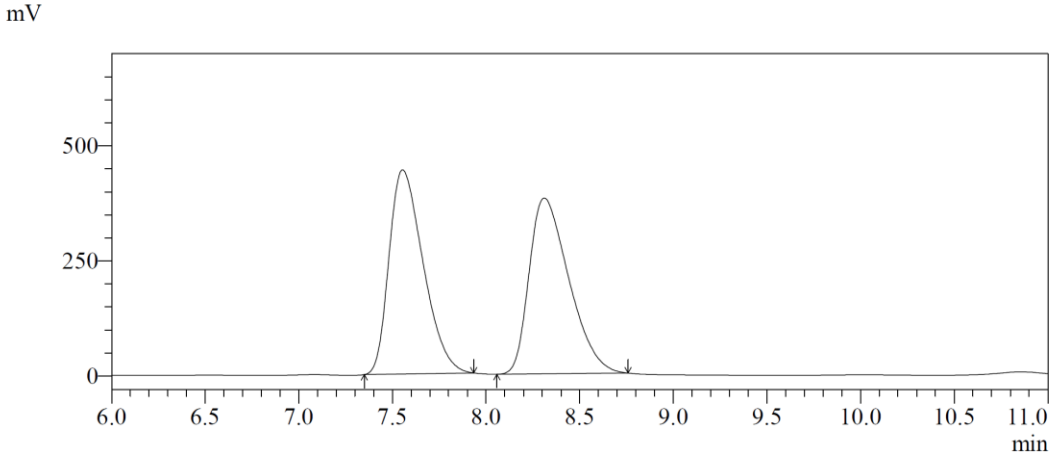


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.353	4.31	71427.41	3633758	308081	50.048
2	8.067	3.71	71427.41	3626815	264672	49.952
Total				7260572	572752	100.000

Figure S1 HPLC trace of racemic **2a**

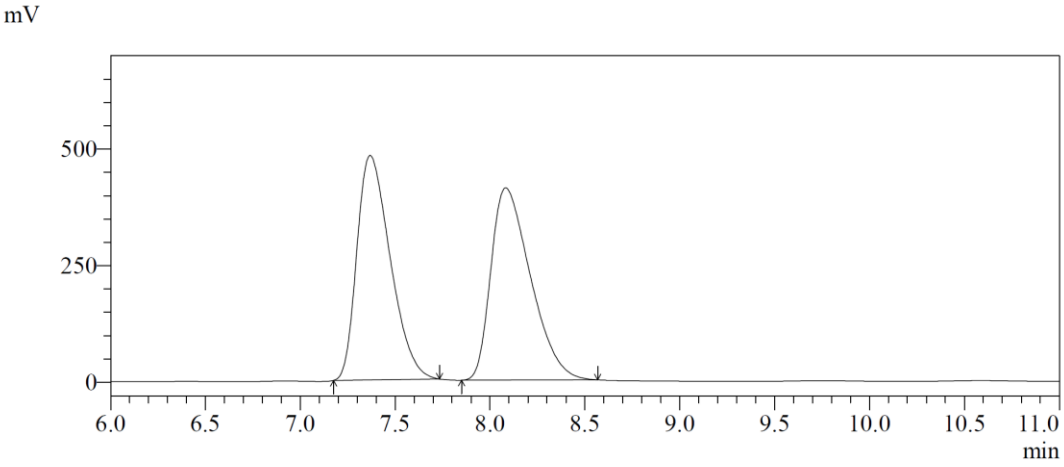


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.554	202.04	2193.26	5626605	443131	49.931
2	8.311	174.23	2193.26	5642197	382124	50.069
Total				11268801	825255	100.000

Figure S2 HPLC trace of **2a** obtained by using (*R*)-segphos as the ligand

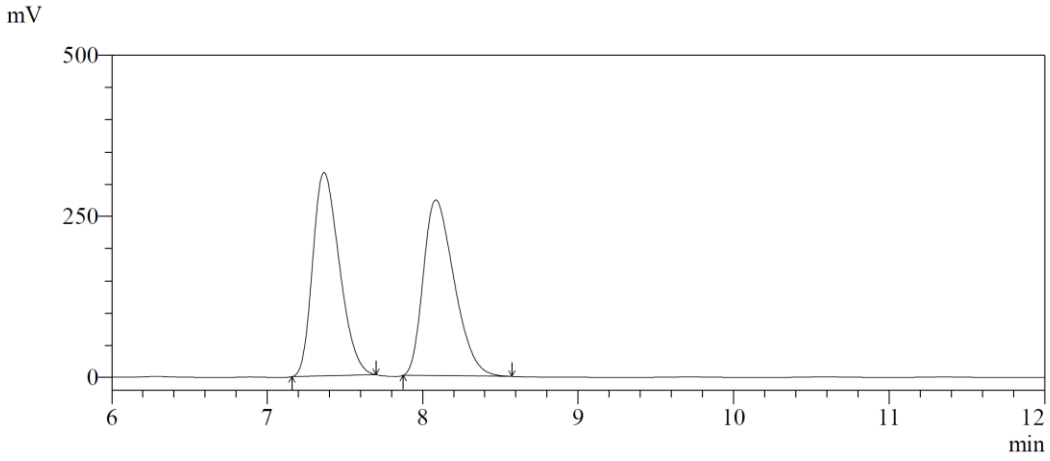


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.368	325.70	1479.81	5887006	481977	49.560
2	8.083	278.78	1479.81	5991439	412542	50.440
Total				11878445	894519	100.000

Figure S3 HPLC trace of **2a** obtained by using (*R*)-synphos as the ligand

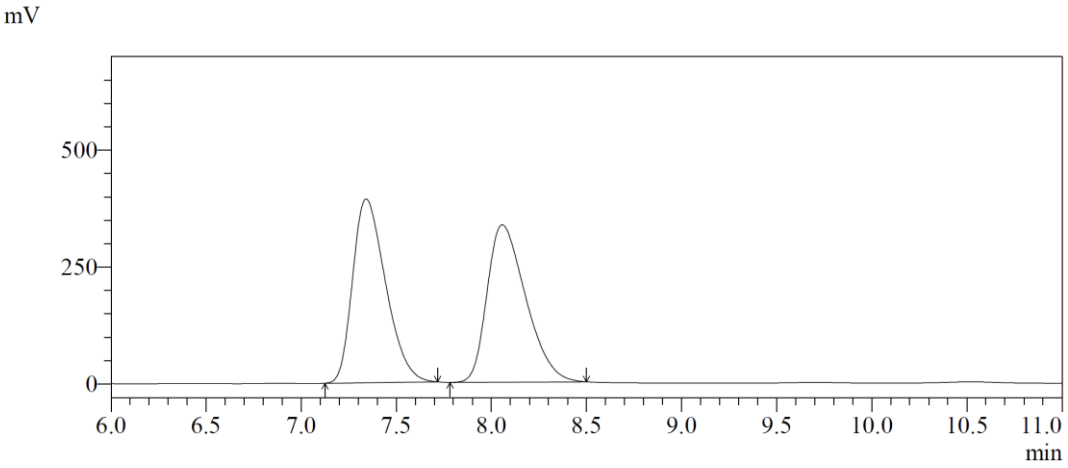


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.366	237.42	1331.44	3773918	316111	49.998
2	8.085	204.90	1331.44	3774204	272808	50.002
Total				7548122	588919	100.000

Figure S4 HPLC trace of **2a** obtained by using (*R*)-H8-binap as the ligand

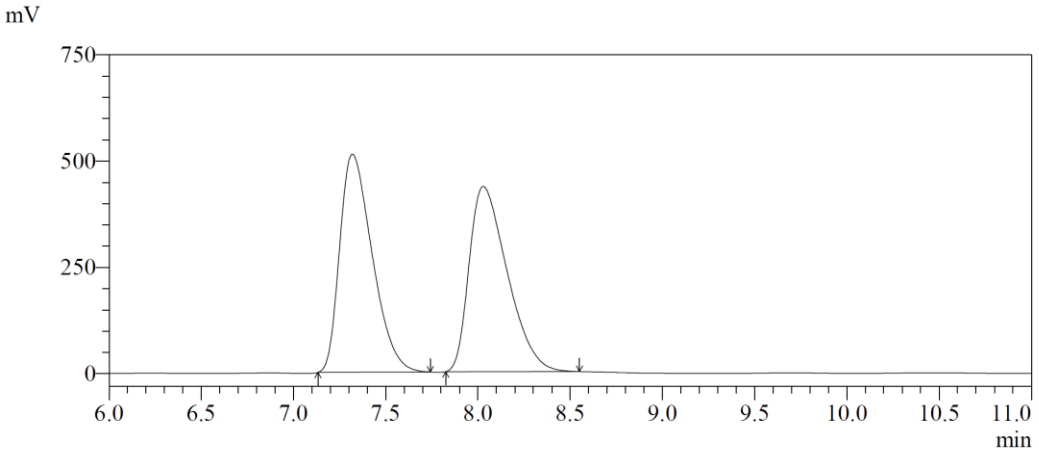


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.341	349.88	1124.29	4750522	393371	49.946
2	8.057	299.58	1124.29	4760860	336819	50.054
Total				9511382	730190	100.000

Figure S5 HPLC trace of **2a** obtained by using (*R*)-MeO-biphep as the ligand

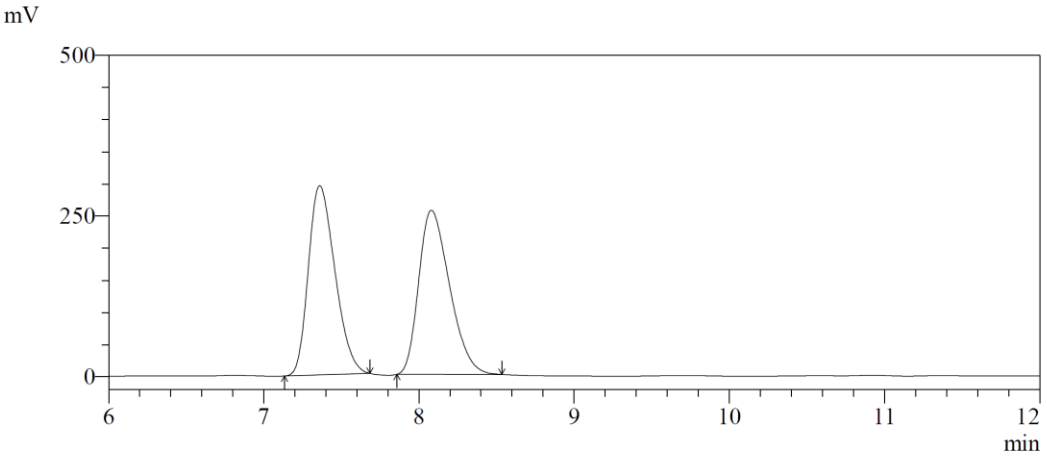


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.319	162.18	3164.17	6293285	513176	50.134
2	8.029	137.61	3164.17	6259583	435424	49.866
Total				12552868	948601	100.000

Figure S6 HPLC trace of **2a** obtained by using (*R*)-binap as the ligand

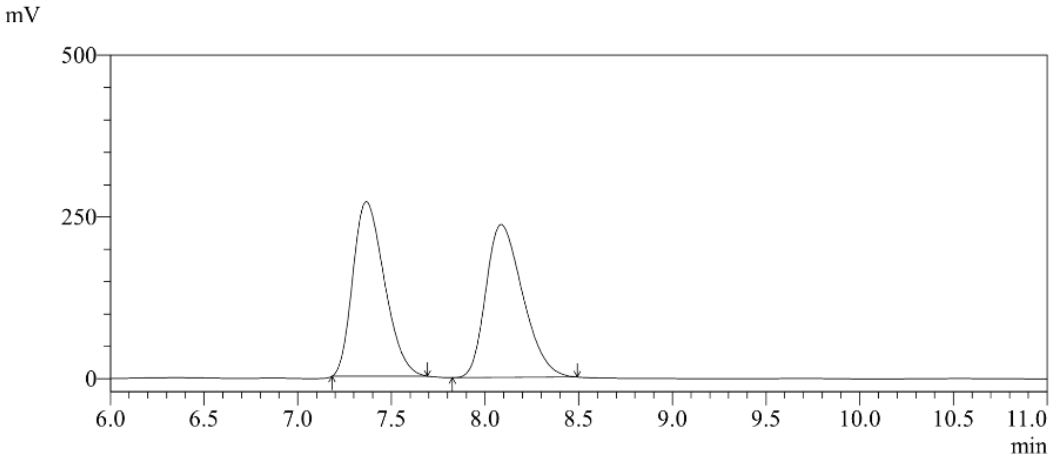


Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.360	180.57	1630.76	3508183	294467	49.849
2	8.080	156.50	1630.76	3529431	255218	50.151
Total				7037615	549686	100.000

Figure S7 HPLC trace of **2a** obtained by using (*R*)-tol-binap as the ligand



Peak Table

Detector A 254nm

Peak#	Ret. Time	S/N	Noise	Area	Height	Area%
1	7.366	196.67	1372.15	3169186	269857	49.453
2	8.086	172.32	1372.15	3239314	236446	50.547
Total				6408500	506303	100.000

Figure S8 HPLC trace of **2a** by using (*R*)-dm-binap as the ligand

V. General procedure for the reactions of benzocyclobutenols

General procedure A: synthesis of *meta-β*-keto phenols

A solution of $Pd(OAc)_2$ in 1,4-dioxane (4.0 mM) was prepared, stored in the glove box and used for the catalytic reaction. To an oven-dried Schlenk tube with a stirring bar was successively added dppe (3.2 mg, 8.0 μmol), K_3PO_4 (21.2 mg, 0.1 mmol), and

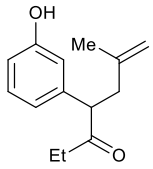
benzocyclobutenol **1** (0.2 mmol). The tube was evacuated and backfilled with inert gas for three times. After the addition of $Pd(OAc)_2$ (1.0 mL, 4.0 μmol), the tube was directly placed in an oil bath at 110 ^oC and stirred for 3 h. The mixture was then quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product **2** or **5**.

General procedure B: the distal C−C bond cleavage/deallylation cascade

A solution of $Pd(OAc)_2$ in 1,4-dioxane (5.0 mM) was prepared, stored in the glove box and used for the catalytic reaction. To an oven-dried Schlenk tube with a stirring bar was added K_3PO_4 (21.2 mg, 0.1 mmol), benzocyclobutenol **1** (0.2 mmol) and 1,4-dioxane (0.5 mL). After stirring at 110 ^oC for 1h, the tube was cooled to room temperature. $Pd(OAc)_2$ (0.8 mL, 4.0 μmol) and dppe (3.2 mg, 8.0 μmol) were successively added. The resulting solution was stirred at 110 ^oC for additional 3 h. Saturated aqueous NH_4Cl solution was added and the mixture was extracted with EtOAc for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product **6**.

VI. Characterizations of products 2, 5 and 6

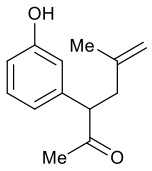
4-(3-Hydroxyphenyl)-6-methylhept-6-en-3-one (2a)



Following the general procedure A, benzocyclobutenol **1a** (43.7 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2a** as a yellow liquid (37.6 mg, 86% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.30 (brs, 1H), 7.17 (dd, *J* = 9.6, 5.7 Hz, 1H), 6.80 – 6.77 (m, 3H), 4.69 (s, 1H), 4.58 (s, 1H), 3.89 (t, *J* = 7.4 Hz, 1H), 2.80 (dd, *J* = 14.8, 8.0 Hz, 1H),

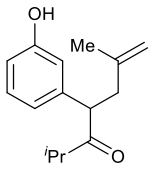
2.57 – 2.34 (m, 3H), 1.66 (s, 3H), 0.97 (t, J = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.10, 156.45, 142.90, 140.20, 129.99, 120.65, 114.56, 114.54, 111.96, 56.73, 39.91, 35.27, 22.79, 7.79. HRMS (ESI^+) for $C_{14}H_{18}NaO_2$ $[M + Na]^+$: calcd 241.1199; found 241.1208.

3-(3-Hydroxyphenyl)-5-methylhex-5-en-2-one (2b)



Following the general procedure A, benzocyclobutenol **1b** (40.9 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2b** as a yellow liquid (37.8 mg, 93% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (t, J = 7.8 Hz, 1H), 6.90 – 6.50 (m, 4H), 4.71 (s, 1H), 4.60 (s, 1H), 3.87 (t, J = 7.4 Hz, 1H), 2.79 (dd, J = 14.9, 7.8 Hz, 1H), 2.37 (dd, J = 14.9, 7.0 Hz, 1H), 2.12 (s, 3H), 1.67 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.73, 156.51, 142.74, 139.72, 130.06, 120.53, 114.67, 114.61, 111.97, 57.63, 39.45, 29.08, 22.75. HRMS (ESI^+) for $C_{13}H_{17}O_2$ $[M + H]^+$: calcd 205.1223; found 205.1215.

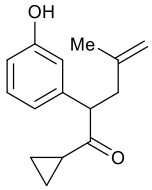
4-(3-Hydroxyphenyl)-2,6-dimethylhept-6-en-3-one (2c)



Following the general procedure A, benzocyclobutenol **1c** (46.5 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2c** as a yellow liquid (28.5 mg, 61% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.17 (t, J = 8.0 Hz, 1H), 6.79 – 6.76 (m, 3H), 6.56 (brs, 1H), 4.70 (s, 1H), 4.60 (s, 1H), 4.02 (t, J = 7.3 Hz, 1H), 2.80 – 2.68 (m, 2H), 2.33 (dd, J = 14.5, 6.7 Hz, 1H), 1.67 (s, 3H), 1.08 (d, J = 7.0 Hz, 3H), 0.92 (d, J = 6.7 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 215.12, 156.41, 142.90, 140.16, 129.97, 120.90, 114.54, 114.48,

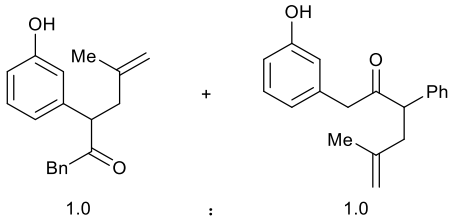
112.14, 55.48, 40.51, 40.16, 22.82, 18.79, 18.24. HRMS (ESI^+) for $C_{15}H_{21}O_2$ [M + H]$^+$: calcd 233.1536; found 233.1535.

1-Cyclopropyl-2-(3-hydroxyphenyl)-4-methylpent-4-en-1-one (2d)



Following the general procedure A, benzocyclobutenol **1d** (46.1 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2d** as a yellow liquid (26.2 mg, 57% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (t, *J* = 7.8 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.79 – 6.72 (m, 2H), 6.63 (s, 1H), 4.70 (s, 1H), 4.60 (s, 1H), 4.02 (t, *J* = 7.4 Hz, 1H), 2.82 (dd, *J* = 14.9, 7.8 Hz, 1H), 2.36 (dd, *J* = 14.9, 7.0 Hz, 1H), 2.01 – 1.93 (m, 1H), 1.67 (s, 3H), 1.03 – 0.98 (m, 2H), 0.90 – 0.84 (m, 1H), 0.80 – 0.74 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 211.50, 156.48, 142.91, 140.09, 129.95, 120.88, 114.68, 114.49, 111.87, 57.76, 39.81, 22.82, 20.62, 12.01, 11.72. HRMS (ESI^+) for $C_{15}H_{18}NaO_2$ [M + Na]$^+$: calcd 253.1199; found 253.1207.

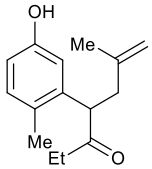
3-(3-Hydroxyphenyl)-5-methyl-1-phenylhex-5-en-2-one (2e) and 1-(3-hydroxyphenyl)-5-methyl-3-phenylhex-5-en-2-one (2e′)



Following the general procedure B, benzocyclobutenol **1e** (56.1 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 10 : 1) afforded **2e** and **2e′** as an inseparable mixture in 1:1 ratio (27.3 mg, 49% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.17 (m, 9H), 7.14 (t, *J* = 7.8 Hz, 1H), 7.07 (s, 1H), 7.05 (s, 1H), 6.78 – 6.75 (m, 2H), 6.73 – 6.69 (m, 2H), 6.61 (d, *J* =

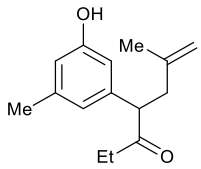
7.5 Hz, 1H), 6.54 (s, 1H), 5.94 (brs, 1H), 5.72 (brs, 1H), 4.65 (s, 2H), 4.51 (s, 2H), 4.02 – 3.94 (m, 2H), 3.67 (s, 2H), 3.60 (s, 2H), 2.83 – 2.74 (m, 2H), 2.37 – 2.29 (m, 2H), 1.58 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 207.81, 207.66, 156.29, 155.90, 142.69, 142.67, 139.84, 138.19, 135.34, 133.77, 130.10, 129.77, 129.58, 128.91, 128.56, 128.42, 127.40, 126.97, 121.80, 120.89, 116.48, 114.90, 114.58, 114.13, 112.07, 112.02, 56.00, 55.85, 48.87, 48.69, 39.97, 39.91, 22.66, 22.62. HRMS (ESI^+) for $C_{19}H_{21}O_2$ $[M + H]^+$: calcd 281.1536; found 281.1535.

4-(5-Hydroxy-2-methylphenyl)-6-methylhept-6-en-3-one (2f)



Following the general procedure A, benzocyclobutenol **1f** (46.5 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2f** as a colorless solid (29.0 mg, 62% yield). M.p.: 67.5 – 68.3 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.06 (d, *J* = 9.0 Hz, 1H), 6.80 – 6.60 (m, 3H), 4.70 (s, 1H), 4.59 (s, 1H), 4.14 (dd, *J* = 8.1, 6.2 Hz, 1H), 2.81 (dd, *J* = 14.7, 8.3 Hz, 1H), 2.47 – 2.36 (m, 2H), 2.34 (s, 3H), 2.24 (dd, *J* = 14.7, 6.0 Hz, 1H), 1.67 (s, 3H), 0.98 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.49, 154.80, 143.22, 138.15, 131.89, 127.22, 114.30, 113.67, 111.77, 52.34, 39.79, 35.58, 22.98, 19.05, 7.87. Elemental Anal. for $C_{15}H_{20}O_2$: calcd C 77.55%, H 8.68%, found C 77.42%, H 8.45%.

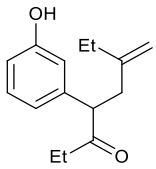
4-(3-Hydroxy-5-methylphenyl)-6-methylhept-6-en-3-one (2g)



Following the general procedure A, benzocyclobutenol **1g** (46.5 mg, 0.2 mmol) was used and the reaction time was 8 h. Purification by column chromatography on silica

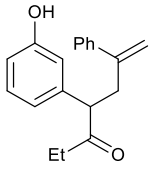
gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2g** as a yellow solid (34.3 mg, 74% yield). M.p.: 75.4 – 76.1 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.60 – 6.57 (m, 3H), 6.47 (brs, 1H), 4.70 (s, 1H), 4.59 (s, 1H), 3.83 (t, *J* = 7.3 Hz, 1H), 2.79 (dd, *J* = 14.8, 8.2 Hz, 1H), 2.54 – 2.30 (m, 3H), 2.27 (s, 3H), 1.67 (s, 3H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.02, 156.30, 143.04, 140.12, 140.01, 121.45, 115.19, 111.78, 111.68, 56.70, 39.85, 35.22, 22.84, 21.32, 7.79. HRMS (ESI^+) for $C_{15}H_{21}O_2$ $[M + H]^+$: calcd 233.1536; found 233.1532.

4-(3-Hydroxyphenyl)-6-methyleneoctan-3-one (2h)



Following the general procedure A, benzocyclobutenol **1h** (46.5 mg, 0.2 mmol) was used and the reaction was placed directly in an oil bath at 110 ^{o}C for 5 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2h** as a yellow liquid (30.5 mg, 66% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.17 (t, *J* = 8.0 Hz, 1H), 6.79 – 6.75 (m, 3H), 4.71 (s, 1H), 4.61 (s, 1H), 3.89 (t, *J* = 8.0 Hz, 1H), 2.83 (dd, *J* = 14.9, 8.2 Hz, 1H), 2.56 – 2.33 (m, 3H), 1.96 (q, *J* = 7.4 Hz, 2H), 0.98 (t, *J* = 7.4 Hz, 3H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.19, 156.45, 148.53, 140.32, 129.98, 120.65, 114.55, 114.51, 109.49, 56.85, 38.43, 35.37, 29.11, 12.17, 7.79. HRMS (ESI^+) for $C_{15}H_{21}O_2$ $[M + H]^+$: calcd 233.1536; found 233.1538.

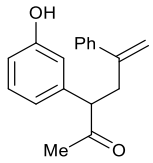
4-(3-Hydroxyphenyl)-6-phenylhept-6-en-3-one (2i)



Following the general procedure A, benzocyclobutenol **1i** (56.1 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl

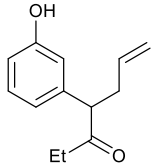
acetate = 20 : 1) afforded **2i** as a colorless liquid (41.8 mg, 75% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.29 (m, 5H), 7.17 (t, *J* = 7.7 Hz, 1H), 6.94 (brs, 1H), 6.81-6.78 (m, 2H), 6.69 (d, *J* = 7.5 Hz, 1H), 5.19 (s, 1H), 4.94 (s, 1H), 3.80 (t, *J* = 7.2 Hz, 1H), 3.36 (dd, *J* = 14.5, 7.6 Hz, 1H), 2.84 (dd, *J* = 14.5, 6.8 Hz, 1H), 2.48 – 2.38 (m, 1H), 2.33 – 2.23 (m, 1H), 0.93 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.30, 156.49, 145.54, 140.51, 140.02, 129.97, 128.39, 127.54, 126.27, 120.74, 114.82, 114.57, 114.51, 56.63, 38.14, 35.63, 7.73. HRMS (ESI^+) for $C_{19}H_{20}NaO_2$ $[M + Na]^+$: calcd 303.1356; found 303.1356.

3-(3-Hydroxyphenyl)-5-phenylhex-5-en-2-one (2j)



Following the general procedure A, benzocyclobutenol **1j** (53.3 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2j** as a yellow liquid (38.1 mg, 71% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35 – 7.31 (m, 4H), 7.31 – 7.27 (m, 1H), 7.17 (t, *J* = 7.8 Hz, 1H), 6.76 (d, *J* = 8.1 Hz, 1H), 6.68 – 6.66 (m, 2H), 6.10 (brs, 1H), 5.18 (s, 1H), 4.92 (s, 1H), 3.74 (t, *J* = 7.1 Hz, 1H), 3.34 (dd, *J* = 14.7, 7.1 Hz, 1H), 2.80 (dd, *J* = 14.7, 7.4 Hz, 1H), 2.02 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.17, 156.36, 145.47, 140.56, 139.80, 130.06, 128.41, 127.57, 126.30, 120.85, 114.86, 114.66, 114.60, 57.56, 37.73, 29.48. HRMS (ESI+) for $C_{18}H_{18}NaO_2$ $[M + Na]^+$: calcd 289.1199; found 289.1202.

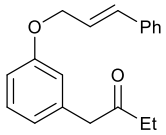
4-(3-Hydroxyphenyl)hept-6-en-3-one (2k)



Following the general procedure A, benzocyclobutenol **1k** (40.9 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2k** as a light brown liquid (26.5 mg, 65% yield). ^{1}H NMR

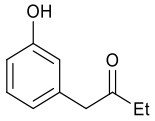
(400 MHz, $CDCl_3$) δ 7.19 (t, *J* = 7.8 Hz, 1H), 6.79 – 6.76 (m, 3H), 5.70 – 5.60 (m, 1H), 5.03 – 4.93 (m, 2H), 3.71 (t, *J* = 7.5 Hz, 1H), 2.80 – 2.73 (m, 1H), 2.54 – 2.34 (m, 3H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.99, 156.46, 139.94, 135.57, 130.07, 120.76, 116.71, 114.59, 114.50, 58.25, 36.38, 35.29, 7.80. HRMS (ESI^+) for $C_{13}H_{16}NaO_2$ $[M + Na]^+$: calcd 227.1043; found 227.1046.

1-(3-(Cinnamyloxy)phenyl)butan-2-one (2l)



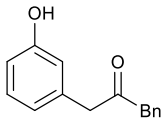
Following the general procedure A, benzocyclobutenol **1l** (56.1 mg, 0.2 mmol) was used and the reaction time was 4 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 40 : 1) afforded **2l** as a colorless liquid (14.0 mg, 25% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 7.7 Hz, 2H), 7.33 (t, *J* = 7.4 Hz, 2H), 7.26 – 7.23 (m, 2H), 6.87 (d, *J* = 8.5 Hz, 1H), 6.81 – 6.80 (m, 2H), 6.73 (d, *J* = 15.9 Hz, 1H), 6.41 (dt, *J* = 15.9, 5.8 Hz, 1H), 4.69 (d, *J* = 5.7 Hz, 2H), 3.66 (s, 2H), 2.48 (q, *J* = 7.3 Hz, 2H), 1.01 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.95, 158.81, 136.36, 135.94, 133.05, 129.72, 128.57, 127.89, 126.54, 124.26, 121.94, 115.85, 113.21, 68.54, 49.89, 35.12, 7.73.

1-(3-Hydroxyphenyl)butan-2-one (5a)



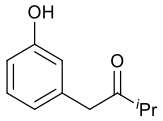
Following the general procedure A, benzocyclobutenol **1m** (43.7 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **5a** as a colorless liquid (29.8 mg, 91% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.17 (t, *J* = 7.8 Hz, 1H), 6.76 – 6.71 (m, 3H), 6.56 (brs, 1H), 3.64 (s, 2H), 2.50 (q, *J* = 7.3 Hz, 2H), 1.03 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.89, 156.24, 135.54, 129.89, 121.38, 116.18, 114.26, 49.65, 35.23, 7.71. HRMS (ESI^+) for $C_{10}H_{12}NaO_2$ $[M + Na]^+$: calcd 187.0730; found 187.0731.

1-(3-Hydroxyphenyl)-3-phenylpropan-2-one (5b)



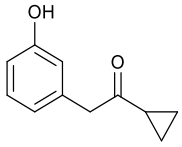
Following the general procedure A, benzocyclobutenol **1n** (56.1 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **5b** as a yellow liquid (24.0 mg, 53% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.24 (m, 3H), 7.19 – 7.14 (m, 3H), 6.74 – 6.69 (m, 2H), 6.63 – 6.62 (m, 1H), 3.73 (s, 2H), 3.67 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 206.89, 156.11, 135.23, 133.72, 129.93, 129.48, 128.72, 127.11, 121.65, 116.35, 114.33, 49.00, 48.92. HRMS (ESI^+) for $C_{15}H_{14}NaO_2$ $[M + Na]^+$: calcd 249.0886; found 249.0885.

1-(3-Hydroxyphenyl)-3-methylbutan-2-one (5c)



Following the general procedure A, benzocyclobutenol **1o** (46.5 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **5c** as a yellow liquid (26.9 mg, 76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.16 (t, *J* = 7.8 Hz, 1H), 6.74 – 6.69 (m, 3H), 6.36 (brs, 1H), 3.70 (s, 2H), 2.80 – 2.70 (m, 1H), 1.10 (s, 3H), 1.09 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 213.59, 156.17, 135.59, 129.80, 121.50, 116.32, 114.19, 47.60, 40.10, 18.29. HRMS (ESI^+) for $C_{11}H_{14}NaO_2$ $[M + Na]^+$: calcd 201.0886; found 201.0885.

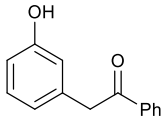
1-Cyclopropyl-2-(3-hydroxyphenyl)ethan-1-one (5d)



Following the general procedure A, benzocyclobutenol **1p** (46.1 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **5d** as a yellow liquid (20.6 mg, 59% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.17 (t, *J* = 7.8 Hz, 1H), 6.79 – 6.66 (m, 3H), 3.77 (s, 2H), 2.03 – 1.97

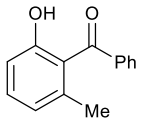
(m, 1H), 1.09 – 1.03 (m, 2H), 0.91 – 0.86 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.20, 156.32, 135.54, 129.86, 121.53, 116.34, 114.26, 50.49, 20.30, 11.84. HRMS (ESI^+) for $C_{11}H_{13}O_2$ $[M + H]^+$: calcd 177.0910; found 177.0910.

2-(3-Hydroxyphenyl)-1-phenylethan-1-one (5e)



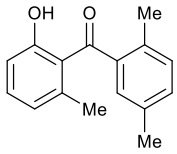
Following the general procedure A, benzocyclobutenol **1q** (53.3 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **5e** as a yellow liquid (11.6 mg, 27% yield) and **6a** (26.5 mg, 62%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.18 (t, *J* = 7.8 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.76 – 6.72 (m, 2H), 5.51 (brs, 1H), 4.23 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 198.09, 155.94, 136.35, 135.98, 133.35, 129.90, 128.68, 128.67, 121.73, 116.35, 114.09, 45.35.

(2-Hydroxy-6-methylphenyl)(phenyl)methanone (6a)



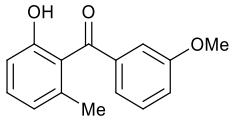
Following the general procedure B, benzocyclobutenol **1q** (53.3 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : dichloromethane = 1 : 1) afforded **6a** as a light yellow liquid (38.5 mg, 91% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.62 (s, 1H), 7.71 (d, *J* = 7.5 Hz, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.30 (t, *J* = 7.9 Hz, 1H), 6.87 (d, *J* = 8.3 Hz, 1H), 6.76 (d, *J* = 7.5 Hz, 1H), 2.00 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 201.01, 158.08, 139.67, 138.53, 133.01, 128.98, 128.69, 123.32, 122.77, 114.88, 22.23. HRMS (ESI^+) for $C_{14}H_{13}O_2$ $[M + H]^+$: calcd 213.0910; found 213.0910.

(2,5-Dimethylphenyl)(2-hydroxy-6-methylphenyl)methanone (6b)



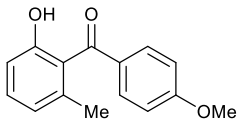
Following the general procedure B, benzocyclobutenol **1r** (58.9 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **6b** as a yellow solid (35.1 mg, 73% yield). M.p.: 96.7 – 97.1 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.08 (s, 1H), 7.32 (t, *J* = 7.9 Hz, 1H), 7.20 – 7.15 (m, 2H), 7.03 (s, 1H), 6.91 (d, *J* = 8.4 Hz, 1H), 6.67 (d, *J* = 7.4 Hz, 1H), 2.31 (s, 6H), 1.84 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 204.54, 161.61, 141.21, 140.15, 135.65, 134.66, 132.39, 131.45, 131.22, 127.97, 122.89, 122.05, 115.83, 22.62, 20.77, 19.19. Elemental Anal. for $C_{16}H_{16}O_2$: calcd C 79.97%, H 6.71%, found C 79.59%, H 6.87%.

(2-Hydroxy-6-methylphenyl)(3-methoxyphenyl)methanone (6c)



Following the general procedure B, benzocyclobutenol **1s** (59.3 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : dichloromethane = 1 : 1) afforded **6c** as a yellow liquid (33.2 mg, 68% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.36 (s, 1H), 7.26 (t, *J* = 7.9 Hz, 1H), 7.22 – 7.18 (m, 2H), 7.16 (d, *J* = 7.6 Hz, 1H), 7.05 – 7.03 (m, 1H), 6.78 (d, *J* = 8.3 Hz, 1H), 6.68 (d, *J* = 7.5 Hz, 1H), 3.76 (s, 3H), 1.95 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 200.64, 159.87, 157.73, 140.84, 138.47, 132.84, 129.71, 123.64, 122.74, 121.92, 119.44, 114.75, 112.96, 55.45, 21.90. HRMS (ESI^+) for $C_{15}H_{15}O_3$ $[M + H]^+$: calcd 243.1016; found 243.1017.

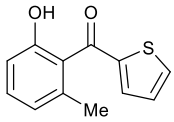
(2-Hydroxy-6-methylphenyl)(4-methoxyphenyl)methanone (6d)



Following the general procedure B, benzocyclobutenol **1t** (59.3 mg, 0.2 mmol) was

used. Purification by column chromatography on silica gel (petroleum ether : dichloromethane = 1 : 3) afforded **6d** as a yellow liquid (17.2 mg, 35% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.73 (d, *J* = 8.8 Hz, 2H), 7.26 (t, *J* = 7.9 Hz, 1H), 6.93 (d, *J* = 8.8 Hz, 2H), 6.84 (d, *J* = 8.2 Hz, 1H), 6.77 (d, *J* = 7.5 Hz, 1H), 3.87 (s, 3H), 2.05 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 198.89, 163.82, 156.90, 137.88, 132.17, 131.88, 131.77, 124.27, 122.62, 114.58, 113.94, 55.50, 21.71. HRMS (ESI^+) for $C_{15}H_{15}O_3$ $[M + H]^+$: calcd 243.1016; found 243.1013.

(2-Hydroxy-6-methylphenyl)(thiophen-2-yl)methanone (6e)



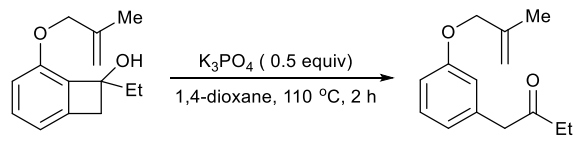
Following the general procedure B, benzocyclobutenol **1u** (54.5 mg, 0.2 mmol) was used. Purification by column chromatography on silica gel (petroleum ether : dichloromethane = 1 : 4) afforded **6e** as a colorless liquid (18.0 mg, 41% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 4.9 Hz, 1H), 7.46 (d, *J* = 3.7 Hz, 1H), 7.24 (t, *J* = 8.0 Hz, 1H), 7.20 – 7.02 (m, 2H), 6.80 (d, *J* = 7.9 Hz, 2H), 2.21 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 191.13, 155.28, 144.70, 137.18, 135.37, 135.24, 131.78, 128.28, 125.39, 122.80, 114.32, 20.96. HRMS (ESI^+) for $C_{12}H_{11}O_2S$ $[M + H]^+$: calcd 219.0474; found 219.0475.

VII. Control experiments

i. The reaction of different benzocyclobutenols in the presence of K_3PO_4

To an oven-dried Schlenk tube with a stirring bar was added K_3PO_4 (21.2 mg, 0.1 mmol) and benzocyclobutenols. The tube was evacuated and backfilled with N_2 for three times. 1,4-Dioxane (1.0 mL) was then added. The tube was heated at 110 ^{o}C for 2 h. The mixture was quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel to afford the ring-opening products.

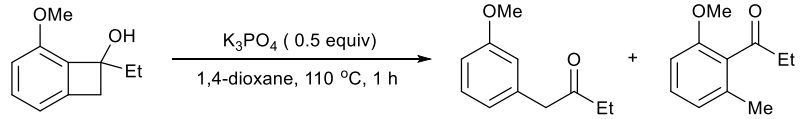
(a)



1a **3**, 76%

Benzocyclobutenol **1a** (43.7 mg, 0.2 mmol) was used and the reaction time was 2 h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 50 : 1) afforded **3** as a yellow liquid (33.1 mg, 76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 (t, *J* = 7.8 Hz, 1H), 6.83 – 6.78 (m, 3H), 5.09 (s, 1H), 4.98 (s, 1H), 4.41 (s, 2H), 3.64 (s, 2H), 2.47 (q, *J* = 7.3 Hz, 2H), 1.83 (s, 3H), 1.02 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.97, 158.96, 140.78, 135.84, 129.61, 121.81, 115.82, 113.18, 112.73, 71.60, 49.87, 35.09, 19.42, 7.73.

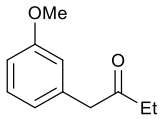
(b)



8 **9**, 63% **10**, 14%

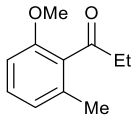
Benzocyclobutenol **8** (35.6 mg, 0.2 mmol) was used and the reaction time was 1h. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 50 : 1) afforded **9** (22.5 mg) in 63% yield and **10** (5.1 mg) in 14% yield.

1-(3-Methoxyphenyl)butan-2-one (9)



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (t, *J* = 8.0 Hz, 1H), 6.82 – 6.78 (m, 2H), 6.75 – 6.74 (m, 1H), 3.79 (s, 3H), 3.65 (s, 2H), 2.47 (q, *J* = 7.3 Hz, 2H), 1.02 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.88, 159.77, 135.89, 129.63, 121.69, 114.95, 112.39, 55.14, 49.85, 35.08, 7.72.

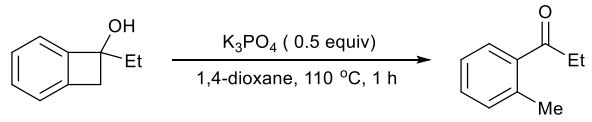
1-(2-Methoxy-6-methylphenyl)propan-1-one (10)



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (t, *J* = 8.0 Hz, 1H), 6.79 (d, *J* = 7.6 Hz, 1H), 6.74

(d, *J* = 8.3 Hz, 1H), 3.79 (s, 3H), 2.77 (q, *J* = 7.3 Hz, 2H), 2.20 (s, 3H), 1.16 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 208.94, 155.93, 135.20, 131.33, 129.55, 122.77, 108.15, 55.52, 37.72, 18.87, 7.78.

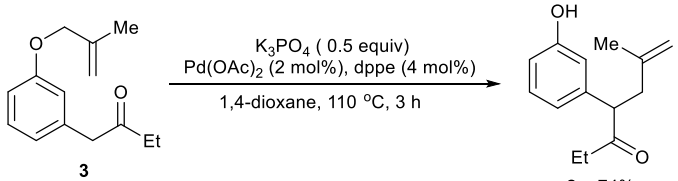
(c)



11 **12**, 78%

Benzocyclobutenol **11** (29.6 mg, 0.2 mmol) was used and the reaction time was 1h. Purification by column chromatography on silica gel (petroleum ether : dichloromethane = 5 : 1) afforded ketone **12** as a colorless liquid (23.0 mg, 78% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.7 Hz, 1H), 7.38 (t, *J* = 7.5 Hz, 1H), 7.28 (d, *J* = 6.5 Hz, 2H), 2.94 (q, *J* = 7.3 Hz, 2H), 2.51 (s, 3H), 1.22 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 205.15, 138.09, 137.83, 131.86, 131.02, 128.22, 125.61, 34.72, 21.24, 8.36.

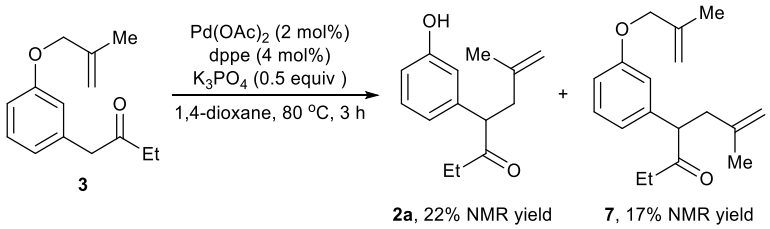
ii. The reaction of ketone 3 under standard conditions



3 **2a**, 74%

Following the general procedure A, ketone **3** (43.7 mg, 0.2 mmol) was used as the substrate. Purification by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) afforded **2a** (32.5 mg) in 74% yield.

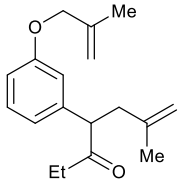
iii. The reaction of ketone 3 at 80 °C



3 **2a**, 22% NMR yield **7**, 17% NMR yield

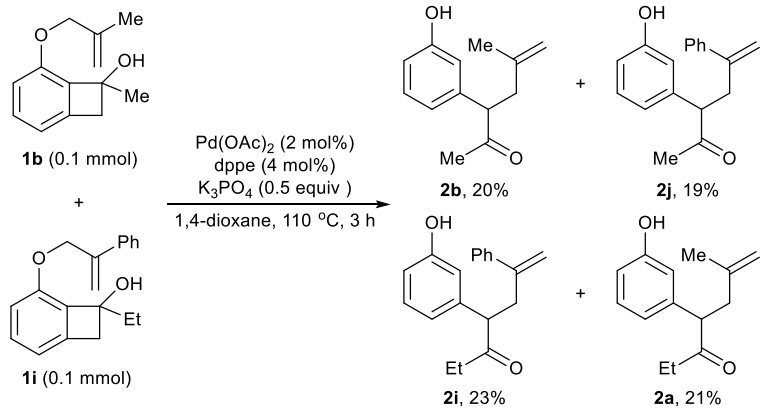
Following the general procedure A except that the reaction temperature was 80 ^{o}C, ketone **3a** (43.7 mg, 0.2 mmol) was used. The NMR yields of compound **2a** and 7 were 22% and 17%, respectively.

6-Methyl-4-(3-((2-methylallyl)oxy)phenyl)hept-6-en-3-one (7)

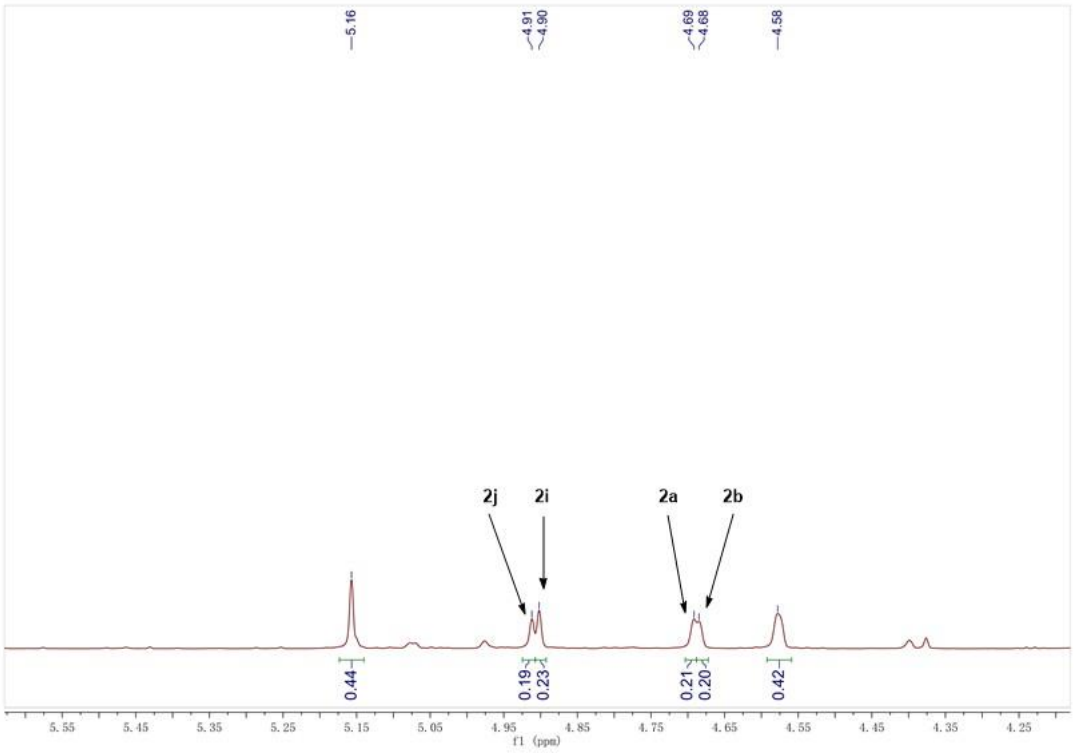


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (t, *J* = 7.7 Hz, 1H), 6.81 – 6.79 (m, 3H), 5.09 (s, 1H), 4.98 (s, 1H), 4.69 (s, 1H), 4.59 (s, 1H), 4.41 (s, 2H), 3.84 (t, *J* = 7.4 Hz, 1H), 2.81 (dd, *J* = 14.8, 7.8 Hz, 1H), 2.51 – 2.30 (m, 3H), 1.83 (s, 3H), 1.67 (s, 3H), 0.96 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.28, 159.00, 143.10, 140.77, 140.39, 129.65, 120.76, 114.66, 113.32, 112.79, 111.85, 71.63, 56.89, 39.86, 35.04, 22.82, 19.44, 7.82. HRMS (ESI^{+}) for $C_{18}H_{24}NaO_2$ [M + Na]$^{+}$: calcd 295.1669; found 295.1671.

iv. The cross-over experiment



Following the general procedure A, benzocyclobutenols **1b** (21.8 mg, 0.1 mmol) and **1i** (28.0 mg, 0.1 mmol) were used as the substrates. After workup, the crude product was analyzed by ^{1}H NMR spectrometer. It was found that compounds **2a**, **2b**, **2i** and **2j** were formed in a ratio of around 1:1:1:1.



VIII. Mechanistic studies by DFT calculations

i. Computational details

All of the calculations were performed with the Gaussian 09 package[7] using B3LYP-D3(BJ) functional.[8] Geometry optimizations were carried out with the def2-SVP[9] basis set. Vibrational frequencies were computed analytically at the same level of theory to confirm whether the structures are minima (no imaginary frequencies) or transition states (only one imaginary frequency). Selected key transition-state structures were confirmed to connect corresponding reactants and products by intrinsic reaction coordinate (IRC) calculations.[10] To obtain better accuracy, energies of the optimized geometries were recalculated using the def2-TZVPP[11] basis set. Solvation effects (1,4-dioxane, ε =2.2099) were taken into account using the PCM model[12] with UFF radii in the single-point calculations. The final Gibbs free energies reported in the article are the single-point energies with Gibbs free energy correction (at 298.15 K).

ii. Key transition states of the C–C bond cleavage

To gain deeper insights into the origins of the substituent-controlled selectivity,

preliminary mechanistic studies were performed by means of density functional theory calculations. Starting from the oxy-anionic intermediates generated *via* the deprotonation of the OH group by K_3PO_4, the key transition states of the proximal and distal C–C bond cleavage were located. The computations show that for the reaction of α-methyl substituted benzocyclobutenol, the proximal C–C bond cleavage is more favored than the distal C–C bond cleavage by 1.1 kcal/mol. On the other hand, for the reaction of α-phenyl substituted benzocyclobutenol, the distal C–C bond cleavage is preferred by 1.0 kcal/mol compared with the proximal C–C bond cleavage. Although the calculated energy differences are somewhat underestimated compared to the experiments, the computations indeed reproduced quite well the selectivity switch upon change of the substituent.

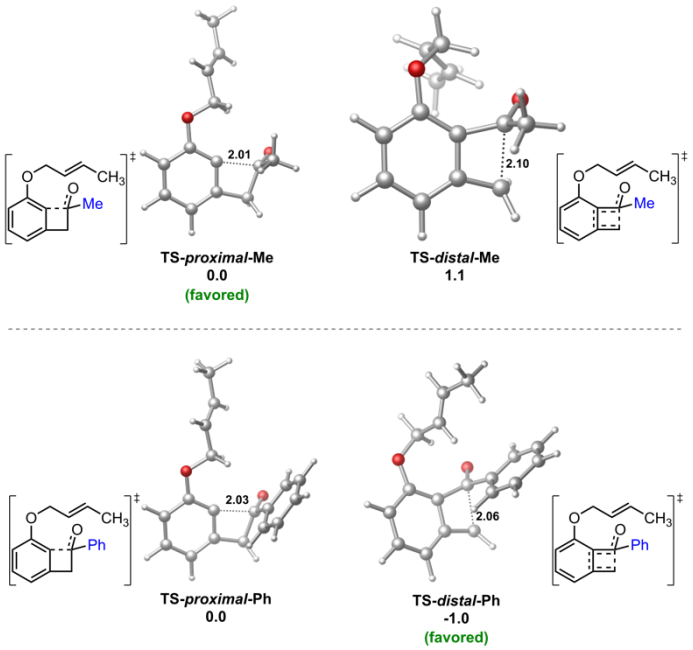


Figure S8. Calculated energies of the proximal and distal C−C bond cleavage. Energies and bond distances are given in kcal/mol and Å, respectively.

iii. Cartesian coordinates and energies

TS-*proximal*-Me

E= -655.1608259

Thermal correction to Gibbs free energy = 0.201389

C	-6.38142800	-0.22226200	2.67312600
C	-5.57580400	-0.73631500	1.64280300

C	-4.59843500	0.10773000	1.10436600
C	-4.38059800	1.41223700	1.56268000
C	-5.22045500	1.90719400	2.55736300
C	-6.21728800	1.09234000	3.12830300
H	-7.15984100	-0.84848900	3.12310300
H	-5.73143800	-1.75752900	1.27643400
H	-6.85762000	1.49681000	3.91956600
O	-5.12886800	3.20313900	3.01440600
C	-4.09251900	3.97176300	2.41910500
H	-4.08980000	3.86634800	1.32008400
H	-3.10838200	3.58445600	2.75367400
C	-4.26174400	5.39501900	2.84891000
C	-4.21038300	6.44758600	2.02554400
H	-4.41946900	5.55280600	3.92511400
H	-4.06521100	6.25981100	0.95352700
C	-4.32906700	7.88383700	2.44375500
H	-5.17385600	8.38420600	1.93596400
H	-4.48322700	7.97749100	3.53083800
H	-3.42383200	8.46078700	2.17893300
C	-2.92914400	1.40307700	0.17861400
C	-3.61561500	-0.01146500	-0.03003600
O	-2.94403000	2.26333300	-0.72675700
H	-4.09988700	-0.00810700	-1.02139600
H	-2.91518800	-0.87036600	0.01360700
C	-1.67475200	1.32330700	1.07185600
H	-0.82276300	0.99104000	0.44512300
H	-1.43622300	2.33019900	1.44767100
H	-1.78627300	0.63425600	1.92380200

TS-*distal*-Me

E= -655.1604541

Thermal correction to Gibbs free energy = 0.202796

C	-6.25953900	0.58122400	2.76907300
C	-5.71207600	0.51361000	1.48142700
C	-4.67868200	1.40805500	1.15789700
C	-4.12910000	2.25536500	2.14115600
C	-4.72344100	2.37461500	3.40356600
C	-5.80036200	1.51695600	3.70524200
H	-7.07925800	-0.08954400	3.05013900
H	-6.10005800	-0.19523600	0.74243000
H	-6.24166700	1.58302800	4.70313500
O	-4.29425400	3.18342300	4.42461500
C	-3.79009200	4.48504600	4.07835200
H	-2.97739500	4.41094600	3.34036400
H	-3.39306200	4.87853400	5.02906800
C	-4.87487100	5.37051900	3.53617800
C	-4.95568600	5.68638300	2.23709900
H	-5.65951800	5.68866300	4.23888700
H	-4.16793800	5.28541400	1.57862500
C	-6.05675200	6.49543500	1.62210300
H	-6.58893000	5.90608800	0.85387000
H	-6.79578000	6.83080500	2.36926000
H	-5.66072600	7.38823900	1.10394000
C	-2.82670200	2.72028800	1.47292800
C	-3.85934000	1.67299400	-0.03287500
O	-2.54434800	3.93643400	1.27739700
H	-4.12365300	2.59419500	-0.56758100
H	-3.64021500	0.83727000	-0.72185600
C	-1.65638500	1.77085600	1.77066700
H	-0.86203900	1.94052700	1.02677200

H	-1.23773300	2.01956300	2.76745400
H	-1.95071200	0.71096400	1.76683200

TS-*proximal*-Ph

E= -846.9922855

Thermal correction to Gibbs free energy = 0.250006

C	-6.34851200	-0.26276200	2.68711500
C	-5.52646700	-0.79095200	1.67735200
C	-4.58894300	0.06917800	1.09525600
C	-4.43510100	1.40034100	1.49145800
C	-5.26888100	1.90511500	2.48593200
C	-6.23148800	1.07359600	3.09069000
H	-7.09886200	-0.89932300	3.16836700
H	-5.63516800	-1.83517200	1.36409200
H	-6.87746200	1.48146100	3.87515200
O	-5.19568100	3.20749300	2.91201300
C	-4.14629400	3.96660300	2.31993700
H	-4.18890700	3.91580400	1.21780700
H	-3.16944900	3.52725700	2.59975300
C	-4.24687100	5.37257100	2.81917500
C	-4.19142300	6.46030400	2.04332200
H	-4.34694700	5.48464900	3.90764000
H	-4.10177900	6.31898000	0.95808700
C	-4.22999100	7.87853700	2.53164100
H	-5.07246000	8.43758900	2.08498900
H	-4.33348100	7.92631800	3.62753900
H	-3.31185400	8.42821200	2.25403100
C	-2.94185000	1.36753400	0.11937600
C	-3.57480200	-0.07067900	-0.00851900
O	-2.96892700	2.15924500	-0.84695700

C	-1.76778600	1.48082600	1.09432200
C	-0.91104000	2.57989200	0.93317500
C	-1.48155400	0.56260800	2.12039500
C	0.18190200	2.77603700	1.78104900
H	-1.14960100	3.26035400	0.11267600
C	-0.38324500	0.74838400	2.96139800
H	-2.14436200	-0.28978200	2.28201600
C	0.45473100	1.86002400	2.80180600
H	0.83080500	3.64738200	1.64270500
H	-0.18143000	0.02329300	3.75643800
H	1.31055700	2.00770500	3.46742600
H	-4.03103800	-0.13126900	-1.01021700
H	-2.85008500	-0.90178500	0.09131400

TS-*distal*-Ph

E= -846.9938628

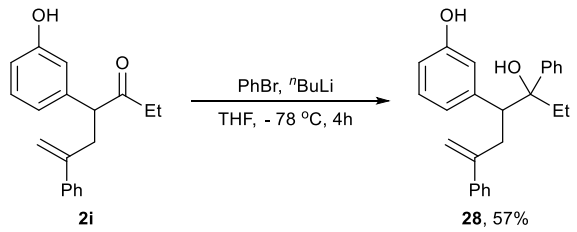
Thermal correction to Gibbs free energy = 0.250113

C	-6.59214900	0.68035100	2.47547000
C	-5.94528600	0.67133200	1.22621900
C	-4.75027300	1.38531900	1.14608900
C	-4.18870800	2.04403900	2.24149300
C	-4.85859400	2.10280500	3.46624100
C	-6.07061000	1.38516700	3.56797900
H	-7.53554300	0.13884400	2.60299300
H	-6.37928300	0.14243200	0.37224400
H	-6.59685900	1.39566500	4.52657500
O	-4.44673300	2.79281100	4.56074100
C	-3.21926500	3.53409800	4.45200200
H	-3.34780400	4.42619900	5.08704600
H	-3.05332900	3.86432900	3.40154600

C	-2.05409300	2.72111500	4.92375300
C	-1.12328700	3.13531100	5.78965400
H	-1.94948500	1.73614400	4.45753000
H	-1.22766200	4.13189600	6.24260000
C	0.10413700	2.35419900	6.15805000
H	0.17446000	2.18495400	7.24890300
H	0.11952900	1.37887000	5.64822800
H	1.02352200	2.89252100	5.86287700
C	-2.90493700	2.53384300	1.43460800
C	-3.67897600	1.79881700	0.16282900
O	-2.65108600	3.80870900	1.37308500
C	-1.68290900	1.65516300	1.83993800
C	-0.45563700	2.31587000	1.96255300
C	-1.73281800	0.28085800	2.12079200
C	0.69435400	1.63277300	2.36502700
H	-0.48695000	3.38832000	1.75032400
C	-0.58642100	-0.40879200	2.52851600
H	-2.68571000	-0.25016400	2.04456500
C	0.63480100	0.26510500	2.65623500
H	1.64410500	2.16896200	2.46689300
H	-0.64588400	-1.47821100	2.75659800
H	1.53023200	-0.27250400	2.98338100
H	-3.99554600	2.59727800	-0.52521700
H	-3.15487800	0.99989600	-0.39115600

IX. Synthetic applications

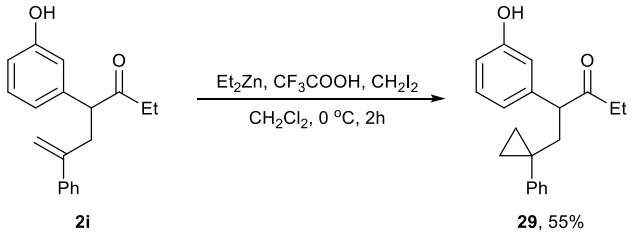
i. Reaction of compound 2i with phenyl lithium[13]



2i **28**, 57%

^{n}BuLi (1.6 M in hexane, 0.28 mL, 0.4 mmol) was added dropwise to the solution of bromobenzene (46.0 μL, 0.4 mmol) in THF (1.0 mL) at -78 °C. After stirring at -78 °C for 1 h, a solution of **2i** (56.1 mg, 0.2 mmol) in THF (1.0 mL) was added dropwise. The reaction solution was stirred at -78 °C for another 4 h and then quenched with saturated aqueous NH_4Cl solution. The aqueous phase was extracted with EtOAc for three times. The combined organic phases were washed with brine, dried over anhydrous $MgSO_4$, filtered, and evaporated. The residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) to afford **28** as a yellow liquid (40.8 mg, 57% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.42 (m, 4H), 7.36 – 7.30 (m, 1H), 7.24 – 7.12 (m, 4H), 6.87 – 6.85 (m, 2H), 6.75 – 6.70 (m, 3H), 5.61 (brs, 1H), 4.89 (s, 1H), 4.67 (s, 1H), 2.94 (dd, *J* = 11.4, 2.6 Hz, 1H), 2.82 – 2.75 (m, 1H), 2.69 (d, *J* = 13.8 Hz, 1H), 1.92 (brs, 1H), 1.75 – 1.65 (m, 1H), 1.36 – 1.26 (m, 1H), 0.49 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.32, 146.59, 144.48, 142.31, 140.75, 129.03, 128.07, 127.92, 127.05, 126.48, 126.42, 125.83, 114.46, 113.63, 79.91, 54.93, 35.91, 34.54, 7.60. HRMS (ESI^+) for $C_{25}H_{26}NaO_2$ [M + Na]$^+$: calcd 381.1825; found 381.1828.

ii. Cyclopropanation of 2i[14]

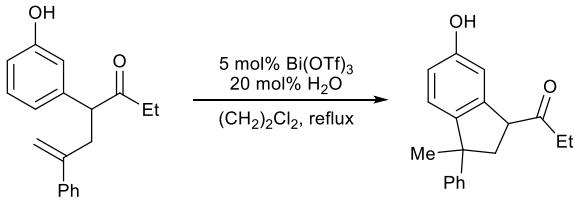


2i **29**, 55%

CF_3CO_2H (22.0 μL, 0.30 mmol) was added to a solution of Et_2Zn (1.0 M in hexane, 0.3 mL, 0.3 mmol) in CH_2Cl_2 (1.0 mL) at 0 °C. After stirring at 0 °C for 20 min, CH_2I_2 (24.0 μL, 0.3 mmol) was added dropwise and the resulting solution was stirred at 0 °C for another 20 min. A solution of **2i** (28.0 mg, 0.1 mmol) in CH_2Cl_2 (1.0 mL)

was then added dropwise. After stirring at 0 ^{o}C for 2 h, **2i** was completely consumed as monitored by TLC. The reaction mixture was quenched with aqueous 3 M HCl solution. The aqueous phase was extracted with EtOAc for three times. The combined organic phases were washed with saturated $NaHCO_3$ solution and brine, dried over anhydrous $MgSO_4$, filtered, and evaporated. The residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) to afford **29** as a colorless liquid (16.2 mg, 55% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.13 (m, 6H), 6.75 – 6.66 (m, 3H), 6.04 (brs, 1H), 3.61 (t, *J* = 6.8 Hz, 1H), 2.60 (dd, *J* = 14.2, 7.4 Hz, 1H), 2.39 – 2.17 (m, 2H), 1.86 (dd, *J* = 14.3, 6.2 Hz, 1H), 0.86 (t, *J* = 7.2 Hz, 3H), 0.70 – 0.68 (m, 3H), 0.44 – 0.42 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.25, 156.26, 144.27, 141.15, 129.89, 128.99, 128.30, 126.19, 120.86, 114.61, 114.28, 56.31, 42.55, 35.48, 24.20, 12.89, 12.84, 7.74. HRMS (ESI$^+$) for $C_{20}H_{22}NaO_2$ [M + Na]$^+$: calcd 317.1512; found 317.1516.

iii. Intramolecular cyclization of 2i[15]

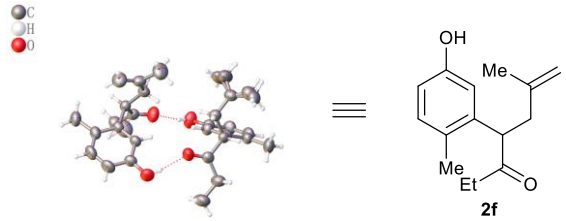


2i **30**, 60%

To an oven-dried Schlenk tube with a stirring bar was successively added **2i** (28.0 mg, 0.1 mmol) and $Bi(OTf)_3$ (3.3 mg, 5.0 μmol). The tube was then evacuated and backfilled with N_2 for three times. H_2O (0.36 μL, 0.02 mmol) and 1,2-dichloroethane (1.0 mL) was then added. The tube was heated to reflux and stirred for 3.5 h. The mixture was quenched with ice water and extracted with Et_2O for three times. The combined organic phases were washed with brine and dried over anhydrous $MgSO_4$. The solvent was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 20 : 1) to afford the desired product **30** as a yellow liquid (16.8 mg, 60% yield, 1.5:1 d. r.). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.22$^+$ (m, 4H, 4H*), 7.17 – 7.11 (m, 2 H, 2H*), 6.92 – 6.77$^+$ (m, 2 H, 2H*), 4.24* (t, *J* = 8.3 Hz, 1H), 4.06 (t, *J* = 8.0 Hz, 1H), 2.77 – 2.46$^+$ (m, 4H, 4H*), 1.82 (s,

3H), 1.69* (s, 3H), 1.18 (t, *J* = 7.3 Hz, 3H), 1.09* (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.67, 212.58*, 155.31, 155.22*, 148.63*, 148.56, 143.95*, 142.28, 142.19, 141.57*, 128.13$^+$, 126.88*, 126.25, 126.07*, 125.98, 125.51*, 125.37, 115.41*, 115.18, 111.72*, 111.61, 55.92*, 55.09, 50.96*, 50.66, 48.16*, 47.84, 34.79, 34.02*, 28.54, 27.56*, 7.85$^+$. HRMS (ESI^+) for $C_{19}H_{20}NaO_2$ $[M + Na]^+$: calcd 303.1356; found 303.1363.

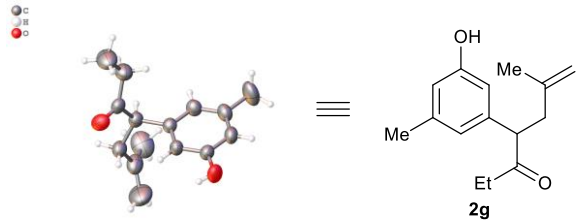
X. X-ray data of compounds 2f, 2g and 6b



2f

Crystal data and structure refinement for compound **2f**:

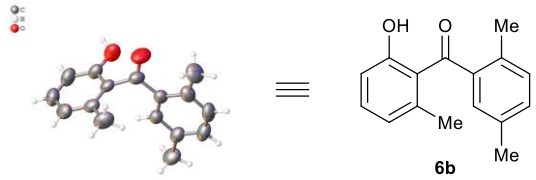
Empirical formula	$C_{15}H_{20}O_2$	
Formula weight	232.31	
Temperature	293.26 (10) K	
Wavelength	1.54184	
Crystal system	monoclinic	
Space group	$P2_1/c$	
Unit cell dimensions	a = 23.7772 (3) Å	α = 90 °
	b = 7.7804 (1) Å	β = 102.3770 (10) °
	c = 15.2918 (2) Å	γ = 90 °
Volume	2763.17(6) $Å^3$	
Z	8	
Density (calculated)	1.117 g/cm^3	
Absorption coefficient	0.570 mm^{-1}	
F(000)	1008.0	
Theta range for data collection	11.43 to 152.112 °	
Index ranges	$-29 \leq h \leq 29$, $-8 \leq k \leq 9$, $-19 \leq l \leq 14$	
Reflections collected	25147	
Independent reflections	5500 [R_{int} = 0.0194, R_{sigma} = 0.0126]	
Data/restraints/parameters	5500/97/335	
Goodness-of-fit on F^2	1.028	
Final R indexes [I>=2σ (I)]	R_1 = 0.0462, wR_2 = 0.1280	
Final R indexes [all data]	R_1 = 0.0497, wR_2 = 0.1311	



2g

Crystal data and structure refinement for compound **2g**:

Empirical formula	$C_{15}H_{20}O_2$	
Formula weight	230.29	
Temperature	294.09 (10) K	
Wavelength	1.54184	
Crystal system	monoclinic	
Space group	C2/c	
Unit cell dimensions	a = 24.5707 (3) Å	α = 90 °
	b = 7.8487 (10) Å	β = 106.1310 (10) °
	c = 15.3888 (2) Å	γ = 90 °
Volume	2850.86 (6) $Å^3$	
Z	8	
Density (calculated)	1.073 g/cm^3	
Absorption coefficient	0.552 mm^{-1}	
F(000)	992.0	
Theta range for data collection	11.974 to 152.206 °.	
Index ranges	$-26 \leq h \leq 30$, $-9 \leq k \leq 9$, $-19 \leq l \leq 19$	
Reflections collected	26256	
Independent reflections	2893 [R_{int} = 0.0212, R_{sigma} = 0.0089]	
Data/restraints/parameters	2893/0/166	
Goodness-of-fit on F^2	0.950	
Final R indexes [I>=2σ (I)]	R_1 = 0.0465, wR_2 = 0.1550	
Final R indexes [all data]	R_1 = 0.0483, wR_2 = 0.1578	



6b

Crystal data and structure refinement for compound **6b**:

Empirical formula	$C_{16}H_{16}O_2$	
Formula weight	240.29	
Temperature	293.74 (10) K	
Wavelength	1.54184	
Crystal system	orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 7.35280 (10) Å	α = 90 °
	b = 7.36750 (10) Å	β = 90 °
	c = 24.5337 (4) Å	γ = 90 °
Volume	1329.03(3) $Å^3$	
Z	4	
Density (calculated)	1.201 g/cm^3	
Absorption coefficient	0.619 mm^{-1}	
F(000)	512.0	
Theta range for data collection	7.206 to 152.764.	
Index ranges	$-9 \leq h \leq 9$, $-9 \leq k \leq 9$, $-30 \leq l \leq 28$	
Reflections collected	12440	
Independent reflections	2657 [R_{int} = 0.0335, R_{sigma} = 0.0199]	
Data/restraints/parameters	2657/0/167	
Goodness-of-fit on F^2	1.079	
Final R indexes [I>=2σ (I)]	R_1 = 0.0420, wR_2 = 0.1210	
R indexes [all data]	R_1 = 0.0448, wR_2 = 0.1237	

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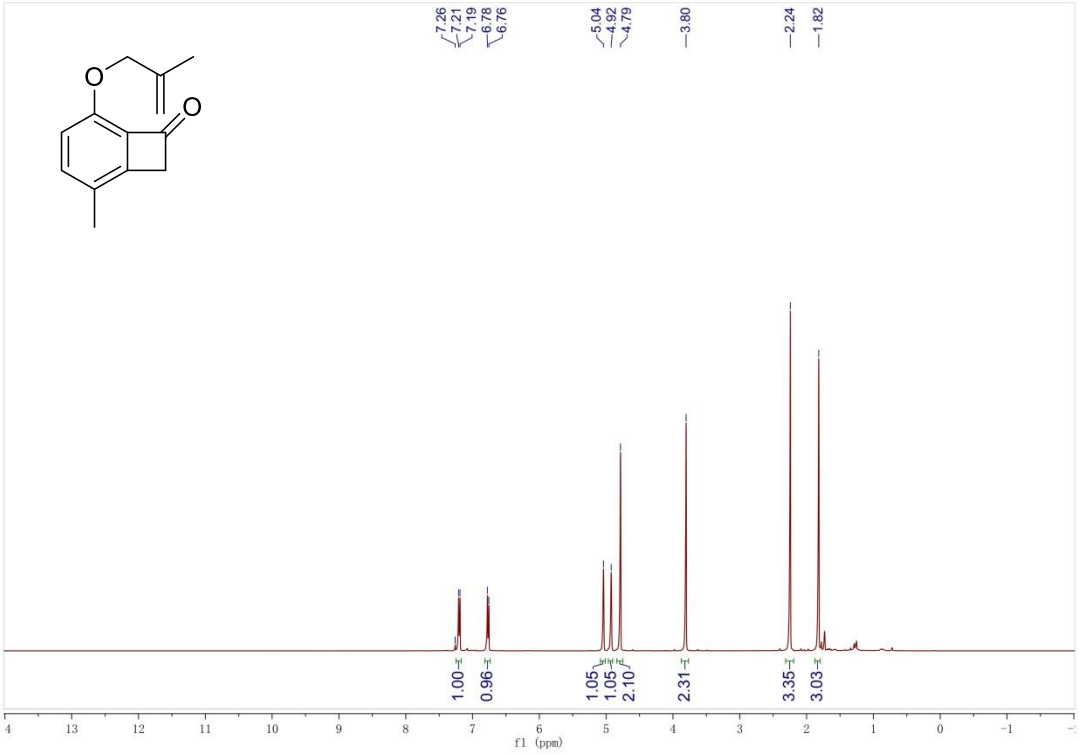
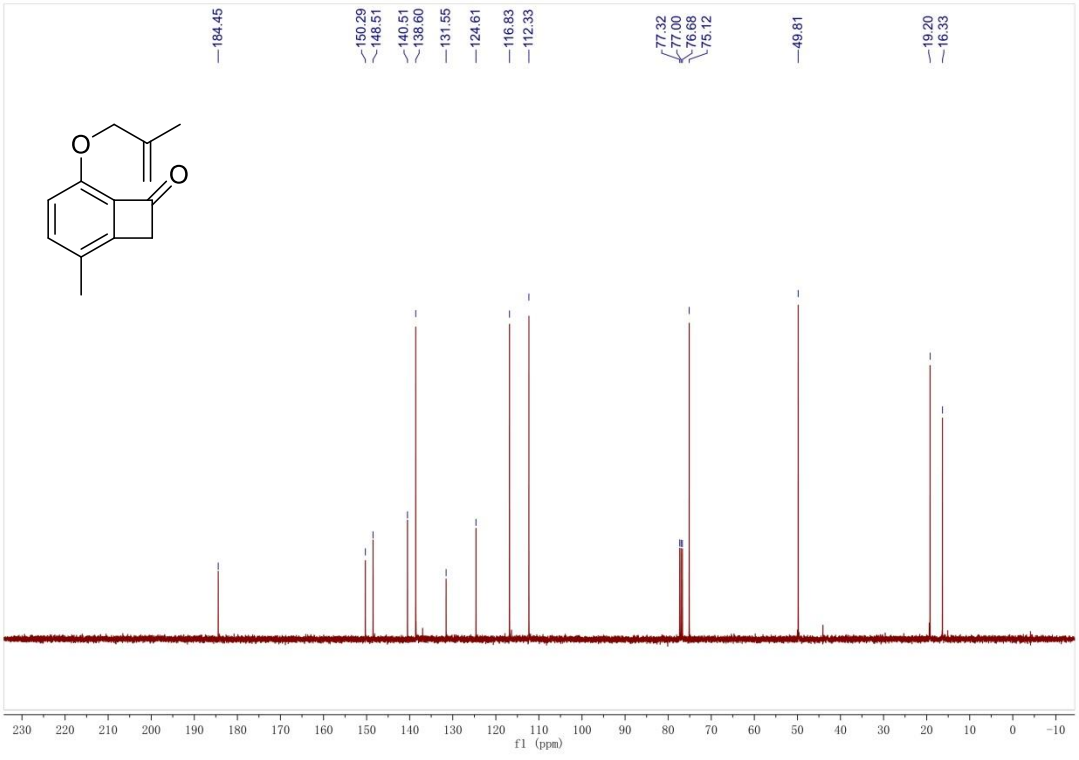
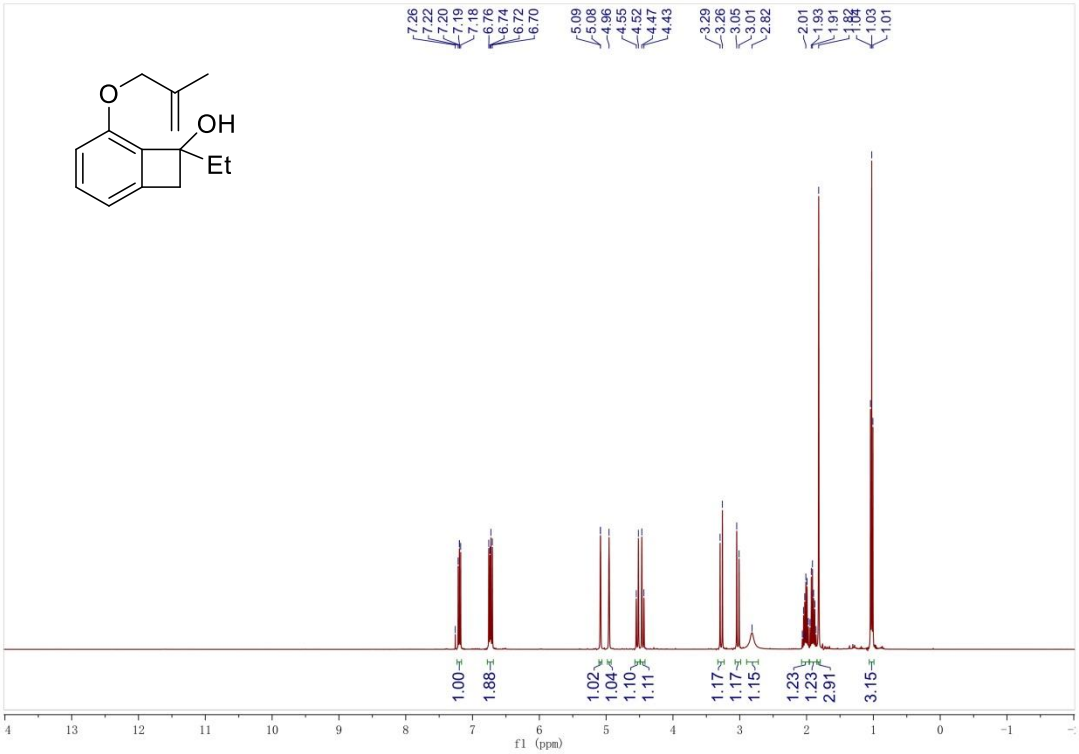
XII. ^{1}H and ^{13}C NMR spectra of the described compounds



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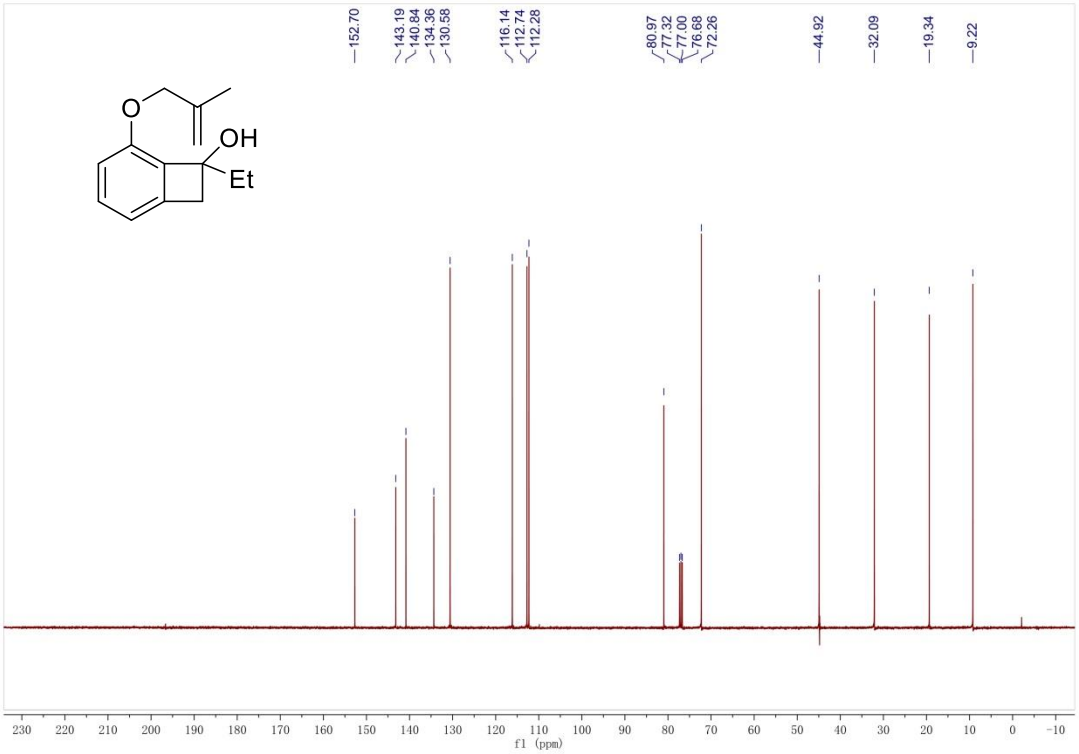
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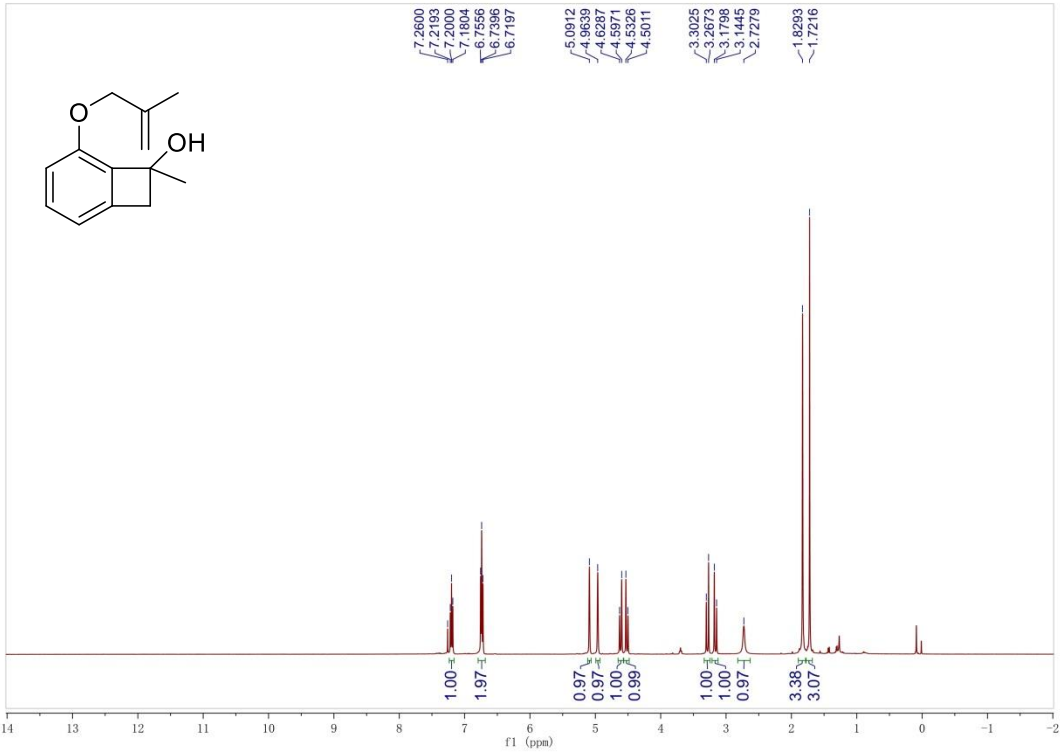
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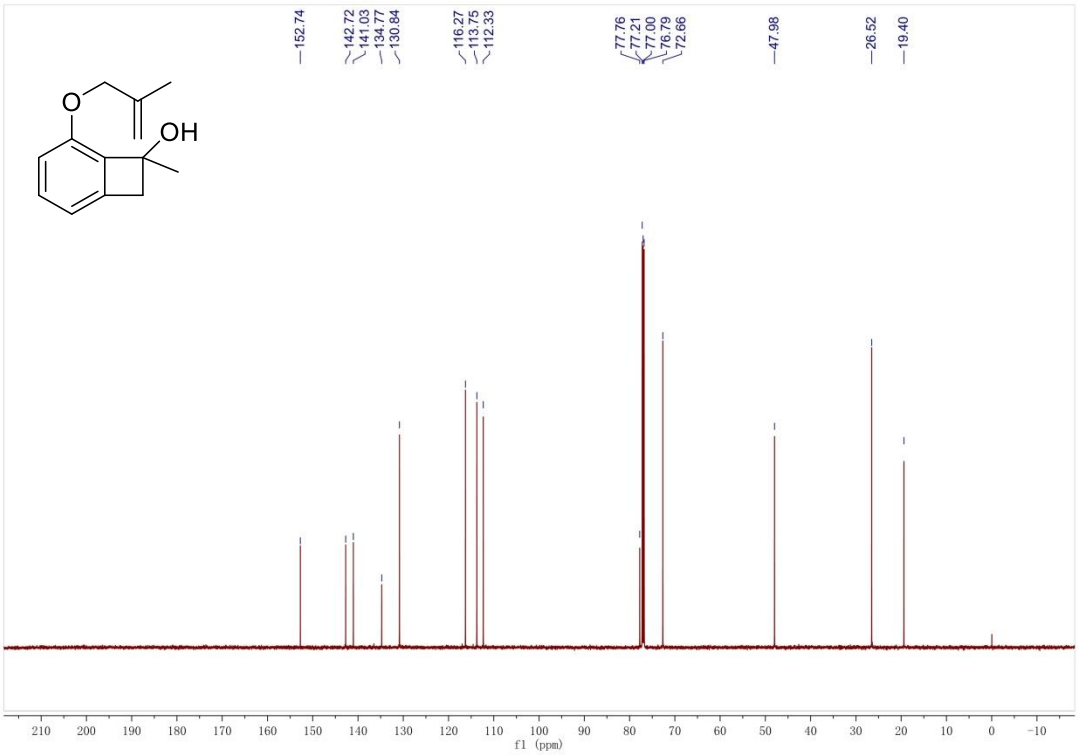
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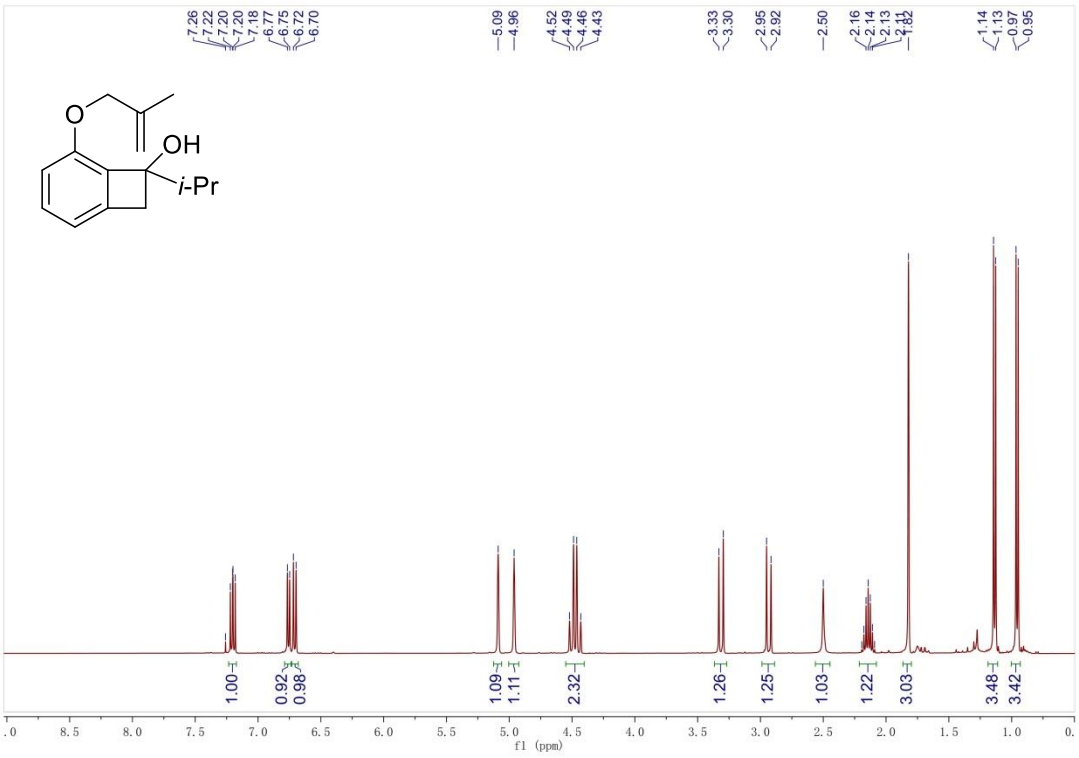
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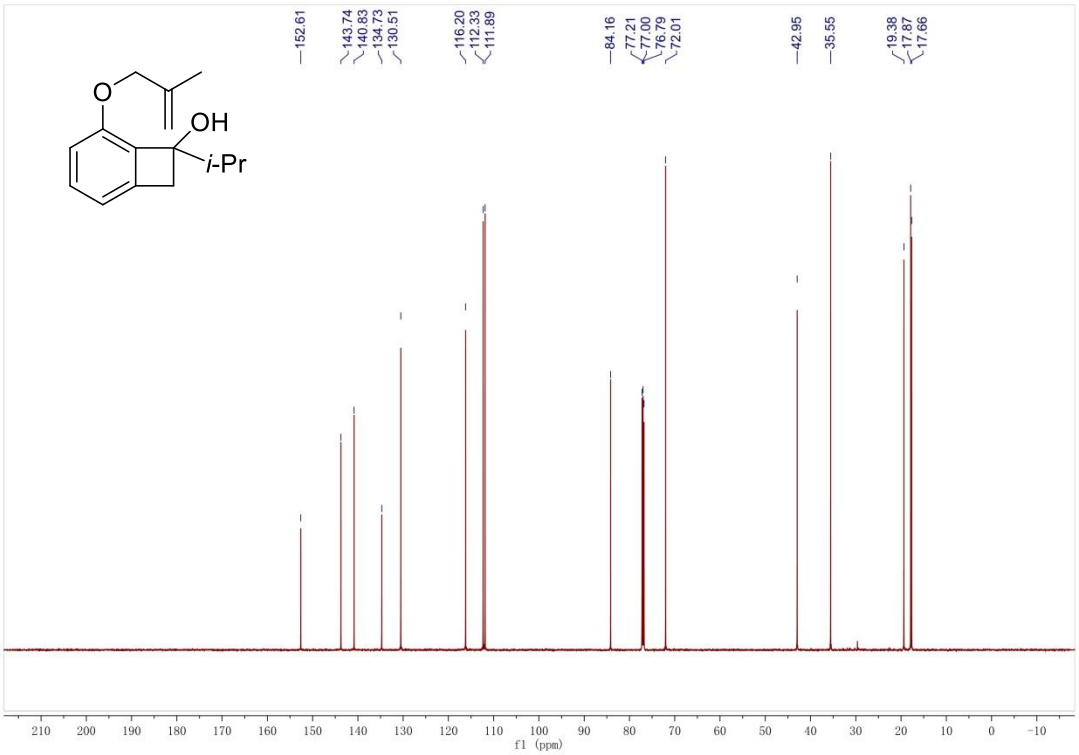
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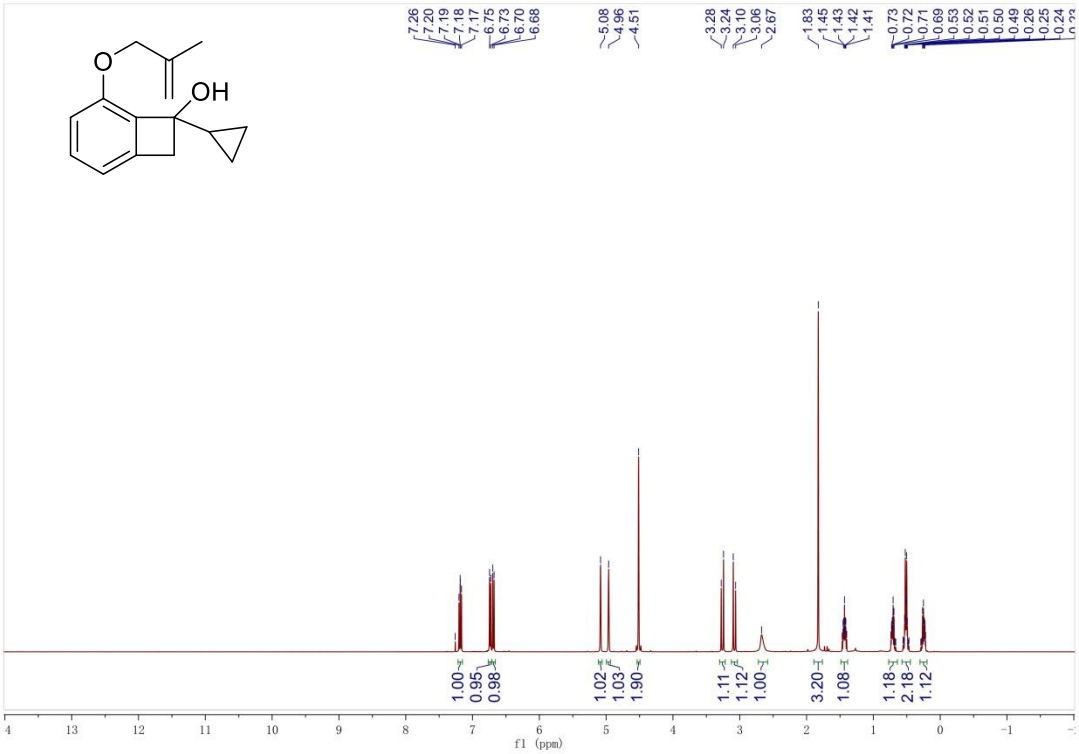
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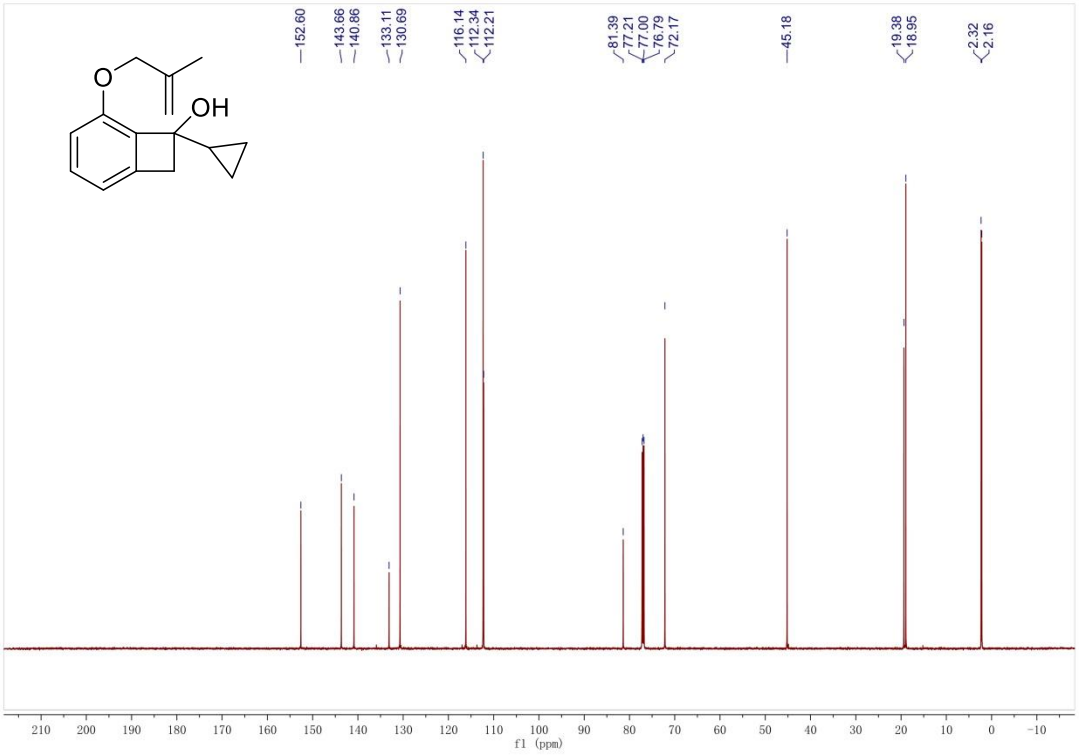
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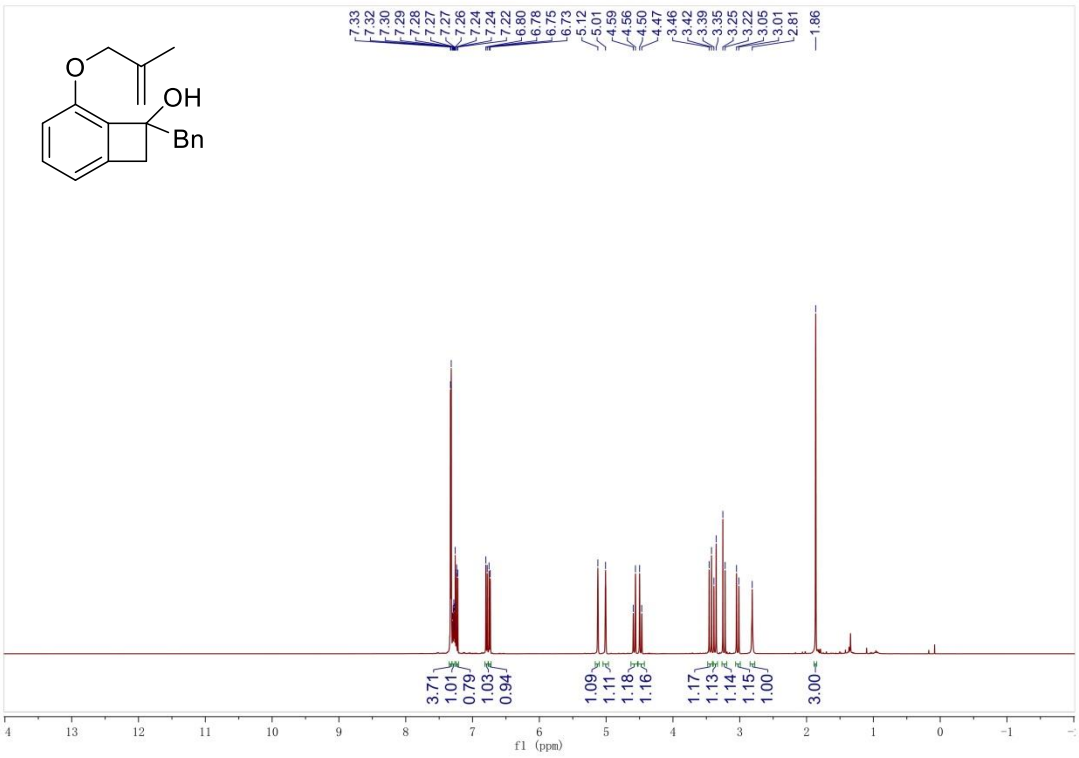
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7.24
7.22
6.80
6.78
6.75
6.73
5.12
5.01
4.59
4.56
4.50
4.47
3.46
3.42
3.39
3.35
3.25
3.22
3.05
3.01
2.81
1.86
O
OH
Bn
3.71
1.01
0.79
1.03
0.94
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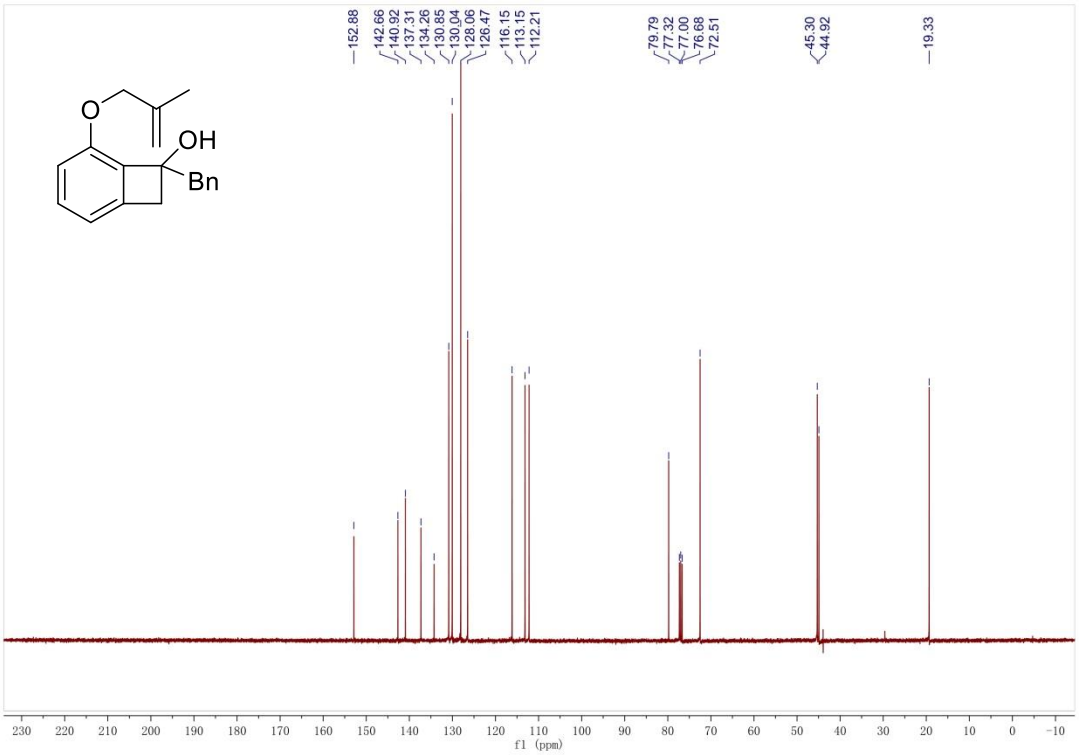
1.17
1.13
1.14
1.15
1.00
3.00
f1 (ppm)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128.06
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116.15
113.15
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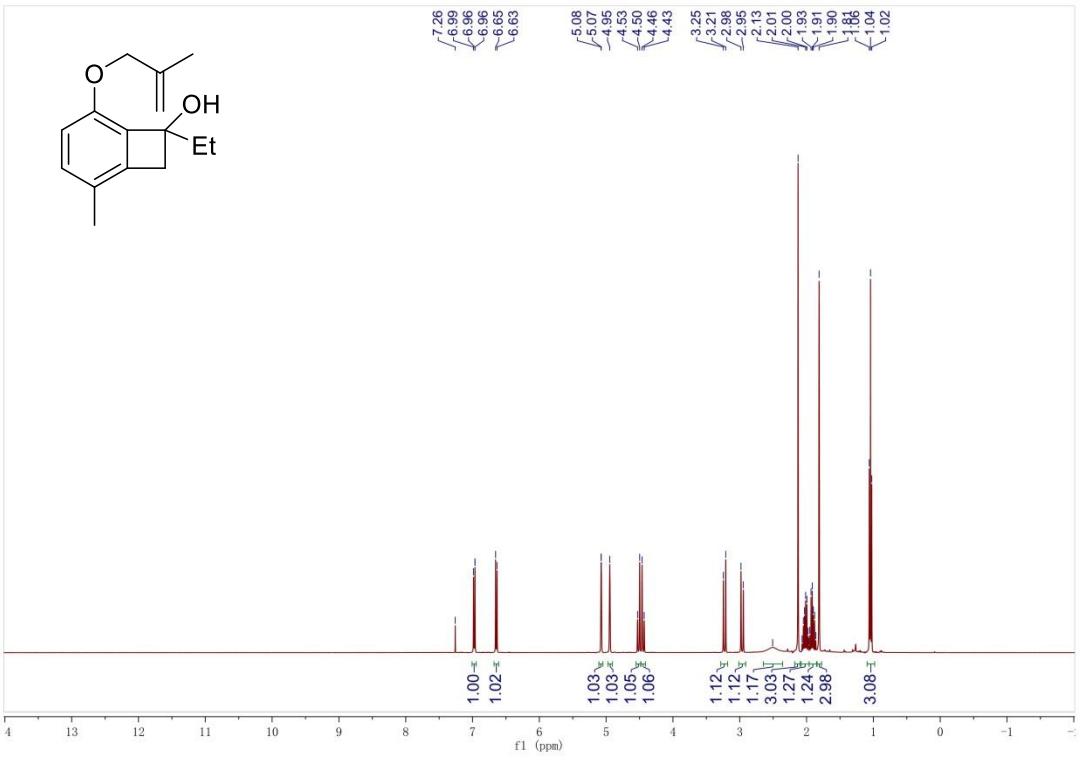
76.68
72.51
45.30
44.92
19.33
O
OH
Bn
f1 (ppm)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5.07
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4.53
4.50
4.46
4.43
3.25
3.21
2.98
2.95
2.13
2.01
2.00
1.93
1.91
1.90
1.81
1.06
1.04
1.02
1.00
1.02
1.03
1.03
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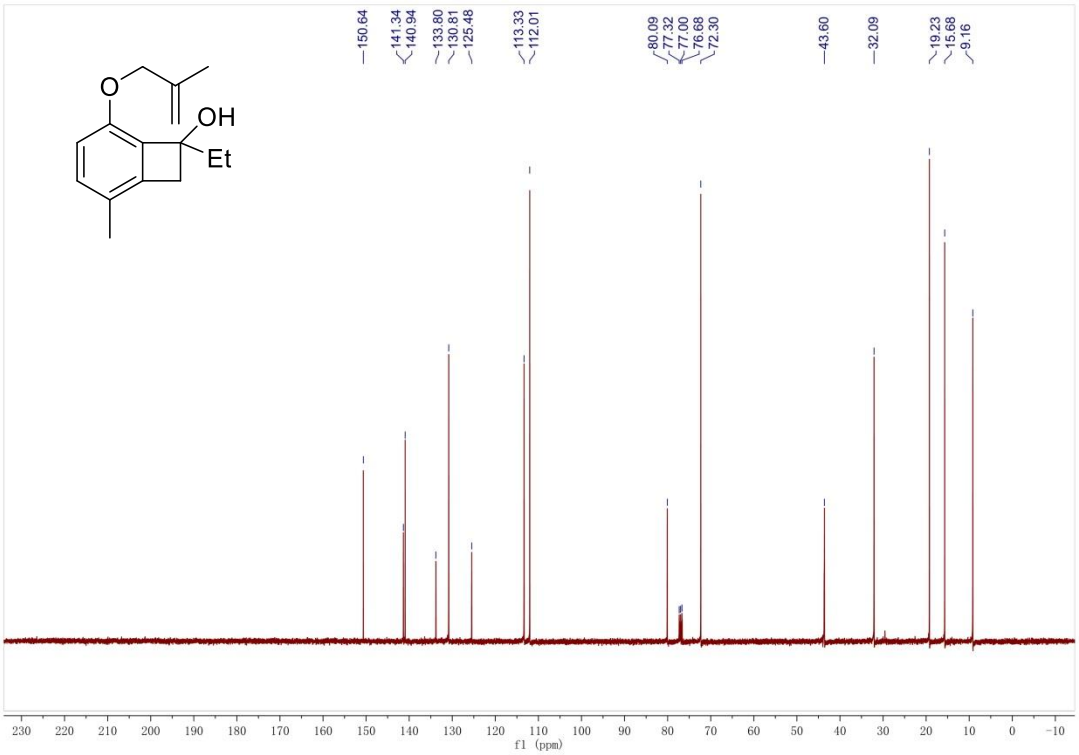
1.12
1.17
3.03
1.27
1.24
2.98
3.08
f1 (ppm)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Et
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77.00
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72.30
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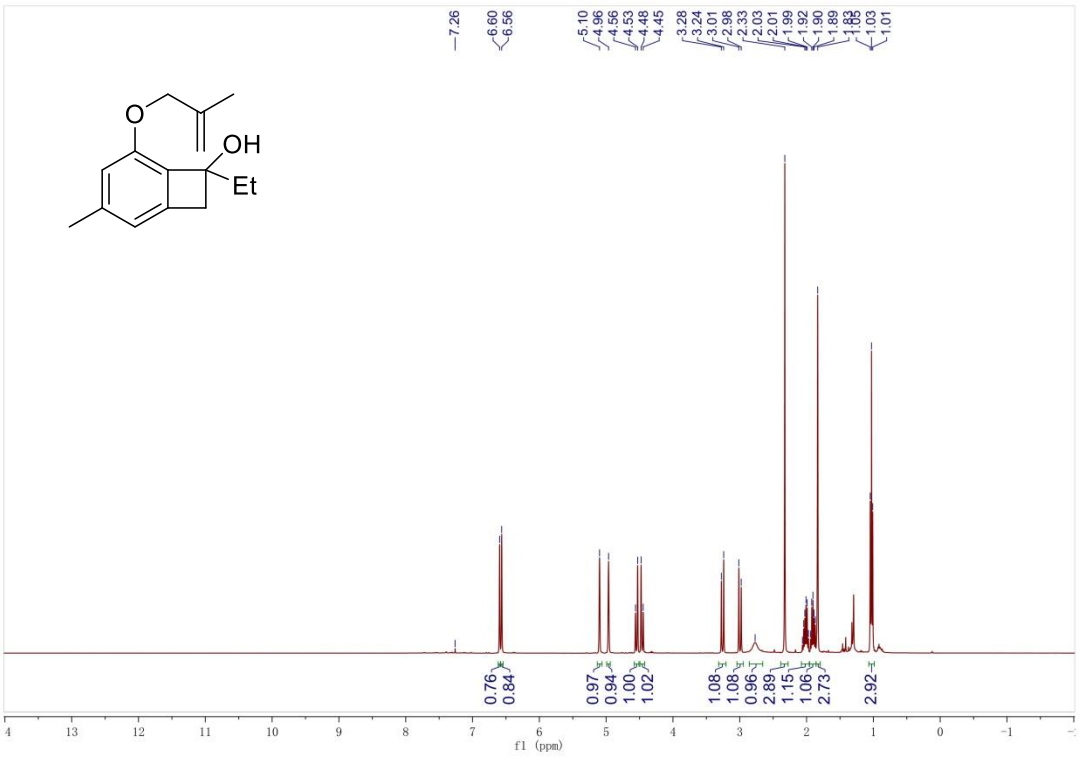
32.09
19.23
15.68
9.16
f1 (ppm)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4.48
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3.28
3.24
3.01
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2.33
2.03
2.01
1.99
1.92
1.90
1.89
1.03
1.01
O
OH
Et
0.76
0.84
0.97
0.94
1.00
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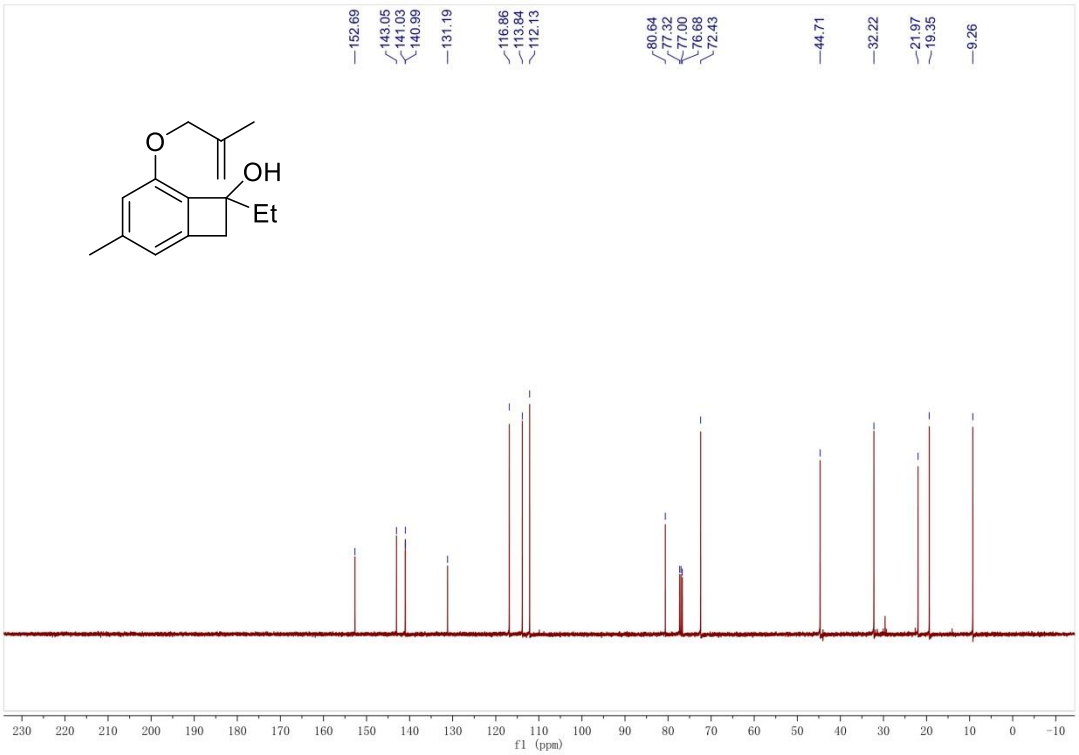
1.08
1.08
0.96
2.89
1.15
1.06
2.73
2.92
f1 (ppm)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72.43
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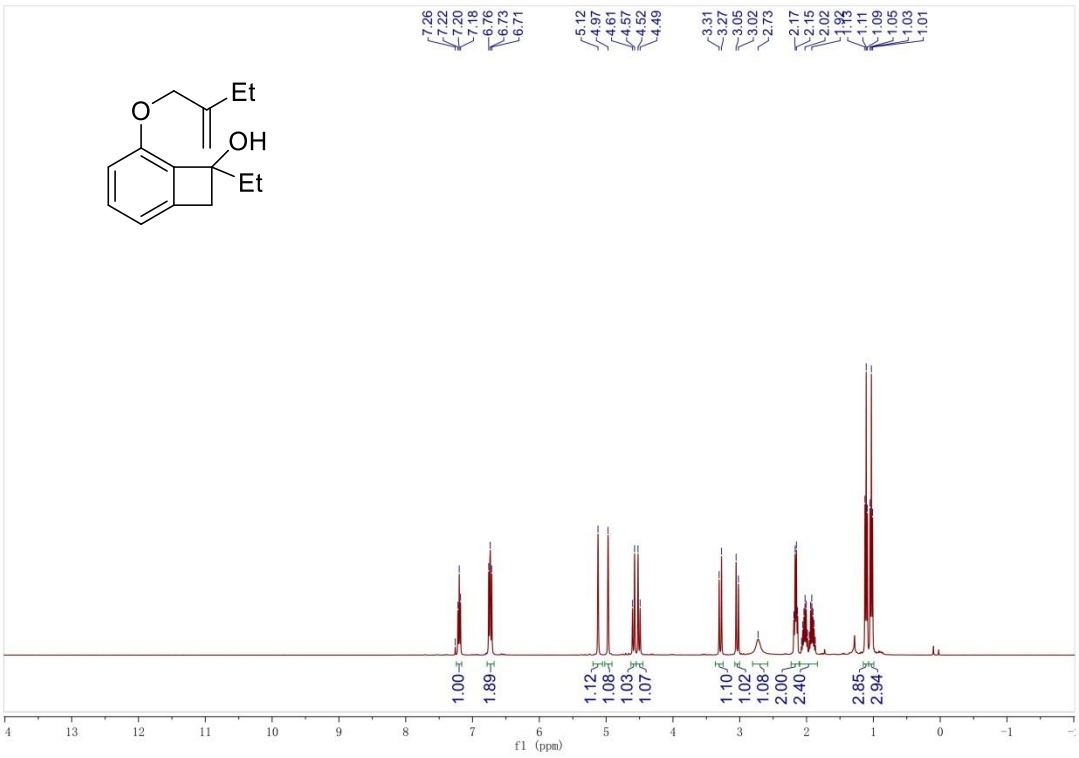
32.22
21.97
19.35
9.26
O
OH
Et
f1 (ppm)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6.73
6.71
5.12
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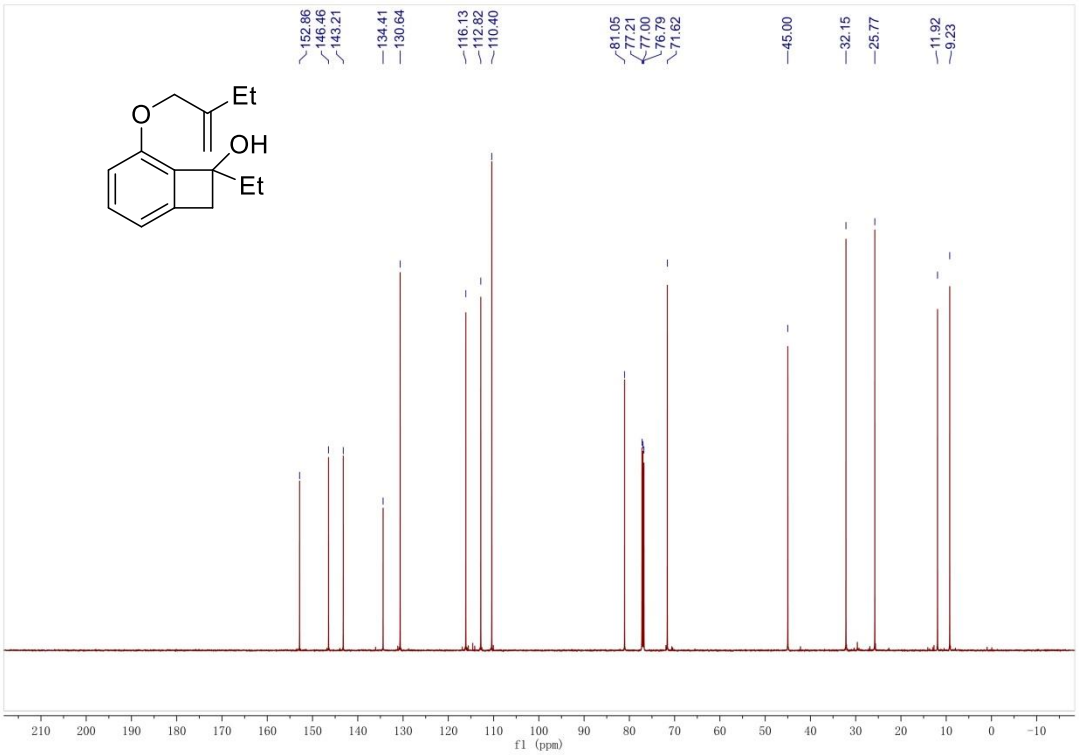
4.61
4.57
4.52
4.49
3.31
3.27
3.05
3.02
2.73
2.17
2.15
2.02
1.93
1.11
1.09
1.05
1.03
1.01
Et
O
OH
Et
1.00
1.89
1.12
1.08
1.03
1.07
1.10
1.02
1.08
2.00
2.40
2.85
2.94
f1 (ppm)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110.40
81.05
77.21
77.00
76.79
71.62
45.00
32.15
25.77
11.92
9.23
Et
O
OH
Et
f1 (ppm)


7.49
7.47
7.38
7.36
7.34
7.33
7.32
7.31
7.29
7.26
7.26
7.24
7.22
7.20
6.79
6.77
5.59
5.48
5.09
5.05
4.98
4.95
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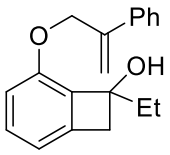
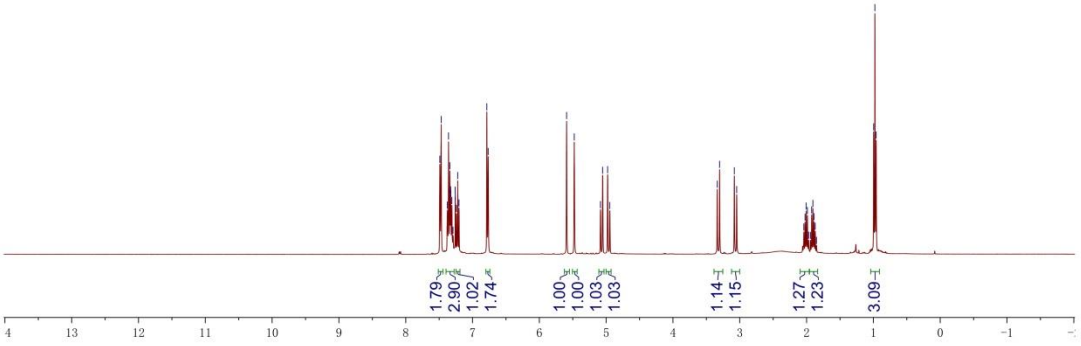
3.30
3.08
3.05
2.01
1.99
1.92
1.91
1.00
0.98
0.96


Ph
O
OH
Et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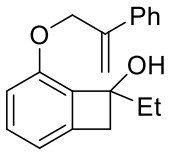
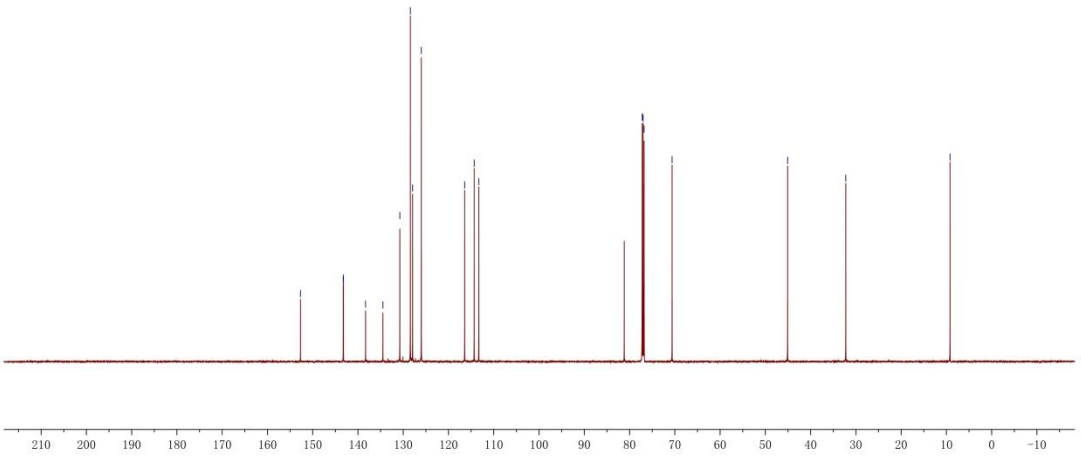
1.00
1.03
1.03
1.14
1.15
1.27
1.23
3.09
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1


152.70
143.26
143.21
138.32
130.76
128.43
127.93
126.01
114.33
113.30
77.21
77.00
76.79
70.60
45.08
32.23
9.20


Ph
O
OH
Et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200
190
180
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90
80
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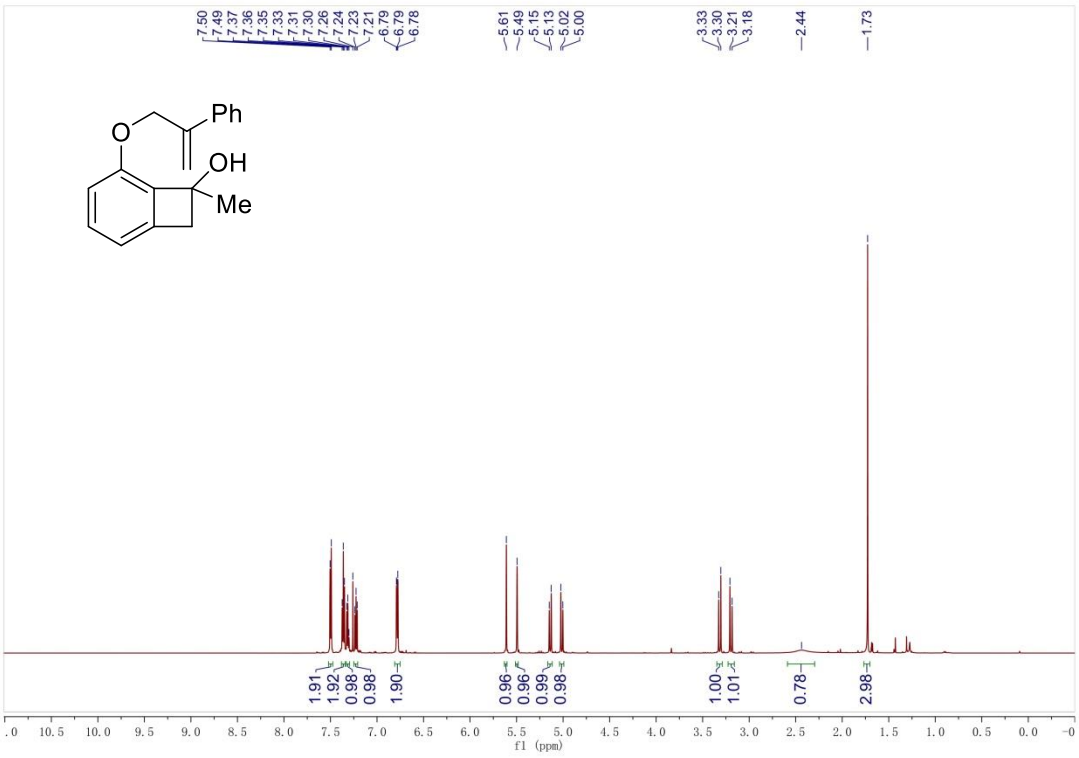
60
50
40
30
20
10
0
−10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7.49
7.37
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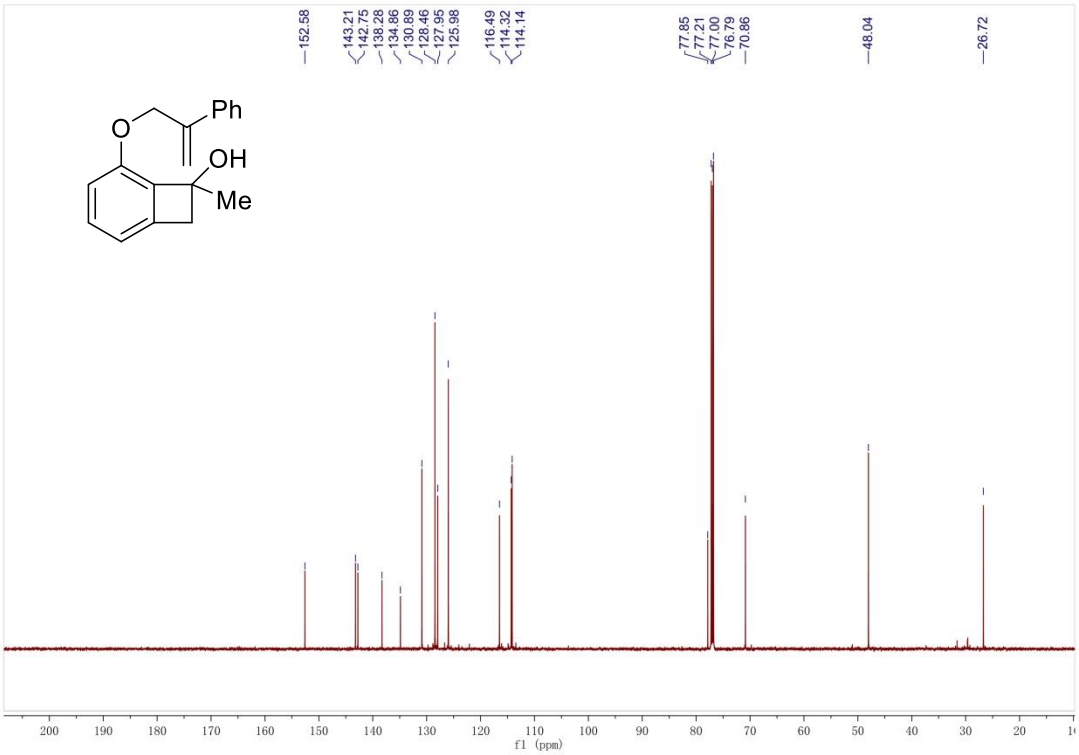
7.33
7.31
7.30
7.26
7.24
7.23
7.21
6.79
6.78
5.61
5.49
5.15
5.13
5.02
5.00
3.33
3.30
3.21
3.18
2.44
1.73
Ph
O
OH
Me
1.91
1.92
0.98
0.98
1.90
0.96
0.96
0.99
0.98
1.00
1.01
0.78
2.98
f1 (ppm)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114.32
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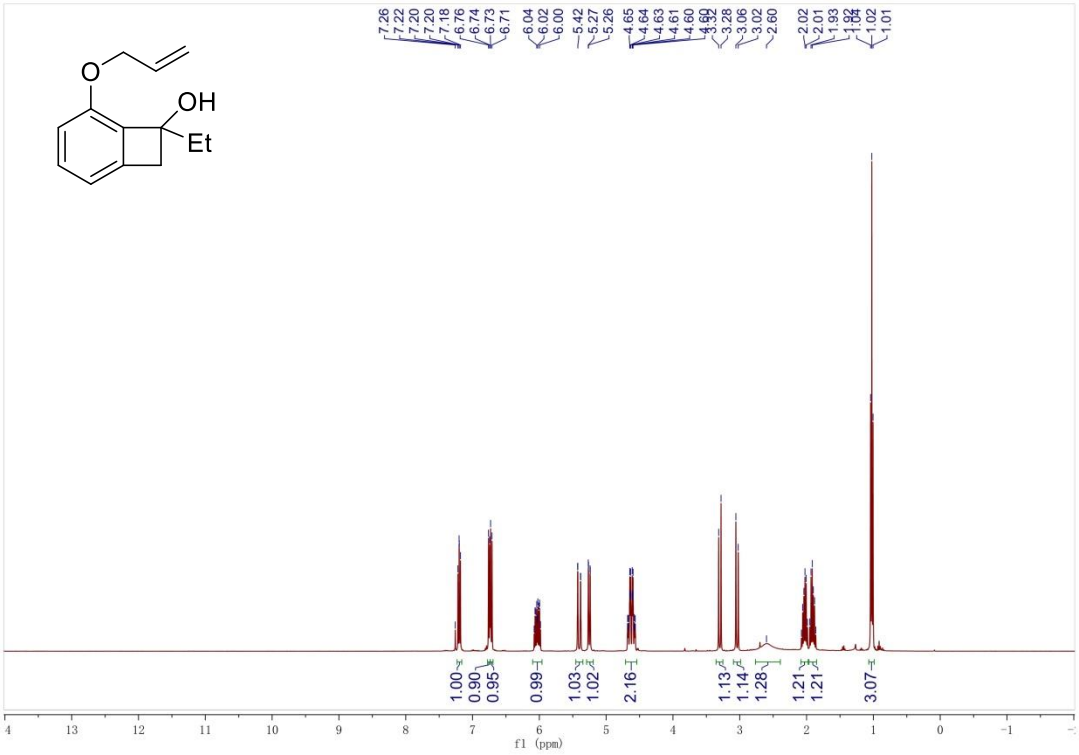
77.21
77.00
76.79
70.86
48.04
26.72
Ph
O
OH
Me
f1 (ppm)


O
OH
Et
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7.22
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7.18
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6.74
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6.71
6.04
6.02
6.00
5.42
5.27
5.26
4.65
4.64
4.63
4.61
4.60
3.32
3.28
3.06
3.02
2.60
2.02
2.01
1.93
1.02
1.01
1.00
0.90
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1.02
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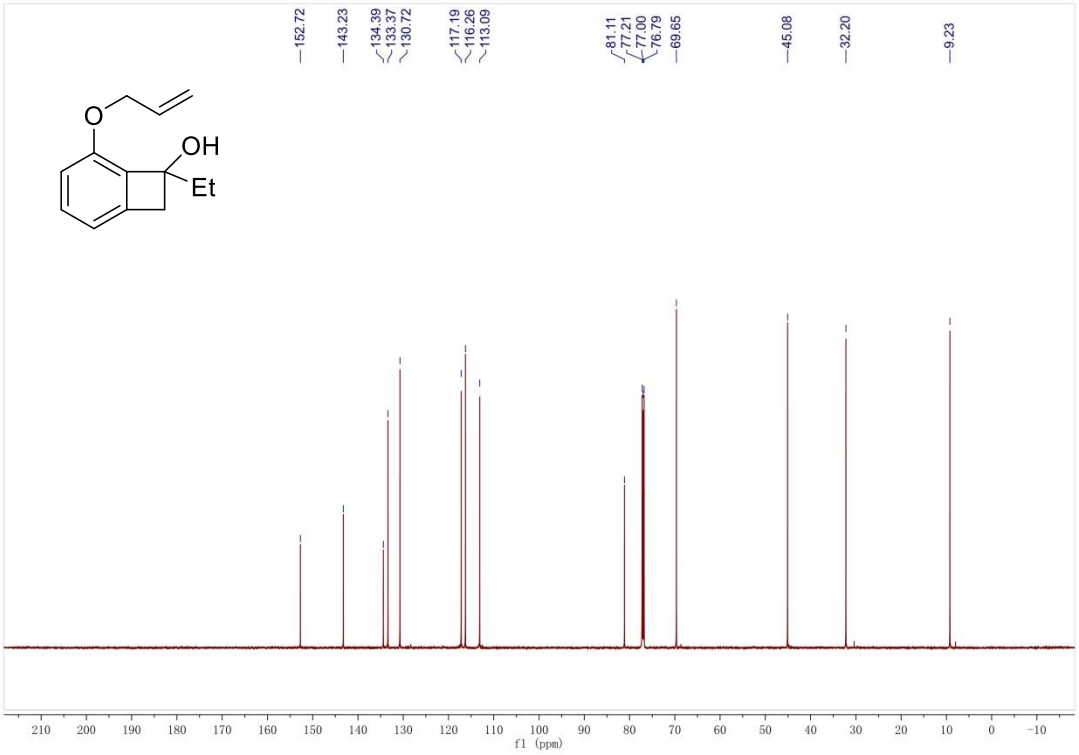
1.13
1.14
1.28
1.21
1.21
3.07
f1 (ppm)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OH
Et
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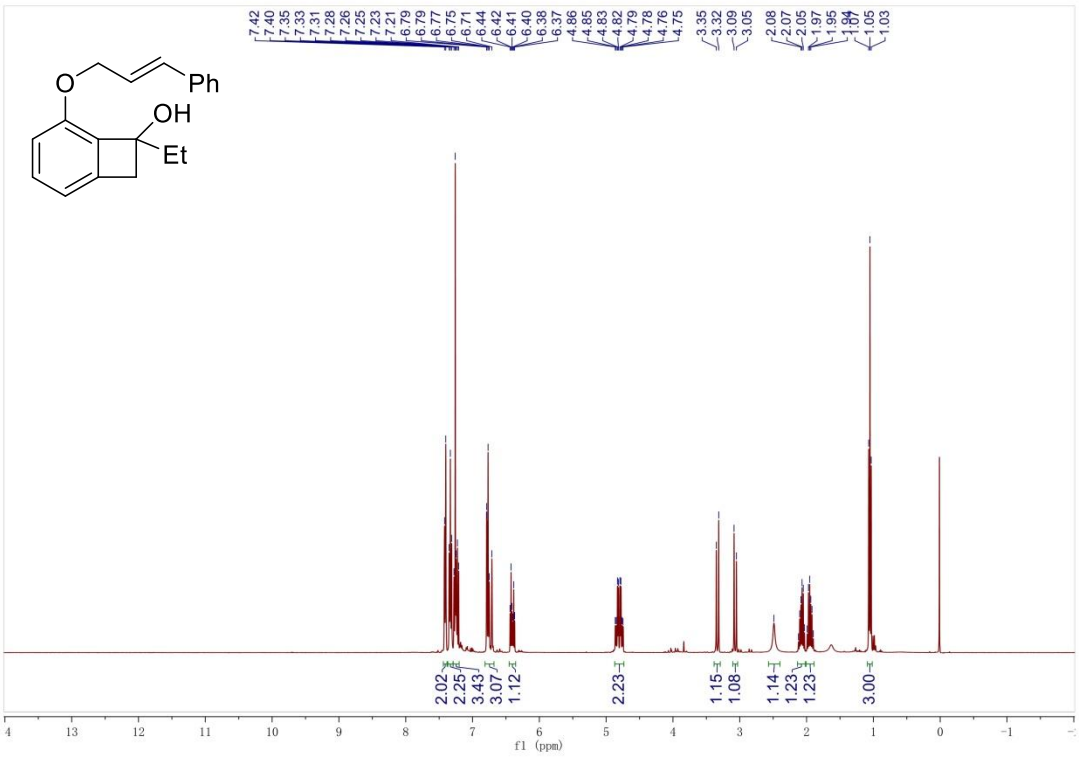
77.00
76.79
69.65
45.08
32.20
9.23
f1 (ppm)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Ph
OH
Et
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7.25
7.23
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6.79
6.79
6.77
6.75
6.71
6.44
6.42
6.41
6.40
6.38
6.37
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4.85
4.83
4.82
4.79
4.78
4.76
4.75
3.35
3.32
3.09
3.05
2.08
2.07
2.05
1.97
1.95
1.94
1.01
1.05
1.03
2.02
2.25
3.43
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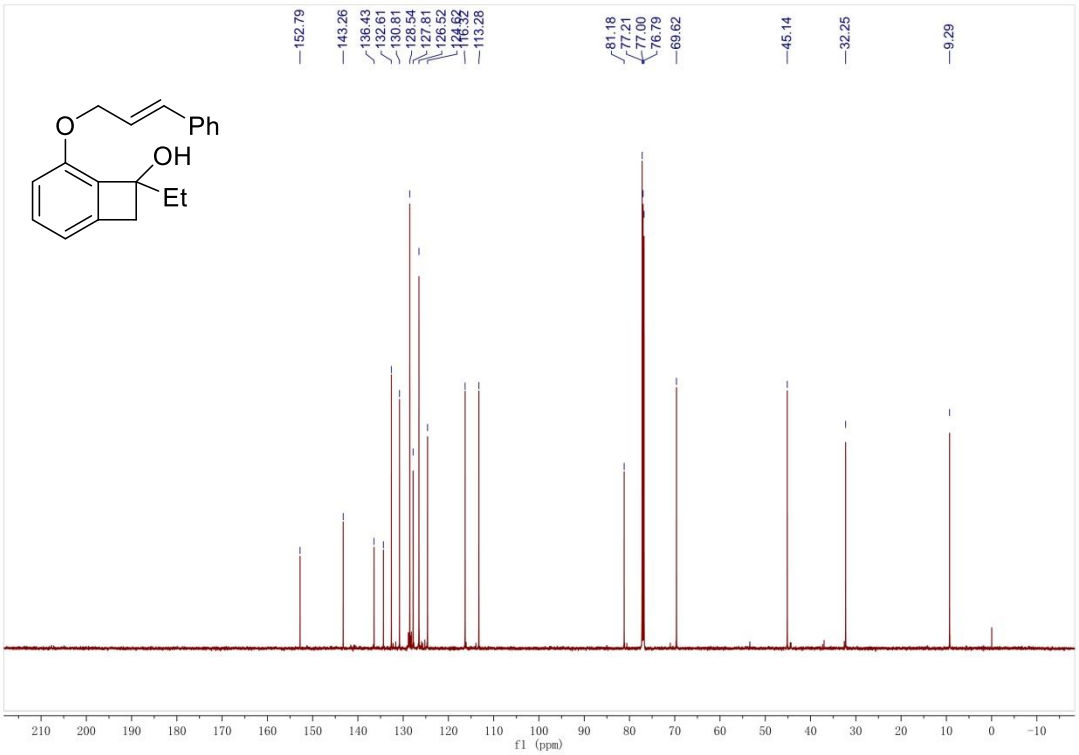
2.23
1.15
1.08
1.14
1.23
1.23
3.00
f1 (ppm)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Ph
OH
Et
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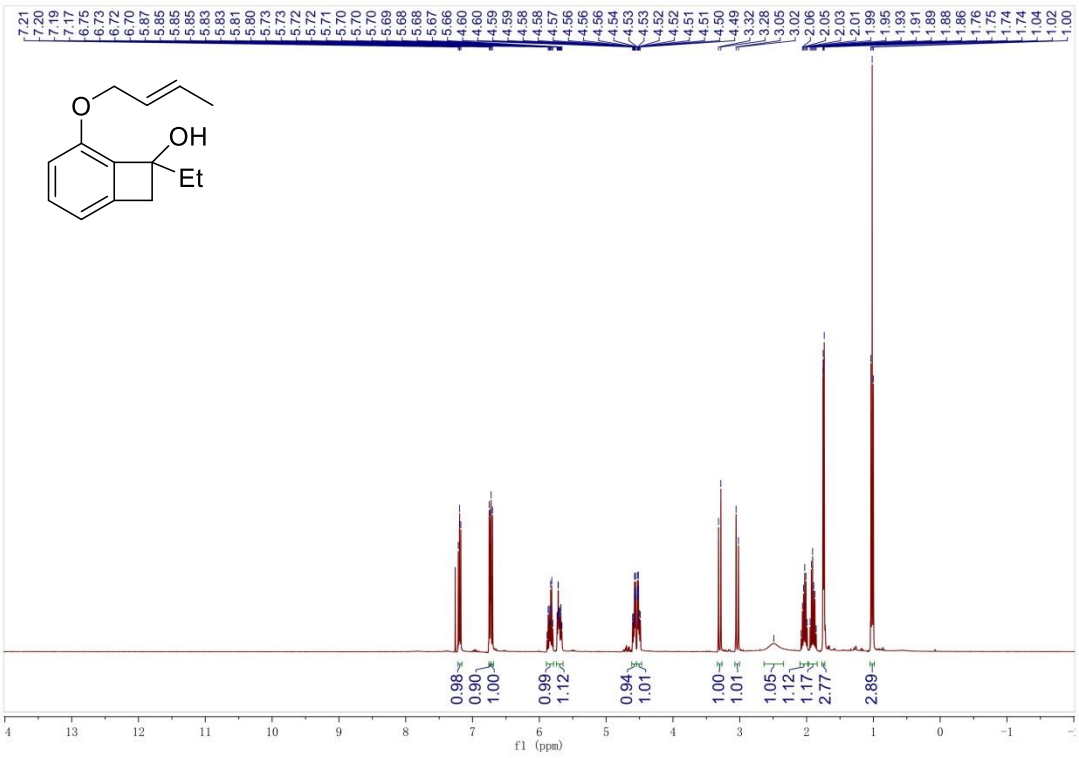
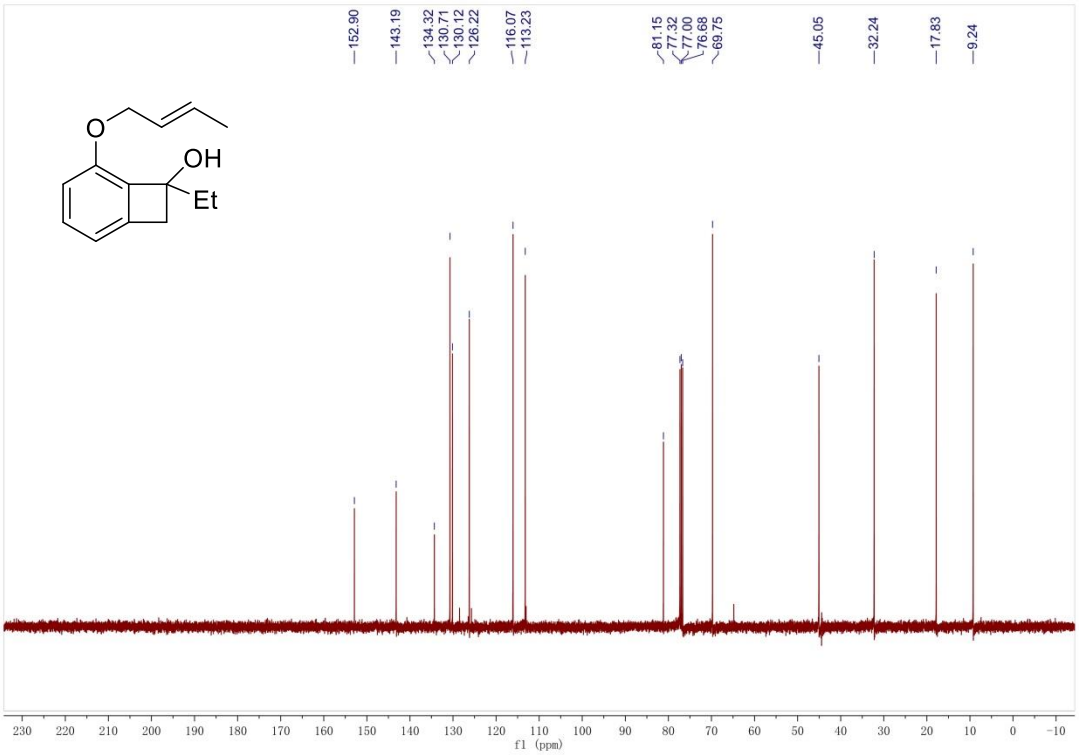
77.00
76.79
69.62
45.14
32.25
9.29
f1 (ppm)


O
OH
Et
f1 (ppm)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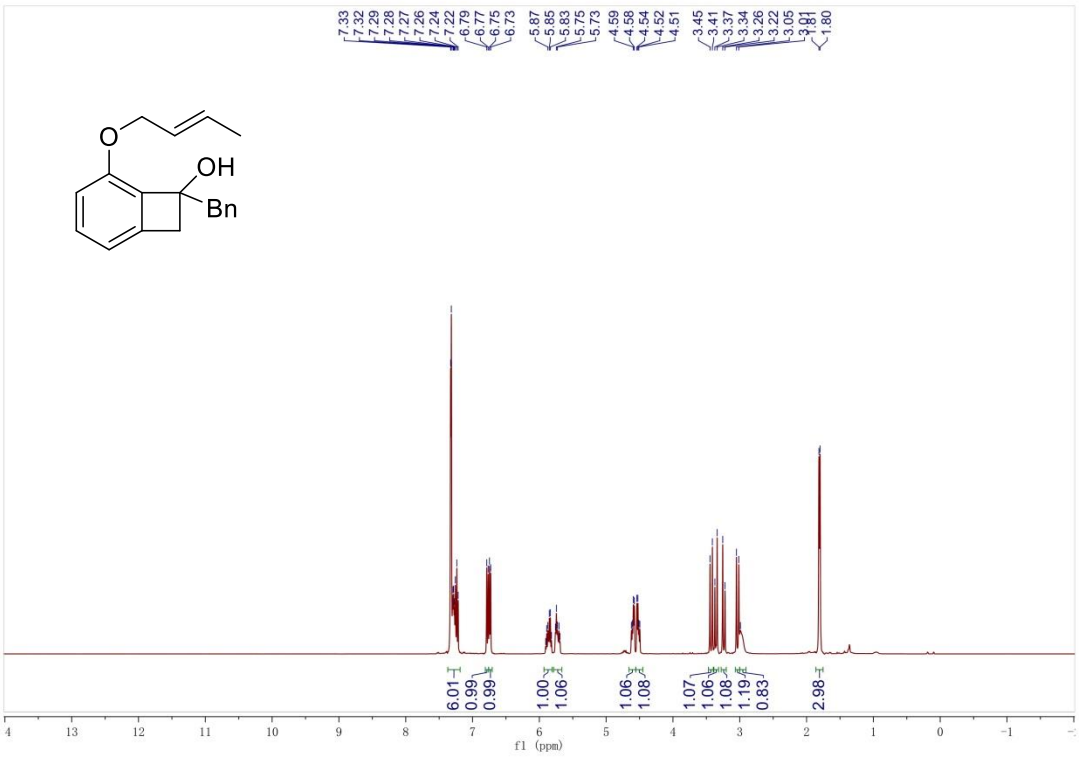
OH
Et
f1 (ppm)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6.75
6.73
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5.85
5.83
5.75
5.73
4.59
4.58
4.54
4.52
4.51
3.45
3.41
3.37
3.34
3.26
3.22
3.05
3.01
1.81
1.80
O
OH
Bn
6.01
0.99
0.99
1.00
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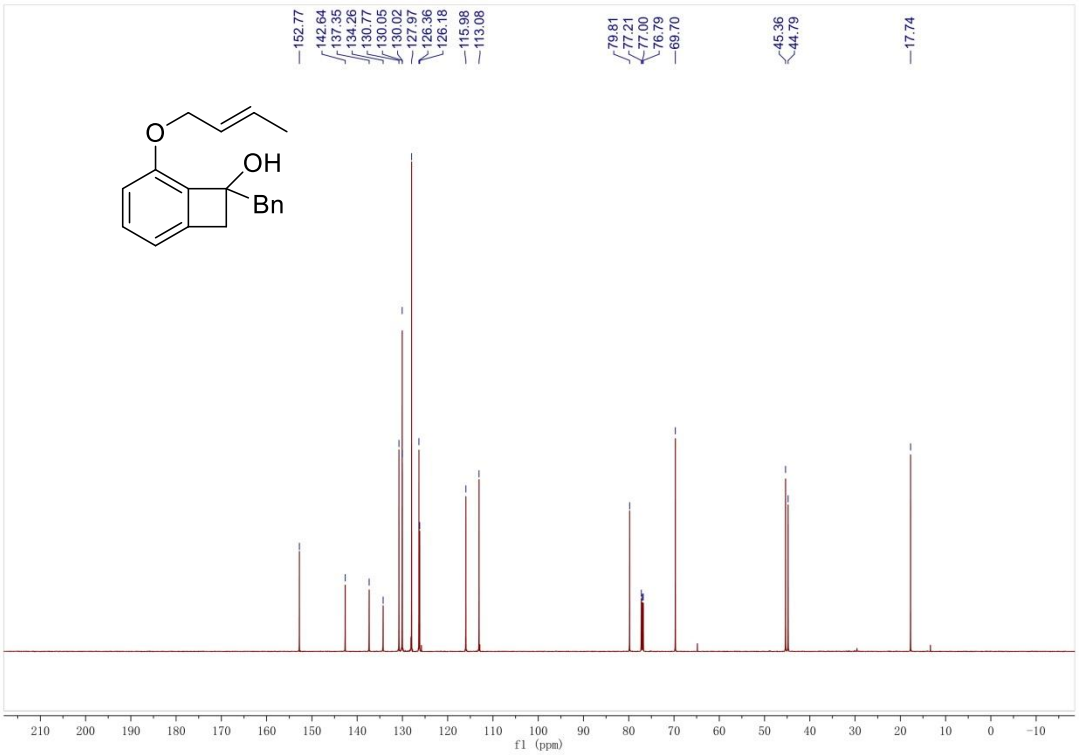
1.06
1.08
1.07
1.06
1.08
1.19
0.83
2.98
f1 (ppm)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115.98
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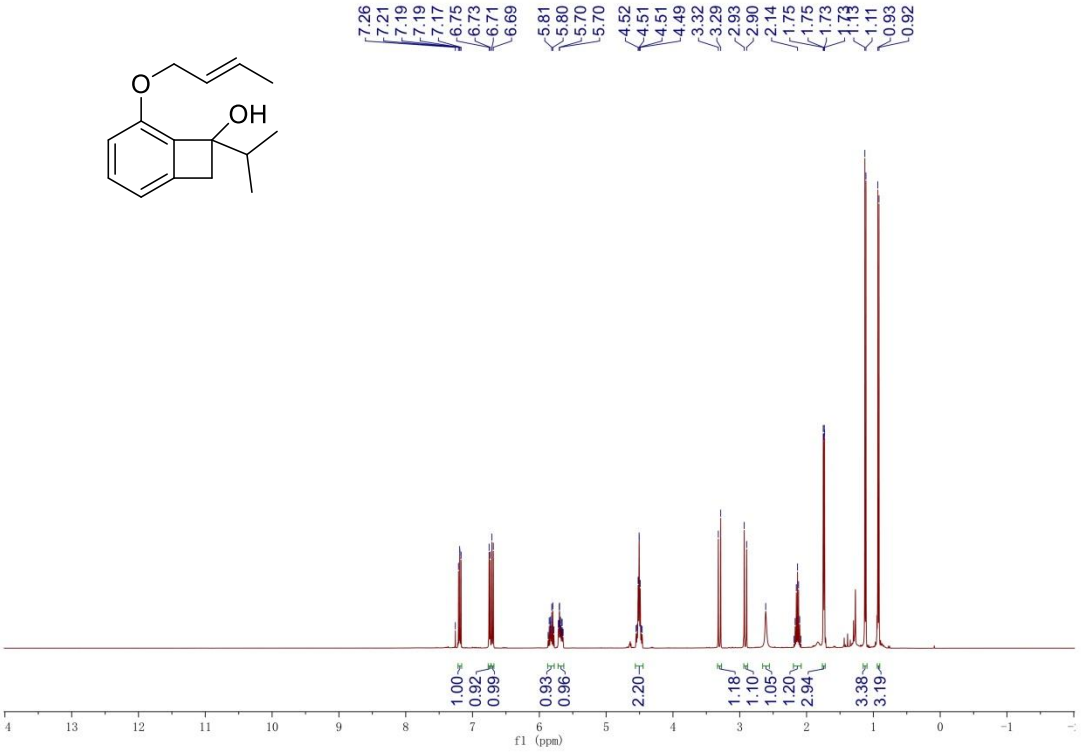
77.00
76.79
69.70
45.36
44.79
17.74
O
OH
Bn
f1 (ppm)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4.52
4.51
4.51
4.49
3.32
3.29
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2.14
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1.75
1.73
1.13
1.11
0.93
0.92
O
OH
1.00
0.92
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0.93
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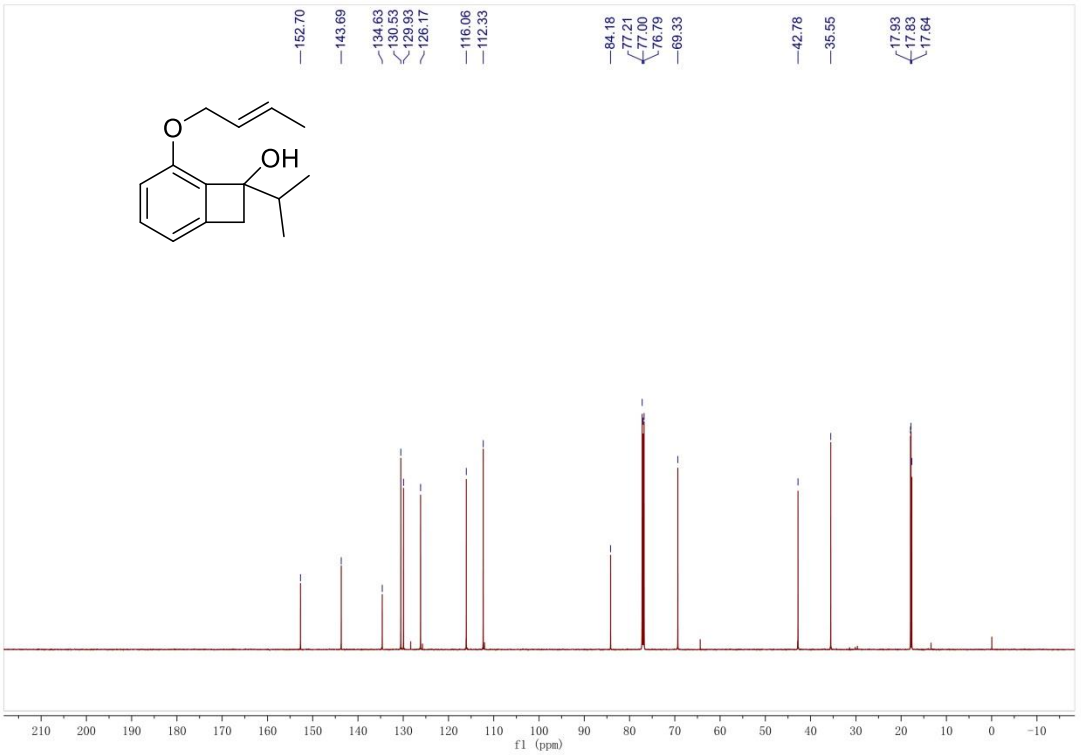
1.10
1.05
1.20
2.94
3.38
3.19
f1 (ppm)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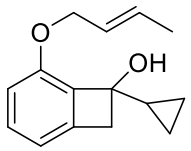
42.78
35.55
17.93
17.83
17.64
O
OH
f1 (ppm)


O
OH

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5.81
5.72
4.55
4.54
3.26
3.22
3.08
3.05
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1.74
1.43
1.42
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0.69
0.68
0.66
0.52
0.51
0.49
0.24
0.23
0.22
1.00
0.87
0.96
0.91
0.94
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1.17
3.03
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1.18
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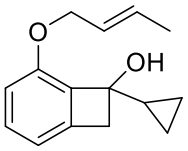
1.19
f1 (ppm)


O
OH

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116.01
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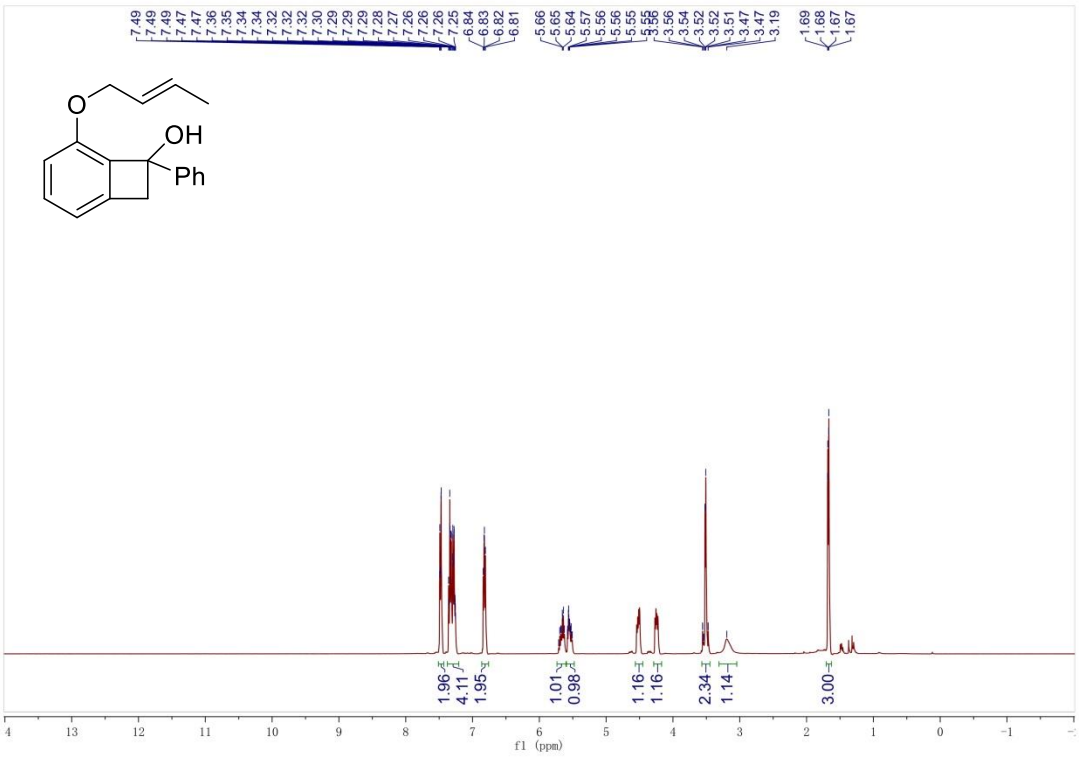
2.23
f1 (ppm)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7.29
7.28
7.27
7.26
7.26
7.25
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6.83
6.82
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5.64
5.57
5.56
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3.56
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3.52
3.51
3.47
3.19
1.69
1.68
1.67
1.67
O
OH
Ph
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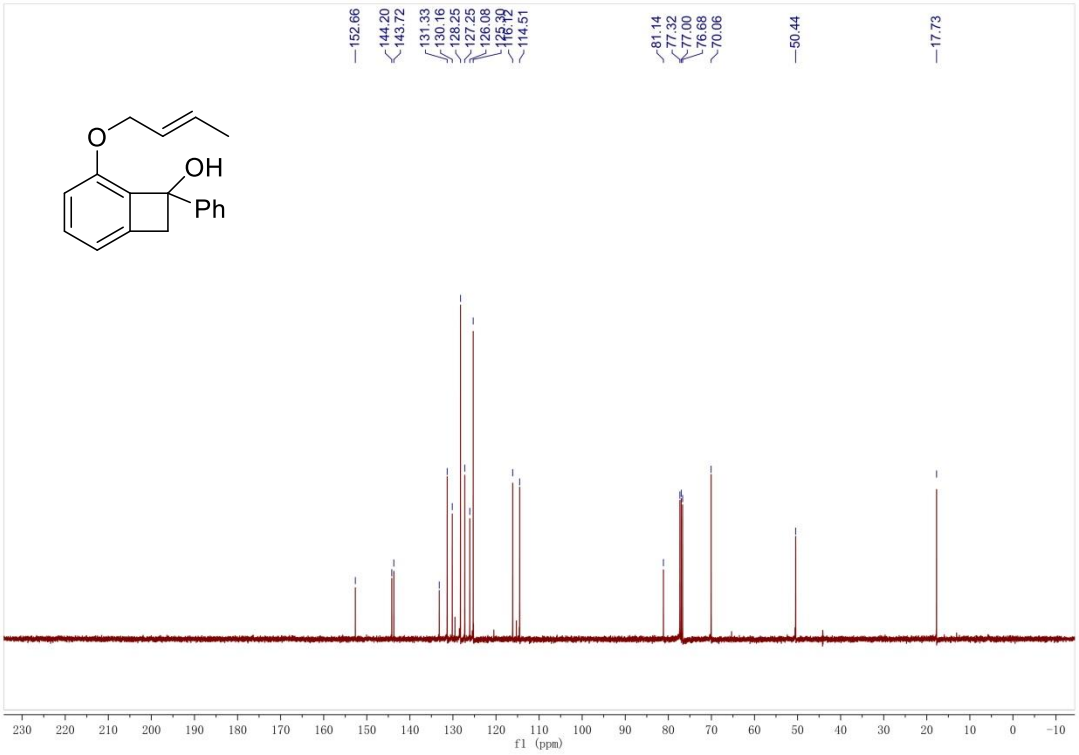
2.34
1.14
3.00
f1 (ppm)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76.68
70.06
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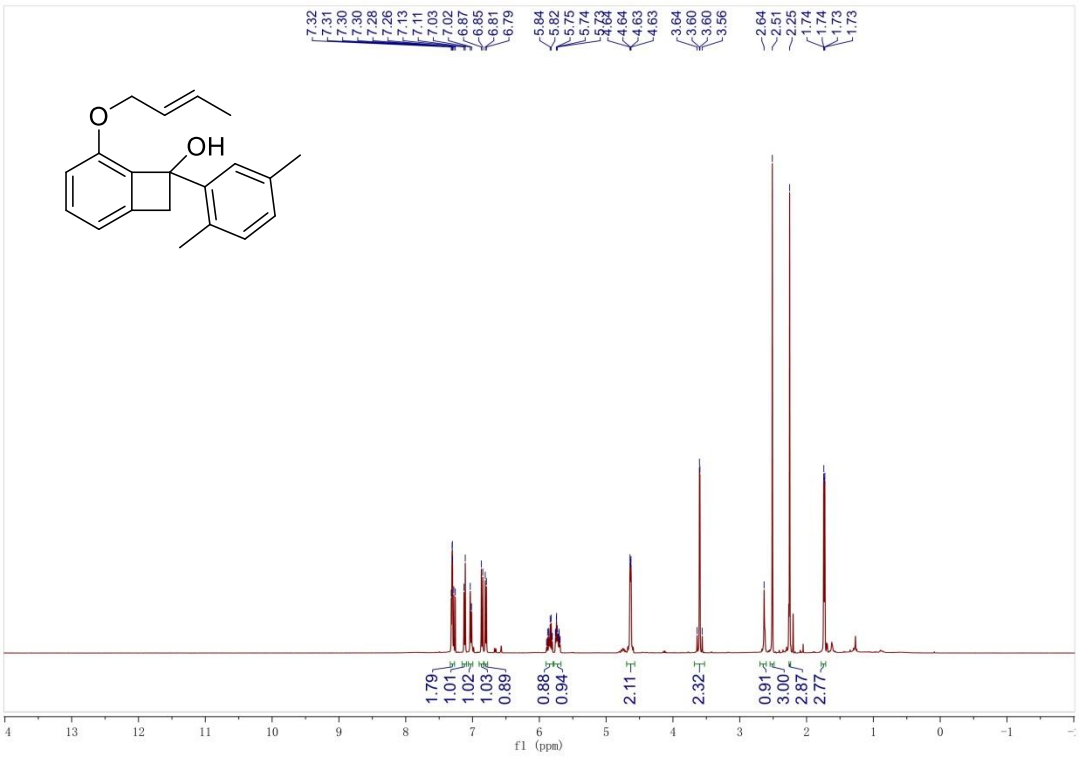
O
OH
Ph
f1 (ppm)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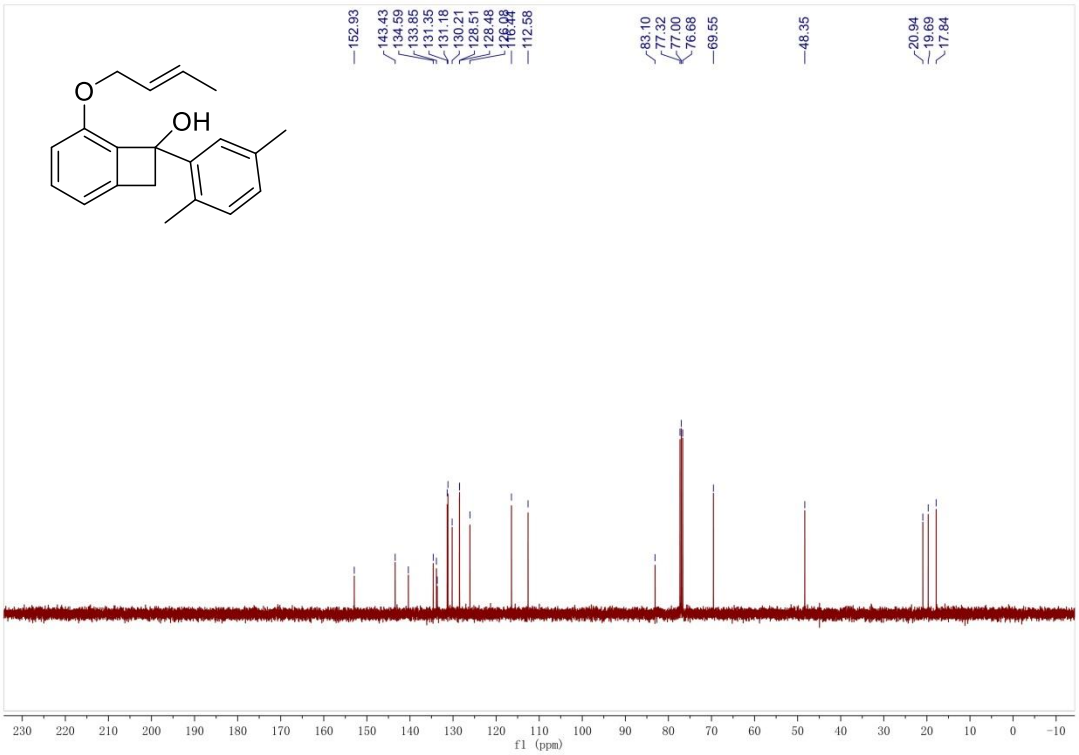
6.79
5.84
5.82
5.75
5.74
4.64
4.64
4.63
4.63
3.64
3.60
3.60
3.56
2.64
2.51
2.25
1.74
1.74
1.73
1.73
O
OH
1.79
1.01
1.02
1.03
0.89
0.88
0.94
2.11
2.32
0.91
3.00
2.87
2.77
f1 (ppm)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130.21
128.51
128.48
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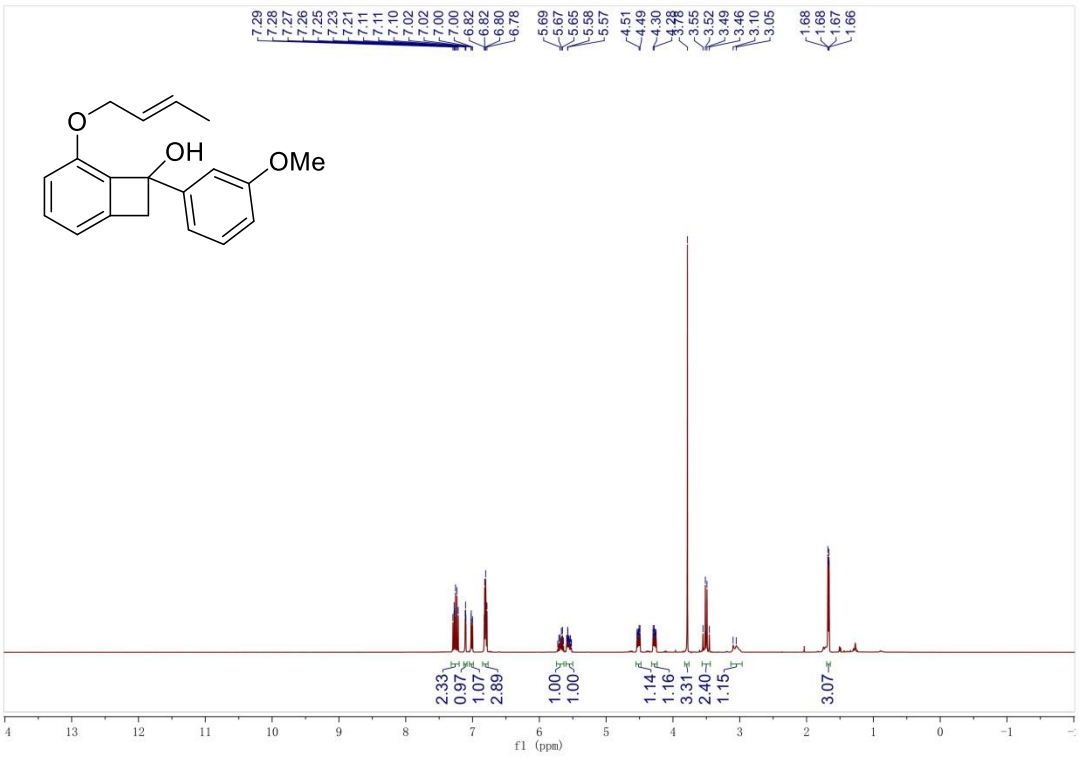
77.00
76.68
69.55
48.35
20.94
19.69
17.84
O
OH
f1 (ppm)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7.21
7.11
7.10
7.02
7.00
6.82
6.80
6.78
5.69
5.67
5.65
5.58
5.57
4.51
4.49
4.30
3.55
3.52
3.49
3.46
3.10
3.05
1.68
1.68
1.67
1.66
O
OH
OMe
2.33
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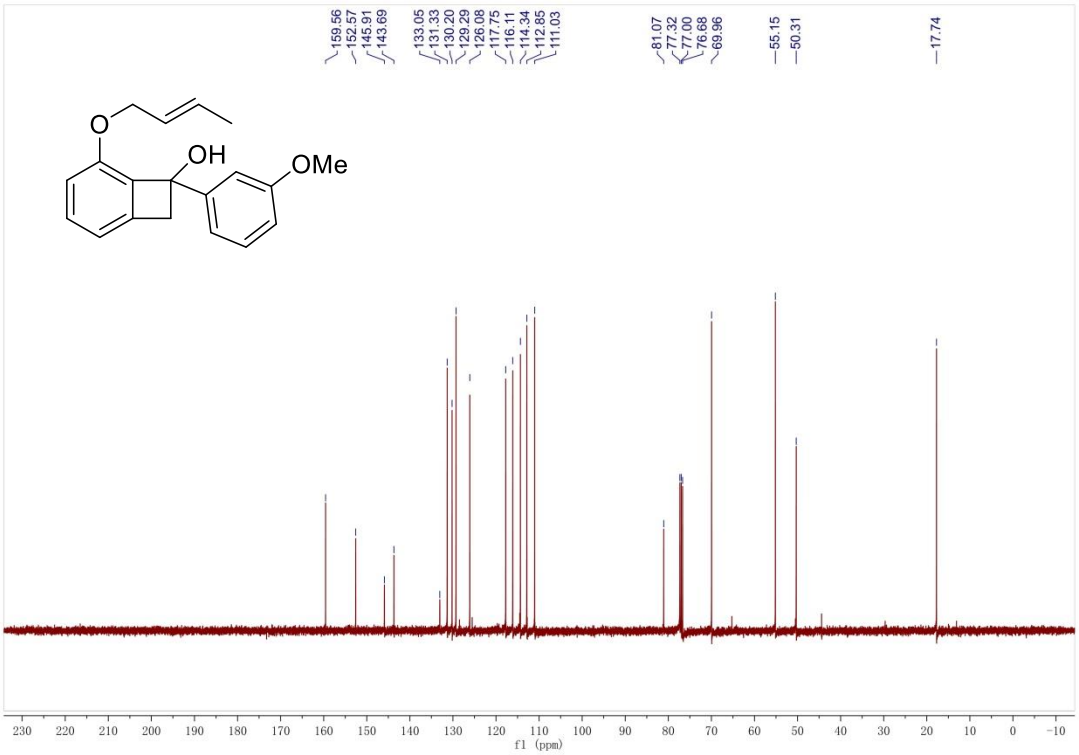
1.00
1.00
1.14
1.16
3.31
2.40
1.15
3.07
f1 (ppm)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133.05
131.33
130.20
129.29
126.08
117.75
116.11
114.34
112.85
111.03
81.07
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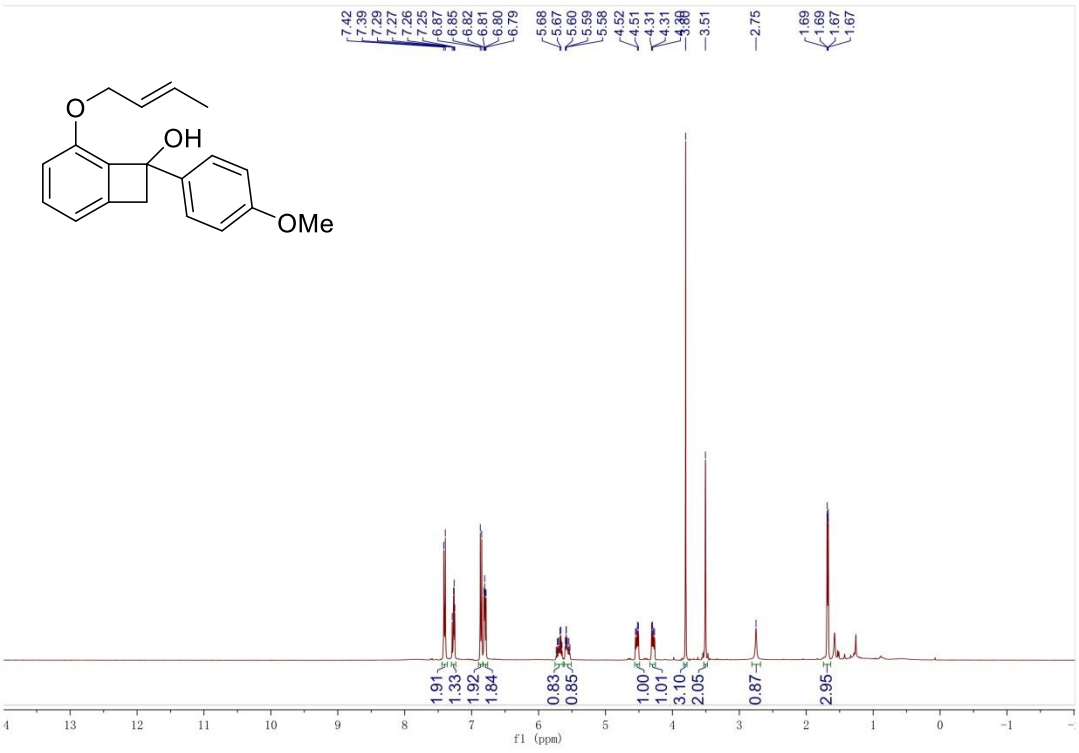
77.00
76.68
69.96
55.15
50.31
17.74
O
OH
OMe
f1 (ppm)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6.85
6.82
6.81
6.80
6.79
5.68
5.67
5.60
5.59
5.58
4.52
4.51
4.31
4.31
3.51
2.75
1.69
1.69
1.67
1.67
O
OH
OMe
1.91
1.33
1.92
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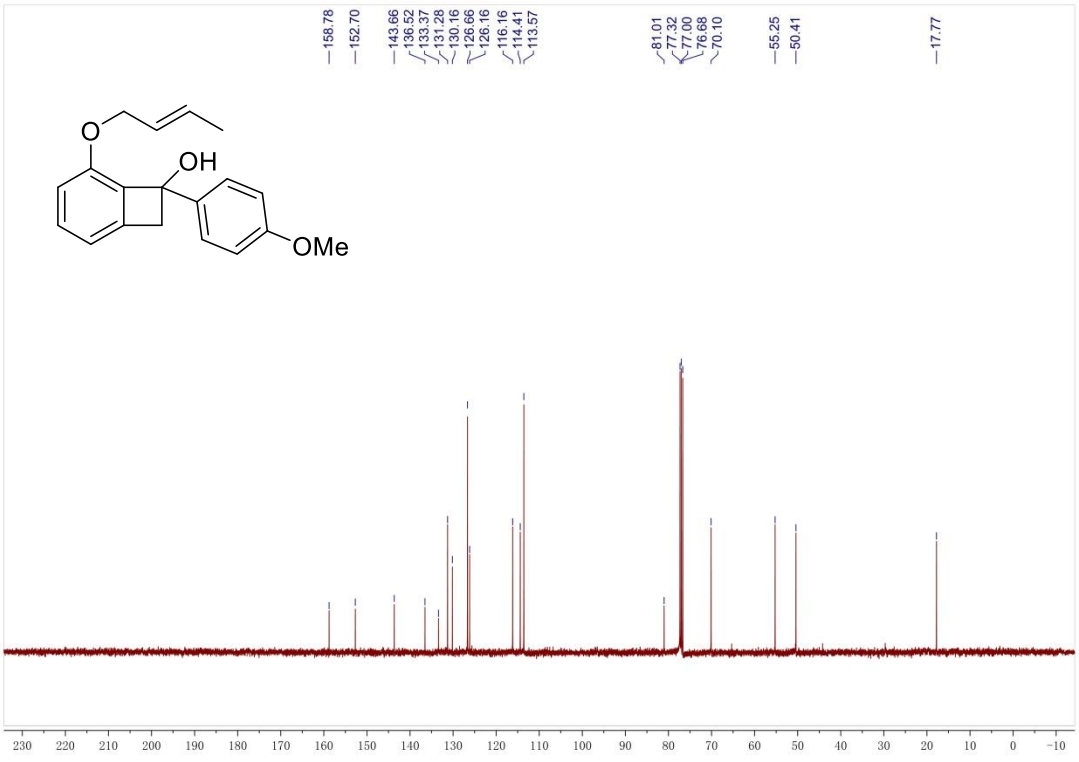
0.83
0.85
1.00
1.01
3.10
2.05
0.87
2.95
f1 (ppm)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126.66
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116.16
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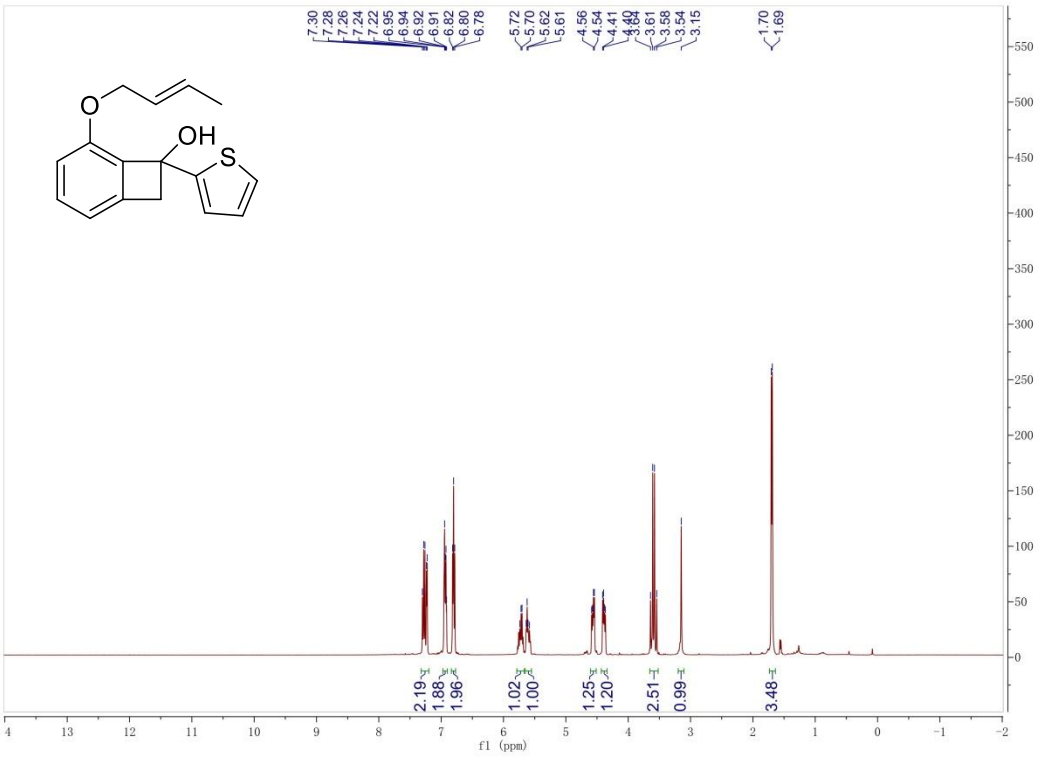
77.32
77.00
76.68
70.10
55.25
50.41
17.77
O
OH
OMe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7.24
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6.94
6.92
6.91
6.82
6.80
6.78
5.72
5.70
5.62
5.61
4.56
4.54
4.41
4.40
3.64
3.61
3.58
3.54
3.15
1.70
1.69
O
OH
S
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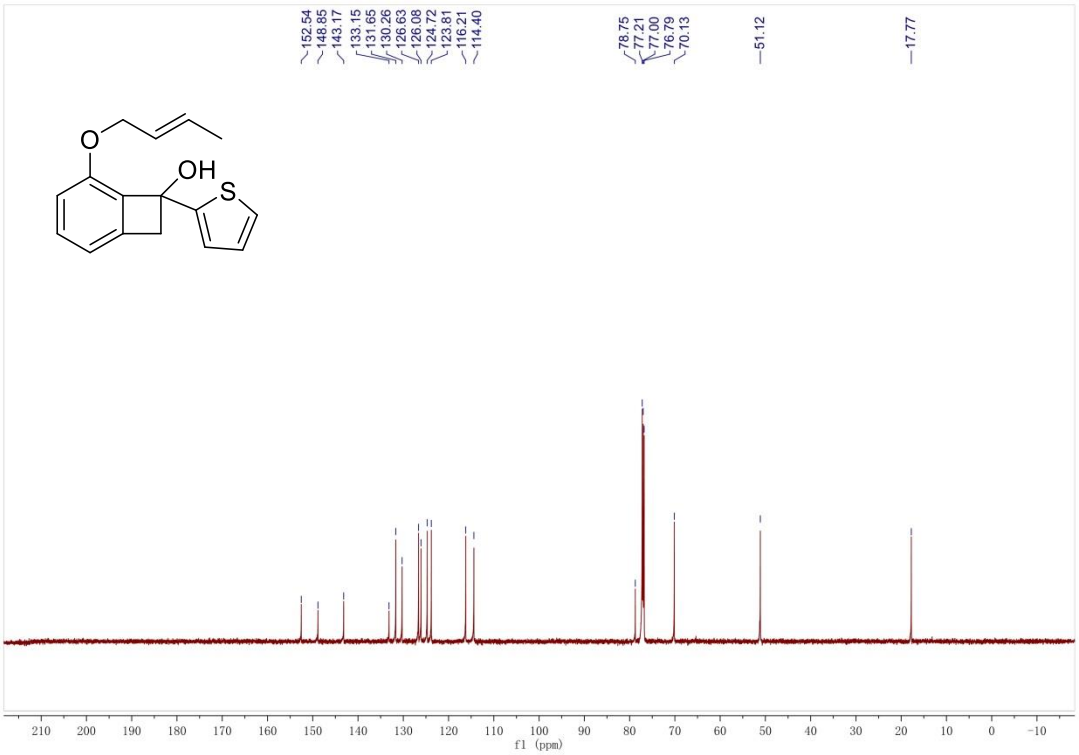
1.96
1.02
1.00
1.25
1.20
2.51
0.99
3.48
f1 (ppm)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130.26
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126.08
124.72
123.81
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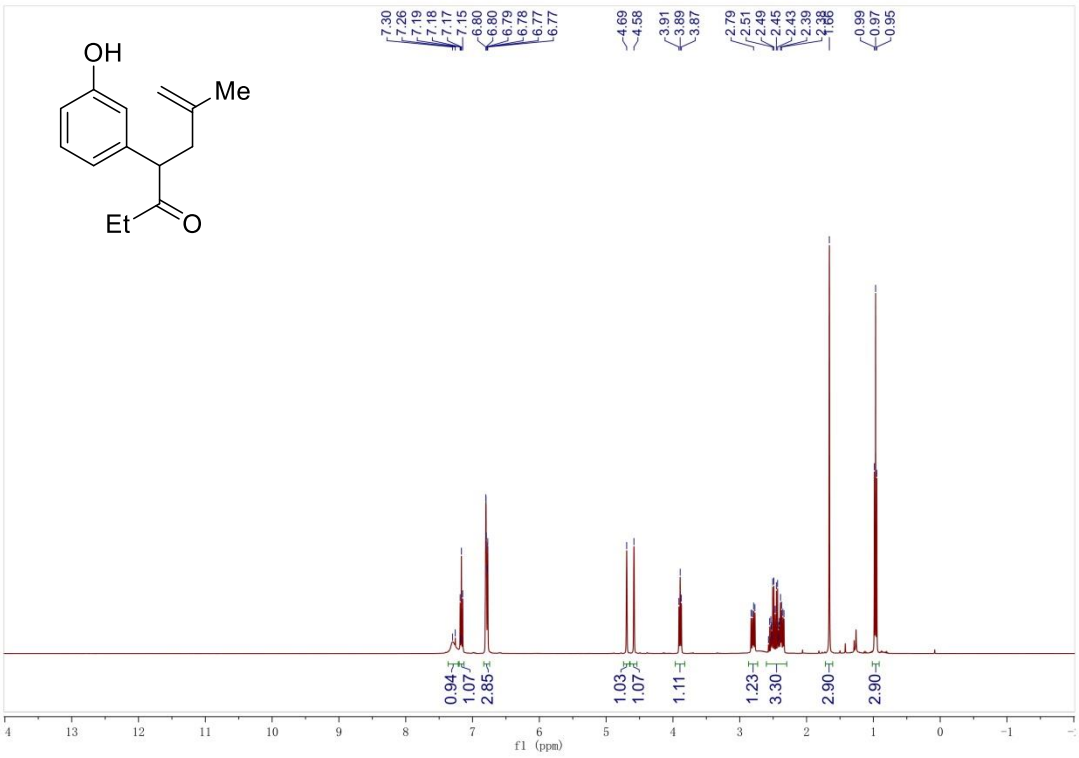
114.40
78.75
77.21
77.00
76.79
70.13
51.12
17.77
O
OH
S
f1 (ppm)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Me
Et
O
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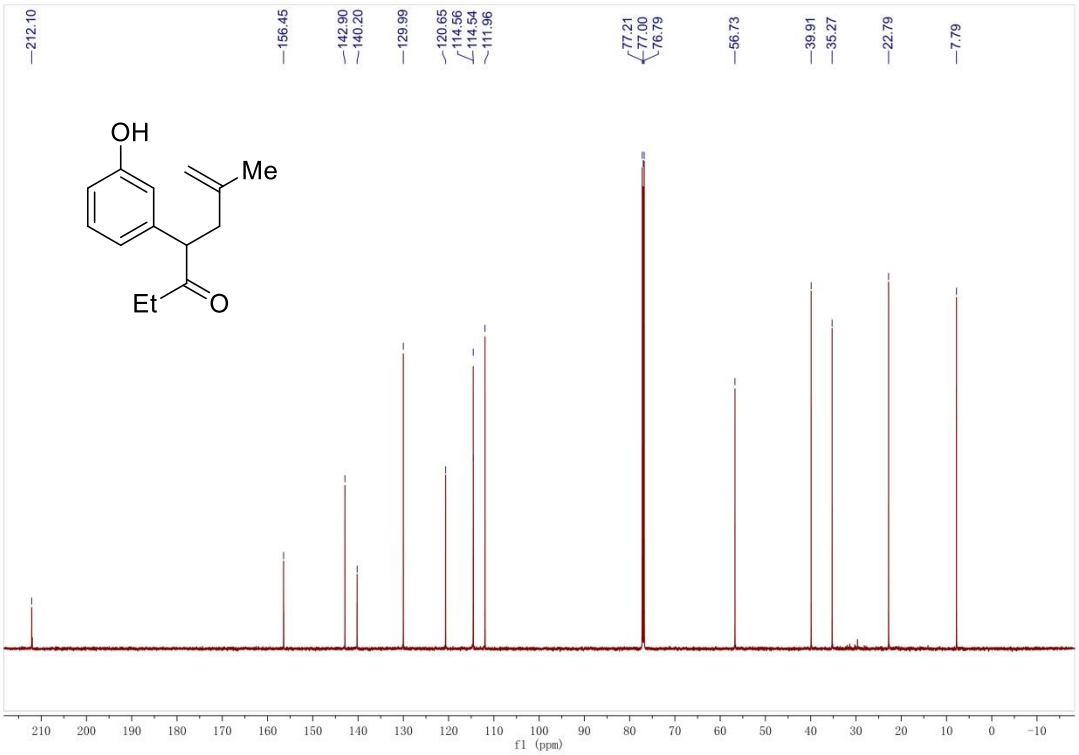
7.19
7.18
7.17
7.15
6.80
6.80
6.79
6.78
6.77
6.77
4.69
4.58
3.91
3.89
3.87
2.79
2.51
2.49
2.45
2.43
2.39
2.38
1.00
0.99
0.97
0.95
0.94
1.07
2.85
1.03
1.07
1.11
1.23
3.30
2.90
2.90
f1 (ppm)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Me
Et
O
212.10
156.45
142.90
140.20
129.99
120.65
114.56
114.54
111.96
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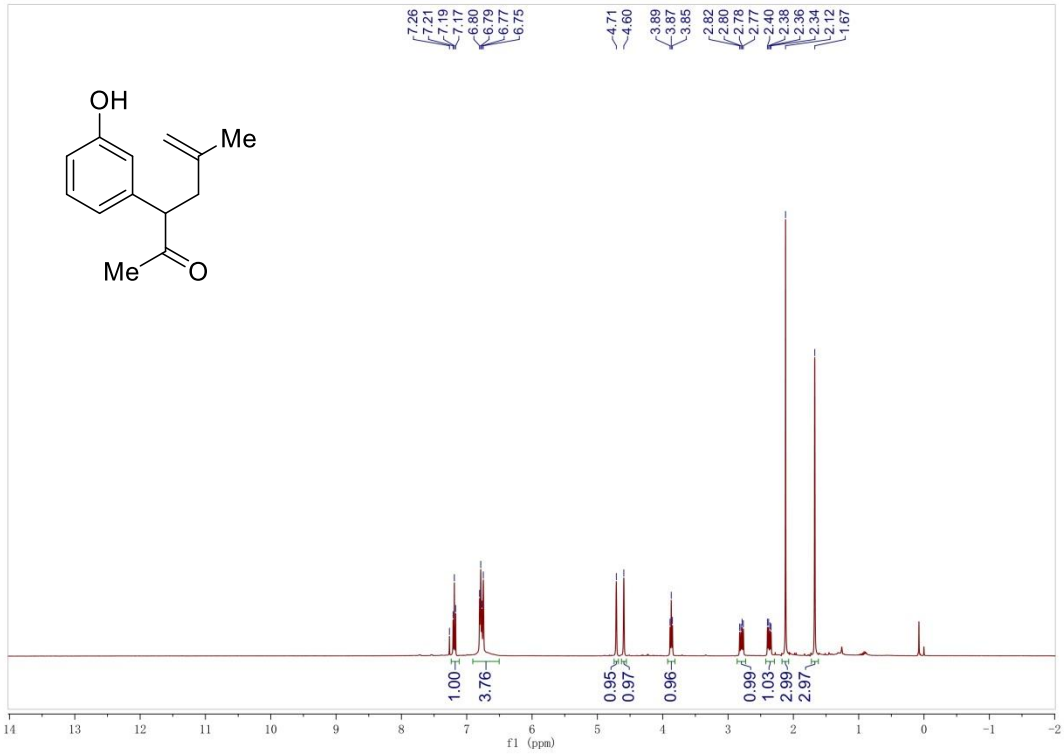
39.91
35.27
22.79
7.79
f1 (ppm)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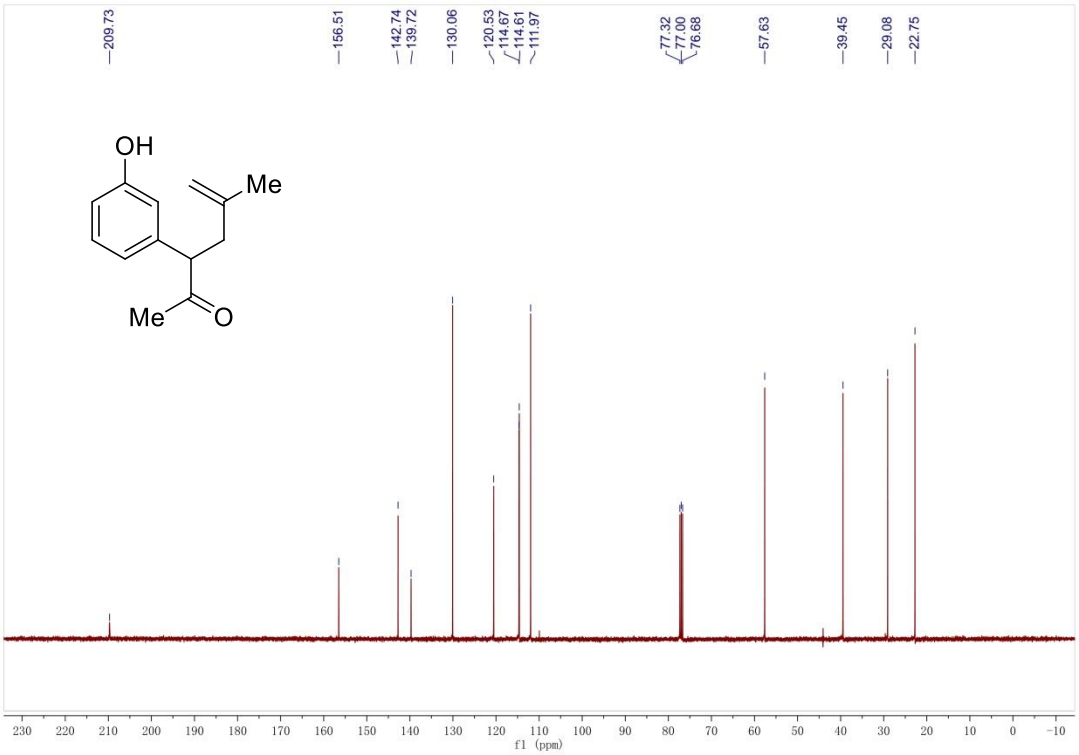
7.21
7.19
7.17
6.80
6.79
6.77
6.75
4.71
4.60
3.89
3.87
3.85
2.82
2.80
2.78
2.77
2.40
2.38
2.36
2.34
2.12
1.67
OH
Me
Me
O
1.00
3.76
0.95
0.97
0.96
0.99
1.03
2.99
2.97
f1 (ppm)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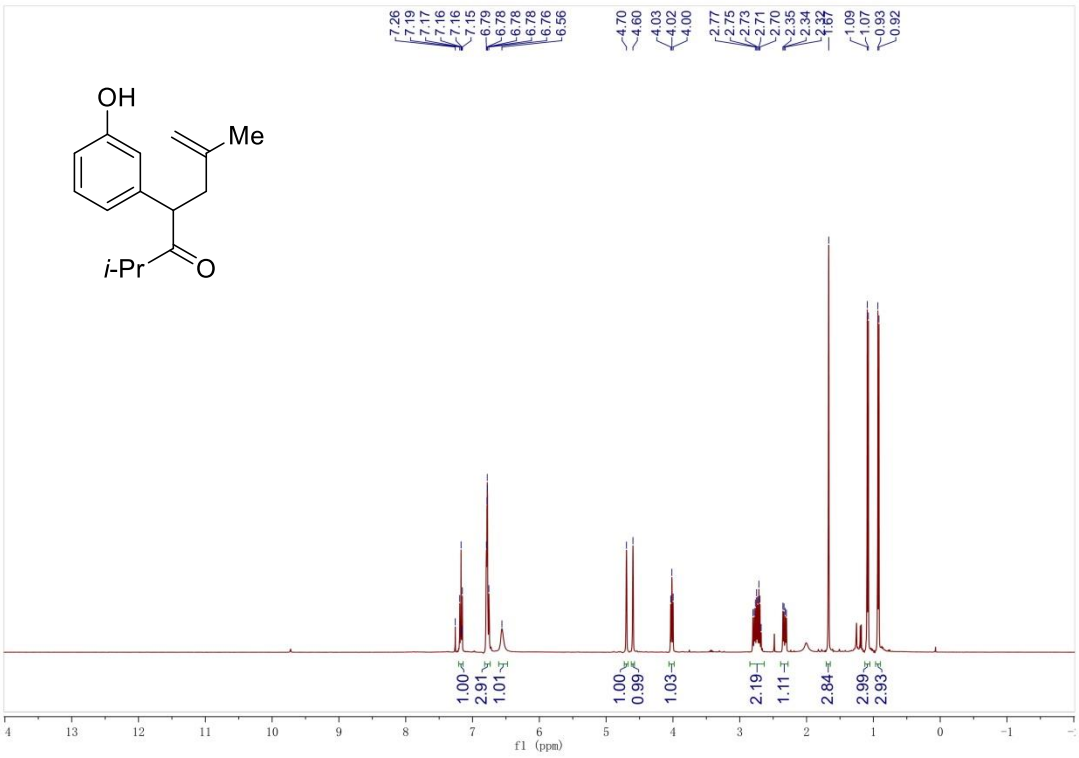
130.06
120.53
114.67
114.61
111.97
77.32
77.00
76.68
57.63
39.45
29.08
22.75
OH
Me
Me
O
f1 (ppm)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7.19
7.17
7.16
7.16
7.15
6.79
6.78
6.78
6.78
6.76
6.56
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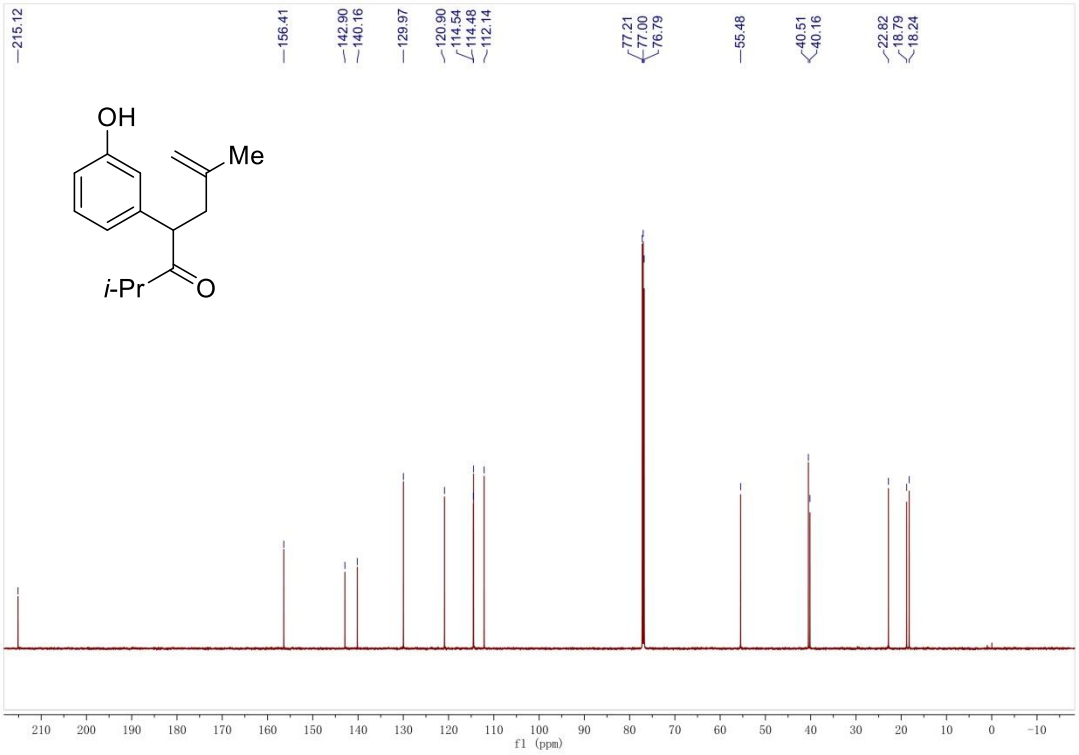
4.60
4.03
4.02
4.00
2.77
2.75
2.73
2.71
2.70
2.35
2.34
2.32
1.87
1.09
1.07
0.93
0.92
OH
Me
i-Pr
O
1.00
2.91
1.01
1.00
0.99
1.03
2.19
1.11
2.84
2.99
2.93
f1 (ppm)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114.48
112.14
77.21
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76.79
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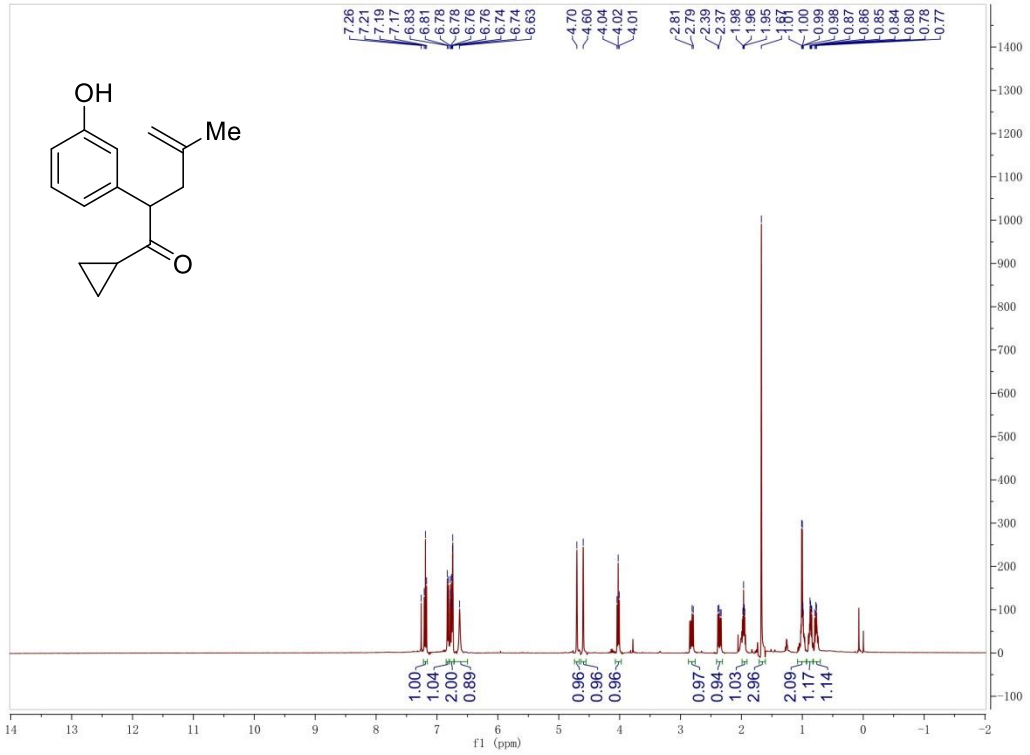
40.51
40.16
22.82
18.79
18.24
OH
Me
i-Pr
O
f1 (ppm)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Me
O
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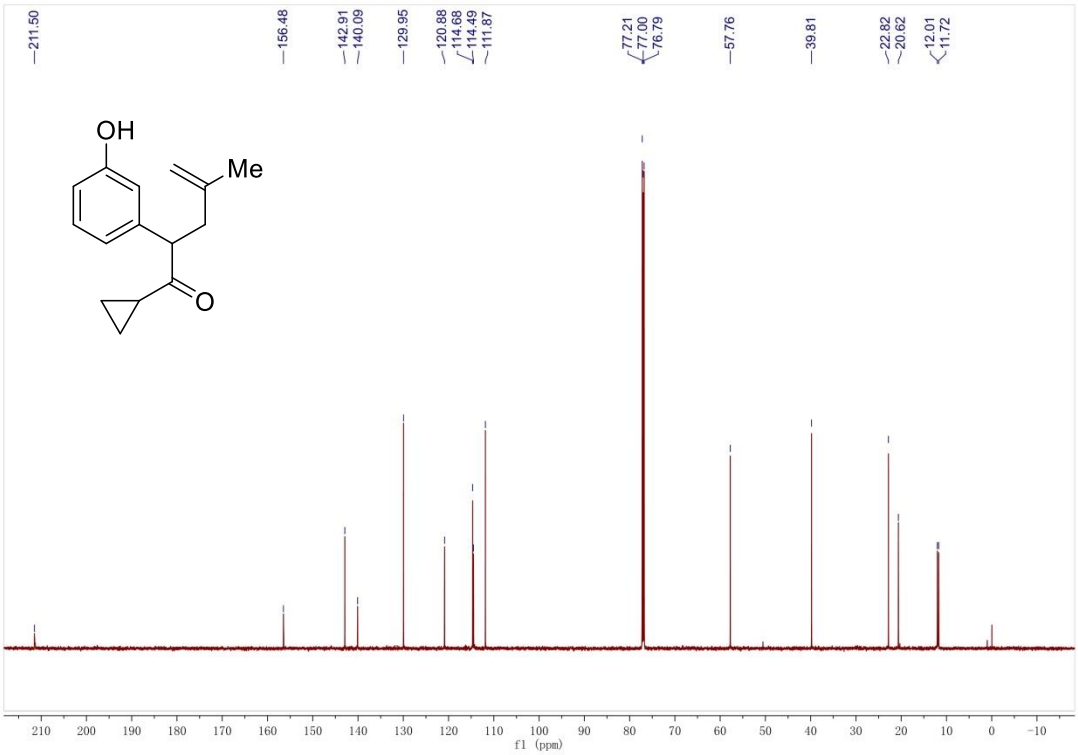
7.21
7.19
7.17
6.83
6.81
6.78
6.78
6.76
6.76
6.74
6.74
6.63
4.70
4.60
4.04
4.02
4.01
2.81
2.79
2.39
2.37
1.98
1.96
1.95
1.00
0.99
0.98
0.87
0.86
0.85
0.84
0.80
0.78
0.77
1.00
1.04
2.00
0.89
0.96
0.96
0.96
0.97
0.94
1.03
2.96
2.09
1.17
1.14
f1 (ppm)


OH
Me
O
211.50
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142.91
140.09
129.95
120.88
114.68
114.49
111.87
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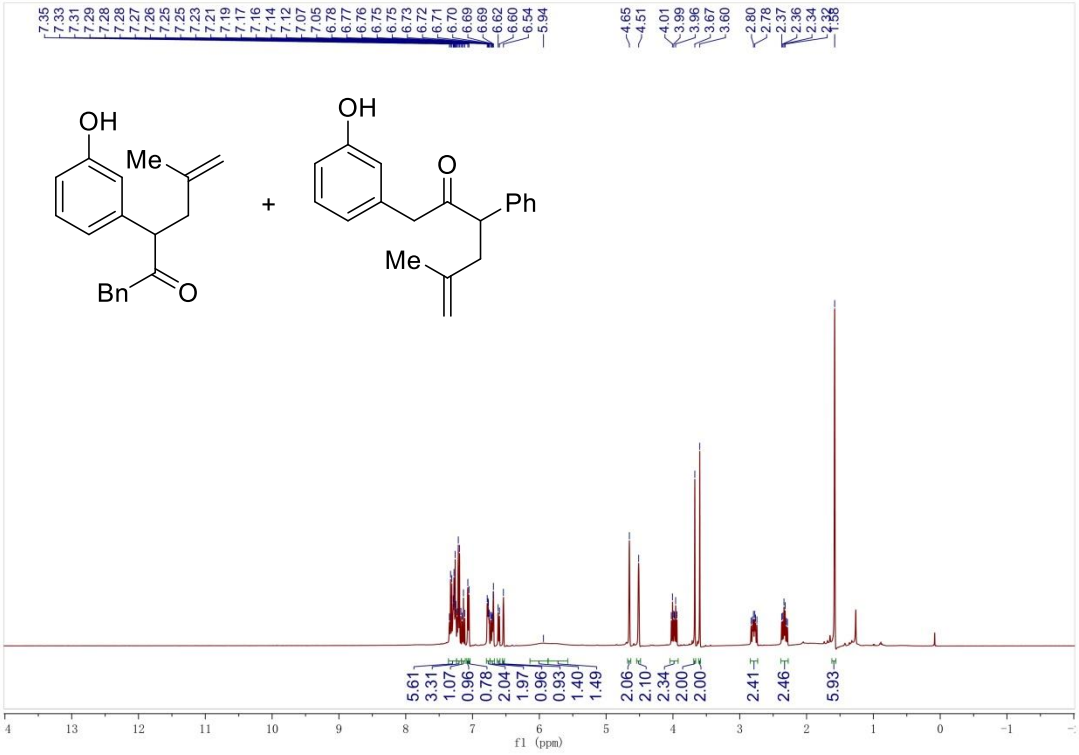
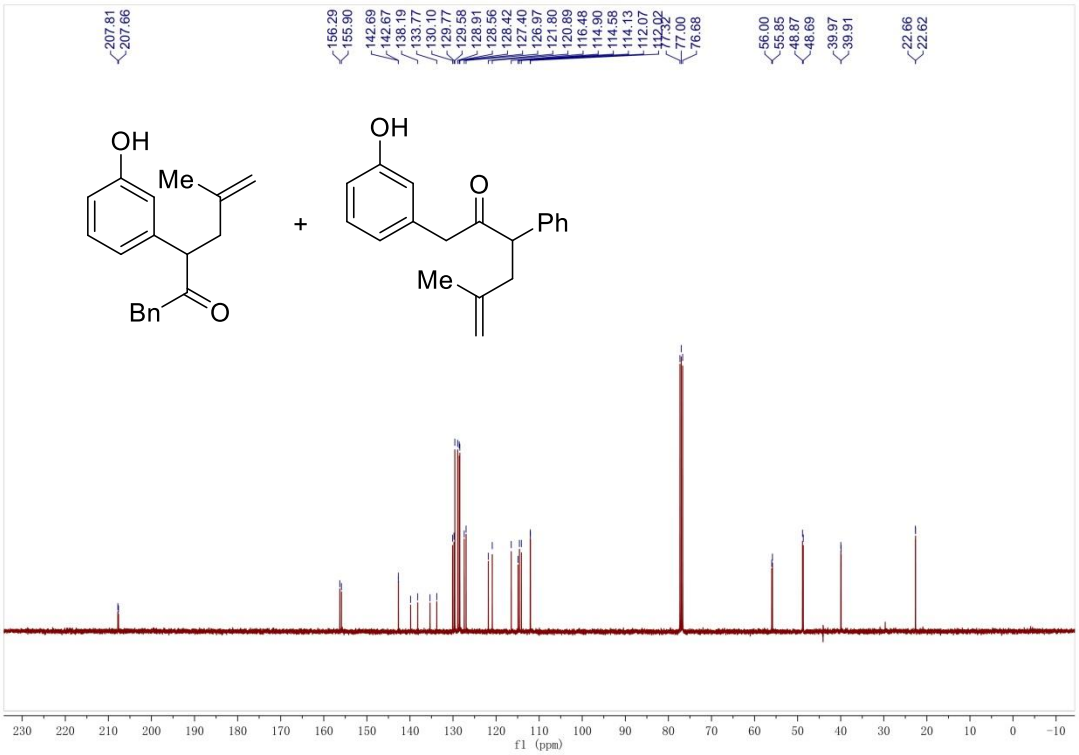
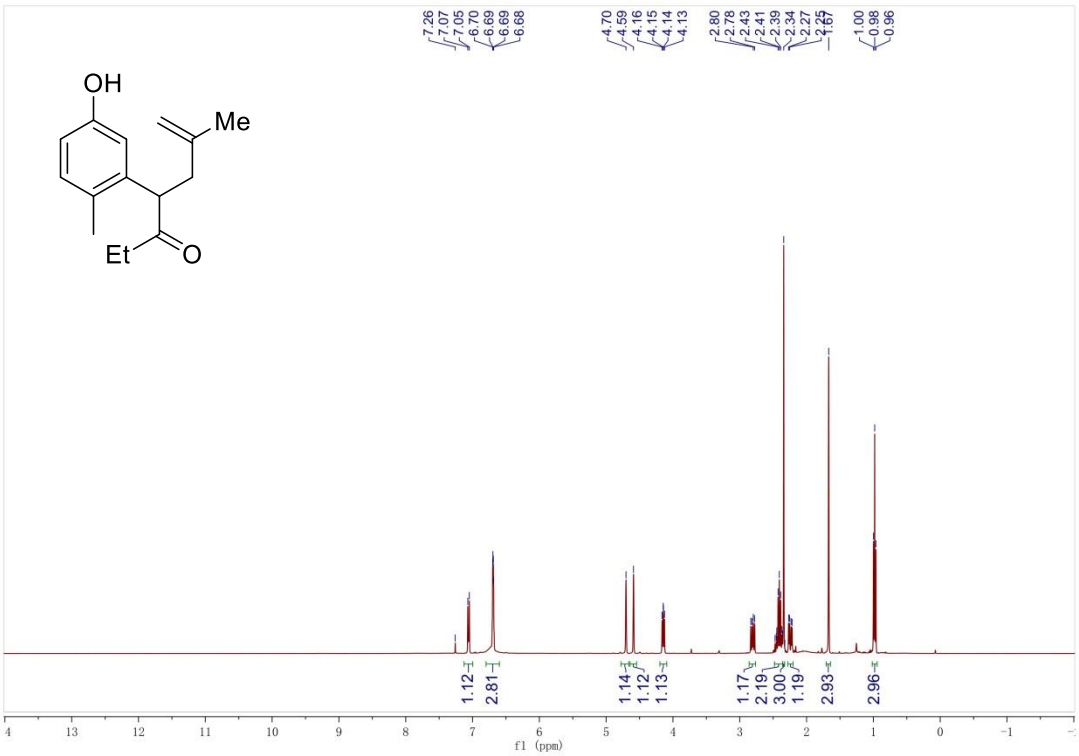
77.00
76.79
57.76
39.81
22.82
20.62
12.01
11.72
f1 (ppm)


OH
Me
Bn
O
+
OH
O
Ph
Me
f1 (ppm)


OH
Me
Bn
O
+
OH
O
Ph
Me
f1 (ppm)


OH
Me
Et
O
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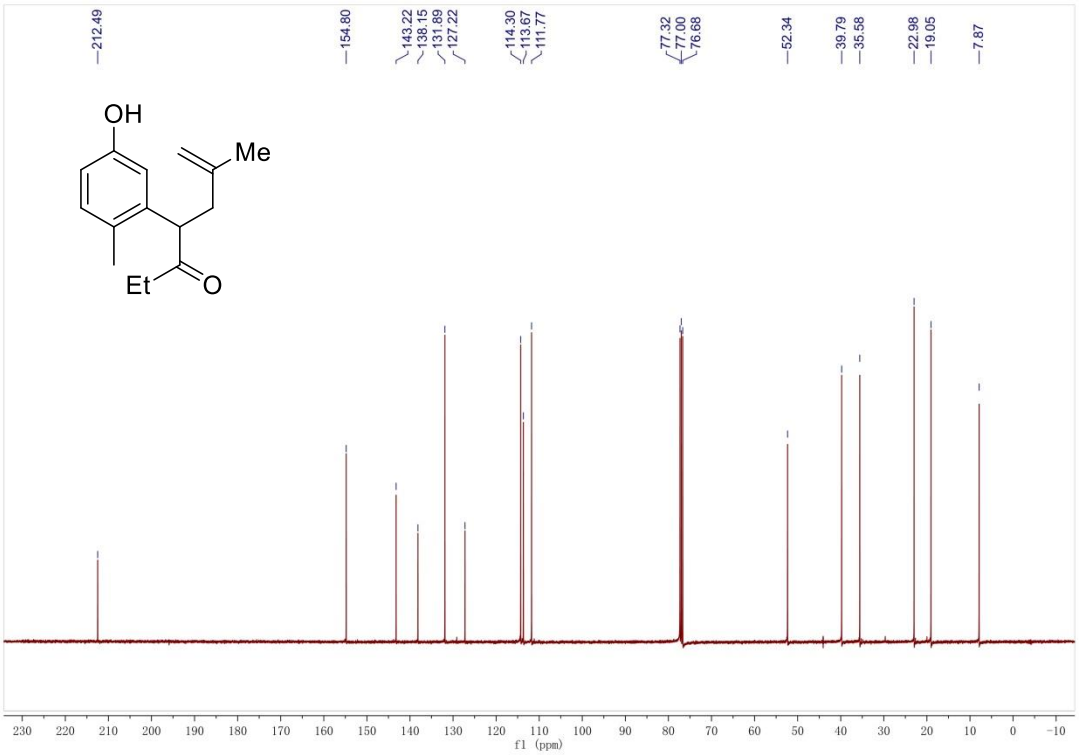
7.07
7.05
6.70
6.69
6.69
6.68
4.70
4.59
4.16
4.15
4.14
4.13
2.80
2.78
2.43
2.41
2.39
2.34
2.27
2.25
1.67
1.00
0.98
0.96
1.12
2.81
1.14
1.12
1.13
1.17
2.19
3.00
1.19
2.93
2.96
f1 (ppm)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Me
Et
O
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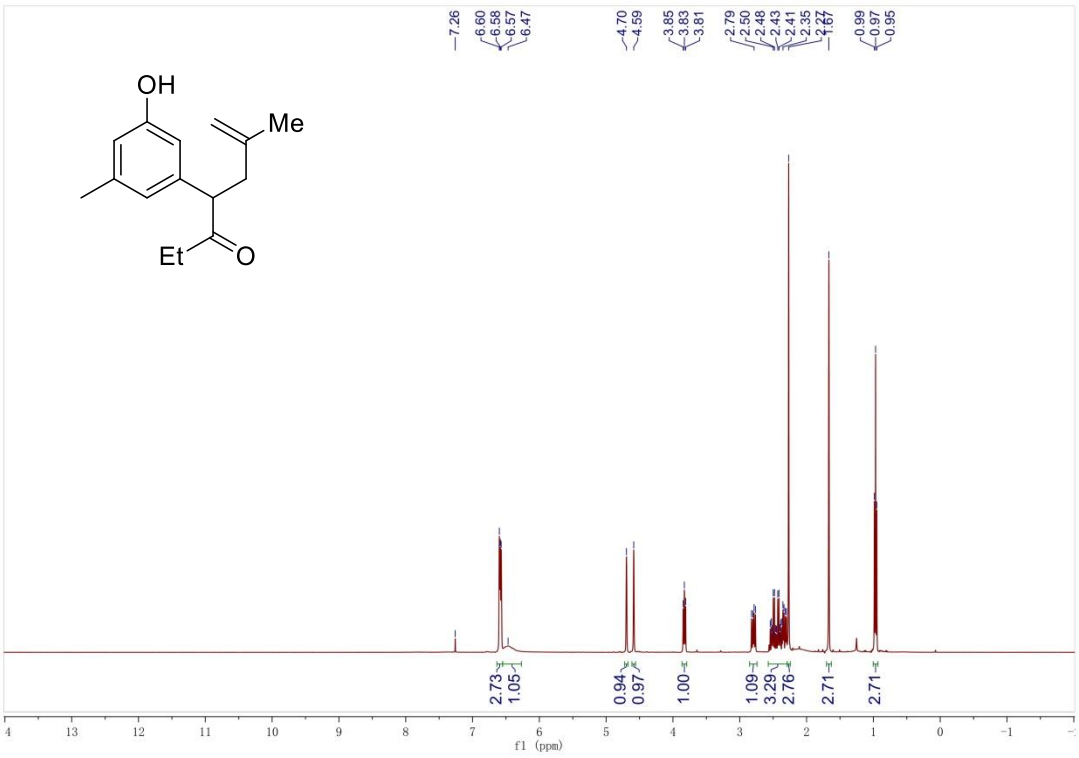
35.58
22.98
19.05
7.87
f1 (ppm)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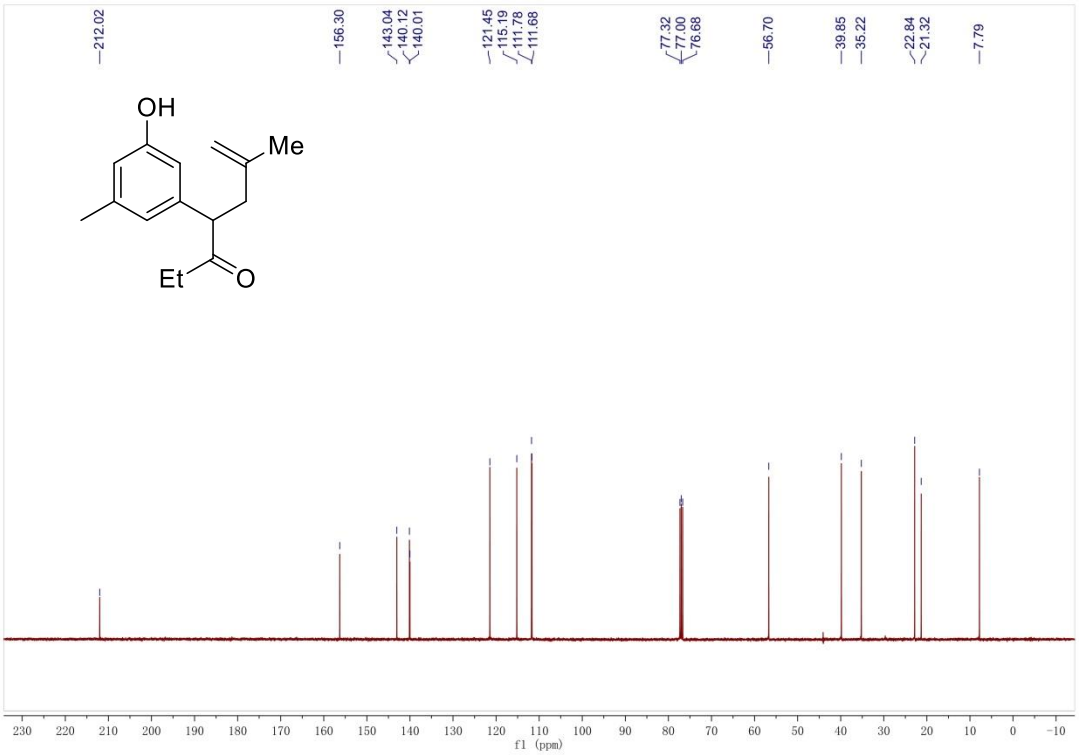
4.59
3.85
3.83
3.81
2.79
2.50
2.48
2.43
2.41
2.35
2.27
1.67
0.99
0.97
0.95
OH
Me
Et
O
2.73
1.05
0.94
0.97
1.00
1.09
3.29
2.76
2.71
2.71
f1 (ppm)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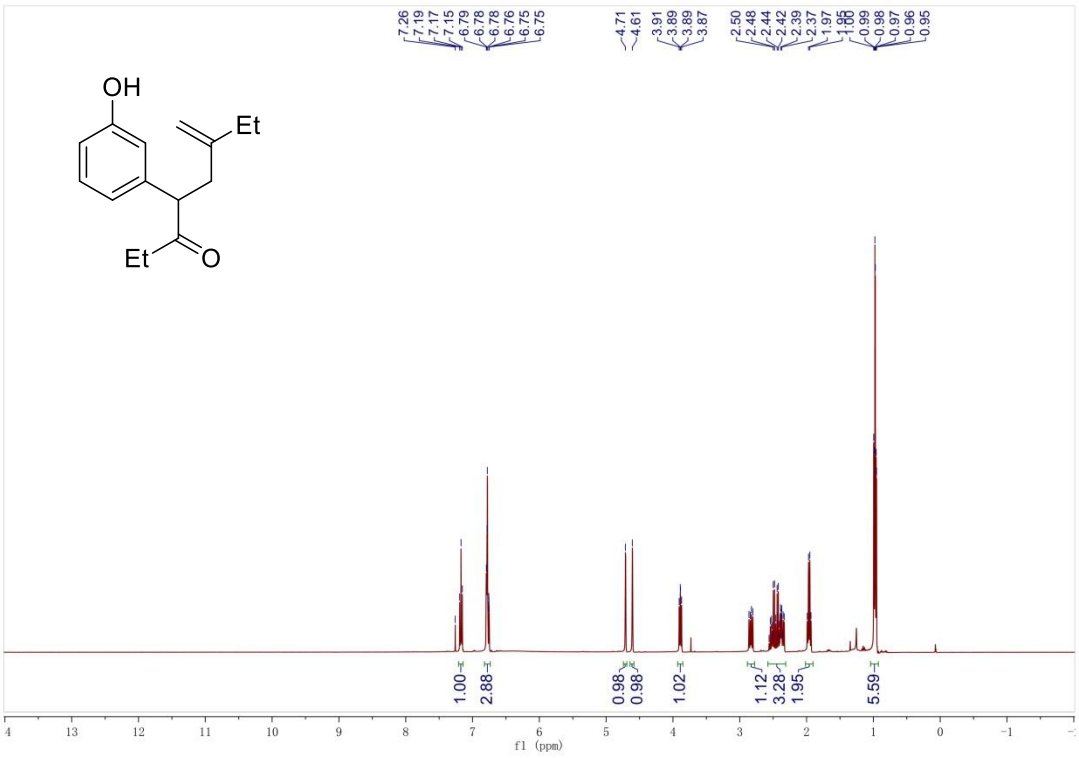
140.01
121.45
115.19
111.78
111.68
77.32
77.00
76.68
56.70
39.85
35.22
22.84
21.32
7.79
OH
Me
Et
O
f1 (ppm)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7.19
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6.78
6.78
6.76
6.75
6.75
4.71
4.61
3.91
3.89
3.89
3.87
2.50
2.48
2.44
2.42
2.39
2.37
1.97
1.05
0.99
0.98
0.97
0.96
0.95
OH
Et
Et
O
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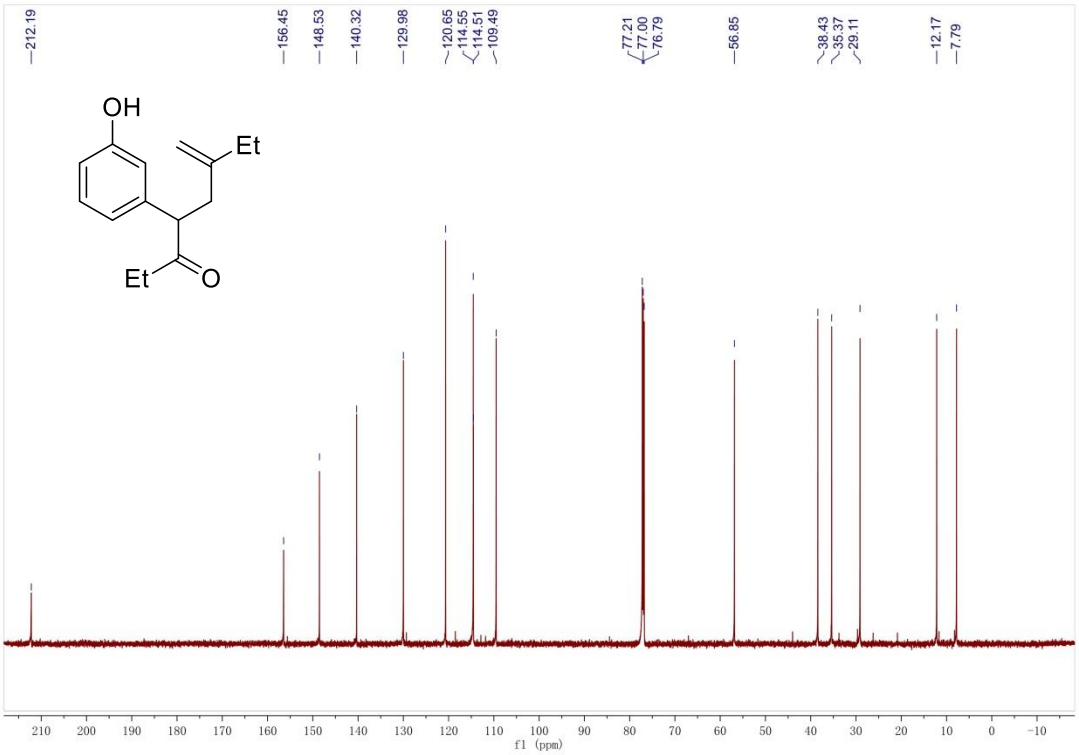
2.88
0.98
0.98
1.02
1.12
3.28
1.95
5.59
f1 (ppm)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120.65
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114.51
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77.21
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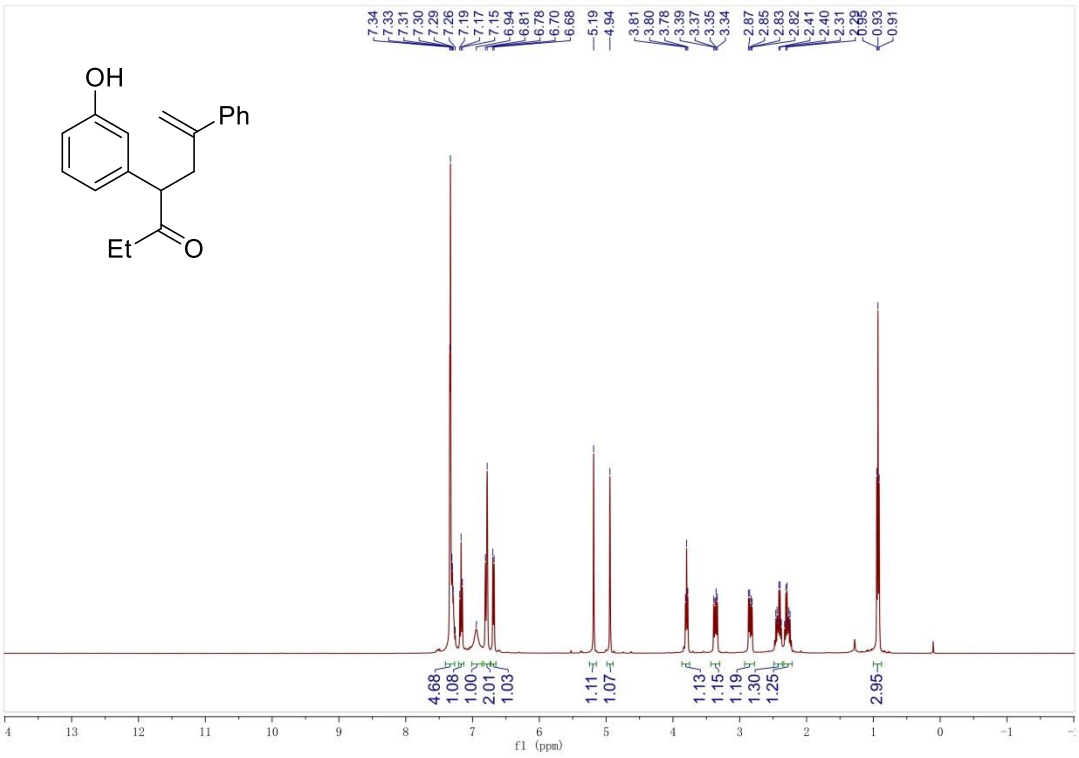
12.17
7.79
OH
Et
Et
O
f1 (ppm)


OH
Ph
Et
O
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7.30
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7.26
7.19
7.17
7.15
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6.78
6.70
6.68
5.19
4.94
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3.80
3.78
3.39
3.37
3.35
3.34
2.87
2.85
2.83
2.82
2.41
2.40
2.31
0.93
0.91
4.68
1.08
1.00
2.01
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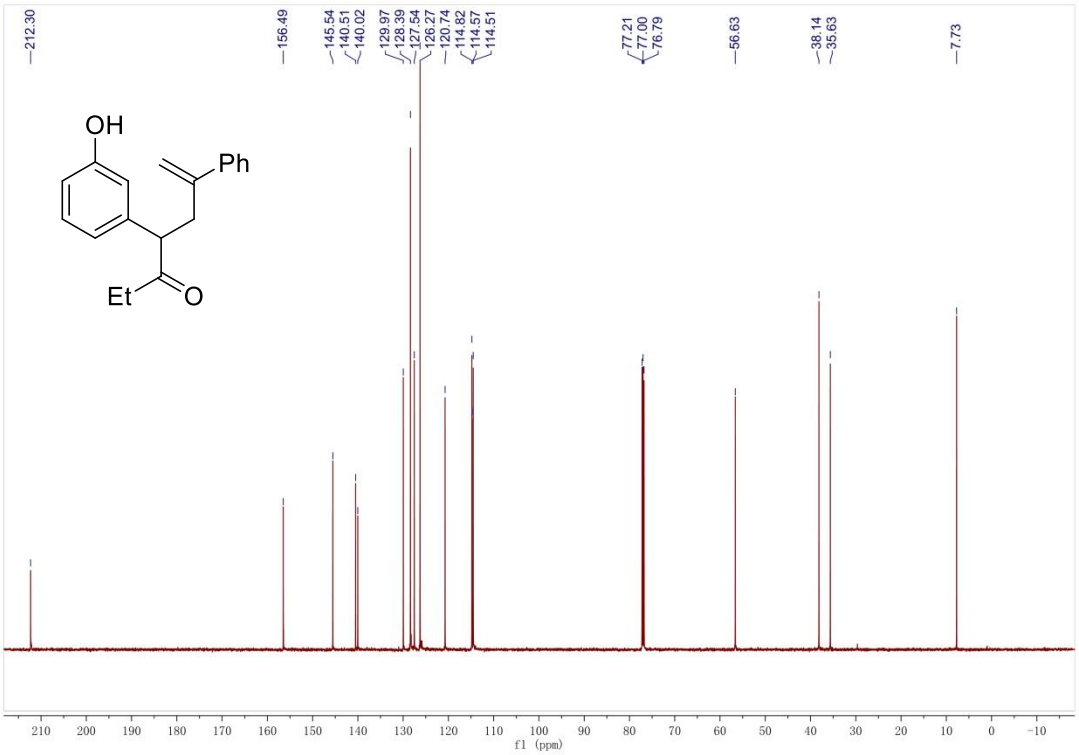
1.11
1.07
1.13
1.15
1.19
1.30
1.25
2.95
f1 (ppm)


OH
Ph
Et
O
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129.97
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127.54
126.27
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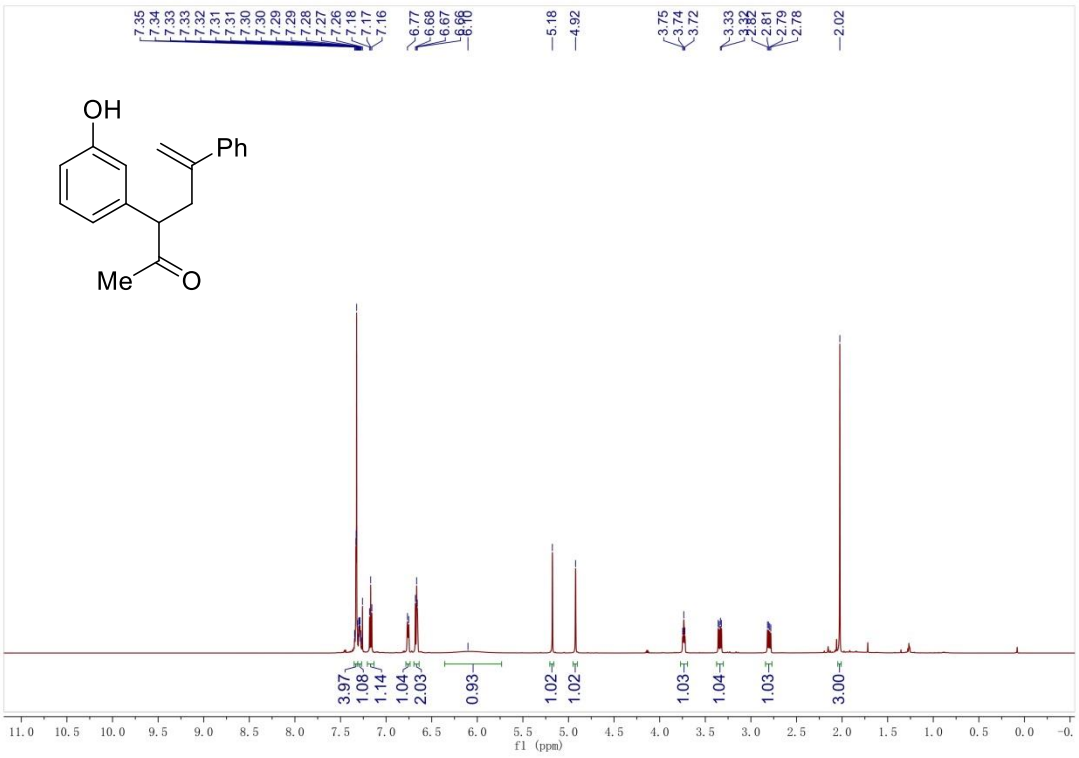
114.82
114.57
114.51
77.21
77.00
76.79
56.63
38.14
35.63
7.73
f1 (ppm)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Ph
Me
O
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7.34
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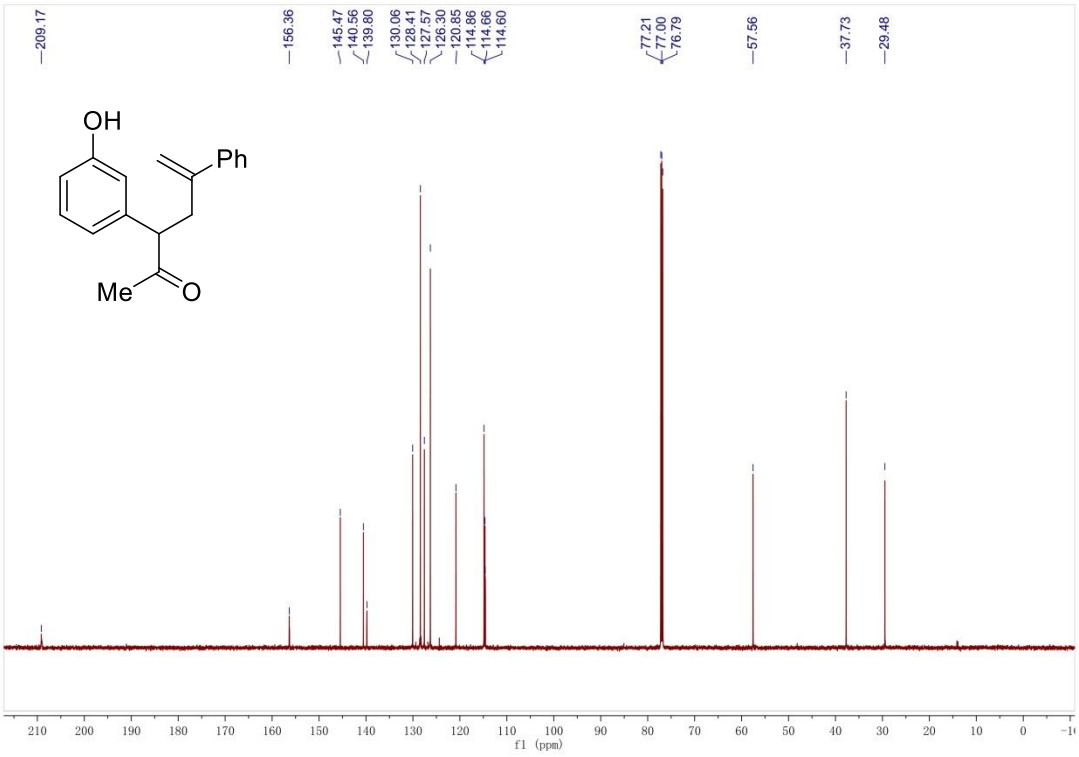
7.33
7.32
7.31
7.31
7.30
7.30
7.29
7.29
7.28
7.27
7.26
7.18
7.17
7.16
6.77
6.68
6.67
5.18
4.92
3.75
3.74
3.72
3.33
2.81
2.79
2.78
2.02
3.97
1.08
1.14
1.04
2.03
0.93
1.02
1.02
1.03
1.04
1.03
3.00
f1 (ppm)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Ph
Me
O
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127.57
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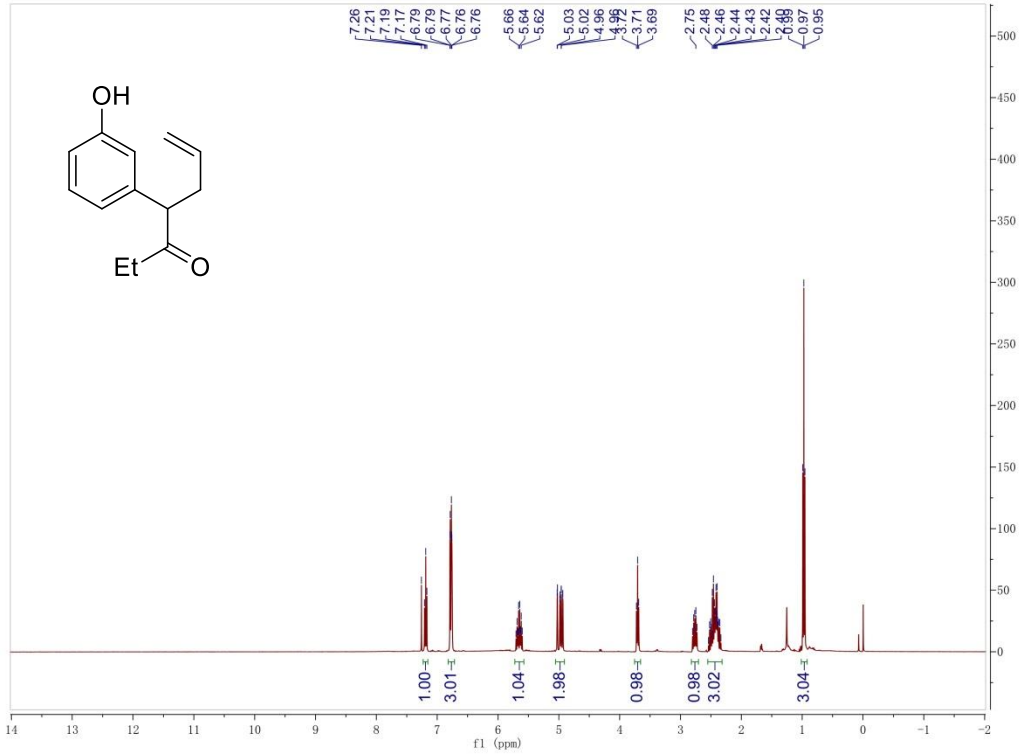
120.85
114.86
114.66
114.60
77.21
77.00
76.79
57.56
37.73
29.48
f1 (ppm)


OH
Et
O
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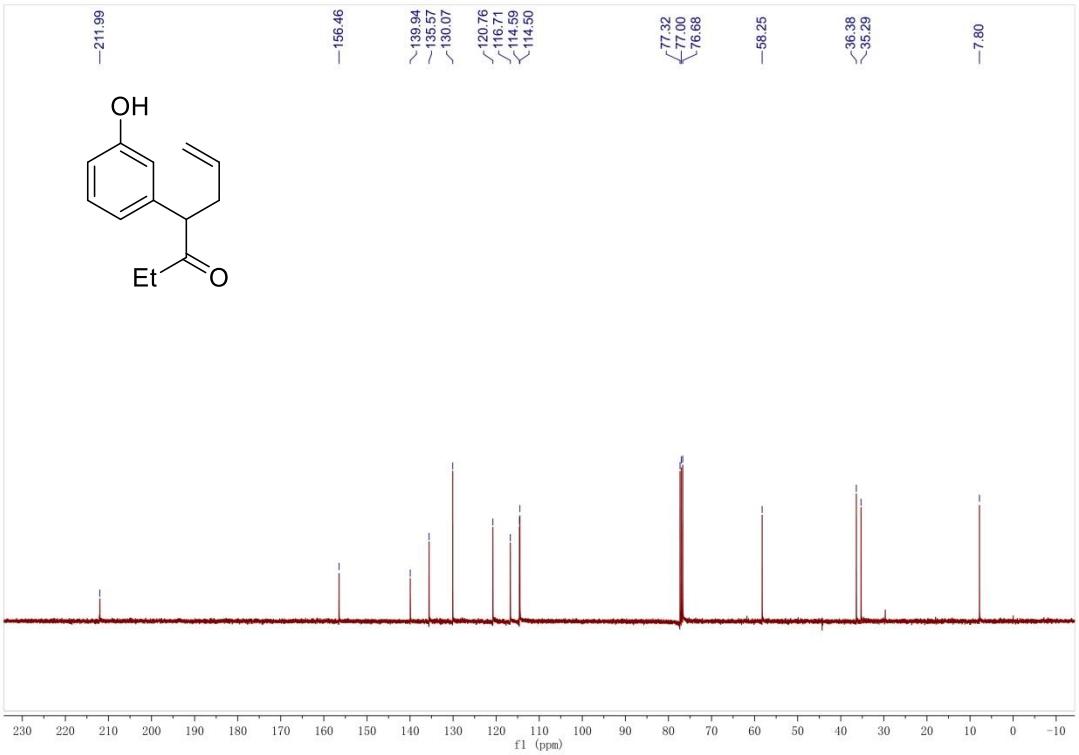
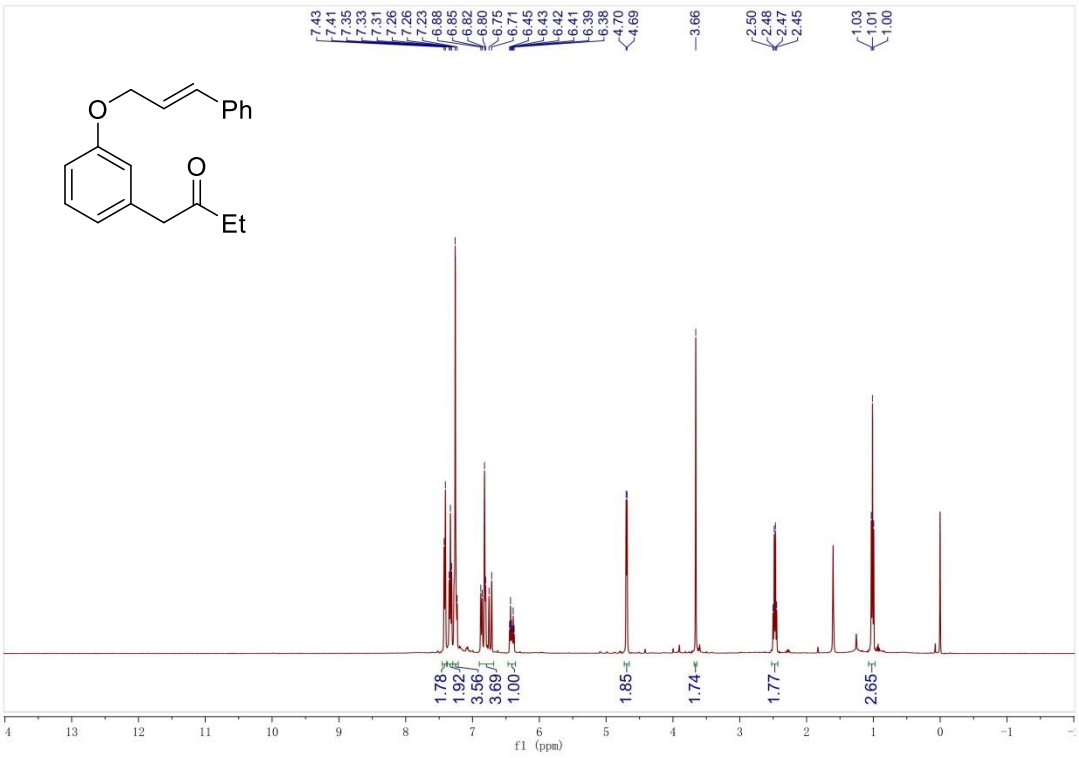
7.21
7.19
7.17
6.79
6.79
6.77
6.76
6.76
5.66
5.64
5.62
5.03
5.02
4.96
3.71
3.69
2.75
2.48
2.46
2.44
2.43
2.42
0.97
0.95
1.00
3.01
1.04
1.98
0.98
0.98
3.02
3.04
f1 (ppm)


OH
Et
O
211.99
156.46
139.94
135.57
130.07
120.76
116.71
114.59
114.50
77.32
77.00
76.68
58.25
36.38
35.29
7.80
f1 (ppm)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7.23
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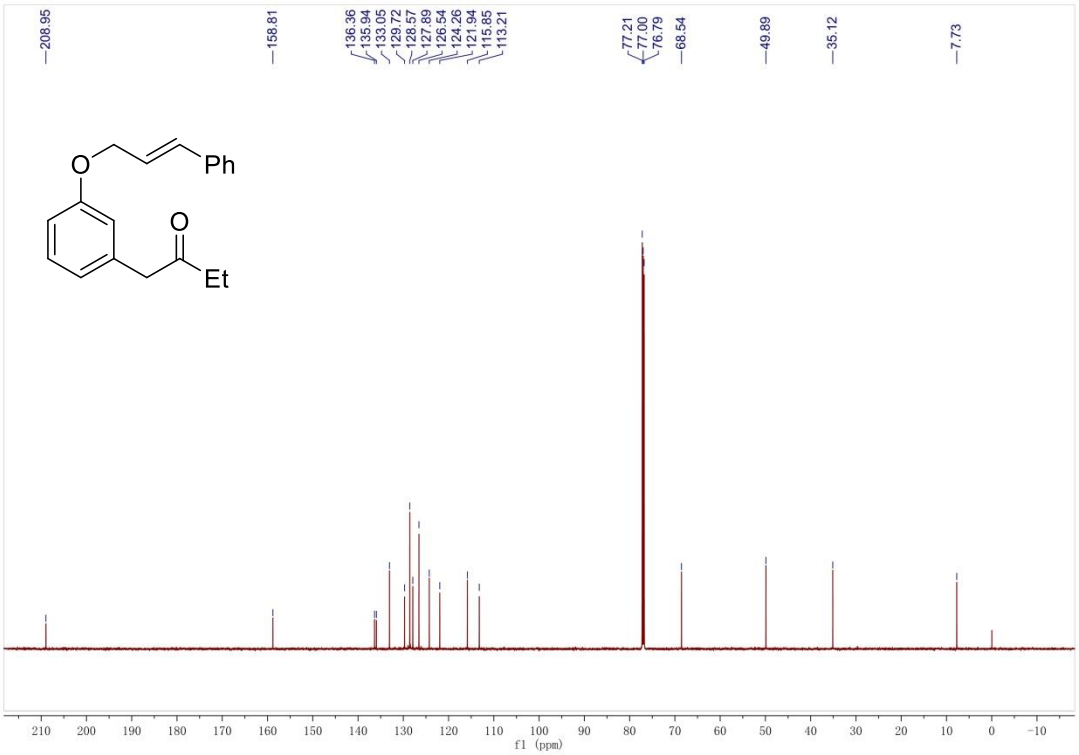
6.85
6.82
6.80
6.75
6.71
6.45
6.43
6.42
6.41
6.39
6.38
4.70
4.69
3.66
2.50
2.48
2.47
2.45
1.03
1.01
1.00
O
Ph
O
Et
1.78
1.92
3.56
3.69
1.00
1.85
1.74
1.77
2.65
f1 (ppm)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129.72
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127.89
126.54
124.26
121.94
115.85
113.21
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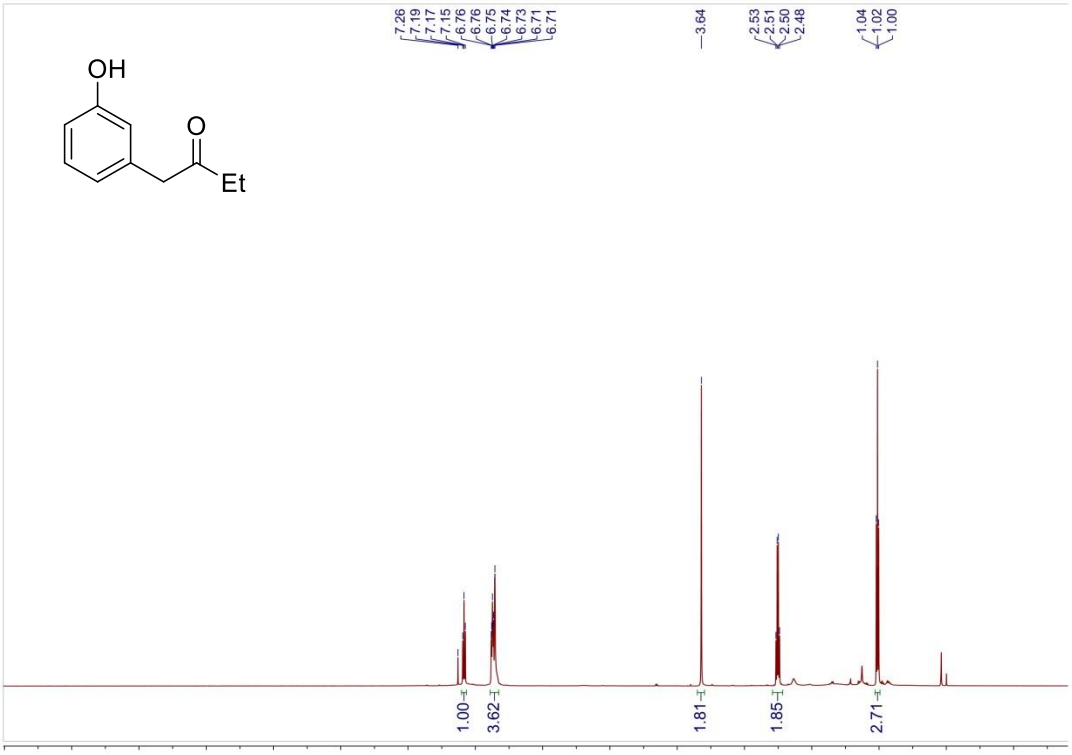
77.00
76.79
68.54
49.89
35.12
7.73
O
Ph
O
Et
f1 (ppm)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7.15
6.76
6.76
6.75
6.74
6.73
6.71
6.71
3.64
2.53
2.51
2.50
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1.04
1.02
1.00
OH
O
Et
1.00
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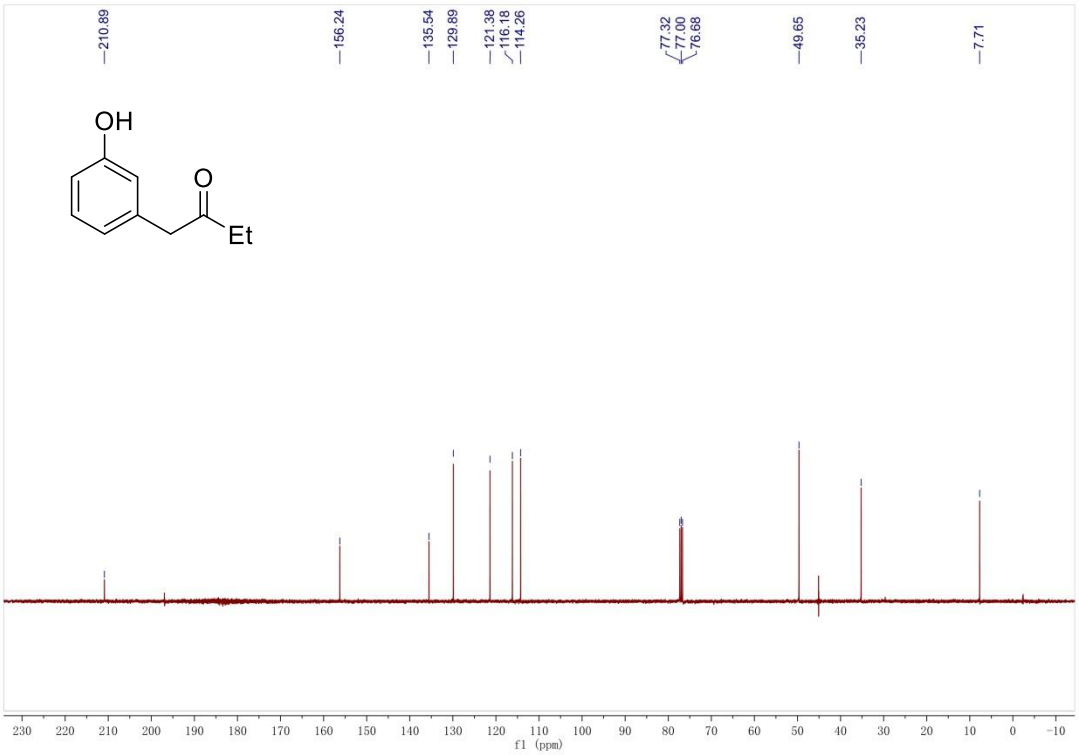
1.85
2.71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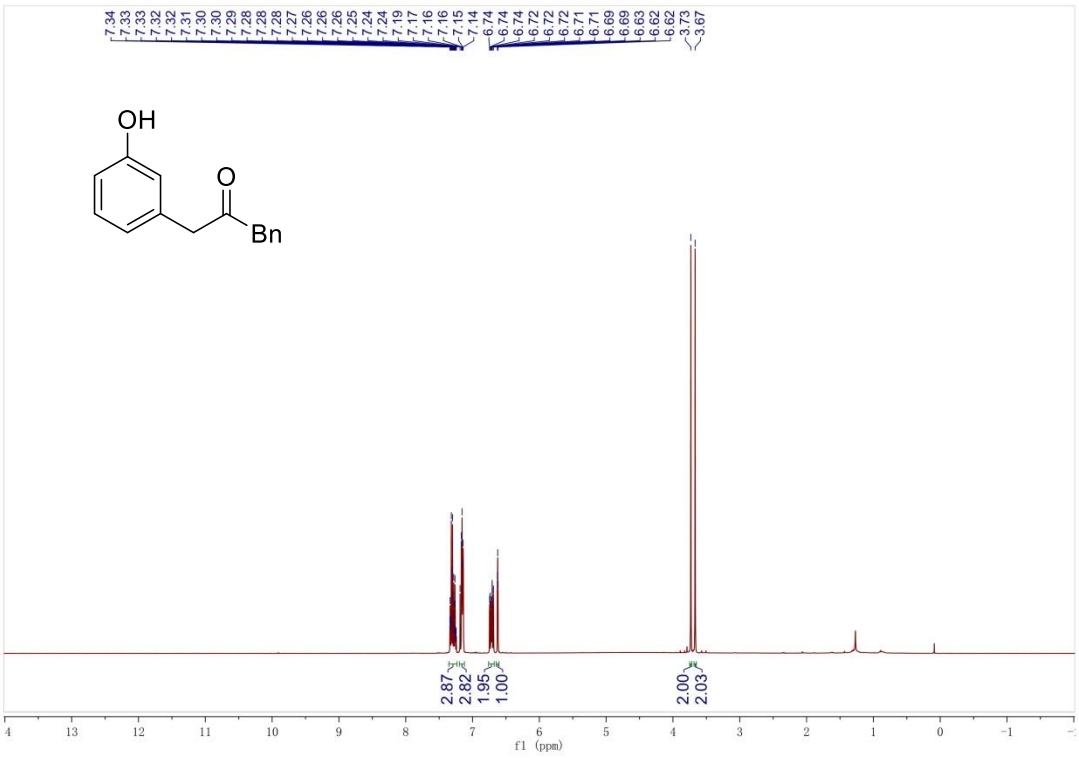
116.18
114.26
77.32
77.00
76.68
49.65
35.23
7.71
OH
O
Et
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.30
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7.28
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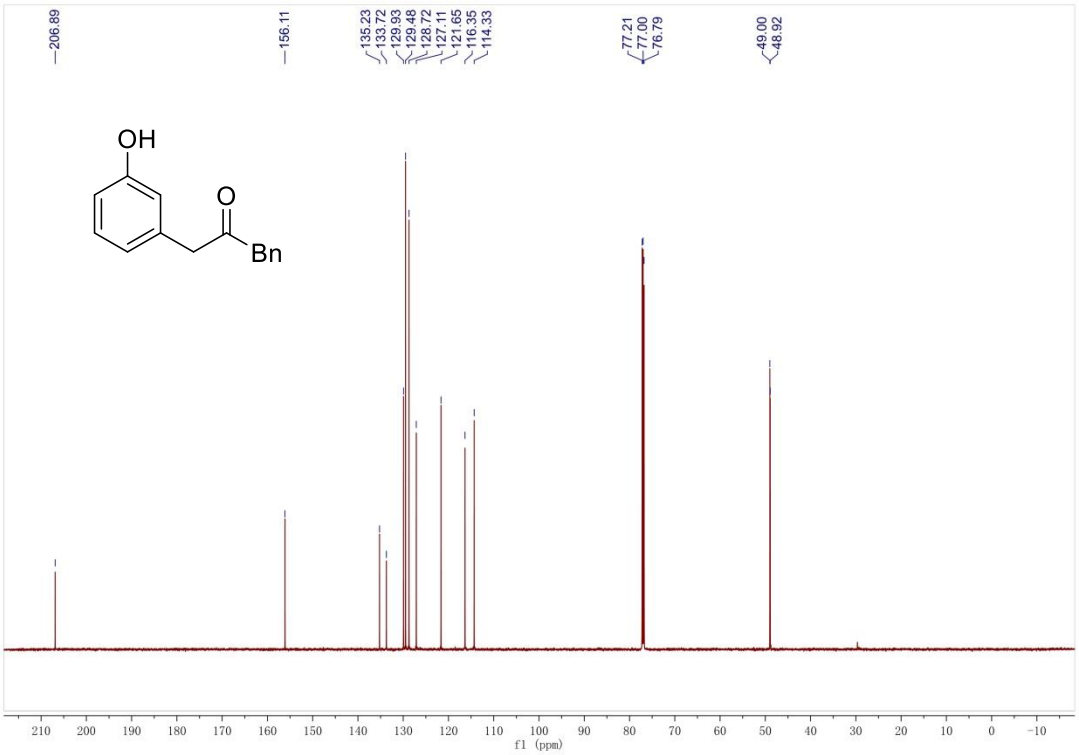
7.26
7.26
7.26
7.25
7.24
7.24
7.19
7.17
7.16
7.16
7.15
7.14
6.74
6.74
6.72
6.72
6.72
6.71
6.71
6.69
6.69
6.63
6.62
6.62
3.73
3.67
OH
O
Bn
2.87
2.82
1.95
1.00
2.00
2.03
f1 (ppm)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128.72
127.11
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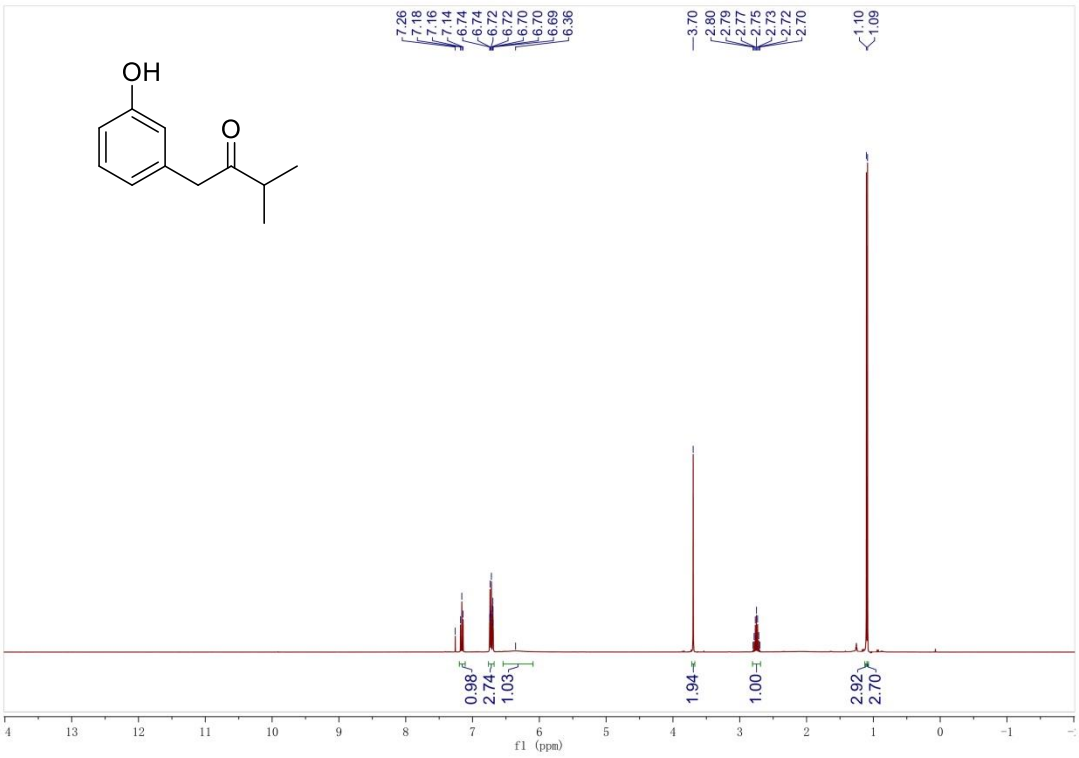
114.33
77.21
77.00
76.79
49.00
48.92
OH
O
Bn
f1 (ppm)


OH
O
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7.16
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6.74
6.72
6.72
6.70
6.70
6.69
6.36
3.70
2.80
2.79
2.77
2.75
2.73
2.72
2.70
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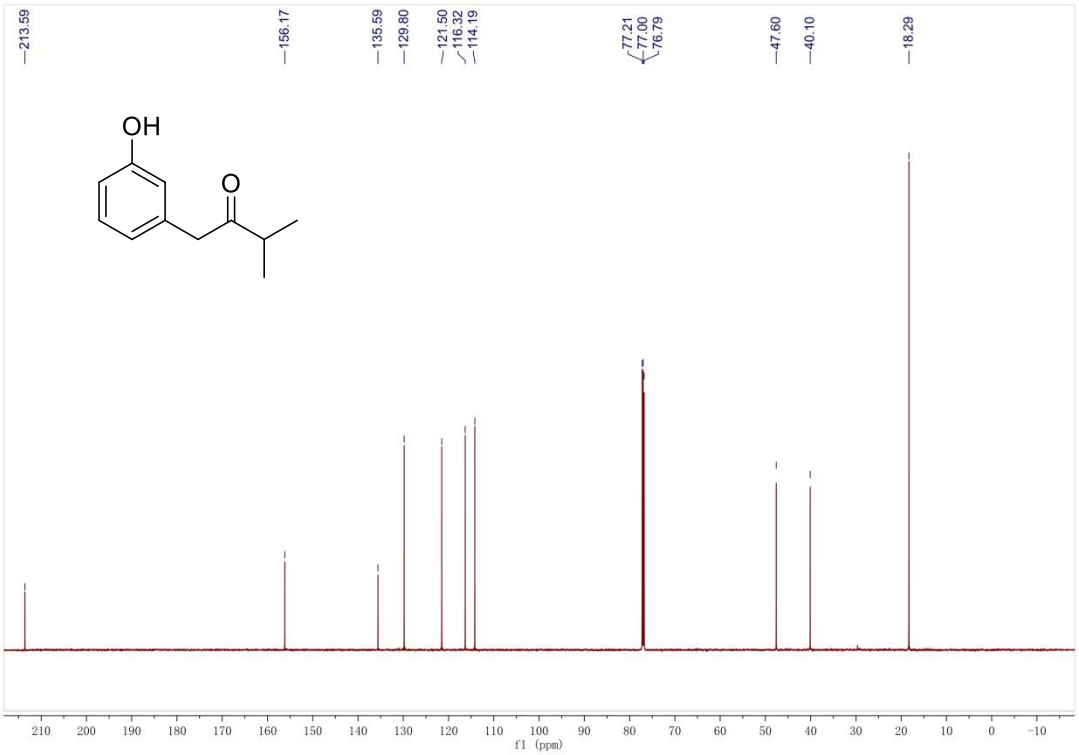
1.09
0.98
2.74
1.03
1.94
1.00
2.92
2.70
f1 (ppm)


OH
O
213.59
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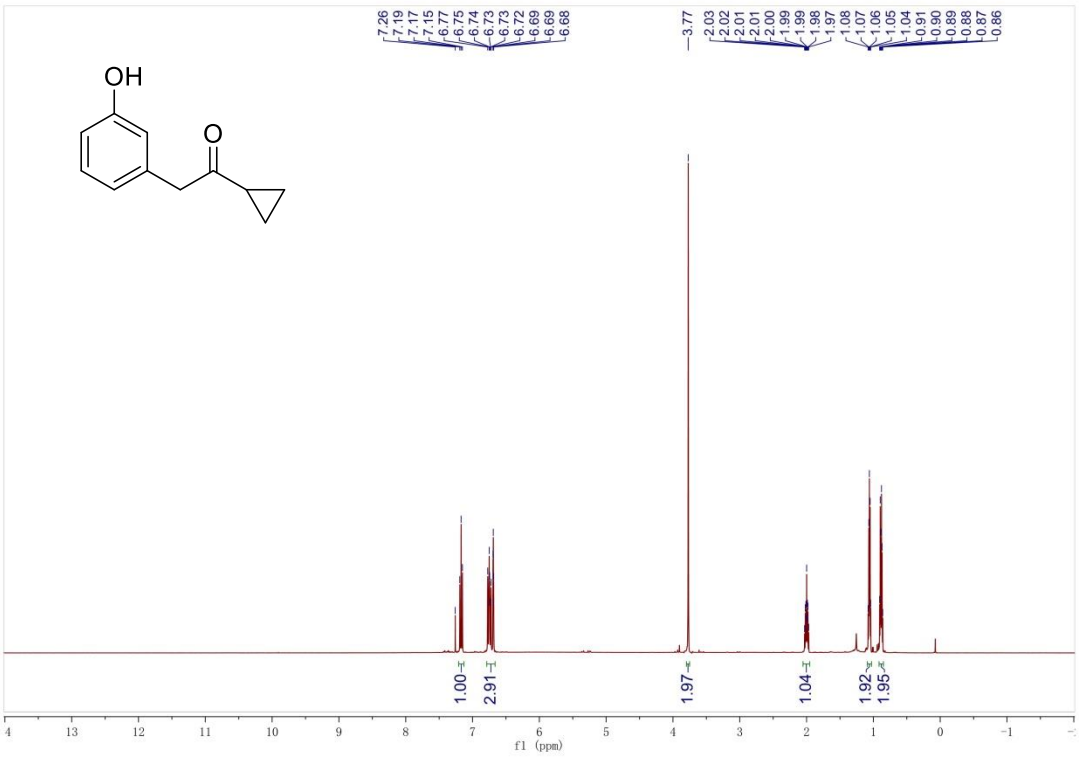
129.80
121.50
116.32
114.19
77.21
77.00
76.79
47.60
40.10
18.29
f1 (ppm)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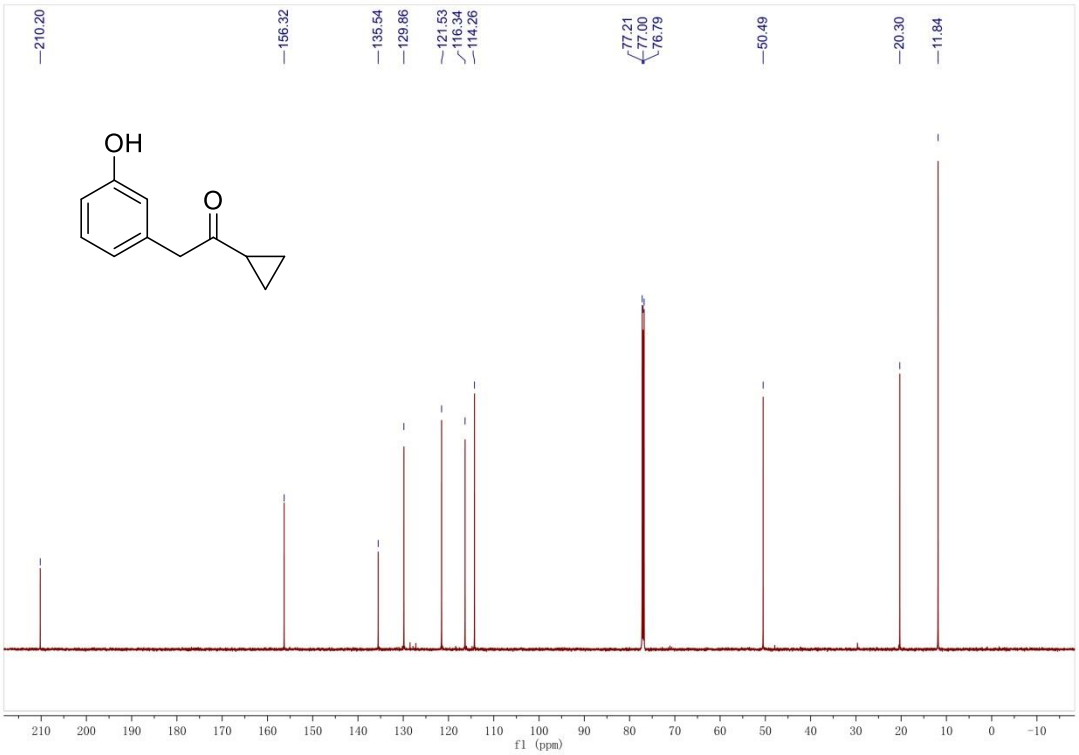
7.19
7.17
7.15
6.77
6.75
6.74
6.73
6.72
6.69
6.69
6.68
3.77
2.03
2.02
2.01
2.00
1.99
1.99
1.98
1.97
1.08
1.07
1.06
1.05
1.04
0.91
0.90
0.89
0.88
0.87
0.86
OH
O
1.00
2.91
1.97
1.04
1.92
1.95
f1 (ppm)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135.54
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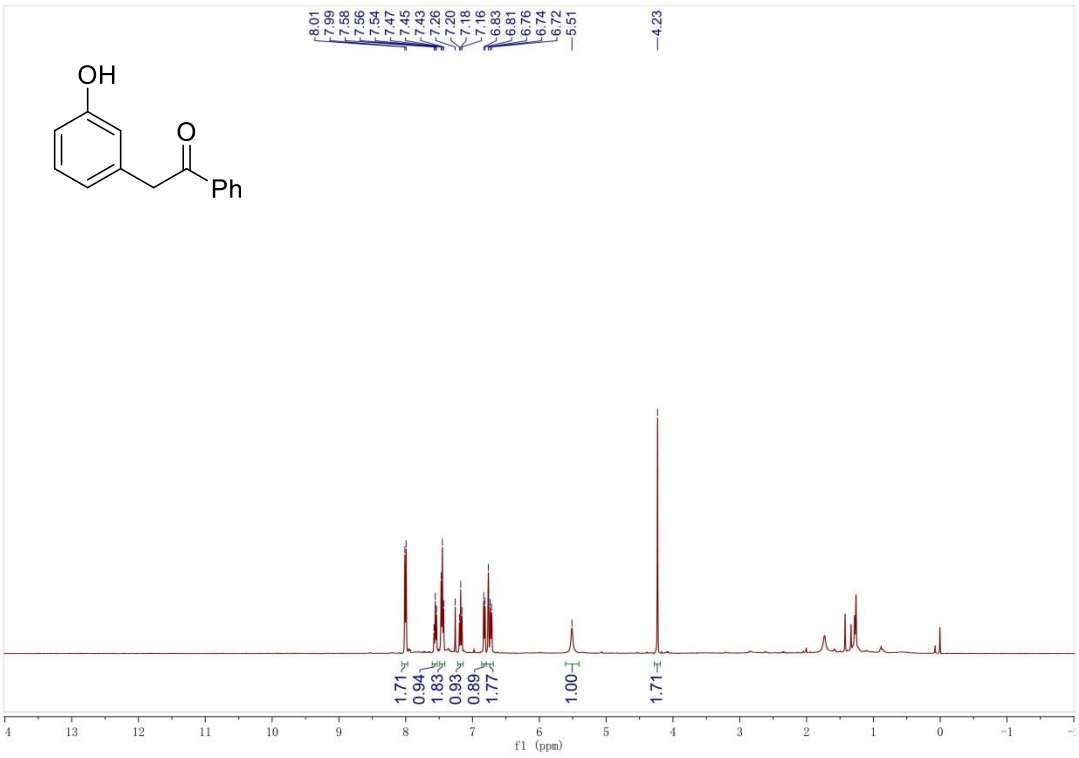
114.26
77.21
77.00
76.79
50.49
20.30
11.84
OH
O
f1 (ppm)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7.99
7.58
7.56
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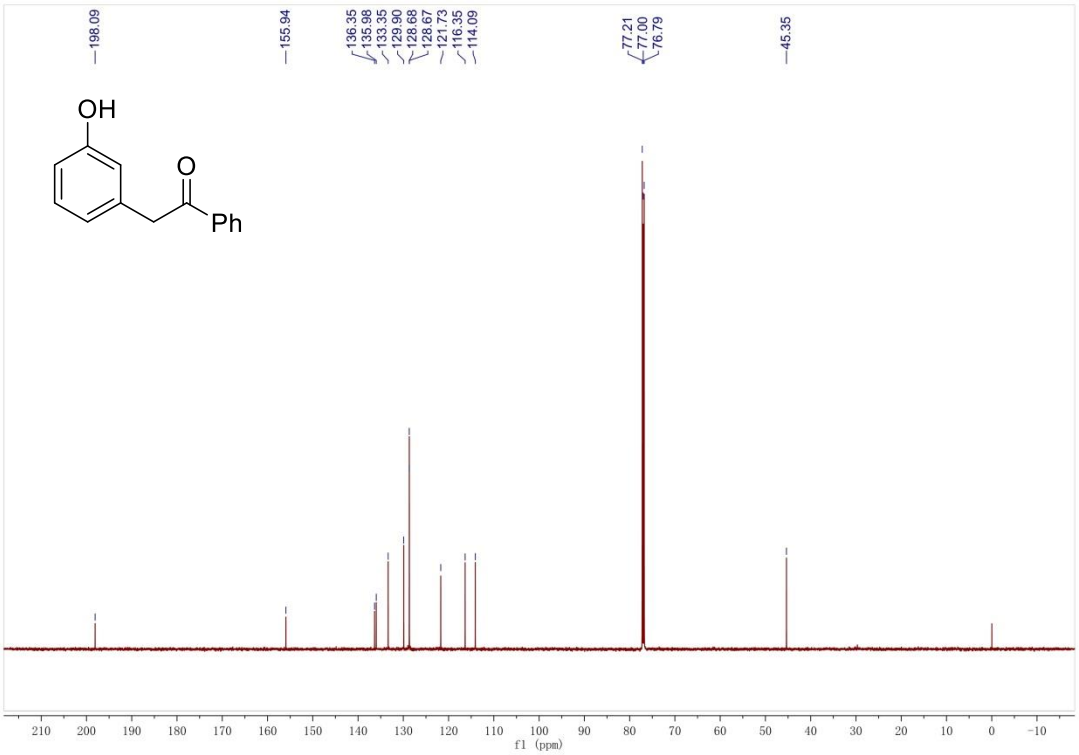
7.47
7.45
7.43
7.26
7.20
7.18
7.16
6.83
6.81
6.76
6.74
6.72
5.51
4.23
OH
O
Ph
1.71
0.94
1.83
0.93
0.89
1.77
1.00
1.71
f1 (ppm)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133.35
129.90
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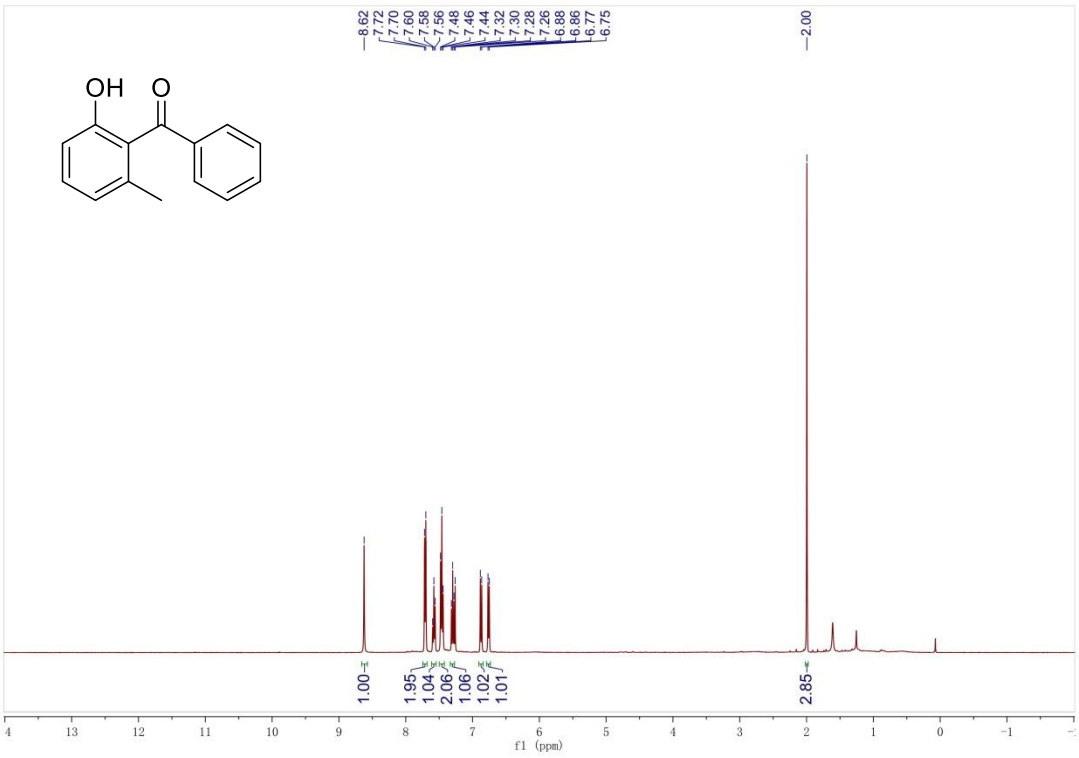
128.67
121.73
116.35
114.09
77.21
77.00
76.79
45.35
OH
O
Ph
f1 (ppm)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7.46
7.44
7.32
7.30
7.28
7.26
6.88
6.86
6.77
6.75
2.00
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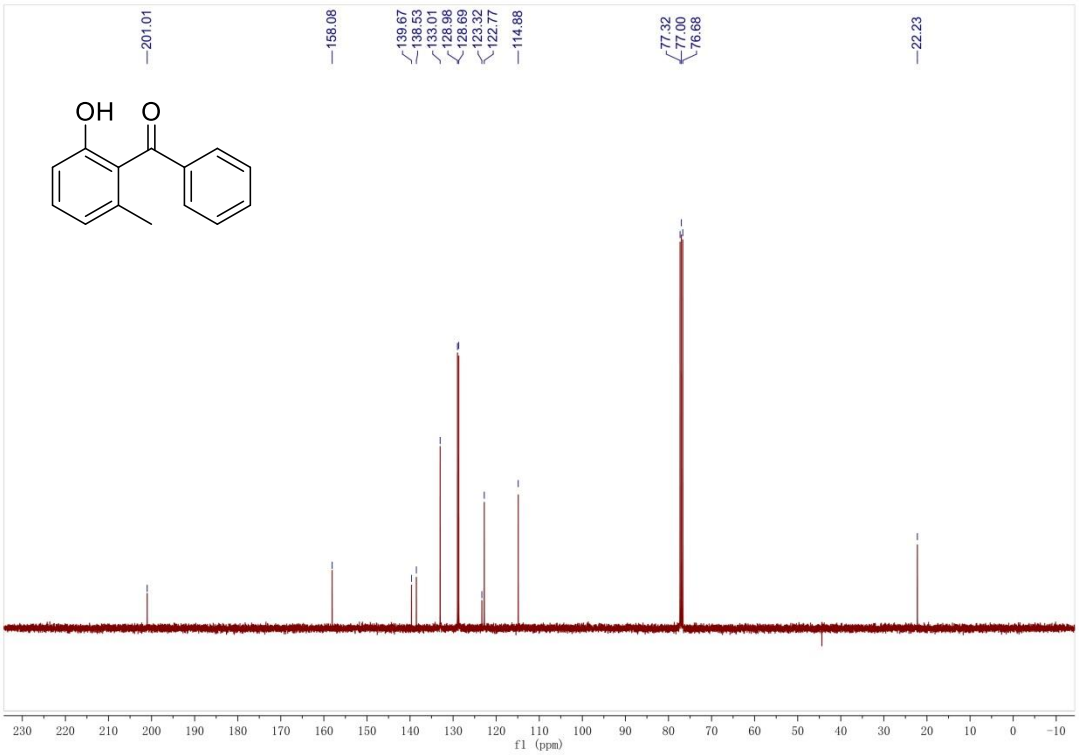
O
1.00
1.95
1.04
2.06
1.06
1.02
1.01
2.85
f1 (ppm)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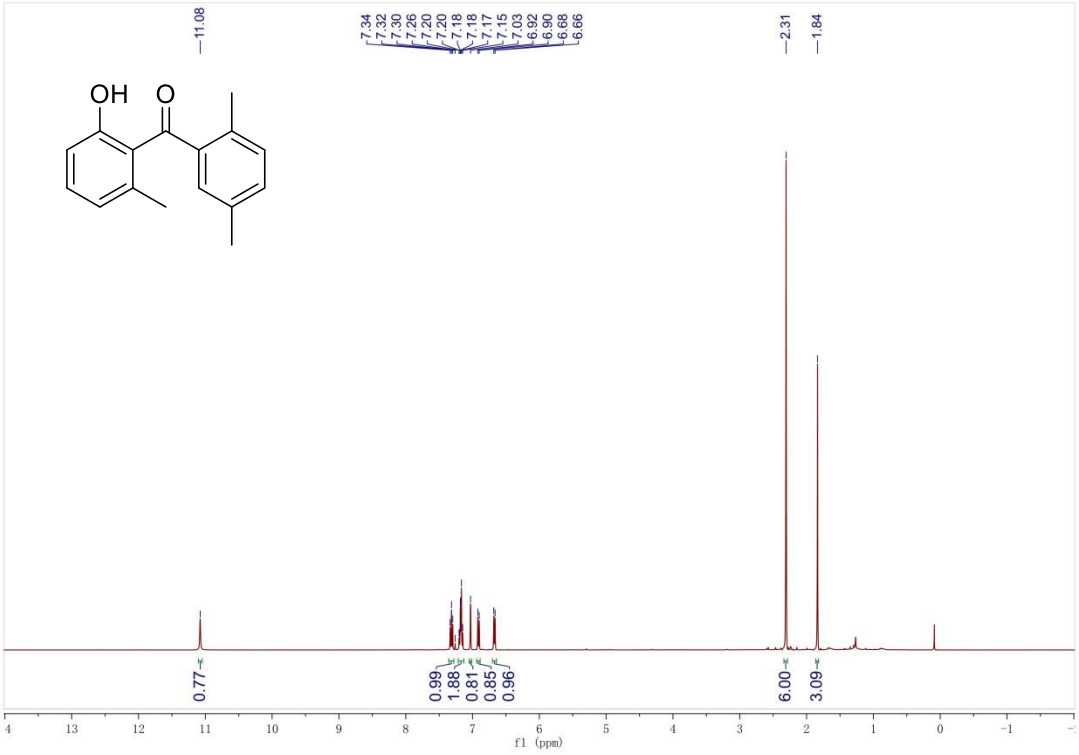
122.77
114.88
77.32
77.00
76.68
22.23
OH
O
f1 (ppm)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7.32
7.30
7.26
7.20
7.20
7.18
7.18
7.17
7.15
7.03
6.92
6.90
6.68
6.66
2.31
1.84
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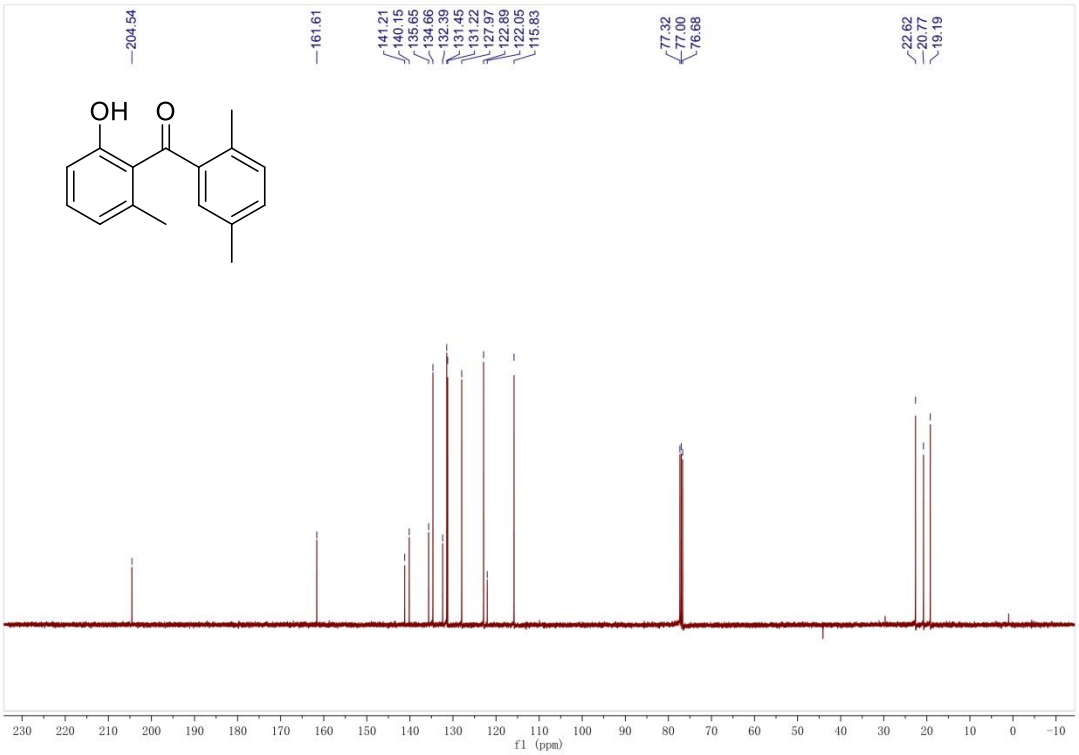
O
0.77
0.99
1.88
0.81
0.85
0.96
6.00
3.09
f1 (ppm)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132.39
131.45
131.22
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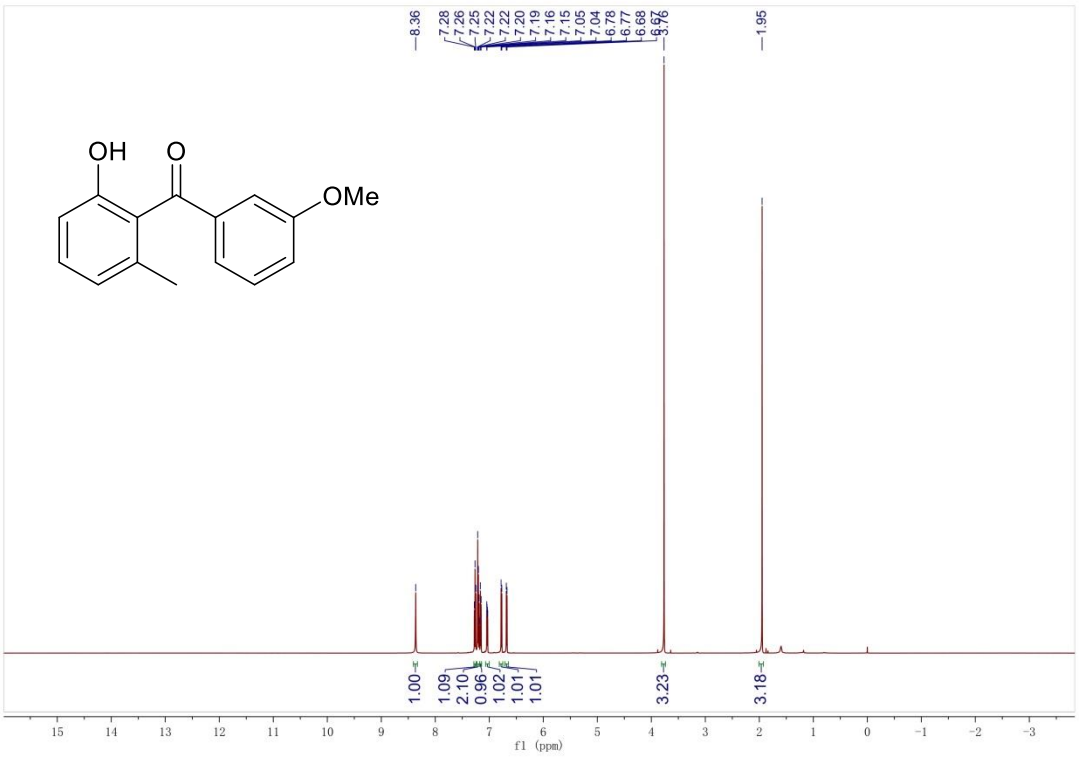
115.83
77.32
77.00
76.68
22.62
20.77
19.19
OH
O
f1 (ppm)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7.22
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7.19
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7.15
7.05
7.04
6.78
6.77
6.68
3.96
1.95
OH
O
OMe
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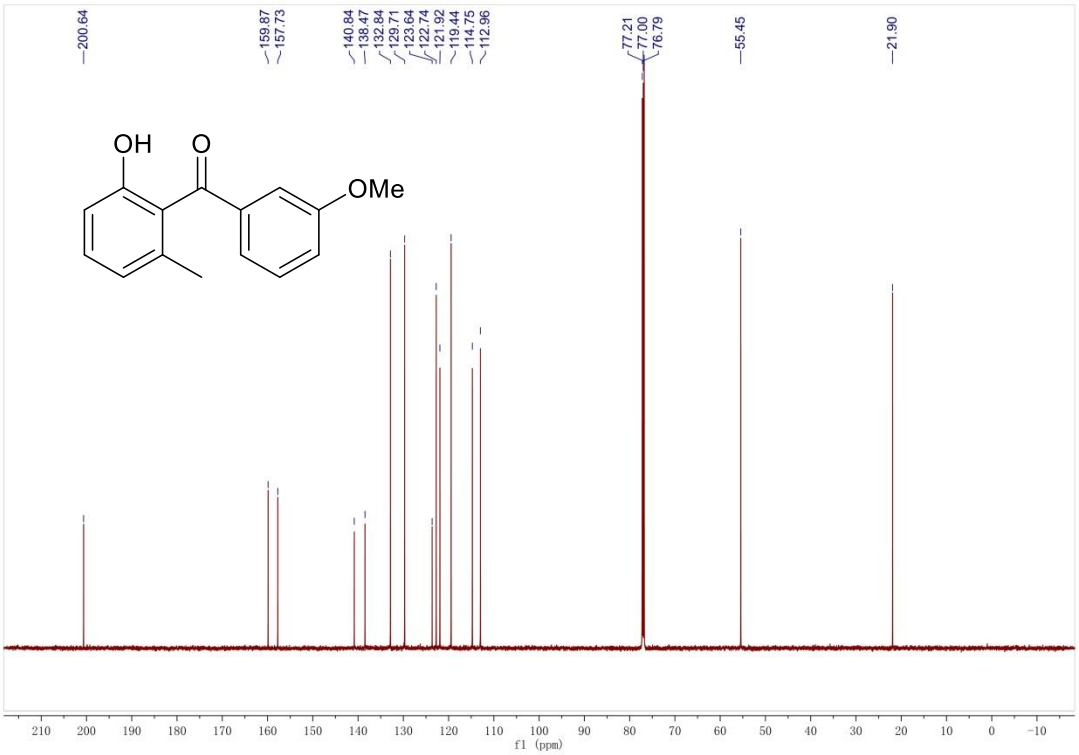
1.09
2.10
0.96
1.02
1.01
1.01
3.23
3.18
f1 (ppm)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122.74
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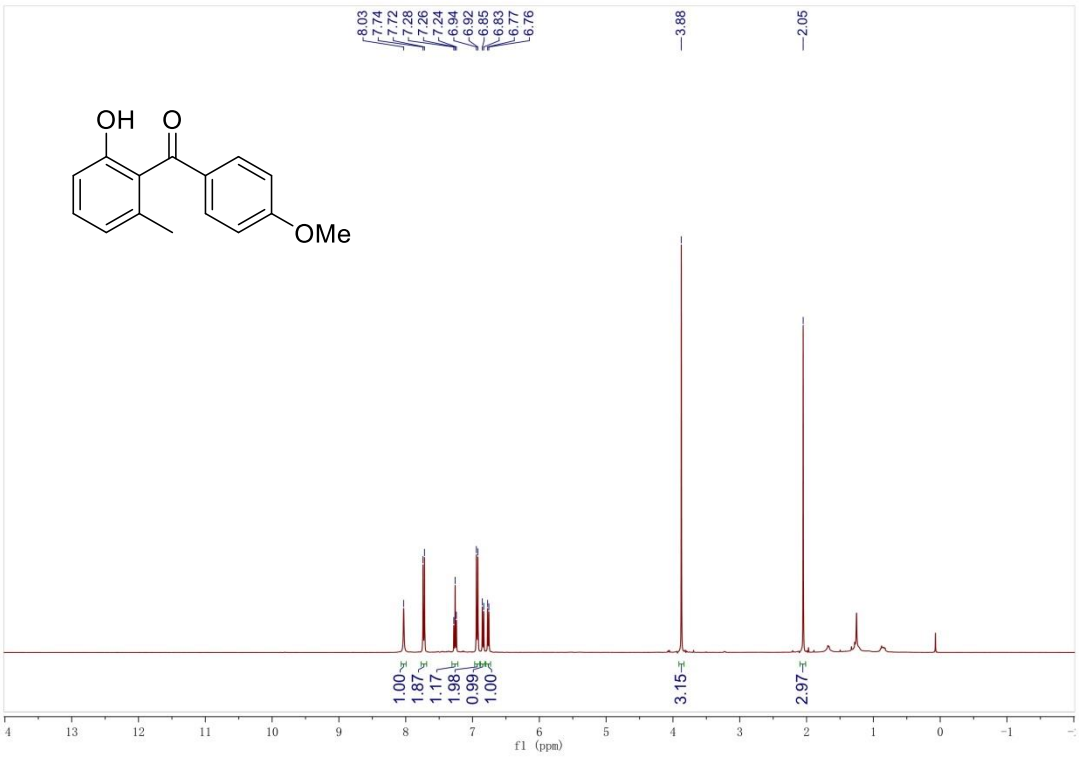
77.21
77.00
76.79
55.45
21.90
OH
O
OMe
f1 (ppm)


8.03
7.74
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7.24
6.94
6.92
6.85
6.83
6.77
6.76
3.88
2.05
OH
O
OMe
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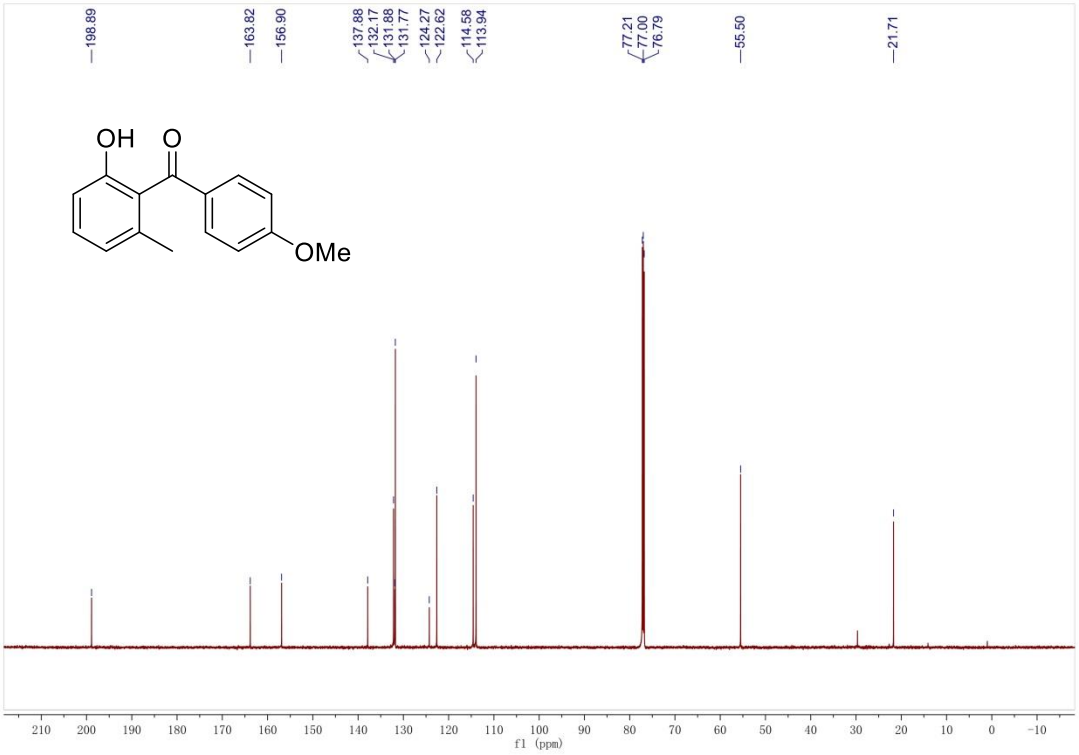
1.17
1.98
0.99
1.00
3.15
2.97
f1 (ppm)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131.88
131.77
124.27
122.62
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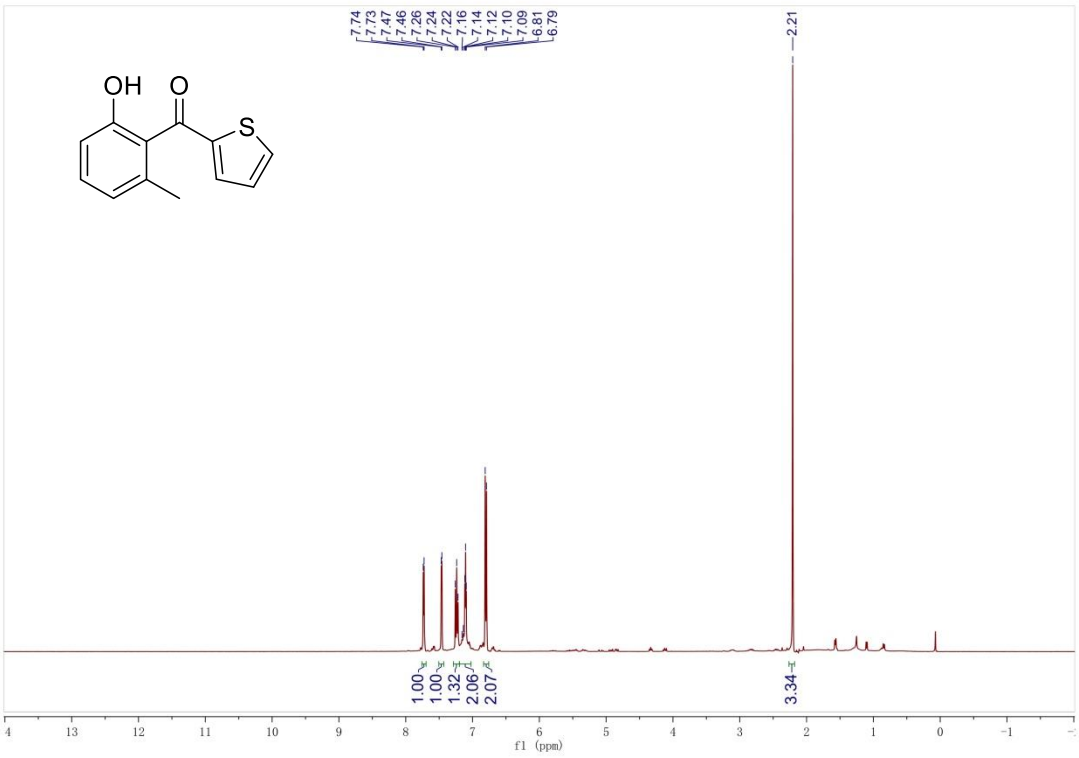
113.94
77.21
77.00
76.79
55.50
21.71
OH
O
OMe
f1 (ppm)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7.24
7.22
7.16
7.14
7.12
7.10
7.09
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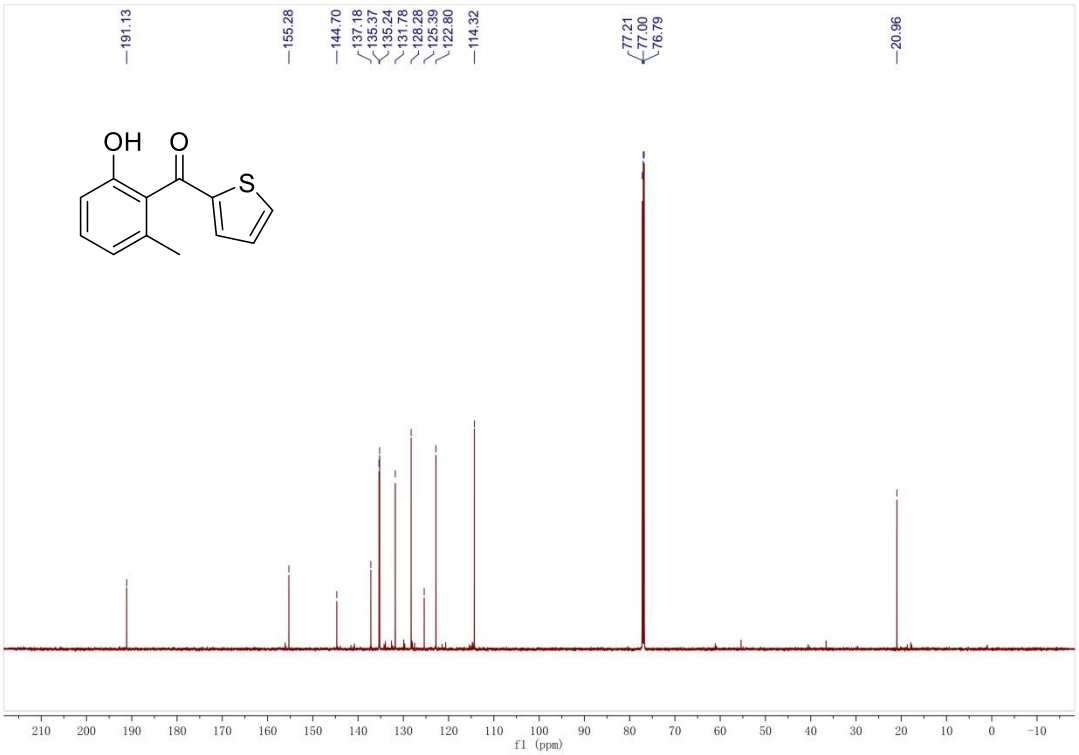
6.79
2.21
OH
O
S
1.00
1.00
1.32
2.06
2.07
3.34
f1 (ppm)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125.39
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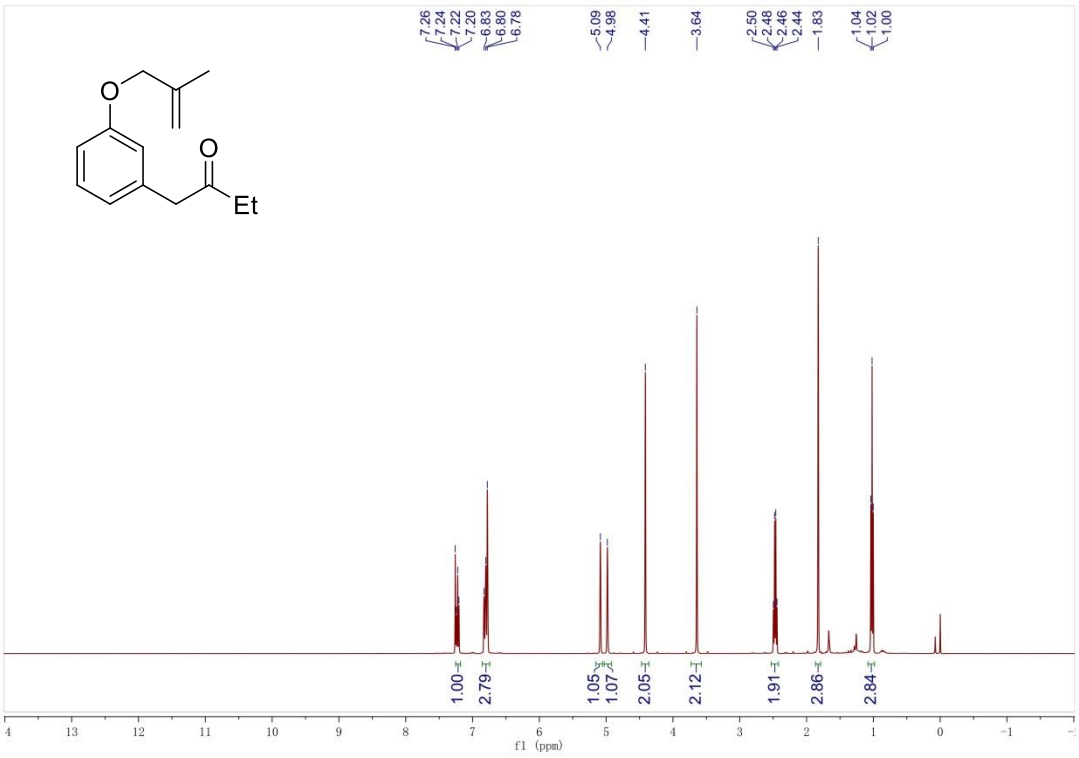
114.32
77.21
77.00
76.79
20.96
OH
O
S
f1 (ppm)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7.24
7.22
7.20
6.83
6.80
6.78
5.09
4.98
4.41
3.64
2.50
2.48
2.46
2.44
1.83
1.04
1.02
1.00
O
O
Et
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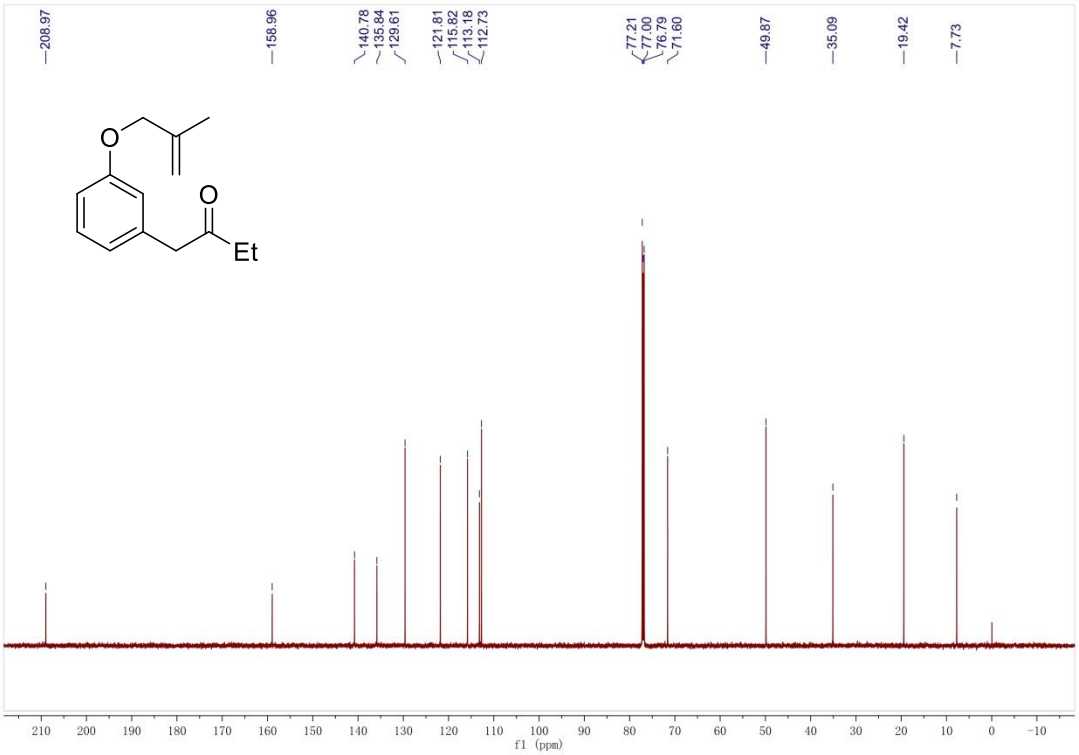
2.79
1.05
1.07
2.05
2.12
1.91
2.86
2.84
f1 (ppm)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113.18
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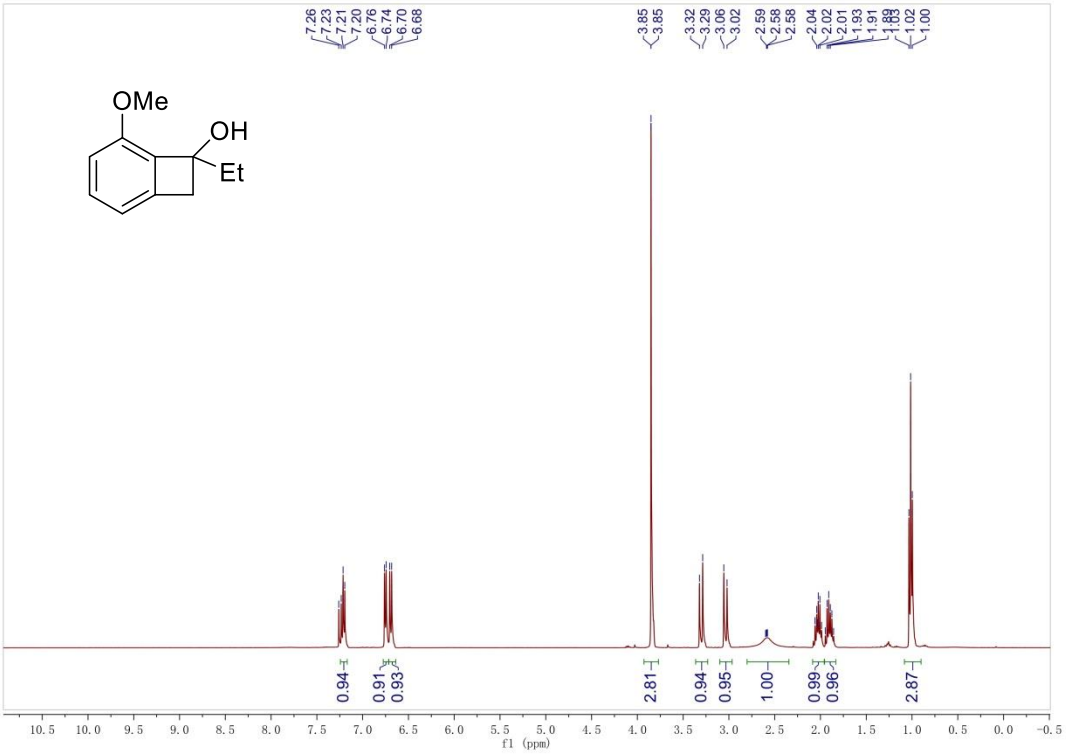
76.79
71.60
49.87
35.09
19.42
7.73
O
O
Et
f1 (ppm)


OMe
OH
Et
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7.23
7.21
7.20
6.76
6.74
6.70
6.68
3.85
3.85
3.32
3.29
3.06
3.02
2.59
2.58
2.58
2.04
2.02
2.01
1.93
1.91
1.02
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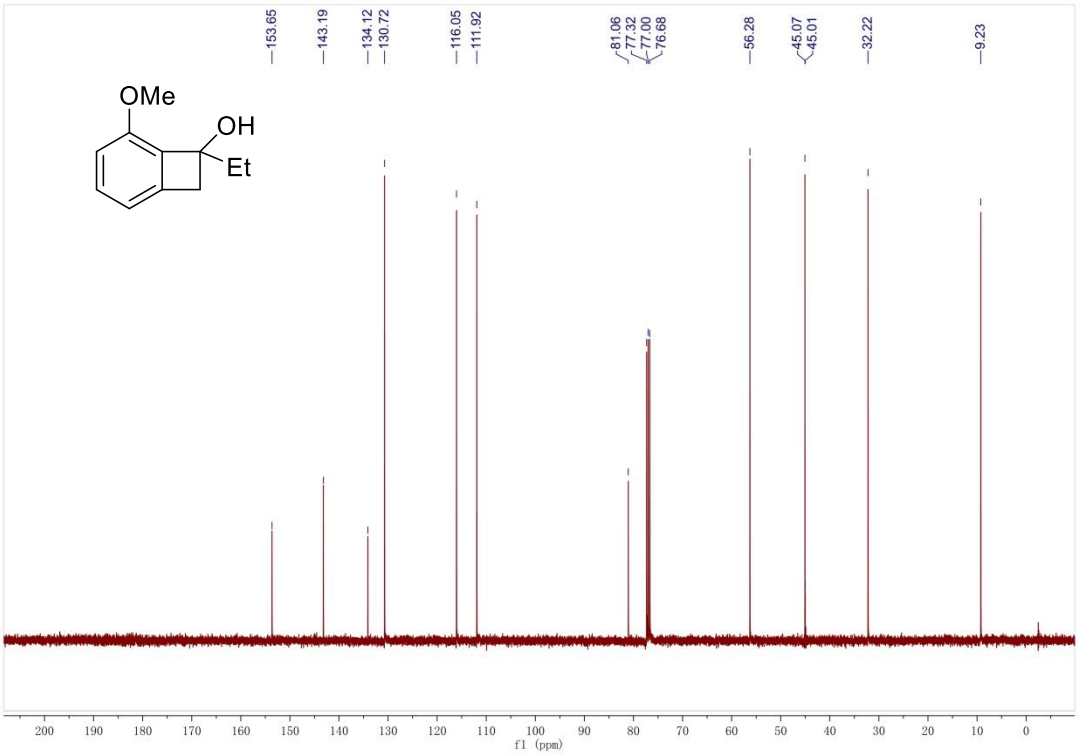
0.93
2.81
0.94
0.95
1.00
0.99
0.96
2.87
f1 (ppm)


OMe
OH
Et
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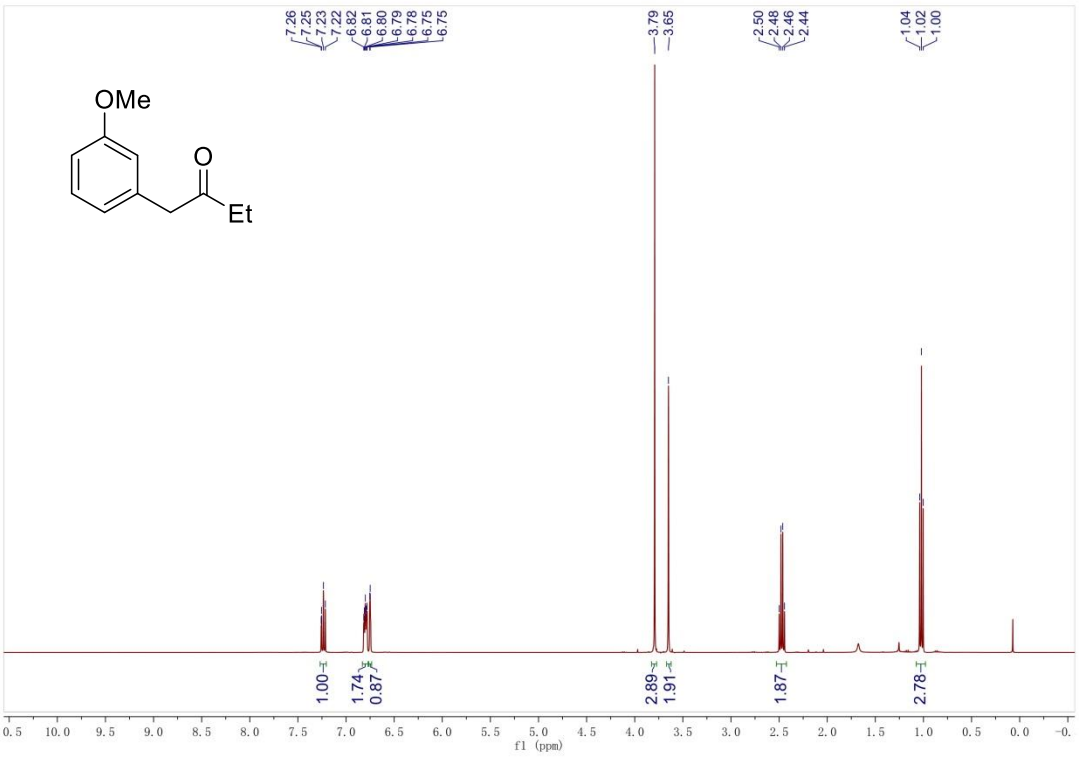
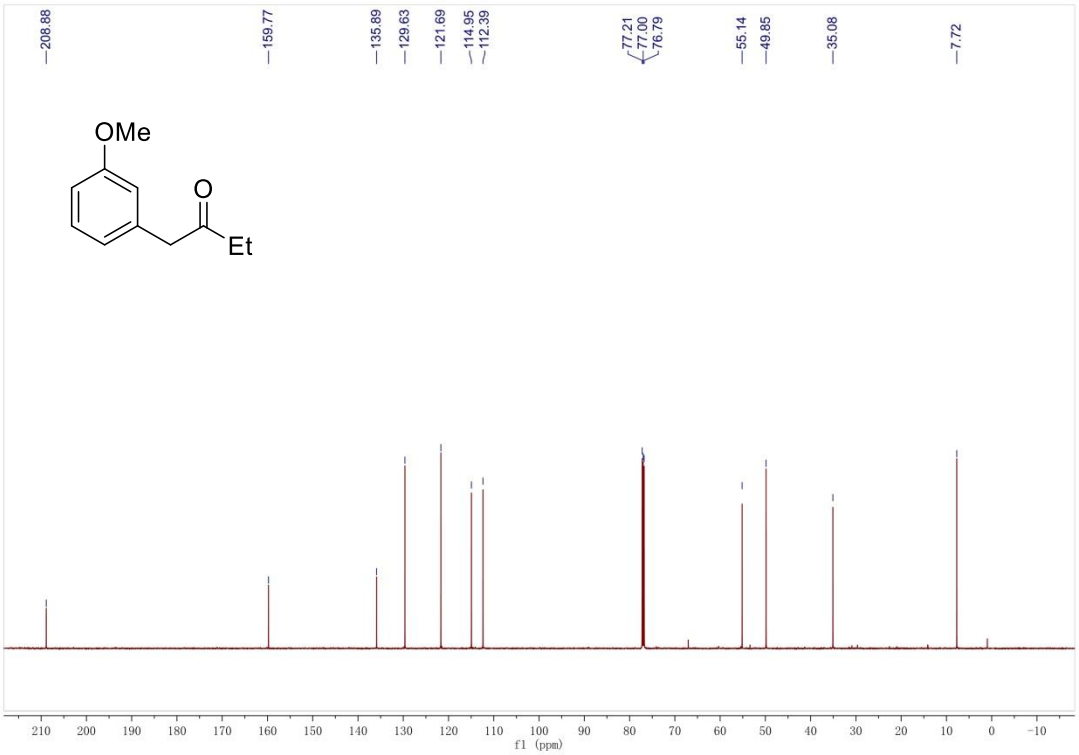
111.92
81.06
77.32
77.00
76.68
56.28
45.07
45.01
32.22
9.23
f1 (ppm)


7.26
7.25
7.23
7.22
6.82
6.81
6.80
6.79
6.78
6.75
6.75
3.79
3.65
2.50
2.48
2.46
2.44
1.04
1.02
1.00
OMe
O
Et
1.00
1.74
0.87
2.89
1.91
1.87
2.78
f1 (ppm)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121.69
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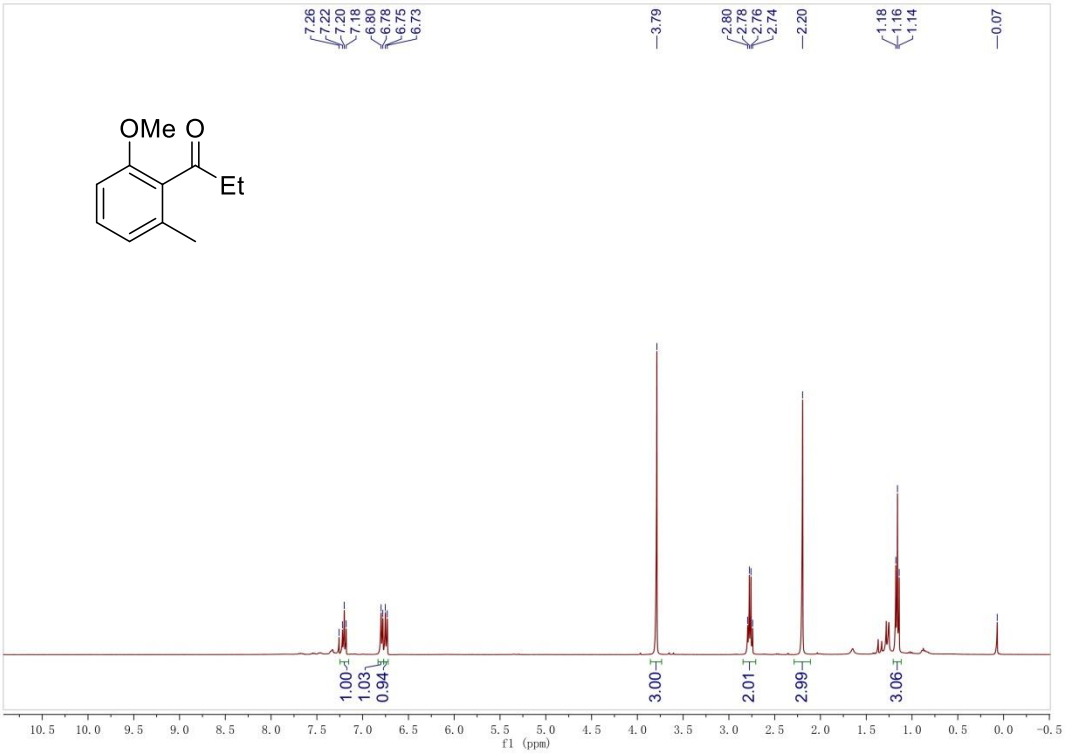
77.00
76.79
55.14
49.85
35.08
7.72
OMe
O
Et
f1 (ppm)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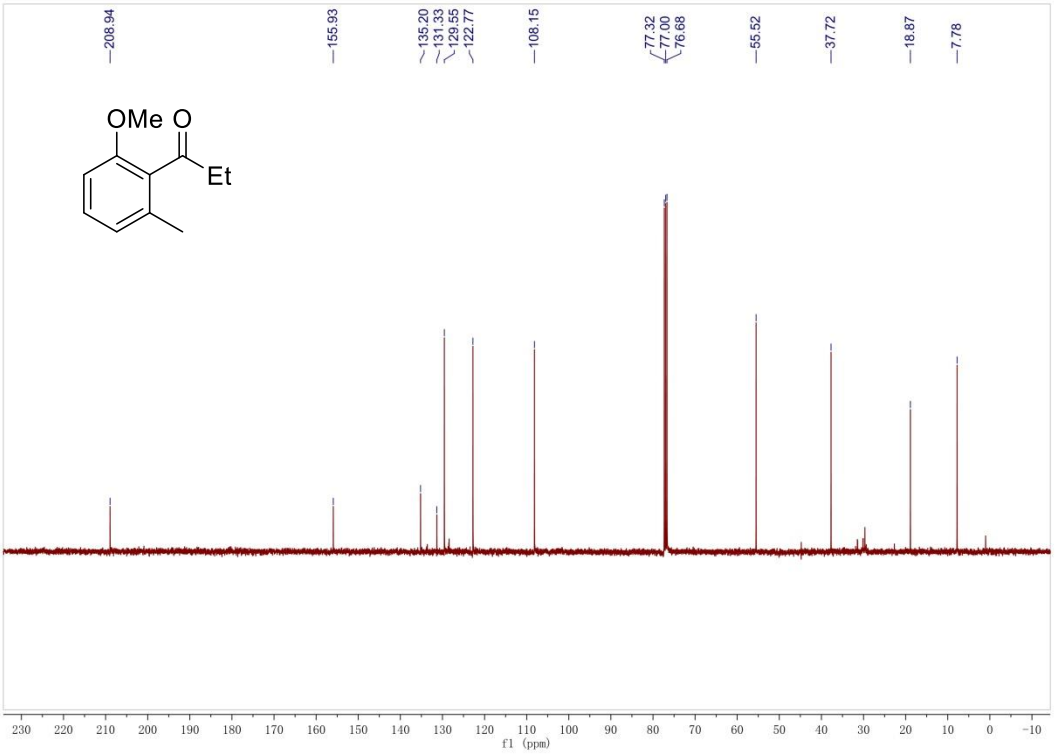
7.22
7.20
7.18
6.80
6.78
6.75
6.73
3.79
2.80
2.78
2.76
2.74
2.20
1.18
1.16
1.14
0.07
OMe O
Et
1.00
1.03
0.94
3.00
2.01
2.99
3.06
f1 (ppm)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77.00
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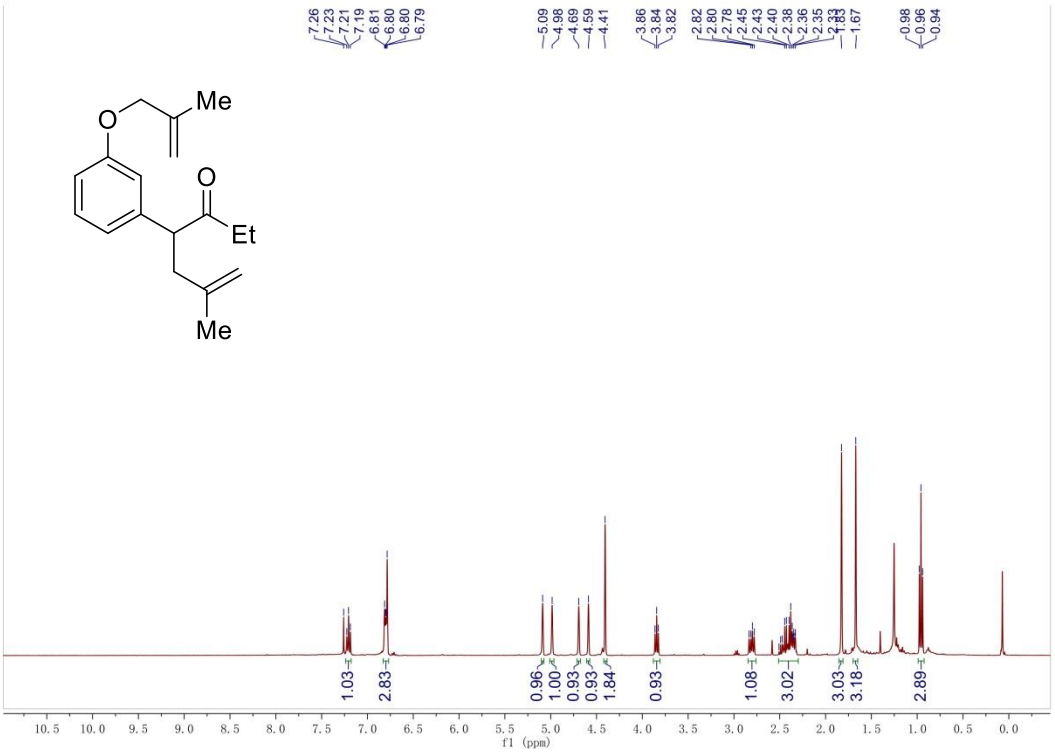
55.52
37.72
18.87
7.78
OMe O
Et
f1 (ppm)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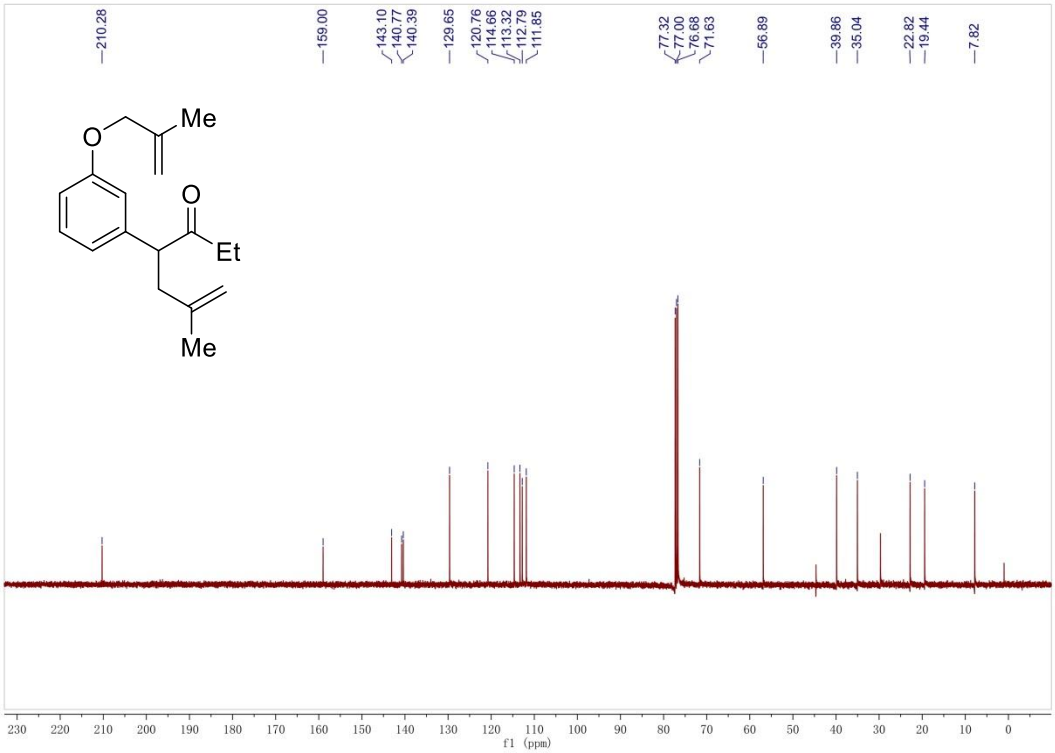
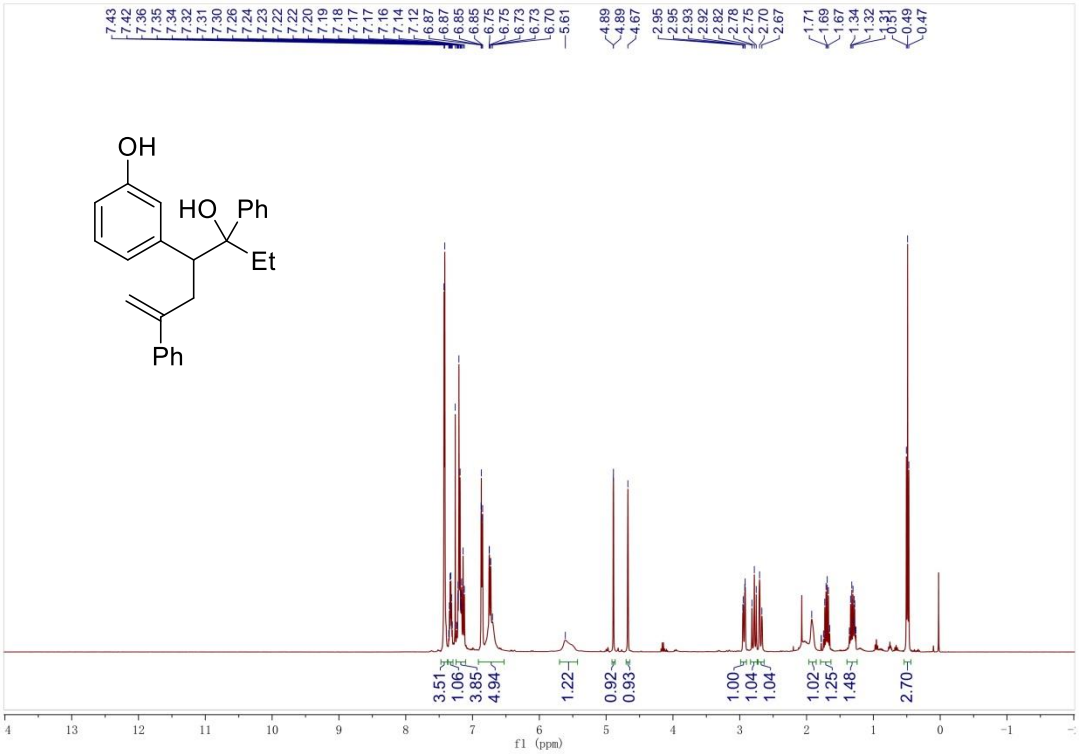
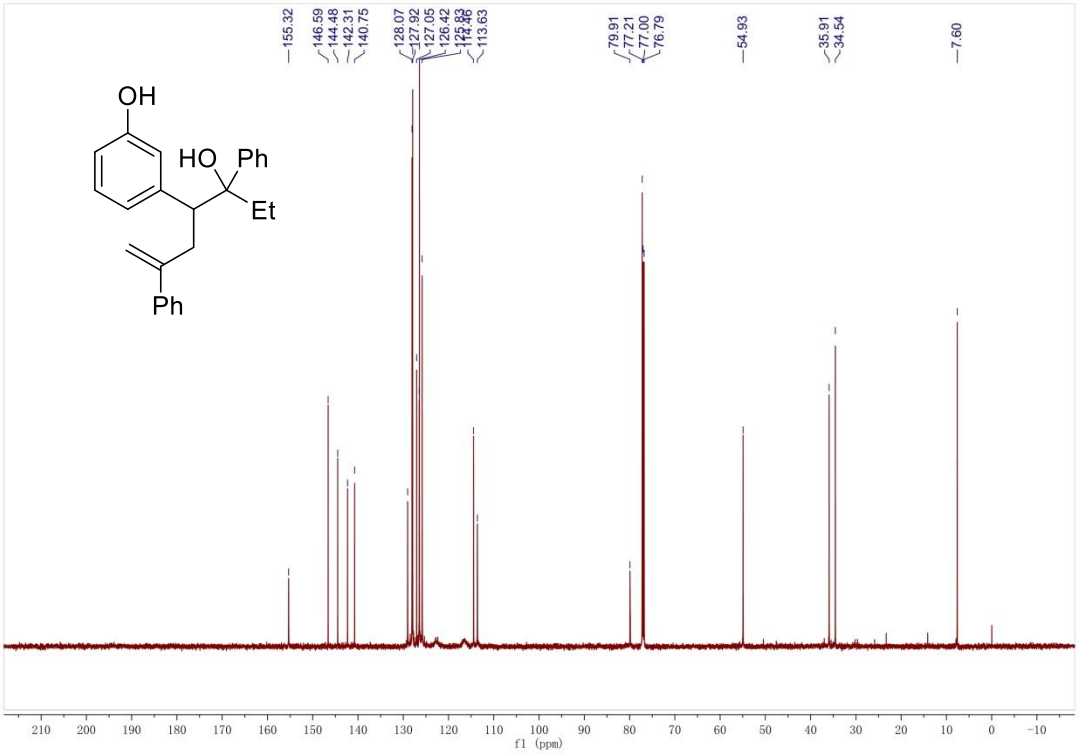
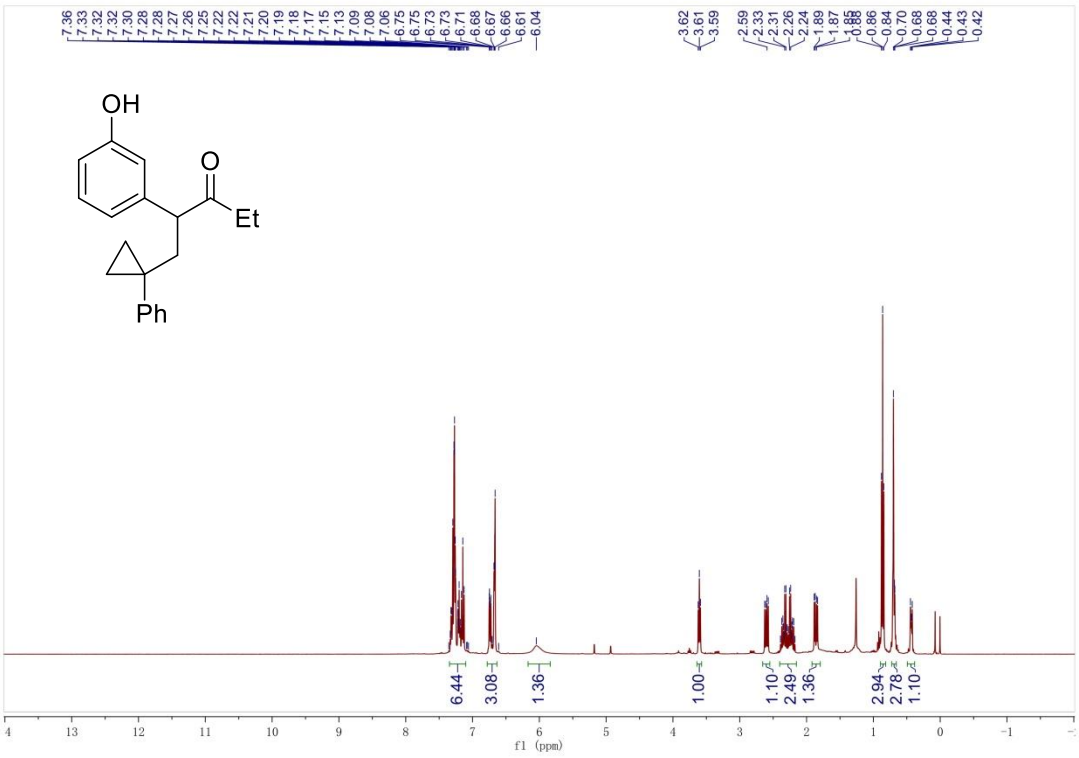
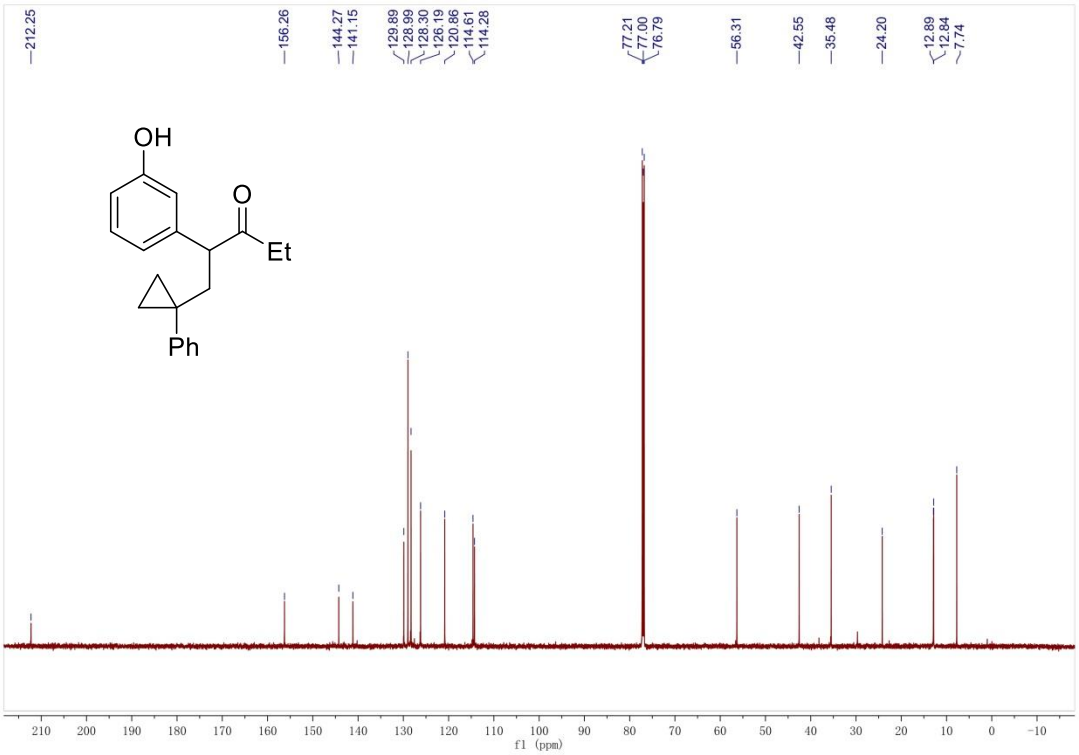
6.80
6.80
6.79
5.09
4.98
4.69
4.59
4.41
3.86
3.84
3.82
2.82
2.80
2.78
2.45
2.43
2.40
2.38
2.36
2.35
1.67
0.98
0.96
0.94
Me
O
O
Et
Me
1.03
2.83
0.96
1.00
0.93
0.93
1.84
0.93
1.08
3.02
3.03
3.18
2.89
f1 (ppm)

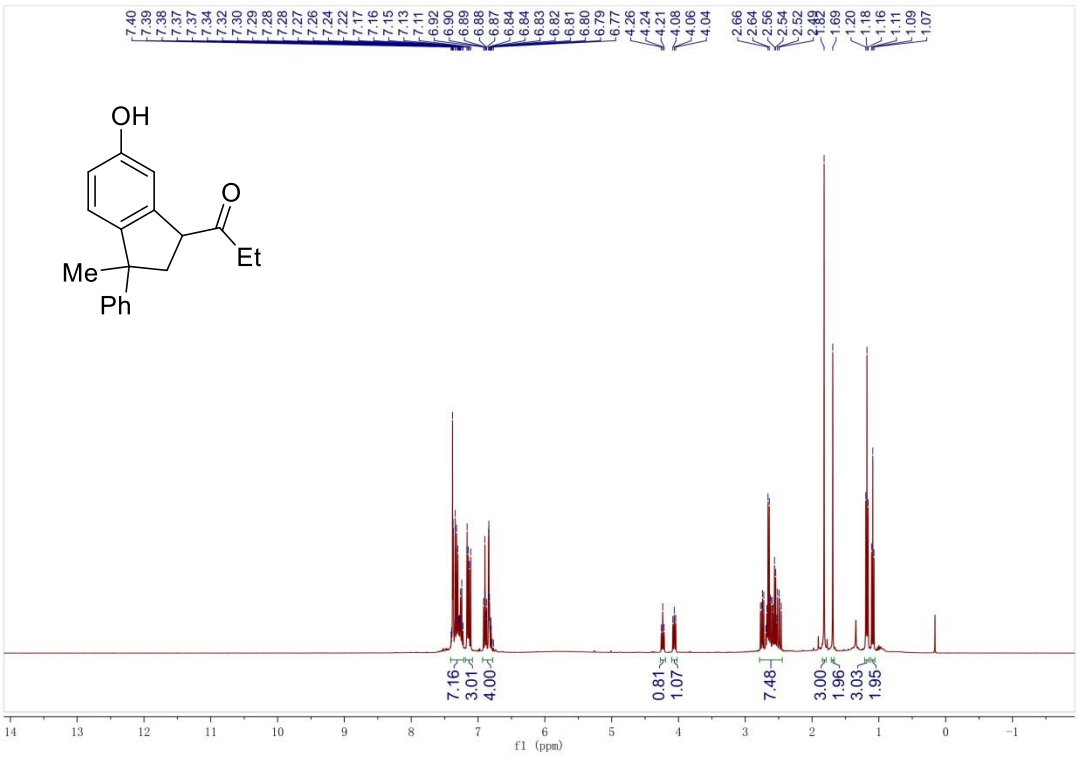

210.28
159.00
143.10
140.77
140.39
129.65
120.76
114.66
113.32
112.79
111.85
77.32
77.00
76.68
71.63
56.89
39.86
35.04
22.82
19.44
7.82
Me
O
O
Et
Me
f1 (ppm)

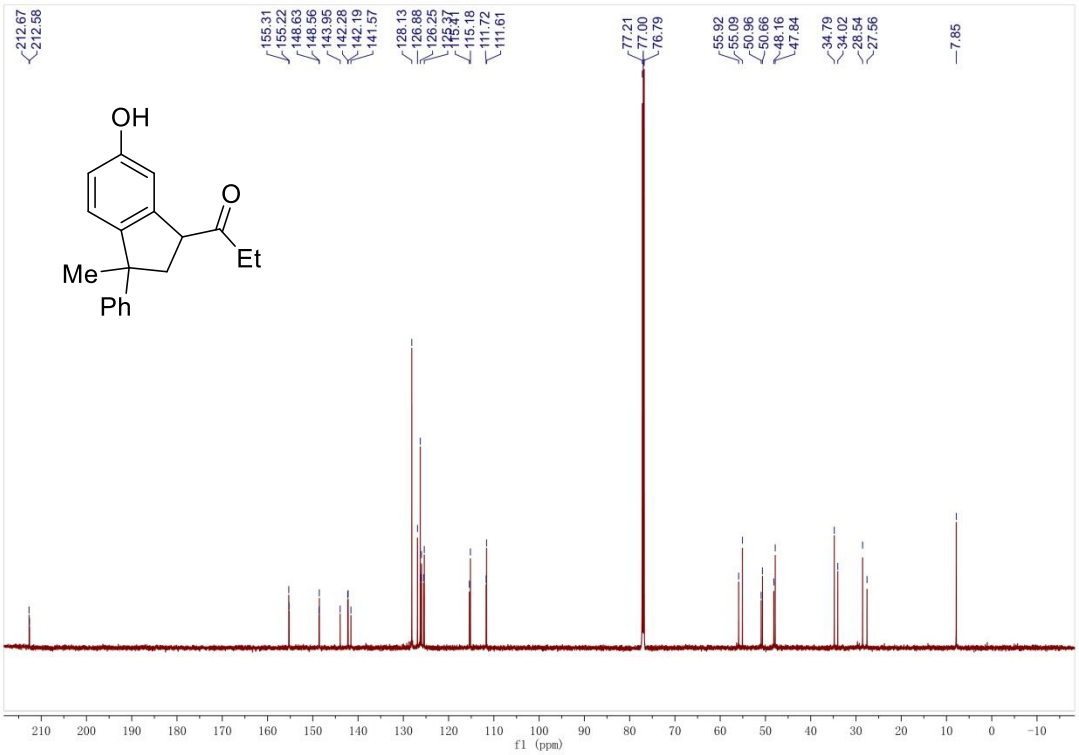

7.43
7.42
7.36
7.35
7.34
7.32
7.31
7.30
7.26
7.24
7.23
7.22
7.22
7.20
7.19
7.18
7.17
7.17
7.16
7.14
7.12
6.87
6.87
6.85
6.85
6.75
6.75
6.73
6.70
5.61
4.89
4.89
4.67
2.95
2.95
2.93
2.92
2.82
2.78
2.75
2.70
2.67
1.71
1.69
1.67
1.34
1.32
1.31
0.49
0.47
OH
HO
Ph
Et
Ph
3.51
1.06
3.85
4.94
1.22
0.92
0.93
1.00
1.04
1.04
1.02
1.25
1.48
2.70
f1 (ppm)


155.32
146.59
144.48
142.31
140.75
128.07
127.92
127.05
126.42
113.63
79.91
77.21
77.00
76.79
54.93
35.91
34.54
7.60
OH
HO
Ph
Et
Ph
f1 (ppm)


OH
O
Et
Ph
f1 (ppm)


OH
O
Et
Ph
f1 (ppm)


OH
O
Et
Me
Ph
f1 (ppm)


OH
O
Et
Me
Ph
f1 (ppm)